Coastal wetland vegetation in Canterbury, 2004–2011

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Abstract

This report provides a summary of the state of vegetated coastal wetland habitats in Canterbury surveyed over the period 2004–2011. It complements a Geographic Information System (GIS) database held by Environment Canterbury that maps the region's vegetated coastal wetland habitats.

The coastal wetland GIS database contains 4087 individual mapping units covering a total area of 7424 ha. Of the 7424 ha mapped area, 5744 ha (77%) were identified as wetland habitats and 1680 ha (23%) as terrestrial at the time of survey. Examples of estuarine, palustrine, lacustrine and riverine wetland hydrosystems were recorded in the survey area, containing the following wetland classes: saltmarsh, swamp, marsh, fen and shallow water. From field information collected on vegetation structure and composition, 173 distinct vegetation composition groups were recognised and described for 11 vegetation structural classes in the database, together with five un-vegetated habitats. These groups were then aggregated into 45 broader 'vegetation types'.

The report shows mapped examples of a range of Canterbury coastal wetland forms, habitats and vegetation types generated from the GIS database. Information on extent and type of coastal wetland vegetation and habitats contained in the database can be used for state of environment reporting at both the regional and local district scale, and help with assessments of wetland ecological significance. It also provides a baseline for monitoring changes in wetland type and extent. Some other applications of the database are discussed.

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1 Introduction

This report provides a summary of the state of vegetated coastal wetland habitats in Canterbury surveyed over the period 2004–2011. It complements a Geographic Information System (GIS) database held by Environment Canterbury that maps the region's vegetated coastal wetland habitats, and describes them following the classification system of Johnson and Gerbeaux (2004). The report also provides a glossary of terms used in the database, descriptions of the vegetation types identified, and list of plant species recorded during the survey.

Canterbury Region has a wide variety of wetland types, reflecting a complex and ancient geology and resulting geography, and more recent (post-glacial) climate and hydrology. Uplift associated with the Kaikoura Orogeny and Banks Peninsula volcanicity, together with the subsequent erosion and deposition processes (and sea level fluctuations) of the Quaternary Period have formed the geographical landscape of mountains and foothills, inter-montane basins and valley floors, outwash plains and coastal hill country. The region's generally exposed, high-energy coastline has limited development of tidal estuaries to the inlets of Banks Peninsula and the relatively sheltered Pegasus Bay coast. Climate is defined by a marked west to east rainfall gradient, with high precipitation in the alpine zone and a dry 'rain shadow' in the intermontane basins, foothills and plains. Surface water hydrology is characterised by large rivers and lakes with their headwaters in the Southern Alps, smaller rivers draining the foothills and spring-fed stream and wetands in the inter-montane basins and on the plains. The regional groundwater resource is substantial, comprising confined and unconfined aquifers, and is an important component of the overall hydrology, especially in parts of the region that receive limited supplies of surface water (Canterbury Regional Council 1994).

The formal definition of wetlands in the Resource Management Act (1991) is "permanently or intermittently wet areas, shallow water or land/water margins that support a natural ecosystem of plants and animals that are adapted to living in wet conditions". This broad range of habitats and biological communities share a number of environmental and ecological features that distinguish wetlands from other terrestrial and aquatic ecosystems. These are:

- Temporary or permanent shallow standing water and/or waterlogged soils;
- Temporary or permanent anaerobic conditions in the soil;
- Dominance by emergent aquatic plants.

A system for classifying and arranging types of New Zealand wetlands has been developed by Johnson and Gerbeaux (2004). Their classification system is based primarily on wetland function. It allows for wetlands to be recognised at several sequential levels of hierarchy, from broadly defined hydrosystems, to wetland classes, then structural classes of vegetation, and finally wetland 'types' distinguished by their composition of dominant plants.

A national GIS database of inland freshwater wetlands is a component of the Freshwater Ecosytems of New Zealand (FENZ) tool, developed over the period 2003–2010 (Leathwick *et al.* 2010). This database focused on freshwater palustrine wetlands and standing waterbodies with a 500 m maximum length. It did not include estuarine, marine, riverine and lacustrine hydrosystems as these are (or will be) the focus of analogous classification projects. Freshwater wetlands adjoining coastal estuarine hydrosystems were also largely excluded. However, other components of the FENZ tool include information on lakes and rivers (lacustrine and riverine hydrosystems).

While the ecological importance of Canterbury's coastal wetland habitats are generally well recognised (e.g. Owen 1992, Taylor 1996, O'Donnell 2000), information on extent and type of estuarine wetland habitats were not captured by the recently-developed national databases. The FENZ database is also of limited accuracy in coastal parts of the region, where freshwater wetland habitats frequently adjoin or grade into brackish coastal lagoons or estuaries. It was decided to carry out a regional survey of coastal wetlands, and develop a database recording type and extent of vegetated coastal wetland habitats as this, together with the FENZ inland freshwater wetland database, would provide an inventory of the region's wetlands.

Definition of the 'coastal wetland survey area' was by landform rather than hydrology in the first instance. It included wetlands associated with estuaries, dunes, coastal lagoons and river mouths -

that is wetland forms that could be considered related directly or indirectly to coastal processes. While estuarine hydrosystems might be expected to predominate, the coastal zone is a dynamic environment where a range of geomorphic and hydrological processes, and human influences, operate to create a diverse and shifting array of wetland hydrosystems, classes and vegetation types. Mapping and describing coastal wetland habitats and adjoining terrestrial habitats at a “point in time” provides information on the state of these habitats and a baseline for monitoring changes in wetland type and extent.

2 Methods

Coastal wetland vegetation and habitats were mapped and described following the hierarchical classification system for wetlands developed by Johnson and Gerbeaux (2004), which in turn drew on the wetland classification of Clarkson *et al.* (2003) and the vegetation mapping and description system of Atkinson (1985). Saltmarsh vegetation was the focus of the survey effort, but freshwater wetland vegetation was also mapped, as well as some adjoining terrestrial vegetation. Un-vegetated wetland habitats, such as tidal mud flats, were generally not mapped.

2.1 Field survey and data capture

During field survey, mapping units were delimited on recent large-scale colour aerial photographs and their vegetation described. GPS way-points were used to help establish boundaries of mapping units on occasions where patterns observable on the ground were not clear on the photographs. Definitions of vegetation structural classes (forest, treeland, scrub, shrubland etc.) and relationships (emergent, canopy, understorey etc.) follow those developed by Atkinson (1985). Where possible, field descriptions followed the Atkinson (1985) system of notation for mapping vegetation. Prominent plant species were listed and identified by six letter codes derived from their botanical name, vegetation tiers were separated by a '/', and estimated canopy abundance of listed species indicated. However, field descriptions of Te Waihora lakeshore wetlands in the 2007 survey followed the classification system of Clark and Partridge (1984) to maintain consistency with the earlier survey. Notes were also made on, for example, other plant species of interest (e.g. rare native species, weeds) not covered by the vegetation description, wetland hydrology and human modification.

For each wetland survey area, field information was entered into a GIS shape file by the observer and checked before being added to the main database. Where the Atkinson vegetation mapping notation was used, abundance of listed species were indicated in the database by a system of letter cases and brackets as shown in the example below:

PLA DIV	> 76% canopy cover of marsh ribbonwood (*Plagianthus divaricatus*);
PLA div	51-75% cover of marsh ribbonwood
Pla div	26-50% cover of marsh ribbonwood
(Pla div)	6-25% cover
[Pla div]	1-5% cover

2.2 Vegetation classification

A subjective hierarchical classification of vegetation types was developed from field descriptions during the course of the survey. Primary classification was based on vegetation structure (e.g. shrubland, reedland, grassland), with composition data (i.e. dominant species plus associates) informing the vegetation types described for each structural class. The process was iterative and went through a series of revisions as the database grew. The classification system of Clark and Partridge (1984) developed from their Te Waihora/Lake Ellesmere survey was a useful model and starting point. Also useful were the vegetation classifications developed from quantitative plot-based surveys by Jupp *et al.* (2007) and Warner and Partridge (2008) of the Avon-Heathcote Estuary/Ihutai and Brooklands estuaries respectively. Their classifications were referred to when mapping and describing the saltmarsh vegetation of those estuaries, and elsewhere when applicable.

In addition to the field survey records, the database includes three nested hierarchical vegetation classifications levels for each mapping unit. The most detailed classification, the 'vegetation composition' grouping, was developed first. A higher level or more generalised 'vegetation type' classification was then developed, principally to help with production of clear maps and generation of summary statistics at a regional scale. The highest level classification is vegetation structure alone, without any composition information. Finally, but sitting outside the hierarchical classification, each mapping unit was assigned into a 'nativeness category' of 'indigenous', 'exotic' or 'mixed indigenous-exotic' on the basis of canopy composition as noted in the field survey records.

2.3 Attributes of the GIS database

Attributes assigned to mapping units (polygons) in the coastal wetland GIS database are listed and described in the metadata appendix (Appendix 2).

2.4 Calculations

Statistics were generated from the coastal wetland GIS database attributes table by utilising the Arc tool box summary statistics tool. Statistics were also generated from the coastal wetland GIS database attributes table by utilising the 'field tap tool summarise' function.

3 Results

The coastal wetland GIS database contains 4087 individual mapping units covering a total area of 7420 ha. The mapping units are within 50 named wetland locations extending from 'Tirohanga Lagoon' in the north to the 'Waitaki River Hāpua' in the south. The largest contiguous area of wetland vegetation in the database, more than 4000 ha, is located around the margins of Te Waihora/Lake Ellesmere. The smallest individually-mapped coastal wetland area was 100 m^2 of saltmarsh reedland at Gore Bay. A list of vegetated coastal wetlands, location maps and proportion of various wetland habitats is in Appendix 1.

Of the 7420 ha mapped area, 5742 ha (77%) were identified as wetland habitats and 1680 ha (23%) as terrestrial at the time of the survey. Examples of estuarine, palustrine, lacustrine and riverine wetland hydrosystems were recorded in the survey area, containing the following wetland classes: saltmarsh, swamp, marsh, fen and shallow water. From field information collected on vegetation structure and composition, 173 distinct 'vegetation composition' groups were recognised and described for 11 vegetation structural classes in the database, together with five un-vegetated habitats. These groups were then aggregated into 45 broader 'vegetation types'. A list and description of the 'structural classes', 'vegetation composition' groups and 'vegetation types' are provided in Appendix 2.

3.1 Coastal wetland habitats

Estuarine hydrosystems supporting saltmarsh or brackish wetland vegetation formed the majority of the mapped area – 4602 ha. However, only 341 ha of saltmarsh vegetation was recorded from within true estuaries subject to sea-water intrusion in daily tidal cycles. These were the Motunau River mouth, Ashley River-Saltwater Creek/Rakahuri estuary, Waimakariri River mouth (including Brooklands Lagoon), Avon-Heathcote Estuary/Ihutai and on Banks Peninsula, Lyttelton Harbour/Whakaraupō, Okains Bay, Le Bons Bay and Akaroa Harbour.

The greater part of Canterbury's vegetated saltmarsh habitats, some 4199 ha, are instead associated with brackish coastal lagoons that are not permanently open to the sea but are nevertheless affected to some degree by salt water (non-tidal estuarine hydrosystems). Additionally there were also 62 ha of saltmarsh vegetation recorded from 'supra-tidal' habitats, the shore zone above the highest tide level of marine and estuarine waters but influenced by splash and spray, and subject to inundation from storm surges (Johnson and Gerbeaux 2004). Another 10 ha of saltmarsh vegetation within the survey area was described as relict, as it was cut off from estuarine hydrology (usually as a result of human modification) but had persisted due to residual soil salinity. However, the distinction between 'non-tidal', 'supra-tidal' and 'relict' saltmarsh vegetation was not always clear. More than 80% of the region's saltmarsh habitats are located on the margins of Te Waihora/Lake Ellesmere.

Saltmarsh vegetation and habitats are almost entirely absent from the mouths of Canterbury's large braided rivers, with the notable exception of the Waimakariri. The Clarence River mouth has a distinctive geomorphology where the braided river discharges more-or-less directly into the sea over a wide alluvial delta. The other large rivers (Waiau, Hurunui, Rakaia, Rangitata, Waitaki) are characterised by the presence of freshwater river mouth lagoons or 'hāpua' (Kirk and Lauder 2000). Water level and outlet location of these larger river mouth lagoons shift constantly in response to the interplay of fluvial and coastal processes, but they are nearly always open to the sea (Hart 2009).

Mouths of the smaller braided Canterbury Rivers (Conway, Waipara, Kowai, Ashburton/Hakatere, Hinds, Orari, Opihi, Pareora, Otaio, Waihao) also form lagoons or hāpua; but these all (with the exception of the Orari) experience frequent mouth closures (Hart 2009). While saltmarsh habitats were also absent from most of the small South Canterbury river mouths, the Opihi River and smaller North Canterbury rivers such as the Conway, Waipara and Kowai did have some areas of saltmarsh vegetation associated with their river mouth lagoons.

Freshwater wetland vegetation and habitats formed a lesser but still significant proportion of the coastal wetlands surveyed; some 1140 ha or about 20% of the total wetland area. Freshwater

wetlands were commonly found on or adjoining the inland margins of estuaries and brackish coastal lagoons, as well as along the edges of freshwater coastal lagoons, rivers and some hāpua within the survey area. Palustrine hydrosystem swamps and marshes were the most widespread freshwater wetland type, totalling 810 ha across the survey area; another 29 ha were described as palustrine fen; 223 ha of lacustrine hydrosystem wetland (mostly marsh) were identified, and 46 ha of riverine marsh and swamp. The remaining 33 ha of mapped freshwater wetlands comprised shallow water or unvegetated habitats.

Table 3-1: Region total of wetland habitats and hydrosystems within surveyed coastal wetlands (N.B. figures include small areas of shallow water and unvegetated habitats)

Habitat	Hydrosystem	Area (ha) and % of total
Saltmarsh or brackish wetland	Estuarine tidal	341 (6%)
	Estuarine non-tidal	4199 (73%)
	Estuarine supra-tidal	62 (1%)
Total saltmarsh / brackish wetland		4602 (80%)
Freshwater wetland	Palustrine	871 (15%)
	Lacustrine	223 (4%)
	Riverine	46 (1%)
Total freshwater wetland		1140 (20%)
Total vegetated wetland area		5742

3.2 Vegetation of the coastal wetland survey area

Of the 4602 ha of saltmarsh habitats mapped in Canterbury region, 3765 ha (82%) was categorised as supporting indigenous vegetation cover. (Note 'indigenous' in this context means the canopy vegetation is predominantly indigenous plant species; exotic species may also be present). The most abundant vegetation types were saltmarsh herbfield (2484 ha; mostly indigenous), marsh ribbonwood (*Plagianthus divaricatus*) shrubland (600 ha; indigenous), sea rush (*Juncus krausii* subsp. *australiensis*) rushland (511 ha; indigenous) and saltmarsh grassland (574 ha; mostly exotic).

However, of the 1140 ha freshwater wetland habitats mapped within the surveyed area, only 268 ha (24%) had predominantly indigenous vegetation canopy cover. 507 ha (44%) of freshwater wetlands were dominated by exotic vegetation, with 297 ha (26%) supporting mixed indigenous-exotic vegetation (another 68 ha was unvegetated). Most extensive freshwater wetland types were willow forest and treeland (379 ha; mostly exotic, some mixed native-exotic), wetland grassland (271 ha; mostly exotic, some mixed native-exotic), native rushland (140 ha; native) and raupō (*Typha orientalis*) reedland (70 ha; native).

Mapping of terrestrial vegetation adjoining coastal wetlands was not comprehensive, as these habitats were not the focus of the survey, but native terrestrial vegetation was always mapped where it occurred alongside or close to wetland habitats. However, the regional total for indigenous terrestrial vegetation cover within the surveyed area was only 93 ha (6% of total 1680 ha mapped terrestrial habitats). Mixed indigenous-exotic terrestrial vegetation covered 140 ha (8% of mapped terrestrial habitats). Main terrestrial vegetation types occurring alongside coastal wetlands were exotic grassland (925 ha), exotic herbfield (14 ha), exotic shrubland/scrub (202 ha; mostly gorse, broom, lupin), exotic treeland and forest (303 ha) and pampas hedge (1 ha).

Table 3-2: Region total area of indigenous/exotic/mixed vegetation for three habitat types within coastal wetland survey area

Habitat	Indigenous canopy vegetation (ha)	Mixed indigenous-exotic canopy (ha)	Exotic canopy vegetation (ha)
Saltmarsh or brackish wetland	3765	501	313
Freshwater wetland	268	297	507
Terrestrial	93	140	1444

Table 3-3: Total area of the ten most abundant vegetation types within the coastal wetland survey area. Habitat and 'nativeness' category are noted

Vegetation type	Area (ha)	Habitat	Category
Saltmarsh herbfield	2484	Saltmarsh/brackish wetland	Mostly indigenous; some mixed indigenous-exotic
Terrestrial grassland	1054	Terrestrial	Mostly exotic; some mixed
Marsh ribbonwood shrubland	602	Mostly saltmarsh/brackish wetland; some terrestrial.	Native
Saltmarsh grassland	574	Saltmarsh/brackish wetland	Mostly exotic; some indigenous, mixed
Sea rush rushland	511	Saltmarsh/brackish wetland	Indigenous
Three square reedland	457	Saltmarsh/brackish wetland	Indigenous
Willow forest and treeland	379	Mostly freshwater wetland; some terrestrial	Mostly exotic; some mixed
Freshwater wetland grassland	272	Freshwater wetland	Exotic
Exotic shrubland	200	Terrestrial	Exotic
Native freshwater rushland	140	Freshwater wetland	Mostly indigneous; some mixed

From the GIS database, it is possible to calculate the extent of each vegetation type across the whole or a selected part of the survey area, and the split of these types across hydrosystems and wetland classes. Most plant species and vegetation types tend to be associated with a particular habitat – saltmarsh, freshwater wetland or terrestrial. However, some species and vegetation types can occur in a range of habitats. For example, we mapped a total of 94 ha of oioi (*Apodasmia similis*) restiad rushland in the survey area. This includes 76 ha of estuarine saltmarsh oioi vegetation, mostly in true tidal estuaries (Brooklands Lagoon, Avon-Heathcote Estuary/Ihutai, Ashley-Saltwater Creek Estuary/Rakahuri), but with smaller amounts in non-tidal brackish coastal lagoons. 17 ha of oioi (mostly on the northwest shore of Te Waihora/Lake Ellesmere) we described as (freshwater) lacustrine marsh, with < 1ha of oioi restiad rushland in other freshwater wetland habitats: palustrine swamp and shallow water.

3.3 Examples

Mapped examples from the database of a range of Canterbury coastal wetland forms, habitats and vegetation types are shown in paired Figures 3-1 – 3-8. Wetland hydrosystems and classes are shown in the first of each pair, with vegetation shown in the second. Note that for purposes of mapping clarity, the broader 'Vegetation Types' are used rather than the more detailed 'Vegetation Composition Groups'. The stippling or cross-hatch on all maps indicate three broad habitats: saltmarsh/brackish wetlands (including estuarine tidal, non-tidal and supra-tidal hydrosystems); freshwater wetlands (palustrine, riverine and lacustrine hydrosystems); and terrestrial.

Ashley-Saltwater Creek / Rakahuri is an example of a tidal estuary saltmarsh (Figures 3-1, 3-2). Palustrine and riverine freshwater wetlands adjoin the tidal saltmarsh here. The Rakaia River mouth (Figures 3-3 and 3-4) is a 'large river hāpua', permanently open to the sea and owing to the volume of river water, an entirely freshwater wetland habitat. Wetland vegetation is not widespread, due to the fluctuating water levels and shifting gravels around much of the hāpua, and is generally restricted to the inland margin of the lagoon. The Opihi is an example of a small river mouth lagoon (Figure 3-5 and 3-6) that is periodically closed to the sea. The Opihi mouth is difficult to classify as it has a spatially and temporally variable hydrology and therefore diversity of wetland habitats: in some parts a freshwater hāpua, others brackish coastal lagoon. Wainono Lagoon (Figure 3-7 and 3-8) is an example of a brackish coastal lagoon, not directly connected to the sea but subject to saltwater intrusion over or through the beach barrier. Most of the lagoon margin wetlands were saltmarsh at the time of survey. However, freshwater inflows, both surface and groundwater, on the northwest side of Wainono Lagoon also support an extensive freshwater wetland habitat.

Figure 3-1: Wetland and terrestrial habitats at Ashley River-Saltwater Creek Estuary / Rakahuri survey area, mapped in 2004

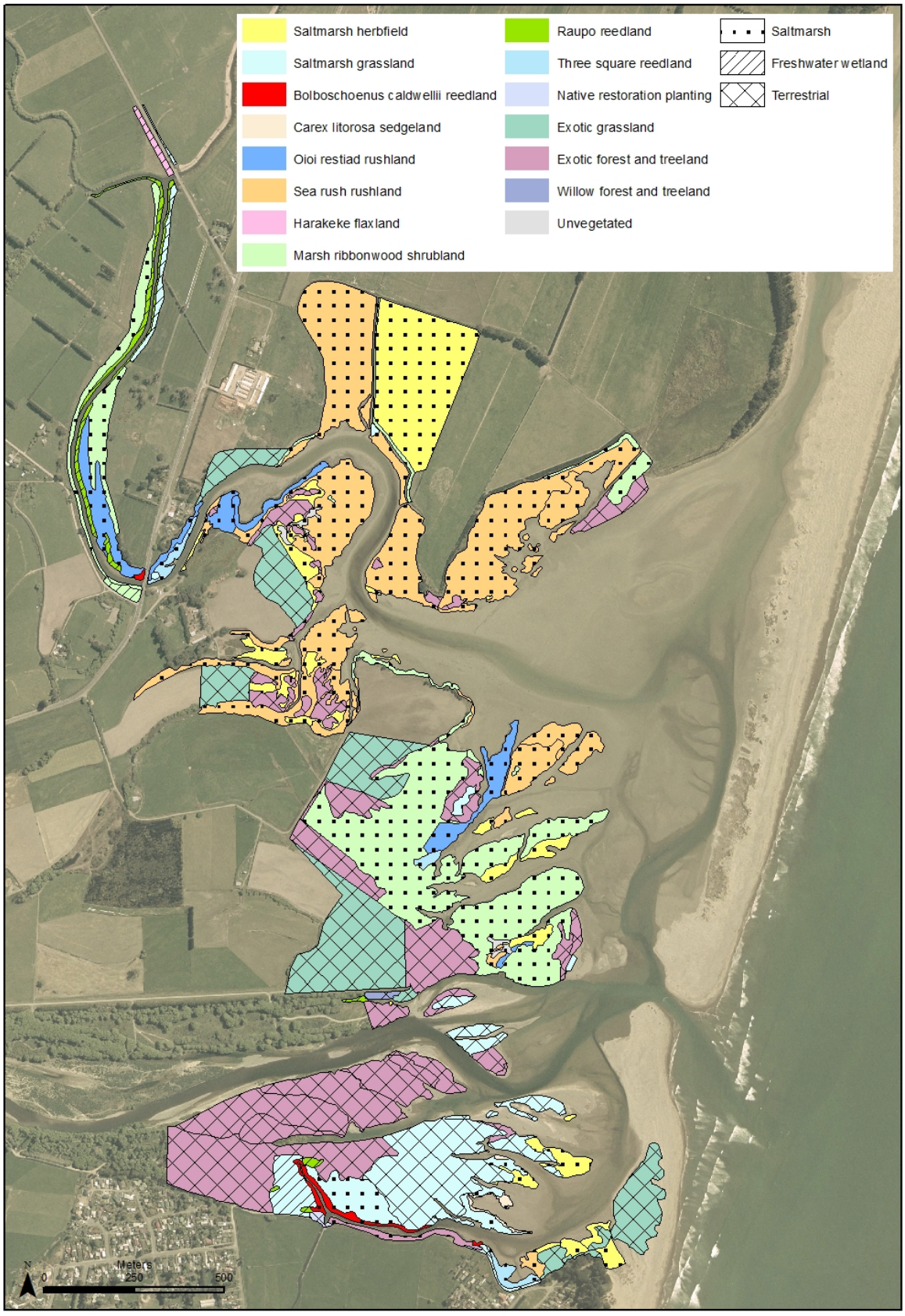

Figure 3-2: Vegetation types at Ashley River-Saltwater Creek Estuary / Rakahuri survey area, mapped 2004

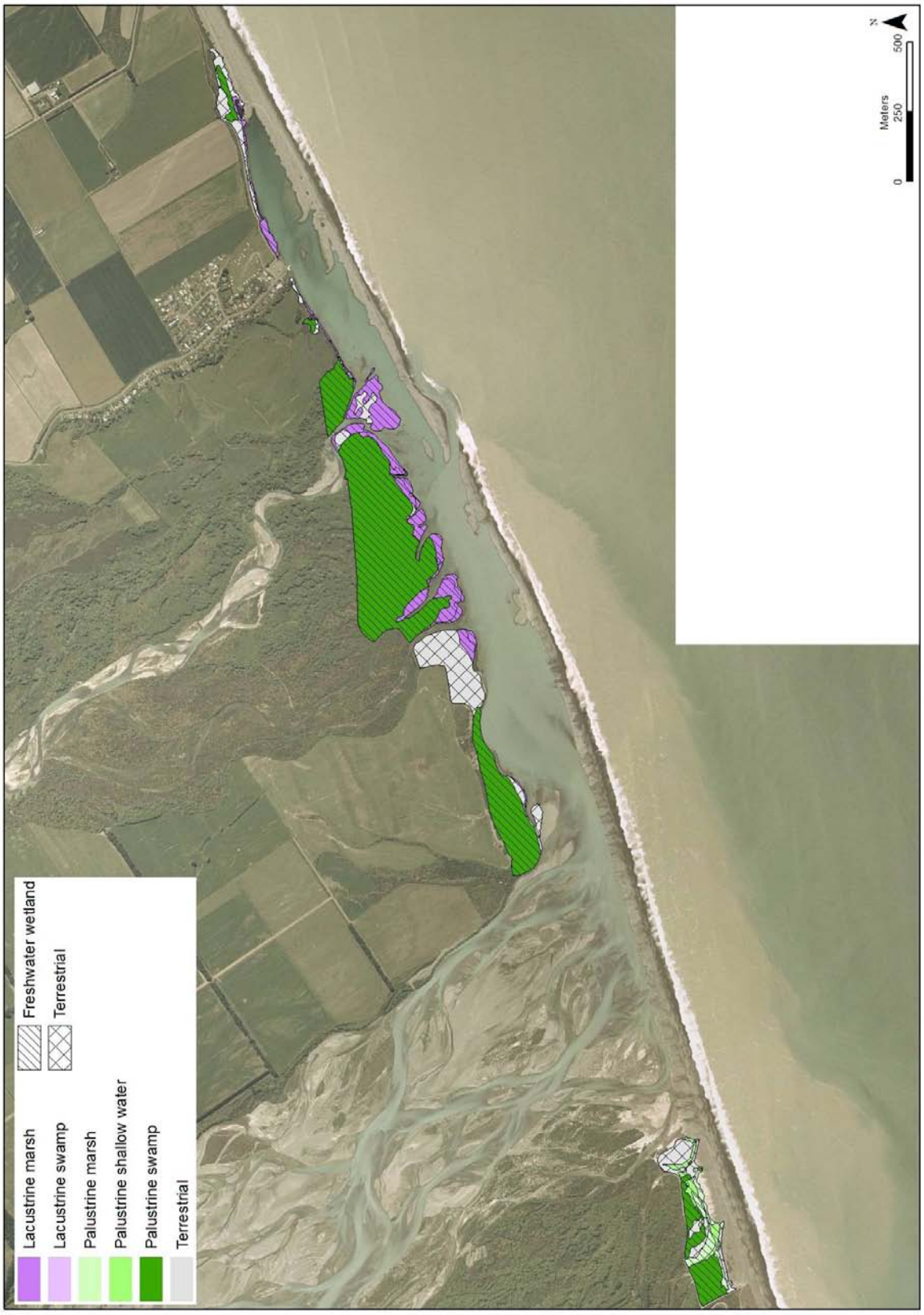

Figure 3-3: Wetland and terrestrial habitats at Rakaia River mouth hāpua survey area, mapped 2010

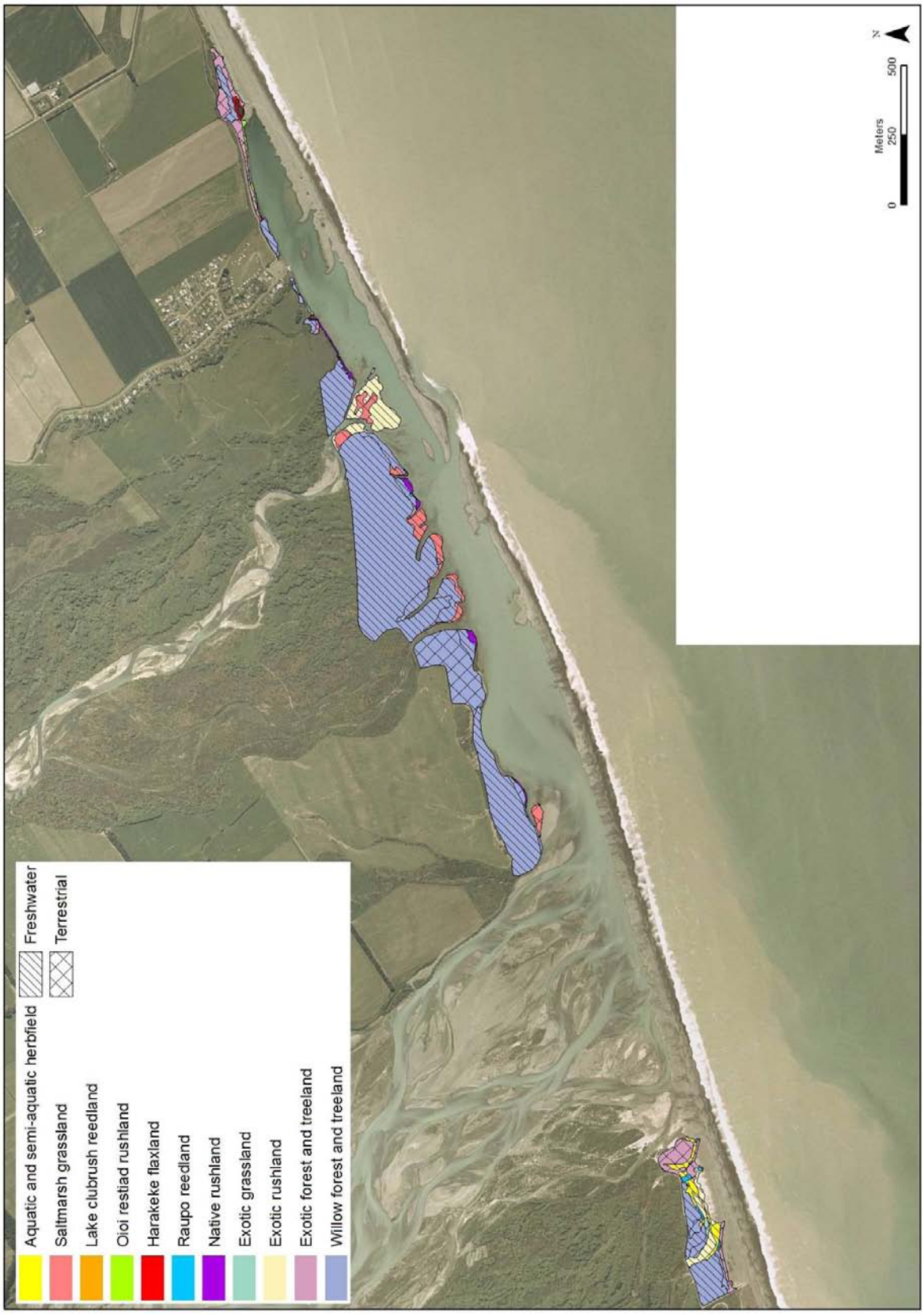

Figure 3-4: Vegetation types mapped at Rakaia River mouth hāpua survey area, 2010

Figure 3-5: Wetland and terrestrial habitats mapped at Opihi River mouth lagoon survey area, 2008

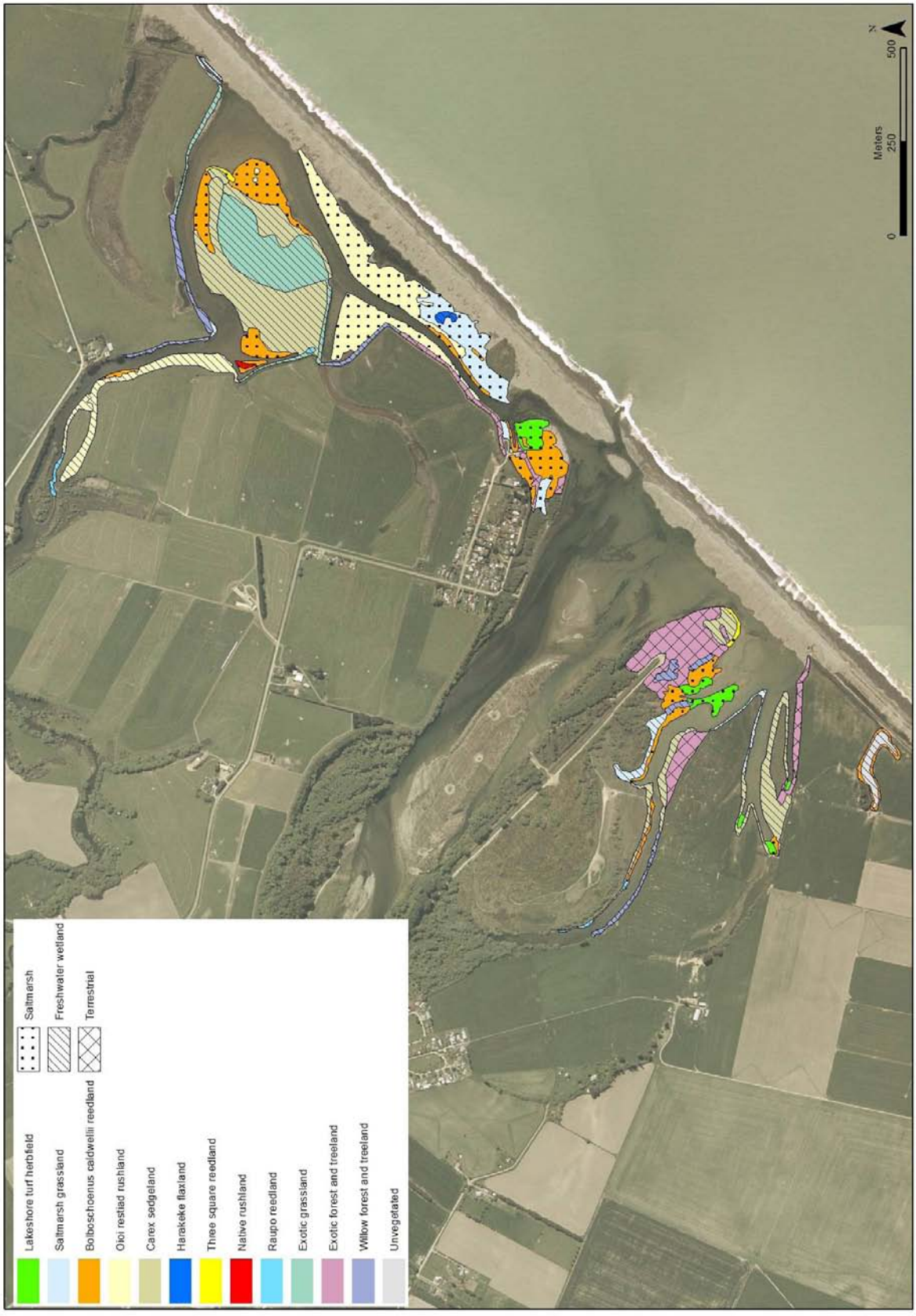

Figure 3-6: Vegetation types mapped at Opihi River mouth lagoon survey area, 2008

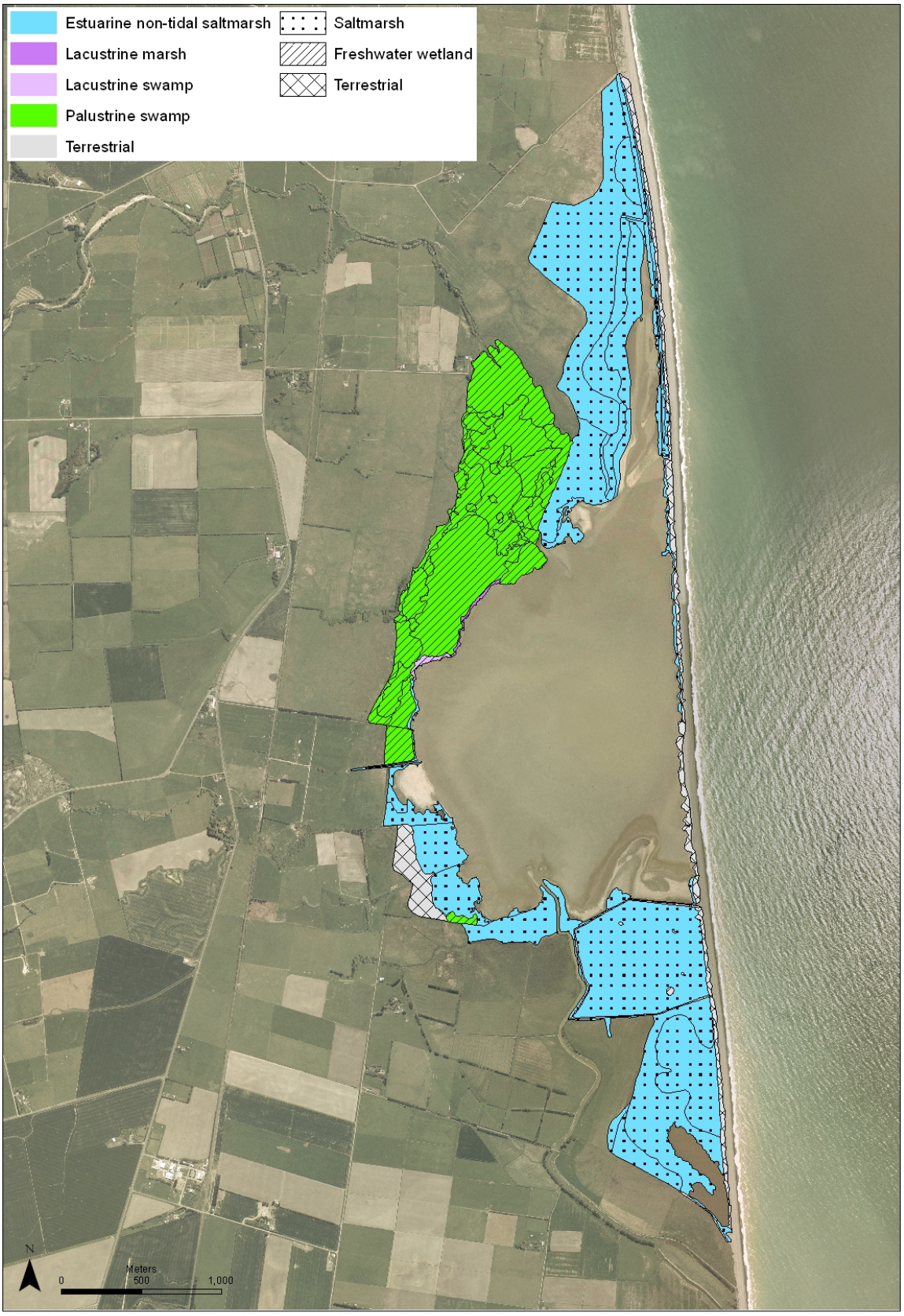

Figure 3-7: Wetland and terrestrial habitats mapped at Wainono Lagoon survey area, 2008

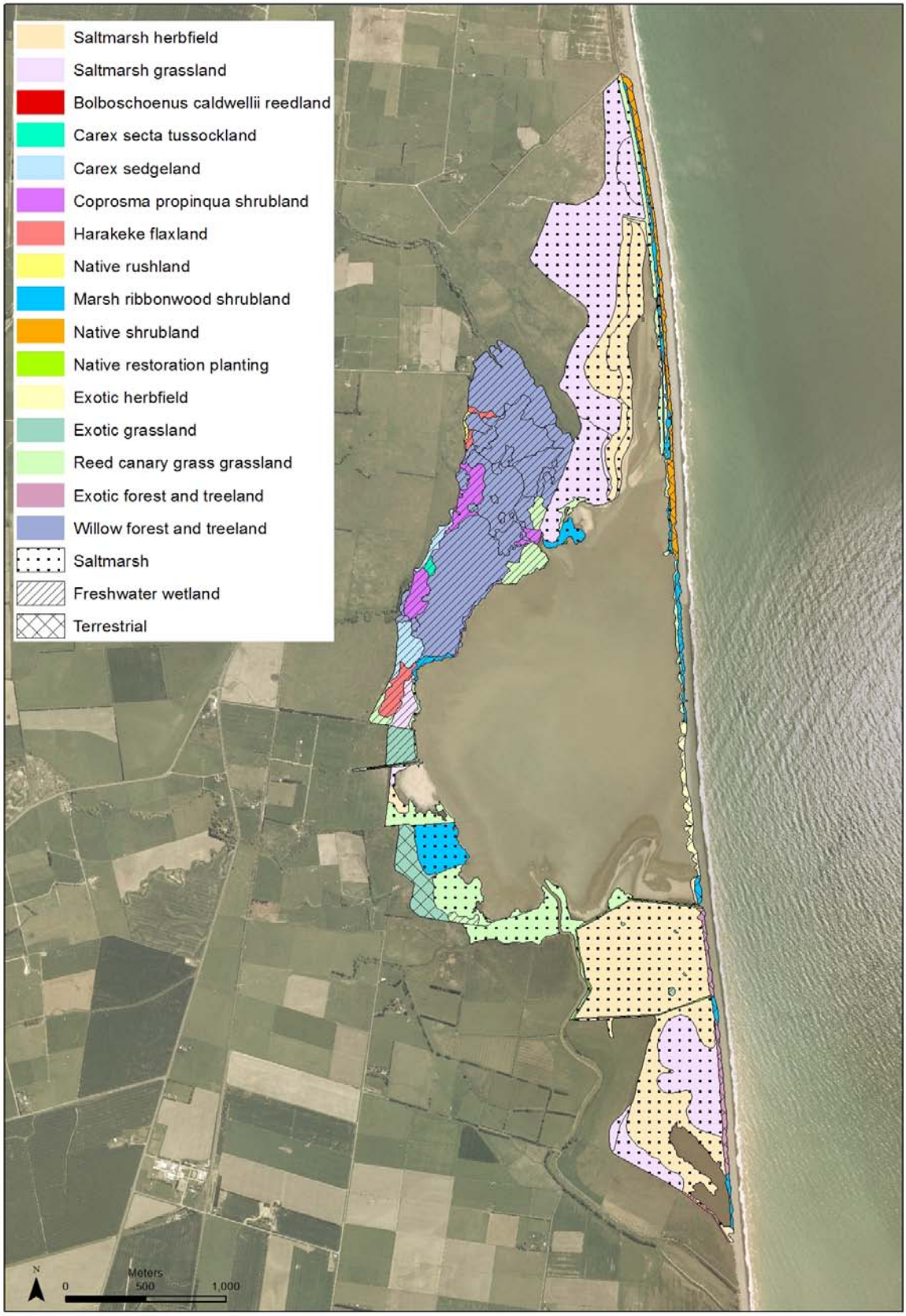

Figure 3-8: Vegetation types mapped at Wainono Lagoon survey area, 2008

4 Discussion

The coastal wetland survey area is the interface between land, rivers, lakes and sea, where terrestrial processes meet riverine, lacustrine and marine processes. It has also, over many parts of the region, been subject to considerable and ongoing human modification (Kirk and Lauder, 2000; Hart and Bryan, 2008). In addition, Canterbury's coastal environment is naturally dynamic, particularly in the southern part of the region where the coastline is retreating at an average rate of 0.3 metres per year (Gabites 2005). The database describes the state of vegetated wetland habitats in this dynamic coastal environment at a point in time. It can then be used as a baseline for monitoring at a range of scales, from local site changes to regional trends.

An estimate of present vs. past (pre-European) extent of coastal saltmarsh habitat in the Canterbury Region can be made by comparing results of the recent survey with the area of soil types that would have developed in a saltmarsh environment (saline gley soils). The current regional total vegetated estuarine (tidal, non-tidal, supra-tidal saltmarsh) wetland area is 4,602 ha, while regional total area of saline gley soils is 10,787 ha (DSIR 1968). The comparison is only indicative as there can be high natural rates of change in location, extent and type of coastal wetlands, but the data suggests a more than 50% net reduction in saltmarsh habitat extent post European settlement. While substantial, it is considerably less than the estimated 90% loss suffered by the region's freshwater wetland habitats (Pompei and Grove 2010). Causes of saltmarsh habitat reduction include construction of stopbanks, drains and culverts; reclamation and urban development; agricultural development; and engineering works associated with flood protection schemes (including the artificial opening regimes of the region's coastal lagoons). The distribution of coastal wetland plants and animals we now see over much of the region is one that has become adjusted to these new artificial or modified hydrological regimes.

170 years ago large freshwater wetlands occupied low-lying coastal areas forming corridors or connections between many estuaries, coastal lagoons and hāpua. For the most part these links no longer exist. Drainage of this low-lying land for agricultural and urban development progressively reduced the complex of freshwater and estuarine wetlands to the isolated fragments that remain around river mouths, estuaries and coastal lakes/lagoons (Kirk and Lauder, 2000; Hart and Bryan, 2008).

Human-induced loss of saltmarsh and other coastal wetland habitats in the region is ongoing, with earthworks and cultivation of saltmarsh herbfield at the head of Lyttelton Harbour/Whakaraupō over the last year a very recent example. There have however, also been examples of successful restoration of coastal wetland habitats in the region over the last decade, such as Charlesworth Reserve on the Avon-Heathcote Estuary/Ihutai and Otipua Wetland near Timaru. The importance of Te Waihora/Lake Ellesemere margins, which support more than 80% of the region's remaining saltmarsh habitat, has been recognised with the inclusion of vegetation values in the National Water Conservation (Te Waihora/Lake Ellesmere) Amendment Order 2011.

Changes to coastal wetland habitats can also be driven by catchment modifications beyond those occurring within the coastal zone. For example, many Canterbury Rivers now have significantly modified flow regimes (Environment Canterbury 2007). For the smaller rivers of the foothills and plains, such as the Ashburton and Pareora, this flow variability causes inter-annual variation in the frequency and duration of outlet closures and barrier breeches. By contrast for larger alpine-fed rivers such as the Rakaia and Rangitata, base-flows although modified remain high enough that these hāpua are rarely choked or closed. Studies of the Ashburton River/Hakatere mouth hāpua have shown the lagoon water surface area has decreased by 10% since the 1940s. Low-flow and closure behaviours have also increased in frequency and severity (Hart and Bryan, 2008). Monitoring extent and type of wetland (and other) vegetation and habitats associated with river mouth hāpua can indicate changes in hāpua ecology that may be associated with increased water abstraction.

Some example uses of the coastal wetland database are discussed in more detail below.

4.1 Monitoring

Two of the 50 coastal wetlands in the database had their vegetation mapped and described previously: Te Waihora/Lake Ellesmere in 1983 (Clark and Partridge, 1984) and the Styx River mouth

in 1996 (Crossland, unpublished). A second round of mapping as part of this study allowed monitoring of changes in wetland type and extent.

Te Waihora

Changes in Te Waihora wetland habitats over the period 1983-2007 were described by Grove and Pompei in *Te Waihora/Lake Ellesmere. State of the Lake and Future Management* (Hughey and Taylor, 2009). Within the 4,400 ha re-surveyed area, there was a *c.*100 ha increase in extent of freshwater wetland habitats and a corresponding decline in extent of brackish wetland or saltmarsh vegetation. Although the total area of saltmarsh habitat had declined by about 100 ha, there had been an increase in extent of native saltmarsh vegetation. And while there had been a corresponding increase in freshwater wetland habitat, there was a marked decline in extent of native freshwater wetland vegetation over the monitoring interval. Causes included the lower average lake levels and reduced lake salinity of recent years, reduced stock grazing pressure along parts of the shoreline, the spread of exotic willows in freshwater wetlands and human disturbance (Hughey and Taylor, 2009). Extent of the most abundant Te Waihora/Lake Ellesmere shoreline wetland vegetation types in 1983 and 2007 are tabled below.

Table 4-1: Extent of the fourteen most abundant wetland vegetation types around Te Waihora/Lake Ellesmere surveyed in 1983 and 2007. Habitat and 'nativeness' category are noted

Vegetation	**1983 (ha)**	**2007 (ha)**
Saltmarsh herbfield (saltmarsh/brackish wetland; indigenous)	2,405	2,253
Three square reedland (saltmarsh/brackish wetland; indigenous)	123	401
Marsh ribbonwood shrubland (saltmarsh/brackish wetland; indigenous)	256	387
Saltmarsh grassland (saltmarsh/brackish wetland; exotic)	536	331
Sea rush rushland (saltmarsh/brackish wetland; indigenous)	271	155
Juncus edgariae rushland (freshwater wetland; indigenous)	159	136
Mixed rushes and sedges (freshwater wetland; mixed indigenous-exotic)	23	59
Wet pasture (freshwater wetland; exotic)	138	159
Crack willow-dominant forest and treeland (freshwater wetland; exotic)	39	70
Grey willow-dominant forest and treeland (freshwater wetland; exotic)	28	70
Harakeke flaxland (freshwater wetland; indigneous)	23	9
Oioi restiad rushland (freshwater wetland; indigenous)	36	11
Raupō reedland (freshwater wetland; indigenous)	28	39
Bolboschoenus caldwellii reedland (saltmarsh/brackish wetland; indigenous)	14	8

The reduced area of saltmarsh herbfield over the monitoring interval is likely more apparent than real as, for this low-elevation vegetation, mapping and therefore total area calculations were only approximate at both survey dates due to lake water levels.

Styx River mouth

The extent of nine vegetation types mapped within the same *c.* 120 ha area at the Styx River mouth in 1996 and 2009 are shown. The more detailed vegetation composition data collected in 2009 has been aggregated to allow comparison with the 1996 information (A. Crossland, unpublished data).

Table 4-2 Extent of nine vegetation types mapped at the Styx River mouth in 1996 and 2009. Habitat and 'nativeness' category are noted

Vegetation types	**1996 (ha)**	**2009 (ha)**
Marsh ribbonwood shrubland (saltmarsh/brackish wetland; indigenous)	15	19
Oioi restiad rushland (saltmarsh/brackish wetland; indigenous)	15	18
Sea rush rushland (saltmarsh/brackish wetland; indigenous)	6	8
Three square and *Bolboschoenus caldwellii* reedland (saltmarsh/brackish wetland; indigenous)	6	2
Saltmarsh herbfield (saltmarsh/brackish wetland; indigenous)	4	2
Raupō reedland (freshwater wetland; indigenous)	8	3
Harakeke flaxland (freshwater wetland; indigenous)	1	<0.1
Exotic grassland (mostly terrestrial)	35	28
Exotic shrubland, scrub and treeland (mostly terrestrial)	30	40

At the Styx River mouth, extent of native saltmarsh shrubland and rushland vegetation increased while native saltmarsh reedland and herbfield decreased over the monitoring interval. Total area of two native freshwater wetland vegetation types – raupō reedland and harakeke flaxland – also decreased. Terrestrial exotic grassland area decreased while the area of terrestrial woody vegetation increased. Overall, a 6 ha reduction in area of freshwater wetland vegetation was offset by 3 ha increased extent in vegetation of both saltmarsh/brackish wetland and terrestrial habitats.

Following the Canterbury earthquakes of September 2010 and February 2011 significant changes have been recorded in bed level and hydrology in and around the estuaries of the Avon-Heathcote/Ihutai (Measures, *et al.,* 2011)) and Brooklands Lagoon-Styx River mouth (Kaitiaki o Ngahere, 2011). Repeating the vegetation survey and mapping of these estuaries in a few years when plant distributions have adjusted to the new conditions will provide a measurable record of changes to extent and type of wetland habitats.

4.2 Wetland management

Coastal wetland vegetation and habitat data can be used to help inform and direct management actions to protect or enhance wetlands, such as where to fence, carry out weed and/or pest control, identify suitable sites for restoration planting, manage public access, or seek improved legal protection. Again, the database provides a baseline to monitor effects of management actions, and can also help with choosing location and design of more detailed quantitative plot- or transect-based monitoring systems.

Willow control to protect Te Waihora/Lake Ellesmere shoreline wetlands
A report and maps showing the distribution and infestation density of invasive willows in the shoreline wetlands surrounding Te Waihora/Lake Ellesmere was prepared, based on results of the 2007 lake shore vegetation survey information contained in the coastal wetland database (Pompei and Grove, 2009). It also described the habitats and vegetation around and within willow-infested areas. The report was intended to help guide land owners and management agencies on where to direct and prioritise willow control operations. It has been used to develop a Department of Conservation willow control strategy for Te Waihora/Lake Ellesmere (Walls 2009), and to support funding applications for willow and other weed control projects.

Te Rauakaaka Nature Reserve (Styx River mouth) restoration
Coastal wetland database information from the 2009 survey of the Styx River mouth formed the basis of an internal report to Environment Canterbury's Properties Section (Grove 2009). This report described and mapped the indigenous biodiversity and habitat values of the newly-named Te Rauakaaaka reserve, part of the Lower Waimakariri Regional Park, and recommended that the area be primarily managed to protect and enhance these values. Other recommendations included 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. A map from the 2009 report is re-produced in Figure 4-1.

Maps and information derived from the coastal wetland database were subsequently incorporated into Chapter 4 of the Waimakariri River Regional Park Management Plan (Environment Canterbury, 2010) and have been referred to in the development of a detailed 25 year restoration plan prepared for Te Rauakaaka Nature Reserve (Kaitiaki o Ngahere, 2011). As mentioned earlier, the 2010-11 Canterbury earthquakes have wrought considerable change to Te Rauakaaka and necessitated some revision of the restoration plan.

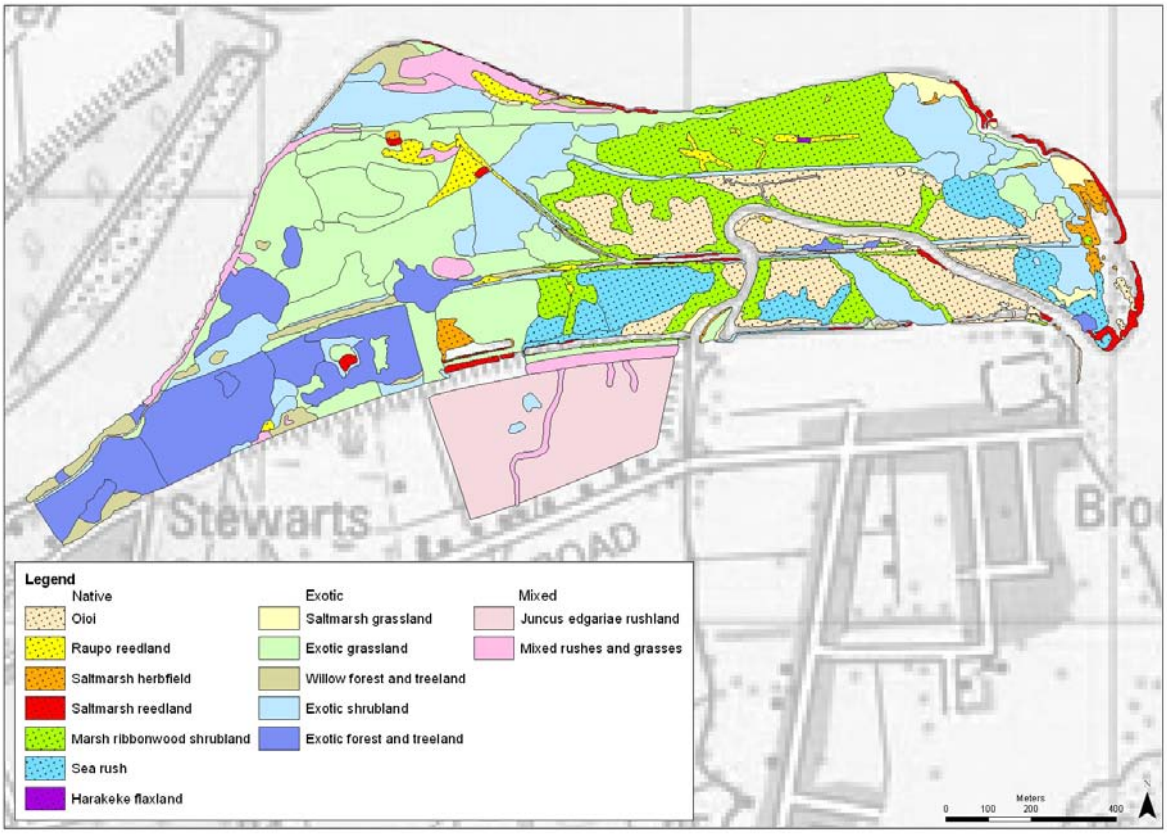

Figure 4-1: Vegetation types at Te Rauakaaka Reserve (Styx River mouth), mapped in 2009

4.3 Assessment of wetland condition and ecological significance

Wetland vegetation/habitat maps are a basis for delineation of wetland extent, assessments of condition and threats (following the standard methodology of Clarkson *et al,* 2003) and assessments of ecological significance. This 'whole wetland' site information is recorded in another GIS database held by Environment Canterbury.

4.4 Further wetland survey work

The system of field survey and database developed for the region's vegetated coastal wetland habitats will now be applied to inland freshwater wetlands. Ground-based survey will be used to update or improve accuracy of wetland delineation in the FENZ database, as well as provide more detailed information on wetland class, vegetation type and overall ecological condition.

5 Acknowledgements

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Appendix 1: List of vegetated coastal wetland areas surveyed and mapped, 2004-2011

Total wetland area and habitat proportions for each site are shown.

Survey Area Name	Survey Year	Wetland area (ha)	Wetland habitats			
			% Tidal saltmarsh	% Supra-tidal saltmarsh	% Non-tidal saltmarsh	% Fresh-water wetland
Kaikoura Water Management Zone						
Tirohanga Lagoon	2010	0.8			2%	98%
Conway River Mouth Lagoon	2010	3			98%	2%
Hurunui-Waiau WMZ						
Gore Bay – Buxton Creek	2010	< 0.1			100%	
Gore Bay – Jed River Mouth	2010	0.6			100%	
Motunau River Mouth	2010	0.2	100%			
Waipara River Mouth	2010	29.7			40%	60%
Kowai River Mouth	2010	0.6			100%	
Leithfield Lagoon	2010	1.3				100%
Amberley Beach Lagoon	2010	5.7				100%
Mimimoto Lagoon	2011	9.3			2%	98%
Ashworths Ponds	2010	9.6			88%	12%
Waimakariri WMZ						
Ashley River – Saltwater Creek Estuary / Rakahuri	2004	86.1	84%		10%	6%
Jockey Baker Creek	2010	14.6	10%	< 1%		90%
Christchurch-West Melton WMZ						
Styx River Mouth	2009	59.8	84%	< 1%	< 1%	16%
Brooklands Lagoon	2010	117.4	93%		7%	<1%
Avon-Heathcote Estuary / Ihutai	2008	56.4	99%			1%
Banks Peninsula WMZ						
Lyttelton Harbour / Whakaraupō	2010	43.4	86%	14%		
Raupō Bay	2010	2		64%	36%	
Okains Bay	2009	10.4	100%			
Le Bons Bay	2009	4.6	100%			
Akaroa Harbour	2010	0.8	91%			9%
Lake Forsyth / Wairewa	2010	102.1	25%			75%
Selwyn-Waihora WMZ						
Te Waihora / Lake Ellesmere	2007	4,380		< 1%	87%	13%
Coopers Lagoon / Muriwai	2007	93.1			7%	93%
Tentburn	2011	17				100%
Rakaia River Hāpua	2010	34.3				100%
Ashburton WMZ						
Wakanui Creek	2010	2.6				100%
Longbeach Coast	2010	9.9		1%		99%
Hinds River Mouth	2011	0.2				100%

Survey Area Name	Survey Year	Wetland area (ha)	Wetland habitats			
			% Tidal saltmarsh	% Supra-tidal saltmarsh	% Non-tidal saltmarsh	% Fresh-water wetland
Coldstream Coast	2011	7.3		<1%	<1%	99%
Rangitata River Hāpua	2010	4.5				100%
Orari-Opihi-Pareora WMZ						
Orari River Mouth Lagoons	2011	15.9				100%
Spider Lagoon	2011	6.3			47%	53%
Prattley Road Lagoon	2011	18.5		8%		92%
Opihi River Mouth Lagoon	2008	34.5			42%	58%
Seaforth Coast	2011	51.1		72%	21%	7%
Washdyke Lagoon	2009	36.6			73%	27%
Saltwater Creek-Otipua	2011	13.1		< 1%	16%	83%
Tuhawaiki Point	2011	0.8		100%		
Normanby Lagoon	2011	2.3				100%
Pig Hunting Creek	2011	4.7			92%	8%
Pareora Coast	2011	1.7			100%	
Pareora River Mouth	2011	14.5				100%
Lower Waitaki – South Coastal Canterbury WMZ						
St Andrews Coast	2011	0.5		12%		88%
Otaio Flats	2011	16.9		9%	26%	65%
Makihikihi Coast	2011	3.3		10%	43%	47%
Wainono Lagoon	2008	373.8			68%	32%
Waihao Dead Arm	2011	16		4%	24%	72%
Willowbridge Coast	2011	19.4		20%	54%	26%
Waitaki River Hāpua	2011	9.6			< 1%	>99%

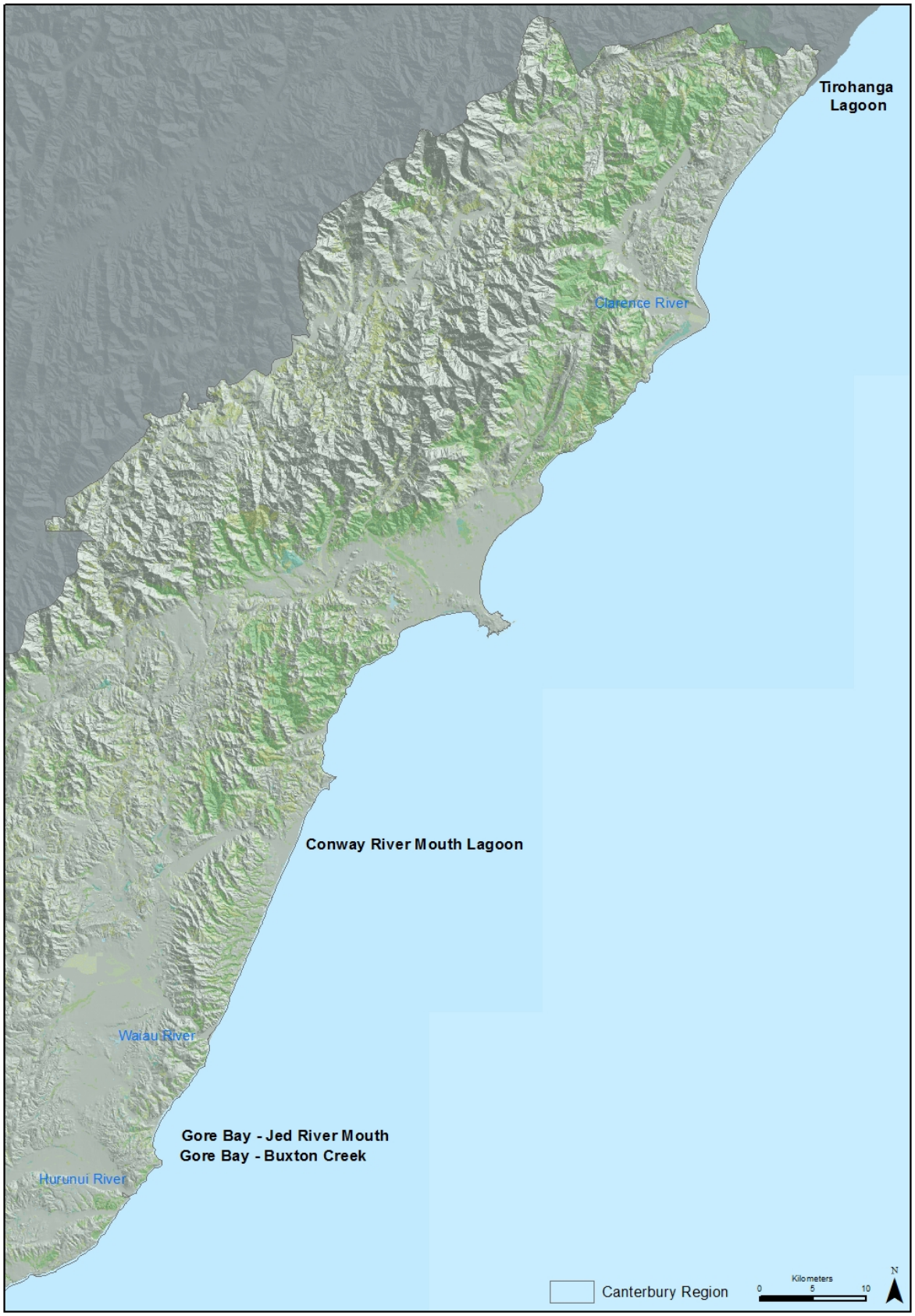

Figure A1-1: Location of coastal wetlands surveyed in Canterbury Region, northern section

Figure A1-2: Location of coastal wetlands surveyed in Canterbury Region, central section

Figure A1-3: Location of coastal wetlands surveyed in Canterbury Region, southern section

Appendix 2: Metadata to accompany GIS layer of Canterbury Region coastal wetland vegetation

ATTRIBUTE INFORMATION

Area Name
Name of wetland or survey area.

Habitat
Wetland or Terrestrial.

Hydrosystem
Nine recognised hydrosystems. The four major ones for wetlands are estuarine, riverine, lacustrine and palustrine. Five minor hydrosystems are more localised or specialised and less relevant to freshwater habitats: marine, inland saline, plutonic, geothermal and nival. Based on the Wetland Classification system of Johnson & Gerbeaux (2004).

Subsystem
The subsystem is the second, and less formal, level of classification allowing for attention to be drawn to particular descriptors of water regime. In the estuarine hydrosystem, tidal fluctuation is a predominant factor. In the palustrine hydrosystem, period and timing of saturation is critical. In the riverine hydrosystem, rate and stability of water flow are important and in the lacustrine hydrosystem, fluctuation period and lake water stratification are strong descriptors. Based on the Wetland Classification of Johnson & Gerbeaux (2004).

Wetland Class
Wetland classes are governed by distinctive combinations of substrate factors, water regime, and the consequent factors of nutrient status and pH. Nine wetland classes accommodate most of the broad level variants of palustrine, estuarine and inland saline hydrosystems: bog, fen, swamp, marsh, seepage, shallow water, ephemeral wetland pakihi and gumland, and saltmarsh. Lacustrine wetland classes are based upon combination of two sets of descriptors, the first being nutrient status (oligotrophic, mesotrophic, eutrophic, dystrophic) and the second being the nature of lake stratification. Riverine wetland classes descriptors concerned with the two factors of water flow (stable, variable, flashy) and channel gradient (steepland, middleland, lowland). Based on the Wetland Classification of Johnson & Gerbeaux (2004).

Wetland Form
For palustrine and estuarine wetlands this category is a set of descriptors of landforms that wetlands occupy, and forms they create or contain. Other wetland forms are associated with standing open water, and flowing open water and channels. Based on the Wetland Classification of Johnson & Gerbeaux (2004).

Structural Class
This classification level is concerned with the general growth form or structure (physiognomy) of the vegetation, or the leading type of ground surface. The structure of vegetation results from the spatial arrangement, stature, and relative abundance of plant growth forms. Structural classes are described without reference to particular plant species: this aspect of describing composition comes into play for the succeeding and lowermost level of the classification. Based on the Wetland Classification of Johnson & Gerbeaux (2004).

Vegetation Type
45 broad vegetation types have been recognised within the survey area. See below for full descriptions.

Vegetation Composition
At a more detailed level, 173 distinct vegetation compositional groups were recognised within the survey area. See below for full descriptions.

'Nativeness' Category
Vegetation in each mapping unit is categorised as Indigenous, Exotic or Mixed. Although most vegetation mapping units contain both native and exotic plant species, they have been classified as 'predominantly indigenous', 'predominantly exotic' or 'mixed indigneous-exotic' on the basis of canopy composition.

Area - square metres

Vegetation Description
Full field survey description data. Where possible, field descriptions followed the Atkinson (1985) notation for mapping vegetation. In this system, prominent species are identified by six letter codes derived form their botanical name. Each vegetation tier (e.g. canopy, sub-canopy, ground-cover) is separated by a '/'. Abundance of the listed species is indicated by case or brackets as shown in the example:

PLA DIV	> 76% canopy cover of marsh ribbonwood (*Plagianthus divaricatus*)
PLA div	51-75% cover of marsh ribbonwood
Pla div	26-50% cover
(Pla div)	6-25% cover
[Pla div]	1-5% cover

Comments

Surveyor
Name of surveyor.

Data
Date of field survey.

Id
Polygon unique identification number.

Vegetation Types

Herbfield
Saltmarsh herbfield
Lakeshore turf herbfield
Silverweed herbfield
Aquatic and semi-aquatic herbfield
Shore bindweed herbfield
Terrestrial exotic herbfield

Grassland
Saltmarsh grassland
Reed canary grass grassland
Freshwater wetland grassland
Terrestrial grassland

Sedgeland
Carex litorosa sedgeland
Carex spp. freshwater sedgeland
Pingao sedgeland
Carex pumila sedgeland

Tussockland
Carex secta tussockland
Schoenus pauciflorus tussockland
Toetoe tussockland
Pampas hedge
Silver tussock with knobby club rush

Rushland
Sea rush rushland
Oioi restiad rushland with saltmarsh associates
Oioi restiad rushland with freshwater wetland associates
Knobby club rush rushland
Native freshwater wetland rushland
Exotic freshwater wetland rushland

Reedland
Three square reedland
Bolboschoenus caldwellii reedland
Lake clubrush reedland
Raupō reedland

Flaxland
Harakeke flaxland

Shrubland and scrub
Marsh ribbonwood shrubland
Coprosma propinqua shrubland
Mānuka scrub
Open willow shrubland with native associates
Terrestrial native shrubland
Native restoration planting
Exotic shrubland

Treeland and forest
Tī kōuka treeland
Ngaio treeland
Willow forest and treeland with native understorey
Willow forest and treeland with exotic understorey
Exotic hardwood forest and treeland
Exotic conifer forest and treeland

Fernland
Bracken fernland

Sparsely vegetated

Description of vegetation composition groups
Exotic plant species denoted by *

Herbfield (including turf)
1.01 Mixed saltmarsh herbfield, glasswort present
Glasswort (*Sarcocornia quinqueflora*) is present, and usually the most abundant species, along with a diversity of saltmarsh herbs and some larger plants. Sea blight (*Suaeda novae-zelandiae*) is sometimes co-dominant. Other species present may include buck's horn plantain (*Plantago coronopus**), orache (*Atriplex prostrata**), salt grass (*Puccinellia stricta*), native musk (*Mimulus repens*), sea primrose (*Samolus repens*), selliera (*Selliera radicans*) and *Leptinella dioica*. Dwarf sedges such as *Isolepis cernua* and *Schoenus concinnus* are also common at some sites. Scattered

taller plants of oioi (*Apodasmia similis*), marsh ribbonwood (*Plagianthus divaricatus*), sea rush (*Juncus krausii* subsp*. australiensis*), knobby club rush (*Ficinia nodosa*) and three square (*Schoenoplectus pungens*) may also be present at some sites.

1.02 Mixed saltmarsh herbfield, glasswort absent
A similar mix of species as above, except that no glasswort present.

1.03 Grass-herbfield
Mixed herbfield vegetation type 1.01 described above forms a mosaic with patches of grassland. Grass species may include exotic creeping bent (*Agrostis stolonifera**), tall fescue (*Schedonurus arundinaceus**), couch (*Elytrigia repens**) and salt barley grass (*Critesion marinum**), as well as native salt grass and adventive salt grasses (*Puccinellia. distans*, P. fasciculata**).

1.04 Glasswort herbfield
Glasswort is the main cover. Low numbers of other saltmarsh herbfield species such as sea primrose, bachelor's button (*Cotula coronopifolia*), orache, sea blight and salt grass species may be present.

1.05 Glasswort grass-herbfield
Glasswort and one or more high salinity-tolerant grass species are co-dominant. Grasses may be adventive salt barley grass, native salt grass or adventive salt grass. Sea primrose, native musk, buck's horn plantain and orache may also be present.

1.06 Glasswort and sea lavender herbfield
The aggressive adventive sea lavender (*Limonium companyonis**) is the subject of a control programme in the Avon-Heathcote estuary as it is a significant threat to native saltmarsh herbfield. At time of survey (2008) it occurred at two sites in the estuary, in association with glasswort and native salt grass.

1.07 Glasswort herbfield plus selliera turf
Dense glasswort patches and selliera patches form a distinctive saltmarsh turf-herbfield mosaic.

1.08 Glasswort and native musk herbfield
A gradation from herbfield dominated by glasswort into one dominated by native musk at lower elevations. Common associated species are native or adventive salt grass at higher elevations, with marsh arrow grass (*Triglochin striata*) and sea primrose lower down.

1.09 Sea blight herbfield
Sea blight is the main cover. Low numbers of other saltmarsh herbfield species may be present.

1.10 Buck's horn plantain herbfield
Buck's horn plantain is the dominant cover; a variety of other species salt-tolerant herbs may be present.

1.11 Sea primrose turf
This vegetation often consists entirely of native primrose, although selliera and native musk can be turf associates at some sites. Other herb species listed in 1.01 may occur at low abundance, with sea rush also present at several sites.

1.12 Selliera turf
Selliera is the dominant ground cover, with sea primrose, glasswort and *Leptinella dioica* at some sites. Scattered sea rush and salt-tolerant grasses may also be present.

1.13 *Leptinella dioica* turf
Leptinella dioica is dominant cover, with selliera and low numbers of other salt marsh herbfield species.

1.14 Native musk herbfield
Native musk is the dominant cover. Associated species may include bachelor's button (*Cotula coronopifolia*), *Lilaeopsis novae-zelandiae* and marsh arrow grass at low-elevation brackish sites;

creeping bent, salt barley grass, selliera and *Leptinella dioica* at higher-elevation brackish sites; and with *Lilaeopsis* and *Crassula sinclairii* at some freshwater habitats.

1.15 Marsh arrow grass herbfield
Marsh arrow grass is the dominant species on relatively sparsely vegetated mudflats. Common associates are native musk and bachelor's button.

1.16 Orache herbfield
Depending on location, *Crassula sinclairii*, sea spurrey (*Spergularia marina**), native musk, bachelor's button may be co-dominant.

1.17 Lotus herbfield
*Lotus tenuis** is the dominant cover. Tall fescue and occasional sea rush are emergent, with buck's horn plantain, glasswort, selliera and salt barley grass also present.

1.18 Sea spurrey herbfield
Sea spurrey is the dominant cover with bachelor's button and *Lilaeopsis*. *Crassula sinclairii*, native musk, glasswort, purple mimulus and bachelor's button are present at some sites.

1.19 Bachelor's button herbfield
Bacehlors button is the main cover. Other species present may include spike sedge (*Eleocharis acuta*), creeping bent and *Lilaeopsis*.

1.20 *Lilaeopsis* herbfield
Lilaeopsis novae-zelandiae is the most abundant species on what are generally sparsely-vegetated, low elevation mudflats. *Lilaeopsis* may occur alone or with mudwort (*Limosella lineata*) as the main associate, dwarf sedges such as *Isolepis cernua* and *Schoenus concinnus* may also be present. At some sites, exotic seral species such as dock (*Rumex crispus*, R. obtusifolius**), sow thistle (*Sonchus oleraceus**) and glaucous goosefoot (*Chenopodium glaucum*) have established with *Lilaeopsis* on temporarily-dry mudflats.

1.21 Mixed freshwater turf
One or more of *Ranunculus limosella, Crassula sinclairii, Myriophyllum triphyllum* and native musk form turf vegetation on gently-sloping freshwater lake/lagoon/pond habitats. Bachelor's button, *Spergularia tasmanica* and *Lilaeopsis* may also be present.

1.22 Silverweed herbfield
Silverweed (*Potentilla anserinoides*) is the dominant species with scattered bachelor's button, Caldwell's sedge (*Bolboschoenus caldwelli*), three square and *Juncus pallidus* also present.

1.23 Silverweed with exotic grasses and herbs
Silverweed, together with exotic herb and grass species, forms a dense groundcover. Abundant associated species may include creeping bent, yarrow (*Achillea millefolium**), plantain (*Plantago lanceolata**), willow weed (*Persicaria* spp.*). Scattered emergent rush and reeds, e.g. *Juncus edgariae, J. pallidus, Bolboschoenus caldwellii* and three square may also be present.

1.24 Monkey musk and water cress aquatic herbfield
Exotic *Mimulus guttatus** and/or *Nasturtium officinale** form dense cover in drains, stream margins. Other species present may include adventive water pepper (*Persicaria hydropiper**), willoweed (*Persicaria* spp.*), both native and adventive buttercups (*Ranunculus* spp.) and creeping bent.

1.25 Water pepper herbfield
Waterpepper is the main cover; marsh bedstraw (*Galium palustre**), jointed rush (*Juncus articulatus**), yarrow and hawksbeard (*Crepis capillaris**) also present. May also have scattered grass, rush and sedge species.

1.26 Water speedwell aquatic herbfield
Water speedwell (*Veronica anagallis-aquatica**) is dominant cover. Dock, creeping bent and kneed foxtail (*Alopecurus geniculatus**) are generally also present; with tall fescue and couch at some sites.

1.27 Floating aquatic herbfield
Pondweed (native *Potomogeton cheesemanii* and/or exotic *P. crispus**.) and duckweed (*Lemna minor*) floating on surface of open water bodies; horses mane (*Ruppia* sp.) and retoreto (*Azolla filiculoides*) may also be present. Introduced aquatic buttercup (*Ranunculus* spp.*) and scattered emergent yellow flag (*Iris pseudacorus**) occur at some sites.

1.30 Exotic seral herbfield
Seral exotic dryland species colonise bare substrate exposed by seasonal drying of shallow pools or shifts in braided river bed and mouth locations. Herbaceous species such as thistles (*Cirsium* spp.*), plantain (*Plantago* spp.*), yarrow, wireweed (*Polygonum aviculare**), scentless mayweed (*Tripleurospermum inodorum**), flatweeds (*Crepis capillaris**, *Hypochoeris radicata**), clovers and fireweed (*Senecio glomeratus**) dominate; occasional lupin (*Lupinus arboreus*) and gorse (*Ulex europaeus*) shrubs may also be present. King Island melilot (*Melilotus indicus**) occurs at some sites.

1.31 Ice plant herbfield
Introduced ice plant (*Carpobrotus edulis**) is the dominant cover on sand and fine gravel beach dunes.

1.32 *Barbarea intermedia* herbfield
Winter cress (*Barbarea intermedia**) with kneed foxtail, creeping bent, bachelor's button and orache.

1.33 *Calystegia soldanella* herbfield
Native bindweed (*Calystegia soldanella*) forms a generally sparse cover on sand and fine gravel dunes.

1.34 Sea rocket herbfield
*Cakile edentula** is the main cover with orache, sheep's sorrel (*Rumex acetosella**), fathen (*Chenopodium album**), occasional marram grass (*Ammophila arenaria**) on coastal dunes.

Grassland
2.01 Spartina grassland
Dense spartina (*Spartina anglica**) patches on tidal mudflats. No other species present.

2.02 Salt grass grassland
Native salt grass is the dominant cover, with glasswort the main associate. Other salt-tolerant herbs species such as buck's horn plantain and selliera may be present.

2.03 *Puccinellia stricta* and salt barley grass grassland
Two grass species tolerant of high salinity, native salt grass and exotic salt barley grass, are co-dominant. Glasswort, buck's horn plantain and orache may also be present.

2.04 Exotic saline grassland with native herbs
Exotic salt-tolerant grasses (*Puccinellia distans**, *Elytrigia repens**, *Critesion marinum**, *Agrostis stolonifera**) are the main cover but native saltmarsh herbs such as glasswort, bachelor's button, selliera and sea primrose are common in the groundcover.

2.05 Creeping bent grassland
Creeping bent forms a dense sward, growing alone or in association with other salt-tolerant exotic grasses such as tall fescue, couch and salt barley grass. Native shrubs, flax (*Phormium tenax*), sea rush and three square, and herbs such as buck's horn plantain, bachelor's button, glasswort and *Leptinella dioica* are present at some sites.

2.06 Tall fescue dominant grassland with native associates
Tall fescue is the dominant cover, with a range of natives such as marsh ribbonwood, sea rush, oioi, flax (*Phormium tenax*), toetoe (*Cortaderia richardii*), raupō (*Typha orientalis*), *Bolboschoenus caldwellii*, sedges, rushes. and herbfield species present at varying levels of abundance.

2.07 Tall fescue dominant grassland with exotic associates
Tall fescue is the dominant cover with other exotic grasses such as creeping bent, couch, cocksfoot (*Dactylis glomerata**) and marram the main associates. Shrubs of gorse, broom (*Cytisus scoparius**), lupin, elder (*Sambucus nigra**) and blackberry (*Rubus fruticosus* agg.*) may be present in grassland on disturbed upper margins of the estuary.

2.08 Reed canary grass grassland
Generally dense cover of invasive reed canary grass (*Phalaris arundinacea**). Scattered emergent natives such as flax, marsh ribbonwood, raupō and *Bolboschoenus caldwelli* persist at some sites.

2.09 Reed canary grass-tall fescue grassland
Scattered marsh ribbonwood, *Coprosma propinqua* and flax may be emergent over exotic grasses.

2.10 Wet pasture
Pasture land subject to periodic freshwater inundation or ponding. Common species include perennial ryegrass (*Lolium perenne**), Yorkshire fog (*Holcus lanatus**), crested dogstail (*Cynosurus cristatus**), creeping bent, tall fescue, couch, cocksfoot and kneed foxtail. Introduced jointed rush (*Juncus articulatus**) and clovers (*Trifolium* spp.*) may also be common.

2.11 Wet pasture with native rushes and sedges
Native rush and sedge species such as *Carex sinclairii, C. coriacea,* spike sedge, raupō, *Juncus pallidus* and *Juncus edgariae* are moderately abundant amongst exotic pasture species. Native groundcovers such as silverweed may also be present.

2.12 Wet pasture with scattered willows, flax
Moisture-tolerant exotic grasses and herbs dominate with scattered willow trees (*Salix* spp.), flax and native rush species also present.

2.20 *Glyceria fluitans* grassland
Rafted floating sweet grass (*Glyceria fluitans**) in shallow water with other aquatic grass and herb species. E.g. *Nasturtium officinale*, Persicaria hydropiper*.*

2.30 Couch grassland
Dense sward of couch grass; other exotic grasses may also be present. Scattered emergent flax and pampas (*Cortaderia selloana*, C. jubata**) occur at some sites.

2.31 Marram grassland
Marram grass dominates vegetation cover of sand dunes above upper margins of the estuary. Tall fescue, cocksfoot and hares tail grass (*Lagurus ovatus**) are also common. Scattered sea rush and marsh ribbonwood, *Carex pumila*, ice plant, gorse, broom, boxthorn (*Lycium ferocissimum**) and lupin shrubs, and pine trees (*Pinus radiata**) may also be present.

2.32 Lyme grass grassland
Stands of lyme grass (*Leymus arenarius**) also occur on sand dunes at the Styx River mouth, though not as widespread as marram grassland. Marram and other associated species listed in 2.31 above are also present.

2.40 Danthonia and needle grass (*Austrostipa nodosa**) grassland
Dryland grassland, extensive on Kaitorete Spit and Birdlings Flat. May include scattered native shrubs e.g. pōhuehue (*Muelenbeckia complexa*) and groundcovers e.g *Scleranthus uniflorus* and mat daisies *Raoulia monroi* and scabweed (*R. australis*).

2.41 Dry grass-mossfield
As above but with native mosses – *Racomitrium, Polytrichum juniperinum, Hypnum cupressiforme* co-dominant.

2.50 Terrestrial exotic grassland
Exotic grasses and herbs such as cocksfoot, tall fescue, browntop (*Agrostis capillaris**), lotus and yarrow dominate the vegetation cover. On drier sites, common grass species include *Bromus*

*hordeaceus**, silvery hair grass (*Aira caryophyllea**) and danthonia (*Rytidosperma* sp.*). Common herbs are sheep's sorrel, plantain (*Plantago lanceolata**, *P. major**) and horehound (*Marrubium vulgare**). Scattered trees and shrubs such as gorse, willow, lupin and marsh ribbonwood are present at some sites.

2.60 Agricultural crops

Sedgeland

3.01 *Carex litorosa* sedgeland
The native sedge *Carex litorosa* forms a generally open canopy at some sandy estuary shorelines. Associated species may include sea rush, three square, marsh ribbonwood and tall fescue.

3.02 *Carex coriacea* sedgeland
Patches of native cutty grass (*Carex coriacea*) form a seasonally-dominant cover at damp sites, generally within or surrounded by terrestrial exotic grassland. Tall fescue, creeping bent and cocksfoot are usually the most abundant associate species.

3.03 *Carex geminata* sedgeland
Carex geminata sedge canopy with spike sedge and creeping bent the main associate species. Tall fescue is canopy associate at some sites. Scattered marsh ribbonwood, flax, *Coprosma propinqua*, *Carex secta, C. virgata*, *Juncus pallidus* and oioi may also be present.

3.04 *Carex sinclairii* sedgeland
Silverweed, creeping bent and jointed rush are common groundcover associates.

3.05 *Carex sinclairii* sedgeland with emergent rushes and willows
Clumps of *Juncus edgariae, J. distegus* and oioi are emergent over the sedge canopy. Scattered grey willow (*Salix cinerea**) shrubs are present at some sites.

3.10 Pingao sedgeland
Pingao (*Ficinia spiralis*) is the dominant cover of dune vegetation along Kaitorete Spit. Common associated species are introduced purple senecio (*Senecio elegans**) and hares tail grass. Marram grass becomes dominant towards the western end of the spit.

3.11 *Carex pumila* sedgeland
Associated species include sickle grass (*Parapholis incurva**), marram, tall fescue, orache, buck's horn plantain.

Tussockland

4.01 *Carex secta* tussockland
Carex secta canopy, with understorey dominated by introduced jointed rush and monkey musk.

4.02 *Carex secta* and marsh ribbonwood
An unusual association in a unique site, cut off from the rest of the Avon-Heathcote Estuary by a causeway and associated drains and culverts. Emergent shrubs of marsh ribbonwood are relictual, and the dominant cover in what is now a freshwater wetland habitat is *Carex secta*. Common associated species are tall fescue, dock and kneed foxtail, with scattered emergent toetoe also present.

4.03 *Carex secta* tussockland with coprosma, raupō and flax
Scattered *Coprosma propinqua*, raupō clumps, flax and occasional grey willow emergent over the tussock sedge canopy.

4.04 *Carex secta* tussockland with willows
Shrubs or small trees of crack willow (*Salix ×fragilis**) and/or grey willow are emergent over tussock sedge canopy.

4.05 *Carex secta* tussockland with exotic grass understorey

4.10 *Schoenus pauciflorus* tussockland
Bog rush (*Schoenus pauciflorus*) tussock canopy with introduced pasture species the main associates.

4.11 *Schoenus pauciflorus* with scattered grey willow

4.20 Toetoe tussockland
Toetoe canopy with ground cover of wet pasture species, jointed rush and monkey musk.

4.30 Pampas hedge
Planted hedgerows of introduced pampas. Gorse may also be present.

4.40 Silver tussock with knobby club rush
Silver tussock (*Poa cita*) and knobby club rush locally dominant, with groundcover predominantly of introduced pasture species. Other native species present are *Carex flagellifera*, pōhuehue, scabweed and, on Kaitorete Spit, the endemic prostrate broom *Carmichaelia appressa*.

Rushland
5.01 Sea rush essentially alone
Almost pure stands of sea rush of varying density, although sometimes with occasional marsh ribbonwood shrubs and/or low abundance of species such as three square, selliera and buck's horn plantain.

5.02 Sea rush with saltmarsh herbfield, glasswort present
Saltmarsh herbfield species such as glasswort, sea primrose, selliera, buck's horn plantain, native musk, and marsh arrow grass occur in the rushland groundcover. Three square, marsh ribbonwood, tall fescue and creeping bent may also be present.

5.03 Sea rush with marsh ribbonwood, oioi, three square
Scattered plants or clumps of one or more of the following: oioi, three square, and marsh ribbonwood are common within the sea rush canopy.

5.04 Sea rush with native salt grass
Open sea rush canopy with native salt grass groundcover.

5.05 Sea rush with knobby club rush
Associated ground cover species may include exotic grasses such as creeping bent, native salt grass and saltmarsh herbs.

5.06 Sea rush with three square

5.07 Sea rush with exotic grasses
Exotic grasses, especially creeping bent and tall fescue, are the main associate species. Marram, couch, salt barley grass and sweet vernal (*Anthoxanthum odoratum**) are present at some sites. Native saltmarsh herbs may also be present. In addition there may be occasional plants of marsh ribbonwood, oioi, three square and knobby club rush.

5.08 Sea rush with freshwater wetland species
Presence of *Juncus edgariae* and flax amongst rush-marsh ribbonwood canopy indicates shift to a freshwater wetland habitat. Ground cover is a mixed sward of creeping bent, jointed rush and spike sedge.

6.01 Oioi restiad rushland
Extensive, dense clumps of oioi almost completely exclude other species. At some sites there are low numbers of sea rush and marsh ribbonwood growing amongst the oioi.

6.02 Oioi with saltmarsh herbfield
A more open oioi canopy permits a groundcover of saltmarsh herbs such as glasswort, sea blight, buck's horn plantain, selliera and sea primrose. Knobby club rush, sea rush and tall fescue may also be present.

6.03 Oioi with marsh ribbonwood and sea rush
Scattered plants or clumps of flax, marsh ribbonwood and/or sea rush are common within the oioi canopy; stands of three square, *Bolboschoenus caldwellii* and scattered knobby club rush occur at some sites. Tall fescue and creeping bent may be present at low abundance.

6.04 Oioi with introduced grasses and jointed rush
Tall fescue and creeping bent are the main associate species, together with jointed rush. Native rush and sedge species, such as *Carex sinclairii*, occur at some sites. Occasional flax, sea rush, marsh ribbonwood and willows may also be present.

6.05 Oioi with *Bolboschoenus caldwellii*
Bolboschoenus caldwelli occurs in association with oioi. Exotic grasses and occasional flax, marsh ribbonwood may also be present.

6.06 Oioi with raupō
Scattered clumps of raupō are emergent above the dense oioi canopy.

6.07 Oioi with scattered emergent flax and willows
On the northwest margin of Lake Ellesmere, threatened swamp nettle (*Urtica linearifolia*) is relatively common amongst this vegetation. This species is listed as 'Declining' by the Department of Conservation (de Lange *et al.,* 2009).

6.10 Knobby club rush rushland
May also include sea rush*,* marram, *Carex pumila* as canopy associates, and saltmarsh herbs in the groundcover.

6.20 *Eleocharis acuta* rushland
Spike sedge forms a dense low (20-30 cm) rush cover, with exotic creeping bent and jointed rush, and native herbs species all common associates at a number of sites. Adventives *Juncus holoschoenus** and *Ranunculus repens** may also be present. On some sloping shorelines, spike sedge grades back into a narrow band of *Carex coriacea* sedgeland with scattered *Juncus holoschoenus*.

6.21 *Eleocharis acuta* with native rushes
Rushland mosaic with stands of taller oioi or *Juncus sarophorus* scattered amongst the *E. acuta*.

6.30 *Juncus edgariae* rushland with other native rush and sedges
Native wetland species such as bog rush, *Bolboschoenus caldwelli*, *Carex sinclairii, Carex secta* and spike sedge are abundant amongst the *J. edgariae* rush canopy.

6.31 Wet *Juncus edgariae* rushland
Juncus edgariae rushland in a seasonal wetland (marsh) habitat. Associated species are predominantly exotic moisture-tolerant grasses and herbs such as crested dogstail and *Glyceria fluitans**, but some native wetland species may also be present: buttercup (*Ranunculus macropus, R. glabrifolius, R. amphitrichus*), pondweed (*Potamageton cheesemanii, Juncus distegus*, *Carex sinclairii*, bog rush, *Juncus pallidus*.

6.32 Damp *Juncus edgariae* rushland
Juncus edgariae forms a rush canopy over exotic grass and herb pasture species. Habitat is terrestrial, seasonally damp pasture rather than wetland.

6.40 *Juncus pallidus* rushland
Tall *J. pallidus* rush canopy; scattered flax, cabbage tree (*Cordyline australis*) and willows present at some sites. Other rushes and sedges such as *Carex secta, C. geminata* and *J. edgariae* may also be present. Exotic grass and herbs generally dominate the ground cover.

6.41 *Juncus sarophorus* rushland
Juncus sarophorus forms the rushland canopy at freshwater wetland sites, with tall fescue dominant beneath.

6.50 Baumea restiad rushland
Baumea (*Baumea rubiginosa*) forms a dense rush cover. Scattered emergent flax, mānuka shrubs (*Leptospermum scoparium*) and cabbage tree are also present.

6.60 Jointed rush rushland
Introduced jointed rush is the predominant cover, with exotic grass and herbs the main associate species. Scattered *Juncus edgariae* rushes may also be present.

6.61 Jointed rush rushland with *Eleocharis acuta*
Exotic jointed rush is the dominant species with native spike sedge the main associate. Scattered emergent *Carex secta* may also be present.

6.62 Jointed rush with native sedge species
Carex sinclairii and/or *C. coriacea* are the main associates.

6.70 *Juncus effusus* rushland
Exotic soft rush (*Juncus effusus**) is main cover. Scattered emergent willows; spike sedge, jointed rush, creeping bent groundcover.

Reedland
7.01 Three square reedland
Three square reed canopy cover of varying density. No canopy associates, but there may be small amounts of glasswort, native musk, bachelor's button, arrow grass, selliera and sea primrose in the groundcover.

7.02 Three square with native saltmarsh shrubs and rushes
One or more of the following emergent from the three square canopy: scattered marsh ribbonwood, sea rush, oioi. There may also be small amounts of native musk, arrow grass, selliera and sea primrose in the groundcover.

7.03 Three square with *Bolboschoenus caldwellii*
Sea rush may also be present.

7.04 Three square with mixed native and exotic groundcover
Creeping bent, dock and willoweed generally dominates the groundcover, but native herbs are also common e.g. bachelor's button, native musk, *Lilaeopsis novae-zelandiae*, marsh arrow grass, selliera and *Leptinella dioica*.

7.05 Three square with exotic grasses
Clumps of tall fescue scattered through three square canopy and/or creeping bent abundant in the groundcover.

7.06 Three square with lotus and *Carex sinclairii*
An unusual association of native and exotic freshwater wetland species together with three square, indicating a relatively recent transition from brackish to freshwater wetland hydrology. Occasional grey willow, *Juncus edgariae* and marsh ribbonwood are also present.

8.01 *Bolboschoenus caldwellii* reedland
A dense canopy of Caldwell's sedge, no other species present.

8.02 *Bolboschoenus caldwellii* with native saltmarsh species
Occasional marsh ribbonwood shrubs emerge above upper fringe of the reed canopy at some sites. Three square, oioi and sea rush may be canopy associates, while low-salinity herbfield species such as bachelor's button and native musk occur in the groundcover.

8.03 *Bolboschoenus caldwellii* with exotic grasses
Tall fescue and/or creeping bent occur with *Bolboschoenus caldwellii*. Occasional sea rush and marsh ribbonwood may also be present. Saltmarsh herbs are also often present in the groundcover: bachelor's button, selliera and orache.

8.04 *Bolboschoenus caldwellii* with spike sedge and *Lilaeopsis*
Spike sedge is the most abundant groundcover under the reed canopy, creeping bent may also be present. Herbfield/turf species such as *Lilaeopsis novae-zelandiae* and mudwort occur at low-elevation margins of the reedland; while taller rushes such as *Juncus pallidus* may be present on upper margins.

8.05 *Bolboschoenus caldwellii* with lake clubrush
Scattered clumps of lake clubrush (*Schoenoplectus tabermontani*) emergent over *Bolboschoenus caldwelli* canopy.

8.06 *Bolboschoenus caldwellii* with raupō
Clumps of raupō scattered amongst the *Bolboschoenus caldwellii* canopy.

9.01 Lake clubrush reedland
Dense stands of lake clubrush emerge from shallow water.

9.02 Lake clubrush with tall fescue

10.01 Raupō reedland
Dense raupō cover. Occasional flax, *Carex secta*, lake clubrush, and emergent cabbage tree and willows may also be present.

10.02 Raupō with *Bolboschoenus caldwellii*
More open raupō canopy; *Bolboschoenus caldwellii* abundant in understorey.

10.03 Raupō with oioi
Open raupō canopy with oioi forming the understorey.

10.04 Raupō with flax and native rush/sedges
Flax and native rush and sedge species such as oioi, baumea, *Carex sinclairii* and spike sedge occur amongst the raupō.

10.05 Raupō with flax, native rush/sedges and willow
Scattered individuals or small stands of grey willow occur amongst the raupō and native associates.

10.06 Raupō with lake clubrush

10.07 Raupō with tall fescue
Caldwell's sedge may join tall fescue in the understorey.

10.08 Raupō with scattered willows
Crack and/or grey willow shrubs and small trees are scattered through or emergent over the raupō canopy.

10.09 Raupō with creeping bent
Creeping bent dominates the reedland groundcover. Occasional scattered willow trees may also be present.

10.10 Raupō with monkey musk and peppermint
Introduced aquatic herbs, principally monkey musk (*Mimulus guttatus*) and peppermint (*Mentha* x*piperita*), dominate the raupō understorey.

Flaxland

11.01 Harakeke flaxland
Dense cover of harakeke/swamp flax, few other species present.

11.02 Harakeke flaxland with native shrubs, sedges and rushes
Native such as marsh ribbonwood, *Coprosma propinqua*, toetoe and cabbage trees are scattered amongst a more open flax canopy, with rushes and sedges in the understorey.

11.03 Harakeke with *Carex secta*
Common associated species include jointed rush, monkey musk and exotic grasses. Raupō, oioi, *Bolboschoenus caldwellii, Juncus edgariae* may also be present, with occasional grey willow shrubs and small trees at some sites.

11.04 Harakeke with exotic grass-herb groundcover

11.05 Harakeke with reed canary grass

11.06 Harakeke with willow
Shrubs and/or small trees of crack and grey willow scattered amongst swamp flax. Exotic grass, exotic herbs, native herbs in groundcover.

11.07 Harakeke with exotic shrubs
Shrubs weeds such as gorse, broom, lupin, blackberry are common associates.

Shrubland and scrub

12.01 Marsh ribbonwood shrubland
A moderate-to-dense cover of marsh ribbonwood, generally located along upper fringe of saltmarsh or in supra-tidal zone. May also occur as relict stands in what is now a terrestrial habitat. Depending on location, other natives such as swamp flax, pōhuehue vine (*Muehlenbeckia complexa* and *M. australis*), taupata (*Coprosma repens*), small-leaved coprosmas, porcupine shrub (*Melicytus alpinus*), cabbage tree, toetoe, ngaio (*Myoporum laetum*), kānuka (*Kunzea ericoides*) and silver tussock may also be present. Variable ground cover: dryland grass and herbs; sea rush etc depending on site.

12.02 Marsh ribbonwood shrubland with oioi
Marsh ribbonwood shrubland with oioi the most abundant associate. Sea rush and tall fescue are often also present in the sub-canopy, while creeping bent, orache and glasswort can occupy the ground cover.

12.03 Marsh ribbonwood with sea rush
Here sea rush is the predominant inter-shrub cover. Knobby club rush and tall fescue are generally common while flax or three square may also be present. Groundcover may include glasswort and other saltmarsh herbs, as well as creeping bent.

12.04 Marsh ribbonwood with knobby club rush

12.05 Marsh ribbonwood with saltmarsh herbfield
Stands of marsh ribbonwood on low-elevation mudflats with a sometimes sparse groundcover of saltmarsh herb species. Three square, *Bolboschoenus caldwellii* and sea rush may also be present at low abundance.

12.06 Marsh ribbonwood with exotic grass
Exotic grasses, principally tall fescue and creeping bent are the most abundant associates, although sea rush, knobby club rush and oioi can also be common. Scattered flax, native and exotic shrubs and trees such as tamarisk (*Tamarisk chinensis**) are often present in or emergent above the shrub canopy. *Leptinella dioica* is common in the groundcover at some sites. Reed canary grass is common at Wainono.

12.07 Marsh ribbonwood with gorse and lupin

Gorse is a common associate of marsh ribbonwood in the shrub canopy with lupin at some sites. Tall fescue is the main groundcover.

12.08 Marsh ribbonwood with *Coprosma propinqua*
Marsh ribbonwood and *C. propinqua* with scattered flax are canopy associates. Occasional emergent willow trees; groundcover dominated by reed canary grass. Found in northwest margin of Wainono Lagoon.

12.09 Marsh ribbonwood with sea rush and grey willow
Shrubs of grey willow scattered amongst the marsh ribbonwood-sea rush canopy. Exotic grass dominates the groundcover.

13.01 *Coprosma propinqua* shrubland
Coprosma propinqua-dominant canopy with flax the main associate species. Scattered cotoneaster (*Cotoneaster* sp.*) shrubs also present with emergent cabbage tree and willows. Found on northwest margin of Wainono Lagoon.

14.01 Mānuka scrub

15.01 Open grey and/or crack willow shrubland with native associates
Willows form a low, relatively open shrub canopy with native shrubs, swamp flax, sedge and rushes also present.

16.01 Terrestrial native shrubland
Mix of small-leaved and broadleaved shrub/tree species e.g. *Coprosma* spp., *Hoheria angustifolia, Olearia paniculata*. Exotic shrub species may be present at low abundance.

16.02 Terrestrial native small-leaved shrubland
Coprosma rigida – C. crassifolia – porcupine shrub – pōhuehue – bracken (*Pteridium esculentum) / Muehlenbeckia axillaris* – ex. grass and herbs. In coastal donga at north end of Waitaki River mouth hāpua.

16.03 Pōhuehue vineland
Muehlenbeckia complexa and/or *M. australis* are dominant cover with marsh ribbonwood, porcupine shrub, *Coprosma propinqua* also present. *Muehlenbeckia ephedroides* present at some sites. Other groundcovers are silver tussock, exotic grass and herbs.

16.04 Prostrate kōwhai (*Sophora prostrata*) shrubland

17.01 Native restoration planting
Where carried out, restoration planting is generally in exotic grassland and shrubland on the upper fringe of or above the saltmarsh/tidal influence. Commonly planted species include swamp flax, cabbage tree, toetoe, ngaio, akeake (*Dodonea viscosa*) and koromiko (*Hebe salicifolia*).

17.02 Native coastal planting
Phormium cookianum, Cortaderia richardii, Muelenbeckia astonii, M. complexa, Hebe spp*., Euphorbia glauca, Ficinia spiralis, Poa billardierei, P. cita, Festuca novae-zelandiae, Anemanthele lessoniana* on beach at near mouth of Saltwater Creek, Timaru.

18.01 Lupin-marsh ribbonwood-*Muehlenbeckia ephedroides* shrubland
Open shrubland of lupin, marsh ribbonwood and threatened *Muehlenbeckia ephedroides* ('Declining' – de Lange *et al.,* 2009) on beach barrier adjoining Wainono Lagoon. Scattered flax and gorse are also present.

19.01 Lupin shrubland
Lupin is the shrub canopy dominant, gorse, broom and boxthorn may also be present. Introduced grasses such as marram, tall fescue, creeping bent and cocksfoot are the main groundcover under the shrub canopy.

19.02 Gorse shrubland
Gorse shrub canopy with exotic grass-dominant ground cover. Associated species may include occasional flax, toetoe, pōhuehue, oioi and marsh ribbonwood in the canopy.

19.03 Gorse scrub
Dense gorse canopy cover, with occasional broom, lupin, blackberry and marsh ribbonwood may also be present.

19.04 Scotch broom and gorse shrubland
Broom is the most abundant shrub but gorse is also common. Tall fescue, creeping bent and other exotic grasses and herbs in the groundcover. Occasional toetoe, flax, marsh ribbonwood, willows and blackberry may also be present.

19.05 Blackberry scrub
Dense blackberry cover with some gorse, tall fescue and cocksfoot.

19.06 Exotic shrubland
Gorse is usually the most abundant shrub species, but broom, lupin, marsh ribbonwood, blackberry, willows, tamarisk, elder, boxthorn 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.

Treeland and Forest
20.01 Tī kōuka treeland with swamp flax
Cabbage tree/tī kōuka forms an open canopy with swamp flax the main understorey species.

20.05 Ngaio treeland
Ngaio canopy with introduced shrub and grass understorey.

21.01 Crack willow treeland with native wetland understorey
Native wetland species such as raupō, *Juncus edgariae, Carex secta, Bolboschoenus caldwellii* and spike sedge are prominent amongst the open willow canopy.

21.02 Grey willow treeland with flax
Swamp flax is abundant in understorey amongst scattered grey willow trees. Some raupō may also be present.

21.03 Grey willow forest with native understorey
Native wetland species present may include oioi, *Juncus edgariae,* baumea, swamp flax, swamp kiokio (*Blechnum novae-zelandiae*) and marsh ribbonwood.

21.04 Crack and grey willow forest with mixed native-exotic understory
A mix of native and exotic species, such as swamp flax, cabbage tree, *Coprosma propinqua, Carex secta, C. sinclairii,* baumea, rushes, cotoneaster, gorse and blackberry occur amongst the grey and crack willow canopy.

21.05 Crack and grey willow forest with tī kōuka and flax
Canopy a mix of crack and grey willow. Cabbage tree scattered though canopy; swamp flax present in understorey at some sites.

21.06 Crack willow forest
Tall crack willow canopy. Grey willow and other exotic trees such as elder may be present in the understorey, with blackberry often abundant. Scattered swamp flax and *Carex secta* persist on the forest floor at some sites.

21.07 Crack willow treeland with exotic understorey
Tall fescue and cocksfoot are the main groundcovers; blackberry, elder and gorse may be present in willow understorey.

21.08 Grey willow forest
Exotic shrubs, grasses and herbs are the main groundcovers beneath a dense grey willow canopy. Scattered crack willow, swamp flax, cabbage tree also present at some sites.

21.09 Grey willow treeland with exotic understorey
Introduced grass species dominant groundcover; tamarisk and gorse shrubs may also be present. Native rush/sedge species – *Juncus. edgariae, J. distegus,* oioi, bog rush – present at low abundance at some sites.

21.10 Willow treeland or forest with terrestrial native shrub understorey

21.11 Willow-conifer treeland with native understorey
Willows, radiata pine and macrocarpa (*Cupressus macrocarpa**) trees form an open canopy with swamp flax, marsh ribbonwood and oioi in the understorey.

21.12 Willow-conifer treeland or forest with exotic understorey
Occasional natives in canopy at some sites e.g. ngaio.

22.01 Exotic deciduous hardwood forest and treeland
One or more of the following are canopy dominants: silver poplar (*Populus alba**), black poplar (*P. nigra**), elder (*Sambucus nigra**) and oak (*Quercus* spp.*). Crack and grey willow may also be present. Gorse, broom, lupin, blackberry, tall fescue and cocksfoot comprise the understorey and groundcover.

23.01 Tamarisk treeland
Canopy of tamarisk trees and shrubs, with tall fescue-dominant ground cover.

24.01 Exotic conifer forest and treeland
Radiata pine and/or macrocarpa are the canopy species. Blackberry, tall fescue and cocksfoot occur in the groundcover with iceplant at some sites.

Fernland
30.01 Bracken fernland
Dense cover of bracken. No other species present.

Sparsely Vegetated
40.01 Sparsely vegetated with native shrubs
Scattered native shrubs e.g. porcupine shrub, *Muehlenbeckia ephedroides*, coprosmas; silver tussock; with exotic fireweed, horned poppy (*Glaucium flavum**), plantain, scarlett pimpernell (*Anagallis arvensis*), tall fescue.

40.02 Sparsely-vegetated with exotic grass, herb, shrub species

Unvegetated
100.01 Mudfield

100.02 Stonefield

100.03 Rockland

100.04 Sandfield

100.05 Open water

Appendix 3: Coastal Wetland Glossary

This glossary of coastal wetland terms is drawn from the *Wetland Types in New Zealand* glossary (Johnson and Gerbeauex, 2004)

backswamp a swamp located on a floodplain where drainage is poor behind a river levee.

bed the floor of a lake, river, or other body of open water; a growth of plants upon such a substrate; also a layer of sediment or other deposited material (e.g. shell bed).

brackish water of intermediate salinity between seawater (c. 35% marine salts) and freshwater (<5% marine salts).

braided river a river with high sediment load having numerous channels which repeatedly branch and rejoin, forming a pattern of low islands and shallow bars.

canopy the layer or layers of uppermost plant crowns in vegetation, i.e. that foliage which faces upwards to the sky and would be seen in 'bird's eye' view.

delta a fan-shaped accumulation of alluvial sediment, usually with several water channels at a river or stream mouth.

dominant cover usually one or more dominant plants (e.g. marsh ribbonwood, oioi) but sometimes a bare substrate (e.g. mud, sand).

dune slack a vegetated depression between sand dune ridges where the water table is close to or above the sand surface; or a hollow between sandbanks which periodically holds slack – or scarcely flowing – water at times of highest tides.

dystrophic water having signficant dark staining from humic matter and an associated deficiency in nutrients.

ecotone transition zone between plant communities.

emergent of aquatic plants, those which are rooted in water but have stems or foliage above the water surface; of terrestrial plants, those with a crown held above the level of the surrounding vegetation canopy.

episodic (of saturation or inundation): rarely, say once every few years.

estuarine a hydrosystem that includes the subtidal and intertidal zones of estuaries themselves, coastal river mouths, and coastal lagoons affected by the mixing of freshwater and seawater, tidal reaches of rivers, and supratidal zones of coasts affected by splash and spray. The inland boundary of the estuarine hydrosystem is where marine salt concentration measures 5%.

estuary a coastal body of water, partly enclosed by land but open to the sea, where seawater is diluted by land drainage, and where tidal effects are evident; often located at the widened funnel-shaped mouth of a river.

eutrophic nutrient-rich, fertile.

fen a wetland class: a peatland receiving inputs of water and nutrients from adjacent mineral soils, and having the water table usually close to the peat surface; fens have low to moderate acidity and nutrient status.

fernland a vegetation structural class having canopy cover of ferns 20–100%, exceeding that of any other growth form.

flaxland a vegetation structural class having canopy cover of flax (*Phormium* spp.) 20–100%, exceeding that of any other growth form.

flooding inundation by storm runoff from adjacent land, overflow from a stream or river, or the rise in water associated with tidal inflow (cf. ponding).

floodplain	alluvial land adjacent to a river which continues to be affected by flood overflows from the present river.
forest	a vegetation structural class having >80% canopy cover of trees and shrubs, with tree cover exceeding that of shrubs. Trees (including tree ferns) are those having a trunk ≥10 cm dbh (diameter at breast height); cf. treeland.
grass	a member of the grass family (Poaceae = Gramineae), the leaves having a narrow blade and a sheath clasping a rounded hollow stem.
grassland	a vegetation structural class having canopy cover of grasses 20–100%, exceeding that of any other growth form or bare ground. Tussock grasses belong in tussockland.
gravel	fragments of rock 2–60 mm in diameter.
groundwater	subsurface water that is in the saturated zone, including underground streams.
habit	the external appearance or growth form of a plant.
habitat	the environment occupied by an organism or community.
hāpua	a distinct form of gravel river-mouth lagoon associated with mixed sand and gravel coasts receiving high wave energy. The term 'hāpua' was first used by Kirk (1991) to distinguish these predominantly-freshwater and outflowing lagoons from river mouths with estuarine inflows.
herbfield	a vegetation structural class having cover of herbs 20–100%, exceeding that of any other growth form or bare ground. The herb growth form includes all herbaceous and low-growing semi-woody plants that are not separated as tussocks, ferns, reeds, rushes, sedges, grasses, cushion plants, turf, mosses, or lichens.
hydrosystem	wetland ecosystem differentiated by broad landform and hydrological settings, and by water salinity, water chemistry, and temperature.
hypersaline	having salinity in excess of 40%, i.e. higher than that of seawater (c. 35%), such as can occur where wet soils or ponded water are subject to high evaporation rates.
intermittent	(of inundation or saturation): in one or a series of wet years, but not every year.
intertidal	the shore zone of marine and estuarine waters between highest and lowest tides.
lacustrine	a hydrosystem associated with lakes and other bodies of open freshwater which are large enough to be influenced by characteristic lake processes such as permanent non-flowing deep water, fluctuating water level, and wave action.
lagoon	a shallow lake, especially one near to and permanently or intermittently connected with a river, lake, or the sea. In New Zealand most often applied to coastal lagoons impounded behind beach ridges or associated with river mouths (referred to as 'Waituna type' lagoons by Kirk and Lauder (2000)) , but the term is also used for inland examples.
lake	a large body of water surrounded by land, its major dimension generally 0.5 km or more, though smaller bodies of water can be validly referred to as lakes on the basis of depth, permanence, or local custom.
levee	an embankment of flood alluvium built up alongside a river and typically with lower-lying land behind.
littoral	the shore zone of a lake or pond between uppermost water level and the depth limit of rooted plants; also the intertidal zone of coasts.
macrophyte	a macroscopic plant, the term used mainly to distinguish relatively large aquatic plants from small algae and microscopic plants.

marine	a hydrosystem including saline open waters (c. 35% marine salts), the seabed, and the foreshore of open sea coasts.
marsh	a wetland class: a mineral wetland which may have a peat component that is periodically inundated by standing or slowly moving water; water levels may fluctuate markedly. Marshes are usually of moderate to high nutrient status.
mesotrophic	of moderate nutrient status; intermediate between oligotrophic and eutrophic.
mossfield	a vegetation structural class having cover of mosses and/or liverworts 20–100%, exceeding that of any other growth form or bare ground.
mud	a mix of silt- and/or clay-sized particles with water.
near-permanent	(of saturation or inundation): throughout the growing seasons of most years.
oligotrophic	nutrient-poor, infertile.
oxbow	a river bend returning almost upon itself, forming an oxbow lake when the bend is cut off.
palustrine	a hydrosystem of all freshwater wetlands fed by rain, groundwater, or surface water, but not directly associated with estuaries, lakes, or rivers.
permanent	(of saturation or inundation): always.
pond	a body of non-flowing freshwater, smaller than a lake but larger than a pool; natural but more often artificial.
ponding	the process of water collecting in a depression or basin (cf. flooding).
pool	a small body of still water; also a slow-flowing and relatively deep reach of a stream or river.
reed	a tall erect herb, emergent from shallow water, having unbranched leaves or stems that are either hollow or have very spongy pith. Examples include *Typha, Bolboschoenus, Schoenoplectus, Phalaris, Zizania, Baumea articulata, Eleocharis sphacelata*, and *Glyceria maxima*.
reedland	a vegetation structural class having canopy cover of reeds 20–100%, exceeding that of any other growth form or open water.
restiad	reed- or rush-like plants belonging to the family Restionaceae; the genera *Apodasmia, Empodisma*, and *Sporadanthus* occur in New Zealand.
riparian	situated along the immediate margin of a river or stream.
riverine	a hydrosystem associated with rivers, streams, and other open channels, both natural and artificial, where the dominant function is continually or intermittently flowing freshwater. Although many wetlands occupy landforms such as valley floors, floodplains, and deltas which owe their genesis to river processes, the riverine hydrosystem extends only so far as flowing channels retain a current influence, which can be defined as the extent covered by the mean annual flood.
rush	strictly, any species of the plant genus *Juncus*, but applied also to other plants of similar form (see below).
rushland	a vegetation structural class having canopy cover of rushes 20–100%, exceeding that of any other growth form or bare ground. The rush growth form is characterised by those species of *Juncus* that have stiff, erect stems or similarly non-flattened leaves, but includes members of other genera (some *Baumea* spp., *Lepidosperma australe*, *Eleocharis acuta*, *Ficinia nodosa*) of similar growth form, and all species of the restiad genera *Sporadanthus*, *Empodisma*, and *Apodasmia*. The term restiad rushland may be used for vegetation dominated by these three genera, and wire rushland for vegetation dominated by *Empodisma*.

salinity the quantity of dissolved salts in water, especially of seawater or its diluted products. Salinity is recorded, by convention, as parts per thousand (‰), i.e. grams of salts per litre of water.

saltmarsh a wetland class embracing estuarine habitats of mainly mineral substrate in the intertidal zone, but including those habitats in the supratidal zone and inland, which although non-tidal, have similar saline substrates and constancy of soil moisture.

sand grains of mineral detritus of particle size range 0.06–2 mm diameter.

scrub a vegetation structural class having canopy cover of shrubs and trees >80%, with shrub cover exceeding that of trees. Shrubs are woody plants with stems <10 cm dbh (diameter at breast height).

seasonal (of saturation or inundation): during one or more seasons of the year.

sedge a member of the sedge family (Cyperaceae).

sedgeland a vegetation structural class having canopy cover of sedges 20–100%, exceeding that of any other growth form or bare ground. The sedge growth form includes those sedges having grass-like but usually coarser leaves, especially *Carex*, *Uncinia*, *Isolepis*, *Cyperus*, *Carpha*, and *Schoenus*. Note that several sedges belong in tussockland, reedland, rushland, and cushionfield.

shallow water a wetland class: aquatic habitats with water generally less than a few metres deep, having standing water for most of the time, and including the margins of lakes, streams, rivers, and estuarine waters plus small bodies of water which may occur within or adjacent to other wetland classes.

shrubland a vegetation structural class having canopy cover of shrubs 20–80%, exceeding that of any other growth form.

soligenous a wetland where water supply is augmented by groundwater seepage or surface runoff that has been in contact with mineral materials in adjacent land and carries inputs of dissolved nutrients and often also suspended inorganic sediments.

spring a stream emerging to the surface from underground, as a single point source of groundwater discharge.

storm beach a ridge of gravel or stones piled by storm waves on the upper shore of a beach on a coast or lake.

structural class level III of the wetland classification, based on the general growth form or structure of the vegetation, or else the leading type of ground surface.

substrate the ground upon which vegetation grows or that underlying a non-vegetated wetland; a general term including rock, sediments, peat, or soil.

subsystem level IA of the wetland classification, which allows hydrosystems to be further described according to the water regime.

subtidal the shore zone of marine and estuarine hydrosystems below the level of lowest tide; permanently inundated.

supratidal the shore zone above highest tide level of marine and estuarine waters; influenced by splash and spray, and including areas inundated by storm surges.

swale an elongated depression between coastal dunes or beach ridges, aligned roughly parallel to the coast.

swamp a wetland class: a soligenous wetland, usually combining mineral and peat substrates, having moderate water flow and fluctuation, and often the presence of leads of standing water or surface channels; swamps are relatively rich in nutrients.

sward	vegetation of grasses or sedges of lawn-like stature.
temporary	(of saturation or inundation): for periods of about two weeks or less during the growing season.
tidal	influenced by rise and fall of twice-daily tides, of bimonthly spring and neap tides, or by ebb and flow in tidal reaches of rivers.
treeland	a vegetation structural class having 20–80% canopy cover of trees, tree cover exceeding that of any other growth form, but tree canopy discontinuous above lower non-woody vegetation; cf. forest.
turf	a vegetation structural type of low stature (generally <3 cm tall) of mainly herbaceous vascular plants forming a ground-hugging and often dense carpet of intertwined plants of numerous species.
tussock	a densely tufted grass or sedge >10 cm tall with fine linear leaves that arch upwards and outwards from a densely clumped base; wetland tussocks include species of *Chionochloa*, *Poa*, *Cortaderia*, *Gahnia*, *Carex*, *Cyperus*, and *Schoenus pauciflorus*.
tussockland	a vegetation structural class having canopy cover of tussocks 20–100%, exceeding that of any other growth form.
water regime	the combination of four main hydrological factors: water source, movement, fluctuation, and periodicity of wetness.
water table	the level below which a substrate is fully saturated; the term is also commonly applied in New Zealand to roadside ditches.
wetland class	level II of the wetland classification, where the units are differentiated by distinctive combinations of substrate factors, water regime, nutrient status, and pH.
wetland complex	a wetland area comprising several adjoining wetland classes, or even more than one hydrosystem; many wetland sites are complexes; likewise mire complex, pool complex, etc.
wetland form	level IIA of the wetland classification, being descriptors of landforms which wetlands occupy, or forms which they create or contain.
zonation	the distribution of organisms or vegetation types in distinctive layers or zones.

Appendix 4: Plant species recorded during Canterbury coastal wetland survey 2004-2011

Taxonomy follows: Ngā Tipu o Aotearoa – New Zealand Plants online database, Manaaki Whenua – Landcare Research (Accessed 03/02/2012)
Exotic species are indicated by *

Code	Botanical name	Common name	Synonyms
Aca mea	*Acacia mearnsii**	black wattle	*Racosperma mearnsii*
Ace pse	*Acer pseudoplatanus**	sycamore	
Ach mil	*Achillea millefolium**	yarrow	
Agr cap	*Agrostis capillaris**	browntop	
Agr sto	*Agrostis stolonifera**	creeping bent	
Air car	*Aira caryophyllea**	silvery hair grass	
Ale exc	*Alectryon excelsus*	tītoki	
Ali lan	*Alisma lanceolatum**	water plantain	
Aln glu	*Alnus glutinosa**	alder	
Alo gen	*Alopecurus geniculatus**	kneed foxtail	
Amm are	*Ammophila arenaria**	marram grass	
Ana arv	*Anagallis arvensis**	scarlet pimpernel	
Ane les	*Anemanthele lessoniana*	gossamer grass	*Oryzopsis lessoniana*
Ant odo	*Anthoxanthum odoratum**	sweet vernal	
Api pro	*Apium prostratum*	New Zealand celery	
Apo sim	*Apodasmia similis*	oioi, jointed wire rush	*Leptocarpus similis*
Art arb	*Artemisia arborescens**	hedge artemisia	
Atr pro	*Atriplex prostrata**	orache	
Azo fil	*Azolla filiculoides*	red azolla	
Bar int	*Barbarea intermedia**	wintercress	
Bau rub	*Baumea rubiginosa*	baumea	
Ble nov	*Blechnum novae-zelandiae*	kiokio, horokio, palm leaf fern	
Bol cal	*Bolboschoenus caldwellii*	grassy club sedge, purua grass, Caldwells clubrush	
Bro dia	*Bromus diandrus**	ripgut brome	
Bro hor	*Bromus hordeaceus**	soft brome	*Bromus mollis*
Bro wil	*Bromus willdenowii**	prarie grass	

Code	Botanical name	Common name	Synonyms
Bro spp	*Bromus** spp.	brome grass	
Cak edu	*Cakile edentula**	sea rocket	
Cal sol	*Calystegia soldanella*	shore bindweed, shore convolvulus, rauparaha	
Car cor	*Carex coriacea*	cutty grass, rautahi	
Car fgl	*Carex flagellifera*	Glen Murray tussock, trip me up	
Car flav	*Carex flaviformis*	yellow sedge	
Car gem	*Carex geminata*	cutty grass, rautahi	
Car lit	*Carex litorosa*	shore sedge, sea sedge	
Car pum	*Carex pumila*	sand sedge	
Car sec	*Carex secta*	pūkio, tussock sedge	
Car sin	*Carex sinclairii*	Sinclair's sedge	
Car app	*Carmichaelia appressa*	prostrate broom	
Car edu	*Carpobrotus edulis**	ice plant	
Cha pal	*Chamaecytisus palmensis**	tree lucerne, tagasaste	
Che che	*Cheiranthus cheiri**	wallflower	
Che gla	*Chenopodium glaucum*	glaucous goosefoot, coastal goosefoot	
Che alb	*Chenopodium album*	fathen	
Chr mon	*Chrysanthemoides monilifera* subsp. *monilifera**	boneseed	
Cir arv	*Cirsium arvense**	Californian thistle	
Cir vul	*Cirsium vulgare**	Scotch thistle	
Con mac	*Conium maculatum**	hemlock	
Con arv	*Convolvulus arvensis**	convolvulus	
Cop are	*Coprosma areolata*	thin-leaved coprosma	
Cop cra	*Coprosma crassifolia*	thick-leaved coprosma	
Cop pro	*Coprosma propinqua*	mingimingi	
Cop rep	*Coprosma repens*	taupata, looking glass plant, mirror plant	
Cop rig	*Coprosma rigida*	small-leaved coprosma	
Cop rob	*Coprosma robusta*	karamū	
Cop vir	*Coprosma virescens*	small-leaved coprosma	
Cor aus	*Cordyline australis*	cabbage tree, tī kōuka	
Cor jub	*Cortaderia jubata**	purple pampas grass	
Cor ric	*Cortaderia richardii*	toetoe, toi toi	*Austroderia richardii*
Cor sel	*Cortaderia selloana**	pampas grass	

Code	Botanical name	Common name	Synonyms
Cot spp.	*Cotoneaster** spp.	cotoneaster	
Cot cor	*Cotula coronopifolia*	bachelor's button, yellow buttons, water buttons	
Cot obi	*Cotyledon orbiculata* var. *orbiculata**	pigs ear	
Cra sin	*Crassula sinclairii*	Sinclair's stonecrop	
Cra mon	*Crataegus monogyna**	hawthorn	
Cre cap	*Crepis capillaris**	smooth hawksbeard	
Cri mar	*Critesion marinum**	salt barley grass	*Hordeum marianum*
Cup mac	*Cupressus macrocarpa**	macrocarpa	
Cyn cri	*Cynosurus cristatus**	crested dogstail	
Cyp era	*Cyperus eragrostis**	Umbrella sedge	
Cyt sco	*Cytisus scoparius**	Scotch broom	
Dac glo	*Dactylis glomerata**	cocksfoot	
Dis tou	*Discaria toumatou*	matagouri, wild Irishman, tūmatakuru	
Dod vis	*Dodonaea viscosa*	akeake	
Ech can	*Echium candicans**	pride of Madeira	
Ech vul	*Echium vulgare**	viper's bugloss	
Ele acu	*Eleocharis acuta*	spike sedge, sharp spike sedge	
Ely pyc	*Elytrigia pycnantha**	sea grass, sea couch	
Ely rep	*Elytrigia repens**	couch grass	
Ery ves	*Eryngium vesiculosum*	sea holly	
Eup gla	*Euphorbia glauca*	shore spurge, sea spurge, waiū-atua, sand milkweed	
Fes nov	*Festuca novae-zelandiae*	fescue tussock, hard tussock	
Fic nod	*Ficinia nodosa*	wīwī, knobby club rush, ethel sedge	*Isolepis nodosa, Scirpus nodosus*
Fic spi	*Ficinia spiralis*	pīngao	*Desmoschoenus spiralis*
Fum mur	*Fumaria muralis**	scrambling fumitory	
Gal apa	*Galium aparine**	cleavers	
Gal pal	*Galium palustre**	marsh bedstraw	
Gaz lin	*Gazania linearis**	gazania	
Gla fla	*Glaucium flavum**	horned poppy	
Gly flu	*Glyceria fluitans**	floating sweetgrass	
Gly max	*Glyceria maxima**	reed sweetgrass	
Heb sal	*Hebe salicifolia*	koromiko, hebe, kōkōmuka	*Veronica salicifolia*
Heb sp.	*Hebe* sp.	hebe	
Heb str	*Hebe strictissima*	Banks Peninsula hebe	*Veronica strictissima*

Code	Botanical name	Common name	Synonyms
Hoh ang	*Hoheria angustifolia*	houhere, narrow-leaved lacebark	
Hol lan	*Holcus lanatus**	Yorkshire fog	
Hyp cup	*Hypnum cupressiforme*	hypnum moss	
Ile mic	*Ileostylus micranthus*	green mistletoe, pirita	
Iri foe	*Iris foetidissima**	stinking iris	
Ire pse	*Iris pseudacorus**	yellow flag iris	
Iso cer	*Isolepis cernua*	slender clubrush	
Iso pla	*Isolepis cernua* var. *platycarpa**	slender clubrush	*Isolepis platycarpa*
Jun art	*Juncus articulatus**	jointed rush	
Jun cae	*Juncus caespiticius*	grass-leaved rush	
Jun dis	*Juncus distegus*	two storey rush	
Jun edg	*Juncus edgariae*	wīwī, edgars rush	*Juncus gregiflorus*
Jun eff	*Juncus effusus var. effusus**	soft rush, leafless rush	
Jun hol	*Juncus holoschoenus*	angled fruit rush	
Jun kra	*Juncus kraussii* var. *australiensis*	sea rush	
Jun pal	*Juncus pallidus*	giant rush, leafless rush	
Jun sar	*Juncus sarophorus*	fan-flowered rush	
Kun eri	*Kunzea ericoides var. ericoides*	kānuka, manuoea, titira, atitira, mānuka-rauriki	
Lac ten	*Lachnagrostis tenuis*	wind grass	*Deyeuxia billardierei var. tenuis, D. tenuis*
Lac ser	*Lactuca serriola**	prickly lettuce	
Lag ova	*Lagurus ovatus**	hares-tail	
Lem min	*Lemna minor*	common duckweed	
Lep dio	*Leptinella dioica*	turf daisy	*Cotula dioica*
Lep sco	*Leptospermum scoparium*	mānuka	
Ley are	*Leymus arenarius**	lyme grass	
Lil nov	*Lilaeopsis novae-zelandiae*	lilaeopsis	*Lilaeopsis lacustris, Lilaeopsis orbiculari*
Lim com	*Limonium companyonis**	sea lavender	
Lim lin	*Limosella lineata*	mudwort	
Lob mar	*Lobularia maritima**	alyssum	
Lol per	*Lolium perenne**	rye-grass	
Lot ten	*Lotus** spp.	lotus	
Lup arb	*Lupinus arboreus**	tree lupin	

Code	Botanical name	Common name	Synonyms
Lyc fer	*Lycium ferocissimum**	boxthorn	
Mal den	*Malva arborea**	tree mallow	*Lavatera arborea, Malva dendromorpha*
Mal syl	*Malva sylvestris**	dwarf mallow, large-flowered mallow	
Mar vul	*Marrubium vulgare**	horehound	
Mel alp	*Melicytus alpinus*	porcupine shrub	
Mel ram	*Melicytus ramiflorus*	māhoe, whitey wood	
Mel ind	*Melilotus indicus**	King Island melilot	
Men pip	*Mentha xpiperita* var. *piperita*	peppermint	
Mic pus	*Microsorum pustulatum*	hound's tounge fern ,kōwaowao, pāraharaha	*Phymatosorus diversifolius, Polypodium pustulatum*
Mim gut	*Mimulus guttatus**	monkey musk	
Mim rep	*Mimulus repens*	native musk, maori musk, native monkey flower	
Mue ast	*Muehlenbeckia astonii*	shrubby tororaro, wiggywig, mingimingi	
Mue aus	*Muehlenbeckia australis*	pōhuehue, large-leaved muehlenbeckia	
Mue com	*Muehlenbeckia complexa*	small-leaved pōhuehue, scrub pōhuehue, wire vine	
Mue eph	*Muehlenbeckia ephedroides*	leafless pōhuehue, leafless muehlenbeckia, twigs	
Myo lae	*Myoporum laetum*	ngaio	
Myr pro	*Myriophyllum propinquum*	common water milfoil	
Mry tri	*Myriophyllum triphyllum*	water milfoil	
Nas mic	*Nasturtium microphyllum**	watercress, kōwhitiwhiti, one rowed watercress	*Rorippa microphylla*
Nas off	*Nasturtium officinale**	watercress	*Rorippa nasturtium-aquaticum*
Nav squ	*Navarretia squarrosa**	Californian stinkweed	
Oen str	*Oenothera stricta**	sand primrose	
Ole pan	*Olearia paniculata*	akiraho, golden akeake	
Ose fru	*Osteospermum fruticosum**	dimorphotheca	
Par inc	*Parapholis incurva**	sickle grass	
Per hyd	*Persicaria hydropiper**	water pepper	*Polygonum hydropiper*
Per spp	*Persicaria* spp.	willow weed, knot weed	
Pha aqu	*Phalaris aquatica**	phalaris	
Pha aru	*Phalaris arundinacea**	reed canary grass	
Phl pra	*Phleum pratense**	timothy	
Pho coo	*Phormium cookianum* subsp. c*ookianum*	mountain flax, whararikí, coastal flax	*Phormium colensoi*
Pho ten	*Phormium tenax*	harakeke, swamp flax	

Code	Botanical name	Common name	Synonyms
Pin rad	*Pinus radiata**	radiata pine	
Pit ten	*Pittosporum tenuifolium*	kōhūhū, black matipo	
Pla div	*Plagianthus divaricatus*	marsh ribbonwood, saltmarsh ribbonwood, mākaka	
Pla cor	*Plantago coronopus**	buck's horn plantain	
Pla lan	*Plantago lanceolata**	narrow-leaved plantain	
Pla maj	*Plantago major**	broad-leaved plantain	
Poa bil	*Poa billardierei*	sand tussock, hinarepe, mātiatia, mātihetihe, pouaka	*Austrofestuca littoralis*
Poa cit	*Poa cita*	silver tussock	
Pol avi	*Polygonum aviculare**	wireweed	
Pol ves	*Polystichum vestitum*	pūnui, prickly shield fern	
Pol jun	*Polytrichum juniperinum*	Polytrichum, star moss	
Pop alb	*Populus alba**	silver poplar, white poplar	
Pop nig	*Populus nigra**	lombardy poplar	
Pot sp.	*Potamogeton* sp.	pondweed	
Pot ans	*Potentilla anserinoides*	silverweed	
Pru cer	*Prunus cerasifera**	cherry plum	
Pse arb	*Pseudopanax arboreus*	five-finger, whauwhaupaku	
Pte esc	*Pteridium esculentum*	bracken fern	
Puc dis	*Puccinellia distans**	reflexed salt grass	
Puc fas	*Puccinellia fasciculata**	salt grass	
Puc str	*Puccinellia stricta*	salt grass	
Que sp.	*Quercus** sp.	oak	
Rac sp.	*Racomitrium* sp.	woolly moss	
Ran amp	*Ranunculus amphitrichus*	waoriki	
Ran gla	*Ranunculus glabrifolius*	waoriki	
Ran lim	*Ranunculus limosella*	mud buttercup	
Ran mac	*Ranunculus macropus*	swamp buttercup	
Ran rep	*Ranunculus repens**	buttercup	
Ran sp.	*Ranunculus* sp.	buttercup	
Rao aus	*Raoulia australis*	scabweed, cushion daisy	
Roa mon	*Raoulia monroi*	fan-leaved mat daisy	
Ros rub	*Rosa rubiginosa**	sweet briar	
Rub fru	*Rubus fruticosus**	blackberry	
Rum ace	*Rumex acetosella**	sheeps sorel	

Code	Botanical name	Common name	Synonyms
Rum cri	*Rumex crispus**	curled dock	
Rum obt	*Rumex obtusifolius**	broad-leaved dock	
Rup spp	*Ruppia* spp.	horses mane weed, lakeweed	
Ryt spp	*Rytidosperma* spp.	danthonia	
Sal cin	*Salix cinerea**	grey willow	
Sal mat	*Salix matsudana**	tortured willow	
Sal fra	*Salix xfragilis**	crack willow	
Sam nig	*Sambucus nigra**	elder	
Sam rep	*Samolus repens*	sea primrose	
Sar qui	*Sarcocornia quinqueflora*	glasswort, ureure	
Sch aru	*Schedonorus arundinaceus**	tall fescue	*Schedonorus phoenix, Festuca arundinacea*
Sch pun	*Schoenoplectus pungens*	three-square	
Sch tab	*Schoenoplectus tabernaemontani*	kuāwa, lake clubrush	*Schoenoplectus vallidus*
Sch con	*Schoenus concinnus*	dwarf cushion sedge	
Sch pau	*Schoenus pauciflorus*	bog rush, sedge tussock	
Scl uni	*Scleranthus uniflorus*	scleranthus	
Sed acr	*Sedum acre**	stonecrop	
Sel rad	*Selliera radicans*	remuremu	
Sen ele	*Senecio elegans**	purple groundsel	
Sen glo	*Senecio glomeratus*	fireweed	
Sen lau	*Senecio lautus*	shore groundsel	
Sol lac	*Solanum laciniatum*	poroporo	
Son ole	*Sonchus oleraceus*	sow thistle, sowthistle	
Sop mic	*Sophora microphylla*	kōwhai, small-leaved kōwhai	
Sop pro	*Sophora prostrata*	kōwhai, prostrate kōwhai	
Spa ang	*Spartina anglica**	cord grass, spartina	
Spe mar	*Spergularia marina**	sea spurrey	
Spe rub	*Spergularia rubra**	sand spurrey	
Spe tas	*Spergularia tasmanica*	sea spurrey	*Spergularia media, Lepigonum tasmanicum*
Sua nov	*Suaeda novae-zelandiae*	sea blight	
Tam chi	*Tamarix chinensis**	Chinese tamarisk, tamarisk	

Code	Botanical name	Common name	Synonyms
Thi jun	*Thinopyrum junceiforme**	sand couch	
Tri rep	*Trifolium repens**	white clover	
Tri spp	*Trifolium** spp.	clover	
Tri str	*Triglochin striata*	arrow grass	
Tri ino	*Tripleurospermum inodorum**	scentless mayweed	
Typ ori	*Typha orientalis*	raupō, bullrush	
Ule eur	*Ulex europaeus**	gorse	
Urt fer	*Urtica ferox*	ongaonga, tree nettle	
Urt lin	*Urtica linearifolia*	swamp nettle	
Ver tha	*Verbascum thapsus**	woolly mullein, common mullein	
Ver ana	*Veronica anagallis-aquatica**	water speedwell	
Vic sat	*Vicia sativa**	vetch	
Vin maj	*Vinca major**	periwinkle	
Vul bro	*Vulpia bromoides**	vulpia hair grass, brome fescue, squirrel-tailed fescue	
Zos mue	*Zostera muelleri subsp. novazelandica*	eel grass	*Zostera capricorni*

Appendix 5: Threatened plant species found during coastal wetland survey and current threat status as listed by the Department of Conservation (de Lange *et al.* 2009)

Species	**Threat status**
Anemanthele lessoniana	Naturally Uncommon
Carex litorosa	Declining
Euphorbia glauca	Declining
Juncus holoschoenus var. *holoschoenus*	Nationally Critical
Mimulus repens	Naturally Uncommon
Muehlenbeckia astonii	Nationally Endangered
Muehlenbeckia ephedroides	Declining
Ranunculus limosella	Declining
Urtica linearifolia	Declining