Biodiversity values and management recommendations for the Styx River mouth reserve, Lower Waimakariri Regional Park

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Environment Canterbury
Your regional council

Executive summary

Council policies and objectives for management of Environment Canterbury lands include safeguarding of significant natural values, and to protect and maintain the health and diversity of indigenous species and habitats.

The Styx River mouth reserve, part of the Lower Waimakariri Regional Park, contains regionally-significant saltmarsh and freshwater wetland habitats. It has high native wildlife value, supporting populations of threatened swamp birds and waders, and is a potential site for reintroduction of some locally extinct bird species.

This report describes the indigenous biodiversity and habitat values of the Styx River mouth reserve and recommends that the area be primarily managed to protect and enhance these values. Recommendations include a list of invasive weeds to be controlled throughout the area, site-led control of willows and shrub weeds, and managing access to avoid disturbance of sensitive wildlife.

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1 Introduction

Objective 11 of the Lower Waimakariri River Management Strategy (CRC 2004) is "to protect and where possible enhance remaining natural wetlands". The Styx River mouth wetland complex, encompassing both tidal saltmarsh and freshwater wetland habitats, is partly Crown land (below MHWS) and part Canterbury Regional Council reserve. Under a Memorandum of Understanding between the Department of Conservation and Canterbury Regional Council, it was agreed that the area would be managed by the Regional Council as part of the Lower Waimakariri River Regional Park (effective from 1 January 2009).

Options for protection and enhancement of the Styx Mouth wetlands are now being investigated by Environment Canterbury Parks and Reserves Section. The purpose of this report is to provide an updated description of the current biodiversity values, an assessment of their significance, and recommendations for future management.

Botanical, wildlife and habitat values of the Styx Mouth wetlands have been well described in publications and reports over the last 15 years. These include *The Estuary. Where our Rivers Meet the Sea* published by Christchurch City Council (ed. Owen 1992) and *The Natural History of Canterbury* (ed. Winterbourne *et al.* 2008), and a number of reports such as those of Meurk (1992), O'Donnell (2000), Blakely and Todd (2005) and Crossland (2008).

The complex of tidal saltmarsh, ephemeral ponds and freshwater wetland habitats around the mouth of the Styx River support extensive, diverse and regionally significant examples of native wetland vegetation. Wildlife values are also high, with the area supporting notable populations of threatened bittern and marsh crake, and nesting waterfowl. In addition, waders and waterfowl feed and roost along the saltmarsh-fringed lagoon, and cormorants feed along the river channel (Crossland 2008). The Styx Mouth wetlands are an integral part of Brooklands Lagoon, a nationally significant wildlife habitat, and are directly connected to the lower Waimakariri River, also considered an outstanding wildlife habitat of national or even international significance (O'Donnell 2000).

A 2005 survey found no evidence of inanga (whitebait) spawning in the tidal section of the Styx River, between the floodgates and Brooklands Lagoon. However, inanga spawning sites were located for the first time in the Styx River immediately upstream of the floodgates, where condition of riparian vegetation has greatly improved in recent years (Taylor 2005).The tidal section of the river is therefore an important migratory pathway for inanga and other fish moving between the lagoon and freshwater habitats upstream.

2 Site description

Soil maps for the Canterbury Plains indicate that prior to European settlement the Styx River mouth area was almost entirely an estuarine saltmarsh habitat, on level poorly drained plains supporting Motukarara Saline Gley Recent Soils. The saltmarsh was bounded by low coastal sand dunes, with soils classified as Kairaki Yellow Brown Sands (Meurk 1992; Williams 2004).

Human activity and modification over the last 150 years includes: excavation of river diversion channels (for both the Styx and the Waimakariri Rivers), drainage canals and borrow pits; construction of stop banks and channel levees; tree planting (poplar, pine, macrocarpa, willow, tamarisk, lupin); introduction of pasture plants and shrub weeds (gorse, broom); and grazing with cattle and horses (Meurk 1992). Three main stopbanks run east-west through the area fragmenting wetland habitats. The southern stopbank separates a grazed paddock with native rush cover from the main body of the reserve. Rock wall embankments have also been constructed along the Waimakariri River on the northern margin of the area. The flood gate on the Styx River, commissioned in the mid-1980s, was a major ecological alteration, resulting in an abrupt change from estuarine to freshwater hydrology on the lower river (Taylor 2005).

At present, the eastern portion of the study area remains a largely salt marsh habitat dominated by native sea rush, oioi and marsh ribbonwood vegetation. Natural low sand ridges and constructed stopbanks running through the saltmarsh support mainly exotic drought-tolerant grasses, herbs and shrubs such as marram, gorse and lupin. Saltmarsh vegetation between the northern-most stopbank and the Waimakariri River is no longer directly connected to the estuary and could therefore be described as relict or 'moribund' (Worner and Partridge, 2008). The western half of the area is now mostly a terrestrial habitat, although freshwater wetland and riparian habitats have developed in the vicinity of groundwater seepages, ponding areas and along the margins of channels, drains and the banks of the Waimakariri River (Appendix 1). For the total *c.* 144 ha survey area, approximate habitat breakdown is 40 ha saltmarsh; 10 ha 'relict saltmarsh', 10 ha freshwater wetland and 80 ha terrestrial.

2.1 Vegetation and habitats

Field survey was carried out over the period February-April 2009. Appendix 2 map shows distribution and extent of 14 vegetation types described for the Styx River mouth survey area below. These vegetation types have been derived from more detailed vegetation maps and descriptions stored in the regional wetland GIS database, currently under development.

The vegetation types have also been classified as 'predominantly native', 'predominantly exotic' and 'mixed native-exotic' on the basis of canopy composition. Generally, saltmarsh habitats support native vegetation types although a range of exotic plant species may also be present; freshwater wetlands have a mix of native and exotic vegetation types; while terrestrial habitats are almost entirely covered by exotic plant species. A notable exception is the grassland vegetation of saltmarsh habitats, where introduced species predominate (Appendix 2).

Plant species composition of the 14 mapped vegetation types is described below. Exotic species are denoted with an * following the scientific name.

1. Saltmarsh herbfield

Saltmarsh herbfield composition is variable at the Styx Mouth, depending on site conditions of elevation, salinity and substrate. Glasswort (*Sarcocornia quinqueflora*) is generally the most abundant species although not present at all sites. Other widespread species include buck's horn plantain (*Plantago coronopus**), orache (*Atriplex prostrata**), salt grass (*Puccinellia stricta*), native primrose (*Samolus repens*), selliera (*Selliera radicans*) and *Cotula dioica*. Scattered taller plants of oioi (*Apodasmia similis*), marsh ribbonwood (*Plagianthus divaricatus*), sea rush (*Juncus krausii*), knobby club rush (*Isolepis nodosa*) and three square (*Schoenoplectus validus*) also occur amongst the herbfield at some sites.

Mudflats at the eastern margin of the survey area support a distinctive native primrose-dominant herbfield; while marsh arrow grass (*Triglochin striata*) with native musk (*Mimulus repens*) and bachelor's button is another distinctive association on some sparsely-vegetated low salinity mudflat sites.

2. Sea rush rushland

Sea rush (*Juncus kraussi*) is dominant but may be joined by oioi, marsh ribbonwood and tall fescue (*Schedonurus phoenix**) as canopy associates. Groundcover is variable: none at lower elevation sites; saltmarsh herbfield species at mid-elevation; and exotic grasses such as creeping bent (*Agrostis stolonifera**), particularly at higher elevation sites on the upper margin of the saltmarsh.

3. Oioi rushland

Oioi is the dominant species; at some sites it forms a dense monoculture while at others it occurs with sea rush and the same range of native and exotic associate species listed above.

4. Saltmarsh reedland

Three square (*Schoenoplectus validus*) and Caldwell's sedge (*Bolboschoenus caldwelli*) are the canopy dominants. Three square is most abundant at higher salinity sites close to or adjoining the main lagoon, with Caldwell's sedge preferring lower salinity environments further upstream. However the two reed species grow together at some places. At lower elevations, three square or Caldwell's

sedge grow alone, but elsewhere native herbfield species and/or exotic salt-tolerant grasses are associated.

5. Marsh ribbonwood shrubland

Marsh ribbonwood shrubs from the canopy either alone or, on the upper margins of the saltmarsh, are joined by flax (*Phormium tenax*), toitoi (*Cortaderia richardii*) and gorse (*Ulex europaeus**). Oioi, sea rush and tall fescue may be present in the sub-canopy, with saltmarsh herbs and/or creeping bent in the groundcover.

6. Saltmarsh grassland

Tall fescue and creeping bent-dominant grassland is widespread throughout the Styx Mouth survey area. This grassland occupies habitats on the upper margin of the saltmarsh at the eastern end of the survey area, where it grows with scattered marsh ribbonwood, sea rush and oioi; and herbfield species at varying levels of abundance. Couch grass (*Elytrigia repens**) forms a dense sward at one site on the northeast margin of the survey area, and is present in other salt-tolerant grassland and shrubland vegetation.

Invasive spartina (*Spartina anglica**) is present at three infestation sites on low-to-mid-elevation mudflats at the eastern (Brooklands Lagoon) margin of the survey area. These infestations are also shown in Appendix 3.

7. Raupo reedland

Raupo is the dominant cover at several riparian and palustrine swamp (freshwater wetland) habitats within the survey area. Associated species include flax, lake clubrush (*Schoenoplectus tabermontani*), Caldwell's sedge, oioi, spike sedge (*Eleocharis acuta*) and tall fescue.

8. Harakeke flaxland

A dense canopy of flax/harakeke. Few other species present.

9. Mixed rushes and grasses

This comprises a number of freshwater wetland vegetation types within the survey area, characteristic of marsh habitats with fluctuating water levels. In places native *Juncus sarophorus* or *J.edgariae* form a rush canopy with a mostly exotic grass and herb understorey. Spike sedge rushland with creeping bent occurs along margins of creeks and the Waimakariri River upstream of saltwater influence. Tall fescue and creeping bent dominant grassland with scattered rushes is present at sites on margins of permanently-wet raupo and willow swamp.

10. Willow forest and treeland

Crack willow (*Salix fragilis*) and grey willow (*S. cinerea*) forest and treeland occurs in both freshwater wetland and terrestrial (albeit damp) floodplain habitats. Willow understorey is exotic shrub, grass and herbs at most sites.

11. *Juncus edgariae* rushland

Open canopy of native *Juncus edgariae* rushes over exotic grass and herbs in grazed pasture. Habitat is seasonally damp terrestrial, rather than wetland.

12. Exotic grassland

The grassland vegetation of terrestrial habitats is dominated by exotic species. At sand dune sites in the north-east corner of the survey area, marram (*Ammophila arenaria**), lyme grass (*Leymus arenaria**), tall fescue and couch are prominent. The damper floodplain grasslands in the western half of the survey area are also dominated by tall fescue, with cocksfoot (*Dactylis glomerata**), creeping bent and sweet vernal (*Anthoxanthum odoratum**) frequent associates. These grasslands may also contain scattered willow trees, native and exotic shrubs (e.g. marsh ribbonwood, gorse, lupin) and rushes.

13. Exotic shrubland

Gorse is usually the most abundant shrub species, but broom, lupin, marsh ribbonwood, blackberry (*Rubus fruticosus**), tamarisk (*Tamarisk chinensis**), elder (*Sambucus nigra**) and hawthorn

(*Crataegus monogyna**) can also be present as canopy or emergent species. Introduced grasses such as marram (on dunes), tall fescue, creeping bent and cocksfoot are the main components of the groundcover.

14. Exotic forest and treeland

Includes stands of exotic conifer trees, radiata (*Pinus radiata**) and macrocarpa (*Cupressus macrocarpa**), as well as deciduous hardwood forest and treeland on terrestrial habitats (stopbanks and floodplain). Poplars (*Populus* spp.) are generally the canopy dominants, with elder, hawthorn, tamarisk and willows present at some sites.

Table 2.1 Total area of 14 vegetation types mapped and described for the Styx river mouth reserve

Vegetation type	Habitat; Native/Exotic/Mixed	Area (ha)
Saltmarsh herbfield	Saltmarsh/brackish wetland; Native	1.5
Sea rush rushland	Saltmarsh/brackish wetland; Native	8.2
Oioi rushland	Saltmarsh/brackish wetland; Native	18.4
Saltmarsh reedland	Saltmarsh/brackish wetland; Native	2.0
Marsh ribbonwood shrubland	Saltmarsh/brackish wetland; Native	19.0
Saltmarsh grassland	Saltmarsh/brackish wetland; Exotic	1.5
Raupo reedland	Freshwater wetland; Native	2.7
Harakeke flaxland	Freshwater wetland; Native	0.03
Mixed rushes and grasses	Freshwater wetland; Mixed native-exotic	5.8
Willow forest and treeland	Terrestrial and freshwater wetland; Exotic	3.5
Juncus edgariae rushland	Terrestrial; Mixed native-exotic	12.9
Exotic grassland	Terrestrial; Exotic	30.7
Exotic shrubland	Terrestrial; Exotic	20.4
Exotic forest and treeland	Terrestrial; Exotic	17.1
Total native vegetation		51.8
Total exotic vegetation		73.2
Total mixed vegetation		18.7
Total survey area		143.6

2.2 Fauna

Swamp birds
There have been several recorded sightings of secretive and threatened Australasian bittern from the Styx River mouth wetland complex in recent years. While bittern utilise the wider saltmarsh, feeding along the margins of rivers and creeks, the large stands of raupo in the centre of the survey area are their critical breeding habitat. Marsh crake are the other, even more secretive, threatened swamp bird species recorded from the Styx Mouth wetlands (Crossland 2008). Pukeko are common throughout the Styx Mouth wetlands and surrounding area.

Cormorants and shags
Little shag and black shag roost in trees along the tidal section of the Styx River (between floodgates and Brooklands Lagoon).

Herons and allies
White-faced heron are resident and breeding in the area and commonly seen feeding along the eastern lagoon margin. White heron and royal spoonbill are regular visitors.

Waterfowl
Mallard, NZ shoveler, NZ scaup, grey teal and paradise shelduck are common, particularly around the mouth of the Styx River and along the eastern edge of the area towards the Waimakariri River. Threatened grey duck have also been recorded. The complex of dense wetland vegetation, creeks and ephemeral ponds provide good waterfowl breeding habitat.

Waders
There are resident breeding populations of South Island pied oystercatcher, pied stilt and banded dotterel. The eastern margin of the area adjoining Brooklands Lagoon provides valuable feeding and high tide roosting habitat for these species as well as migratory wrybill and godwits in season.

Gulls and terns
Black-backed gull and red billed gull are resident in the area, with threatened black-billed gull, black-fronted tern, white-fronted tern and Caspian tern all regular visitors.

Other native birds
Bellbird, fantail, grey warbler, silvereye and brown creeper were recorded for the area by Blakely and Todd (2005). Kingfisher and harrier were observed during the recent vegetation survey.

Fish
Eels, brown trout, yellow-eyed mullet and inanga all move through the lower Styx River. Although no inanga spawning sites were observed below the Styx River floodgates in a recent survey (Taylor 2005), the upper raupo-lined reaches of several small tributary creeks contained within the survey area are considered to be good potential inanga spawning sites (M. Taylor pers. comm. 2009).

3 Assessment of current state, threats and restoration potential

3.1 Vegetation trends

There have been some changes to vegetation and habitats of the Styx Rivermouth reserve since Colin Meurk's 1992 report. In the earlier report, the author described 'Area A', a grazed paddock south of the main stopbank and so separate from the rest of the reserve, as dominated by sea rush with scattered marsh ribbonwood. At that time, 'Area A' was already cut off from the main saltmarsh by stopbanks, and the sea rush, marsh ribbonwood and patches of saltmarsh herbfield described for this area would have been relictual. The sea rush and marsh ribbonwood have now entirely disappeared from the grazed paddock, although some marsh ribbonwood shrubs remain in a narrow strip between the paddock's northern fence and the stopbank. Within the grazed paddock, the sea rush canopy has been replaced by rushes of *Juncus edgariae*, another native rush of freshwater wetland and damp terrestrial habitats. Small patches of saline turf remain, maintained by microsite soil conditions of high salinity, but drains and stopbanks have now rendered 'Area A' a largely terrestrial habitat with some seasonal freshwater wetlands. Grazing has continued here and remains a major influence on vegetation.

Stands of raupo were described as occurring along the margin of waterways downstream of the Styx River floodgate in earlier reports and vegetation maps (Meurk 1992; Crossland 1996 unpub.). Most of these have now gone, probably as a result of increased salinity in this part of the reserve, following floodgate commission. However, large stands of raupo have are present elsewhere (Appendix 2).

The large stand of marsh ribbonwood/oioi shrubland between the northern stopbank and the Waimakariri River has been described as 'saltmarsh' in this report on the basis of species composition. However, because of the stopbank, this vegetation is relictual and may be gradually shifting towards a freshwater wetland habitat, as suggested by presence of raupo stands in deeper channels and permanently wet areas within this part of the reserve. Future vegetation monitoring will clarify trends in vegetation and habitat conditions.

There has been no deliberate stock grazing over the rest of the Styx Rivermouth reserve since the early 1990s (B. Dimbleby pers. comm.. 2009). Several years ago there were some problems with cattle wandering into the saltmarsh north of the stopbank, but there was no evidence of stock intrusion in the recent survey, and saltmarsh vegetation had recovered from previous damage.

Planted stands of silver poplar have been cleared from the western part of the reserve since 2004, in line with the recommendations of Meurk (1992). Scattered grey willows around raupo wetlands in the centre of the area also appear to have been controlled.

Several small but potentially highly invasive stands of spartina at the eastern margin of the Styx Mouth area were recorded in a recent vegetation survey of the Brooklands saltmarsh (Worner and Partridge 2008). This information was passed on to Parks and Reserves Section staff, and initial control carried out in Autumn 2009. Another infestation on the opposite (eastern) side of Brooklands Lagoon was treated at the same time. Annual follow-up control is scheduled (G. Byrnes pers. comm. 2009).

3.2 Current State of the Styx Rivermouth Reserve

Recent survey of the Styx Rivermouth reserve confirms that the ecological values described in earlier reports are still present, with the exception of the grazed paddock south of the main stopbank. In fact, with cessation of grazing north of the main stopbank and control of several invasive plant species (silver poplar, grey willow and spartina) in recent years, overall condition of the area has probably improved. Location of ecologically significant native saltmarsh vegetation and freshwater wetland habitats within the surveyed area are shown in Appendix 3.

While the whole area has habitat value for native wildlife, attention is drawn to several sites of particular importance and sensitivity, shown in Appendix 4. Potential whitebait spawning habitat is present in the upper reaches of two small creeks sourced within the survey area that flow east to join the lower Styx River. In the centre and north of the area, freshwater wetlands with a substantial raupo vegetation cover are core breeding habitat for threatened bittern and marsh crake. A stand of pine trees planted along a stopbank running through the eastern saltmarsh provides cormorant roosts. The eastern margin of the survey area, that is the lagoon shoreline between the Styx River mouth and the Waimakariri River, is a feeding area and high tide roost site for large numbers of gulls, terns, waders and waterfowl.

A formed vehicle track follows the Waimakariri River along the northern side of the reserve, but a locked gate at Stewarts Gully prevents public vehicle access. Track use by walkers and cyclists appears to be generally low, although may increase at certain times such as whitebait season. The stopbank on the southern margin of the reserve is also closed to vehicles, but as a walkway appears to be popular with recreational users from Brooklands village. A combination of water-filled moats (presumably originally created to supply material for stopbank), dense swamp vegetation, and gorse-blackberry thickets on drier sites discourages access into the reserve from the southern stopbank walkway.

3.3 Threats

Weeds and pests

In an earlier report, Meurk (1992) identified gorse as the most serious weed problem for the Styx River Mouth reserve, where it was described at that time as “gaining a stronghold on all the drier ridges and artificial stopbanks”. Gorse, along with other shrub weeds such as broom and blackberry, is now well established on all the drier ridges and stopbanks. However over most of the area, there remains a clear delineation between terrestrial habitats supporting gorse and other exotic vegetation, and saltmarsh supporting native vegetation. Gorse and other shrubweeds do not appear to have spread into saltmarsh or freshwater wetland vegetation to any great extent, presumably because moisture and salinity conditions remain unsuitable for these species. Several sites on the upper margin of the saltmarsh habitat, where scattered gorse and/or blackberry do occur within native marsh ribbonwood shrubland are shown in Appendix 5. Apart from these specified areas, control of gorse and other terrestrial shrubweeds is not considered a priority for the Styx River Mouth.

Grey willow is the main weed threat to freshwater wetland habitats. Some grey willow control has already taken place in the centre of the area. Further control of grey willow is recommended at sites where it adjoins or is spreading into native freshwater wetland vegetation (Appendix 5).

Apart from the more widespread exotic grasses, shrubs and trees, there are a number of other introduced plant species present at low abundance in the study area that could threaten existing biodiversity values or future restoration efforts. These are spartina grass, vines Japanese honeysuckle (*Lonicera japonica*), convolvulus (*Calystegia sylvatica*) and old mans beard (*Clematis vitalba*), pampas (*Cortaderia* sp.), iceplant (*Carpobrotus edulis*), hawthorn, sweet brier (*Rosa rubiginosa*) and sycamore (*Acer pseudoplatanus*). Location is also shown in Appendix 5.

Spartina, a highly invasive grass species of estuarine mudflats and saltmarsh habitats (William 1997), is considered to be the number one weed control priority for the Styx River mouth reserve and Brooklands Lagoon. The other ‘low abundance weeds’ listed are not an immediate threat to the area’s existing native saltmarsh and freshwater wetland vegetation and habitats. However, they are serious environmental weeds of terrestrial dune, shrub and forest habitats elsewhere, and warrant control for this reason.

Reed canary grass (*Phalaris arundinacea**) is another highly invasive species of freshwater and low salinity wetland habitats. It is widespread in Wainono Lagoon and has recently been recorded from Lake Ellesmere. None was found at in the recent survey of the Styx Mouth, but any future infestations should be a control priority. Other surveillance plant pests in a similar ‘find and destroy’ category are purple loosestrife (*Lythrum salicaria**) and beggars ticks (*Bidens frondosa**) (freshwater wetlands); and sea lavender (*Limonium companyosis**) (saltmarsh habitats).

Animal pests were not searched for during the recent survey, but the usual suite of mammalian predators (rodents, hedgehogs, mustelids, feral cats) are likely to be present.

Human disturbance

The Styx Rivermouth reserve contains habitats native vegetation and wildlife that are highly sensitive to human disturbance. Some of the vegetation, for example oioi rushland is, easily trampled by people and other animals. Threatened swamp birds such as bittern and marsh crake may be flushed off their nests by passing walkers and dogs, and nest failure result. The high tide bird roosts on the lagoon margin are also a temptation to uncontrolled dogs. As well as feral cats, the domestic cats of nearby households will regularly hunt native birds and lizards within the reserve. 'Accidental' shooting of protected bird species sometimes occurs during the game bird hunting season.

Considering its proximity to population centres and the heavily-used lower Waimakariri River, human recreational use of the area appears low. This is no doubt because of the relative difficulty of access to the Styx Rivermouth compared with adjoining areas (e.g. Kairaki Beach, Kaiapoi River mouth, the main Brooklands Lagoon, south side of Waimakariri River mouth) that offer similar recreation opportunities. The northern track and Waimakariri riverbank appears to have a small number of regular users: walkers, dog-walkers and salmon fishermen. The southern stopbank walkway has higher usage. Whitebaiters and game bird hunters also use boats to access hunting and fishing spots in season. Two hunting/fishing huts are maintained in the area. There are only low levels of littering, fires and other damage at present. However, an increase in such damage and disturbance to wildlife remains a threat if general human use of the area was also to increase.

4 Recommendations

The general recommendation is to manage, maintain and enhance the area as an important, relatively undisturbed wetland and wildlife habitat. A focus on conservation management for this area would best give effect to the Council's Policies for Management of Environment Canterbury Lands (adopted April 2009), in particular:

Objective 2.3	To safeguard significant natural values;
Objective 5.2	To manage indigenous…ecosystems within Environment Canterbury land so they are healthy and life-sustaining;
Policy 5.2(a)	Existing indigenous ecosystems will be protected;
Obj. 5.2.1	To protect and maintain the health and diversity of indigenous species and habitats on Environment Canterbury land.

Some more specific recommendations for protection and enhancement of the Styx River mouth reserve are listed in (approximate) order of priority.

4.1 Weed control

Weeds are the main threat to the native saltmarsh and freshwater wetland vegetation and habitats within the Styx Mouth reserve. Terrestrial and sand dune habitats at present support very few native plants. It is not practicable or even necessarily useful to attempt eradication of widespread weeds such as crack willow, grey willow, gorse, broom, blackberry, tall fescue and marram grass across the whole area. However, a number of other invasive species presently occur at low levels of infestation. These should be priorities for control across the whole reserve to prevent further spread. Control of grey willow, gorse and blackberry is also recommended for several defined sites within the reserve where these species are spreading into native vegetation.

- Control (eradicate) all infestations of spartina and other 'low abundance' weeds shown in Appendix 5 (and any other infestations found).

- Control grey willow at freshwater wetland sites shown in Appendix 5. Work should be done in late summer-autumn, after the bird breeding season.
- Control gorse and blackberry at sites shown in Appendix 5, time control work to avoid bird breeding season.

Apart from the 'low abundance' weeds identified, weed control in the exotic-dominant terrestrial grassland, shrubland and forest habitats is not a priority, and need only be carried out as part of any future restoration planting projects for these areas.

4.2 Access

Public access needs to be managed to avoid damage to native vegetation and disturbance of sensitive wildlife. Much of the area's present ecological value is due to its relative inaccessibility and low level of public use. Future protection and restoration initiatives, such as predator control and bird reintroductions, will also require controls on access.

- Discourage activities such as trail bike riding and uncontrolled dogs that damage habitats and disturb wildlife.
- Do not promote or facilitate increased public use of the northern track from Stewarts Gully. At present this track directs people and their dogs past important bittern and marsh crake habitat, and towards the sensitive high tide bird roost area (Appendix 4).
- Do not promote or facilitate increased access for whitebaiters. If future studies confirm the presence of whitebait spawning habitat along channels draining into the Styx, it is important that these are disturbed as little as possible. These potential whitebait spawning sites are also bittern and marsh crake habitat (Appendix 4).
- Manage/direct public access around rather than through or into the area. The existing southern stopbank walkway provides good views of the wetland habitats and waterways without directing people into sensitive ecological areas.
- Do not promote or facilitate increased access for game bird hunters.

While these recommendations may appear restrictive, they follow on from an assessment of the areas existing and potential biodiversity values in the context of Objective 11 of the Lower Waimakariri River Management Strategy ("to protect and where possible enhance remaining natural wetlands"), and general policies and objectives for management of Environment Canterbury lands (CRC 2009). Nearby areas already provide a range of recreation opportunities that could be enhanced with less or minimal impact on valuable wetland habitats and wildlife.

4.3 Predator control

The existing moat system that follows the southern stopbank could be extended so as to create an effective barrier to domestic cats entering the wetlands from Brooklands village. This would also deter people from entering the wetlands away from formed access tracks.

Initiate a predator control programme throughout the Styx Mouth area north of the stopbank walkway. This will assist local populations of vulnerable bird species and create a protected environment ready for introduction of locally extinct bid species (Crossland 2008).

4.4 Bird introductions

The Styx River mouth wetlands are large enough and of sufficient quality to support reintroduced populations of locally extinct bird species including fernbird, banded rail, spotless crake and brown teal (Crossland 2008). However, these species are vulnerable to disturbance and predation. Therefore reintroductions should only be attempted if human disturbance and predation (including domestic cats and dogs) can be effectively managed. Future bird reintroductions should be planned and carried out in coordination with relevant staff from the Department of Conservation and Christchurch City Council.

4.5 Native planting

Restoration planting is a low priority compared to other recommendations such as weed and pest control. However, with more than half the reserve area (73 ha) presently under exotic vegetation, there is plenty of scope for terrestrial restoration planting to complement the remnant native wetland habitats as regional park development budgets permit.

A site for initial restoration planting efforts is suggested: a relatively small (< 2ha), discrete dune ridge that is surrounded by native saltmarsh vegetation, and is easily accessible from Brooklands village (Appendix 5). Present cover is gorse-tamarisk-lupin shrubland, with an understorey of blackberry, tall fescue and marram grass. A list of recommended suitable species is in Appendix 6, but ngaio, akeake, coprosmas, olearias, pittosporums, cabbage tree, kowhai, kanuka and poroporo would be the main elements (Meurk 1992).

The 'mixed rushes and grasses' vegetation of freshwater wetland habitats and margins of raupo reedlands (Appendix 2) would also be good restoration planting sites, to extend and buffer these core habitats. Recommended species suitable for these habitats are listed in Appendix 6.

5 Acknowledgements

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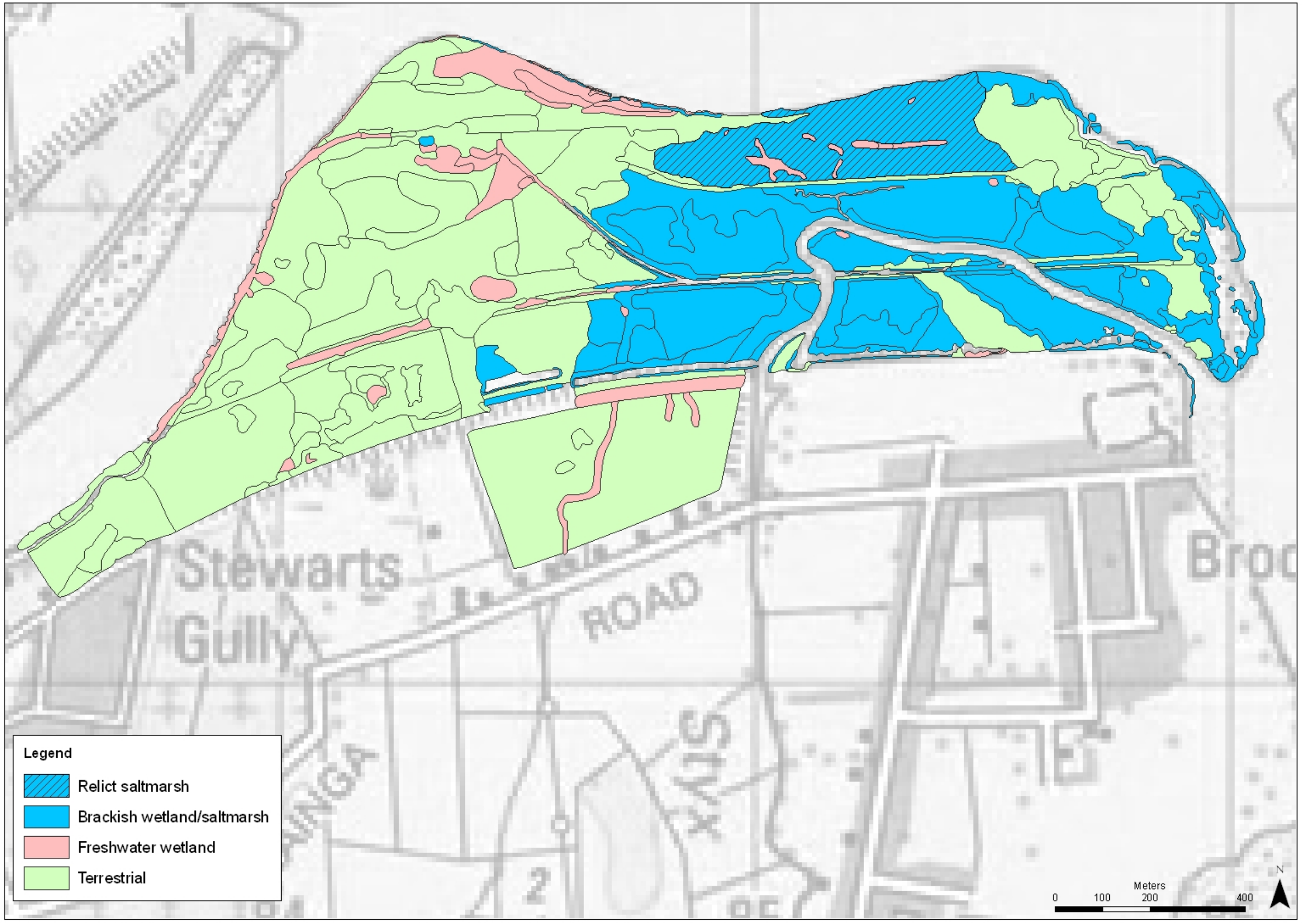
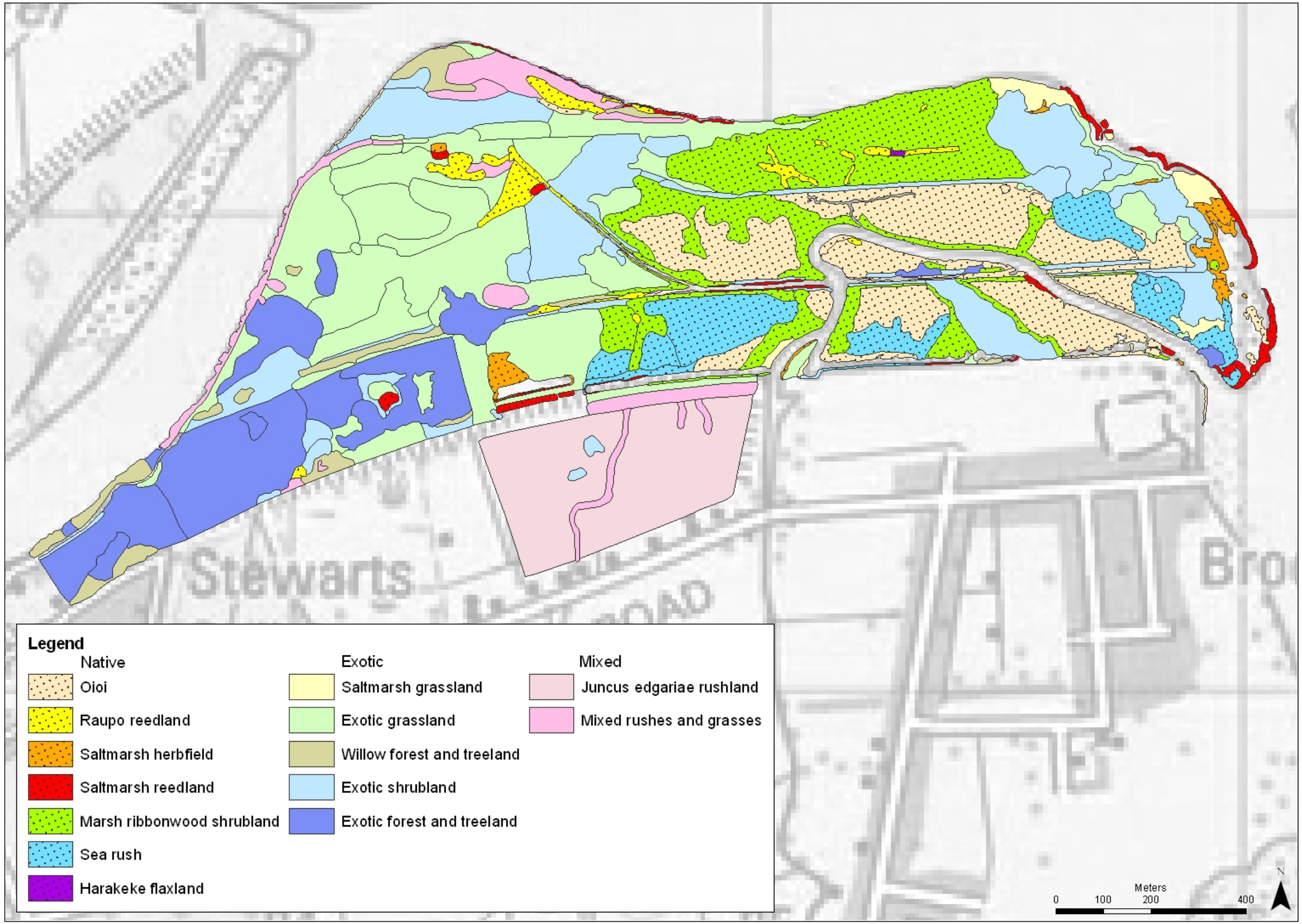
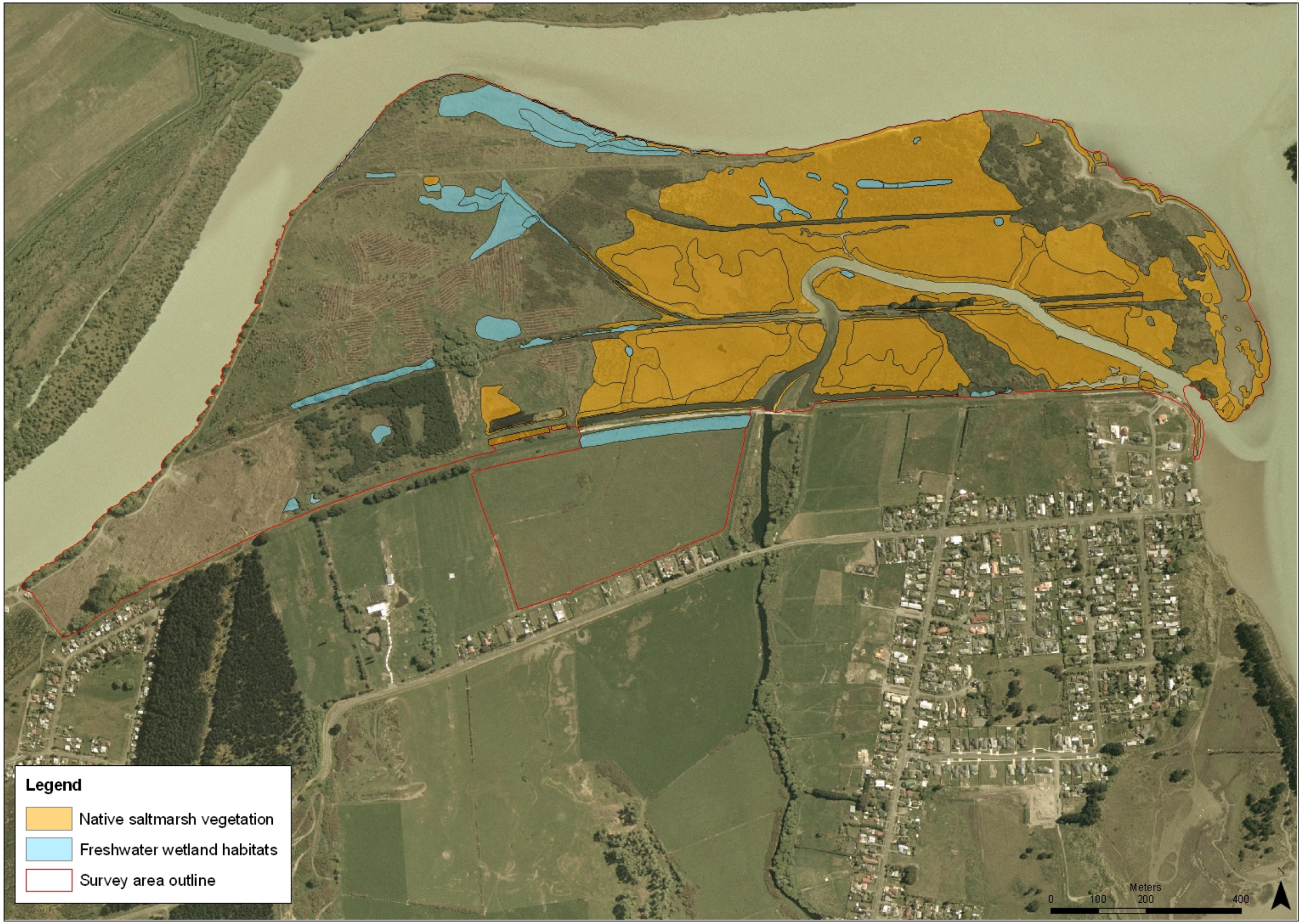
Appendix 1. Location of four main habitats within the Styx River mouth reserve: saltmarsh or brackish wetland; 'relict saltmarsh'; freshwater wetland; and terrestrial


Stewarts
Gully
ROAD
Legend
Relict saltmarsh
Brackish wetland/saltmarsh
Freshwater wetland
Terrestrial
Meters
0
100
200
400
N

Appendix 2. Vegetation map of the Styx River Mouth Reserve showing location of six native, five exotic and two mixed native-exotic vegetation types described for the area


Stewarts
Legend
Native
Oioi
Raupo reedland
Saltmarsh herbfield
Saltmarsh reedland
Marsh ribbonwood shrubland
Sea rush
Harakeke flaxland
Exotic
Saltmarsh grassland
Exotic grassland
Willow forest and treeland
Exotic shrubland
Exotic forest and treeland
Mixed
Juncus edgariae rushland
Mixed rushes and grasses
Meters
0
100
200
400
N

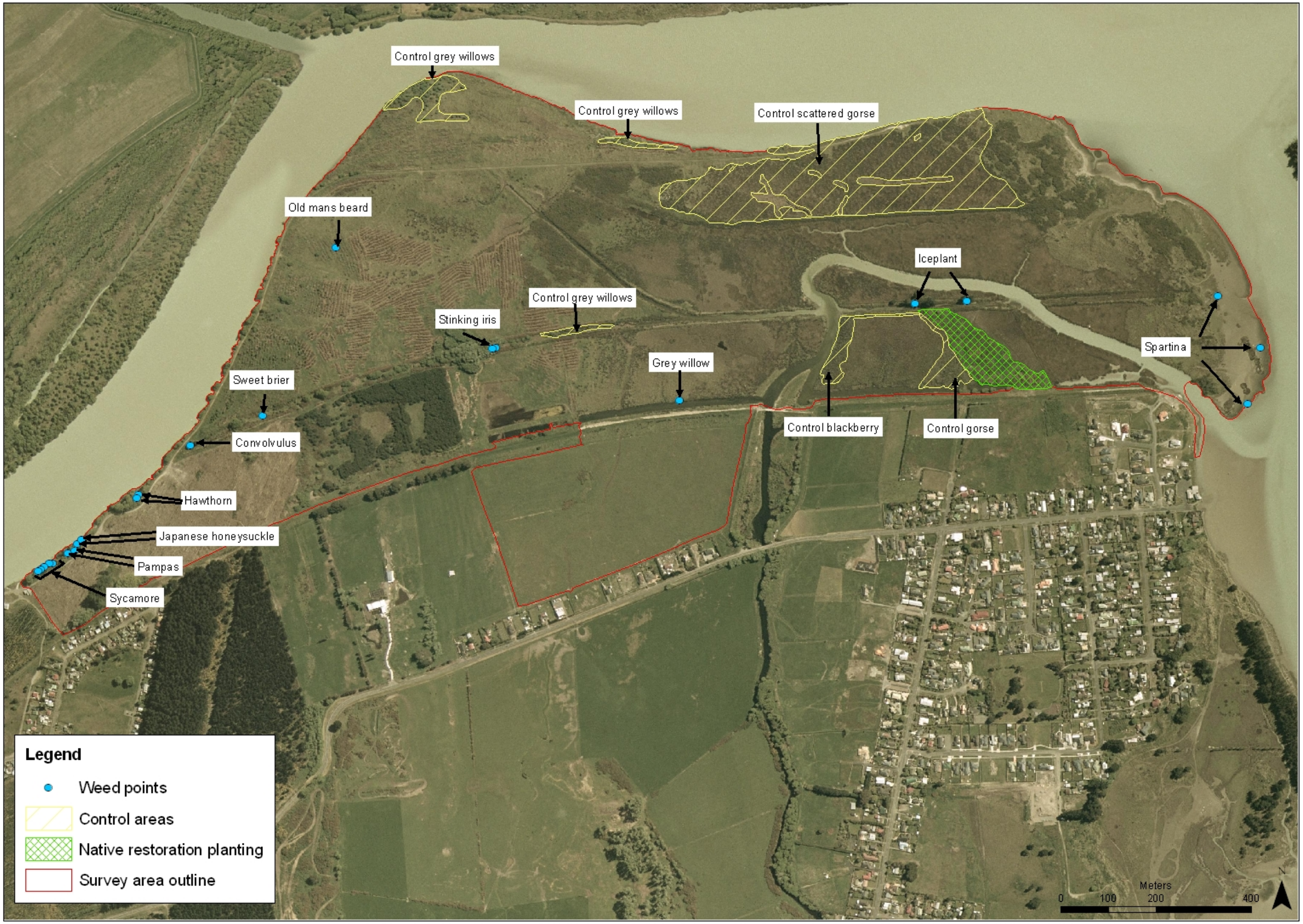
Appendix 3. Ecologically significant native vegetation and freshwater wetland habitats, Styx River Mouth Reserve


Legend
Native saltmarsh vegetation
Freshwater wetland habitats
Survey area outline
Meters
0
100
200
400
N

Appendix 4. Ecologically important areas for wildlife, Styx River Mouth Reserve


Legend
Whitebait spawning
Bittern and marsh crake
Cormorant roosts
Roosting area for waders, gulls, terns and waterfowl
Survey area outline
Meters
0
100
200
400
N

Appendix 5. Location of low abundance weeds; recommended gorse, willow and blackberry control sites; and suggested native restoration planting site. Styx River Mouth Reserve


Control grey willows
Control grey willows
Control scattered gorse
Old mans beard
Iceplant
Control grey willows
Stinking iris
Spartina
Grey willow
Sweet brier
Control blackberry
Control gorse
Convolvulus
Hawthorn
Japanese honeysuckle
Pampas
Sycamore
Legend
Weed points
Control areas
Native restoration planting
Survey area outline
Meters
0
100
200
400
N

Appendix 6. Suitable plants for dry and (non-saline) wet sites (from Meurk 1992)

A. Plants for dry banks and sand ridges

NZ broom	*Carmichaelia arborea*
Mikimiki	small-leaved *Coprosma* spp.
Karamu	*Coprosma robusta, C. lucida*
Cabbage tree/ti kouka	*Cordyline australis*
Korokio	*Corokia cotoneaster*
Toitoi	*Cortaderia richardii*
Matagouri	*Discaria toumatou*
Akeake	*Dodonea viscosa*
Broadleaf	*Grislenia littoralis*
Koromiko	*Hebe salicifolia*
Kanuka	*Kunzea ericoides*
Shrub pohuehue	*Muehlenbeckia australis*
Ngaio	*Myoporum laetum*
Mapou/red matipo	*Myrsine australis*
Olearias	*Olearia panicualta, O. avicenniifolia*
Tauhinu	*Ozothamnus leptophylla*
Lemonwood/tarata	*Pittosporum eugenioides*
Kohuhu/black matipo	*Pittosporum tenuifolium*
Lancewood	*Pseudopanax crassifolius*
Poroporo	*Solanum lacianatum*
Kowhai	*Sophora microphylla*

B. Plants for damp sites e.g. margins of freshwater wetlands

Mikimiki	small-leaved *Coprosma* spp.
Karamu	*Coprosma robusta*
Cabbage tree	*Cordyline australis*
Toitoi	*Cotaderia richardii*
Kahikatea	*Dacrycarpus dacrydioides*
Pokaka	*Elaeocarpus hookerianus*
Broadleaf	*Griselinia littoralis*
Manuka	*Leptospermum scoparium*
Rohutu	*Lophomyrtus obcordata*
NZ flax/harakeke	*Phormium tenax*
Lemonwood/tarata	*Pittosporum eugenioides*
Kohuhu	*Pittosporum tenuifolium*
Lowland ribbonwood/manatu	*Plagianthus regius*
Five finger	*Pseudopanax arboreus*