# ECOLOGICAL RESTORATION PLAN FOR YARRS FLAT WILDLIFE MANAGEMENT RESERVE, TE WAIHORA, CANTERBURY





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#### **Project Team:**

Helen McCaughan - Project manager, report author Des Smith - Report author Melissa Hutchison - Report author Roger Bawden - GIS mapping William Shaw - Peer review

Prepared for: Department of Conservation Living Water programme Mahaanui Office Christchurch

CHRISTCHURCH OFFICE: LEVEL 1, UNIT B, 238 BARRINGTON STREET, P.O. BOX 33-499, BARRINGTON, CHRISTCHURCH 8244; Ph 03-332-3868; Fax 03-332-3869

# EXECUTIVE SUMMARY

Te Waihora/Lake Ellesmere is the largest wetland of its type in New Zealand, with extensive areas of saltmarsh around the lake margin, *Juncus edgariae* or  $w\bar{v}$  on brackish margins, and species such as saltmarsh ribbonwood (*Plagianthus divaricatus*) near the lake edge. Te Waihora is an internationally recognised wildlife habitat, with *c*.158 species of bird using it, including migratory waders, waterfowl, and swamp birds. Te Waihora also has very important cultural significance to Ngāi Tahu, who view the sustainable management of the lake as vitally important.

The outstanding values of Te Waihora/Lake Ellesmere have been recognised in a national Water Conservation Order, and a statutory Joint Management Plan (JMP) for the lake has been established between the Department of Conservation and Ngāi Tahu. The JMP vision includes restoration of Ngāi Tahu identity, through rejuvenation of the mauri and life supporting capacity of Te Waihora, and endorses management in an integrated manner that enhances the enjoyment of the wetland for all New Zealanders.

Yarrs Flat is a 286 hectare Wildlife Management Reserve on the northern shore of Te Waihora/Lake Ellesmere, and consists mainly of wetland habitat and lake. Yarrs Flat has been identified as having outstanding value for wading birds, high value for waterfowl, and moderate to high value for swamp birds. Yarrs Flat has been identified as an important feeding site for Australasian bittern (*Botaurus poiciloptilus*) which are now classified as Threatened-Nationally Critical. A number of rare plants are also present at Yarrs Flat, such as swamp nettle (*Urtica perconfusa*) and native musk (*Thyridia repens*). The primary purpose of the reserve is wildlife management, and its classification allows for habitat manipulation. It also allows for the development of public facilities as long as these support the primary objectives of wildlife management.

Yarrs Flat is adjacent to the Ararira/LII River mouth. The Ararira/LII River and its subcatchment is one of five Living Water programme sites. The Living Water programme is a tenyear partnership between the Department of Conservation and Fonterra Co-operative Group Limited (Fonterra). The programme's vision is "that a sustainable dairy industry is part of healthy, functioning ecosystems that together enrich the lives of all New Zealanders". The Department of Conservation, through the Living Water partnership, commissioned Wildland Consultants Ltd to develop a 10 year non-statutory ecological management plan for Yarrs Flat. The plan focusses on a portion of the Wildlife Management Reserve c.70 hectares of land at the northwestern end of the reserve.

The management plan has the following objectives:

- Identify key ecological threats to the wetland and wetland habitats, describing options for the management and control of these key threats.
- Provide strategic advice and recommendations on the protection and enhancement of wildlife, indigenous vegetation, and important habitats.
- Develop a framework for monitoring the wildlife and vegetation, and key threats to them, so that accurate assessments of the effectiveness of the proposed management actions and the ecological integrity of the area can be made.
- Summarise opportunities to encourage recreational and stakeholder engagement.



It is intended that the implementation of works that meet these objectives will bring to fruition the following vision for Yarrs Flat:

# Yarrs Flat is a thriving wetland ecosystem habitat for New Zealand's unique wildlife, prized by Ngāi Tahu as a taonga, and enjoyed and cared for by the New Zealand public.

The following are significant threats to the ecological integrity of Yarrs Flat:

- Water levels and their management. The flow of water, both fresh and brackish, has a significant influence on habitat types.
- Weed species, such as willows and salt-tolerant introduced grass. Weeds out-compete indigenous vegetation and put at risk the wildlife habitat values of Yarrs Flat.
- Introduced mammalian pests, including predators and browsers.

To address these threats, the following are suggested:

- Undertake a hydrological study into water movement at the site, and determine which is the best option to ensure that summer water levels are maintained as this will benefit indigenous birds and reduce invasion by pest plants.
- Pest animal control to protect indigenous wildlife from introduced mammalian predators.
- Enhancement of bittern feeding habitat.
- That the Ararira/LII River be allowed to flood a narrow strip of Yarrs Flat close to the river mouth, to allow for the enhancement of raupō as bittern breeding habitat.
- That monitoring is undertaken to establish whether salt-tolerant grass is affecting the availability of habitat for wading birds.
- Pest plant control targeting willows, reed canary grass, orange day lily, gorse, boxthorn, and introduced grasses.
- Restoration plantings are undertaken to:
  - Establish a kahikatea community;
  - Increase the extent of flaxland, raupō, and *Carex dipsacea*.
- Rare plants such as swamp nettle (*Urtica perconfusa*) and native musk (*Thyridia repens*) should be monitored to ensure that management activities are compatible with their ongoing presence.
- That vehicle access is restricted to a parking and amenities area.
- That walking tracks are developed in a manner that minimises disturbance to birds.

A staged approach to management is presented, with timings for management actions. It is envisaged that restoration works can start immediately, with control of willows being of highest priority, followed by medium-term actions to water management to enhance raupō, and implementation of pest control.



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Reviewed and approved for release by:

W.B. Shaw Director/Principal Ecologist Wildland Consultants Ltd

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# 1. INTRODUCTION

Yarrs Flat is a 286 hectare Wildlife Management Reserve on the northern shores of Te Waihora/Lake Ellesmere, where the Ararira/LII River flows into the Lake (Figure 1). The Reserve is bounded by Wolfes Road (north), Greenpark Sands Conservation Area (east), Te Waihora/Lake Ellesmere (south), and the Ararira/LII River (west). Te Waihora/Lake Ellesmere is a very important site for Ngāi Tahu, and its outstanding values are recognised in a national Water Conservation Order.<sup>1</sup>

A statutory Joint Management Plan (JMP) between the Department of Conservation and Ngāi Tahu covers the wider Te Waihora area and this represents a coming together of the rangatiratanga of Ngāi Tahu and the kāwanatanga of the Crown. The JMP vision includes restoration of Ngāi Tahu identity through rejuvenation of the mauri and life supporting capacity of Te Waihora, and management of the JMP area in an integrated manner that enhances the enjoyment of the wetland for all New Zealanders. Te Waihora/Lake Ellesmere is a wetland that has been recognised as having national and international significance, primarily due to its use by migratory birds, and because of the high numbers of water birds that use it.

An application was made by Department of Conservation and Ngāi Tahu to amend the National Water Conservation Order on Lake Ellesmere under the Environment Canterbury Act (2010) to recognise additional outstanding values such as indigenous wetland vegetation and fish and other significant values in accordance with tikanga Māori in respect of Ngāi Tahu history, mahinga kai, and customary fisheries (DOC 2011). Some of the evidence provided by witnesses supporting this application used guidelines for the nomination of Ramsar sites and Te Waihora/Lake Ellesmere scored highly against those guidelines.

Yarrs Flat Wildlife Management Reserve (WMR) is on the margins of the Ararira/LII River and in 1979 this area became a Government Purpose (Wildlife Management) Reserve for the primary purpose of wildlife management. This classification allows for active management, such as habitat manipulation, development of facilities, and control of public access, as long as these support the primary objectives of wildlife management (Hughey 1987).

The Living Water programme is a 10-year partnership between the Department of Conservation and Fonterra Co-operative Group Limited (Fonterra) that is focussed on working with local iwi, dairy farmers, communities, and other stakeholders to improve New Zealand's waterways and natural habitat at five key sites. Their vision is "that a sustainable dairy industry is part of healthy, functioning ecosystems that together enrich the lives of all New Zealanders". The Ararira/LII sub-catchment of Te Waihora/Lake Ellesmere is one of the five Living Water sites and is highly modified and under threat, particularly from weed infestations such as willow (*Salix* spp.).

The Te Waihora Living Water Annual Plan for 2016/17 includes the development of a non-statutory Ecological Management Plan for Yarrs Flat (Smith 2016). The

<sup>&</sup>lt;sup>1</sup> Regional policy statements, regional plans, and district plans must be consistent with provisions in the Water Conservation Order.

Department of Conservation, through the Living Water partnership, commissioned Wildland Consultants to develop this Plan with the view that it will help to guide management of the Reserve for the next ten years, and beyond. Because a large proportion of the reserve is lake bed, the area covered by this Plan is referred to as the 'Operational Area' and is shown in Figure 1, comprising 67.3 hectares of predominantly wetland habitat.

This Plan provides options and suggested approaches for restoration of the Operational Area. This includes guidelines and priorities for the management of water, pest plants and other exotic vegetation, pest animals, and restoration and protection of indigenous plants and fauna. Fish and invertebrates are beyond the scope of this Plan.

## 2. METHODS

## 2.1 Literature review

A review was carried out of existing ecological information. The review included both published and unpublished documents and relevant databases. Discussions were held with Department of Conservation staff familiar with the site and its values, and with other relevant experts, to gain more detailed information on values, threats, and opportunities.

2.2 Site visit

A walk-over site visit was undertaken on 6 September 2016 by Department of Conservation Senior Ranger Robin Smith and Wildlands' ecologists Helen McCaughan, Melissa Hutchison, and Des Smith. The site was traversed on foot, and ecological features and management issues were discussed.

# 3. CULTURAL CONTEXT

Te Waihora has very significant spiritual, cultural, and economic values to Ngāi Tahu (James 1991). Historically, the Lake has been a highly valued food source, renowned for the abundance of fish, waterfowl, plants (including medicinal plants), and special muds used for dyeing. The large population of pīngao (*Ficinia spiralis*) on nearby Kaitorete Spit was also a significant resource.

The water of Te Waihora and its many resources formed the basis of the Ngāi Tahu social and economic structure. Individual and collective identification, welfare, and mana were dependent on water and its resources. In particular, Ngāi Tahu relied on foods derived from water because of the climate which prevented easy or extensive cultivation of crops in many areas. The Lake and Kaitorete Spit were also used as a thoroughfare from Banks Peninsula to regions in the south. Archaeological evidence of many camp sites and urupa have been found along the Spit. Sustainable management of Te Waihora is a vital concern for Ngāi Tahu.





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# 4. ECOLOGICAL CONTEXT AND HISTORY

## 4.1 Location

Yarrs Flat WMR is situated on the northern shore of Te Waihora/Lake Ellesmere, in Ellesmere Ecological District, which is part of the Canterbury Plains Ecological Region. Ellesmere Ecological District comprises the entire lake and Kaitorete Spit. Te Waihora receives water from the Waikirikiri/Selwyn River, Irwell River, Halswell River, Kaituna River, and the Ararira/LII River.

## 4.2 General

More than half of Yarrs Flat WMR is lake bed and this Plan therefore focuses on an Operational Area of approximately 70 hectares of land at the northwestern end of the Reserve: bounded by the River, the Lake, and Wolfes Road. This Operational Area comprises slightly undulating land, providing drier and wetter areas for different plant and animal communities.

## 4.3 Geology, soils and climate

Te Waihora/Lake Ellesmere is a shallow brackish lagoon that is separated from the sea by a Holocene gravel and sand bank (Kaitorete Spit), which contains the largest naturally vegetated dunelands in New Zealand. Saline soils with salty high water table bound the lagoon margin; while excessively-drained sandy and stony soils are present on Kaitorete Spit.

The coastal climate is harsh and dry. It is characterised by cool winters with onshore southerlies and fogs, frequent salt spray, dry summers, and cool easterlies. Annual rainfall is 400-550 mm on Kaitorete Spit (the driest part of Canterbury), and up to 650 mm further inland, around the Lake.

There is a general gradient in soils, through the Operational Area, with muddier soils near the river (on the west) and sandier soils in the east (Hughey 1987). Wave action, particularly when the lake levels are high, makes the lake edge soils prone to erosion (Hughey 1987). Butt (2015) provided the following overview of the soils environment:

"The site is composed of a mixture of very poorly drained deep sandy loams and silty loams with a thin phalanx of well drained deep sandy loam running from north to south at its eastern edge. For the most part these soils preclude the establishment of indigenous woody vegetation due to their near constant waterlogged state. The drier deep sandy loams pose a quite different challenge as to the establishment of indigenous vegetation due to their droughty nature. These soils are reflected in the plant communities that overlay them".

## 4.4 Threatened environment classification

The Threatened Environment Classification (Walker *et al.* 2007) assigns different threat classes to the Land Environments of New Zealand (LENZ) framework (Leathwick *et al.* 2003) based on the amount of original indigenous vegetation cover

remaining in each land environment. The margins of Te Waihora are located in Chronically Threatened land environments with 10-20% indigenous vegetation cover remaining (Appendix 3). Acutely Threatened land environments with <10% indigenous vegetation cover remaining are located to the north, west, and south, including Kaitorete Spit.

### 4.5 Hydrology

Burrows (1970) provides a good description of the environment and vegetation of Te Waihora:

"The lake is a large, shallow body of brackish water. Its sides are very gently sloping so that small changes in water levels cause large changes in area and the shoreline is of correspondingly different length. The maximum depth is about two metres below mean sea level. The southern shore tends to be gravelly but the northern shore is mainly sandy or muddy.

Freshwater flows into the lake from the Selwyn, Irwell and Halswell Rivers, other streams and various springs, but at low lake levels and during high tides sea water can flow in. Salinity varies in space and time in the lake. It may rise as high as 56% of seawater but is generally about 20% of seawater and is least near streams. The shores of the lake are very exposed, especially to the south. Sou'west storms whip up waves and push water high onto the northeastern shores. These various physical factors determine well-marked vegetation patterns. In the main, these take the form of zonation, dependent chiefly on mean length of immersion and concentration of salt in the substrate."

Yarrs Flat is a wetland subject to both freshwater and estuarine influences. The lowlying nature of the land means that it is subject to periodic inundation from the lake and flooding from the Ararira/LII River, and it contains a number of freshwater springs and waterways. The hydrology of the wetland is dominated by flows in the Ararira/LII River, the level of Te Waihora and upwelling of groundwater at several sites. The Ararira/LII is a spring-fed river, with its headwaters in Lincoln Township (Golder Associates 2015). This river periodically floods through the Operational Area, providing inputs of freshwater, nutrients and sediment.

The Lake itself is brackish and water levels fluctuate, resulting in periods of inundation of the Reserve and also periods when there are significant areas of exposed mudflat. The brackishness gives an estuarine influence to the more lakeward section of the Reserve. The Ararira/LII River also influences the Reserve, providing it with a more freshwater habitat on the western side, and also periodically flooding into the Reserve. These factors combine to vary the soil salinity across the Reserve, with a general trend of increasing salinity from the west to the east, where surface salt can be seen at times (Hughey 1987).

Te Waihora lake levels fluctuate through the year, with the level able to get quite high and to inundate the lower part of the Reserve. This brackish water makes the lower areas of the Reserve quite wet and gives it an estuarine influence, with salinity levels of up to 20% having been recorded near Yarrs Flat (Hughey 1987). When the lake level is high it can affect water in the Ararira/LII River as far as four kilometres upstream of the mouth (Golder Associates 2015). Lake levels are managed, mainly to reduce flooding risk to surrounding land, and once the lake is opened water level can drop quickly. If the Lake is opened in summer the Reserve can suffer significant drying, with prolonged openings resulting in desiccation of swamp and lake edge vegetation (Hughey 1987).

Small springs on the western (river) side of the Reserve percolate through the rough salt-tolerant pasture of the wetland, draining into ponding areas and small waterways that mostly drain into the lake (Figure 2 - Source: Robin Smith, Department of Conservation, pers. comm., and Canterbury Maps). During droughts many of these springs dry out (Hughey 1987). Some of the waterways that flow through the Operational Area drain neighbouring farmland and so tend to be more nutrient- and sediment-laden than the water coming from the springs.

#### 4.6 Vegetation

## Original Vegetation

At the time of European settlement, it is believed that extensive areas of freshwater wetland (swamp) - dominated by harakeke/lowland flax (*Phormium tenax*), raupō (*Typha orientalis*) and *Carex* species - were present north and west of Te Waihora (Burrows 1970). Since that time, the area of wetland has been reduced substantially by burning and draining of swampland for conversion to farmland (Appendix 1), and it is thought that more than 80% of the original area of wetlands has disappeared (Palmer 1982).

### Current Vegetation and Flora

Current vegetation at Te Waihora includes extensive saltmarsh around the lake margins, *Juncus edgariae* or  $w\bar{1}$  away from brackish margins, and saltmarsh ribbonwood (*Plagianthus divaricatus*), sea rush (*Juncus kraussii* subsp. *australiensis*), glasswort (*Sarcocornia quinqueflora*), remuremu (*Selliera radicans*), and native musk (*Thyridia repens*, At Risk-Naturally Uncommon<sup>1</sup>) on the lake edge (McEwen 1987).

Evans (1935) summarised the plant community zonation patterns<sup>2</sup> at Te Waihora as follows:

- In the water: beds of totally submerged plants *Ruppia* spp., *Zannichellia palustris*.
- Immersed for much of the time: native musk, *Lilaeopsis novae-zelandiae*.
- Immersed for slightly shorter periods: three-ribbed arrowgrass (*Triglochin striata*) and sea spurrey (*Spergularia marina*\*).
- Regularly immersed but also above water level for long periods: glasswort.
- Occasionally flooded: mixed saltmarsh with glasswort, remuremu, bucks horn plantain (*Plantago coronopus*\*) and others, often present in depressions.

<sup>&</sup>lt;sup>1</sup> Threat classifications for plants from de Lange *et al.* (2013).

<sup>&</sup>lt;sup>2</sup> Introduced plant species are denoted by an asterisk \*

- On slightly raised areas, stands of salt barley grass (*Critesion marinum*\*) and salt grass (*Puccinellia stricta*) occur, and on areas a little higher still, stands of sea rush occur, which may or may not be accompanied by stands of saltmarsh ribbonwood. Sea rush and saltmarsh ribbonwood, about 0.6 m and 1.8 m tall respectively, contrast with the otherwise very short vegetation.
- The highest clearly distinguishable zone, which usually merges into cultivated farmland, is characterised by creeping bent (*Agrostis stolonifera\**). Salinity in the soil increases from the lake up the shore until a maximum is reached in the glasswort zone. Salinity then declines again and in the *Agrostis* zone, where there is much emergent groundwater in winter, it falls to nil. There are variations in this generalised pattern.
- Where freshwater streams enter the lake, large beds of raupō up to two metres tall are present, and where emergent groundwater tends to lower the salinity a little, extensive beds of three-square (*Schoenoplectus pungens*), 15-30 cm tall, are present on muddy soils.

Uncommon plants on the lake edge include lady's tresses orchid *Spiranthes novaezelandiae* (Threatened-Nationally Vulnerable<sup>1</sup>), square sedge (*Lepidosperma australe*), lake clubrush (*Schoenoplectus tabernaemontani*), and baumea (*Machaerina rubiginosa*) (McEwen 1987). The lake is the type locality of the aquatic macrophytes *Ruppia polycarpa, R. megacarpa* (At Risk-Naturally Uncommon), and *Lepilaena bilocularis* (Threatened-Nationally Vulnerable). *Cyperus ustulatus* reaches its southern limit on the eastern South Island at Te Waihora.

## <u>Seasonality</u>

Much of the wetland vegetation of the shoreline of Te Waihora displays a high degree of seasonality, as there are many summer-green species (Clark and Partridge 1984). For instance, areas close to the west bank of the Ararira/LII River have the appearance in winter of a wet grassland of creeping bent (*Agrostis stolonifera*), while in summer they have a dense growth of one metre tall *Bolboschoenus caldwellii*. Other summer-green species include raupō and three-square. In summer, three-square can occupy extensive areas of mudflats which are almost devoid of vegetation during the winter months. It is important to consider these seasonal differences in shoreline vegetation when interpreting vegetation patterns at Te Waihora.

## 4.7 Fauna

## <u>Avifauna</u>

Te Waihora is the largest wetland of its type in New Zealand and is renowned for its outstanding wildlife values. A total of 158 (133 indigenous) bird species have been recorded to use the lake and its periphery, with 80 species being regular users (O'Donnell 1985). This is the highest recorded number of bird species for any wetland in New Zealand. Birds that use the lake include international migrants such as the cattle egret (*Ardea ibis*; Migrant) and curlew sandpiper (*Calidris ferruginea*; Migrant); indigenous waterfowl such as black swan (*Cygnus atratus*; Not

Threatened<sup>1</sup>) and grey teal (*Anas* gracilis; Not Threatened), introduced waterfowl such as mallard duck (*Anas platyrhynchos*; Introduced and Naturalised) and Canada goose (*Branta Canadensis*; Introduced and Naturalised); native gulls (*Larus spp.*) including black-billed gulls (*Larus bulleri*; Threatened-Nationally Critical) and red-billed gulls (*Larus novaehollandiae*; Threatened-Nationally Vulnerable); Australasian crested grebe (*Podiceps cristatus*; Threatened-Nationally Vulnerable); endemic waders such as wrybill (*Anarhynchus frontalis*; Threatened-Nationally Vulnerable), banded dotterel (*Charadrius bicinctus*; Threatened-Nationally Vulnerable), pied stilt (*Himantopus himantopus*; At Risk-Declining) and black stilt (*Himantopus novaezelandiae*; Threatened-Nationally Critical). Te Waihora is an essential staging point and overwintering habitat for many migratory bird species. Peak numbers of wading birds assemble at the lake before dispersing to breed, or congregate at the completion of breeding before northward and overseas migration.

For some species, large proportions of the total New Zealand population are estimated to reside on the lake at certain times of the year e.g. pied stilt (50%), red-necked stint (*Calidris ruficollis*; Migrant; 68%), and Australasian shoveler (*Anas rhynchotis*; Not Threatened; 75%) (O'Donnell 1985). Since 2013, the Waihora Ellesmere Trust has been coordinating an annual February bird count around the entire lake. The lake is split into sections, each of which is counted simultaneously by a large number of volunteers. Each year between 41,500 and 55,000 individual birds are counted within a single day. For a list of species counted during these surveys see Appendix 2.

Wetlands peripheral to Te Waihora are important habitat for swamp birds such as Australasian bittern (*Botaurus poiciloptilus*; Threatened-Nationally Critical), marsh crake (*Porzana pusilla*; At Risk-Relict), and pūkeko (*Porphyrio melanotus*; Not Threatened). The Te Waihora area has been identified as a stronghold for Australasian bittern in the Canterbury Region with an estimated 25-35 birds using the area between the Halswell River mouth and Harts Creek Wildlife Management Reserve, including Yarrs Flat (Langlands 2012). Te Waihora also forms part of the historical distribution of other swamp birds such as fernbirds (*Bowdleria* punctata; At Risk-Declining) and banded rail (*Gallirallus philippensis*; At Risk-Declining), but both species are now locally extinct in the area.

## <u>Lizards</u>

Central Canterbury spotted skink (*Oligosoma* aff. *lineoocellatum* "Central Canterbury"; Threatened-Nationally Vulnerable <sup>2</sup>), McCann's skink (*Oligosoma maccanni*; Not threatened), southern grass skink, (*Oligosoma* aff. *polychroma* Clade 5; At Risk-Declining), and Canterbury gecko (*Woodworthia* cf. *brunnea*; At Risk-Declining) have all been recorded on Kaitorete Spit (McEwen 1987; Lettink *et al.* 2008). All or some of these species are also likely to be present in peripheral areas, including within the riparian zones of waterways entering the Lake. The At Risk-Declining jewelled gecko (*Naultinus gemmeus*) is widespread over Banks Peninsula and could also occur within Yarrs Flat WMR.

<sup>&</sup>lt;sup>1</sup> Threat classifications for birds from Robertson *et al.* (2013), and O'Donnell and Robertson (2016)..

<sup>&</sup>lt;sup>2</sup> Threat classification for reptiles from Hitchmough *et al.* (2013).

## 4.8 Management - past and current

Manipulation of the lake level and associated drainage activities have had significant effects on the surrounding land, with wetland extent being much reduced to what it was historically (Golder Associates 2015). Most of this activity has occurred deliberately, to reduce the size of wetland areas in order to support the region's continually growing agricultural land use. As the lake rises it threatens to flood surrounding land and so it is opened to the sea at key trigger point levels. This has been managed since pre-European times and is currently managed by the Lake Opening Protocol Group, with Environment Canterbury and Te Rūnanga O Ngāi Tahu being the joint holders of resource consents to open the Lake (ECan website 2016). This group works to balance the needs of surrounding farmers with the needs of Ngāi Tahu, migratory fish, and wading birds. The National Water Conservation (Lake Ellesmere) Order 1990, restricts lake openings and closings, prohibits damming or draining the lake, and restricts the granting of water rights (James 1991).

Historically, the area has been used for mahinga kai and, in pre-European times, the lake was periodically opened to the sea by Māori, but it would have generally been at a considerably higher level that in recent times, meaning that much of Yarrs Flat would have been under water most of the time (Hughey 1987). Since European settlement in the 1800s, livestock grazing began in the area and once the Wildlife Management Reserve was gazetted in 1979 grazing was reviewed, to improve the condition of the habitat for wildlife (Hughey 1987). Grazing in the reserve ceased approximately eight to ten years ago (Robin Smith, Department of Conservation, pers. comm.).

Due to this wetland being located within a large area of low-lying land, artificial waterways have been dug through it to alleviate flooding on surrounding farmland. Hughey (1987) discussed the experimental use of bores and trenches dug in the wetland to distribute water into the drier areas. These turned out to be not particularly successful because not enough water was available during drier times of the year when it was most needed. Bore flows seemed to be highly dependent on inland water abstraction used for irrigation.

The Ararira/LII River is currently managed by the LII Drainage Committee to reduce the impacts of flooding on surrounding land. It is dredged periodically, with spoil deposited along its banks. In the region of Yarrs Flat WMR most dredging activity is carried out on the true right side, but there is a small patch on the true left where aquatic macrophytes are deposited (Robin Smith, Department of Conservation, pers. comm.). Although this patch is just outside the northwestern tip of the Reserve, it occurs on public conservation land and is included in the Operational Area addressed by this Plan (Figure 2). Land drainage activities are also controlled through rules in Environment Canterbury's Land and Water Regional Plan and the Code of Practice for Defences Against Water and Drainage Schemes July 2015.

Recently, predominantly through activities of the Living Water Programme and Te Ara Kākāriki, community planting days have focussed on ecological restoration of indigenous vegetation within the amenities area (Figure 2). Ongoing maintenance is being carried out there, including weed control around the planted areas, mowing of a vehicle access/walking track, and control of hares (*Lepus europaeus*).



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There has also been work to control some of the pest plants in and around the Reserve, such as willow (*Salix* spp.) and reed canary grass (*Phalaris arundinaceous*) (Section 9). Control of grey willow using aerial spraying and ground control methods has been carried out in the Yarrs Flat Operational Area (Plates 1-2) and on adjacent private land west of the Ararira/LII River (see McCombs 2006).

There is practical road access to the Operational Area, which lends itself to community involvement. Unfortunately, this has also enabled vehicles to obtain access to parts of the Reserve and this has resulted in damage to wetland values. The road currently terminates at part of the Reserve where the implementation of the Lincoln University School of Landscape Architecture Master Plan planting plan has begun, using community volunteer labour. This planted area is within the amenities area shown in Figure 2.

# 5. VISION STATEMENT

Yarrs Flat and the surrounding Te Waihora catchment are ecologically and culturally significant. To help focus efforts in the Reserve towards achieving ecologically sound and sustainable outcomes, the following vision statement is proposed:

Yarrs Flat is a thriving wetland ecosystem habitat for New Zealand's unique wildlife, prized by Ngāi Tahu as a taonga, and enjoyed and cared for by the New Zealand public.

## 6. GOALS AND OBJECTIVES

Guiding principles of this Ecological Management Plan aim to incorporate sound science-based knowledge with cultural understanding and community values into a document that can help to guide the future of the Reserve for the next 10 years and beyond. This plan focusses on the ecological context of the Reserve, but also provides advice on recreational use and stakeholder engagement. In particular, this plan aims to:

- Identify key ecological threats to the wetland and wetland habitats, describing options for the management and control of these key threats
- Provide strategic advice and priorities for the protection and enhancement of wildlife, indigenous vegetation, and important habitats
- Develop a framework for monitoring the wildlife and vegetation, and key threats to them, so that accurate assessments of the effectiveness of the proposed management actions and the ecological integrity of the area can be made.
- Summarise opportunities to encourage recreational and stakeholder engagement.

It is important that ongoing management of this wetland is contiguous with management in and around Te Waihora and is in keeping with the principles in the



JMP. Management should enhance the mauri of the lake and its tributaries, and not detract from the customary use of and access to Te Waihora and its resources. Management must also be consistent with its original designation as a Wildlife Management Reserve and with the Canterbury Conservation Management Strategy (CMS). A number of statutory policies are relevant to Te Waihora and its tributary streams, and these constrain some potential ecological restoration actions, such as the restoration of former hydrology.

General objectives defined by Hughey (1987) are to manage the Reserve as a wetland habitat for wildlife: maintaining and enhancing the vegetation to provide suitable wildlife habitat and to protect valuable indigenous species, whilst permitting game bird hunting and free public recreational access. The Department of Conservation's current medium term stretch goals (Smith 2016) are focussed on a 'mountains to the sea' approach to protect 50 freshwater ecosystems, effectively manage pests in 50% of New Zealand's natural ecosystems, enrich 90% of New Zealander's lives through connecting them with nature, and enable tangata whenua kaitiaki responsibilities over natural and cultural resources on public conservation lands and waters.

The overall theme for the Ararira Living Water Programme (Smith 2016) is "sustainable management for healthy lowland freshwater ecosystems". This has the key goals of protecting and enhancing the catchment's biodiversity, and connecting people to the lake and catchment, so that it is valued.

# 7. VEGETATION AND HABITATS

## 7.1 Overview

Vegetation in Yarrs Flat WMR has been surveyed previously by Clark and Partridge (1984) and Grove (2007) as part of their wider surveys of the shoreline of Te Waihora. Clark and Partridge (1984) provided the following descriptions:

"The vegetation of Yarrs Flat Wildlife Reserve is made up of a complex pattern of saline and fresh water communities modified to varying extents by agriculture. Those parts nearest the LII River tend to be fresh water, while eastward the vegetation grades into the sandy saline types which continue to the Greenpark Sands. The wide area of mudflats of Yarrs Bay essentially divides the area into these two parts. The parts at present grazed by cattle have little botanical value except for two small raised bogs which they tend to avoid. The areas of interesting halophyte vegetation however are only lightly grazed by sheep and thus show 1ittle damage. They should remain so provided cattle are confined to their present location.

[The vegetation] "includes a stand of willows against the river bank with a highly modified pasture and mudflats behind. The pasture is mostly creeping bent while the mudflats are three-square or *Mimulus* and *Triglochin*. A raised promontory has a mixture of sea rush and glasswort with halophytic herbs, while beyond this there is a wide bay of mudflats, with *Mimulus* and *Triglochin* and some three-square around the edge. The effects of this bay extend far inland as a stand of increasing density of marsh ribbonwood and sea rush, first on mudflats and later with grasses beneath. The eastern side of the bay rises more gradually and therefore has mudflats of scattered sea

rush with occasional raised areas of grasses and halophytic herbs below. At higher elevations there is a marsh ribbonwood and sea rush mixture which grades into a ribbonwood dominated grassland further inland."

The initial assessment by Clark and Partridge (1984) identified 12 different vegetation types in Yarrs Flat WMR and eight of these occur within the Yarrs Flat Operational Area (see Appendix 4 for a map and brief descriptions of the types). The more recent assessment by Grove (2007) identified 14 vegetation types in Yarrs Flat Operational Area (see Table 1 and Figure 3). These can be grouped into three broad categories:

- Freshwater wetland vegetation (22.7 ha)
- Saltmarsh or salt-tolerant vegetation (41.3 ha)
- Terrestrial/dryland vegetation (3.2 ha)

Brief descriptions and photos (taken during the site visit on 6 September 2016) of the different vegetation types (as classified by Grove 2007) are provided below. It should be noted that the vegetation cover at Yarrs Flat has probably changed somewhat since the 2007 survey - either as a result of dynamic natural processes or management interventions such as willow control - but this is the most recent vegetation survey data available. More recently, Butt (2015) carried out a rapid botanical assessment of Yarrs Flat Operational Area.

## 7.2 Freshwater wetland vegetation

The western part of Yarrs Flat Operational Area contains several types of freshwater wetland vegetation, which are technically classified as either *swamp* or *marsh* (Johnson and Gerbeaux 2004). With the exception of the crack willow-dominant vegetation type (which receives water directly from the Ararira/LII River), the freshwater wetlands at Yarrs Flat are all *palustrine*, meaning that they receive water from rain, groundwater, or surface water rather than from rivers, lakes, or estuaries (Johnson and Gerbeaux 2004).

Crack willow (*Salix X fragilis*) forest and treeland covers approximately 5.3 hectares of the Operational Area (according to data from Grove 2007) (Plates 1-2). It occurs along the margin of the Ararira/LII River for almost its entire length and occupies a discrete patch around a freshwater spring (see Figure 2). A number of indigenous plant species were observed underneath crack willows during the site visit, including the sedge pūkio (*Carex secta*; Plate 2) and ferns swamp kiokio (*Blechnum minus*) and *Hypolepis ambigua*. Grey willow (*Salix cinerea*)-dominant forest occupies approximately 1.2 hectares; most of this occurs about halfway down the Ararira/LII River, however there is a small patch further south, and scattered grey willows occur in amongst the crack willows (Figure 3).

It is uncertain what specific vegetation would have been historically present in Yarrs Flat, but Burrows (1970) comments that:

"At the time of European settlement, it is believed that extensive areas of freshwater wetland (swamp) - dominated by harakeke/lowland flax (Phormium tenax), raupō (Typha orientalis) and Carex species - were present north and west of Te Waihora."



Table 1: Vegetation types present in Yarrs Flat Wildlife Management Reserve (from Grove 2007). These types are mapped in Figure 3.

Vegetation Category	Vegetation Type	Hydrosystem	Wetland Class	Description	Species Dominance	Area (ha)
Freshwater Wetland	Carex secta sedgeland	Palustrine	Swamp	Carex secta with willows	Native	0.06
	Crack willow dominant	Riverine	Swamp	Crack willow forest and treeland with exotic understorey	Exotic	5.29
	Grey willow dominant	Palustrine	Swamp	Open grey and/or crack willow with native associates	Exotic	1.20
	Juncus edgariae rushland	Palustrine	Marsh	Juncus edgariae with native rushes and sedges	Native	12.93
	Raupō	Palustrine	Swamp	Raupō with Schoenoplectus tabernaemontani	Native	0.14
	Wet mixed pasture	Palustrine	Marsh	Wet pasture	Exotic	3.10
Saltmarsh/Salt-tolerant	Bolboschoenus caldwellii sedgeland	Estuarine	Saltmarsh	Bolboschoenus caldwellii with exotic grasses	Native	3.03
	Salt-tolerant grassland	Estuarine	Saltmarsh	Creeping bent grassland	Exotic	3.78
	Saltmarsh herbfield	Estuarine	Saltmarsh	Mixed saltmarsh herbfield with glasswort	Native	1.20
	Saltmarsh ribbonwood shrubland	Estuarine	Saltmarsh	Saltmarsh ribbonwood with sea rush	Native	5.00
	Sea rush rushland	Estuarine	Saltmarsh	Sea rush with exotic grasses	Native	3.05
	Three-square sedgeland	Estuarine	Saltmarsh	Three-square with mixed native and exotic groundcover	Native	25.28
Terrestrial/Dryland	Dry herbaceous vegetation	Terrestrial	NA	Terrestrial exotic grassland	Exotic	2.97
	Exotic shelterbelts	Terrestrial	NA	Exotic conifer treeland	Exotic	0.24







Plate 1: Crack willow dominant vegetation type.

Plate 2: Scattered pūkio (*Carex secta*) occur under crack willows next to the Ararira/LII River.

Clark and Partridge (1984) state: "At Yarrs Flat there are not the problems with willows that are found elsewhere around the lake margin as at, for instance, Harts Creek Wildlife Reserve. Crack willow is confined to the river margin and although the field adjacent appears a suitable habitat, there are no signs of it invading, the presence of grazing cattle perhaps stopping it. Grey willow (*Salix cinerea*) is absent, and at any sign of its entry into the reserve should be removed immediately. Willows will not invade any of the saline areas."

Grey willow has clearly increased its extent and abundance at Yarrs Flat WMR since the Clark and Partridge (1984) survey. Butt (2015) commented: "Crack willow has been present for quite some time, but grey willow is a relatively recent arrival. Aerial images from 1984 indicate little or no grey willow either at the reserve or on the true right of the Ararira/LII River. Since 1984 the grey willow has invaded many of the available sites, particularly the freshwater springs."

Control of grey willows using aerially-applied herbicide and manual ground-based methods has been carried out in the Yarrs Flat Operational Area (Plates 3-4) and on adjacent private land west of the Ararira/LII River (see McCombs 2006).

Juncus edgariae rushland is the most widespread freshwater wetland vegetation type in the Operational Area, covering approximately 12.9 ha. The density of  $w\bar{i}$  - mostly *J. edgariae*, with small amounts of *J. australis*, and *J. sarophorus* - varies markedly from dense rushland (Plate 5) to scattered plants in amongst a lower cover of grasses, sedges, and herbaceous species (Plate 6). During our site visit on 6 September, many of the areas mapped as *Juncus edgariae* rushland by Grove (2007) appeared to have few or no *Juncus* plants and instead appeared to be dominated by introduced grasses and herbs (i.e. similar to the wet mixed pasture vegetation type). It is possible that the density of *Juncus* spp. may have reduced since the 2007 survey and that introduced grasses have become more abundant, however this observation is based on a single brief site visit and would need to be verified.





Plate 3: Grey willow dominant vegetation type. Control of grey willow is being carried out in the Operational Area - this large patch of grey willows has been aerially sprayed with herbicide.



Plate 4: Manual control of grey willow saplings has also been carried out; here cut stems have been piled up to help prevent regrowth.



Plate 5: *Juncus edgariae* rushland. A dense patch of wī near the Ararira/LII River, with crack willow forest in the background.



Plate 6: *Juncus edgariae* rushland. Scattered wī plants occur above a low cover of grasses, herbs and sedges.

*Carex secta* sedgeland occupies only 0.06 ha of the Operational Area, with a single patch located next to an area of grey willows (Figure 3). This vegetation type has reduced in extent since the Clark and Partridge (1984) survey, when several patches of *C. secta* sedgeland were identified near the Ararira/LII River (Vegetation Type I, see Appendix 4). Most of the *C. secta* sedgeland appears to have been invaded by grey willows, however *C. secta* has survived underneath the willow canopy in some places (e.g. *Carex secta* can be seen under the grey willows in Plate 4). The area of *Carex secta* sedgeland is likely to increase again, as control of grey willow has been carried out and "There has been prolific regeneration of *C. secta* seedlings in the sprayed areas - probably spurred on by the clearing of competition by the herbicide" (Butt 2015).

Raupō sedgeland currently covers a very small portion (0.14 hectare) of the freshwater wetland habitats in the Operational Area, with the largest patch situated near the mouth of the Ararira/LII River (Figure 3). Smaller patches and seedlings have been observed in other places, often near springs (see Plates 7-8), however the locations of these smaller patches have not been accurately mapped (a few sites are

shown in Figure 4). Raupō usually occupies shallow fertile waters up to c.1.5 m deep or water-logged soils in and around sheltered lakes, swamps, ponds or seepages. Although raupō sometimes occurs in slightly brackish waters, it does not tolerate high salinity (it is not listed as a relatively salt-tolerant plant species by Winterbourn *et al.* 2008), and its potential distribution in the Operational Area will be limited to areas with a regular supply of freshwater and a high water table i.e. the margins of the Ararira/LII River (which is mostly occupied by crack willow forest at present) and around springs.



Plate 7: Raupō vegetation type. Large patch of raupō (*Typha orientalis*) about half-way down the Ararira/LII River.

Plate 8: Raupō establishing on the true left bank of the Ararira/LII River.

Wet mixed pasture covers 3.1 hectares along the northern boundary of the Operational Area adjacent to Wolfes Road. It was difficult to identify grass and rush species during our site visit in September (lack of seed heads), but the vegetation is dominated by introduced species including cocksfoot (*Dactylis glomerata*), sweet vernal (*Anthoxanthum odoratum*), creeping bent (*Agrostis stolonifera*), kneed foxtail (*Alopecurus geniculatus*), creeping buttercup (*Ranunculus repens*), and jointed rush (*Juncus articulatus*).

## 7.3 Saltmarsh or salt-tolerant vegetation

The central part of the site contains extensive areas of saltmarsh or salt-tolerant vegetation, which covers two-thirds of the Operational Area. Most of the salt-tolerant vegetation types are dominated by indigenous plant species (Table 1), with the exception of the salt-tolerant grassland type, which is dominated by creeping bent (*Agrostis stolonifera*) (Plate 9).

*Bolboschoenus caldwellii* sedgeland occupies approximately three hectares along the lake edge towards the mouth of the Ararira/LII River. Surprisingly, this vegetation type was not identified here by Clark and Partridge (1984); instead these areas were mapped as *Pasture of Creeping Bent* (i.e. Vegetation Type C, see Appendix 4). This may have something to do with the timing of the two surveys, as *Bolboschoenus caldwellii* is a summer-green species that dies down over winter. As Clark & Partridge (1984) pointed out, "areas close to the west bank of the Ararira/LII River have the appearance in winter of a wet grassland of creeping bent (*Agrostis stolonifera*), while in summer they have a dense growth of 1 m tall *Bolboschoenus caldwellii*" (see comments on seasonality in Section 4.6).

Saltmarsh herbfield dominated by glasswort occurs in two places in the northeastern part of the site. Small patches of saltmarsh herbfield occur in amongst the other salt-tolerant vegetation types, often in low-lying depressions or areas disturbed by vehicles (Plate 10). Common indigenous saltmarsh species include bachelor's button (*Cotula coronopifolia*), remuremu (*Selliera radicans*), and salt grass (*Puccinellia stricta*); these occur with several salt-tolerant introduced species: bucks horn plantain (*Plantago coronopus*), sea spurrey (*Spergularia marina*), and orache (*Atriplex prostrata*) are some of the most abundant species.



Plate 9: Salt-tolerant grassland. Dense sward of introduced grasses dominated by creeping bent (*Agrostis stolonifera*).

Plate 10: Saltmarsh herbfield dominated by glasswort in a shallow depression (foreground); with Saltmarsh ribbonwood shrubland (background).

Saltmarsh ribbonwood shrubland (five hectares) occurs on the slightly higher 'peninsula' in the eastern part of the Operational Area (Plates 10-11). Many of the ribbonwood plants appear to be old, and support a high cover of epiphytic lichens such as *Ramalina celastri* and gold-eye lichen (*Teloschistes chrysophthalmus*). Introduced grasses such as creeping bent and couch (*Elytrigia repens*) form a dense ground cover in between the shrubs. Despite the thick grass sward, seedlings of saltmarsh ribbonwood were frequently seen during our site visit, suggesting that there is good potential for regeneration of shrubland.

Three-square sedgeland is the most extensive vegetation type in the Operational Area, covering approximately 25 hectares in the central part of the site (Plate 12). It spans a relatively wide salinity range, as it occurs from Wolfes Road right down to the lake edge. A variety of indigenous herbaceous species occur along the lake edge in amongst sea rush, including New Zealand celery (*Apium prostratum*), button daisy (*Leptinella dioica*), and sea primrose (*Samolus repens*) (Plate 13). *Lilaeopsis novae-zelandiae* and native musk (*Thyridia repens*) are present on the mudflats.

Sea rush rushland occupies a three hectare area in the middle of the three-square sedgeland (Plate 14), where sea rush forms a patchy cover over a dense sward of introduced grasses (e.g. creeping bent).





Plate 11: Saltmarsh ribbonwood shrubland, with a thick sward of exotic grasses (mainly creeping bent) in between the shrubs.



Plate 12: Three-square sedgeland. Threesquare can be difficult to recognise in winter as it is a 'summer-green' species.



Plate 13: Sea rush is common on the lake edge, along with a number of indigenous herbaceous species.



Plate 14: Sea rush rushland vegetation type. Patchy rushland dominated by sea rush with a dense ground cover of exotic grasses.

## 7.4 Terrestrial/dryland vegetation

A small part of the Operational Area (3.2 hectares) contains terrestrial (non-wetland) vegetation (Figure 3). Most of this dryland area is covered in exotic grassland dominated by couch, crested dogstail (*Cynosurus cristatus*), sweet vernal (*Anthoxanthum odoratum*), and Chewings fescue (*Festuca rubra* subsp. *commutata*). A single individual of *Olearia lineata* cv. *dartonii* has been planted in this area (Jensen 2014, Plate 15). This species is not part of the native flora of Ellesmere Ecological District, however it is a sterile cultivar and there is not risk of it spreading.

Exotic shelterbelts of macrocarpa (*Cupressus macrocarpa*) have been planted on the edge of the grassland (Plate 15).

A variety of indigenous tree and shrub species were planted in the grassland in winter 2016 (Plate 16), under the guidance of a plan developed by the Lincoln University School of Landscape Architecture DesignLab (2016).





Plate 15: Dry herbaceous vegetation (exotic grassland) and exotic shelterbelts (mostly macrocarpa). Note the single *Olearia lineata* cv. *dartonii* tree (planted) in the grassland.



Plate 16: Dry herbaceous vegetation. A variety of indigenous tree and shrub species were planted by volunteers in spring 2015 and 2016 (see Table 10). The concept and rationale behind the planting is described in Lincoln University (2016).

# 8. FLORA

## 8.1 Overview

Clark and Partridge (1984) recorded 26 indigenous and 42 introduced vascular plant species in their vegetation survey of Yarrs Flat WMR, while Butt (2015) found 54 indigenous and 53 introduced species during his survey of Yarrs Flat Operational Area (see Appendix 5). Recent site visits by others have added three more introduced plant species to the list: yellow flag iris (*Iris pseudoacorus*), stitchwort (*Stellaria graminea*), and a cultivar of *Olearia lineata* (*Olearia lineata* cv. *dartonii*), which is not part of the native flora of Ellesmere Ecological District. Three non-vascular plant species - two lichens and one freshwater alga - were observed during our site visit on 6 September 2016, however a thorough survey of non-vascular plants has not been carried out at Yarrs Flat WMR.

## 8.2 Rare plants

No nationally Threatened plant species<sup>1</sup> are known to occur within the Operational Area (or the rest of Yarrs Flat WMR), however three At Risk and three locally uncommon plant species were recorded during the most recent survey (Butt 2015) (Table 2).

<sup>&</sup>lt;sup>1</sup> As classified by de Lange *et al.* (2013).



Scientific Name	Common Name	Conservation Status (de Lange <i>et al.</i> 2013)	Vegetation Category
Urtica perconfusa	Swamp nettle	At Risk-Declining	Freshwater wetland
Stuckenia pectinata	Fennel-leaved pondweed	At Risk-Naturally Uncommon	Freshwater wetland
Thyridia repens <sup>1</sup>	Native musk	At Risk-Naturally Uncommon	Saltmarsh/Salt- tolerant
Carex dipsacea	Teasel sedge	Locally uncommon <sup>a</sup>	Freshwater wetland
Montia fontana subsp. fontana	Native blinks	Locally uncommon <sup>b</sup>	Freshwater wetland
Schoenoplectus tabernaemontani	Lake clubrush, kuawa	Locally uncommon <sup>c</sup>	Freshwater wetland

Table 2:Nationally At Risk and locally uncommon plant species recorded at Yarrs Flat<br/>Operational Area in 2014 (Butt 2015).

<sup>a</sup> Uncommon on the Canterbury Plains and described as "locally uncommon" (Butt 2015).

<sup>b</sup> No other records from the Canterbury Plains; it is "likely that this species is locally rare" (Butt 2015).

<sup>c</sup> Rare in Canterbury (Clark 1984 and NZPCN 2016d).

#### Swamp Nettle (Urtica perconfusa)

Swamp nettle is very common along the margins of the Ararira/LII River (Jason Butt pers. comm.) and was often seen during our site visit in September 2016 (Plate 17). Despite its apparent abundance at Yarrs Flat, there are only a few mapped records (Figure 4). Swamp nettle occurs in higher nutrient wetland and riparian habitats; most often where stock have no access (Butt 2015). This species is classified as At Risk-Declining (de Lange *et al.* 2013), with the qualifier 'Sparse'. It is found throughout lowland Canterbury and New Zealand from about the middle of the North Island, with a mostly easterly distribution. It can also be found in montane areas. Swamp nettle is a scrambler and is often found growing over other vegetation/structures such as fence posts, sedges and rushes, and the lower trunks of willows (Plate 18).



Plate 17: Swamp nettle (Urtica perconfusa).

Plate 18: Swamp nettle scrambling over dead trunks and branches of crack willows at Yarrs Flat Operational Area.

It is worth noting that Clark and Partridge (1984) did not record swamp nettle in Yarrs Flat WMR, which implies that this species may have increased its distribution and abundance at this site since the 1980s. The exact reason for this is unknown, although

<sup>&</sup>lt;sup>1</sup> Previously known as *Mimulus repens*.



exclusion of stock from Yarrs Flat WMR 8-10 years ago may have been beneficial for swamp nettle.

## Native Musk (Thyridia repens)

Native musk is a mat-forming succulent perennial herb of tidal estuaries and lagoons (Plates 19-20). It is typically found in permanently damp or soggy, saline mud or silt soils (NZPCN 2016a). At Te Waihora it is not subject to tidal fluctuation, but the habitat is similar in that the lake level fluctuates with opening and closing events (Butt 2015). Native musk is mostly found in coastal situations but has also been found some distance from the sea. The species does not tolerate much competition from taller plants or faster growing mat-forming species.

Native musk is classified as At Risk - Naturally Uncommon, with the qualifiers of: Extreme Fluctuations, Range Restricted, Secure Overseas (it is also present in Australia), and Sparse (de Lange *et al.* 2013).



Plate 19: Native musk (*Thyridia repens*). (Photograph by MH at Lake Forsyth/Wairewa in February 2015).

Plate 20: Native musk occupies saltmarsh habitats at Te Waihora that are under water for much of the time (Photograph: Alice Shanks).

## Fennel-Leaved Pondweed (Stuckenia pectinata)

A small patch of the aquatic macrophyte *Stuckenia pectinata* was found in a drain at the eastern edge of the Operational Area in November 2014 (Butt 2015). This species usually occurs in brackish water, such as in slow moving tidal streams or lagoons, but is also found in shallow lowland pools (NZPCN 2016b). It is indigenous to New Zealand, where it has been collected from the North, South and Chatham Islands.

Fennel-leaved pondweed is classified as At Risk-Naturally Uncommon, with the qualifiers of: Partial Decline, Secure Overseas, and Sparse (de Lange *et al.* 2013). Management of this species is being addressed under the Whakaora Te Waihora macrophyte restoration programme (Whakaora Te Waihora 2012 cited in Butt 2015).

## Teasel Sedge Carex dipsacea

The sedge *Carex dipsacea* (Plate 21) was found in crack willow forest at Yarrs Flat Operational Area (Butt 2015; Figure 4). It occurs throughout New Zealand, from





coastal to subalpine habitats. Favouring wetlands, this species usually grows along rivers, lakes and ponds within sand dunes, tall forest, shrubland, and tussock grassland (NZPCN 2016c). There are no formal records of teasel sedge from the Canterbury Plains, however there is a small population at Rakaia Island and a handful of plants near the mouth of the Waimakariri River (Butt 2015). *Carex dipsacea* is considered to be a locally uncommon species.

#### Native Blinks (Montia fontana subsp. fontana)

Native blinks (Plate 22) was found near a freshwater spring in the Operational Area (Butt 2015; Figure 4). Native blinks is a small herb with trailing to sub-erect stems that occupies freshwater habitats. Although it occurs throughout New Zealand, there are no other records from the Canterbury Plains, and this species is likely to be locally rare (Butt 2015).



Plate 21: Teasel sedge (*Carex dipsacea*). (Photograph: Pat Enright).



Plate 22: Native blinks (*Montia fontana* subsp. *fontana*). (Photograph: Chris Morse via NatureWatch).

#### Lake Clubrush (Schoenoplectus tabernaemontani)

Lake clubrush or kuawa (Plate 23) is present at Te Waihora and was recorded as "rare" in the Operational Area by Butt (2015), however there are no specific details on its location. This species occurs mostly in standing water, growing in brackish or freshwater systems such as lakes, ponds, lagoons, and river and stream margins (NZPCN 2016d). It is also found well inland around geothermal systems, and occupies coastal to montane habitats (up to 300 m a.s.l.).



Plate 23: Lake clubrush or kuawa (Schoenoplectus tabernaemontani). (Photograph: Colin Meurk).



Lake clubrush is found throughout the North Island, and in the Nelson, Marlborough, and Westland regions, however it is rare in the rest of the South Island, including Canterbury (Clark 1984 and NZPCN 2016d). It occurs in a few places around Christchurch and Te Waihora, and is considered to be locally uncommon.

#### 8.3 Pest plants

#### Overview

A number of pest plant species (weeds) are present in Yarrs Flat Operational Area and pose a threat to indigenous ecological values in the Reserve and the wider Te Waihora area (Table 3). Most of these weeds occur in freshwater wetland habitats. The locations of selected weeds at Yarrs Flat are shown in Figure 5 (data from Butt 2015 and the NatureWatch website).

Table 3:	Pest plant species present in Yarrs Flat Operational Area (from Butt 2015 and the
	NatureWatch website).

Common Name	Scientific Name	Vegetation Category	Pest Status (Maw 2011)
Boxthorn	Lycium ferocissimum	Freshwater wetland, Terrestrial	Biodiversity Pest
Crack willow	Salix Xfragilis	Freshwater wetland	
Gorse	Ulex europaeus	Freshwater wetland, Terrestrial	Containment Control Pest
Grey willow	Salix cinerea	Freshwater wetland	
Orange day lily	Hemerocallis fulva	Freshwater wetland	
Reed canary grass	Phalaris arundinacea	Freshwater wetland	
Yellow flag iris	Iris pseudacorus	Freshwater wetland	

Brief information on each pest plant species is provided below, and management of each species is addressed in the Pest Plant Control section (Section 14). Species summaries below are listed in the approximate order of priority for control.

#### Crack Willow and Grey Willow

Approximately seven hectares of crack willow is present adjacent to the Ararira/LII River and 1.85 hectares of grey and crack willow has been aerially controlled (Butt 2015). See description under Vegetation and habitats (Section 7).

#### Reed Canary Grass (Phalaris arundinacea)

Scattered plants of reed canary grass have been found in the Yarrs Flat Operational Area (see Figure 5 for observations of reed canary grass downloaded from the NatureWatch website). Reed canary grass is a very hardy, tall perennial grass that grows quickly and spreads easily both by seed and by creeping rhizomes. It poses a major threat to wetlands because it can outcompete and replace native species. It is difficult to eradicate once established (ECan 2010).







## Orange Day Lily (Hemerocallis fulva)

One small patch of orange day lily was found on the edge of the Ararira/LII River (Butt 2015). It has many small corms so could easily spread further if a flood erodes the riverbank. Orange day lily has a reputation as an invasive weed in the USA, but does not seem to have made a great impact in New Zealand yet.

## Gorse (Ulex europaeus)

There are scattered gorse plants on both sides of Wolfes Road and around two of the freshwater springs (Butt 2015) (see Plate 24 and Figure 5). Gorse is more likely to invade drier areas, but can also invade higher ground in wet areas. The roadside gorse is mature and producing seed. The gorse growing at the springs is stunted, with relatively few flowers.



Plate 24: Gorse in flower at a freshwater spring in Yarrs Flat Operational Area (Sept 2016). Note the dead (sprayed) willows.

## Boxthorn (Lycium ferocissimum)

One boxthorn plant was found under crack willows at the largest spring (Butt 2015). Boxthorn is listed as a Biodiversity Protection Pest in the Canterbury Regional Pest Management Strategy (Maw 2011), however the reserve is not particularly suited to this species, apart from the terrestrial/dryland area (i.e. amenity area in Figure 2).

## Blackberry (Rubus fruticosus agg.)

Blackberry is rare in Yarrs Flat Operational Area, however it is abundant along the bank of the Ararira/LII River adjacent to the road between the boat ramp and the Reserve (Butt 2015).

## Scotch Broom (Cytisus scoparius)

Although there are no live Scotch broom plants at Yarrs Flat, broom has been used in the construction of some of the maimais and old seed pods are present (Butt 2015). It is unlikely that broom would establish on the saline soils in the vicinity of the maimais, however there is suitable habitat on the higher sandy soils in the vicinity of the old hut site. Care should be taken to ensure that no new weed threats are introduced to the Reserve through lack of awareness or careless behaviour.


# 9. FAUNA

#### 9.1 Avifauna

#### Records and Values

Due to habitat diversity and a favourable water regime, Yarrs Flat has historically been considered to be of outstanding value for wading birds (waders), high value for waterfowl, and moderate to high value for swamp birds (O'Donnell 1985). During the summer of 1981-1982, 49 wetland species were recorded in the study area, with Arctic waders continuously present (O'Donnell 1985). During the 2016 Te Waihora/Lake Ellesmere birds census, undertaken by the Te Waihora/Ellesmere Trust, 20 bird species were seen at Yarrs Flat (see Appendix 2), but this survey was undertaken in a single day and is difficult to compare to the intensive surveying undertaken in 1981-1982. Because all other saltmarshes around the lake had dried up, it was estimated during the same period that 95% of waders on the lake were resident within the Yarrs Flat area.

Further inland, freshwater ponds were observed to be used by pied stilt, Pacific golden plover (*Pluvialis fulva* - migrant), sharp-tailed sandpipers (*Calidris acuminata* - Migrant), and pectoral sandpipers (*Calidris melanotos* - Vagrant). The most numerous waders were pied stilt and banded dotterel with high numbers present during autumn, early winter and early spring. Two international migrant waders, the curlew sandpiper and the red-necked stint (*Calidris ruficollis*) also made significant use of the area.

Waterfowl numbers can be high at Yarrs Flat, particularly during southerly storms, when waterfowl species shelter near the Ararira/L II River mouth. During the summer of 1981-1982 large flocks of grey teal (*c*.1,000) were recorded (O'Donnell 1985). Herons, gulls, terns, and shags also frequently use the area. The river itself in the lower reaches is an important feeding site for little shag (*Phalacrocorax melanoleucos* - Not Threatened), black shag (*Phalacrocorax carbo* - Naturally Uncommon), and scaup (*Aythya novaeseelandiae* - Not Threatened), shoveller, and grey teal breed within the river (Langlands 2014). Refer to Appendix 2 of O'Donnell (1985) for detailed bird counts undertaken within Yarrs Flat in the 1970s and 1981-1982

Australasian bittern (Plate 25) are known to feed in the area, and a pair possibly nests in a patch of raupō on the eastern side of the mouth of the Ararira/LII River (Peter Langlands, pers. comm.). Marsh crake are present in the *Juncus* rushlands.

New Zealand fantail (*Rhipidura fuliginosa* - Not Threatened), grey warbler (*Gerygone igata* - Not Threatened), sacred kingfisher (*Todiramphus sanctus* - Not Threatened), and numerous exotic passerines use the willows and other vegetation within the Reserve.

#### Key Habitats

Waders prefer the saltmarsh zones along the foreshore, with the smaller waders (e.g. curlew sandpipers and wrybill) foraging in the surface film and shallow lake water, while the taller pied stilt can make use of the deeper edge and open lake waters (O'Donnell 1989). Saltmarsh vegetation in this area has been recognised as nationally

important given its rarity elsewhere in New Zealand (Clarke and Partridge 1984). When the lake level is as high as 1.25 m a.s.l. most lake edge waters are too deep to allow waders to exploit saltmarsh habitat, with the exception of stilts (O'Donnell 1989).

Waterfowl typically use the open-lake water more frequently than other habitats. Although, black swans and Canada geese do spend time grazing on the dry saltmarshes and submerged vegetation around the edge of the lake (O'Donnell 1989). Salt-tolerant pasture is generally not utilised by most bird species.

Bittern mainly breed in raupō (Plate 26) but occasionally breed in *Carex secta* (O'Donnell 2011), and their preferred feeding habitat is areas of water with high clarity and a depth of 5-20 cm, that they can perch over (Langlands 2013, Colin O'Donnell, Department of Conservation, pers. comm.). Yarrs Flat is mostly utilised by bittern as a feeding habitat, but booming has been heard in raupō at the mouth of the Ararira/LII River and it is possible a pair nests there (Peter Langlands pers. comm.).





Plate 25: Adult Australasian bittern, Bexley wetlands, Christchurch. Photograph: Grahame Bell (New Zealand Birds Online).

Plate 26: Adult Australasian bittern camouflaged amongst Raupō in Waitangi Wetland, Hawke's Bay. Photograph: Adam Clarke (New Zealand Birds Online).

#### 9.2 Lizards

A targeted survey for reptiles was beyond the scope of this project, but various lizard species are likely to be present where suitable habitat exists. Skinks are commonly seen in the dry eastern peninsula area of the site (Robin Smith, Department of Conservation, pers. comm.) and despite limited available data, southern grass skink, McCann's skink, Canterbury spotted skink, and Canterbury gecko may all be present there, and in the riparian zone of the Ararira/LII River. Moreover, the area lies within areas of high lizard diversity meaning that passive colonisation of the site by lizards, including threatened species such as the Canterbury spotted skink, is likely to occur through time if a predator-management regime is operating.



#### 9.3 Introduced mammals

Brown hares (*Lepus europaeus*), rabbits (*Oryctolagus cuniculus*), mice (*Mus musculus*), hedgehogs (*Erinaceus europaeus*), rats (*Rattus* spp.), possums (*Trichosurus vulpecula*), feral cats (*Felis catus*), and mustelids (*Mustela spp.*) are all present in the various terrestrial and riparian habitats adjacent to the lake, and would be expected to be present at Yarrs Flat. Hares in particular commonly damage young woody plants, and are currently causing problems within recent plantings in the Operational Area.

# 10. OVERVIEW OF PROPOSED MANAGEMENT

The main threats to ecological values in Yarrs Flat Operational Area include:

- Changes in hydrology/salinity/lake levels
- Pest plants (weeds)
- Pest animals
- Vehicles

Proposed management of the Operational Area within the next 10 years will address:

- Willow removal.
- Habitat quality improvements that support breeding pairs of bittern and enhance cultural values and use.
- Improvement of indigenous plant populations of interest.
- Increased public visitation, with the experience being enhanced by improved access and information.
- Local people becoming more connected to the wetland and Te Waihora/Lake Ellesmere through an enhanced visitation experience and/or active involvement in aspects of the project.

Key management issues are addressed in more detail in the sections that follow.

# 11. HYDROLOGICAL MANAGEMENT

A key focus of the Reserve is the protection and enhancement of habitats for wildlife. The flow of water, both fresh and brackish, in the wetland has a large influence on habitat types and some manipulation of it could be beneficial. Raupō, in particular, is very important as bittern habitat (as discussed in Section 9.1 above) and the creation of areas of shallower and slower flowing freshwater will help to encourage the establishment of larger patches. It would be advisable to do this alongside the lower (southern) parts of the Ararira/LII River, after removal of willow. Possible options are:



- Reduce the level of the upper bank, akin to a two-stage ditch, allowing for areas of shallower water with slower flow for the raupō to establish.
- Cut a short channel loop that will go out of the Ararira/LII River and then back into it.
- Opening some of the small channels that already exist in the more southern parts of the Operational Area, to get freshwater flowing more freely through them.

It was suggested by both Butt (2015) and Hughey (1987) that to enhance habitat for swamp birds, water levels should be controlled to keep more water in the wetland during dry periods, e.g. by the installation of weirs. This would have to be balanced with the needs of wading birds to forage in the littoral zone, which is exposed when the Lake level is low, and the needs of surrounding landowners that want to let the water drain away from their land and through the Reserve.

An investigation should be commissioned to address the following key matters:

- Assess effects of the above potential works on neighbouring land.
- Gauge relative effectiveness of the various options for enhancement of habitat.
- Determine which option(s) would be the most practical to implement and maintain.

# 12. RAUPŌ MANAGEMENT

The main objective for management of raupō in the Operational Area is to increase its extent in order to provide more breeding habitat for bittern. The approach for raupō management should be to provide suitable habitat and conditions for the species to spread naturally at the site. Raupō seedlings usually establish on the edges of waterways or in mud during summer and autumn, then plants gradually invade deeper water by growth of their rhizomes.

Removal of the willows along the margins of the Ararira/LII River and at the springs will provide more habitat suitable for raupō to establish. Raupō already on site will most likely expand to fill the habitat available to it, and the potential habitat appears to be at least five hectares (Butt 2015). Consideration should also be given to potential effects of raupō expansion on other species. Raupō tends to form very dense stands that exclude most other plant species, therefore the expansion of raupō in the Operational Area will need to be managed carefully so that there are no adverse effects on rare plant species such as swamp nettle (At Risk-Declining).

The current distribution of raupō in the Operational Area has not been mapped in detail, which makes it difficult to assess the effects of management activities such as willow control and changes in hydrology on raupō. Accurate mapping of the current distribution and abundance of raupō is required, in conjunction with ongoing monitoring, in order to inform management decisions. Supplementary planting of raupō in key areas for bittern habitat may be required, but only if it does not naturally colonise the hydrologically-altered areas.



# 13. FAUNA MANAGEMENT

#### 13.1 Overview

Te Waihora has been identified as a wildlife habitat of international importance, particularly for bird species. Yarrs Flat was classified as a Wildlife Management Reserve to protect migratory waders, waterfowl, and swamp birds, and it was recommended at that time that wader and swamp bird habitat needed to be protected and enhanced. For all of these groups of birds, Yarrs Flat forms a small but important part of the available habitat within their range. On its own, it is of insufficient size to protect viable populations of waders, swamp birds, or waterfowl, but successful restoration will establish an important precedent for habitat protection in the area, and form part of a larger habitat matrix essential for the survival of these species.

Large parts of Yarrs Flat are subject to encroachment by salt-tolerant rank grass and willows and this has affected the extent and quality of the wetland, and may have reduced the area of available saltmarsh habitat. It has also been suggested that much of the wetland is now suffering from reduced water movement, which is making parts of it stagnant and unsuitable for birds to forage for fish (Peter Langlands, pers. comm.).

The following management actions and priorities should be addressed to ensure that Yarrs Flat remains a high value habitat for wildlife:

- Improve habitat for bittern feeding and breeding.
- Pest control to protect indigenous fauna.
- Lizard inventory and habitat management.
- Monitoring the extent of saltmarsh habitat.

#### 13.2 Bittern feeding and breeding habitat

Australasian bittern has a conservation status of Threatened-Nationally Critical (Colin O'Donnell, Department of Conservation, pers. comm.), with only *c*.900 birds throughout New Zealand, and only 1000 in Australia. The principal reason for their decline is the contraction and loss of suitable wetland habitat. It has also been identified that a high proportion of juvenile bittern released from rescue programmes die of starvation (Williams and Brady 2014). The Selwyn-Te Waihora area has been identified as one of the most important areas for bittern in Canterbury, with a recent region-wide survey recording 43% of observations around Te Waihora (Langlands 2013). If sites such as Yarrs Flat are left to continue to degrade, it will put this species at further risk of regional (and national) extinction.

#### Feeding Habitat

Yarrs Flat is an important feeding area for bittern, including those that have nested elsewhere, and may constitute c.20% of the feeding area available for bittern at Te Waihora (Peter Langlands, pers. comm.). Bittern feed mainly on fish, including eels, in areas of clear water of 5-20 cm depth, and need dense vegetation cover close by. Surveys should be undertaken of the area shown in orange in Figure 6, to establish

whether there is sufficient widespread water movement that provides high quality bittern feeding habitat, which would be characterised as:

- Having a concentration of small fish species
- Shallow clear water
- Thick vegetation nearby for cover.

Areas of poor water flow should be identified and management options considered, including dredging of excess vegetation, channel excavation where practicable, and the restoration of vegetation that may provide suitable cover. Increased water flows resulting from the restoration of bittern breeding habitat (see below) may also improve the water flow through this area.

Bittern require high quality wetland habitat and therefore are likely to act as a key indicator species (Roberge and Angelstam 2004) for wetland conservation. Consequently, the management actions outlined for bittern will benefit other wetland fauna at Yarrs Flat.

#### Breeding Habitat

Raupō provides key habitat for bittern and raupō growth should be encouraged in a thin strip along the true left of the Ararira/LII River, as shown in blue in Figure 6, by allowing water from the Ararira/LII River into this area. The intention would be to establish an area of raupō growth suitable for the nesting of three to four breeding pairs of bittern. *Juncus* and *Carex* species should also be encouraged to establish in the area. This should be undertaken in conjunction with willow control and will need to be balanced with the land needs of the At Risk-Declining swamp nettle. Solitary pairs of bittern have been observed to breed in patches of raupō as small as 50 m by 20 m (Peter Langlands, pers. comm.), therefore extensive raupō in the area described should be sufficient to achieve these objectives.

It is not clear how much raupō was originally present at Yarrs Flat, but it is likely that significant areas of raupō wetland have been lost from the area with the encroachment of farmland into the margins of Te Waihora. This management action will therefore be a step towards increasing the availability of this habitat for bittern. The availability of raupō as nesting habitat may be a limiting factor for Australasian bittern.

Some options for diverting water into the bittern nesting habitat restoration area are discussed in Section 11.

#### 13.3 Pest control to protect indigenous fauna

Mustelids, feral cats, rats, hedgehogs, and brushtail possums are well known predators of New Zealand's indigenous wildlife, and are all likely to inhabit or frequent the Operational Area. Swamp birds, waders, waterfowl, land-dwelling passerines, and multiple lizard species are all therefore likely to benefit from the control of these introduced predators (c.f. O'Donnell *et al.* 2014). However, predator control should not be seen as mutually exclusive to habitat restoration efforts. Predator control will be of little benefit to swamp birds such as bittern if there is not suitable habitat for breeding and feeding, and will be of little benefit to waders if saltmarsh habitat degrades. Predator control should therefore be coupled with habitat restoration to create a high quality environment, free of predators. Also, given the small size of Yarrs Flat, and the transient nature of many of the bird species that use the area, predator control is unlikely to protect viable 'stand-alone' bird populations. However, a significant reduction of predators at Yarrs Flat could act as a 'proof of concept', encouraging predator control to be implemented in other similar habitats around Te Waihora.

Relatively intensive pest control should be undertaken in the dry margins encircling Yarrs Flat (see Figure 7, intensive buffer control). This would include:

- The use of DOC 200s and DOC 250s, alternating, and spaced 100 m apart for the control of stoats, weasels, and ferrets.
- Timms traps at 200-400 m spacing for the control of possums and feral cats. The entry hole should be widened by 10 mm to allow access by larger feral cats.
- Victor Pro rat traps baited with peanut butter and placed in covers that exclude non-target wildlife. These should be placed 50-100 m apart.

The main wetland area should be treated as a 'low intensity control area' (Figure 7). This is because pest control within the wetland itself is problematic in terms of accessing trapping stations, and trap sets would be put at risk by changing water levels. Mustelids and feral cats have large home ranges, and therefore it is unlikely that they will inhabit the wetland without coming into contact with traps in the buffer control area, so it is expected that buffer control will reduce their excursion rate into the wetland. Rats are more problematic as they have small home ranges and form colonies, particularly Norway rats (*Rattus norvegicus*), which can form colonies around water. If rat colonies are detected in the 'low intensity control area' then efforts should be made to control intensively by temporary use of bait stations and/or intensive trapping during dry periods. This would be similar to a 'sanctuary style' of management where there is a response plan to detections. Similarly, if problem mustelids or feral cats are detected in the 'low intensity control area' they could be removed with targeted trapping during dry periods.

In recent years it has been demonstrated that low intensity landscape scale pest control on farmland surrounding sensitive areas can significantly reduce predator densities in the sensitive areas, and produce biodiversity benefits on the farmland (see for example Poutiri Ao o Tane <u>http://tangoio.Māori.nz/kaupapa/our-treasured-environment/poutiri-</u> <u>ao-o-tane/</u>). The Living Waters Programme should engage with adjacent landowners, to see if they would collaborate in the implementation of pest control on adjacent farmland to reduce the rate at which predators move into the Yarrs Flat area. As a basic rule of thumb, this type of control might involve a mixture of DOC 200s, DOC 250s, and Timms traps, with at least one trap every 4-6 hectares.









#### 13.4 Lizard inventory and habitat management

Informal inventory of the lizard species inhabiting the Yarrs Flat area should focus on the eastern peninsula and riparian margins of the Ararira/LII River. If rare species are found (e.g. jewelled gecko and/or the Canterbury spotted skink) then specific management advice should be sought from a herpetologist. In the interim, the inclusion of fruit-bearing shrubs such as *Melicytus alpinus*, *Coprosma* spp. and *Muehlenbeckia* spp., and species that provide thick, tangled cover, such as sedges, toetoe, and flax, in any planting is likely to be of benefit for lizards. Planting plans could consider linking habitat within the site, and between the site and adjacent areas (refer to Section 15).

#### 13.5 Fauna monitoring

In this section a series of monitoring priorities is outlined for fauna and their habitats at Yarrs Flat. In conjunction with this monitoring, the following pieces of work should be undertaken to support this monitoring:

- Commission an investigation of the feasibility of the hydrological changes necessary to enhance Yarrs Flat for bittern and other wetland species. This would include consideration of effects on neighbouring land uses.
- A GIS-based study using current and historical aerial photographs. The purpose of this study would be to understand the extent to which the wetland has changed over the past 50 years, and would help to identify future restoration targets.

#### <u>Bittern</u>

Annual monitoring of bittern and other swamp bird species should be undertaken at Yarrs Flat in a coordinated and consistent manner, which allows for comparison between seasons and years. This would include listening surveys to detect signs of breeding, and surveys that establish the extent with which feeding habitat is exploited. Listening stations should be recorded with GPS waypoints, and search patterns and survey effort (time spent searching or listening) recorded. If funding is available, radio-tagging of bittern would be useful to ascertain other sites they are using within the Te Waihora area. Key monitoring objectives are:

- To determine the current habitat use of Yarrs Flat by bittern.
- To determine whether or to what extent habitat enhancements lead to increased use of Yarrs Flat by bittern.

Bittern monitoring should be coupled with monitoring of water quality, water movement, and fish abundance in the bittern feeding habitat area (Figure 6). This should be used to identify the management actions necessary under Section 13.2.

#### Waders

Annual surveys should be undertaken to record the abundance and distribution of different wader species. The 1981-1982 monitoring of waders at Yarrs Flat, reported

by O'Donnell (1989) will form an important baseline for this monitoring. The principal objectives of this monitoring will be to:

• Determine whether Yarrs Flat still contains habitat of outstanding value to waders.

#### Mammalian Pests

Two tracking tunnel lines should be set up in the 'intensive buffer control area' (Figure 7), following the methods of Gillies and Williams (2013): one on the eastern peninsula and one on the true left side of the Ararira/LII River. These should be used to monitor mustelids and rodents 2-3 times per year. One or two cat tracking tunnels should also be included on each line. Another two tracking tunnel lines should be established in a similar manner on another part of the lake edge not subject to pest control (these will provide non-treatment monitoring). A minimum of two tracking tunnel monitors should be undertaken prior to the implementation of pest control, and should continue each year that pest control is in place. The objectives of this monitoring will be to:

- Estimate the relative abundance of mammalian predators in the 'intensive buffer control' area.
- Evaluate the effectiveness of pest control at reducing the abundance of mammalian predators in the 'intensive buffer control' area.

Exploratory predator monitoring should be undertaken in the 'low intensity control' area. This would be undertaken in late-summer when lake levels are low, and follow a more unorthodox 'sanctuary' style monitoring, where a combination of standard, and cat, tracking tunnels are spread through the area in a  $200 \times 200$  metre grid. The extent of this grid will be dependent on the practicality of foot access to the wetland. Tracking tunnels should be run continuously for 2-3 weeks and then be removed from the area, so that they are not lost when water levels rise. The objective of this monitoring is to identify rat colonies, and the presence or absence of 'rogue' mustelids or feral cats.

#### Monitoring of Lizards on the Eastern Peninsula

Should an informal inventory of lizard habitat values indicate a viable population of a lizard species, artificial cover objects constructed from Onduline could be used to undertake further inventory work and then to monitor lizards on the eastern peninsula. The purpose of this monitoring would be to determine the species present and measure their response to pest control. Application of these techniques should follow Department of Conservation best practice (e.g. Lettink 2012). Fine scale monitoring would not be required if low-effort monitoring was continued through time.

#### Other Avifauna Monitoring

Five-minute bird count transects should be established in different parts of the Operational Area. These will be used to monitor the response of terrestrial passerines and other non-wetland birds species to pest control and restoration plantings. Annual waterfowl counts would also be useful, but the annual February count undertaken by

the Waihora Ellesmere Trust may be sufficient to provide useful information on the use of Yarrs Flat by waterfowl.

#### Saltmarsh Habitat

If saltmarsh habitat is being lost to salt-tolerant grass then this may have a long-term detrimental effect on the use of the Yarrs Flat area by various bird species. No management action is prescribed at this point, but saltmarsh habitat should be monitored.

A fine-scale map of saltmarsh habitat adjacent to the Operational Area should be prepared. This area should be resurveyed and re-mapped each year to establish whether, or at what rate, salt-tolerant grass is encroaching into saltmarsh habitat.

If saltmarsh habitat is being lost then efforts could be made to create shallow ponds that may be suitable for foraging by waders.

# 14. PEST PLANT CONTROL

Pest plant control should be carried out in the Operational Area, as outlined below<sup>1</sup>. Species are listed in the approximate order of priority for control. The three highest priority weeds for control are grey willow, crack willow, and reed canary grass.

#### 14.1 Crack willow and grey willow

Grey willow has huge potential to spread in Yarrs Flat WMR (it produces very large numbers of wind-dispersed seeds) and is the highest priority weed species for control. All plants in the Operational Area should be controlled, and preferably also on adjacent land west of the Ararira/LII River, e.g. the McBean flat wetland (see McCombs 2006).

Larger patches of grey willow in Yarrs Flat WMR have already been aerially sprayed, although this has been only partially successful (Butt 2015). Ground control of willows at the springs has also been undertaken. There has been some collateral damage to *Carex secta*, however there has also been prolific regeneration of *C. secta* seedlings in the sprayed areas, probably enabled by the clearing of competition by the herbicide (Butt 2015).

Gradual removal of crack willow along the margins of the Ararira/LII River should be implemented, allowing for a mixture of natural regeneration and restoration planting with indigenous species. Control should be carried out in a way that minimises ground disturbance and the potential for erosion of the riverbank, i.e. drill and poison large trees rather than physical removal. Priority areas for crack willow control are the lower half of the Ararira/LII River (i.e. blue area in Figure 6) and the two areas where

<sup>&</sup>lt;sup>1</sup> Details on control methods for each weed species are outside the scope of this Plan.

community planting of kahikatea forest is proposed (i.e. dark pink areas in Figure 6; see Restoration planting Section 15).

Removal of crack willow will provide more suitable habitat for raupō to establish, however care must be taken that this does not lead to adverse effects on other indigenous plant species, in particular swamp nettle (see sections below). The remaining areas of crack willow along the Ararira/LII River should be left initially so that some non-treatment areas are available for monitoring and comparison.

The following willow control methods and timing are from Butt (2015):

- Follow-up is required in all of the areas where both aerial and ground control programmes have occurred. This work should be undertaken using a range of methods to allow for the retention of regenerating native plants.
- Larger trees should be drilled and injected with glyphosate.
- Smaller seedlings should be cut off low down and the stump treated with a suitable herbicide.
- Willow seedlings are very dense in some places and can be spot-sprayed with a knapsack where there are very few indigenous plants. All green crack willow material should be stacked in a manner that will prevent resprouting.
- Where seedling densities are very high (making cutting and stump painting impractical) and there is abundant indigenous vegetation, it is only necessary to control those seedlings that are 750 mm or taller. This allows for natural mortality to control a number of the seedlings. However, it is important to prevent any grey willow seedlings reaching maturity, so regular follow-up will be required.

Areas where willows have been controlled should be re-treated once a year for the next two years and every second year for the following six years. Seed [from grey willows] will continue to invade the site, so efforts should be made to also get neighbouring landowners to control female grey willows at the very least. All control work should be undertaken during the active growing season.

#### Monitoring

The Operational Area will continue to be at risk of invasion by both grey willow and crack willow; therefore regular, ongoing monitoring of all freshwater springs and previously-controlled areas should be carried out every 2-5 years.

Butt (2015) stated: "Once cleared of willows, the springs will initially support sedges, but are likely to succeed to raupō and eventually willows again if no monitoring and follow up control is conducted. Eradication of willows at the site is possible. Keeping them out will be more problematic. Thirty years ago there were no grey willows on site and now they are abundant. It is easy to get complacent or reprioritise resources."



#### 14.2 Reed canary grass (*Phalaris arundinacea*)

Control of reed canary grass across a number of sites at Te Waihora (including Yarrs Flat WMR) is being coordinated and funded by Environment Canterbury. The grass-selective herbicide Haloxyfop is being used. Information on reed canary grass control planned for next season was provided by Frances Schmechel (July 2016):

"The objective of the control is to protect existing high value wetland habitat around the margins of the lake from invasion by reed canary grass. The plan is to do three sweeps (using Haloxyfop/Gallant except where it could go into or on water) as recommended by Paul Champion, NIWA. We will also be placing markers at all the sites and establishing photo points for monitoring purposes. All known sites will be searched and treated if necessary. If funding allows additional grey willow work will also be undertaken. A total budget of \$16,000 has been proposed."

The goal should be to eradicate reed canary grass from the Operational Area, in conjunction with control at other sites around Te Waihora. Annual monitoring and follow-up control will be required over the next 10 years (or more) in order to achieve this.

14.3 Orange day lily (*Hemerocallis fulva*)

Orange day lily should be sprayed with an appropriate herbicide and monitored for regrowth.

#### 14.4 Gorse (*Ulex europaeus*)

Gorse present on the roadside near the stock yards and on the east side of Wolfes Road adjacent to the Hill property (eastern side of Wolfes Road) should be sprayed using an appropriate herbicide. Some replacement planting with indigenous species would help to control regrowth of gorse in the long term. Dense shady species should be used to prevent reinfestation (Butt 2015).

The small number of gorse plants at the springs should be controlled by a mixture of cutting and painting and spot spraying, depending on the surrounding vegetation i.e. where gorse is in very close proximity to indigenous plant species spraying should not be used.

#### 14.5 Boxthorn (*Lycium ferocissimum*)

The one boxthorn plant found under crack willows at the largest spring should be controlled. Drilling and injecting would be an effective method (Butt 2015).

#### 14.6 Introduced grasses

A number of introduced grasses (in particular creeping bent, couch and salt barley grass) have invaded the saltmarsh/salt-tolerant vegetation and form dense swards in parts of the Operational Area e.g. the 'Salt-tolerant grassland' vegetation type (Figure 3). Direct control of introduced grasses is not practical over large areas (these species are difficult to control as they quickly reinvade from rhizomes), however in

the long-term it may be possible to suppress and reduce the dominance of these grasses in some places by increasing the cover of saltmarsh ribbonwood. There appears to be some potential for natural regeneration (and expansion) of saltmarsh ribbonwood in the Operational Area, as seedlings were seen during the site visit, therefore supplementary planting may not be necessary to increase the shrub cover.

14.7 Pest plant surveillance

Ongoing surveillance for any potential pest plants should be maintained throughout the Operational Area, preferably on an annual basis. Any other pest plant species encountered during the surveillance or other management activities should be recorded and control carried out as necessary. Ongoing monitoring of these sites should also be carried out to ensure that reinfestation does not occur.

# 15. RESTORATION PLANTING

There are several key habitat types that could be actively restored and/or enhanced in the Operational Area. These are mainly freshwater wetland habitats - such as kahikatea forest and flaxland - and some planting in terrestrial/dryland (amenity) areas is also being undertaken (see Plate 16). Habitats and areas proposed for planting are shown in Figure 6, and appropriate brief descriptions and planting schedules for each area are provided below (from Butt 2015).

#### Methods

Detailing a planting schedule and methodology is beyond the scope of this plan, but some key considerations are:

- Only ecologically-appropriate eco-sourced plants should be used: ensure availability of preferred species grown from locally sourced seed.
- Site preparation: initial weed control.
- Plant maintenance to help plants establish: control weeds, prevent hare damage, removal of plant guards, infill planting.

#### <u>Monitoring</u>

Monitoring is essential for measuring the success and effectiveness of management actions, particularly when looking at trends over time. A series of permanent photopoints should be set up throughout the project area to monitor:

- Changes in pest plant distribution and abundance;
- Establishment and growth of restoration plantings, and the transition to an indigenous vegetation community.

Drone footage could be potentially useful for monitoring changes at Yarrs Flat. It is a relatively low impact and cost-effective technique that can record changes throughout the area, including in hard-to-reach areas. The placement of ground markers (such as those used for photopoints) would help to pinpoint locations and facilitate future comparisons.

#### Kahikatea Community

In conjunction with control of crack willow at the site, restoration of a kahikatea forest community could be undertaken by planting with appropriate indigenous species. Butt (2015) proposed that kahikatea forest could be planted in two areas adjacent to the Ararira/LII River (see dark pink areas on Figure 6). A list of species suitable for planting in each of the two areas and the suggested composition and spacing, are provided in Tables 4 and 5 below. The northern area is referred to as *Kahikatea Forest A* and the southern area is *Kahikatea Forest B*.

Butt (2015) suggested the following approach for the plantings:

"These plantings should be undertaken in spring. The retention of the willow canopy while the seedlings establish will be beneficial as it will provide shelter from wind and a degree of frost protection. The willows can be killed standing and left to rot and collapse naturally once these plants are well established."

The above approach suggested by Butt (2015) seems reasonable (i.e. retention of the adult willows until indigenous plants are established) and the planting schedules in Tables 4 and 5 are appropriate for the general Te Waihora area. They will be appropriate at Yarrs Flat subject to the matching of particular species to local site characteristics, particularly substrate conditions (e.g. nutrient and salinity levels) and soil moisture, including variation associated with different lake levels. A good understanding of lake level effects is required prior to any planting (or other physical works).<sup>1</sup>

Scientific Name	Common Name	Composition	Spacing	Number
Astelia fragrans	kakaha	8%	1.2	220
Astelia grandis	kakaha	4%	1.2	110
Carpodetus serratus	putaputawētā	2%	1.5	35
Coprosma linariifolia	yellow wood, mikimiki	5%	1.5	90
Coprosma propinqua	mikimiki	8%	1.2	220
Coprosma robusta	karamū	12%	1.5	210
Coprosma rotundifolia	round-leaved coprosma	5%	1.5	90
Cordyline australis	cabbage tree, tī kōuka	10%	1.5	175
Dacrycarpus dacrydioides	kahikatea	5%	1.5	90
Elaeocarpus hookerianus	pōkākā	4%	1.5	70
Hebe salicifolia	koromiko	4%	1.2	110
Hoheria angustifolia	narrow-leaved lacebark, houhere	narrow-leaved lacebark, 6%		100
Pennantia corymbosa	kaikōmako	3%	1.5	55
Pittosporum eugenioides	tarata	4%	1.5	70
Pittosporum tenuifolium	kōhūhū	7%	1.5	120
Plagianthus regius	mānatu	7%	1.5	125
Podocarpus totara	tōtara	1%	1.5	20
Prumnopitys taxifolia	mataī	2%	1.5	35
Pseudopanax arboreus	whauwhaupaku	3%	1.5	55
			TOTAL	2,000

Table 4: Planting schedule for Kahikatea Forest A (8,350 m<sup>2</sup> and 41% planted) (from Butt 2015).

<sup>&</sup>lt;sup>1</sup> More detailed prescriptions have not been provided here as that would require in-depth assessment of the proposed restoration planting areas, which was beyond the scope of this project.

Scientific Name	Common Name	Composition	Spacing	Number
Austroderia richardii	toetoe	12%	1.5	115
Carex secta	pūkio, niggerhead	25%	1.0	530
Dacrycarpus dacrydioides	kahikatea	8%	1.5	75
Elaeocarpus hookerianus	pōkākā	2%	1.5	20
Leptospermum scoparium	mānuka	35%	1.0	745
Phormium tenax	harakeke/lowland flax	18%	1.5	170
			TOTAL	1,655

# Table 5:Planting schedule for Kahikatea Forest B (3,650 m² and 51% planted) (from Butt 2015).

#### Flaxland

Harakeke/lowland flax is currently rare in the Operational Area (Appendix 3), however there is an opportunity to restore indigenous flaxland in some freshwater wetland habitats. Butt (2015) suggested the planting of two areas of flaxland along the northern boundary of the site, adjacent to Wolfes Road (Figure 6). The western area is referred to as *Flaxland A* and the eastern area is *Flaxland B*. See Tables 6-7 for suggested plant species, spacing, and numbers. These plantings should be undertaken in late spring/early summer, as the soils are permanently moist, and planting should be done in conjunction with a lake opening, to avoid inundation (Butt 2015).

Table 6:Planting schedule for Flaxland A (10,100 m² and 43% planted) (from Butt 2015).

Scientific Name	Common Name	Composition	Spacing	Number
Austroderia richardii	toetoe	25%	1.5	550
Coprosma propinqua	mikimiki	15%	1.2	52
Cordyline australis	cabbage tree, tī kōuka	10%	1.5	220
Phormium tenax	harakeke/lowland flax	50%	1.5	1,100
			TOTAL	2,390

Table 7: Planting schedule for Flaxland B (3,600 m<sup>2</sup> and 22% planted) (from Butt 2015).

Scientific Name	Common Name	Composition	Spacing	Number
Austroderia richardii	toetoe	25%	1.5	200
Cordyline australis	cabbage tree, tī kōuka	5%	1.5	40
Phormium tenax	harakeke/lowland flax	70%	1.5	560
			TOTAL	800

The proposed planting schedules in Tables 6 and 7 are appropriate for restoration of indigenous flaxland at this site, with harakeke/lowland flax being the main species to be planted. Comments above in relation to Tables 4 and 5 are also relevant.

#### Carex dipsacea site

Butt (2015) proposed that the area of crack willows where *Carex dipsacea* is located (Figure 4) should be under-planted with a mixture of indigenous species, including kahikatea,  $p\bar{o}k\bar{a}k\bar{a}$  and cabbage tree (see Table 8). Once these replacement trees have formed a canopy the willows should be poisoned. This will allow for the retention and expansion of the *C. dipsacea* population. Care should be taken to ensure that *C. dipsacea* plants are not adversely affected by these works.



Scientific Name	Common Name	Composition	Spacing	Number	
Astelia grandis	kakaha	4%	1.2	75	
Carpodetus serratus	putaputawētā	2%	1.5	25	
Coprosma linariifolia	karamū	5%	1.5	60	
Coprosma propinqua	mikimiki	8%	1.2	150	
Coprosma robusta	karamū	11%	1.5	140	
Coprosma rotundifolia	round-leaved coprosma	5%	1.5	60	
Cordyline australis	cabbage tree, tī kōuka	abbage tree, tī kōuka 10%			
Dacrycarpus dacrydioides	kahikatea 5%		1.5	60	
Elaeocarpus hookerianus	pōkākā	4%	1.5	50	
Hebe salicifolia	koromiko	4%	1.2	75	
Hoheria angustifolia	narrow-leaved lacebark, 6%		1.5	70	
Pennantia corymbosa	kaikōmako	3%	1.5	35	
Plagianthus regius	mānatu	7%	1.5	85	
Podocarpus totara	tōtara	1%	1.5	10	
Prumnopitys taxifolia mataī		2%	1.5	25	
Pseudopanax arboreus	whauwhaupaku	3%	1.5	35	
			TOTAL	1,075	

Table 8:Planting schedule for the Carex dipsacea site (2,380 m² and 100% planted)<br/>(from Butt 2015).

Comments above in relation to Tables 4 and 5 are also relevant here.

#### Amenity Area (Dryland Area)

A Landscape Plan for the amenity area (i.e. the dryland area in Figure 6) was developed by Lincoln University (2016). The Plan described the concept behind the planting. Butt (2015) provided a suggested planting schedule for this area (Table 9), which included a number of species that are typical of 'dryland' environments (e.g. *Discaria toumatou, Muehlenbeckia astonii, Ozothamnus leptophyllus*). This list was reviewed by DOC staff and a smaller number of species was planted at the site by volunteers in 2015 and 2016 (see Table 10).

Table 9:Planting schedule for the amenity area (37,114 m² and 23% planted) (from Butt<br/>2015) (referred to as the 'Duneland-Hut area' in Butt 2015).

Scientific Name	Common Name	Composition	Spacing	Number
Coprosma crassifolia	thick-leaved mikimiki	5%	1.2	340
Coprosma propinqua	mikimiki	10%	1.2	680
Coprosma virescens	lacy mikimiki	2%	1.2	135
Cordyline australis	cabbage tree, tī kōuka	3%	1.5	130
Corokia cotoneaster	korokio	2%	1.2	135
Discaria toumatou	matagouri, tūmatakuru	5%	1.2	340
Hoheria angustifolia	narrow-leaved lacebark, houhere	2%	1.5	90
Kunzea robusta	kānuka	10%	1.5	435
Leptospermum scoparium	mānuka	3%	1.2	200
Muehlenbeckia astonii	wiggywig, shrubby tororaro	3%	1.2	200
Muehlenbeckia complexa	pōhuehue	5%	1.2	340
Ozothamnus leptophyllus	tauhinu	35%	1.2	2,380
Pittosporum tenuifolium	kōhūhū	8%	1.5	350
Plagianthus regius	mānatu, lowland ribbonwood	2%	1.5	90
Podocarpus totara	tōtara	1%	1.5	45
Solanum laciniatum	poroporo	1%	1.5	45
Sophora microphylla	kōwhai	1%	1.5	45
Teucridium parvifolium	NZ verbena	2%	1.2	135
			TOTAL	6.115



Scientific Name	Common Name	Composition	Spacing	Number

Duneland Climbers – To be planted once the canopy is established						
Clematis foetida	clematis			50		
Parsonsia capsularis	NZ jasmine			50		
Rubus schmidelioides	bush lawyer, tātarāmoa			50		
Rubus squarrosus	leafless bush lawyer, tātarāmoa			50		
			TOTAL	200		

Table 10:Species and number of plants that were planted in the amenity area by volunteers<br/>in 2015 and 2016 (information provided by Robin Smith, December 2016).

Scientific Name	Common Name	Number of plants 2015	Number of plants 2016
Austroderia richardii	toetoe	100	300
Carmichaelia australis	native broom	80	-
Coprosma propinqua	mikimiki	150	112
Cordyline australis	cabbage tree, tī kōuka	120	462
Discaria toumatou	matagouri	80	-
Hoheria angustifolia	narrow-leaved lacebark, houhere	60	-
Leptospermum scoparium	mānuka	48	-
Phormium tenax	harakeke/lowland flax	258	527
Plagianthus divaricatus	saltmarsh ribbonwood	24	1200
Plagianthus regius	mānatu, lowland ribbonwood	80	-
	TOTAL	1000	2601

The plants in Table 10 are considered to be appropriate for this site, with the exception of native broom (*Carmichaelia australis*) and matagouri (*Discaria toumatou*), which are not particularly tolerant of damp or slightly saline soils. Comments above in relation to Tables 4 and 5 are also relevant here.

# 16. MANAGEMENT AND MONITORING OF RARE PLANTS

Any management undertaken in Yarrs Flat Operational Area should consider the habitat requirements of rare plant species. For example, removal of the willow canopy and changes in salinity or water levels may have detrimental effects on rare plants such as swamp nettle (Butt 2015).

#### Swamp Nettle (Urtica perconfusa)

Swamp nettle appears to be common along the margins of the Ararira/LII River, however its distribution and abundance in the Operational Area have not been accurately documented or mapped, i.e. there are no GPS coordinates or other GIS data showing its extent. Lack of information makes it difficult to determine whether the swamp nettle population is stable, increasing, or decreasing over time, which in turn makes it difficult to make management decisions, for swamp nettle and for other species at Yarrs Flat. For example, swamp nettle may not survive in dense patches of raupō, therefore expansion of raupō in the Operational Area needs to be managed carefully so that it does not spread into key swamp nettle habitats.

In order to obtain baseline data and allow for future monitoring of the swamp nettle population in the Operational Area, a survey of its distribution and abundance should be carried out in the near future. Monitoring of swamp nettle should then be carried out every 2-3 years to detect any changes in the population size or extent. This will then allow the Department of Conservation to assess whether management undertaken at the site is having any adverse effects on swamp nettle, and to determine an appropriate management response.

#### Native Musk (Thyridia repens)

Native musk occurs in the mudflats on the northern edge of Te Waihora, which is mostly outside the Operational Area. Active management of native musk through planting is not considered to be feasible. A recent report by Wildland Consultants (2016) describes efforts to transplant native musk and the challenges associated with establishing plants at new sites on the edge of the Waitemata Harbour in Auckland.

Monitoring of native musk at Yarrs Flat is essential to determine the size, condition, and trends of the population, to provide information on the impacts of pest plants and fluctuating lake levels on its habitat, and to determine how it is best managed. Regular scheduled monitoring of native musk is required at one-yearly intervals for three years, to establish baseline information and then at two-yearly intervals to monitor trends. This frequency is warranted as the habitat that it occurs in is vulnerable to weed incursions and changes in water level may affect the availability of suitable habitat. Changes in the lake water level in particular may be important for its management, as it may behave as an ephemeral in response the changing availability of suitable lake margin habitat.

Monitoring should focus on the following components:

- Plant locations to be recorded using a GPS unit.
- Plant number and size.
- Plant health, e.g. foliage density, dieback, browse.
- Associated species and vegetation cover.
- Abundance of pest plants.
- Site location in relation to lake water levels.

#### Fennel-leaved Pondweed (Stuckenia pectinata)

Management of *Stuckenia pectinata* in the lake is being addressed through the Whakaora Te Waihora aquatic macrophyte restoration programme (Butt 2015).

#### Locally Uncommon Plant Species

• <u>Carex dipsacea</u>

The exact size and extent of the *Carex dipsacea* population at Yarrs Flat WMR is not known. It is suggested that a baseline survey is carried out to determine the distribution and abundance of *C. dipsacea* in this area. Ongoing monitoring of *C. dipsacea* is also suggested in conjunction with the planting proposed above, in order to ensure that the population is not adversely affected by management activities such as willow control and planting.



#### • Lake clubrush/kuawa (Schoenoplectus tabernaemontani)

Lake clubrush is rare at Yarrs Flat. Monitoring should be carried out to determine population trends in the Operational Area.

# 17. RECREATIONAL USE AND FACILITIES

Being so close to Christchurch City and the more rural townships such as Tai Tapu, Lincoln, Springston, Doyleston, Southbridge, Leeston, and Prebbleton, there is a large local population base and potential for increased visitation to the Reserve. Enhancement of access to the Reserve and promoting it as a visitation site will encourage more community involvement in, and understanding of, this lowland wetland. Comments provided below reinforce similar suggestions provided by Lincoln University (2016) and Opus (2016).

It will be important to ensure that activities and related infrastructure are in keeping with the principles in the JMP, where these should not detract from the customary use of, and access to, Te Waihora and its resources. It will also be important, given that the Reserve was primarily set aside for wildlife management, that the specific locations of any tracks or other infrastructure take into account how they may affect wildlife, so people can view but not negatively impact its protection, for example ensuring they are not too close to important feeding and breeding areas. The placement of new walking tracks may also have to take into consideration the current location of maimai, to avoid potential safety issues.

Any archaeological sites discovered during planning and/or implementation of infrastructure development will need to be dealt with in a respectful and appropriate manner. An accidental discovery protocol may need to be prepared.

#### **Recreational Activities**

The main activities currently undertaken at and immediately around Yarrs Flat are bird observation, game bird shooting, fishing, boating, photography, walking, and picnicking. These types of activities generally have low ecological impacts and would be priority activities to continue in this area, for the long-term. Maimai, for game bird hunting, are already present in the area (Plate 27) and it is suggested that no more are built.

#### Reserve Access

Vehicles are currently able to be driven into parts of the wetland and this is causing damage to the sensitive plant communities (Plate 28). Vehicle tracks through the wetland also detract from the naturalness of the reserve and can make it appear less valued and cared for. Butt (2015) mentions the role of disturbance in maintenance of some plant communities (turf communities) and that some areas of *Cotula coronopifolia, Sarcocornia quinquiflora* subsp. *quinquiflora, Puccinellia stricta* and *Triglochin striata* could be invaded by grasses such as *Agrostis stolonifera*, if they were left undisturbed. However, these communities are common around the lake and so will be maintained elsewhere.



Plate 27: Maimai erected by game bird hunters.

Plate 28: Damage caused by vehicle access to the lake edge in Yarrs Flat Operational Area.

Vehicle access to the Reserve must be restricted, as a priority, and a bollarded and gravelled access route is suggested, to guide traffic from the main entrance gate into a planted parking and amenities area. This area is well-defined in the Lincoln (2016) and Opus (2016) plans and planting has already commenced here. Consideration will need to be made as to whether there is a justifiable requirement for a maintenance vehicle access route through the bollards, such as a lockable gate/portal installed during construction.

#### Walking Tracks

It will be important to consider, in the development of walking tracks, the level of access in relation to disabled access and access during wet periods. Some of the existing vehicle tracks could be used by foot traffic, such as the one that heads in a southerly direction along the 'eastern peninsula'. This already provides a relatively open and easy to follow track, but it is suggested that some levelling off needs to occur where substantial ruts have formed. This will make the access easier and safer for people. A new track leading people from the parking/amenities area, in a southeasterly direction, to very near the lake edge would provide a wonderful vista across the Lake.

It may be ideal, in the longer term, to construct a loop track that traverses much of the Reserve, taking in the various habitat types and the Ararira/LII River. Extreme care would need to be taken in the development of such a track, to ensure that it avoids areas used by swamp birds, waders, and waterfowl. It should also avoid important bittern and marsh crake feeding areas, as these species are shy and may be discouraged from using areas if there is higher public use.

#### Picnic Area

It would be desirable to encourage people to stay in the Reserve for longer, by providing a picnic area. A nice spot for this could be the suggested slightly raised area, just beyond the parking/amenities area. The practice of 'pack it in, pack it out' could be encouraged at this site and so no rubbish bins would be provided. If people



are going to be encouraged to stay for longer periods then a toilet facility will need to be installed, to avoid the creation of more mess and pollution.

#### Information and Education

To enhance public appreciation of the Reserve it would be ideal to install interpretation panels at selected sites. These would highlight features of the Reserve, such as: cultural history and use; vegetation, flora, and fauna (terrestrial and aquatic); European history; and why the Reserve was established and is important. Lincoln Primary School have adopted Yarrs Flat as their outdoor classroom and a variety of nature based activities have been run there by Te Ara Kakariki and Enviroshcools Canterbury. Other local schools could be further encouraged by being given projects to run, such as: planting maintenance, lizard monitoring, or predator control. There could be scientific research opportunities associated with monitoring responses of the wetland habitats and natural communities that could be attractive to the involvement of Lincoln and/or Canterbury universities. Lincoln EnviroTown or the Waihora Ellesmere Trust could also adopt the Reserve.

#### <u>Monitoring</u>

Because of the high sensitivity of some avifauna to disturbance, it would be advisable to monitor the effects of increased public use:

- Wading bird mapping, discussed in Section 13.3, could include an assessment of bird use of the area in relation to maimai.
- A bittern monitoring programme, as discussed in Section 13.5, should incorporate ways to address the effects of a public walking track on bittern.

# 18. STAKEHOLDER INVOLVEMENT

Key stakeholders involved with Yarrs Flat are: Te Rūnanga o Ngāi Tahu, the Department of Conservation, Fonterra Co-operative Group Limited, the Waihora Ellesmere Trust, neighbouring landowners and the nearby community, including schools. Their interests and priorities for involvement will vary and could include wanting to protect the habitat and wildlife, retention of spiritual and mahinga kai values, spending time observing birds, boating, game bird shooting, seeing the area as a flood buffer and drainage conduit, spending time relaxing, enjoying the environment, and learning about its natural values. Sometimes these interests could conflict and so will need to be balanced or possibly segregated to some degree. It will be important to base these decisions on sound knowledge of the site and its ecology, with a strong emphasis on the main priorities for the Reserve and the overall vision.

Ways to encourage stakeholder engagement could include:

- Continue the community planting days.
- Hold community event days or workshops where people can come and learn more about the ecology of the wetland and its functions and cultural uses of plant and food sources available there.



- Scientific involvement, such as mini-bioblitz: this could involve many people and also collect some valuable information on the Reserve's flora and fauna.
- Landowner workshops to show people the wetland is a useful and functional part of the environment - perhaps promote how they could develop areas on their land. This could also benefit other endangered wetland species that are not present at Yarrs Flat, such as Canterbury mudfish.
- Promotional days, in a similar vein to the godwit days at at Charlesworth Reserve.
- Promotion of Yarrs Flat as a destination picnicking or an exciting detour destination on a cycle trip. It may be worthwhile to investigate how this could be incorporated into a side-loop of the rail trail.
- Engage more local schools to adopt a patch or adopt a species or management activity (such as suggested in Section 17).

# 19. FUTURE MANAGEMENT

Ecological health of Yarrs Flat is greatly influenced by the wider catchment and water control. Restoration works can start immediately, such as weed control and some planting, but further investigation is required of water flows/barriers, early on in the process, to ensure that sensitive plants will not be adversely affected. Management actions are listed in Table 11, with indicative timings and relative priorities.



Task	Priority	Area/Zone	Action Required	Timing	Objective/ Reason
Ecological survey	High	Whole site	<ul> <li>Hydrological study to determine a viable option for redirecting the water to enhance habitats.</li> </ul>	ASAP	
Ecological survey	High	Bittern restoration area	Survey for bittern.	Spring- Summer 2016/2017 (ongoing)	Determine the current area of Yarrs Flat used by bittern.
Ecological survey	High	Freshwater wetland	Survey for swamp nettle ( <i>Urtica perconfusa</i> ) to determine distribution and population size.	2017 (this must be done prior to crack willow control)	Help determine management needs for an At Risk plant species.
Ecological survey	High	Freshwater wetland	Accurately map the distribution of raupō.	Summer 2017	Help determine needs for bittern habitat enhancement.
Ecological survey	Medium	Freshwater wetland	Survey for <i>Carex dipsacea</i> to determine distribution and population size.	Summer 2017	Help determine management needs for locally uncommon plant species.
Ecological survey	Medium	Bittern restoration area	Water flow/quality surveys.	Spring- Summer 2016/2017 (ongoing)	Determine the amount of available bittern feeding habitat.
Ecological survey	Medium	Saltmarsh habitat	Saltmarsh surveys.	Summer 2016/2017 (ongoing)	Fine-scale mapping of saltmarsh habitat.
Ecological survey	Medium	Lake edge	Wader surveys.	Summer 2016/2017 (ongoing)	Understand bird activity.
Ecological survey	Medium	Intensive buffer control area	<ul> <li>Establish tracking tunnel monitoring of predators.</li> </ul>	Spring 2017 (ongoing)	Baseline predator indices.
Ecological survey	Low	Whole site	<ul> <li>Survey vegetation and update the vegetation types map (the last vegetation survey was done in 2007).</li> </ul>	Within two years	Detect any large-scale changes in vegetation cover.
Weed control	High	Freshwater wetland	Control grey willow at all sites in the Operational Area.	2017	Restore indigenous freshwater wetland vegetation.

 Table 11:
 Summary of management actions and priorities for Yarrs Flat Wildlife Management Reserve.



Task	Priority	Area/Zone	Action Required	Timing	Objective/ Reason
Weed control	High	Freshwater wetland	<ul> <li>Control crack willow in the lower half of the Ararira/LII River and the two proposed kahikatea forest planting areas (see Figure 6). The specific areas to be controlled and the sequence/timing of control should be determined after the swamp nettle survey has been carried out.</li> </ul>	2017 (this must be done after the swamp nettle survey)	Restore indigenous freshwater wetland vegetation.
Weed control	High	Freshwater wetland	<ul> <li>Control/eradicate reed canary grass.</li> <li>Control of this species is already underway at various sites around Te Waihora and is being co-ordinated by ECan.</li> </ul>	2016/ 2017 ongoing	Protect indigenous ecological values. This highly invasive weed currently has a limited distribution at the site.
Weed control	Medium	Freshwater wetland	Control orange day lily.	2017	Protect indigenous ecological values.
Weed control	Medium	Freshwater wetland	Control yellow flag iris.	2017	Protect indigenous ecological values.
Weed control	Low	Freshwater wetland	Control boxthorn.	2017	Protect indigenous ecological values.
Weed control	Low	Freshwater wetland/ roadsides	Control gorse.	2017	Protect indigenous ecological values.
Pest animal control	High	Intensive buffer control area	<ul> <li>Implement intensive buffer control for mammalian pests.</li> </ul>	Winter 2018 (ongoing)	Reduce predator abundance.
Pest animal control	Medium	Low intensity control area	<ul> <li>Undertake mammalian pest control in this area, as per the plan, if monitoring indicates it is required.</li> </ul>	Late-summer 2019 (repeated annually)	Remove predators from within the wetland.
Pest animal control	Medium	Adjacent farmland	Commence liaison about community led landscape scale control.	ASAP - with a view to commencing control during winter 2018.	Reduce immigration of predators.
Planting / vegetation management	Medium	Amenities area	<ul> <li>Planting of indigenous species as per Lincoln University DesignLab report (2016).</li> </ul>	Ongoing	Improve the aesthetics and amenity values.
Planting / vegetation management	Medium	Freshwater wetland	<ul> <li>Planting of indigenous flaxland community (Figure 6).</li> </ul>	2018-2020	Restore indigenous vegetation cover and improve aesthetics.
Planting / vegetation management	Medium	Freshwater wetland	<ul> <li>Planting of kahikatea forest community (following crack willow control).</li> </ul>	2018-2020	Restore indigenous vegetation cover.
Planting /	Medium	Freshwater wetland	Planting of Carex dipsacea site (following crack	2018-2020	Restore indigenous vegetation



Task	Priority	Area/Zone	Action Required	Timing	Objective/ Reason
vegetation management			willow control).		cover and retain a locally uncommon plant species.
Planting / vegetation management	Medium to low	Freshwater wetland	<ul> <li>Possible enhancement planting of raupō - but only if sufficient natural colonisation does not occur</li> </ul>	Monitoring dependant	Increase the cover of raupo for bittern.
Planting / vegetation management	Low	Salt-tolerant vegetation types	<ul> <li>Retain indigenous vegetation cover and allow for an increase in saltmarsh ribbonwood cover.</li> </ul>	Ongoing	Increase indigenous vegetation cover.
Waterway and riparian management	High	Bittern breeding and feeding restoration areas	<ul> <li>Hydrological assessment of bank/riparian alterations for raupō establishment.</li> </ul>	Immediate	Feasibility and options for water management.
Waterway and riparian management	High	Bittern breeding and feeding restoration areas	<ul> <li>Commencement of bank/riparian alterations, and channel management to enhance bittern areas.</li> </ul>	c. February- March 2018	Enhancement of bittern breeding and feeding habitat.
Waterway and riparian management	Low	Northwestern tip, public conservation land just outside reserve	<ul> <li>Spoil dumping on true left of Ararira/LII River - approach the LII drainage committee to see if an alternative can be sourced.</li> </ul>		Improve aesthetics.
Monitoring	High	Whole site	<ul> <li>Establish photopoints for qualitative monitoring. Insert marker pegs/posts that can be easily relocated in drone footage and as sites to take still photographs from.</li> </ul>	Summer 2017	Enable accurate ongoing comparisons of vegetation changes throughout the wetland.
Monitoring	High	Freshwater wetland	<ul> <li>Monitor the distribution and abundance of swamp nettle.</li> </ul>	Annual	Determine population trends and ongoing management needs of swamp nettle.
Monitoring	High	Freshwater wetland	<ul> <li>Monitor the distribution of raupō and colonisation of any hydrologically altered areas.</li> <li>If raupō is not naturally increasing within this time period then enhancement planting will be needed.</li> </ul>	Annual	Assess the response of raupō to willow control and hydrological changes.
Monitoring	Medium	Ararira/LII River margins	<ul> <li>Monitor the Carex dipsacea population.</li> </ul>	Annual	Determine population trends and ongoing management needs of <i>Carex dipsacea</i> .
Monitoring	Medium	Mudflats	Monitor the native musk population.	Annual	Determine population trends and ongoing management needs of native musk.
Monitoring	High	Bittern and bittern habitat monitoring	<ul><li>Survey for bittern.</li><li>Surveys of raupō establishment, water flow and</li></ul>	Annual (ongoing)	Assess the success of bittern habitat restoration.



Task	Priority	Area/Zone	Action Required	Timing	Objective/ Reason	
			feeding habitat quality.			
Monitoring	High	Saltmarsh habitat	Saltmarsh surveys.	Annual (ongoing)	Fine-scale mapping of saltmarsh habitat and its use by waders.	
Monitoring	High	Lake edge	Wader surveys.	Annual (ongoing)	Understand bird use over time.	
Monitoring	High	Pest control monitoring	<ul> <li>Tracking tunnel monitoring to be established - to monitor before pest control begins and then ongoing.</li> </ul>	Annual (ongoing)	To determine the impact of pest control on mammalian predator distribution.	
Public recreational use and facilities	High	Amenities area	<ul> <li>Bollarded access road to be built.</li> <li>Establish designated parking area.</li> </ul>	Summer 2017	To prevent further vehicle damage in sensitive areas.	
Public recreational use and facilities	Medium to low	Amenities area	<ul> <li>Toilet and picnic area.</li> </ul>	2018	To encourage visitors to stay longer by providing facilities.	
Public recreational use and facilities	Medium	Amenities area	<ul> <li>Lookout/viewpoint to be established just beyond the amenities area, perhaps a slightly raised area.</li> <li>Walking tracks/boardwalk.</li> <li>Levelling of deep vehicle tracks.</li> </ul>	2018-2019	To enhance the visitor experience by providing good tracks, viewing spots and information about key features and values of the wetland and	
Public recreational use and facilities	Medium	Whole site	<ul> <li>Site interpretation/signage.</li> <li>School/University involvement - approach local schools to see how they are prepared to become involved in the site.</li> </ul>	2017 - 2018	Te Waihora.	



# 20. CONCLUSIONS

Te Waihora/Ellesmere is a very important wetland, with particularly significant ecological and cultural values. It has, though, been subject to a long history of ecological degradation.

Yarrs Flat Wildlife Management Reserve is a key part of the Te Waihora/Ellesmere ecosystem, with many of the values and ecological management issues evident in the wider system.

There are considerable opportunities to improve the state of habitats at Yarrs Flat and this Plan includes provisions for the management of water flows, pest plants, pest animals, and restoration planting opportunities within the project area. The Plan also provides details of threatened species, recreation opportunities, and stakeholder engagement. Monitoring is also addressed, including the establishment of photopoints and options for fauna monitoring.

Restoration work can start immediately, and this will provide a catalyst for community engagement.

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# PAST AND PRESENT DISTRIBUTION OF WETLAND VEGETATION AROUND TE WAIHORA/LAKE ELLESMERE



Maps from Clark and Partridge (1984), Page 4.

(a) Probable distribution of wetland vegetation in pre-European times (after Burrows 1969).



(b) Distribution of present day wetland vegetation.

# WAIHORA ELLESMERE TRUST BIRD COUNTS 2013-2016

#### **Monitoring Sites**

Kaitorete Tip, Kaitorete Spit, Birdlings Flat A, Birdlings Flat B, Kaituna Lagoon, Halswell Flats B, Halswell Flats A, Osbornes, Eastern Greenpark, Embankment Road, Yarrs Flat, Selwyn, Rennies Bay, Doyleston, Harts Creek, Lakeside, Taumutu.

Group	Species	2016	2015	2014	2013
Shags	Black shag	341	339	615	396
	Pied shag	187	137	240	159
	Little shag	15	6	51	28
	Spotted shag	3		4	2
	Total	546	482	910	585
Herons	White heron	0	4	3	5
	White-faced heron	39	78	92	99
	Australasian bittern	1			1
	Total	40	82	95	105
Waterfowl	Mute swan	6	9	14	6
	Black swan	7,186	5,528	7,473	8,598
	Feral goose	206	291	443	530
	Canada goose	4,537	3,312	3,777	5,576
	Cape Barren goose	2	3		
	Paradise shelduck	4,085	4,548	5,148	4,163
	Chestnut-breasted shelduck	1			
	Duck species		749	696	1,942
	Mallard (and grey duck hybrids)	1,896	3,610	5,173	5,916
	Australasian shoveler	2,086	2,070	5,893	5,173
	Grey teal	12,565	13,145	12,504	13,102
	Grey teal/shoveler	80	2,947	780	
	New Zealand scaup	170	70	12	82
	Total	32,820	36,282	41,913	45,088
Oystercatchers	Variable oystercatcher			2	
	Pied oystercatcher	12	18	17	33
	Total	12	18	19	33
Stilts	Pied stilt	3,261	4,777	4,959	3,726
	Black stilt	2	2	2	2
	Hybrid stilt	3	2		4
	Total	3,266	4,781	4,961	3,732
Plovers, Dotterels	Banded dotterel	1,323	2,325	1,496	1,228
and Lapwings	Wrybill	216	167	243	429
	Spur-winged plover	66	169	328	197
	Turnstone			4	1
	Pacific golden plover	24	10	45	7
	Total	1,629	2,671	2,116	1,862
Sandpipers,	Sharp-tailed sandpiper	9	3	18	12
Godwits and	Red-necked stint	23	61	44	34
Curlews	Bar-tailed godwit	224	189	120	436
	Red knot	44	40	44	9
	Curlew sandpiper	3	9	18	2
	Pectoral sandpiper	2		6	3
	Sanderling		1	2	
	Common greenshank			1	
	Total	305	303	253	496

Group	Species	2016	2015	2014	2013
Gulls and Terns	Black-backed gull	878	812	691	1733
	Red-billed gull	16	43	38	57
	Black-billed gull	183	433	2359	829
	Black-fronted tern	34	23	61	46
	White-fronted tern	166	48	175	59
	Caspian tern	115	113	386	405
	Gull-billed tern		2	16	7
	Total	1,392	1,474	3,726	3,136
Kingfishers	New Zealand kingfisher	1	10	6	4
Swallows	Welcome swallow	759	899	127	
Raptors	Australasian harrier	75	76	67	67
Rails Pūkeko		87	90	97	114
Grebes	Australasian crested grebe	2	1	3	2
Spoonbills	Royal spoonbill	656	689	871	531



Bird counts for Yarrs Flat during the 2016 Waihora Ellesmere Trust survey






# THREATENED ENVIRONMENT CLASSIFICATION

Threatened Environment Classification for Te Waihora area from Walker et al. (2007).



<u>Key</u>

Acutely Threatened	<10% indigenous vegetation cover remaining
Chronically Threatened	10-20% indigenous vegetation cover remaining
At Risk	20-30% indigenous vegetation cover remaining
Critically Underprotected	>30% indigenous vegetation cover remaining and <10% protected
Underprotected	>30% indigenous vegetation cover remaining and 10-20% protected
Less Reduced and Better Protected	>30% indigenous vegetation cover remaining and >20% protected



## VEGETATION TYPES IN YARRS FLAT WILDLIFE MANAGEMENT RESERVE

The following map and descriptions of the vegetation types in Yarrs Flat Wildlife Management Reserve are from Clark and Partridge (1984): The Shoreline Vegetation of Lake Ellesmere, Canterbury, New Zealand. Scientific names have been updated (introduced species are denoted by \*).



#### A. Improved Pasture on Dry Soils

In the field at the end of Wolfes Road is an area of elevated land which is far drier than the rest of this part of the reserve. The pasture grasses such as crested dogstail (*Cynosurus cristatus*\*), sweet vernal (*Anthoxanthum odoratum*\*) and chewings fescue (*Festuca rubra* subsp. *commutata*\*) are indicative of this type of pasture as is the small clover, haresfoot trefoil (*Trifolium dubium*\*).

#### **B.** Improved Pasture on Wet Soils

Most of the area grazed by cattle has a mixture of grasses and weeds which tolerate both grazing and heavy trampling. The grasses include cocksfoot (*Dactylis glomerata*\*), creeping bent (*Agrostis stolonifera*\*) and kneed foxtail (*Alopecurus geniculatus*\*), while common weeds include toadrush (*Juncus bufonius*\*), jointed rush (*Juncus articulata*\*) and monkey musk (*Erythranthe guttata*\*).

#### C. Pasture of Creeping Bent

The least elevated of the pasture types is almost pure creeping bent. This area is subject to flooding when the lake levels are high.

#### D. Pasture with Sea Rush and Marsh Ribbonwood

This is a mixture of the taller halophytes, sea rush (Juncus kraussii subsp. australiensis) and marsh ribbonwood (Plagianthus divaricatus) and somewhat salt-tolerant pasture



grasses such as salt barley grass (*Critesion marinum*\*), couch (*Elytrigia repens*\*) and creeping bent. The density of the tall plants can vary from open with plentiful pasture between, to almost impenetrable with very little between.

### E. Mosaic of Sea Rush and Smaller Halophytes

On the long finger of raised land there are patches of sea rush with larger areas of smaller halophytes such as glasswort (*Sarcocornia quinqueflora* subsp. *quinqueflora*), *Puccinellia stricta*, *Selliera radicans*, buck's-horn plantain (*Plantago coronopus*\*) and creeping bent. These species are more salt-tolerant than the grasses of D.

#### F. Sea Rush on Mudflats (NB. not in Yarrs Flat Operational Area)

Clumps of sea rush occur on mudflats colonised by species different from those of the above pasture and saline areas. These are semi-aquatics such as *Thyridia [Mimulus] repens* and *Triglochin striata*, or in some cases the ground may be bare. Occasionally there are raised areas with species of D and E such as salt barley grass, creeping bent or *Selliera radicans*.

## G. Glasswort and Salt Barley Grass (NB. not in Yarrs Flat Operational Area)

Towards the east the soil salinity increases, resulting in the absence of the less tolerant species. Furthermore it becomes sandier so that the species of the muddier areas such as sea rush, saltmarsh ribbonwood and three-square (*Schoenoplectus pungens*) are also absent. The two species which remain are the annual salt barley grass and the very tolerant glasswort, which together form a fairly dense sward on the sandy saline soils.

## H. Rushes of *Juncus edgariae*

Adjacent to the willows of J are two areas of dense *Juncus edgariae* rushes which have been grazed around the outer margin. This has resulted in a ring of dead plants surrounding those in the centre which have been less grazed.

#### I. Carex secta

The northern-most larger area of *Carex secta* is a stand which has been grazed around the margin by cattle, while the extremely soft mud in the centre appears to have deterred animal entry, resulting in the survival of the stand. The two smaller areas are raised bogs which move when stood on. The *Carex secta* on these are healthy and are surrounded by a number of smaller bog plants, of which monkey musk and jointed rush are the most common.

#### J. Crack Willow

Along the edge of the LII River is a stand of tall crack willow (*Salix fragilis*\*), the plants decreasing in height and health towards the river mouth.

## K. Plantation

A small plantation has been planted around the pond in the centre of the largest cultivated area. The lower branches of the trees have been chewed back except where cattle cannot reach over the water.

#### L. Three-square

Areas of dense three-square are found on saturated mud along the eastern side of the raised area of Vegetation Type E.

## M. Lake



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## PLANT SPECIES RECORDED AT YARRS FLAT WILDLIFE MANAGEMENT RESERVE

Indigenous (Table A) and introduced (Table B) vascular plant species recorded by Clark and Partridge (1984) in Yarrs Flat Wildlife Management Reserve and by Butt (2015) in Yarrs Flat Operational Area (17 and 18 November 2014). Abundance from Butt (2015) is indicated by: A = abundant, C = common, O = occasional, R = rare. The three indigenous non-vascular plant species recorded by Melissa Hutchison on 6 September 2016 are included at the bottom of Table A. The vegetation category/s (see Figure 3) in which each species occurs is/are indicated by Y.

#### A. Indigenous Species

	Common Name		Survey		Vegetation Category			
Scientific Name		Life Form	Clark & Partridge (1984)	Butt (2015)	Freshwater Wetland	Saltmarsh	Terrestrial	Conservation Status (de Lange <i>et al.</i> 2013)
Apium prostratum	NZ celery	Dicot herb	Y	0		Y		
Asplenium species		Fern		R	Y			
Azolla rubra	Water fern	Fern	Y	С	Y			
Blechnum minus	Swamp kiokio	Fern		0	Y			
Blechnum penna-marina	Little hard fern	Fern		R	Y			
Bolboschoenus caldwellii	Purua grass, Caldwells clubrush	Sedge	Y	С	Y	Y		
Cardamine species	Bittercress	Dicot herb		С	Y			
Carex coriacea	Cutty grass, rautahi	Sedge		0	Y			
Carex dipsacea	Teasel sedge	Sedge		R	Y			Locally uncommon <sup>1</sup>
Carex flagellifera		Sedge	Y		Y			
Carex maorica	Cutty grass, rautahi	Sedge		R	Y			
Carex secta	Pūkio, niggerhead	Sedge	Y	R	Y			
Carex sinclairii		Sedge		С	Y			
Carex virgata	Swamp sedge	Sedge	Y	R	Y			
Coprosma ×cunninghamii		Tree		R	Y		Y	
Cordyline australis	Cabbage tree, tī kōuka	Tree		R	Y		Y	
Cotula australis	Common cotula, soldiers button	Dicot herb		R	Y		Y	
Cotula coronopifolia	Bachelor's button	Dicot herb	Y	С		Y		
Crassula moschata		Dicot herb	Y			Y	Y	
Eleocharis acuta	Sharp spike sedge	Sedge		С	Y			
Epilobium billardiereanum	Willow herb	Dicot herb		R	Y			
Epilobium species	Willow herb	Dicot herb		0	Y			
Galium propinquum	Native bedstraw	Dicot herb		С	Y		Ι	
Galium trilobum		Dicot herb	Y		Y		Y	



	Common Name	Life Form	Survey		Vegetation Category			
Scientific Name			Clark & Partridge (1984)	Butt (2015)	Freshwater Wetland	Saltmarsh	Terrestrial	Conservation Status (de Lange <i>et al.</i> 2013)
Histiopteris incisa	Water fern, mātātā	Fern		R	Y			
Hydrocotyle species	Pennywort	Dicot herb		0	Y			
Hypolepis ambigua	Pig fern	Fern		0	Y			
Isolepis cernua var. cernua	Slender clubrush	Sedge		R	Y	Y		
Isolepis prolifera		Sedge		R	Y	Y		
Juncus australis	Leafless rush, wī	Rush		R	Y			
Juncus edgariae	Leafless rush, wī	Rush	Y	Α	Y	Y		
Juncus kraussii var. australiensis	Sea rush	Rush	Y	А		Y		
Juncus planifolius	Flat-leaved rush	Rush		R	Y			
Juncus sarophorus	Leafless rush, wī	Rush		R	Y			
Lemna disperma	Common duckweed	Monocot herb	Y	С	Y			
Leptinella dioica	Button daisy	Dicot herb	Y	R		Y		
Lilaeopsis novae-zelandiae		Dicot herb	Y	0		Y		
Limosella lineata		Dicot herb	Y		Y			
Montia fontana subsp. fontana	Blinks, dwarf montia	Dicot herb		0	Y			Locally uncommon <sup>2</sup>
Muehlenbeckia australis	Large-leaved pohuehue	Vine		R	Y		Y	
Myriophyllum propinquum	Common water milfoil	Dicot herb	Y	0	Y			
Phormium tenax	Flax, harakeke	Monocot herb		R	Y			
Plagianthus divaricatus	Saltmarsh ribbonwood, mākaka	Shrub	Y	С		Y		
Potentilla anserinoides	Silverweed	Dicot herb	Y	0	Y			
Pseudognaphalium luteoalbum	Jersey cudweed	Dicot herb		0	Y			
Puccinellia stricta	Salt grass	Grass	Y	С		Y		
Samolus repens	Sea primrose, shore pimpernel	Dicot herb	Y	С		Y		
Sarcocornia quinqueflora subsp. quinqueflora	Glasswort	Dicot herb	Y	С		Y		
Schoenoplectus pungens	Three-square	Sedge	Y	С	Y	Y		
Schoenoplectus tabernaemontani	Lake clubrush, kuawa	Sedge	Y	R		Y		Locally uncommon <sup>3</sup>
Selliera radicans	Remuremu	Dicot herb	Y	0		Y		
Senecio glomeratus	Native groundsel, fireweed	Dicot herb		0	Y		Y	
Senecio minimus	Native fireweed	Dicot herb		R	Y		Y	
Stuckenia pectinata	Fennel-leaved pondweed	Monocot herb		R	Y			At Risk-Naturally Uncommon
Thyridia repens	Native musk	Dicot herb	Y	С		Y		At Risk-Naturally Uncommon
Triglochin striata	Three-ribbed arrowgrass	Monocot herb	Y	С		Y		
Typha orientalis	Raupō, bull rush	Rush		0	Y			
Urtica perconfusa	Swamp nettle	Dicot herb		С	Y			At Risk-Declining
Non-Vascular Species								
Nitella species	Stonewort	Alga	-	-	Y			



	Common Name	Life Form	Survey		Vege	etation Catego		
Scientific Name			Clark & Partridge (1984)	Butt (2015)	Freshwater Wetland	Saltmarsh	Terrestrial	Conservation Status (de Lange <i>et al.</i> 2013)
Ramalina celastri		Lichen	-	-				
Teloschistes chrysophthalmus	gold-eye lichen	Lichen	-	-				

<sup>1</sup> Uncommon on the Canterbury Plains and described as "locally uncommon" (Butt 2015). <sup>2</sup> No other records from the Canterbury Plains; it is "likely that this species is locally rare" (Butt 2015). <sup>3</sup> Rare in Canterbury (Clark 1984 and NZPCN 2016c).

#### **B. Introduced Species**

			Survey			Habitat Type		
Scientific Name	Common Name	Life Form	Clark & Partridge (1984)	Butt (2015)	Freshwater wetland	Saltmarsh	Terrestrial	Pest Status
Agrostis stolonifera	Creeping bent	Grass	Y	А	Y	Y		
Alopecurus geniculatus	Kneed foxtail	Grass	Y		Y	Y		
Anagallis arvensis	Scarlet pimpernel	Dicot herb		R			Y	
Anthoxanthum odoratum	Sweet vernal	Grass	Y	С	Y		Y	
Atriplex prostrata	Orache	Dicot herb	Y	С		Y		
Bellis perennis	Daisy	Dicot herb		R			Y	
Bromus hordeaceus	Soft brome	Grass	Y				Y	
Bromus willdenowii	Prairie grass	Grass		R			Y	
Callitriche stagnalis	Starwort	Dicot herb	Y	С	Y			
Capsella bursa-pastoris	Shepherds purse	Dicot herb		R			Y	
Cerastium fontanum	Mouse-eared chickweed	Dicot herb	Y				Y	
Cerastium glomeratum	Annual mouse-ear chickweed	Dicot herb		С	Y		Y	
Chamaemelum nobile	Chamomile	Dicot herb		R			Y	
Cirsium arvense	Californian thistle	Dicot herb		R			Y	
Cirsium vulgare	Scotch thistle	Dicot herb	Y	R			Y	
Conyza canadensis	Fleabane	Dicot herb		R			Y	
Crepis capillaris	Hawksbeard	Dicot herb	Y				Y	
Critesion marinum	Salt barley grass	Grass	Y			Y	Y	
Critesion murinum	Barley grass	Grass	Y				Y	
Cupressus macrocarpa	Macrocarpa, Monterey cypress	Tree		R			Y	
Cynosurus cristatus	Crested dogstail	Grass	Y		Y		Y	
Dactylis glomerata	Cocksfoot	Grass	Y	R	Y		Y	
Elytrigia repens	Couch, twitch	Grass	Y	С	Y	Y	Y	
Erythranthe guttata	Monkey musk	Dicot herb	Y	0	Y			Weed (Howell 2008)



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	Common Name	Life Form	Survey		Habitat Type			
Scientific Name			Clark & Partridge (1984)	Butt (2015)	Freshwater wetland	Saltmarsh	Terrestrial	Pest Status
Festuca rubra subsp. commutata	Chewings fescue	Grass	Y		Y		Y	
Galium aparine	Cleavers	Dicot herb	Y	0	Y			
Glyceria fluitans	Floating sweetgrass	Grass		R	Y			Weed (Howell 2008)
Glyceria plicata	Plicate sweetgrass	Grass	Y		Y			
Hemerocallis fulva	Daylily, orange day lily	Monocot herb		R	Y			Weed (Butt 2015)
Holcus lanatus	Yorkshire fog	Grass	Y	0	Y		Y	
Hypochaeris radicata	Catsear	Dicot herb	Y	R	Y		Y	
Iris pseudacorus <sup>1</sup>	Yellow flag iris	Monocot herb			Y			Weed (Howell 2008)
Juncus articulatus	Jointed rush	Rush	Y	0	Y			
Juncus bufonius	Toad rush	Rush	Y		Y	Y		
Juncus effusus	Soft rush	Rush	Y	0	Y			Weed (Howell 2008)
Leontodon autumnalis	Autumn hawkbit	Dicot herb	Y				Y	
Lolium perenne	Perennial ryegrass	Grass	Y				Y	
Lotus pedunculatus	Lotus	Dicot herb		С	Y			
Lycium ferocissimum	Boxthorn	Shrub		R			Y	Biodiversity Pest (Maw 2011)
Mentha X piperita	Peppermint	Dicot herb		0	Y			
Myosotis laxa subsp. caespitosa	Water forget-me-not	Dicot herb		0	Y			
Olearia lineata cv. dartonii <sup>2</sup>	Tree daisy	Tree					Y	
Persicaria hydropiper	Water pepper	Dicot herb		0	Y			
Phalaris arundinacea	Reed canary grass	Grass		0	Y			Weed
Phleum pratense	Timothy	Grass	Y		Y		Y	
Pinus species	Pine	Tree		R			Y	
Plantago coronopus	Bucks horn plantain	Dicot herb	Y	С		Y		
Plantago major	Broad-leaved plantain	Dicot herb	Y				Y	
Poa annua	Annual poa	Grass	Y				Y	
Poa trivialis		Grass	Y		Y			
Polygonum aviculare	Wireweed	Dicot herb	Y				Y	
Potamogeton crispus	Curly pondweed	Dicot herb		0	Y			Weed (Howell 2008)
Ranunculus repens	Creeping buttercup	Dicot herb	Y	Α	Y			Weed (Howell 2008)
Ranunculus sceleratus	Celery-leaved buttercup	Dicot herb		С	Y			······································
Rorippa nasturtium-aquaticum	Watercress	Dicot herb		0	Y			
Rosa rubiginosa	Sweet briar, briar rose	Shrub	Y	R	Y			Restricted Pest (Maw 2011)
Rubus fruticosus agg.	Blackberry	Shrub		0	Y			Restricted Pest (Maw 2011)
Rumex obtusifolius	Broad-leaved dock	Dicot herb	Y	R	Y			
Salix cinerea	Grey willow	Tree		C	Y			Weed (Howell 2008)
Salix Xfragilis	Crack willow	Tree	Y	C	Y			Weed (Howell 2008)
Sambucus nigra	Elderberry	Tree		R	Y		Y	

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			Survey		I	Habitat Type		
Scientific Name	Common Name	Life Form	Clark & Partridge (1984)	Butt (2015)	Freshwater wetland	Saltmarsh	Terrestrial	Pest Status
Schedonorus arundinaceus	Tall fescue	Grass		С	Y			
Senecio vulgaris	Common groundsel	Dicot herb		R	Y			
Solanum chenopodioides	Velvety nightshade	Dicot herb		0	Y			
Solanum nigrum	Black nightshade	Dicot herb	Y				Y	
Sonchus asper	Prickly sow thistle	Dicot herb		0	Y			
Sonchus oleraceus	Pūhā, smooth sow thistle	Dicot herb		0	Y			
Spergularia marina	Sea spurrey	Dicot herb		С		Y		
Stellaria graminea <sup>3</sup>	Stitchwort	Dicot herb			Y			
Stellaria media	Chickweed	Dicot herb	Y	С	Y			
Taraxacum officinale	Dandelion	Dicot herb	Y	R			Y	
Trifolium dubium	Haresfoot trefoil	Dicot herb	Y				Y	
Trifolium fragiferum	Strawberry clover	Dicot herb	Y				Y	
Trifolium repens	White clover	Dicot herb	Y	R	Y			
Ulex europaeus	Gorse	Shrub	Y	0	Y		Y	Containment Pest (Maw 2011)
Vicia sativa	Vetch	Dicot herb		0	Y		Y	

<sup>1</sup>Observed by Frances Schmechel on 5 November 2015 (recorded on the NatureWatch website, see <u>http://naturewatch.org.nz/observations/2350503</u>). <sup>2</sup> A single tree of *Olearia lineata* cv. *dartonii* has been planted near the macrocarpa trees (Jensen 2014). This is a cultivar of *Olearia lineata*, therefore it is not included in the indigenous species list. <sup>3</sup> Observed by Melissa Hutchison on 6 September 2016.





Providing outstanding ecological services to sustain and improve our environments

Fax: +64 7 3439018 ecology@wildlands.co.nz Rotorua 3042, New Zealand

 
 Call Free 0508 WILDNZ
 99 Sala Street
 Regional Offices located in

 Ph: +64 7 343 9017
 PO Box 7137, Te Ngae
 Auckland, Hamilton, Tauranga,

 Fax: +64 7 3439018
 Botorus 3042
 Whakatane, Wellington
Whakatane, Wellington, Christchurch and Dunedin

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