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Broad Scale Intertidal Habitat Mapping of Waikawa Estuary



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Prepared for



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Cover photo: Waikawa Estuary (Environment Southland)

TABLE OF CONTENTS

1. INTRODUCTION.....	1
2. METHODS.....	1
2.1 Overview.....	1
2.2 Colour aerial photography.....	2
2.3 Ground-truthing of habitat features.....	2
2.4 Digitisation of habitat boundaries.....	2
3. CLASSIFICATION AND DEFINITIONS OF HABITAT TYPES.....	3
3.1 Classification of habitat features.....	3
3.2 Habitat codes and terminology.....	3
3.3 Definitions of classification Level III Structural Class.....	5
4. RESULTS AND DISCUSSION.....	6
5. OVERVIEW.....	12
6. ACKNOWLEDGEMENTS.....	12
7. REFERENCES.....	12

LIST OF TABLES

Table 1 Classification of estuarine habitat types (adapted UNEP-GRID classification).....	4
Table 2 Area of dominant habitats and substrata within Waikawa Estuary, April 2004.....	7
Table 3 Areas of dominant terrestrial vegetation mapped adjacent to Waikawa Estuary, April 2004.....	11

LIST OF FIGURES

Figure 1 The area of structural class habitats (based on dominant cover) in Waikawa Estuary.....	6
Figure 2 Broad structural habitat (vegetation and substrates)of Waikawa Estuary, April 2004.....	8
Figure 3 Colour legend and species codes for the habitat and substrate complexes identified in Waikawa Estuary.....	9
Figure 4 Detail of the dominant habitat cover within the Waikawa Estuary, April 2004 (see Figure 3 for legend).....	10

Approved for release by:
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1. INTRODUCTION

Estuarine intertidal areas play an important role in the nourishment of coastal ecosystems, linking terrestrial and marine environments and often encompassing high value ecological habitats and resources of cultural, recreational and/or commercial importance. Environment Southland (ES) are monitoring a number of estuaries in their region and the Cawthron Institute (Cawthron) has previously undertaken both broad and fine scale habitat mapping and assessment of estuaries in the Southland region (*e.g.* Jacobs River, New River, Mataura) to assist in regional strategic planning, and in the management of specific issues associated with estuarine habitat (*e.g.* resource consents, pollution, and state of the environment monitoring).

To further extend the spatial coverage of the estuaries being monitored, ES and Cawthron recently undertook broad scale mapping of the intertidal substrate and habitat complexes present in Waikawa Estuary. This report summarises the results of a detailed point-in-time, spatial survey of major habitats in the intertidal regions of Waikawa Estuary. This report includes the following components:

- A CD-ROM containing the completed habitat maps (titled “*Broad Scale Intertidal Habitat Mapping: Waikawa Estuary*”).
- A summary report (this document) which includes:
 - a methodology outline.
 - a map showing the broad scale habitats present (*e.g.* Rushland, Tussockland).
 - a map representing the pattern of dominant cover (*e.g.* *Leptocarpus similis*).
 - a summary table of major habitats and substrates within the estuary, providing the area and relative proportions of each grouping.
 - a brief summary of results for the Waikawa Estuary.

2. METHODS

2.1 Overview

The methodology used to collect data was based on the National Estuary Monitoring Protocol (Robertson *et al.* 2002) which uses field-verified broad scale mapping of habitat zones. This procedure involves the use of aerial photography together with detailed ground-truthing and digital mapping using Geographical Information System (GIS) technology. The broad scale habitat

mapping approach provides a description of the intertidal environment according to dominant habitat types based on substrate characteristics (mud, sand, cobble, rock, shellfish beds, *etc*) and the vegetation present (*e.g.* rushes, tussocks, eelgrass, seaweed, *etc*), in order to develop a baseline map of the estuary. Once a baseline map has been constructed, changes in the position and/or size of habitats (MfE Confirmed Indicators for the Marine Environment, ME6 2001) can be assessed by repeating the mapping exercise. This information can then be used to evaluate the implications of natural perturbations such as flood/climate events and human impacts such as land management practices (and related river water quantity and quality) on the structure and function of the intertidal ecosystem.

2.2 Colour aerial photography

Aerial photographs of Waikawa Estuary were taken on 1 May 1994 by Les McGraw (ES) and provided to Cawthron as a rectified “tiff” files at scales of 1:6,500 and 1:9,000.

2.3 Ground-truthing of habitat features

Aerial photographs, through different textural and tonal patterns, indicate the presence of different substrate types and their spatial extents. To identify the dominant habitat present, and confirm the boundaries between substrates, an experienced estuarine scientist (Cawthron) supported by ES staff walked over the whole estuary at low-mid tide during April 2004. Dominant habitat types, including various categories of bare and vegetated substrate were recorded directly onto laminated aerial photographs (scale 1:5,000 to 1:10,000) using the codes listed in Table 1. The upper boundary was set at MHWS (Mean High Water Spring), unless supra-littoral habitat was considered integral with the upper intertidal, in which case it was included. The lower boundary was set at MLWS (Mean Low Water Spring). Some terrestrial vegetation was also mapped to indicate where shrub, scrub, and forest areas were present around the edge of the estuary.

2.4 Digitisation of habitat boundaries

Vegetation and substrate features were then digitally mapped on-screen from the rectified photographs using Arcmap 8.3 GIS software. This procedure involved copying, as precisely as possible, the habitat features recorded on aerial photographs during the field surveys onto rectified aerial photographs within the GIS. Each drawing was then saved to a shape file (or GIS layer) associated with each specific feature. The software was then used to produce maps and calculate the area cover for each habitat type.

3. CLASSIFICATION AND DEFINITIONS OF HABITAT TYPES

3.1 Classification of habitat features

The classification of substrate and habitat features has been based on the proposed estuarine national classification system (with adaptations), which was developed under a Ministry for the Environment SMF (Sustainable Management Fund) programme (Monitoring Changes in Wetland Extent: An Environmental Performance Indicator for Wetlands) by Lincoln Environmental, Lincoln. The classification system for wetland types is based on the Atkinson System (Atkinson 1985) and covers four levels, ranging from broad to fine scale. The broad scale mapping focuses on Levels III and IV (see Table 1). Substrate classification is based on surface layers only and does not consider underlying substrate; *e.g.* gravel fields covered by sand would be classed as sand. A list of all the classification types used in the study and their codes are given in Table 1, with definitions for classification of the Level III structural class provided in Section 3.3.

3.2 Habitat codes and terminology

Dominant biota with a spatial coverage of >2m in diameter has been classified using an interpretation of the Atkinson (1985) system. In this report biota and substratum are listed in order of dominance as described below:

- Individual plant species are coded using the two first letters of their Latin species and genus names *e.g.* Pldi = *Plagianthus divaricatus* (ribbonwood), Lesi = *Leptocarpus similis* (jointed wire rush).
- _ is used to indicate subdominant species *e.g.* Lesi_Pldi = Pldi is subdominant to Lesi. The classification is based on the subjective observation of which vegetation is the dominant or subdominant species within the patch, and not on percentage cover.
- Shape files in the GIS have been labelled in the same manner as that described above.

Table 1 Classification of estuarine habitat types (adapted UNEP-GRID classification).

Level I Hydrosystem	Level IA SubSystem	Level II Class	Level III Structural Class	Level IV Dominant Cover	Habitat Code
Estuary (alternating saline and freshwater)	Intertidal/ supratidal	Saltmarsh	Shrub/Scrub/Forest	<i>Cordyline australis</i> "Cabbage tree" <i>Coprosma repens</i> "Taupata" <i>Hebe</i> spp., "Hebe species" <i>Leptospermum scoparium</i> , "Manuka" <i>Lupinus arboreus</i> , "Tree lupin" Native trees <i>Pinus radiata</i> , "Pine tree" <i>Plagianthus divaricatus</i> , "Saltmarsh ribbonwood" <i>Podocarpus totara</i> , "Totara" <i>Ulex europaeus</i> , "Gorse" <i>Plagianthus divaricatus</i> , "Saltmarsh ribbonwood"	Coau Core Hesp Lesc Luar Natr Pira Pldi Poto Uleu Pldi Casp Phte Pust Amar Fear Ungr Isce Isno Jukr Lesi Ledi Sare Saqu Sera Inwe
			Estuarine Shrubland Tussockland	<i>Carex</i> spp. "Sedge" <i>Phormium tenax</i> , "New Zealand flax" <i>Puccinella stricta</i> , "Salt grass" <i>Ammophila arenaria</i> , "Marram grass" <i>Festuca arundinacea</i> , "Tall fescue" Unidentified grass	
			Grassland	<i>Isolepis cernua</i> , "Slender clubrush" <i>Isolepis nodosa</i> , "Knobby clubrush" <i>Juncus kraussii</i> , "Searush" <i>Leptocarpus similis</i> , "Jointed wirerush"	
			Sedgeland Rushland	<i>Leptinella dioica</i> <i>Samolus repens</i> , "Primrose" <i>Sarcocornia quinqueflora</i> , "Glasswort" <i>Selliera radicans</i> , "Remuremu"	
			Herbfield	Unidentified Introduced Weeds	
			Introduced weeds	<i>Zostera</i> sp, "Eelgrass"	Zosp
			Seagrass meadow	<i>Enteromorpha</i> sp. <i>Gracilaria chilensis</i> <i>Ulva</i> sp, "Sea lettuce"	Ensp Grch Ulri
			Macroalgal bed		
			Artificial Structure	Boulder Field man-made Rock Wall man-made Sand Field man-made Bridge Wharf	BFmm RFmm SFmm BRG WHF
			Mud/sandflat	Firm shell/sand Firm sand Soft sand Mobile sand Firm mud/sand Soft mud/sand Very soft mud/sand	FSS FS SS MS FMS SM VSM
Boulderfield Rockfield Stonefield	Boulder field Rockfield Cobble field Gravel field	BF RF CF GF			
Shell bank Shellfish field	Shell bank Cocklebed Musselreef Oysterreef	Shell Cockle Mussel Oyster			
Worm field	Sabellid field	Sabellid			
	Subtidal	Water	Water		Water

3.3 Definitions of classification Level III Structural Class

- Forest:** Woody vegetation in which the cover of trees and shrubs in the canopy is >80% and in which tree cover exceeds that of shrubs. Trees are woody plants ≥ 10 cm dbh. Tree ferns ≥ 10 cm dbh are treated as trees.
- Treeland:** Cover of trees in canopy 20-80%. Trees are woody plants >10 cm dbh.
- Scrub:** Woody vegetation in which the cover of shrubs and trees in the canopy is $> 80\%$ and in which shrub cover exceeds that of trees (c.f. FOREST). Shrubs are woody plants <10 cm diameter at breast height (dbh).
- Shrubland:** Cover of shrubs in canopy 20-80%. Shrubs are woody plants <10 cm diameter at breast height (dbh).
- Tussockland:** Vegetation in which the cover of tussock in the canopy is 20-100% and in which the tussock cover exceeds that of any other growth form or bare ground. Tussock includes all grasses, sedges, rushes, and other herbaceous plants with linear leaves (or linear non-woody stems) that are densely clumped and >100 cm height. Examples of the growth form occur in all species of *Cortaderia*, *Gahnia*, and *Phormium*, and in some species of *Chionochloa*, *Poa*, *Festuca*, *Rytidosperma*, *Cyperus*, *Carex*, *Uncinia*, *Juncus*, *Astelia*, *Aciphylla*, and *Celmisia*.
- Grassland:** Vegetation in which the cover of grass in the canopy is 20-100%, and in which the grass cover exceeds that of any other growth form or bare ground. Tussock-grasses are excluded from the grass growth-form.
- Sedgeland:** Vegetation in which the cover of sedges in the canopy is 20-100% and in which the sedge cover exceeds that of any other growth form or bare ground. "Sedges have edges." Sedges vary from grass by feeling the stem. If the stem is flat or rounded, it's probably a grass or a reed, if the stem is clearly triangular, it's a sedge. Sedges include many species of *Carex*, *Uncinia*, and *Scirpus*. Tussock-sedges and reed-forming sedges (c.f. REEDLAND) are excluded.
- Rushland:** Vegetation in which the cover of rushes in the canopy is 20-100% and in which the rush cover exceeds that of any other growth form or bare ground. A tall grasslike, often hollow-stemmed plant, included in the rush growth form are some species of *Juncus* and all species of *Leptocarpus*. Tussock-rushes are excluded.
- Reedland:** Vegetation in which the cover of reeds in the canopy is 20-100% and in which the reed cover exceeds that of any other growth form or open water. If the reed is broken the stem is both round and hollow – somewhat like a soda straw. The flowers will each bear six tiny petal-like structures – neither grasses nor sedges will bear flowers, which look like that. Reeds are herbaceous plants growing in standing or slowly-running water that have tall, slender, erect, unbranched leaves or culms that are either hollow or have a very spongy pith. Examples include *Typha*, *Bolboschoenus*, *Scirpus lacustris*, *Eleocharis sphacelata*, and *Baumea articulata*.
- Cushionfield:** Vegetation in which the cover of cushion plants in the canopy is 20-100% and in which the cushion-plant cover exceeds that of any other growth form or bare ground. Cushion plants include herbaceous, semi-woody and woody plants with short densely packed branches and closely spaced leaves that together form dense hemispherical cushions.
- Herbfield:** Vegetation in which the cover of herbs in the canopy is 20-100% and in which the herb cover exceeds that of any other growth form or bare ground. Herbs include all herbaceous and low-growing semi-woody plants that are not separated as ferns, tussocks, grasses, sedges, rushes, reeds, cushion plants, mosses or lichens.
- Lichenfield:** Vegetation in which the cover of lichens in the canopy is 20-100% and in which the lichen cover exceeds that of any other growth form or bare ground.
- Seagrass meadows:** Seagrasses are the sole marine representatives of the Angiospermae. They all belong to the order Helobiae, in two families: Potamogetonaceae and Hydrocharitaceae. Although they may occasionally be exposed to the air, they are predominantly submerged, and their flowers are usually pollinated underwater. A notable feature of all seagrass plants is the extensive underground root/rhizome system which anchors them to their substrate. Seagrasses are commonly found in shallow coastal marine locations, salt-marshes and estuaries.
- Macroalgal bed:** Algae are relatively simple plants that live in freshwater or saltwater environments. In the marine environment, they are often called seaweeds. Although they contain chlorophyll, they differ from many other plants by their lack of vascular tissues (roots, stems, and leaves). Many familiar algae fall into three major divisions: Chlorophyta (green algae), Rhodophyta (red algae), and Phaeophyta (brown algae). Macroalgae are algae observable without using a microscope.
- Firm mud/sand:** A mixture of mud and sand, the surface appears brown, and many have a black anaerobic layer below. When walking on the substrate you'll sink 0-2 cm.
- Soft mud/sand:** A mixture of mud and sand, the surface appears brown, and many have a black anaerobic layer below. When walking on the substrate you'll sink 2-5 cm.
- Very soft mud/sand:** A mixture of mud and sand, the surface appears brown, and many have a black anaerobic layer below. When walking on the substrate you'll sink greater than 5 cm.
- Mobile sand:** The substrate is clearly recognised by the granular beach sand appearance and the often rippled surface layer. Mobile sand is continually being moved by strong tidal or wind-generated currents and often forms bars and beaches. When walking on the substrate you'll sink less than 1 cm.
- Firm sand:** Firm sand flats may be mud-like in appearance but are granular when rubbed between the fingers, and solid enough to support an adult's weight without sinking more than 1-2 cm. Firm sand may have a thin layer of silt on the surface making identification from a distance impossible.
- Soft sand:** Substrate containing greater than 99% sand. When walking on the substrate you'll sink greater than 2 cm.
- Stone field/Gravel field:** Land in which the area of unconsolidated gravel (2-20 mm diameter) and/or bare stones (20-200 mm diam.) exceeds the area covered by any one class of plant growth-form. Stonefields and gravelfields are named based on which form has the greater ground cover. They are named from the leading plant species when plant cover of $\geq 1\%$.
- Cobble field:** Land in which the area of unconsolidated cobbles/stones (20-200 mm diam.) exceeds the area covered by any one class of plant growth-form. Cobble fields are named from the leading plant species when plant cover of $\geq 1\%$.
- Boulder field:** Land in which the area of unconsolidated bare boulders (> 200 mm diam.) exceeds the area covered by any one class of plant growth-form. Boulderfields are named from the leading plant species when plant cover is $\geq 1\%$.
- Rock/Rock field:** Land in which the area of residual bare rock exceeds the area covered by any one class of plant growth-form. Cliff vegetation often includes rocklands. They are named from the leading plant species when plant cover is $\geq 1\%$.
- Artificial structures:** Introduced natural or man-made materials that modify the environment. Includes rip-rap, rock walls, wharf piles, bridge supports, walkways, boat ramps, sand replenishment, groynes, flood control banks, stopgates.
- Cockle bed:** Area that is dominated by primarily dead cockle shells.
- Mussel reef:** Area that is dominated by one or more mussel species.
- Oyster reef:** Area that is dominated by one or more oysters species.
- Sabellid field:** Area that is dominated by raised beds of sabellid polychaete tubes.

4. RESULTS AND DISCUSSION

The results of the broad scale survey of intertidal habitat within Waikawa Estuary are summarised in Figure 1 and Table 2, and presented graphically in Figures 2 and 4. In total, 705 Ha of estuary was mapped (Table 2), comprising 585 Ha of intertidal habitat and 120 Ha of subtidal habitat (represented as water). Within the intertidal habitat, only 6% of the estuary (41 Ha) had vegetation as the dominant cover, with the vast majority of the estuary (77%) dominated by unvegetated substrata (544 Ha).

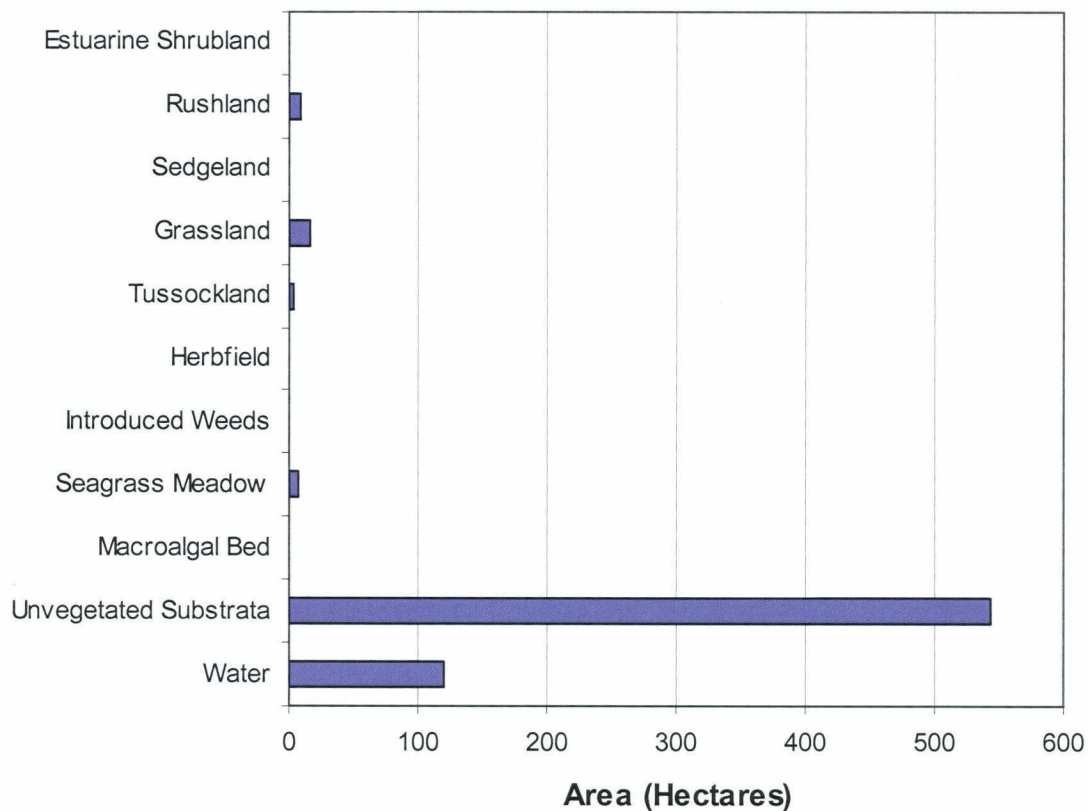


Figure 1 The area of structural class habitats (based on dominant cover) in Waikawa Estuary.

Within the unvegetated substrata, 35% (192 Ha) was classified as very soft mud, 34% (185 Ha) firm muddy sand, 13% (73 Ha) firm sand, 9% (50 Ha) soft mud/sand, and 5% (30 Ha) mobile sand. The remaining 4% (13 Ha) consisted of shell, rock, and cobble. Overall, the presence of large areas of soft mud in the upper reaches of the estuary, changing to firmer sand towards the mouth (Figure 2), indicates that fine sediments are being deposited in the upper parts of the estuary. It is not possible to determine, with the information available, whether the source of this sediment is natural or human influenced, nor whether its presence is recent or historical.

Table 2 Area of dominant habitats and substrata within Waikawa Estuary, April 2004.

ESTUARINE VEGETATION		Area	% of
Class	Dominant species	(Ha)	Total
Estuarine Shrubland		2.57	0.36
	<i>Plagianthus divaricatus</i> , "Saltmarsh ribbonwood"	2.57	0.36
Tussockland		3.61	0.51
	<i>Phormium tenax</i> , "New Zealand flax"	3.52	0.50
	<i>Puccinella stricta</i> , "Salt grass"	0.09	0.01
Grassland		16.91	2.40
	<i>Ammophila arenaria</i> , "Marram grass"	14.05	1.99
	<i>Festuca arundinacea</i> , "Tall fescue"	1.92	0.27
	Unidentified grass	0.94	0.13
Sedgeland		0.01	0.00
	<i>Isolepis cernua</i> , "Slender clubrush"	0.01	0.00
Rushland		9.25	1.31
	<i>Leptocarpus similis</i> , "Jointed wirerush"	9.25	1.31
Herbfield		1.03	0.15
	<i>Samolus repens</i> , "Primrose"	0.71	0.10
	<i>Sarcocornia quinqueflora</i> , "Glasswort"	0.24	0.03
	<i>Selliera radicans</i> , "Remuremu"	0.09	0.01
Introduced Weeds		0.51	0.07
	Introduced weeds	0.51	0.07
Seagrass Meadow		6.68	0.95
	<i>Zostera</i> sp., "Eelgrass"	6.68	0.95
Macroalgal Bed		0.62	0.09
	<i>Gracilaria chilensis</i>	0.62	0.09
Estuarine Vegetation Total		41.20	5.84
UNVEGETATED SUBSTRATA			
Class	Primary Sub-dominant	Area	% of
Boulder field		1.60	0.23
Rock field		6.46	0.92
	<i>Gracilaria chilensis</i> , <i>Enteromorpha</i> sp.	0.08	0.01
Cobble field		3.12	0.44
	Firm Muddy Sand	0.41	0.06
	Firm Sand	0.12	0.02
	<i>Gracilaria chilensis</i> , <i>Enteromorpha</i> sp.	0.59	0.08
	Rock Field	0.20	0.03
Shell bank		3.15	0.45
Mobile sand		29.50	4.18
Firm sand		72.84	10.33
	Shell Bank	1.01	0.14
Firm mud/sand		185.19	26.27
	<i>Ulva</i> sp	63.15	8.96
Soft mud/sand		49.86	7.07
Very soft mud/sand		192.24	27.27
	<i>Gracilaria chilensis</i>	0.43	0.06
Unvegetated Substrata Total		543.98	77.15
WATER		119.88	17.00
Grand Total		705.06	100.00

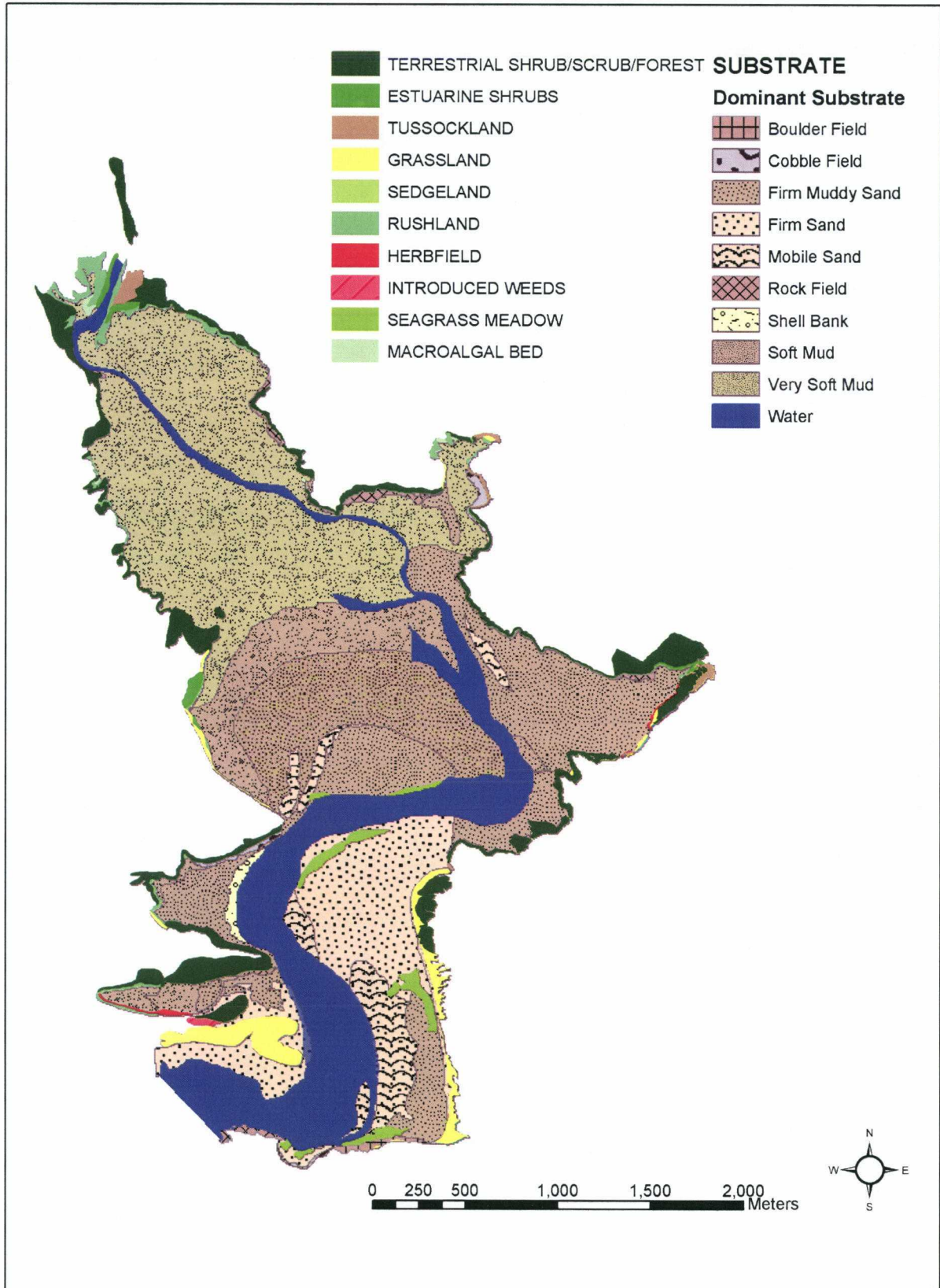


Figure 2 Broad structural habitat (vegetation and substrates)of Waikawa Estuary, April 2004.



Figure 3 Colour legend and species codes for the habitat and substrate complexes identified in Waikawa Estuary and shown in Figure 4. Species codes are listed in Table 1.

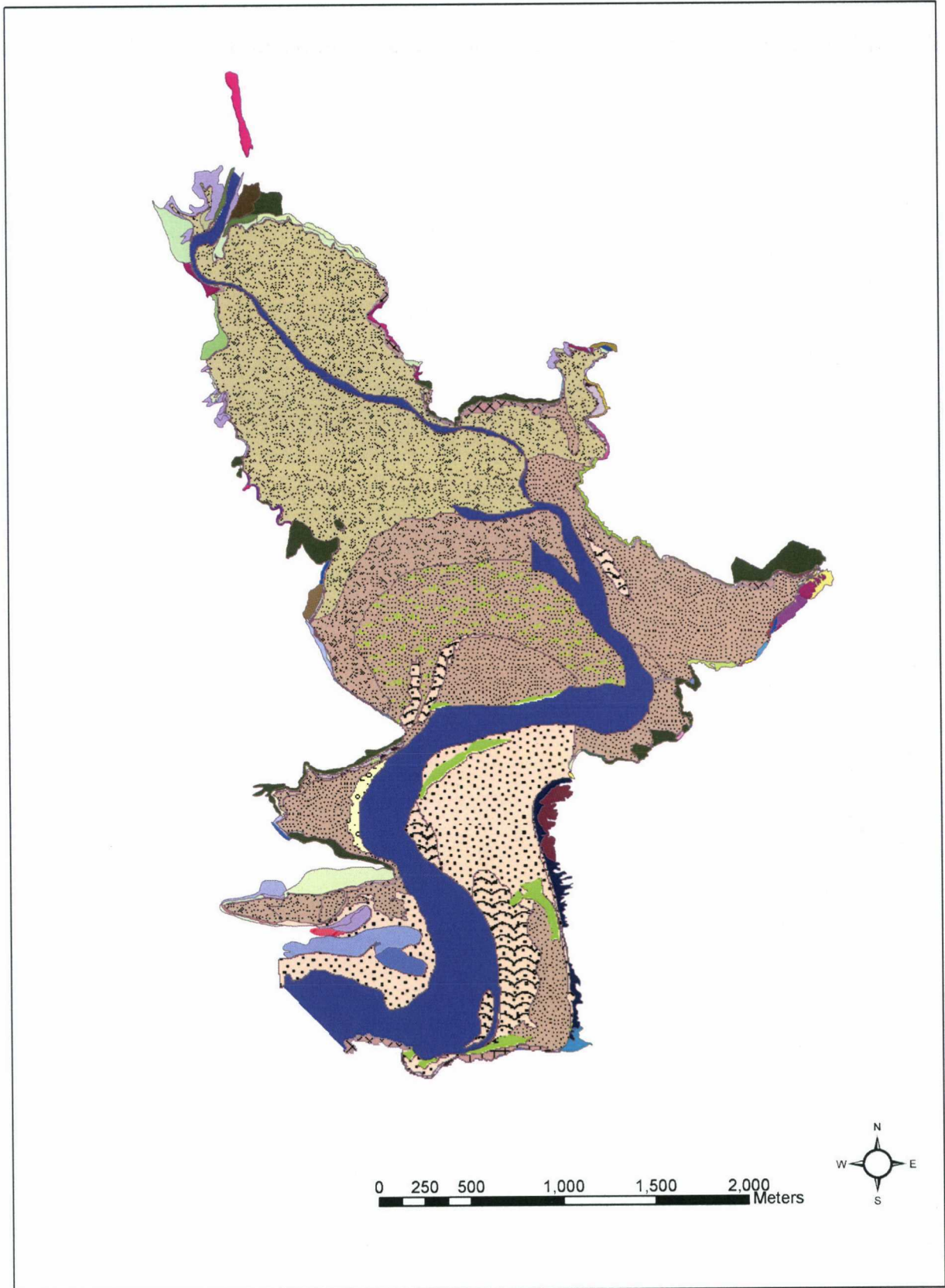


Figure 4 Detail of the dominant habitat cover within the Waikawa Estuary, April 2004 (see Figure 3 for legend).

Where vegetation was the dominant cover, Grassland was most common (17 Ha), with marram grass *Ammophila arenaria* (14 Ha) the dominant species. This was found mainly towards the mouth of the estuary. Rushland was the next most common habitat (9 Ha) located throughout the upper tidal reaches of the estuary, followed by Seagrass Meadows (7 Ha) consisting of eelgrass (*Zostera*) present only near the main channel and estuary mouth. Tussockland covered 4 Ha, providing dominant cover just on the eastern side of the estuary, but in relatively large clumps where present. Macroalgal beds (*Gracilaria*) provided a very small amount of dominant cover (0.6 Ha) in the upper part of the estuary.

Vegetation was also present as a subdominant cover within areas dominated by unvegetated substrate. When this vegetation is included in the tally, the total vegetated component of the estuary increases to 15% (105 Ha), with the increase almost entirely due to the presence of 63 Ha of *Ulva* (sea lettuce) present as a subdominant cover within firm mud/sand in the centre of the estuary (see Figure 3).

In addition to the intertidal mapping, 48 Ha of terrestrial vegetation was mapped to indicate the presence of shrub, scrub and forest cover along the riparian margin of the estuary. Extensive modification of the estuary margin was apparent through agricultural development – including drainage and bush clearance activities. However, no consistent boundary has been applied to the mapping of terrestrial areas (e.g. catchment boundaries), and mapping has not included other vegetation present such as pasture. Therefore, terrestrial estimates in Table 3 should not be directly compared to the intertidal mapping results. Most of the terrestrial vegetation was classified as being dominated by native trees (29 Ha), with manuka, *Leptospermum scoparium* (7 Ha) and gorse, *Ulex europaeus* (6 Ha) also common.

Table 3 Areas of dominant terrestrial vegetation mapped adjacent to Waikawa Estuary, April 2004.

TERRESTRIAL VEGETATION	Dominant species	Area (Ha)
Terrestrial Shrub/Scrub/Forest		48.12
	<i>Hebe</i> sp., "Hebe species"	0.14
	<i>Leptospermum scoparium</i> , "Manuka"	7.38
	<i>Lupinus arboreus</i> , "Tree lupin"	1.68
	Native trees	29.40
	<i>Pinus radiata</i> , "Pine tree"	0.17
	<i>Podocarpus totara</i> , "Totara"	2.97
	<i>Ulex europaeus</i> , "Gorse"	6.38

Full details on the vegetation and substrates present, from which the broad scale figures and tables are derived, are included on the accompanying CD-ROM, “*Broad Scale Intertidal Habitat Mapping: Waikawa Estuary*”.

5. OVERVIEW

The broad scale habitat characterisation of the Waikawa Estuary identified the following features:

- A broad range of habitats typical of well-flushed southern NZ estuaries (Robertson *et al.* 2002) with developed catchments
- An unusually large proportion of the estuary dominated by soft muds
- A moderately extensive area of macroalgal (sea lettuce - *Ulva*) growth
- Extensive modification of the estuary margin through agricultural development – including drainage and bush clearance activities

The combination of these factors suggests that this estuary receives a relatively high level of sediment and nutrient input which nourishes and provides habitat for the existing vegetation, but also resulted in a very muddy upper estuary.

6. ACKNOWLEDGEMENTS

Thanks to Les McGraw (Environment Southland) for producing and rectifying the aerial photographs, and Michelle White (Environment Southland) for her help with the ground-truthing of the habitat features. Ben Robertson (Cawthron) digitised many of the shape files, and Paul Barter (Cawthron) provided invaluable assistance with the GIS components of the work.

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