

ECOLOGICAL MANAGEMENT PLAN
FOR HAWKS BURY LAGOON,
WAIKOUAITI

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Prepared for:

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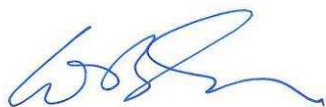
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PART 1:
ECOLOGICAL ASSESSMENT

1. REPORT STRUCTURE

This report comprises two parts.

Part 1 is an ecological assessment of the Hawksbury Lagoon, at Waikouaiti. It includes a desk-top review of information relating to the ecology of Hawksbury Lagoon, as well as a description of current vegetation, flora, fauna habitats, threats, and ecological processes, based on a field survey.

Part 2 is an ecological restoration plan for public land and a small area of private land within the study area. It contains:

- Objectives for indigenous restoration at the site;
- An outline of appropriate indigenous plant species for different habitats/areas;
- Appropriate planting densities for different species;
- Post-planting maintenance requirements;
- Requirements for control of weeds and pest animals;
- Indicative costs of ecological restoration at the site;
- A timeline for planting and maintenance, with staged planting if necessary;
- A suggested approach for ecological restoration.

2. INTRODUCTION

Hawksbury Lagoon Wildlife Refuge was formed in 1973 to protect the considerable wildlife values of the Hawksbury Lagoon, at Waikouaiti. This coastal lagoon has been strongly modified by human activities, including infilling, hydrological controls, residential development, and operation of a nearby landfill. Hawksbury Lagoon Inc. is a Waikouaiti-based community group who wish to improve the indigenous biodiversity values of the lagoon and surrounding land, and are seeking advice to help plan for ecological restoration of public land on the lagoon margins.

3. METHODS

A review was undertaken of relevant literature on terrestrial vegetation, indigenous fauna, and fisheries within or adjacent to the Hawksbury Lagoon. This included databases such as the New Zealand Freshwater Fish Database (NZFFD; NIWA 2009), unpublished reports, and published material.

A field visit was undertaken in July 2009. The site was defined (Figure 1) as:

- the lagoon proper;
- DOC- and DCC-administered land adjacent to the lagoon;
- the outlet of the lagoon to the coast; and
- a section of privately-owned land below Hawksbury Inlet.

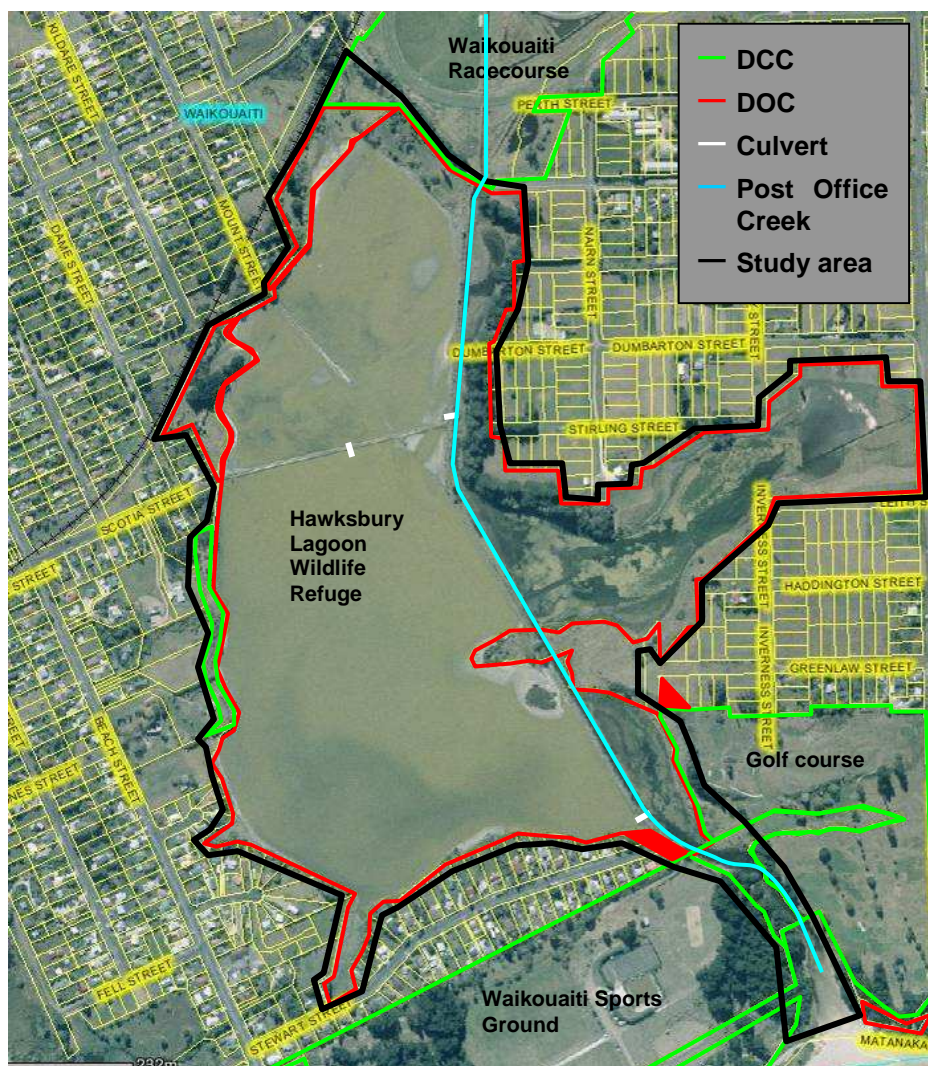


Figure 1: Land tenure, Hawksbury Lagoon and environs, Waikouaiti.

A walk-through survey was undertaken of accessible lagoon margins and causeways. The remainder of the site was viewed from a distance using binoculars. Plant species, vegetation types, fauna habitats, and hydrology were assessed, described, and mapped. Particular attention was paid to the potential of parts of the site for ecological restoration.

4. ECOLOGICAL CONTEXT

4.1 Waikouaiti Ecological District

The landcover database (LCDB2) gives an indication of the vegetation and habitats that are present within each ecological district in New Zealand. A large proportion of the 68,287 ha Waikouaiti Ecological District is covered in high-producing exotic grassland (20,950 ha; c.31% of total area) and low-producing grassland (24,518 ha; 36% of total area), reflecting the predominantly pastoral land use. There is relatively little indigenous vegetation remaining (<15% of total area), although there are areas of

Hall's totara/ngaio-lacebark-ribbonwood-kowhai-mahoe coastal forest; matai-totara-rimu/hardwood forest at lower altitudes inland; extensive kanuka-manuka scrub; hard tussock, silver tussock, and snow tussock grassland at higher altitude in the west; silver beech, hardwood and kaikawaka forests in the uplands around the South branch of the Waikouaiti River and Silver Stream (McEwen 1987). Herbaceous freshwater vegetation (8.72 ha; 0.01% of total area), lakes and ponds (19.23 ha; 0.03%), estuarine open water (147.15 ha; 0.22%), and herbaceous saline vegetation (183.81 ha; 0.27%) comprise a small proportion of the ecological district.

4.2 Hydrology

Hawksbury Lagoon is a shallow, lowland coastal lagoon, with an elevational range of 0-2 m asl. It receives fresh water inputs from Post Office Creek to the north, and two smaller unnamed waterways, one entering at the head of Hawksbury Inlet (the arm of the lagoon which extends east towards Edinburgh Street) and the other in the southwestern corner of the Lagoon. Post Office Creek is now a constructed channel running down the eastern margins of the Lagoon. It is separated from the Lagoon proper by a causeway, through which pass two gated culverts. A further ungated culvert is located in a second causeway which divides the Lagoon east to west. The gated culverts, which are in poor repair, are opened and closed by a local resident, so that water levels in the lagoon remain relatively constant (c.0.5 m deep). On the eastern side of the main causeway are the Hawksbury Inlet and two areas of mudflats. Water levels in Hawksbury Inlet are uncontrolled, with large areas of mudflat becoming exposed in summer months. There is a little saline intrusion into the lagoon, resulting in a mix of fresh and brackish water, and the persistence of salt-tolerant plant species (e.g. *Leptinella dioica*, *Selliera radicans*, *Samolus repens*). The creek mouth to the sea is sometimes blocked by build up of sand and is then bulldozed open when the water level threatens residential properties.

The intent of current management is to:

- Maintain water levels within the Lagoon to minimise smells and nuisance insects;
- Lower water levels within the Lagoon when they encroach on private property;
- Keep the channel open to the sea to avoid water backing up and flooding adjoining land;
- Protect residential properties by diverting Post Office Creek flood flows directly to the sea.

5. LAND TENURE

Most of Hawksbury Lagoon is administered by the Department of Conservation (DOC). One small area on the western margins of the lagoon, and areas near the outlet are administered by Dunedin City Council (DCC). Private land, comprising residential properties, market gardens, and grazed pasture, abuts the lagoon along much of its margin (Figure 1).

6. CULTURAL SIGNIFICANCE

Information in this section was supplied by Kati Huirapa Runaka ki Puketeraki (August 2009). Kai Tahu have strong links to this part of the Otago coast. The Maori name for Hawksbury Lagoon is Matainaka which refers to juvenile whitebait/inaka. A fishing easement was set aside by the Native Land Court in 1868 as partial redress for loss of mahika kai in the area. This easement is located on the eastern side of the lagoon and includes the small peninsula that extends into the main lagoon. The main causeway passes through this private Maori land, and public access is allowed by kind favour of the trustees of this block. An ancillary claim was lodged as part of the 1998 Ngai Tahu Settlement, because the conservation status of Hawksbury Lagoon (Wildlife Refuge) forbade fishing. The claim was successful and descendants of the beneficiaries of the fishing easement now have rights to take eels and other fish from within the lagoon, as well as legal recognition of mahika kai. The runaka are intimately involved in the past and future of this area and it is important that their support is sought for any work likely to be undertaken.

7. ECOLOGICAL SIGNIFICANCE

Hawksbury Lagoon is listed in Schedule 25.4 'Areas of Significant Conservation Value' in Dunedin City District Plan (DCC 2006). Site C021 (Part of Hawksbury Lagoon Wildlife Refuge), administered by DOC, is included because of its wetland habitat values for indigenous bird and fish species. Site C105 (Edge of Hawksbury Lagoon) is included because it is a regionally significant lowland lake listed in the WERI database.

'Hawksbury Inlet' (CPA7) is listed in Schedule 2 'Management Areas' in the Otago Regional Council's Regional Plan: Coast (ORC 2001). Values within the Coastal Marine Area are listed as "Kai Tahu cultural and spiritual values. Estuarine values which include a habitat for a large number of wading birds and water fowl."

Hawksbury Lagoon is also listed as a significant wetland in the Otago Regional Council's Water for Otago (ORC 2004). This excludes Hawksbury Inlet listed in ORC (2001). The wetland is culturally significant to Kai Tahu as a mahika kai site, has a high diversity of bird and fish life, and provides regionally significant habitat for waterfowl.

8. VEGETATION AND HABITATS

Ten broad vegetation types were identified. These are described below and mapped in Figures 2a and b.

8.1 Grassland dominated by exotic species

8.1.1 Tall fescue-dominated grassland

Tall fescue (*Schedonorus phoenix*) and cocksfoot (*Dactylis glomerata*) dominate grassland on lagoon margins in the northern-most part of the site. Curled dock

(*Rumex crispus*), vetch (*Vicia sativa*), red clover (*Trifolium pratense*), yarrow (*Achillea millefolium*), narrow-leaved plantain (*Plantago lanceolata*), and Scotch thistle (*Cirsium vulgare*) are scattered throughout. Plantings of species such as narrow-leaved lacebark (*Hoheria angustifolia*), cabbage tree (*Cordyline australis*), kowhai (*Sophora microphylla*), and kohuhu (*Pittosporum tenuifolium*) have been undertaken in this area.

Adjacent to this area, on wet ground closer to the lake, tall fescue dominates with frequent Yorkshire fog (*Holcus lanatus*) and creeping bent (*Agrostis stolonifera*), and scattered creeping buttercup (*Ranunculus repens*). This type is also present within Hawksbury Inlet. There are a few trees of tortured willow (*Salix matsudana* var. *tortuosa*) present at the northern site and scattered bittersweet (*Solanum dulcamara*) in the Hawksbury Inlet site.

Tall fescue also dominates grassland on the sides of causeways on the eastern side, and crossing, the lagoon. Browntop (*Agrostis capillaris*) and Yorkshire fog are also common, with scattered vetch, red clover, and narrow-leaved plantain. Scattered plantings have been undertaken along the sides of the eastern causeway, and there are some species which have established themselves. These species include those native to the area (e.g. kohuhu, kowhai, lemonwood (*Pittosporum eugenioides*), *Coprosma propinqua*, saltmarsh ribbonwood (*Plagianthus divaricata*), harakeke (*Phormium tenax*), *Olearia avicenniifolia*, *O. arborescens*, *O. lineata*, toetoe (*Cortaderia richardii*), knobby clubrush (*Ficinia nodosa*), *Muehlenbeckia complexa*, *Juncus edgariae*), non-local natives (*Pittosporum ralphii*, akeake (*Dodonaea viscosa*), *Olearia traversiorum*), and environmental weeds (gorse (*Ulex europaeus*), Scotch broom (*Cytisus scoparius*), pampas (*Cortaderia* spp.), tree lupin (*Lupinus arboreus*), and marram (*Ammophila arenaria*)).



Plate 1: Tall fescue-dominant grassland on the lagoon's north-western margins.



Plate 2: The sides of the main causeway separating Post Office Creek from the lagoon are dominated by tall fescue on lower slopes, with browntop and scattered plantings on upper slopes.

8.1.2 Marram-dominant grassland

Marram grassland is present on dunes near the lagoon outlet. Cocksfoot is also common, with scattered vetch, catsear, and emergent shrubs of tree lupin and Scotch broom. A small area of planted pingao (*Desmoschoenus spiralis*) on the edge of a dune has been partially eroded by wave action.

8.1.3 Cocksfoot-dominant grassland

Cocksfoot dominates two small grasslands on low hillslopes in Hawksbury Inlet. Yorkshire fog, browntop, and Californian thistle (*Cirsium arvense*) are also present. Scattered throughout are uncommon creeping buttercup, hemlock, and mouse-ear chickweed. Totara (*Podocarpus totara*), which have been planted at c.5 m spacings in these grasslands, are now 10 years old and c.1.5 m tall. Another small grassland, on the lagoon margin north of the Scotia Street road-end, has abundant cocksfoot and frequent Californian thistle and browntop.

Cocksfoot, frequent Yorkshire fog, and patchy tussocks of tall fescue dominate grassland grazed heavily by horses on Stewart Street. Also common is daisy, chickweed, mouse-ear chickweed, catsear, browntop, Californian thistle, and broad dock.

8.2 Treeland dominated by exotic species

In the northeast of the study area, alongside Inverary Street, crack willow (*Salix fragilis*), Lombardy poplar (*Populus nigra*), and alder (*Alnus glutinosa*) form a treeland over mown grassland dominated by cocksfoot. Browntop, yarrow, daisy (*Bellis perennis*), white clover (*Trifolium repens*), narrow-leaved plantain, and curled dock are also present. At the edge of the lagoon is a tree of Sitka spruce (*Picea stichensis*) and patches of periwinkle (*Vinca major*).

Poplar (*Populus* spp.) treeland is present at several sites on lagoon margins. Exotic grassland dominates the groundcover.

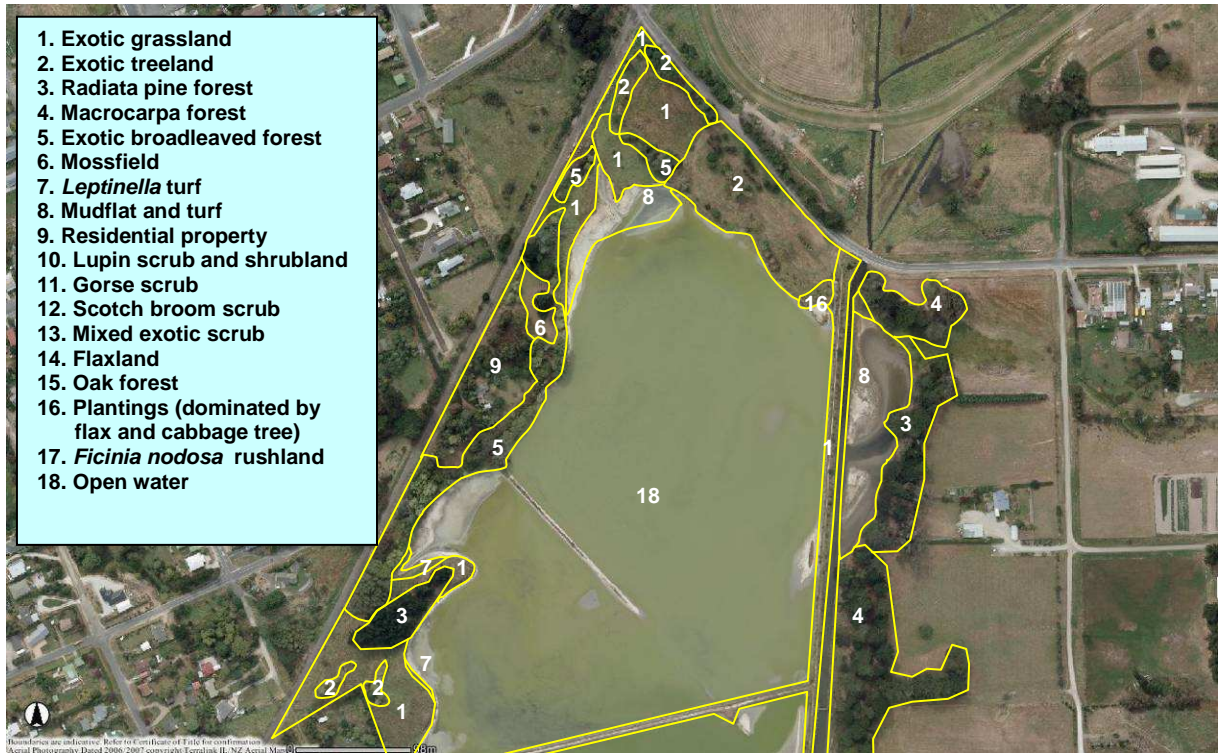
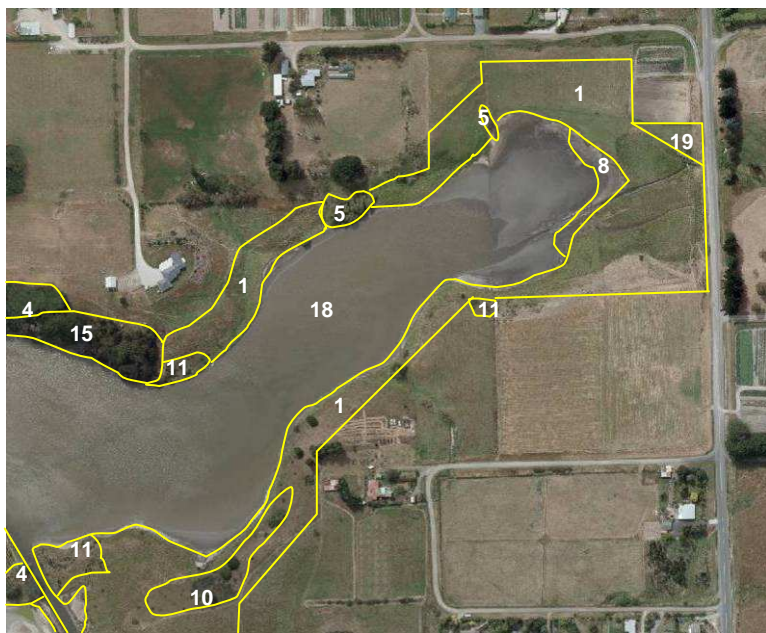


Figure 2a: Vegetation and habitat map for the northern part of Hawksbury Lagoon.



- 1. Exotic grassland
- 2. Exotic treeland
- 3. Radiata pine forest
- 4. Macrocarpa forest
- 5. Exotic broadleaved forest
- 6. Mossfield
- 7. *Leptinella* turf
- 8. Mudflat and turf
- 9. Residential property
- 10. Lupin scrub and shrubland
- 11. Gorse scrub
- 12. Scotch broom scrub
- 13. Mixed exotic scrub
- 14. Flaxland
- 15. Oak forest
- 16. Plantings (dominated by flax and cabbage tree)
- 17. *Ficinia nodosa* rushland
- 18. Open water
- 19. Market garden

Figure 2b: Vegetation and habitat map for the southern and eastern parts of Hawksbury Lagoon.

Planted golden willow (*Salix alba* var. *vitellina*) forms treeland at scattered sites within exotic grassland on the western margins of the lagoon.

8.3 Broadleaved forest dominated by exotic species

8.3.1 White poplar forest

White poplar (*Populus alba*) forest is present at one site next to the railway line. Several of the large poplar trees appear to have fallen at some time in the past and branches from the horizontal trunks now form the canopy. The understorey comprises frequent elder and occasional hawthorn and bittersweet. The groundcover comprises frequent tall fescue and cocksfoot, with patchy creeping buttercup, cleavers, and chickweed, and rare prickly shield fern (*Polystichum vestitum*) and stinking iris (*Iris foetidisma*).

8.3.2 Crack willow forest

Crack willow (*Salix fragilis*) forest has a limited distribution at the site, only being present as two small areas, one on the northern margin of Hawksbury Inlet and the other next to the railway line. The Hawksbury Inlet site has a groundcover of cocksfoot, creeping buttercup (*Ranunculus repens*), chickweed (*Stellaria media*), and scattered purei (*Carex geminata*) and floating sweetgrass (*Glyceria fluitans*). Tall fescue and creeping bent are present near the edge of the lagoon. The site next to the railway has blackberry (*Rubus fruticosus* agg.), elder (*Sambucus nigra*), hawthorn (*Crataegus monogyna*), and a groundcover of waxweed (*Hydrocotyle heteromeria*), cleavers (*Galium aparine*), chickweed, creeping buttercup, and hemlock (*Conium maculatum*). A few male fern (*Dryopteris filix-mas*) are also present. There is a small stream nearby with scattered floating sweetgrass, starwort (*Callitriche stagnalis*), and watercress (*Nasturtium microphyllum*).

8.3.3 Oak forest

Oak forest is present on the northern margin of the eastern inlet of the lagoon. Several large exotic beech (*Fagus sylvatica*) trees are also present. In the understorey, there are frequent hawthorn and young trees of oak and beech, and scattered Scotch broom, gorse, kohuhu seedlings, *Coprosma dumosa*, and cabbage tree (*Cordyline australis*). The groundcover is dominated by cocksfoot and litter, but cleavers, browntop, ragwort (*Senecio jacobaea*), and a small patch of hounds tongue fern (*Microsorium pustulatum*) are also present.



Plate 3: The understorey is relatively open on the western boundary of oak forest, Hawksbury Lagoon. Macrocarpa forest is visible through the oak trees.

8.4 Exotic conifer forest

Exotic conifer forest is present on low hillslopes along the eastern margins of the lagoon, on dunes near the outlet, and a small area on flats on the western margin of the lagoon. Macrocarpa (*Cupressus macrocarpa*) is dominant on north-eastern hillslopes. Also present in the canopy are radiata pine (*Pinus radiata*), and, immediately adjacent to the lagoon, a few oak (*Quercus* sp.). There is little understorey, with a few African boxthorn (*Lycium ferocissimum*) on the margins. Groundcover comprises patchy nettle (*Urtica urens*) and bare earth. This is one of two sites where stock (sheep) have been present.

Further south, radiata pine is dominant for c.100 m. A few eucalyptus (*Eucalyptus* sp.) are also present. There is little understorey, with scattered Scotch broom and seedlings of radiata pine and macrocarpa. The groundcover comprises pine needle litter and scattered *Lepidium ?pseudotasmanicum*, and tussocks of cocksfoot. At the start of Hawksbury Inlet, macrocarpa is dominant at the top of the hillslope, adjoining an oak forest which descends the slope almost to the inlet margin.

A small area of radiata pine forest on the western margins of the lagoon has a groundcover of needles and a few stacks of cut firewood. On the southern side of the lagoon outlet is forest dominated by radiata pine. Scattered macrocarpa are also present. The ground is covered in sand and pine needle litter.

8.5 Scrub dominated by exotic species

8.5.1 Gorse scrub and Scotch broom scrub

Several small patches of gorse scrub and Scotch broom scrub are present on flats and low hillslopes in the east and southeast of the study area. These are surrounded by rank grassland dominated by tall fescue and cocksfoot. Some examples on the margins of Hawksbury Inlet have a few tall unidentified trees (possibly eucalypts) growing in or near them. One patch near the southern end of Inverness Street comprises gorse, with elder and hawthorn. These examples were viewed from a distance.

Gorse is also present along a small drain in the southwest part of the site that adjoins Stewart Street, adjacent to pasture grazed by horses.

8.5.2 Lupin scrub

Lupin scrub is present on dunes near the beach. Marram is also present. Small areas of lupin scrub and shrubland are also present next to gorse scrub on low hillslopes near 70 Greenlaw Street (Maori land). These areas were viewed from a distance.



Plate 4: Lupin (L), gorse (G), and Scotch broom (B) scrub on hillslopes and flats on the southeast side of Hawksbury Lagoon. This photograph was taken from the main causeway over the excavated channel of Post Office Creek.

8.6 Harakeke flaxland

Harakeke-dominant vegetation is present on a small island located in the south-eastern part of the lagoon. Other species present include gorse (some dead), knobby clubrush, and tall fescue. At the northern end of the island there is a band of saltmarsh ribbonwood, linked to a band of oioi (*Apodasmia similis*) rushland.

Harakeke-dominant plantings are also present near Inverary Street and on private property on the western margins of the lagoon. Other species present include cabbage tree, toetoe, and kohuhu.

8.7 Mudflats and open water

Mudflats are present east of the main causeway and walking track. Little vegetation is present except for scattered *Elatine gratioloides*. There is a small clump of three-square (*Schoenoplectus pungens*) at the northern end of one mudflat, with scattered batchelor's buttons (*Cotula coronopifolia*) along its margins. The main lagoon, Hawksbury Inlet, and Post Office Creek contained mostly open water at the time of survey.



Plate 5: Mudflats with *Elatine gratioloides* bordering a close-cropped turf of creeping bent, in the northeast of Hawksbury Lagoon. Forest dominated by macrocarpa and radiata pine is visible on hillslopes on the left.

8.8 Turf

In the northeast of the site, mudflats border a turf of close-cropped creeping bent, with patchy *Selliera radicans*, *Apium prostratum*, and *Leptinella dioica* on its western edge.

Turf dominated by *Leptinella dioica* and creeping bent is present on wet western margins of the lagoon north of Scotia Street. Other species present include tall fescue, *Selliera radicans*, *Samolus repens*, *Apium prostratum*, buck's horn plantain (*Plantago coronopus*), and *Plantago triandra*.

Turf dominated by *Leptinella dioica* and creeping bent also extends under nearby poplar, willow, and eucalyptus trees, but associate species there are narrow-leaved plantain, *Senecio minimus*, yarrow, white clover, daisy, selfheal (*Prunella vulgaris*), broad-leaved dock, hemlock, foxglove, and scattered ragwort. Turf habitats appear to be maintained by waterfowl grazing.



Plate 6: Turf dominated by creeping bent, *Leptinella dioica*, and *Selliera radicans*, with scattered *Apium prostratum* and tall fescue, located on the eastern margins of Hawksbury Lagoon.

8.9 Mossfield

Mossfield is present next to the railway in the northwestern part of the study area. The vegetation comprises an abundant unidentified moss species, frequent creeping bent and narrow-leaved plantain, and occasional *Trifolium dubium*, ragwort, and foxglove. Variegated flax has been planted on the lagoon margins near this area.

8.10 Residential properties and market garden

Residential property boundaries are very close to, or abut, the lagoon in the south and southwest of the study area. Residential gardens incorporate many exotic plant species (which are not identified in this report), some of which are likely to be invasive (e.g. cotoneaster and Chilean rhubarb (*Gunnera tinctoria*)). Mown lawns often reach to the water's edge. In some cases, residents have incorporated parts of reserve land into their gardens. This is especially evident in the DCC-administered esplanade reserve (CARS 19) on the western margins of the lagoon.

Land at the head of Hawksbury Inlet is leased. Current land uses include market gardening and sheep grazing.

9. FLORA

A total of 121 plant species were recorded, of which 43 (36%) were local natives, five (4%) were non-local natives, and 72 (60%) were exotics (Appendix 1). Two species are classified as nationally uncommon (as per de Lange *et al.* 2009). Gossamer grass (*Anemanthele lessoniana*; At Risk-Declining) was recorded under a canopy of exotic trees on the western margins of the lagoon. This species is commonly grown in gardens and it is likely that the observed plants were garden escapes rather than naturally-occurring specimens. Pingao (*Desmoschoenus spiralis*; At Risk-Relict) has been planted on dunes near the beach, and plantings have been partially destroyed after a storm.

Many invasive weed species are present. Several patches of periwinkle (*Vinca major*) were recorded at the head of the lagoon and at the end of Scotia Street. A large infestation of ivy (*Hedera helix*) is also present within exotic grassland at the end of Scotia Street. Flowering currant (*Ribes sanguineum*) and Scotch broom (*Cytisus scoparius*) are common alongside the railway line, with Scotch broom also present on south-eastern lagoon margins. Elder (*Sambucus nigra*) is scattered along both eastern and western margins. Gorse (*Ulex europaeus*) is mostly concentrated on hillslopes in the southeastern part of the site. Hawthorn (*Crataegus monogyna*) is only common under oak forest, but is also present in the western part of the site. Pampas (*Cortaderia selloana*) is scattered along the causeways. Marram grass (*Ammophila arenaria*) is common only on dunes near the sea, although there is one small area on the main causeway. Only a few plants of stinking iris (*Iris foetidisma*), blackberry, karamu (*Coprosma robusta*), cotoneaster (*Cotoneaster* sp.), holly (*Ilex aquifolium*), red hot poker (*Kniphofia uvaria*), and male fern (*Dryopteris filix-mas*) were recorded. Of the tree species present, the greatest threats are posed by crack willow (*Salix fragilis*), alder (*Alnus glutinosa*), and silver birch (*Betula pendula*), all of which can spread within wetland environments. Abundant, low-stature exotic grasses such as tall fescue (*Schedonorus phoenix*) and creeping bent (*Agrostis stolonifera*) will require repeated control around any indigenous plantings.



Plate 7: Pampas on the main causeway at the southern end of Hawksbury Lagoon.

10. FAUNA

10.1 Avifauna

More than 30 bird species have been recorded at Hawksbury Lagoon (Appendix 3), several of which are nationally threatened or uncommon species (Table 1). The lagoon also provides important habitat for more common water fowl such as New Zealand shoveler (*Anas rhynchos variegata*), paradise shelduck (*Tadorna variegata*), grey teal (*Anas gracilis*), black swan (*Cygnus atratus*), and mallard (*Anas platyrhynchos*). Several species breed at the site. While there is a predominance of wetland bird species, a few common forest species such as grey warbler (*Gerygone igata*), bellbird (*Anthornis melanura melanura*), and tui (*Prosthemadera novaeseelandiae novaeseelandiae*) are also present.

Table 1: Nationally threatened and uncommon avifauna recorded at Hawksbury Lagoon. National threat classifications are from Miskelly *et al.* (2009).

Species	Common Name	Threat Classification
<i>Anas superciliosa superciliosa</i>	Grey duck	Threatened - Nationally Critical
<i>Egretta alba modesta</i>	White heron	Threatened - Nationally Critical
<i>Falco novaeseelandiae</i> "eastern"	Eastern falcon	Threatened - Nationally Vulnerable

Species	Common Name	Threat Classification
<i>Haematopus unicolor</i>	Variable oystercatcher	At Risk - Recovering
<i>Himantopus himantopus leucocephalus</i>	Pied stilt	At Risk - Declining
<i>Hydroprogne caspia</i>	Caspian tern	Threatened - Nationally Vulnerable
<i>Larus bulleri</i>	Black-billed gull	Threatened - Nationally Endangered
<i>Larus novaehollandiae scopulinus</i>	Red-billed gull	Threatened - Nationally Vulnerable
<i>Phalacrocorax carbo novaehollandiae</i>	Black shag	At Risk - Naturally Uncommon
<i>Phalacrocorax melanoleucos brevirostris</i>	Little shag	At Risk - Naturally Uncommon
<i>Phalacrocorax sulcirostris</i>	Little black shag	At Risk - Naturally Uncommon
<i>Platalea regia</i>	Royal spoonbill	At Risk - Naturally Uncommon

10.2 Fish

There are no fish records for Hawksbury Lagoon or contributing tributaries in the New Zealand Freshwater Fish Database (NIWA 2009). However the Regional Plan: Coast for Otago (ORC 2004), lists eels and inanga as present (Table 2). Department of Conservation (1987) lists bullies (*Gobiomorphus* sp.), eels, and occasional visits by salt water species when the outlet is open to the sea.

Table 2: Freshwater fish species recorded at Hawksbury Lagoon (ORC 2004).

Species	Common Name	Threat Classification
<i>Anguilla</i> sp.	Eel	N/A (depends on species)
<i>Galaxias maculatus</i>	Inanga	Not Threatened
<i>Gobiomorphus</i> sp.	Bully	Not Threatened

10.3 Herpetofauna

Department of Conservation (1987) lists common skink (*Oligosoma nigriplantare polychrome* - Not Threatened) and frogs (species not identified) as present.

10.4 Mammals

European rabbits (*Oryctolagus cuniculus*) were observed at the site. Other pest animals that are also likely to be present include brown hares (*Lepus europaeus*), rats (*Rattus* spp.), brushtail possums (*Trichosurus vulpecula*), hedgehogs (*Erinaceus europaeus*), domestic cats (*Felis catus*), house mice (*Mus musculus*), and mustelids (*Mustela* spp.). Domestic dogs (*Canis familiaris*) are taken on lagoon walking tracks. Sheep have access to mudflats and turf through macrocarpa forest in the northeastern part of the site, although sign was only observed in forest. Sheep also graze hillslope pasture at the head of Hawksbury Inlet.

PART 2:
ECOLOGICAL
MANAGEMENT PLAN

11. VISION

It is suggested that a vision is developed for the restoration of Hawksbury Lagoon. The vision should, ideally, include elements such as improving water quality and the extent and quality of indigenous vegetation and fauna habitats, specifically referring to indigenous plants, birds, fish, and invertebrates. A vision could be along the following lines:

To restore and maintain ecological health and key ecological processes of the Hawksbury Lagoon, to provide long-term good quality habitats for indigenous plants, birds, fish, and other biota.

12. RESTORATION OBJECTIVES

In order to meet the overall vision, a series of objectives for Hawksbury Lagoon ecological restoration should be developed. The following are suggested:

- To increase the extent of indigenous vegetation through plantings;
- To improve water quality through the establishment of indigenous vegetation;
- To improve habitats for native plants and fauna through control of weeds, establishment of indigenous vegetation, and improvement of water quality;
- To reduce the incidence of ecological weeds through weed control;

Other objectives relating to recreation and amenity values would be relevant, but are outside the scope of this report.

13. VEGETATION AND HABITAT RESTORATION APPROACH

13.1 Stakeholders

Several organisations, groups, and individuals are likely to have an interest in restoration plans and activities undertaken at Hawksbury Lagoon. These include, but are not limited to, the Department of Conservation, Otago Regional Council, Dunedin City Council, NZ Fish and Game, NZ Ornithological Society, local residents and property owners, and local Maori. Involving and working with all of these stakeholders will be required for successful restoration of Hawksbury Lagoon.

13.2 Hydrology and water quality

Several options have been previously considered by the Department of Conservation (DOC) for altering hydrological flows to improve water quality (Ian Hadland, Fish & Game New Zealand, pers. comm., August 2009). This information could be obtained from DOC or Fish & Game, and be used to determine or advance ideas on possible water management strategies. Due to the need to protect existing properties from flooding and decrease the incidence of nuisance insects, it appears that permanent opening of all culverts between Post Office Creek and the lagoon is not a viable

option. It has been suggested recently that installing a weir at the southern end of the lagoon and permanently opening a culvert at the northern end would be the best solution. The feasibility of this option would need to be investigated by a hydrological engineer. At a minimum, new and easily-managed flap gates should be installed so that they can be opened and closed easily. However, this option still requires a volunteer to manage water levels.

Whatever option is adopted, ecological restoration can proceed with the existing water management regime. Well-drained habitats will not change markedly with any modification of the existing system, and any wetland plantings, if appropriate species are used, will migrate with any gradual change in the water level regime. Water quality is likely to improve with establishment of aquatic species such as raupo (*Typha orientalis*), which will help to trap suspended sediment and thereby reduce nutrients levels which promote nuisance algal growth.

13.3 Management zones

Eleven management zones (A-K) have been identified based on existing land cover, land use, and location (Figure 2). The primary purpose of these zones is to identify specific management needs for particular areas. It is not envisaged at this stage that restoration would be undertaken on dunes and beach as, ideally, this should be undertaken as part of the restoration of the entire DCC-administered estate (part of Waikouaiti Sports Ground and the Waikouaiti Recreation Reserve) that extends south to the Waikouaiti River estuary. The restoration approach for each management zone is outlined below:

Zone A: Inverary Street

Aim: To retain an accessible mown area for picnics, views, and other related uses while increasing indigenous habitats by undertaking plantings along the lagoon margins, as ‘clumps’ within the mown area, and in the entire north-western half of the zone.

Weeds: Periwinkle, tall fescue, and sitka spruce are the main weeds along the lagoon margins. Alder and willow are present in the mown area. Rank cocksfoot and other exotic grasses are dominant in the north-western half of site. Removal of non-local planted species such as karamu and non-invasive species such as tortured willow and poplar would increase ecological values if indigenous plantings are undertaken.

Planting: Species tolerant of moist soils (Table 4) should be planted on lagoon margins. Plant species of well-drained sites from the edge of mown area to near the railway line, and as ‘clumps’ within the mown area.

Amenity: Seating, tables.

Notes: Builds on plantings already undertaken. Leave a 10 m-wide unplanted buffer zone near the railway line. Permission to control weeds on railway land should be sought. Plantings may need protection from vandalism in this area.

Zone B: Walkways/Causeways

- Aim:** To increase indigenous habitats and protect against wave-induced erosion, while retaining views.
- Weeds:** Pampas, marram, lupin, gorse, apple, and Scotch broom. Removal of several planted non-local species such as *Olearia traversiorum* and *Pittosporum ralphii* would increase ecological values in the long term.
- Planting:** Plant species tolerant of moist soils that will 'soften' wave action on the sides of causeways. Species suited to well-drained sites can be planted on top. Use species that will not require large amounts of maintenance to keep the walkway open. Leave gaps at top of the causeway unplanted so that views are retained (but plant lower banks).
- Works:** Repair of eroded parts of the causeway may be necessary before planting.
- Notes:** It is the Society's wish that non-local native species planted by former members be retained.

Zone C: Conifer Forest and Oak Forest

- Aim:** To create indigenous coastal forest comprising Hall's totara, ngaio, narrow-leaved lacebark, ribbonwood, kowhai, mahoe, and other appropriate tree species.
- Weeds:** Boxthorn, hawthorn, Scotch broom, radiata pine, macrocarpa, oak, beech, and planted non-local natives.
- Planting:** Species of well-drained sites on hillslopes, with a narrow band of moisture tolerant species on lagoon margins.
- Notes:** The felling of large trees is a major undertaking and contractor quotes should be sought. Most of the felled material will need to be removed from the site (or mulched) to allow access for planting and maintenance.

Zone D: Margins of Hawksbury Inlet

- Aim:** To create indigenous podocarp/broadleaved forest on upper slopes and increase the extent of indigenous vegetation on moist soils.
- Weeds:** Crack willow, gorse, lupin, hawthorn, Scotch broom, and a few unidentified trees (viewed from a distance). Elder is present next to Edinburgh Street.
- Planting:** Hillslopes as for Zone C. Large area of moist soils at head of inlet with some *Carex geminata* already present.

Notes: Grazing of unplanted pasture at the head of Hawksbury Inlet should be continued, with progressive removal of stock as staged planting proceeds. Totara has already been planted at two sites. Rank grass should be controlled by mechanical releasing and/or mulching and the gaps between existing trees planted with appropriate indigenous species (Table 4).

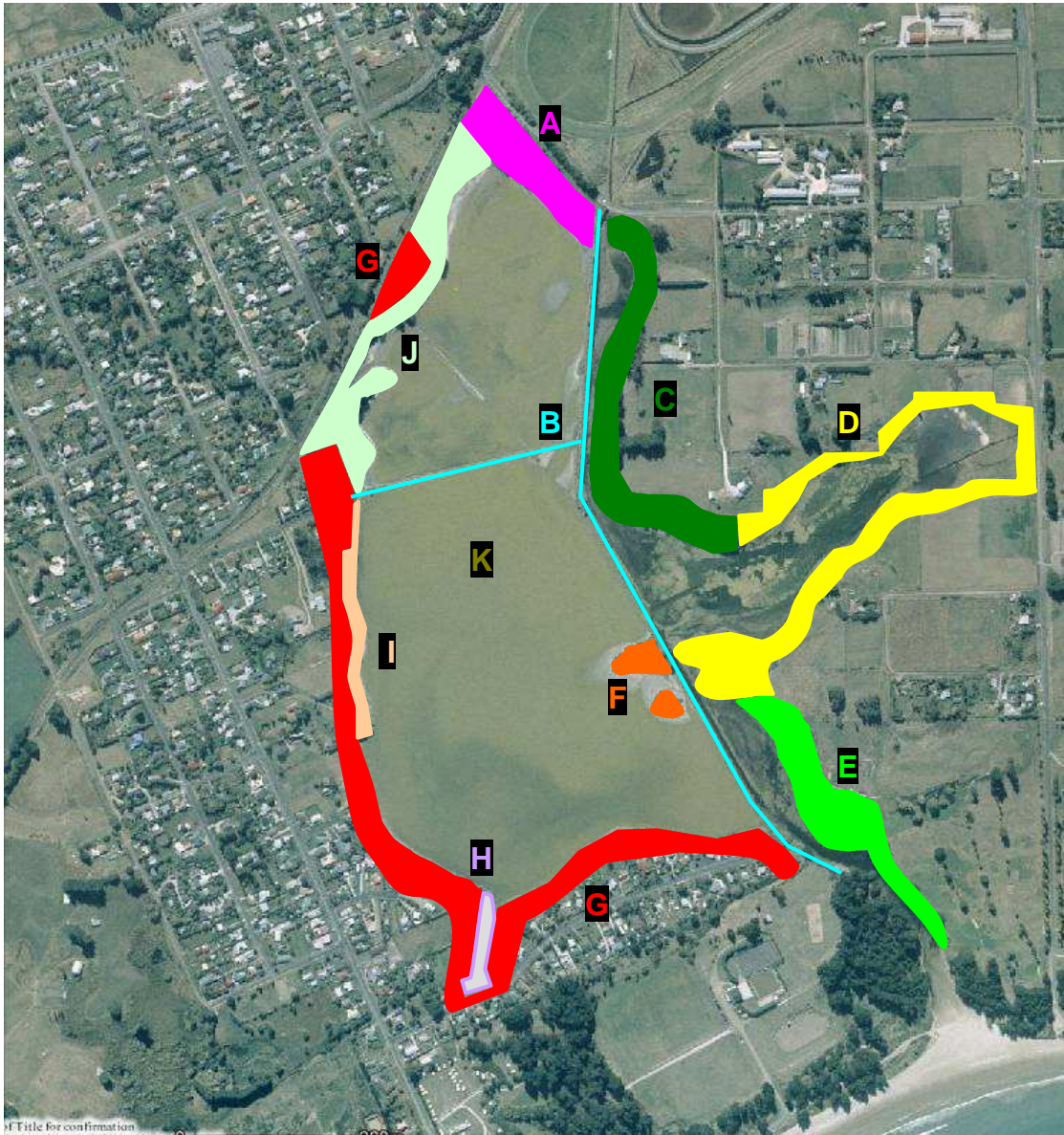


Figure 2: Management zones (A-K), Hawksbury Lagoon.

Zone E: Eastern Side of Outlet

Aim: To increase the extent of indigenous vegetation and habitats.

Weeds: Radiata pine, macrocarpa, poplar, elder, gorse, Scotch broom, lupin, hawthorn.

Planting: Plant low-lying area currently covered in tall fescue and scattered gorse and Scotch broom with species tolerant of moist site conditions. Hillslopes planted in species of well-drained sites.

Zone F: Island and Peninsula

Aim: To increase the quality and quantity indigenous habitats by building on previous plantings and weed control.

Weeds: Silver birch, macrocarpa, and gorse.

Planting: Fill gaps in current indigenous cover with flax. Leave some areas open for views.

Notes: Removal of macrocarpa is a major undertaking, seek quotes from contractors.

Zone G: Residential Properties

Aim: Educate owners as to value of indigenous species.

Weeds: Likely to be many (most properties not visited). Includes willows, cotoneaster, and non-local natives.

Planting: Encourage property owners to plant locally-sourced indigenous species on lagoon margins. Educate people about the weediness of some non-local native species such as karamu and the potential impacts of pets on wildlife.

Notes: Due to the difficulty of liaising with a large number of landowners, this zone has the lowest priority for restoration. At least one property owner has already undertaken indigenous plantings of flax, cabbage tree, and kohuhu.

Zone H: Horse Paddock

Aim: To establish indigenous habitats, while providing access to, and views from, the lagoon margin.

Weeds: Pampas, eucalyptus, and gorse. Willow on property boundary to the east. Hawthorn on property to northwest.

Amenity: Construct gravel path to viewing area by lake.

Planting: Species tolerant of moist soil by stream and lagoon edge. Elsewhere species of well-drained sites.

Notes: Remove grazing animals.

Zone I: DCC Reserve, Western Margins

- Aim:** To create a buffer of indigenous vegetation along the lake edge.
- Weeds:** Non-local natives, cotoneaster. Ivy in narrow strip north of DCC reserve.
- Planting:** Low-stature species tolerant of moist soils (e.g. flax, toetoe). Locally-sourced indigenous species could be supplied to adjacent landowners to plant in the reserve.
- Notes:** This zone incorporates a narrow strip north of the DCC reserve. The reserve is incorporated into nearby residential gardens (it is mown, planted). Steep slopes on nearby residential properties will enable views to be retained if lower stature species are planted.

Zone J: North-Western Margins

- Aim:** Increase extent of indigenous habitats.
- Weeds:** Variegated flax, stinking iris, male fern, elder, crack willow, blackberry, hawthorn, Scotch broom, flowering currant, Sitka spruce, eucalyptus, and poplar. Neighbouring property has a tall hawthorn hedge.
- Planting:** Do not plant areas of *Leptinella* turf alongside the lagoon. The low-lying area to the north (covered in tall fescue grassland) and a small stream further south should be planted in species tolerant of moist/wet soils. Species suited to well-drained sites for higher elevation areas.
- Notes:** Do not plant in a 5-10 m wide buffer zone alongside the railway line. Permission to undertake plantings and control weeds on railway land should be sought. The nearby landowner appears to manage some areas beyond their property boundaries and there may be some resistance to removal of existing exotic trees.

Zone K: Open Water, Mudflats, and Turf

- Aim:** To create habitats for indigenous avifauna by planting aquatic species.
- Weeds:** Creeping bent-dominant turf provides food for grazing waterfowl and should not be controlled.
- Planting:** Aquatic species. Plant at selected sites around lagoon margins. Include sites distant from access ways, to provide nesting sites for avifauna.
- Notes:** Consider construction of an island(s) at least 50 m from lagoon margins or causeways. Plant the island in indigenous species, as well as nearby aquatic habitats.

13.4 Weed control

Many environmental weeds are present. These are listed below in Table 3 with their recommended control techniques. Resource consent may be required for the use of herbicide near water.

Table 3: Control methods recommended for selected environmental weeds recorded in the Hawksbury Lagoon study area, July 2009.

Species/Group	Control Method
Blackberry (<i>Rubus fruticosus</i> agg.)	Dig out and dispose of root crowns off-site or cut and paste stump with herbicide.
Boxthorn (<i>Lycium ferocissimum</i>)	Pull out seedlings or cut and paste stump with herbicide.
Cotoneaster (<i>Cotoneaster</i> sp.)	Pull out seedlings or cut and paste stump with herbicide.
Crack willow (<i>Salix fragilis</i>)	Kill specimens located in inaccessible areas while standing. Bore a hole every 100 mm around the trunk and fill each hole with undiluted Glyphosate (10ml) or 2,4-D ester (20ml).
Elder (<i>Sambucus nigra</i>)	Pull out seedlings or cut and paste stump with herbicide; stack wood off ground or remove from site to prevent resprouting.
Exotic grasses and grassland herbs	Spray with Glyphosate herbicide.
Flowering currant (<i>Ribes sanguineum</i>)	Pull out seedlings or cut and paste stump with herbicide.
Gorse (<i>Ulex europaeus</i>)	Cut and paste stump with herbicide.
Hawthorn (<i>Crataegus monogyna</i>)	Cut and paste stump with herbicide.
Holly (<i>Ilex aquifolium</i>)	Pull out seedlings or cut and paste stump with herbicide.
Ivy (<i>Hedera helix</i>)	Spray with Glyphosate herbicide or, for vines growing up trees, cut and paste stump with herbicide; seek access to and control ivy on private property near Scotia Street.
Karamu (<i>Coprosma robusta</i>)	Pull out seedlings or cut and paste stump with herbicide.
Male fern (<i>Dryopteris filix-mas</i>)	Dig out and dispose off-site.
Marram (<i>Ammophila arenaria</i>)	Spray with Glyphosate herbicide.
Pampas (<i>Cortaderia selloana</i>)	Spray with Glyphosate herbicide.
Periwinkle (<i>Vinca major</i>)	Spray with Glyphosate herbicide; seek access to and control periwinkle on private property near Scotia Street; hard to kill and constant follow-up control required.
Red hot poker (<i>Kniphofia uvaria</i>)	Dig out and dispose of tubers off-site.
Scotch broom (<i>Cytisus scoparius</i>)	Cut and paste stump with herbicide.
Stinking iris (<i>Iris foetidisma</i>)	Spray with Glyphosate herbicide or dig out and dispose of rhizomes off-site.

13.5 Specimen trees

Many exotic trees have been planted within the project area. These include golden willow, tortured willow, alder, macrocarpa, silver birch, radiata pine, poplars, oak, and beech. Some of these provide food sources for birds (e.g. oaks provide acorns that are eaten by ducks), as well as shelter and nest sites (white-faced heron have nested in radiata pine), but in general, these trees do not provide as many ecological benefits as indigenous vegetation would. In addition, some species (e.g. silver birch,

alder) pose a risk to existing values and to restoration activities due to their invasive nature. It is therefore recommended that these trees are progressively removed from areas targeted for restoration plantings. Willows require herbicide application to kill them, either by boring, frilling, or painting cut stumps. All other trees can be felled, making sure no foliage is left below the cut. If some specimen trees (such as oaks) are retained, under-planting with indigenous species will increase ecological values.

13.6 Planting guidelines

A key management objective for restoration of Hawksbury Lagoon is the establishment of indigenous vegetation cover in order to improve water quality and enhance aquatic and well-drained habitats. This will require fencing to exclude livestock, weed control, pest animal control, planting, and ongoing maintenance.

13.6.1 Fencing

Stock should be excluded from the head of Hawksbury Inlet before planting is undertaken in this area. This should be possible by keeping stock behind existing fence lines¹. The breach in the fence in the northeastern corner of the site should be fixed before beginning any other work. Permanent 8-wire fencing is recommended, as this will exclude both cattle and sheep, and requires little maintenance. If any fencing is required at a later date, the fence should be placed as far from the wetland as possible (this will usually be on the property boundary). In pasture areas, leaving an unplanted strip 1 m wide between the fence and the plantings will prevent plantings from being eaten by livestock, and allow for the development of a strip of rank grass which will entrap sediment and slow overland flow of water.

13.6.2 Site preparation

Site preparation is a key factor in the successful establishment of indigenous plantings. Non-invasive weeds should be sprayed with a Glyphosate-based herbicide two weeks prior to planting. Larger woody species will require felling or killing with herbicide while standing. Many weed species will require follow up control operations to ensure total removal prior to planting. The weed control component of site preparation should be undertaken over the summer months in those areas designated for planting in the following autumn.

13.6.3 Pest animal control

Pest animals will require control prior to planting. There are likely to be several potentially problematical pest species present, including brushtail possums, brown hares, and rabbits. It is important that these species are controlled to levels that will not affect the revegetation plantings or natural regeneration. Possum control can be undertaken using a network of bait stations. Rabbits and hares are best controlled by spotlighting and shooting, but because the lagoon is located in a residential area, pindone poison baits are likely to be the preferred option. See Section 12.6.4 for more detail on pest animal control.

¹ Redundant fences/posts located in open water and mudflats in the Hawksbury Inlet and on western margins of the lagoon could be removed, although this is not required on ecological grounds.

13.6.4 Planting

Eco-Sourcing

The species to be planted at the restoration site should occur naturally at other similar habitats in Waikouaiti Ecological District and they should be “eco-sourced” (grown from seeds, propagules or cuttings collected from naturally occurring populations elsewhere in the Waikouaiti Ecological District or the Otago Coast Ecological Region). Cultivars of indigenous species (e.g. variegated flax, *Pseudopanax* spp., *Pittosporum* spp.) and non-local natives (e.g. karamu, *Hoheria populnea*, *Olearia traversii*, *Pittosporum ralphii*) are not suitable for restoration plantings.

Species Selection

Species selection for indigenous plantings must be guided by local factors such as existing vegetation cover, soil type, and flooding regime (Table 4). Planting sites can be divided into four broad categories on the basis of soil moisture and flooding levels:

- Hillslopes, with well-drained soils, should be planted in taller trees and shrubs.
- Low banks, causeways near the lagoon, and low-lying areas, should be dominated by species tolerant of moist soils, including scattered woody plants, such as koromiko, *Coprosma propinqua*, and manuka.
- Lagoon margins, with wet soils, should have plants that are able to withstand regular inundation, such as sedges.
- Aquatic sites should have species such as raupo that tolerate permanent inundation.

Plant schedules (Table 4) are dominated by hardy species such as flax and *Coprosma propinqua*. On hillslopes these species will provide shelter for slower-growing species such as totara and matai.

Plant Stock, Spacing, and Density

The density of plantings and the grades of plants used will determine the total planting cost. In revegetation plantings, some species can establish from a root trainer (RT) size (if planted well), but others, as noted in the plant schedules, require planting at bigger grades (PB3 or larger) to ensure successful establishment. To achieve good success when using smaller grade plants, site preparation must be carried out to a high standard and plants must be well cared for prior to planting. Weed control and releasing around plants must be undertaken carefully and on time. In order to keep costs as low as possible at Hawksbury Lagoon, while still achieving good ecological outcomes, plantings are dominated by smaller grade, low-cost species such as flax.

A high planting density of 10,000 plants/ha (1 m centres) is recommended to achieve canopy closure within 2-3 years of planting and reduce the opportunity for weed establishment. Large canopy trees such as Hall’s totara and kahikatea are spaced at least 5 m apart amongst the smaller, faster growing species which are spaced 1 m apart. On lagoon margins, sedges and grasses should be planted at 0.5-0.75 m centres to rapidly cover the bank and reduce erosion from wave action.

Planting at this density will require considerable resources, which may not be available to the Society. In this case, a staged approach may be a better option, involving successive planting of small areas over a duration of ten or more years.

Planting density could be reduced, but this would require more post-planting maintenance to prevent smothering of planted trees by exotic grass swards. It would be better to plant at 1 m spacing within clumps, and disperse individual clumps so that overall density within a fixed area would be reduced. Over time, the gaps between clumps should also be planted.

Table 4: Planting schedule for well-drained, moist, and wet sites at Hawksbury Lagoon. The proportion of each species to be planted is provided (e.g. 45% of plants in wet sites should be *Carex geminata*).

Scientific Name	Common Name	Plant Size	Spacing (m)	Dry Sites (%)	Moist Sites (%)	Wet Sites (%)	Aquatic
<i>Apodasmia similis</i> ¹	oioi	RT	0.5	0	0	0	✓
<i>Aristotelia serrata</i>	wineberry	PB	5	5	0	0	✗
<i>Carex geminata</i>		PB	0.5	0	0	45	✗
<i>Carpodetus serratus</i>	putaputaweta	PB	1	1	0	0	✗
<i>Coprosma propinqua</i>		PB	1	10	15	0	✗
<i>Cordyline australis</i>	cabbage tree	PB	1	10	10	5	✗
<i>Cortaderia richardii</i>	toetoe	RT	0.5	0	20	20	✗
<i>Dacrycarpus dacrydioides</i>	kahikatea	PB	5	0	1	0	✗
<i>Dacrydium cupressinum</i>	rimu	PB	5	1	0	0	✗
<i>Eleocharis acuta</i> ¹	sharp spike sedge	RT	0.5	0	0	0	✓
<i>Ficinia nodosa</i> ¹	knobby clubrush, wiwi	RT	0.5	0	1	2	✗
<i>Griselinia littoralis</i>	broadleaf	PB	5	5	0	0	✗
<i>Hebe salicifolia</i>	koromiko	PB	1	0	5	0	✗
<i>Hoheria angustifolia</i>	narrow-leaved lacebark	PB	5	5	0	0	✗
<i>Isolepis cernua</i> ¹	slender clubrush	RT	0	0	0	0	✓
<i>Juncus kraussii</i> var. <i>australiensis</i> ¹	searush	RT	0.5	0	0	1	✗
<i>Kunzea ericoides</i>	kanuka	RT	1	4	0	0	✗
<i>Leptospermum scoparium</i>	manuka	RT	1	0	15	2	✗
<i>Melicope simplex</i> ³		PB	1	1	0	0	✗
<i>Melicytus ramiflorus</i>	mahoe	PB	1	3	0	0	✗
<i>Myoporum laetum</i> ²	ngaio	PB	5	1	0	0	✗
<i>Myrsine australis</i>	mapou	PB	1	1	0	0	✗
<i>Olearia avicenniifolia</i>		PB	5	6	0	0	✗
<i>Phormium tenax</i>	harakeke, flax	RT	1	20	30	25	✗
<i>Pittosporum tenuifolium</i>	kohuhu	PB	1	20	0	0	✗
<i>Plagianthis divaricatus</i>	saltmarsh ribbonwood	PB	1	0	2	0	✗
<i>Plagianthus regius</i>	lacebark	PB	5	1	0	0	✗
<i>Podocarpus hallii</i>	Hall's totara	PB	5	1	0	0	✗
<i>Prumnopitys taxifolia</i>	matai	PB	5	1	0	0	✗
<i>Pseudopanax crassifolius</i> ³	lancewood	PB	1	3	0	0	✗
<i>Schoenoplectus pungens</i> ¹	three-square	RT	0	0	0	0	✓
<i>Sophora microphylla</i>	kowhai	PB	5	1	1	0	✗
<i>Typha orientalis</i> ¹	raupo	PB	0.5	0	0	0	✓

¹ Plant as 'clumps' at selected locations on lagoon margins.

² Plant only near lagoon outlet.

³ Plant once cover established.

Timing

Plants should be ordered as early as possible (up to a year before planting). This will enable the supplier(s) to ensure that they have enough stock of the appropriate species, and can mean that the price per plant is more economical than if the plants are purchased without placing a prior order. Planting of well-drained sites should be undertaken in early autumn (March-April) or late winter/early spring (August-early September), but the timing of planting needs to be flexible and to take account of seasonal weather patterns. For example if a very dry summer is experienced, soil moisture may not be sufficient for autumn planting. Spring plantings can be affected by equinoctial or dry northwest winds and staking may be required to provide initial support for species that are susceptible to wind, with irrigation required for those species that are sensitive to water stress. Planting of wetland sites (e.g. reservoir margins and drains) should be undertaken in November, when the stems of wetland plants are actively growing and will not rot.

Maintaining Plantings

The plantings will need to be released from weed competition two or three times during the first year following planting, and 1-2 times in the following two or three years, until the indigenous plants have become established. Aggressive woody weeds, such as elder, gorse, and Scotch broom, are likely to require further control until canopy closure is achieved.

Plants that die in the first year should be replaced, particularly where their absence would allow the growth of aggressive weeds. Some infilling planting may also be required in subsequent years.

Monitoring

For the first year following planting, all plantings should be inspected on a fortnightly or monthly basis, depending on seasonal requirements. This surveillance will allow the project manager to identify changes in vegetation composition, assess the survival of indigenous plants, and gauge the success of weed control. The information can be used to determine if further infill planting and/or pest control is required.

While not essential, monitoring can detect patterns of change over time in plant growth, and the effectiveness of weed control. A simple method is to establish fixed photopoints and to take photographs at set intervals, e.g. every six or twelve months. At the least, photographs should be taken prior to work starting and on completion.

13.7 Habitat enhancement for fauna

13.7.1 Habitat diversity

Indigenous wetland and forest birds that are likely to utilise a restored lagoon require a variety of habitats. For example:

- Mallards, grey duck, New Zealand shoveler, and grey teal favour shallow water around the edges of the lagoon.

- Paradise shelduck feed on turf within the lagoon.
- Pied stilts feed on worms and insects in shallow water and mud flats.
- All waterfowl need open water to moult in safety, away from predators.
- Tui, silvereyes, and bellbirds will feed on flax and kowhai nectar.
- Pukeko nest on clumps of grass or rushes and feed on grasses, clover, and raupo.
- Kereru will eat kowhai foliage and the fruits of kahikatea.

Restoration should focus on improving habitats for existing species. However, habitat may be able to be created or improved for other bird species, especially if combined with restoration at larger scales (e.g. Waikouaiti River Estuary, dune and beach restoration):

- Marsh crake prefer raupo swamps and saltmarsh habitats.
- Spotless crake prefer raupo swamps and reedbeds.
- South Island fernbird prefer wetlands with dense ground cover under a selection of shrubs and small trees like manuka.
- Australasian bittern prefer tall, dense raupo and reeds.

13.7.2 Food supplies

Wetland birds require a variety of food sources. Species such as white-faced heron, bittern, and royal spoonbill feed on fish, frogs, and invertebrates, while mallard and black swans feed on aquatic plants, and paradise shelduck and geese graze on pasture and aquatic vegetation. Tui, bellbird, silvereye feed on nectar from plants such as flax and kowhai, and kereru food sources include kowhai foliage and podocarp fruits. Indigenous plantings will supply additional food sources for forest and water birds, as well as provide shelter and increase habitat diversity.

As a large range of bird species currently utilise the lagoon, many of these food sources must exist in sufficient quantity to sustain their populations, or their seasonal food requirements. Indigenous plantings, especially aquatic plantings, will increase the diversity of invertebrates in the lagoon, but the only other way of increasing food supplies is through changing the hydrological regime of the lagoon. Regular tidal flushing would have the greatest effect on productivity, but this is an impractical scenario given the flooding threat to private property. The construction of a weir and open culvert may increase the food supply within the lagoon by improving water quality.

13.7.3 Islands

Along with the lack of suitable vegetation, a lack of predator-free areas is likely to be preventing several bird species from utilising and/or breeding at the site. One way of providing such habitats is to create an island (or two) in the middle of the lagoon. The surrounding water will discourage predators such as cats from reaching the island. The existing island is too close to the shore and, during periods of low water levels, is connected to the surrounding land by mudflats. The following guidelines apply to construction of islands:

- Site at a sufficient distance from the edge of the lagoon to discourage predators.

- Create gently-sloping edges to provide easy access for waterfowl and loafing areas.
- Plant with indigenous species, including aquatic species in surrounding water, to provide shelter, hiding places, and nest sites.

13.7.4 Pest animal control

Possum control undertaken for protection of plantings may also reduce predation on indigenous fauna, and improve ecological processes such as seed dispersal and pollination. Intensive mustelid and rat control may reduce predation rates on indigenous birds, lizards, and invertebrates. However, in general, there is less information on the benefits of intensive pest control for wetland bird communities than, for example, for indigenous forest bird communities, and the main contributors to improving wildlife habitat may be revegetation and catchment/hydrology management. The main benefit of mustelid and rat control (when combined with possum control) may be to improve the functioning of ecological processes, such as seed dispersal and pollination, which help sustain indigenous vegetation communities around the lagoon. Options for pest animal control at Hawksbury Lagoon are set out, with costs, in Table 5.

Table 5: Pest animal control options and costs for Hawksbury Lagoon.

Target Species	Operational Target	Method	Annual Cost ¹
Possum	Maintain possum numbers continuously at very low levels	Kill-traps (Timms trap, Warrior), approx. 45 ² traps checked fortnightly, <u>or</u> 45 baitstations filled 6 times per annum with Pestoff (if risks of catching domestic cats in traps are deemed unacceptable). Set-up cost approx. \$1,000-\$2,000	\$3,000 - \$4,680
Rabbit, hare	Maintain rabbit and hare numbers continuously at very low levels	Pindone, hand-laid, 4 times per annum (requires controlled substance licence.	\$1,200
Dogs	Minimise disturbance and predation of wildlife, minimise risk to dogs	Compulsory use of leads Compulsory containment behind residential fences	
Domestic cats	Minimise disturbance and predation of wildlife, minimise risk to cats	Keep cats well-fed, speyed/neutered	
Indicative annual total to protect revegetation work and minimise disturbance (and risks to) domestic dogs and cats			\$4,200 - \$5,880
Mustelids (stoats, ferrets, weasels); rodents (Norway rat, ship rat)	Maintain mustelid and rat numbers continuously at very low levels	DOC200 kill-traps, approx. 45 checked fortnightly. Set-up cost approx. \$3,000 - \$4,000	\$4,680
Indicative annual total for mustelid and rat control			\$4,680
Overall Indicative Total			\$8,880 - \$10,560

¹ Indicative annual cost using contractor.

² Estimated 4.5 km lagoon perimeter, where bait stations/traps would be located.

Feral geese (*Anser anser*) could also be controlled. This has been previously undertaken by Fish & Game and the NZ Wildlife Service, but may no longer be carried out (Derek Onley pers. comm. August 2009).

13.7.5 Bird monitoring

The Ornithological Society undertakes bird counts at the lagoon 2-3 times per year. These counts could be used to assess the success of restoration activities with regard to avifauna.

13.8 Fisheries management

Movement of diadromous fish species from Hawksbury Lagoon to the sea is currently limited to when the outlet is open. This will not change under the proposed management regime. Existing culverts are barriers to fish passage when closed, and the velocity of water when open may also inhibit the passage of some species. If a weir is built at the southern end of the lagoon, then a fish pass can be incorporated into the design. Some relatively cheap designs are available (e.g. Mitchell 1994), although specialist advice should be sought on design and construction. An armoured outfall will be required to prevent erosion. An open channel/culvert at the northern end of the lagoon, if combined with the weir, may allow fish passage, thus negating the need for a fish pass. If current lagoon water levels are to be maintained, there do not appear to be any other options for fish passage other than the weir/open culvert combination.

Fish habitats will also be improved through the restoration of aquatic plant communities. Aquatic plants are important to fish because they:

- Purify water.
- Recycle nutrients.
- Provide a physical link between water and air that is required by many invertebrates (that are a food source).
- Provide refugia for zooplankton which graze phytoplankton and keep water clear.
- Provide cover for fish and invertebrates.
- Provide spawning areas.
- Provide food.
- Provide habitat diversity by affecting flow patterns and creating physical habitat (Petr 2000).

13.9 Recreational use

Recreational use can be compatible with the ecological values of some wetland areas, providing the following guidelines are followed:

- Dogs are leashed at all times.
- Boating is not permitted.

- Walkways are carefully placed to retain some areas away from public use. This may preclude the establishment of a walkway along the entire lagoon margins. Buffers of vegetation between tracks and the lagoon will also partially protect wildlife from disturbance.
- Walkways are appropriately surfaced to provide a low-maintenance permeable surface, and are set back from water margins.
- Boardwalks and bridges are used to cross side tributaries, in order to retain fish migration pathways.
- All wet areas, permanent or ephemeral, are crossed by boardwalks to avoid changes in site hydrology.
- Defined access points are allowed for between walkways and the waters edge, to focus use at locations that are less environmentally sensitive (e.g. away from steep banks, or areas of higher quality vegetation or fauna habitat).

13.10 Management of surrounding areas

A long term objective could be to improve the quality of water entering the lagoon by establishing riparian buffers alongside all contributing waterways. This would have the added benefits of increasing indigenous habitats and establishing links or 'stepping stones' for mobile species to other areas of indigenous habitat in the vicinity of Waikouaiti.

Restoration of dune/beach communities from the base of Cornish Head to the Waikouaiti River estuary would also increase the value of habitats for indigenous fauna, including birds (e.g. South Island fernbird). However, this is a major undertaking that requires a separate management plan and funding.

14. IMPLEMENTATION PLAN

14.1 Staged approach

The Hawksbury Lagoon site is large and therefore restoration activities should be staged over several years. If only small amounts of funding are received, then only small areas (c.1-1.5 ha) should be planted each year. This will leave sufficient resources available for maintenance of existing plantings, while undertaking ongoing restoration activities such as weed control elsewhere. Staged planting may also reduce the risk of extreme climatic events affecting all of the plantings.

14.2 Prioritisation of tasks

It is recommended that the staged approach is based on the following priorities:

- Confirm long-term water management regime.
- Seek funding.
- Order plants
- Install water control device(s)/fish pass, if required.
- Fix fence in north-east corner.

- Control invasive weeds (e.g. boxthorn, marram, pampas)
- For each management zone, or part of, in succession:
 - Planting preparation.
 - Undertake indigenous plantings.
 - Maintain plantings.
 - Monitor progress.

14.3 Prioritisation of zones

If funding or other resources are limited, the following management zones should be restored first:

- Zones that require the least planting preparation (i.e. dominated by exotic grassland).
- Zones with greatest potential ecological gain (e.g. aquatic habitats, buffers to other land uses).
- Highly visible zones (e.g. those visible from existing access points) to promote the project.

The highest priority zones are therefore A, B, D, F, H, and K. Second priority zones are E, C, I, and J. Zone G (residential properties) has the lowest priority. Although smaller areas within these latter zones could also be planted easily, it is probably better to work on each zone in its entirety.

15. COST ESTIMATES

15.1 Plantings

Planting cost estimates of c.\$30,000/ha (Table 6) include the following:

- site preparation costs (spot-spraying or screefing, control of woody weeds). These vary between management zones.
- plant costs of \$1.20 per RT and \$3.50 per PB2/PB3.
- planting density of 10,000 plants/ha.
- 90-95% of plants being RTs.
- releasing of plantings 2-3 times/year for three years. Costs in years 2 and 3 are lower than in the first year.

15.2 Additional costs

Contractor quotes should be sought for felling of large trees (e.g. pines, macrocarpa, poplar, silver birch), and are additional to planting costs. A weir and a fish pass may cost as little as \$2,000, depending on the design, but extra costs are likely to be incurred through the consent application process which may require an engineer's drawing and flow assessment. Contractors' quotes should also be sought for the upgrading of flap gates on existing weirs. Fence construction costs (Zone C) are likely to be \$10-15/meter. Creating an island could cost \$1,500 or more, depending on heavy digger transport costs, access, and resource consent requirements.

All of the cost estimates provided below are indicative only. When planning work, quotes should be sought from all contractors and suppliers required to undertake the work. Establishing a community native plant nursery and involving volunteers are useful options for reducing planting and maintenance costs.

Table 6: Cost estimates for restoration at Hawksbury Lagoon. Areas available for planting are approximate.

Zone	Plantable Area (ha)	Additional Costs	Plantings (Including Preparation and Maintenance)
A	0.5 (excludes retained mown areas)	Contractor tree felling	\$15,000
B	0.3	-	\$9,000
C	2.5	Contractor tree felling	\$75,000
D	4.5	-	\$135,000
E	1.5	Contractor tree felling	\$45,000
F	<0.1	Contractor tree felling	\$1,000
G	-	-	-
H	0.5	-	\$15,000
I	0.5	Contractor tree felling	\$15,000
J	2.0	Contractor tree felling	\$60,000
K	0.5 ¹	Island construction, weir, fish pass (all optional) + resource consent	\$1,000 (plants only)
Total	12.9		\$371,000

¹ Only small parts of the total area of open water to be planted.

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PLANT SPECIES RECORDED AT HAWKS BURY LAGOON DURING SITE VISITS

* Exotic species.

Non-local native species.

Species	Common Name	Plant Type	Abundance
<i>Acaena novae-zelandiae</i>	Bidibid	Dicot herb	Rare
<i>Achillea millefolium</i> *	Yarrow	Dicot herb	Occasional
<i>Agrostis capillaris</i> *	Browntop	Grass	Frequent
<i>Agrostis stolonifera</i> *	Creeping bent	Grass	Occasional
<i>Alnus glutinosa</i> *	Alder	Tree	Rare
<i>Ammophila arenaria</i> *	Marram grass	Grass	Rare
<i>Anemanthele lessoniana</i>	Gossamer grass	Grass	Rare
<i>Apium prostratum</i>	Native celery	Dicot herb	Rare
<i>Apodasmia similis</i>	Oioi; jointed wire rush	Rush	Rare
<i>Barbarea intermedia</i> *	Winter cress	Dicot herb	Rare
<i>Bellis perennis</i> *	Daisy	Dicot herb	Rare
<i>Betula pendula</i> *	Silver birch	Tree	Rare
<i>Callitriche stagnalis</i> *	Starwort	Dicot herb	Rare
<i>Cardamine hirsuta</i> *	Bitter cress	Dicot herb	Rare
<i>Carex geminata</i>	Purei	Sedge	Rare
<i>Cerastium fontanum</i> *	Mouse-ear chickweed	Dicot herb	Rare
<i>Cirsium arvense</i> *	Californian thistle	Dicot herb	Occasional
<i>Cirsium vulgare</i> *	Scotch thistle	Dicot herb	Occasional
<i>Conium maculatum</i> *	Hemlock	Dicot herb	Rare
<i>Coprosma areolata</i>		Tree	Rare
<i>Coprosma dumosa</i>		Shrub	Rare
<i>Coprosma propinqua</i>		Tree	Rare
<i>Coprosma robusta</i> #	Karamu	Tree	Rare
<i>Cordyline australis</i>	Cabbage tree; ti kouka	Tree	Occasional
<i>Cortaderia selloana</i> *	Pampas	Grass	Rare
<i>Cortaderia richardii</i>	Toetoe	Grass	Occasional
<i>Cotoneaster</i> sp.*	Cotoneaster	Shrub	Rare
<i>Cotula coronopifolia</i>	Bachelor's buttons	Dicot herb	Rare
<i>Crataegus monogyna</i> *	Hawthorn	Tree	Occasional
<i>Crepis capillaris</i> *	Hawksbeard	Dicot herb	Rare
<i>Critesion murinum</i> subsp. <i>murinum</i> *	Barley grass	Grass	Rare
<i>Cupressus macrocarpa</i> *	Macrocarpa	Tree	Frequent
<i>Cytisus scoparius</i> *	Scotch broom	Shrub	Occasional
<i>Dactylis glomerata</i> *	Cocksfoot	Grass	Abundant
<i>Desmoschoenus spiralis</i>	Pingao	Sedge	Rare
<i>Digitalis purpurea</i> *	Foxglove	Dicot herb	Occasional
<i>Dodonea viscosa</i> #	Akeake	Tree	Rare
<i>Dryopteris filix-mas</i> *	Male fern	Fern	Rare
<i>Elatine gratioloides</i>		Dicot herb	Occasional
<i>Eucalyptus</i> spp.*	Eucalyptus	Tree	Occasional
<i>Fagus sylvatica</i> *	Beech	Tree	Occasional
<i>Ficinia nodosa</i>	Knobby clubrush	Rush	Occasional
<i>Galium aparine</i> *	Cleavers	Dicot herb	Occasional
<i>Glyceria fluitans</i> *	Floating sweetgrass	Grass	Rare

Species	Common Name	Plant Type	Abundance
<i>Hedera helix</i> *	Ivy	Liane	Rare
<i>Hieracium pilosella</i> *	Mouse-ear hawkweed	Dicot herb	Rare
<i>Hoheria angustifolia</i>	Narrow-leaved lacebark	Tree	Rare
<i>Hoheria ?populnea</i> #		Tree	Rare
<i>Holcus lanatus</i> *	Yorkshire fog	Grass	Frequent
<i>Hydrocotyle heteromeria</i>	Waxweed	Dicot herb	Rare
<i>Hypochaeris radicata</i> *	Catsear	Dicot herb	Occasional
<i>Ilex aquifolium</i> *	Holly	Tree	Rare
<i>Iris foetidisma</i> *	Stinking iris	Monocot herb	Rare
<i>Juncus distegus</i>		Rush	Rare
<i>Juncus edgariae</i>		Rush	Rare
<i>Kniphofia uvaria</i> *	Red hot poker	Monocot herb	Rare
<i>Lepidium sp.</i> *	Argentine cress	Dicot herb	Occasional
<i>Leptinella dioica</i>		Dicot herb	Occasional
<i>Leucanthemum vulgare</i> *	Oxeye daisy	Dicot herb	Rare
<i>Lupinus arboreus</i> *	Lupin	Shrub	Occasional
<i>Lycium ferocissimum</i> *	African boxthorn	Shrub	Rare
<i>Malus x domestica</i> *	Apple	Tree	Rare
<i>Microsorium pustulatum</i>	Hounds tongue fern	Fern	Rare
<i>Muehlenbeckia australis</i>	Pohuehue	Liane	Rare
<i>Muehlenbeckia complexa</i>	Shrubby pohuehue	Shrub	Rare
<i>Myostis sylvatica</i> *	Garden forget-me-not	Dicot herb	Rare
<i>Nasturtium microphyllum</i> *	Watercress	Dicot herb	Rare
<i>Olearia arborescens</i>	Tree daisy	Tree	Rare
<i>Olearia avicenniifolia</i>		Tree	Rare
<i>Olearia lineata</i>		Tree	Rare
<i>Olearia traversiorum</i> #		Tree	Occasional
<i>Phormium tenax</i>	Harakeke; flax	Monocot herb	Frequent
<i>Picea sitchensis</i> *	Sitka spruce	Tree	Rare
<i>Pinus radiata</i> *	Radiata pines	Tree	Frequent
<i>Pittosporum eugenioides</i>	Lemonwood	Tree	Rare
<i>Pittosporum ralphii</i> #		Tree	Rare
<i>Pittosporum tenuifolium</i>	Kohuhu	Tree	Occasional
<i>Plagianthus divaricatus</i>	Saltmarsh ribbonwood	Shrub	Occasional
<i>Plantago coronopus</i> *	Buck's horn plantain	Dicot herb	Rare
<i>Plantago lanceolata</i> *	Narrow-leaved plantain	Dicot herb	Occasional
<i>Plantago triandra</i>	Starweed	Dicot herb	Rare
<i>Podocarpus totara</i>	Totara	Tree	Rare
<i>Polystichum vestitum</i>	Prickly shield fern	Fern	Rare
<i>Populus alba</i> *	White poplar	Tree	Rare
<i>Populus nigra</i> *	Lombardy poplar	Tree	Rare
<i>Populus sp.</i> *	Poplar	Tree	Occasional
<i>Prunella vulgaris</i> *	Selfheal	Dicot herb	Rare
<i>Pyrrosia eleagnifolia</i>	Leather-leaf fern	Fern	Rare
<i>Quercus sp.</i> *	Oak	Tree	Rare
<i>Ranunculus repens</i> *	Creeping buttercup	Dicot herb	Occasional
<i>Ranunculus amphitrichus</i>	Waoriki	Dicot herb	Rare
<i>Ribes sanguineum</i> *	Flowering currant	Shrub	Occasional
<i>Rosa sp.</i> *	Rose	Shrub	Rare
<i>Rubus fruticosus</i> agg.*	Blackberry	Shrub	Rare
<i>Rumex crispus</i> *	Curled dock	Dicot herb	Occasional
<i>Rumex obtusifolius</i> *	Broad-leaved dock	Dicot herb	Rare
<i>Salix ?alba</i> var. <i>vitellina</i> *	Golden willow	Tree	Occasional
<i>Salix ?babylonica</i> *	Weeping willow	Tree	Rare
<i>Salix fragilis</i> *	Crack willow	Tree	Rare
<i>Salix matsudana</i> var. <i>tortuosa</i> *	Tortured willow	Tree	Occasional

Species	Common Name	Plant Type	Abundance
<i>Sambucus nigra</i> *	Elder	Tree	Occasional
<i>Samolus repens</i>		Dicot herb	Occasional
<i>Schedonorus phoenix</i> *	Tall fescue	Grass	Abundant
<i>Schoenoplectus pungens</i>	Three-square	Rush	Rare
<i>Selliera radicans</i>	Remuremu	Dicot herb	Rare
<i>Senecio jacobaea</i> *	Ragwort	Dicot herb	Occasional
<i>Senecio minimus</i>		Dicot herb	Occasional
<i>Senecio vulgaris</i> *	Groundsel	Dicot herb	Rare
<i>Solanum dulcamara</i> *	Bittersweet	Shrub	Occasional
<i>Solanum laciniatum</i>	Poroporo	Tree	Rare
<i>Solanum nigra</i> *	Nightshade	Dicot herb	Rare
<i>Sonchus oleraceus</i>	Sow thistle	Dicot herb	Rare
<i>Sophora microphylla</i>	Kowhai	Tree	Rare
<i>Stelleria media</i> *	Chickweed	Dicot herb	Occasional
<i>Trifolium dubium</i> *	Suckling clover	Dicot herb	Rare
<i>Trifolium pratense</i> *	Red clover	Dicot herb	Occasional
<i>Trifolium repens</i> *	White clover	Dicot herb	Rare
<i>Ulex europaeus</i> *	Gorse	Shrub	Occasional
<i>Urtica urens</i> *	Nettle	Dicot herb	Rare
<i>Vicia sativa</i> *	Vetch	Dicot herb	Occasional
<i>Vinca major</i> *	Periwinkle	Dicot herb	Occasional

AVIFAUNA RECORDED AT HAWKSBURO LAGOON

References: Department of Conservation (1987), Forest and Bird (2003), ORC (2004), OSNZ (2007 & 2009), current survey, Derek Onley (pers. comm. August 2009).

National threat classifications are from Miskelly *et al.* (2009).

Hybrids (grey duck-mallard, black stilt-pied stilt, Canada goose-feral goose) have also been recorded.

*Exotic species.

†Rarely recorded

Species	Common Name	Threat Classification
<i>Alauda arvensis</i> *	Skylark	Introduced and Naturalised
<i>Anas gracilis</i>	Grey teal	Not Threatened
<i>Anas platyrhynchos</i> *	Mallard	Introduced and Naturalised
<i>Anas rhynchotis variegata</i>	New Zealand shoveler	Not Threatened
<i>Anas superciliosa superciliosa</i>	Grey duck	Threatened - Nationally Critical
<i>Anser anser</i> *	Feral goose	Introduced and Naturalised
<i>Anthornis melanura melanura</i>	Bellbird	Not Threatened
<i>Ardea novaehollandiae</i>	White-faced heron	Not Threatened
<i>Aythya novaeseelandiae</i> †	New Zealand scaup	Not Threatened
<i>Branta canadensis</i> *	Canada goose	Introduced and Naturalised
<i>Chrysococcyx lucidus lucidus</i>	Shining cuckoo	Not Threatened
<i>Carduelis carduelis</i> *	Goldfinch	Introduced and Naturalised
<i>Carduelis chloris</i> *	Greenfinch	Introduced and Naturalised
<i>Carduelis flammea</i> *	Redpoll	Introduced and Naturalised
<i>Charadrius melanops</i> †	Black-fronted dotterel	Native - Coloniser
<i>Circus approximans</i>	Australasian harrier	Not Threatened
<i>Cygnus atratus</i> *	Black swan	Introduced and Naturalised
<i>Egretta garzeta</i> †	Little egret	Native - Vagrant
<i>Egretta alba modesta</i> †	White heron	Threatened - Nationally Critical
<i>Emberiza citronella</i> *	Yellowhammer	Introduced and Naturalised
<i>Falco novaeseelandiae</i> "eastern" †	Eastern falcon	Threatened - Nationally Vulnerable
<i>Fringilla coelebs</i> *	Chaffinch	Introduced and Naturalised
<i>Fulica atra</i> †	Australian coot	Native - Coloniser
<i>Gerygone igata</i>	Grey warbler	Not Threatened
<i>Gymnorhina tibicen</i> *	Australian magpie	Introduced and Naturalised
<i>Haematopus unicolor</i>	Variable oystercatcher	At Risk - Recovering
<i>Himantopus himantopus leucocephalus</i>	Pied stilt	At Risk - Declining
<i>Hirundo tahitica neoxena</i>	Welcome swallow	Not Threatened
<i>Hydroprogne caspia</i> †	Caspian tern	Threatened - Nationally Vulnerable
<i>Larus bulleri</i>	Black-billed gull	Threatened - Nationally Endangered
<i>Larus dominicanus dominicanus</i>	Southern black-backed gull	Not Threatened
<i>Larus novaehollandiae scopulinus</i>	Red-billed gull	Threatened - Nationally Vulnerable
<i>Passer domesticus</i> *	House sparrow	Introduced and Naturalised
<i>Phalacrocorax carbo novaehollandiae</i> †	Black shag	At Risk - Naturally Uncommon
<i>Phalacrocorax melanoleucos brevirostris</i>	Little shag	At Risk - Naturally Uncommon
<i>Phalacrocorax sulcirostris</i> †	Little black shag	At Risk - Naturally Uncommon
<i>Platalea regia</i>	Royal spoonbill	At Risk - Naturally Uncommon

Species	Common Name	Threat Classification
<i>Porphyrio melanotus</i>	Pukeko	Not Threatened
<i>Prosthemadera novaeseelandiae novaeseelandiae</i>	Tui	Not Threatened
<i>Prunella modularis</i> *	Dunnoek	Introduced and Naturalised
<i>Rhipidura fuliginosa fuliginosa</i>	South Island fantail	Not Threatened
<i>Stictocarbo punctatus punctatus</i>	Spotted shag	Not Threatened
<i>Sturnus vulgaris</i> *	Starling	Introduced and Naturalised
<i>Tadorna tadornoides</i> [†]	Chestnut-breasted shelduck	Native - Vagrant
<i>Tadorna variegata</i>	Paradise shelduck	Not Threatened
<i>Todiramphus sanctus</i>	Kingfisher	Not Threatened
<i>Tringa stagnatilis</i> [†]	Marsh sandpiper	Native - Vagrant
<i>Turdus merula</i> *	Blackbird	Introduced and Naturalised
<i>Turdus philomelos</i> *	Song thrush	Introduced and Naturalised
<i>Vanellus miles</i>	Spur-winged plover	Not Threatened
<i>Zosterops lateralis lateralis</i>	Silvereye	Not Threatened