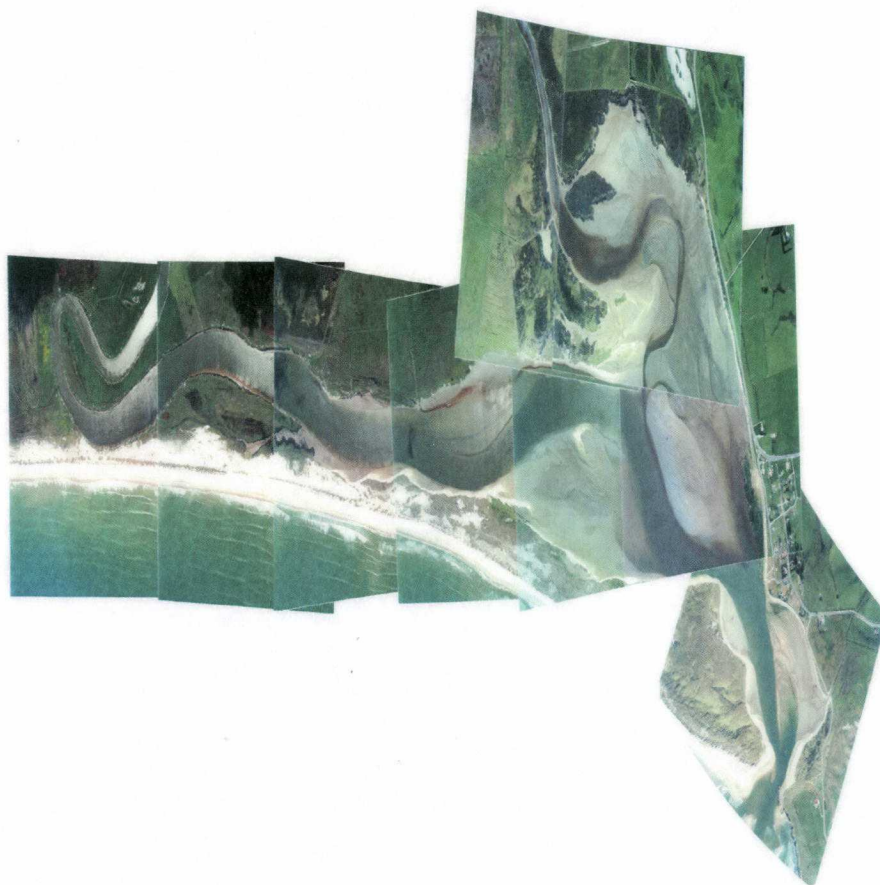


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7 OCT 2013
13:00:00



Broad Scale Mapping of Fortrose Estuary Intertidal Habitats



Prepared for





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Environment Southland

by

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Cover Photograph: Aerial photograph mosaic of Fortrose Estuary (Dec 2002).

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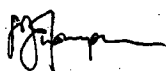
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This document is accompanied by the CD-ROM called “*Estuary Habitat Maps Fortrose and Jacobs River*” containing the completed habitat maps, Arcview™ extensions and ReadMe File.

Report reviewed by:



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1. INTRODUCTION

Estuarine intertidal and delta systems of large rivers are known to play an important role in the nourishment of coastal ecosystems, providing a link between terrestrial and marine environments (Gillespie, 1983). They also often encompass high value ecological habitats and resources of cultural, recreational and/or commercial importance.

A detailed point-in-time, spatial survey of major habitats of the Fortrose Estuary intertidal region was undertaken using a methodology known as broad-scale habitat mapping. The results of this investigation are reported here as an output of the 2002-2003 Environment Southland, State of Environment Monitoring Programme. The report includes the following components:

- A CD-ROM (called “*Estuary Habitat Maps Fortrose and Jacobs River*” containing the completed habitat maps).
- A summary report (this document) which includes:
 - a methodology outline,
 - a map describing the general structural class distribution of habitats (*e.g.* rushland),
 - a map representing the pattern of dominant cover (*e.g.* *Leptocarpus similis*),
 - a summary table comparing the areas of major habitats,
 - a table providing the area and relative proportions of the habitat groupings and
 - a brief summary of results.

2. AIM

The aim of the broad-scale habitat mapping was to describe the intertidal environment according to different dominant habitat types based on surface features of substrate characteristics (mud, sand, cobble, *etc*) and vegetation type (mangrove, eelgrass, salt marsh species, *etc*), in order to develop a baseline map. 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. This procedure involves the use of aerial photography together with detailed ground-truthing and digital mapping using Geographical Information System (GIS) technology. An outline of the approach is provided in detail in Robertson *et al.* (2002) and in summary below.

3. METHODS

3.1 Colour aerial photography

The photograph used for the Fortrose Estuary study was taken on 25 November 2002 by Les McGraw (Environment Southland) and provided to us as a rectified tiff file at a scale of 1:4,200.

3.2 Classification of habitat features

The classification of the features follows the proposed national classification system (with adaptations), which was developed under a Ministry of 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;

- Level I: Hydrosystem (*e.g.* intertidal river delta)
- Level II: Wetland Class (*e.g.* saltmarsh, mud/sand flat, macroalgal bed)
- Level III: Structural Class (*e.g.* marshland, mobile sand, cobble)
- Level IV: Dominant Cover (*e.g.* *Leptocarpus similis*)

Substrate classification was based on surface layers only and does not consider underlying substrate; *e.g.* cobble or gravel fields covered by sand would be classed as sand flat. The classification of habitats in the current study was based on Level III and Level IV. A list of all the classification types used in the study and their codes are given in Table 1, followed by the definitions for classification of the Level III structural class. Further detail is provided in Section 4.

Table 1. Adapted Estuarine components of UNEP-GRID classification

Level I Hydrosystem	Level IA Sub-System	Level II Wetland Class	Level III Structural Class	Level IV Dominant Cover	Habitat Code
River delta (alternating saline and freshwater)	Intertidal/ supratidal	Saltmarsh	Grassland	<i>Ammophila arenaria</i> , "Marram grass" <i>Elytrigia pycnanph</i> , "Sea couch" <i>Festuca arundinacea</i> , "Tall fescue" <i>Paspalum distichum</i> , "Mercer grass"	Amar Elpy Fear Padi
			Herbfield	<i>Apium prostratum</i> , "Native celery" <i>Cotula coronopifolia</i> , "Bachelor's button" <i>Leptinella dioica</i> <i>Plantago coronopus</i> , "Buck's-horn plantain" <i>Samolus repens</i> , "Primrose" <i>Sarcocornia quinqueflora</i> , "Glasswort" <i>Selliera radicans</i> , "Remuremu" <i>Suaeda novae-zelandiae</i> , "Sea blite" <i>Triglochin striata</i> , "Arrow-grass"	Appr Coco Ledi Plco Sare Saqu Sera Suno Trst

Level I Hydrosystem	Level IA Sub-System	Level II Wetland Class	Level III Structural Class	Level IV Dominant Cover	Habitat Code
			Reedland	<i>Glyceria maxima</i> , "Reed sweetgrass" <i>Spartina anglica</i> , "Cord grass" <i>Spartina alterniflora</i> , "Smooth cord grass" <i>Typha orientalis</i> , "Raupo"	Glma Span Spal Tyor
			Rushland	<i>Baumea juncea</i> , "Bare twig rush" <i>Isolepis nodosa</i> , "Knobby clubrush" <i>Juncus artoiculatus</i> , "Jointed rush" <i>Juncus effuses</i> , "Softrush" <i>Juncus kraussii</i> , "Searush" <i>Juncus pallidus</i> , "Pale rush" <i>Leptocarpus similis</i> , "Jointed wirerush" <i>Wilsonia backhousei</i>	Baju Isno Juar Juef Jukr Jupa Lesi Wiba
			Sedgeland	<i>Cyperus eragrostis</i> , "Umbrella sedge" <i>Cyperus ustulatus</i> , "Giant umbrella sedge" <i>Eleocharis sphacelata</i> , "Bamboo spike-sedge" <i>Isolepis cernua</i> , "Slender clubrush" <i>Schoenoplectus pungens</i> , "Three-square" <i>Avicennia marina var. resinifera</i> , "Mangrove" <i>Cordyline australis</i> , "Cabbage tree" <i>Cytisus scoparius</i> , "Broom" <i>Leptospermum scoparium</i> , "Manuka" <i>Plagianthus divaricatus</i> , "Saltmarsh ribbonwood" <i>Ulex europaeus</i> , "Gorse"	Cyer Cyus Els Isce Scpu Avre Coau Cysc Lesc Pldi Uleu
			Scrub		
			Tussockland	<i>Cortaderia</i> sp., "Toetoe" <i>Phormium tenax</i> , "New Zealand flax" <i>Poa</i> , "Silver tussock" <i>Puccinella stricta</i> , "Salt grass" <i>Stipa stipoides</i> , "Needle tussock"	Co sp Phte Poa Pust Stst
		Seagrass meadows	Seagrass meadow	<i>Zostera</i> sp., "Eelgrass"	Zo sp
		Macroalgal bed	Macroalgal bed	<i>Enteromorpha</i> sp. <i>Gracilaria chilensis</i> <i>Ulva</i> sp., "Sea lettuce"	En sp Grch Ulri
		Mud/sandflat	Firm shell/sand (<1cm) Firm sand (<1cm) Soft sand Mobile sand (<1cm) Firm mud/sand (0-2cm) Soft mud/sand (2-5cm) Very soft mud/sand (>5cm)		FSS FS SS MS FMS SM VSM
		Stonefield Boulderfield Rockland Shell bank Shellfish field	Gravel field Cobble field Boulder field Rockland Shell bank Cocklebed Musselreef Oysterreef		GF CF BF RF Shell Cockle Mussel Oyster
		Worm field	Sabellid field		Sabellid
	Subtidal	Water	Water		Water

3.3 Ground-truthing of habitat features

Field surveys were undertaken to verify photography, and identify dominant habitat and map boundaries. The approach involved an experienced estuarine scientist plus a technician walking over the whole estuary at low-mid tide during the period December 2002, identifying the dominant habitats and their boundaries and recording these as codes on aerial images at a scale of approximately 1:5,000 or 1:10,000. For the purposes of this intertidal survey, the upper boundary was set at MHWS (Mean High Water Spring), however in some areas supra-littoral habitat was included where it was considered integral with the upper intertidal. The lower boundary was set at MLWS (Mean Low Water Spring). The substrate types and their spatial extents were confirmed by field verification of the textural and tonal patterns identified on the aerial photographs. The codes and list of dominant habitat types, including various categories of bare and vegetated substrate, are shown in Table 1.

3.4 Digitisation of habitat boundaries

Vegetation and substrate features were then digitally mapped on-screen from the rectified photographs using the Arcview™ software package 'image analysis' extension. This procedure required using the mouse to draw habitat boundaries overlaid on rectified aerial photographs on the computer screen, as precisely as possible, around the features identified from the field surveys. Each drawing was then saved to a shape file or GIS layer associated with each specific feature. To calculate the area cover for a chosen habitat type, the Arcview 'X-tools' extension was used. This provides the area of any selected features in hectares.

4. CLASSIFICATION AND DEFINITIONS OF HABITAT TYPES

4.1 Habitat codes and terminology

The identified vegetation patches were classified using an interpretation of the Atkinson (1985) system (Table 1), described below:

- The individual plant species have been coded by using the two first letters of their Latin species and genus names *e.g.* Pldi = ribbonwood, *Plagianthus divaricatus*.
- / separates canopy vegetation *e.g.* Pldi/Lesi (ribbonwood is taller than jointed wire rush).
- - separates vegetation with approximately the same height *e.g.* Lesi-Jukr (jointed wire rush is the same height as searush).

- () are used for subdominant species e.g. (Pldi)/Lesi = dominant cover is jointed wire rush and subdominant cover is ribbonwood. The use of () is not based on percentage cover but the subjective observation of which vegetation is the dominant or subdominant species within the patch.
- The classification always starts with the tallest vegetation type and works down e.g. (Pldi/Baju)/Lesi-Jukr = a patch with a dominant cover of jointed wire rush and searush (which are of the same height) with a subdominant cover of ribbonwood and *Baumea juncea* (which are taller than the dominant cover).

4.2 Definitions of classification Level III Structural Class

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.

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. Example include *Typha*, *Bolboschoenus*, *Scirpus lacustris*, *Eleocharis sphacelata*, and *Baumea articulata*.

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.

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. Included in the sedge growth form are many species of *Carex*, *Uncinia*, and *Scirpus*. Tussock-sedges and reed-forming sedges (c.f. REEDLAND) are excluded.

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).

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 > 10 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*.

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.

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 that can be seen without the use of 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.

Stonefield/gravelfield: 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. The appropriate name is given depending on whether stones or gravel form the greater area of ground surface. Stonefields and gravelfields are named from the leading plant species when plant cover of $\geq 1\%$.

Boulderfield: Land in which the area of unconsolidated bare boulders (> 200mm 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 $\geq 1\%$.

Rockland: 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 $\geq 1\%$

Cocklebed: Area that is dominated by primarily dead cockle shells.

Musselreef: Area that is dominated by one or more mussel species.

Oysterreef: Area that is dominated by one or more oysters species.

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

5. RESULTS

The broad-scale survey of intertidal habitats in the Fortrose Estuary (see accompanying CD-ROM for details) produced a total mapped area (intertidal and subtidal) of 497 ha (Table 2 and Figure 1) of which 265 ha was classified as intertidal. The survey indicated that the intertidal area was dominated by unvegetated habitat (37% of the total estuary area, covering 177 ha). The majority of the unvegetated habitat was classified as firm mud/sand (126 ha), and the remainder consisted of a variety of habitats including firm sand, soft mud, mobile sand, gravel and cobble.

Table 2. Area of Dominant Habitats in Fortrose Estuary, December 2002.

Habitat Type	Area (ha)	% Total Area
Scrubland	6.03	1.21
<i>Plagianthus divaricatus</i>	6.03	1.21
Rushland	47.385	9.53
<i>Leptocarpus similis</i>	47.162	9.48
<i>Plagianthus divaricatus - Leptocarpus similis</i>	0.223	0.04
Herbfield	0.851	0.17
<i>Samolus repens</i>	0.232	0.05
<i>Selliera repens</i>	0.619	0.12
Grassland	27.514	5.53
<i>Festuca arundinacea</i>	25.814	5.19
<i>Ammophila arenaria</i>	1.7	0.34
Tussockland	5.715	1.15
<i>Phormium tenax</i>	2.2	0.44
<i>Puccinella stricta</i>	3.515	0.71
Unvegetated	177.401	35.66
Soft Mud	15.811	3.18
Firm Sand	18.194	3.66
Gravel Field	8.16	1.64
Firm Mud/Sand	126.272	25.38
Mobile Sand	8.897	1.79
Cobble Field	0.067	0.01
Macroalgal Bed	0.429	0.09
<i>Enteromorpha</i> sp	0.044	0.01
<i>Gracilaria chilensis</i>	0.385	0.08
Water	232.115	46.66
Total Area of Estuary	497.44	

The vegetated habitats covered 87 ha (approximately 18% of the total estuary area), dominated by rushland (mostly by *Leptocarpus similis* - jointed wirerush) covering approximately 10% of total estuary area. Other habitats of significance included grassland (dominated by *Festuca arundinacea* - tall fescue) and scrubland (dominated by *Plagianthus divaricatus* - saltmarsh ribbonwood). There

were also minor areas of tussocks and herbfields. The broad scale map from which Figures 1, 2 and 3 are derived is included on the CD-ROM, "*Estuary Habitat Maps Fortrose and Jacobs River*".

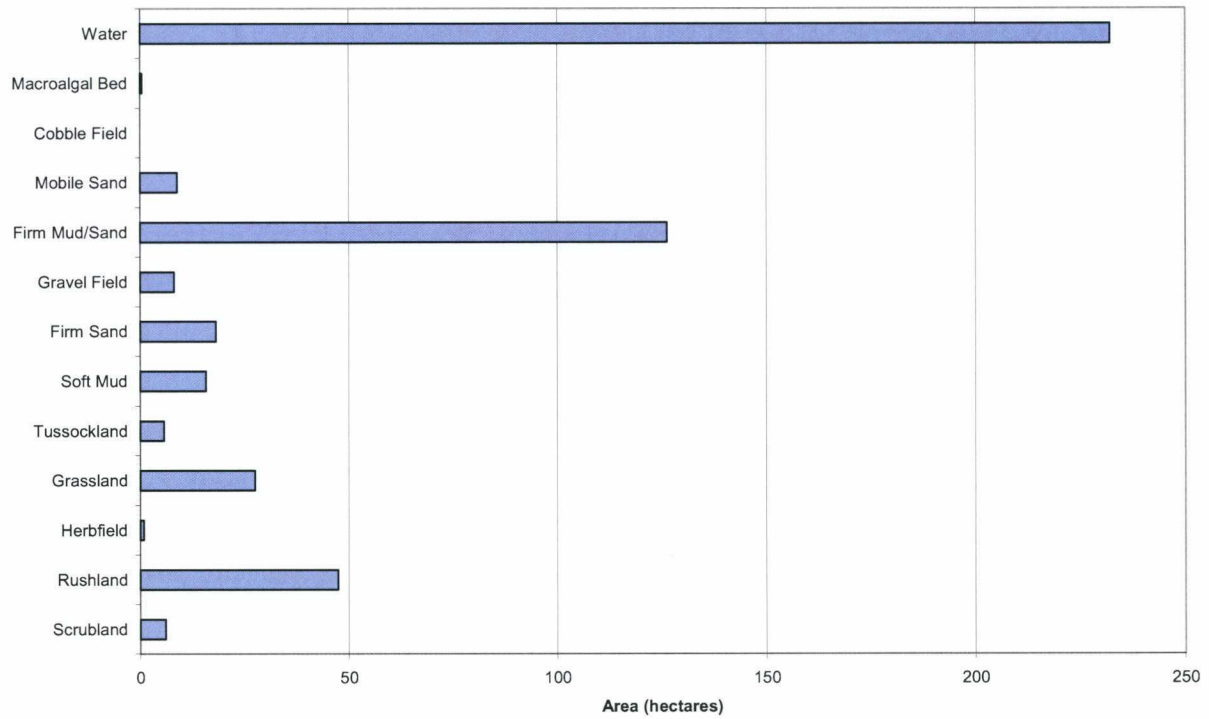


Figure 1. The areas of selected structural class habitats of the Fortrose Estuary



Figure 2. Structural habitat of the Fortrose Estuary

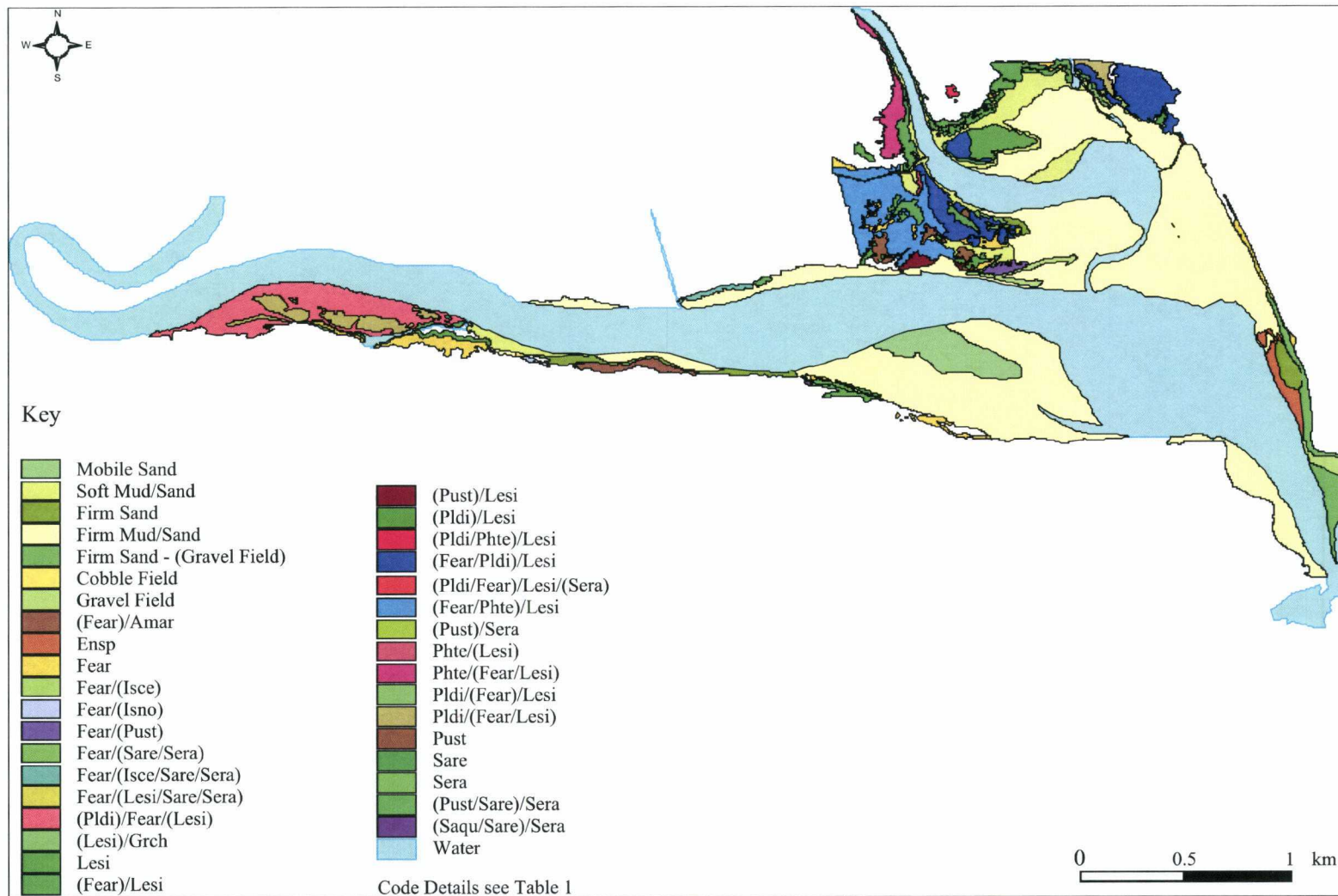


Figure 3. Dominant cover habitat of the Fortrose Estuary

6. ACKNOWLEDGEMENTS

Thanks to Les McGraw (Environment Southland) for producing and rectifying the aerial photographs, Michelle White (Environment Southland) for her help with the ground-truthing of the habitat features and to Stephanie Thompson (Cawthron) for reviewing this report.

7. REFERENCES

- Atkinson, I.A.E. 1985. Derivation of vegetation mapping units for an ecological survey of Tongariro National Park North Island, New Zealand. *New Zealand Journal of Botany* 23: 361-378
- Gillespie, P.A. 1983. Tidal nutrient exchange in Delaware Inlet. In Gillespie, P.A. (Ed) Nutrient Processing and Biomass Production in New Zealand Estauries. *Water and Soil Miscellaneous Publication 60*. Wellington, Ministry of Works and Development. 4-6.
- Robertson, B.M.; Gillespie, P.A.; Asher, R.A.; Frisk, S.; Keeley, N.B.; Hopkins, G.A.; Thompson, S.J.; Tuckey, B.J. 2002. *Estuarine Environmental Assessment and Monitoring: A National Protocol*. Part A. Development, Part B. Appendices, and Part C. Application. Prepared for supporting Councils and the Ministry for the Environment, Sustainable Management Fund Contract No. 5096. Part A. 93p. Part B. 159p. Part C. 40p plus field sheets.

