

Broad Scale Habitat Mapping of Moutere Inlet

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Prepared for



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EXECUTIVE SUMMARY

A broad scale habitat characterisation of Moutere Inlet, based on aerial photographs (collected January 2004), is reported here. A companion report describing fine scale benthic characteristics of the dominant sand flat habitat is provided in a separate report (Gillespie et al. 2006).

A general overview of the broad scale habitat features identified is as follows:

- Unvegetated habitat was dominated by firm muddy sand (66%). Soft muddy sand and firm sand were also common.
- Estuarine vegetation was dominated by rushland (51%) and herbfield (34%).
- Extensive modification of the estuary margin was evident. Roads encircle 46% of the estuary margin. The vegetated margins of the estuary were quite diverse but also show extensive modification with the presence of many exotic species such as *Ulex europaeus* (gorse) and *Pinus radiata* (radiata pine).

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1. INTRODUCTION

1.1. Background

Estuarine intertidal areas play an important role in the nourishment of coastal ecosystems, linking terrestrial and marine environments. They often encompass habitats of high ecological value and have resources of cultural, recreational and/or commercial importance. Broad scale habitat mapping can be used to assist in regional strategic planning, and in the management of specific issues associated with estuarine habitat (*e.g.* resource consents, pollution monitoring, and state of the environment monitoring).

This report summarises the results of a detailed point-in-time, spatial survey of major habitats in the intertidal regions of Moutere Inlet. A subsequent fine scale benthic assessment of the dominant habitat (carried out March 2006) is described in a companion report (Gillespie et al. 2006).

The following components are included in the present report:

A CD-ROM containing the completed habitat maps (titled “*Broad Scale Intertidal Habitat Mapping: Moutere Inlet*”).

A summary report (this document) which includes:

- a methodology outline,
- a map showing the broad scale habitats present (*e.g.* Rushland, Tussockland),
- a summary table of major habitats and substrates within the estuary, providing the area and relative proportions of each grouping, and
- a brief summary of results for the Moutere Inlet.

1.2. Study area

The Moutere Inlet is located approximately 24 km northwest of Nelson near the town of Motueka (Figure 1). It is a bar-built, tidal estuary open to the sea at two locations (Port Motueka and the north western end of Kina Peninsula). Having near-complete drainage at low tide, it encompasses a total intertidal area of 713 ha (Spencer & Westcott 1980). The intertidal habitats are characterised by open mud flats fringed with salt marsh in peripheral regions, and productive sand flats in central regions that are colonised by microalgae and in some areas macroalgae or eelgrass.

Considerable modification/infilling of peripheral intertidal and supratidal habitats has occurred in past years in conjunction with roading development. State Highway 60, along the inland estuary margin, cuts access of these embayments to tidal flushing or creates partial flow restrictions with consequent reduction of estuary ecosystem function. Wharf Road cuts across the top (Moutere) end of the inlet with significant flow restriction resulting in partial ponding of tidal waters and nutrient retention (Gillespie et al. 2005). These historical changes in the areas of saltmarsh are likely to have been ecologically significant.

The Inlet receives a relatively small freshwater input from the Moutere River (~1280 litres/s) and a number of smaller inflow streams with a total mean flow of ~450 litres/s (Gillespie et al. 1995). Sources of freshwater nutrients and the enrichment status of benthic habitats in the estuary are described by Gillespie et al. (1995) in a detailed assessment of the Moutere Inlet ecosystem. Further background and historical ecological information may be obtained from references cited in that report.

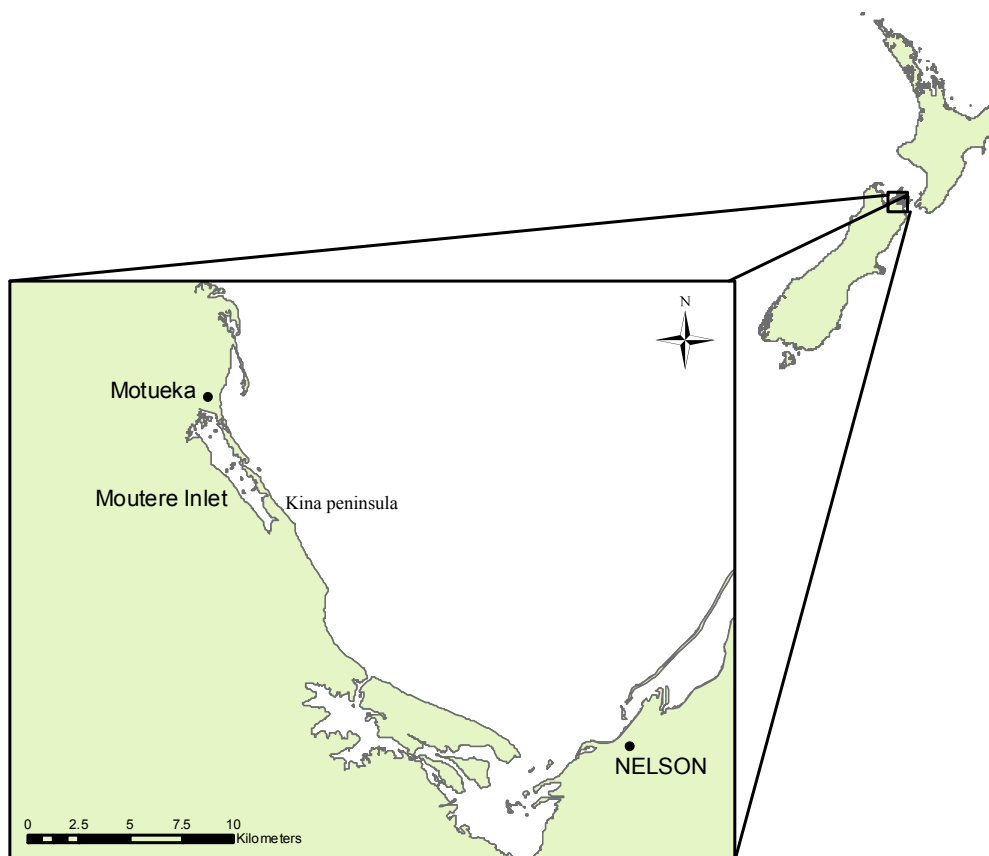


Figure 1. Moutere Inlet.

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 Moutere Inlet were taken on 17 January 2004 by Pete Inwood (TDC) and provided to Cawthron as rectified “tif” files at scales of 1:10,000.

2.3. Ground-truthing of habitat features

Aerial photographs, through different textural and tonal patterns, indicate the presence and spatial extent of different substrate and vegetation types. To identify the dominant habitat present and confirm the boundaries between substrates, in situ surveys were undertaken over the whole estuary at low-mid tide. 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). A 10 m wide riparian strip was also mapped to indicate the type of habitat surrounding the edge of the estuary.

2.4. Digitisation of habitat boundaries

Vegetation and substrate features were digitally mapped from the rectified photographs using Arcmap 9.0 GIS software. This procedure involved copying, as precisely as possible, the field-verified habitat features onto rectified aerial photographs within the GIS. The software was then used to produce maps and calculate the area cover of each habitat type.

3. CLASSIFICATION AND DEFINITIONS OF HABITAT TYPES

3.1. Classification of habitat features

The classification of substrate and habitat features is 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 > 2 m in diameter was 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).
- Subdominant species are indicated by a _; *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.
- Individual features 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>Beilschmiedia tawa</i> "Tawa" <i>Cordyline australis</i> "Cabbage tree" <i>Cytisus scoparius</i> "Broom" <i>Dodonea viscosa</i> "Akeake" Exotic scrub/shrub/trees <i>Knightia excelsa</i> "Rewarewa" <i>Leptospermum scoparium</i> , "Manuka" <i>Metrosideros excelsa</i> " Pohutukawa" <i>Myoporum laetum</i> "Ngaio" Native scrub/shrub/trees <i>Paraserianthes lophantha</i> " Brush wattle" <i>Pinus radiata</i> , "Pine tree" <i>Plagianthus divaricatus</i> , "Saltmarsh ribbonwood" <i>Ulex europaeus</i> , "Gorse"	Beta Coau Cysc Dovi Esst Knex Lesc Meex Myla Nsst Palo Pira Pldi Uleu		
			Estuarine Shrubland	<i>Plagianthus divaricatus</i> , "Saltmarsh ribbonwood"	Pldi		
			Tussockland	<i>Carex</i> spp. "Sedge" <i>Cortaderia selloana</i> "Pampas grass" <i>Cortaderia</i> sp. "Toetoe" <i>Phormium tenax</i> , "New Zealand flax"	Casp Cose Cosp Phte		
			Grassland	<i>Festuca arundinacea</i> , "Tall fescue" Unidentified grass	Fear Ungr		
			Sedgeland	<i>Cyperus eragrostis</i> "Umbrella sedge" <i>Schoenoplectus pungens</i> "Three-square"	Cyer Scpu		
			Rushland	<i>Isolepis nodosa</i> , "Knobby clubrush" <i>Juncus kraussii</i> , "Searush" <i>Leptocarpus similis</i> , "Jointed wirerush"	Isno Jukr Lesi		
			Reedland	<i>Typha orientalis</i> "Raupo"	Tyor		
			Herbfield	<i>Carpobrotus edilis</i> "Ice Plant" <i>Samolus repens</i> , "Primrose" <i>Sarcocornia quinqueflora</i> , "Glasswort" <i>Selliera radicans</i> , "Remuremu" <i>Suaeda novae-zelandiae</i> "Sea Blite"	Caed Sare Saqu Sera Suno		
			Introduced weeds	Unidentified Introduced Weeds	Inwe		
				Seagrass meadow	Seagrass meadow	<i>Zostera</i> sp, "Eelgrass"	Zosp
				Macroalgal bed	Macroalgal bed	<i>Enteromorpha</i> sp. <i>Gracilaria chilensis</i> <i>Ulva</i> sp, "Sea lettuce"	Ensp Grch Ulri
				Artificial Structure	Man-made structure Road Wharf		MM Road WHF
				Mud/sandflat	Firm sand Soft sand Mobile sand Firm mud/sand Soft mud/sand Very soft mud/sand		FS SS MS FMS SM VSM
				Stonefield	Cobble field Gravel field		CF GF
				Shellfish field	Cocklebed		Cockle
	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 diameter at breast height (dbh). Tree ferns ≥ 10 cm dbh are classified as trees.

Treeland: Cover of trees in canopy 20-80%. Trees are woody plants > 10cm 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 (cf. FOREST). Shrubs are woody plants < 10 cm dbh.

Shrubland: Cover of shrubs in canopy 20-80%. Shrubs are woody plants < 10 cm dbh.

Duneland: Vegetated sand dunes in which the cover of vegetation in the canopy (commonly Spinifex, Pingao or Marram grass) is 20-100% and in which the vegetation cover exceeds that of any other growth form or bare ground.

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 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 (cf. 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. 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. The flowers will each bear six tiny petal-like structures – neither grasses nor sedges will bear flowers. Examples include *Typha*, *Bolboschoenus*, *Scirpus lacustris*, *Eleocharis spachelata*, 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 identified 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 class 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 will 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 will 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 will 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 will 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 will 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 primarily by 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 oyster species.

Sabellid field: Area that is dominated by raised beds of sabellid polychaete tubes.

4. RESULTS AND DISCUSSION

A total of 762 hectares of the Moutere Inlet was mapped. Of the total area 7.5% (57.4 ha) was subtidal at the time the aerial photographs were taken. The remaining intertidal area 88% (704.4 ha) was predominantly unvegetated (Figure 2). A detailed description of the area covered by the dominant habitats and substrata is presented in Tables 2 and 3. A GIS-based map of broad habitat groupings is presented in Figure 3.

Where vegetation was the dominant cover, Rushland was the most common classification (51%, 43.0 ha), with *Juncus kraussii* (Searush) the dominant species. This was found mainly along the western margins and at both the northern and southern ends of the estuary. Also very common was Herbfield (34%, 29.1 ha), dominated by *Sarcocornia quinqueflora* (Glasswort). This was found in patches throughout the estuary but particularly at the northern end. The estuarine vegetation in Moutere Inlet was quite diverse with most classifications of vegetation present including Grassland, Tussockland, Reedland, Sedgeland and Estuarine Shrubs. Where macroalgal beds were present they were dominated by *Gracilaria chilensis*. Some small patches of *Ulva* sp. were also found but were always within a more dominant substrate. Only a very small area (1%, 0.9 ha) of Seagrass meadow (*Zostera* sp.) was present.

Within the unvegetated substrata 66% (410.5 ha) was made up of firm muddy sand, 11% (68.14 ha) soft muddy sand, 8% (51.5 ha) was classified as firm sand, 3.9% (24.2 ha) very soft muddy sand, 3.8% (23.7 ha) cobble field, 3.5% (22 ha) gravel field and 3% (18.9 ha) mobile sand. The remaining 0.2% (1.12 ha) was a mixture of cockle beds, sabellid fields and man-made structures (*e.g.* wharf).

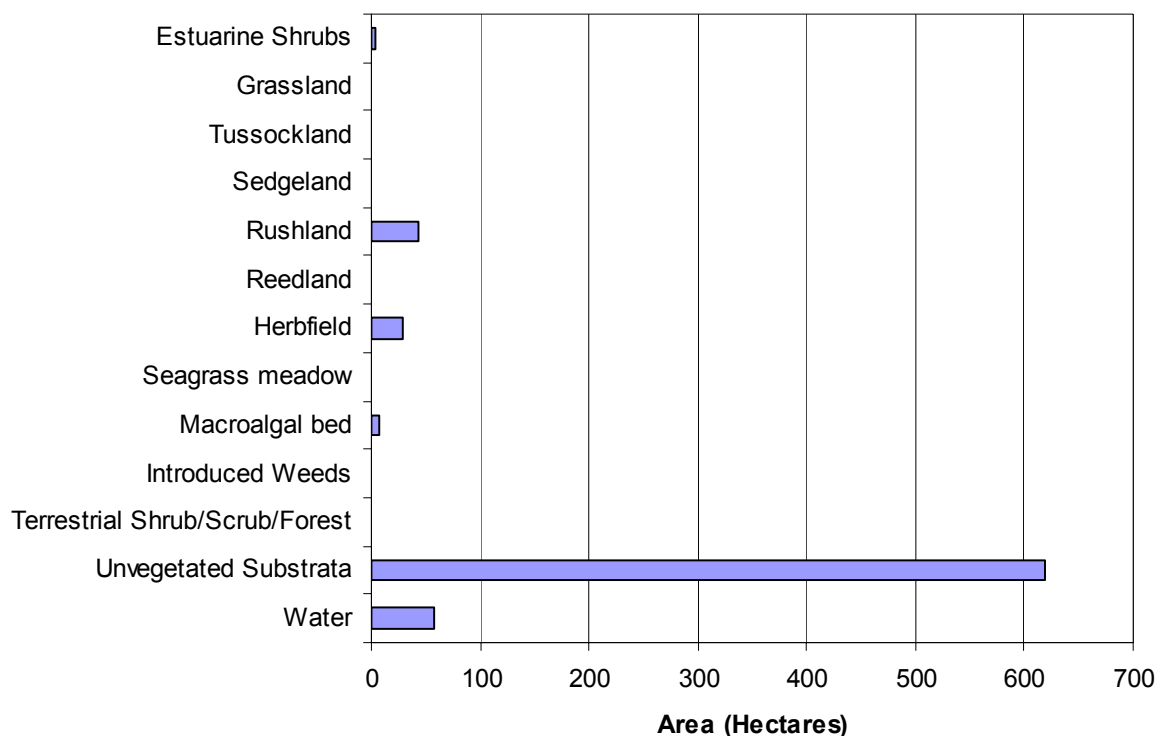


Figure 2. The area of structural class habitats (based on dominant cover) in Moutere Inlet.

Table 2. Area of dominant habitats within Moutere Inlet, 2006.

ESTUARINE VEGETATION				
Class	Dominant Species	Primary Sub-dominant	Area (Ha)	% of Total
Terrestrial Shrub/Scrub/Forest			1.25	1.5
	<i>Knightsia excelsa</i> (Rewarewa)	<i>Sarcocornia quinqueflora</i> (Glasswort)	0.65	0.8
	<i>Leptospermum scoparium</i> (Manuka)		0.16	0.2
		<i>Metrosideros excelsa</i> (Pohutukawa)	0.35	0.4
	<i>Ulex europaeus</i> (Gorse)		0.10	0.1
Estuarine Shrubs			2.98	3.5
	<i>Plagianthus divaricatus</i> (Saltmarsh ribbonwood)		0.39	0.5
		<i>Festuca arundinacea</i> (Tall fescue)	1.05	1.2
		<i>Isolepis nodosa</i> (Knobby clubrush)	0.02	0.0
		<i>Juncus kraussii</i> (Searush)	0.67	0.8
		<i>Leptocarpus similis</i> (Jointed wirerush)	0.34	0.4
		<i>Suaeda novaezelandiae</i> (Sea blite)	0.15	0.2
		Unidentified grass	0.36	0.4
Grassland			0.35	0.4
	<i>Festuca arundinacea</i> (Tall fescue)		0.35	0.4
Herbfield			29.08	34.4
	<i>Carpobrotus edulis</i> (Ice Plant)	<i>Juncus kraussii</i> (Searush)	0.02	0.0
	<i>Sarcocornia quinqueflora</i> (Glasswort)		19.15	22.7
		<i>Carpobrotus edulis</i> (Ice Plant)	0.20	0.2
		<i>Festuca arundinacea</i> (Tall fescue)	0.18	0.2
		Gravel field	0.25	0.3
		<i>Isolepis nodosa</i> (Knobby clubrush)	1.22	1.4
		<i>Juncus kraussii</i> (Searush)	1.60	1.9
		<i>Knightsia excelsa</i> (Rewarewa)	0.39	0.5
		<i>Leptocarpus similis</i> (Jointed wirerush)	0.02	0.0
		<i>Plagianthus divaricatus</i> (Saltmarsh ribbonwood)	0.09	0.1
		<i>Samolus repens</i> (Primrose)	2.64	3.1
		<i>Suaeda novaezelandiae</i> (Sea blite)	3.32	3.9
	<i>Suaeda novaezelandiae</i> (Sea blite)	<i>Sarcocornia quinqueflora</i> (Glasswort)	0.01	0.0
Tussockland			0.27	0.3
	<i>Carex</i> spp. (Sedge)	<i>Plagianthus divaricatus</i> (Saltmarsh ribbonwood)	0.27	0.3
Rushland			42.99	50.9
	<i>Isolepis nodosa</i> (Knobby clubrush)		3.40	4.0
		<i>Festuca arundinacea</i> (Tall fescue)	0.92	1.1
		<i>Leptocarpus similis</i> (Jointed wirerush)	0.33	0.4
		<i>Sarcocornia quinqueflora</i> (Glasswort)	1.44	1.7
		Unidentified grass	0.03	0.0
	<i>Juncus kraussii</i> (Searush)		20.69	24.5
		<i>Carpobrotus edulis</i> (Ice Plant)	0.02	0.0
		<i>Festuca arundinacea</i> (Tall fescue)	0.05	0.1
		<i>Isolepis cernua</i> (Slender clubrush)	0.01	0.0
		<i>Leptocarpus similis</i> (Jointed wirerush)	1.22	1.4
		<i>Plagianthus divaricatus</i> (Saltmarsh ribbonwood)	0.19	0.2
		<i>Sarcocornia quinqueflora</i> (Glasswort)	11.87	14.0
		<i>Suaeda novaezelandiae</i> (Sea blite)	0.02	0.0
		<i>Typha orientalis</i> (Raupo)	1.72	2.0
	<i>Leptocarpus similis</i> (Jointed wirerush)		0.11	0.1
		<i>Isolepis nodosa</i> (Knobby clubrush)	0.95	1.1
		<i>Sarcocornia quinqueflora</i> (Glasswort)	0.02	0.0
Reedland			0.09	0.1
	<i>Typha orientalis</i> (Raupo)	<i>Plagianthus divaricatus</i> (Saltmarsh ribbonwood)	0.09	0.1
Sedgeland			0.22	0.3
	<i>Schoenoplectus pungens</i> (Three-square)		0.19	0.2
		Gravel field	0.03	0.0
Introduced Weeds			0.06	0.1
	Unidentified introduced weeds		0.06	0.1
Seagrass meadow			0.91	1.1
	<i>Zostera</i> sp (Eelgrass)		0.91	1.1
Macroalgal bed			6.34	7.5
	<i>Gracilaria chilensis</i>	Firm mud/sand (0-2cm)	0.11	0.1
		Soft mud/sand (2-5cm)	6.23	7.4
GRAND TOTAL			84.54	100.0

Table 3. Area of dominant substrata within Moutere Inlet, 2006.

UNVEGETATED SUBSTRATA				
Class	Dominant Substrata	Primary Sub-dominant	Area (Ha)	% of Total
Cobble field			23.67	3.8
	Cobble field		7.41	1.2
		Firm sand (<1cm)	8.35	1.3
		<i>Sarcocornia quinqueflora</i> (Glasswort)	1.23	0.2
		Cockle bed	6.68	1.1
Gravel field			21.96	3.5
	Gravel field		20.29	3.3
		<i>Carpobrotus edulis</i> (Ice Plant)	0.57	0.1
		<i>Sarcocornia quinqueflora</i> (Glasswort)	0.73	0.1
		<i>Ulva</i> spp (Sea lettuce)	0.37	0.1
Firm mud/sand (0-2cm)			410.53	66.2
	Firm mud/sand (0-2cm)		400.43	64.6
		Gravel field	0.17	0.0
		Cockle bed	9.93	1.6
Firm sand (<1cm)			51.49	8.3
	Firm sand (<1cm)		32.79	5.3
		Cockle bed	18.70	3.0
Mobile sand (<1cm)			18.86	3.0
	Mobile sand (<1cm)		15.96	2.6
		Cockle bed	2.37	0.4
		<i>Ulva</i> spp (Sea lettuce)	0.53	0.1
Soft mud/sand (2-5cm)			68.07	11.0
	Soft mud/sand (2-5cm)		46.60	7.5
		<i>Gracilaria chilensis</i>	18.70	3.0
		Cockle bed	0.88	0.1
		<i>Ulva</i> spp (Sea lettuce)	1.89	0.3
Very soft mud/sand (>5cm)			24.21	3.9
	Very soft mud/sand (>5cm)		7.80	1.3
		<i>Gracilaria chilensis</i>	16.41	2.6
Cockle bed			1.10	0.2
	Cockle bed	Firm mud/sand (0-2cm)	1.10	0.2
Sabellid field			0.021	0.0
	Sabellid field		0.021	0.0
Man-made structures			0.003	0.0
	Wharf		0.003	0.0
GRAND TOTAL			619.9	100
OVERALL SUMMARY - MOUTERE INLET				
		Area (Ha)		% of Total
	Water (subtidal)		57.38	7.5
	Unvegetated Substratum		619.92	81.4
	Estuarine Vegetation		84.54	11.1
GRAND TOTAL			761.84	100

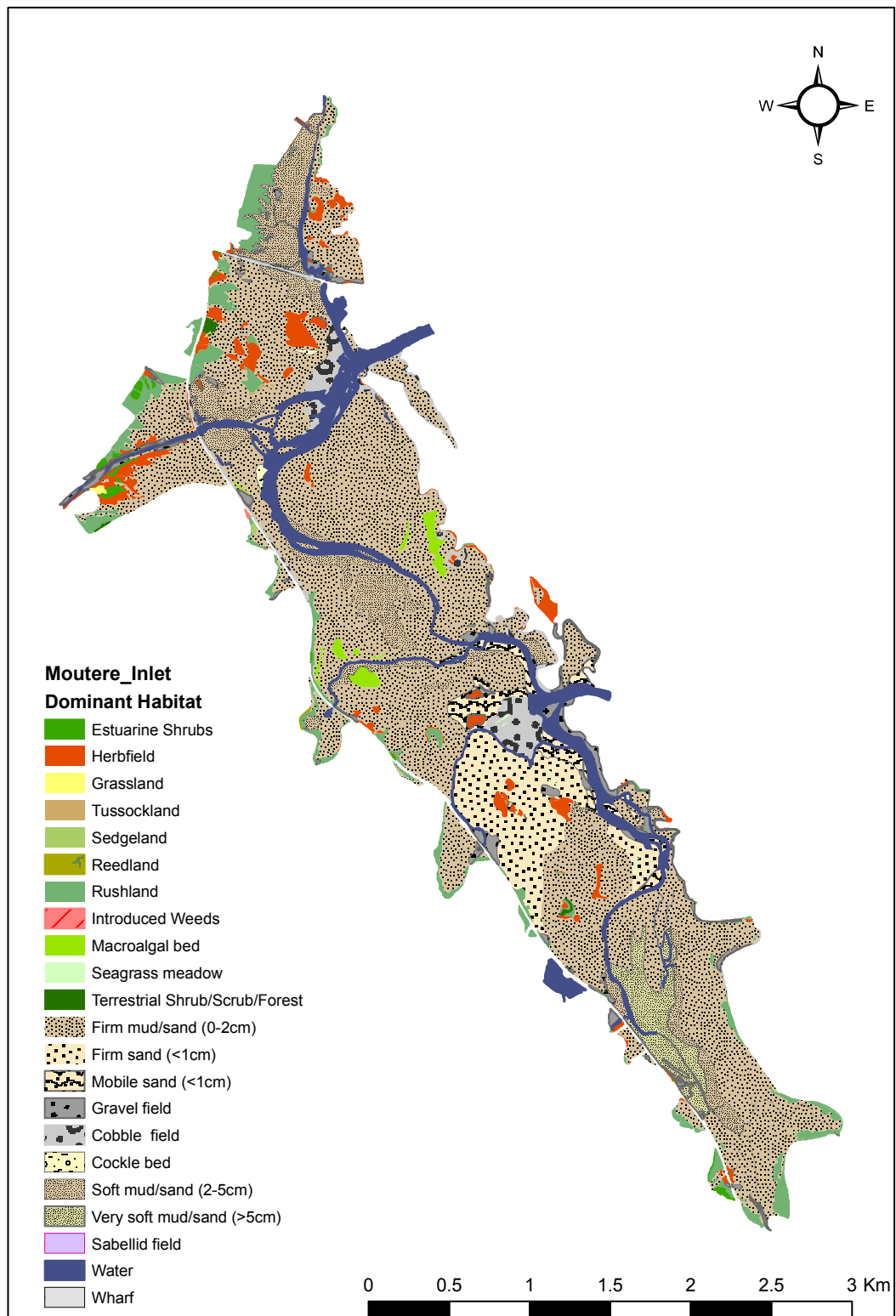


Figure 3. Broad structural habitat (vegetation and substrates) of Moutere Inlet, 2006.

The type of habitat immediately bordering the estuary is summarised in Table 4 and presented in Figure 4. Extensive modification of the land surrounding the estuary is evident. The most significant impact has most likely been the road, which has formed a barrier between the estuary itself and much of the low-lying surrounding land. The road covers 46% of the estuary margin, particularly on the western side.

Table 4. Riparian habitat surrounding Moutere Inlet.

Habitat Border Class	Dominant Species	%
Terrestrial Shrub/Scrub/Forest		28.9
	<i>Beilschmiedia tawa</i> (Tawa)	0.8
	<i>Cordyline australis</i> (Cabbage tree)	2.1
	<i>Myoporum laetum</i> (Ngaio)	1.8
	<i>Pinus radiata</i> (Pine tree)	8.7
	<i>Ulex europaeus</i> (Gorse)	3.6
	Exotic scrub/shrub/trees	11.0
	Native scrub/shrub/trees	0.9
Estuarine Shrubs		1.1
	<i>Plagianthus divaricatus</i> (Saltmarsh ribbonwood)	1.1
Grassland		6.4
	Unidentified grass	6.4
Herbfield		10.9
	<i>Carpobrotus edulis</i> (Ice Plant)	10.9
Reedland		2.1
	<i>Typha orientalis</i> (Raupo)	2.1
Rushland		0.7
	<i>Juncus kraussii</i> (Searush)	0.4
	<i>Leptocarpus similis</i> (Jointed wirerush)	0.3
Tussockland		1.4
	<i>Cortaderia selloana</i> (Pampas grass)	0.4
	<i>Phormium tenax</i> (New Zealand flax)	1.0
Unvegetated		48.6
	Road	45.8
	Man-made structure	1.8
	Firm mud/sand (0-2cm)	0.9
GRAND TOTAL		100.0

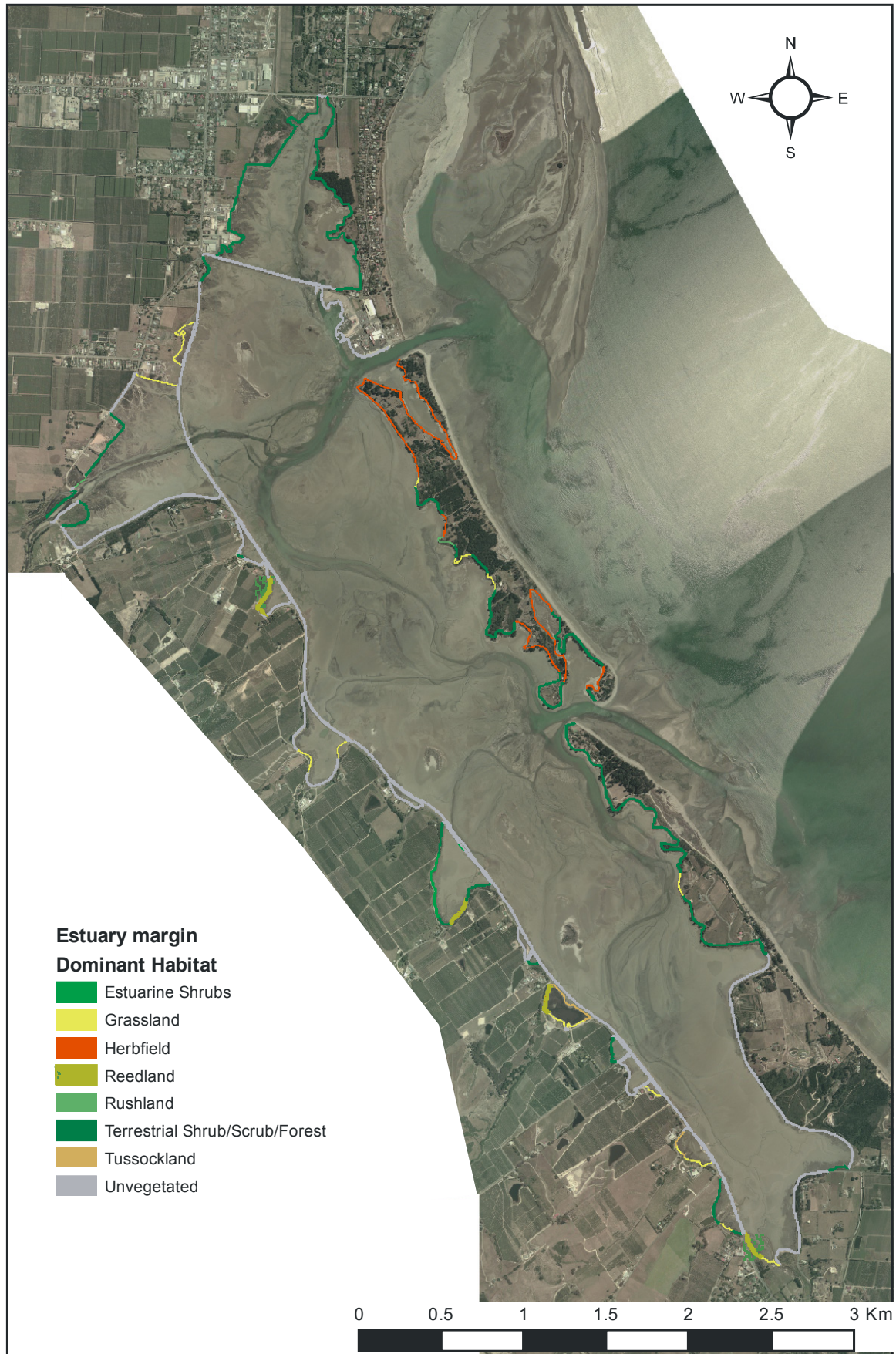


Figure 4. Habitat features surrounding Moutere Inlet.

For the purposes of the broad-scale study undertaken here, it was not practical to map each stratum of vegetation, and therefore only dominant species have been recorded. For simplicity, only the dominant vegetation types are shown in Figure 4 and Table 4 above. However, the estuary margins are much more complex. While almost half the estuary margin is unvegetated (48.6%), the vegetated boundaries are quite diverse. The margin tends to be stratified with species such as *Carpobrotus edulis* (ice plant) and *Juncus kraussii* (Searush) found adjacent to the high tide mark, grasses and small scrub (e.g. *Ulex europaeus* (gorse)) growing higher up and larger trees including *Pinus radiata* (radiata pine) dominating further up the shore.

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

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