Habitat Mapping of the Catlins Estuary

Otago Regional Council State of the Environment Report

Prepared by

Ryder Consulting

January 2009

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ecology + planning + project management

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Cover photo: Amphibola crenata on mudflats at the head of Catlins Estuary.

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Table of Contents

1. Introduction

The Otago Regional Council (ORC) has identified a need to gather information on the biological resources of river estuaries present within Otago to assist in both strategic planning and in the management of specific issues associated with resource consents, pollution, and state of the environment monitoring.

The Catlins Estuary, also called Catlins Lake or Catlins Lake Estuary, is considered to be of regional, national, or international importance in terms of its ecological, scenic, spiritual and/or cultural values. As such it is designated as a Coastal Protection Area (CPA31) under the Otago Regional Council's Regional Plan: Coast. Note that maps in Schedule 2 of the Plan refer to the Catlins Lake Estuary as CPA30, not CPA31, with CPA31 being Jacks Bay. The Catlins Estuary also has significant recreational value (boating, swimming, fishing and walking) and as such is designated CRA15 under the Otago Regional Council's Regional Plan: Coast. It is recognised that there is the potential for adverse effects on the intertidal ecosystem of this estuary from sedimentation, runoff, discharges, stormwater, recreational use and alterations to the stream processes.

To gather robust baseline data against which future changes may be compared a comprehensive estuarine environmental assessment is essential. Such an assessment will comprise broad and fine scale mapping.

The ORC has engaged Ryder Consulting to carry out the estuary mapping.

2. Objectives

To carry out broad and fine scale mapping of the Catlins Estuary in accordance with the National Estuary Monitoring Protocol and produce a report outlining:

1) The methodology used in the mapping and sampling programme and any problems encountered.
2) A record of the references cited and used to assist in the sampling.
3) Photographs of all the sites surveyed.
4) MapInfo GIS maps of all the surveyed areas with dominant cover habitats shown and sampling site locations.
5) A discussion for each fine-scale site of the fauna and flora identified and any nationally or regionally significant species, and any other information relevant

to the Client.

6) An identification of the pressures at each site that will become part of the sensitivity matrix.
7) A set of recommendations on the most suitable method(s) for resource management of identified problems.

Broad scale mapping is a robust GIS-based methodology for mapping the spatial distribution of intertidal estuarine habitats and consists of:

I. Visiting each site to record and ground-truth the key habitat types and substrate features on rectified aerial photographs supplied by the Client.
II. Providing a subjective assessment of the ecological health and vulnerabilities from pressures (human influences). This information will become part of the sensitivity matrix.
III. Digitising habitat and substrate features into MapInfo or other suitable GIS software.

Fine-scale mapping involves measuring environmental characteristics that are known to be indicative of estuary or coastal condition, and are likely to provide a means for detecting habitat degradation, as well as providing a measure of subsequent change. In other words, fine-scale mapping examines the spatial variation and inter-relationships of a suite of commonly measured indicators and consists of:

I. Selecting at least two representative sites within the dominant intertidal habitat.
II. Taking replicate sediment samples at each site and analysing for known important variables.

3. Methodology

3.1 Broad scale mapping

Aerial photographs, supplied by the ORC, were used to generate base maps of vegetation and substrata within the estuary. The photographs were ground truthed by Ryder Consulting staff during field surveys using obvious landmarks and a handheld Garmin GPS unit. A minimum of six landmarks were identified and used, in conjunction with GIS software, to rectify each aerial photograph in an attempt to keep on-ground spatial errors to <5m.

Field surveys were conducted on foot by an experienced coastal marine scientist to verify vegetation and substrate types, and to identify features not distinguishable through aerial photography alone. Using GPS and 100m measuring tapes, the spatial extent of all substrate and habitat features encountered in the field was transcribed to hard copies of photographs/maps with locations accurately defined in relation to obvious landmarks. Positional accuracy was recorded by calculating the root mean square (RMS) error for each landmark. Hard copies of maps and photographs were to be digitised to enable transfer of data to a GIS computer program. However, all images supplied by the ORC were in digital format and this was, therefore, unnecessary. All sites/features visited in the field were digitally photographed.

Classification for wetland types was based on the Atkinson System (Atkinson 1985) that covers four levels, ranging from broad to fine-scale. The broad-scale mapping to be carried out for this project focused on Levels III and IV (below).

Level I Hydrosystem (*e.g.* intertidal estuary)
Level II Wetland Class (*e.g.* saltmarsh, mud/sand flat)
Level III Structural Class (*e.g.* marshland, mobile sand)
Level IV Dominant Cover (*e.g. Zostera muelleri*)

Substrate classification was based on surface layers only and did not consider underlying substrate; e.g., cobble or gravel fields covered by sand were classed as sand flat.

Level III structural classes formed the basis of the broad scale mapping and are detailed below.

Definitions of Classification of Level III Structural Class – Estuaries (from Robertson et al. *2002*).

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 lacutris, 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 grass like, 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. Sedges include many species of *Carex, Uncinia,* and *Scirpus*. Tussock-sedges and reed-forming sedges (c.f. REEDLAND) are excluded.
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.
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*.
Shrubland: Cover of shrubs in canopy 20-80%. Shrubs are woody plants <10 cm diameter at breast height (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).
Treeland: Cover of trees in canopy 20-80%. Trees are woody plants >10cm dbh.
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 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.
Gravel field: Land in which the area of unconsolidated gravel (2-20 mm diameter) exceeds the area covered by any one class of plant growth-form. Gravel fields are named from the leading plant species when plant cover of = 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 is =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 =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 = 1%

During the field visit to the estuary any obvious environmental pressures were noted. A simple risk assessment matrix (Table 1) was used to define the level of concern associated with different environmental pressures on habitats encountered and a colour ranking (red = high, green = low) was used to indicate risk or level of concern. The use of letters and numbers (A1 – D4) enables further definition of the drivers for the level of concern based on the percentage of the resource affected and the likely recovery time. For example if an environmental pressure affects say 30% of the area and the area would take approximately 3 years to recover from that impact a risk of B3 would be assigned for that pressure (e.g. see Table 1). It is important to note that the matrix does not confirm the presence of an impact, merely the presence of pressures and possible consequences of that pressure on the environment.

Table 1. *Risk assessment matrix for evaluating levels of concern regarding habitat pressures at each site. Red = high; yellow = moderate concern; green = low.*

		Recovery from impact			
		(Slow) >10 years	5-10 years	1-4 years	(Rapid) <1 year
% of habitat affected		1	2	3	4
>50% (Large)	A	A1	A2	A3	A4
30-50%	B	B1	B2	B3	B4
10-30%	C	C1	C2	C3	C4
0-10% (Small)	D	D1	D2	D3	D4

The environmental pressures identified during this survey include:

- Flooding
- Introduced weeds
- Nutrient pollution
- Stormwater
- Vehicles
- Wind blown and deliberately dumped litter and other items
- Stock
- Erosion
- Reclamation

This report gives a broad overview of the activities that may influence the environmental quality within the estuary, and possible significance of each.

3.2 Fine scale mapping

Although the Catlins Estuary is one of the larger estuaries in Otago and while the substrate at the head of the upper estuary (Catlins Lake) differs from that in the lower estuary, it is, overall, relatively uniform within each part of the estuary. Consequently just two representative sites were selected within the lower estuary, based on broad scale mapping and field observations. The sites were located in the mid- to low-water zone within the dominant habitat type, taking care to avoid channels and areas of significant vegetation. Each site comprised an area 60m x 30m divided into 12 sub-areas (Figure 1). Within each sub-area a randomly selected plot was sampled as follows:

1 **Sediment core profiles** (and depth of Redox Discontinuity Layer):

- One randomly positioned 80mm diameter core was collected to a depth of at least 100mm from each plot.

- The core was extruded onto a white plastic tray, labelled, and photographed alongside a ruler for scale.
- The stratification of colour and texture, particularly the occurrence of any black (anoxic) zones, was used to assess the depth of any lighter-coloured surface layer - the depth of the Redox Discontinuity Layer (RDL).

2. **Epifauna** (surface-dwelling animals):

- Epifauna was assessed from one randomly placed 0.25m^2 quadrat within 1m of the core sample in each plot. All animals observed on the sediment surface were identified and counted, and any visible microalgal mat development noted. The species, abundance and related descriptive information were recorded on specifically designed, waterproof field data sheets containing a checklist of expected species.
- Field notes were transferred to a spreadsheet or database for statistical analyses.

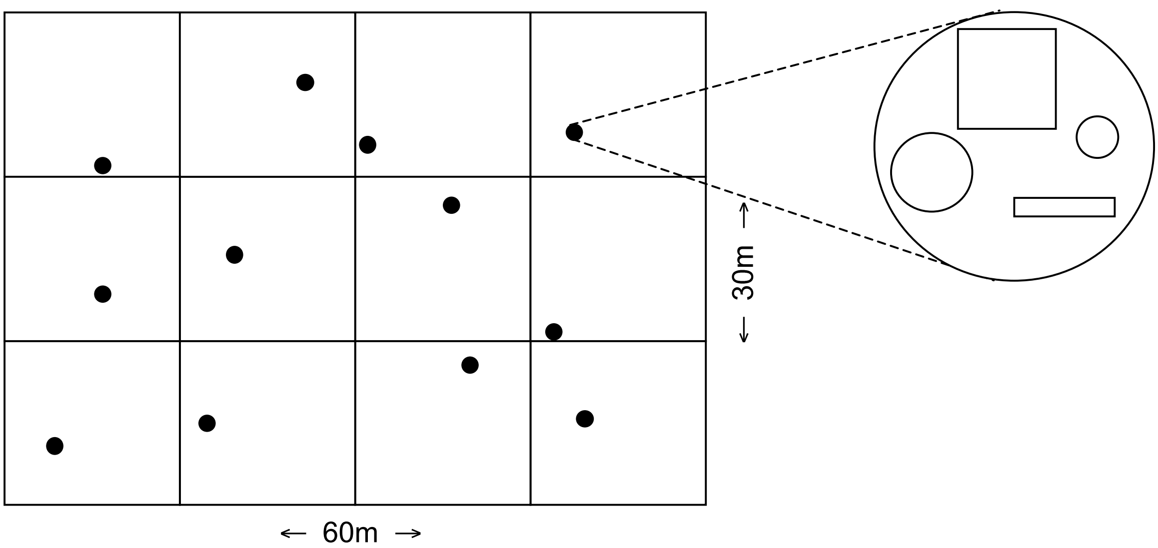

Figure 1. *Layout of sampling area. Squares are sub-areas; black dots are randomly located sampling plots. Circle on right is an enlargement of a sampling plot showing 0.25m^2 quadrat for epibiota analysis, small sediment core for RDL determination, large sediment core for infauna analysis, and small rectangle for sediment physico/chemical analysis.*

3. **Macroalgae** (seaweeds) % cover:

- Where a significant macroalgal cover existed, the percent coverage was estimated using a grid quadrat.

4. **Infauna** (animals living buried in the sediments):

- Three replicate sediment cores were collected from each site at random positions (i.e. six per estuary) using a 125mm diameter (area = 0.0039m^2) corer.
- The corer was driven into the sediments to a depth of 150mm, removed with core intact and the contents washed through 0.5mm Endicott® sieve using local seawater. Captured material and fauna was carefully emptied into labelled plastic containers and preserved using 95% ethanol.
- Samples were returned to the laboratory and examined using a 10X dissecting microscope.
- Invertebrate species were identified to the lowest taxonomic level possible, counted and recorded.
- Data was transferred to a spreadsheet/database for future comparisons.

3.3 Chemical analyses

- Twelve replicate sediment samples (each of approximately 250 grams, with one from each plot) were collected from the top 20mm of fine sediment within each sub-area. The 12 samples were thoroughly mixed to provide one composite sample per site (i.e. a total of two samples for the estuary), as done by Stevens *et al*. (2004) for a similar exercise around Wellington and by Stewart (2007, 2008a,b) for other Otago estuaries. Samples were placed into pre-labelled ziplock plastic bags and stored on ice in the field before being frozen prior to shipping to the Hill Laboratories in Hamilton for analysis.
- The following analyses was carried out:

  Grain size (% mud silt and sand)
  Ash free dry weight
  Total nitrogen
  Total phosphorus
  Cadmium
  Chromium
  Copper
  Lead
  Nickel
  Zinc

4. Results

4.1 Environmental Pressures

A summary of environmental pressures identified at each site and a subjective assessment of the level of concern for each is shown in Table 2 using the matrix presented in Table 1. Blank spaces indicate that the identified pressure is not considered significant or relevant, while a "?" indicates that the pressure may be present, but needs confirmation.

Introduced weeds were widely present, but, as in Stevens *et al*. (2004) and Stewart 2007, 2008a,b) any influence from this pressure has not been defined due to the fact that impact and recovery from this pressure is species and location specific. Although common, the coverage of introduced weeds was often extremely scattered and, where this happened, they were not recorded under broad scale mapping in this survey. However, where dense stands of gorse (*Ulex europaeus*) and tree lupin (*Lupinus arboreus*) were encountered these were recorded as scrubland.

A subjective assessment of the degree of modification to the estuary has also been included. In the case of the Catlins Estuary modification is generally limited to reclamation, the formation of vehicle tracks, installation of fences, and the construction of bridges and sea walls/stop banks.

Table 2. *Summary of environmental pressures at each site and level of concern. Red = high concern; yellow = moderate concern; green = low concern (Refer to Table 1).*

Pressure	Catlins Estuary
Flooding	B4
Introduced weeds	✓
Nutrient pollution	A3
Stormwater	D4
Vehicles	D3
Litter and dumped items	D3
Stock (grazing/trampling)	D3
Erosion	C3
Reclamation	D2
Degree of modification*	M

* VH = Very High, H = High, M = Moderate, L = Low.

This identification and ranking of pressures should be viewed as a starting point for discussion. Detailed information is likely to be available on many aspects, and local knowledge could be of great benefit. Such further investigation is beyond the scope of this survey. It is envisaged that this summary will provide a starting point for deciding whether further investigation is justified, and, if so, where priorities may lie.

Considering the amount of cultivated farmland upstream or adjacent to the estuary, nutrient enrichment is likely, but is difficult to quantify without further investigation.

Reclamation has certainly occurred in past years, but the majority of pasture and fencing on reclaimed land appears to be very well established and may be in the order of many decades old. The majority of reclamation has taken place around the upper reaches of the estuary.

For the Catlins Estuary the presence of a single red cell (Table 2) shows there is a need for some further investigation and/or action with respect to the estuary.

Erosion in the upper reaches of the estuary was evident, but in most instances was relatively minor and appeared to be quite old. At the mouth, however, there was evidence of recent and quite large-scale erosion of the sand dunes on the true left bank of the river (Figure 2).

Figure 2. *Erosion of sand dunes along the true left bank near the mouth of the Catlins Estuary.*

4.2 Broad Scale Mapping – Catlins Estuary

4.2.1 Ground-truthing and digitising habitat

The Catlins Estuary was visited for the purpose of broad scale mapping on 19th and 20th of November 2008. Six prominent landmarks were located using aerial photographs (Figure 3) and GPS readings taken at points either end of each landmark. The distance between points on each landmark was measured using a 100m tape, then compared with maps generated using aerial photographs and tfw files supplied by the ORC. Aerial photographs were ortho-rectified using MAPublisher® 6.2. All distances measured on photographs corresponded with ground truth measurements to within 2m.

Estuary boundaries were set by EHWS (extreme high water spring tide) and ELWS (extreme low water spring tide). The entire estuary was walked with notes being taken on substrate type, vegetation cover and type, and any other distinguishing features. At the same time, drawings were made on field copies of aerial photographs to aid in the digitising of field information. Vegetation and substrate features identified during the field surveys were digitally mapped as precisely as possible on-screen from the rectified photograph. GIS shape files were then used to visually represent each specific feature, as well as to calculate the area of cover for different habitat/substrate types.

4.2.2 Habitat and Substrate Features

The Catlins Estuary comprises the estuaries of two rivers, the Catlins River and the Owaka River (Figures 3 and 4). The estuary is ~7.65km long and quite broad in places (up to 1.53km across Catlins Lake) and overall covers slightly in excess of 859ha, excluding deep water (Table 3). A very high percentage of the estuary area is exposed at low water and with the apparently continuously open river mouth there is a high degree of flushing of the estuary with each tidal cycle. It is apparent some tracts of the estuary have been reclaimed over past years, notably some sizeable areas for farming at the head of the estuary. Some small areas of the remaining estuary are still exposed to stock from time to time.

Grassland is widespread around the majority of the Catlins Estuary (Figure 4). It is generally dominated by tall fescue (*Festuca arundinacea*) and includes other exotic grasses such as cocksfoot (*Dactylis glomerata*), browntop (*Agrostis capillaris*) and Yorkshire fog (*Holcus lanatus*).

There are two main patches of shrubland around the estuary (Figure 4). The first patch is located on the true left bank on the very edge on the estuary mouth. The second section of shrubland is located on the edge of the true right bank near the mouth of the Catlins River at the head of the estuary. The shrubland is generally dominated by mingimingi (*Coprosma propinqua*), with saltmarsh ribbonwood (*Plagianthus divaricatus*) and bracken (*Pteridium esculentum*) often present in abundance.

Figure 3. *Catlins Estuary with ground truthing sites marked as yellow bars.*

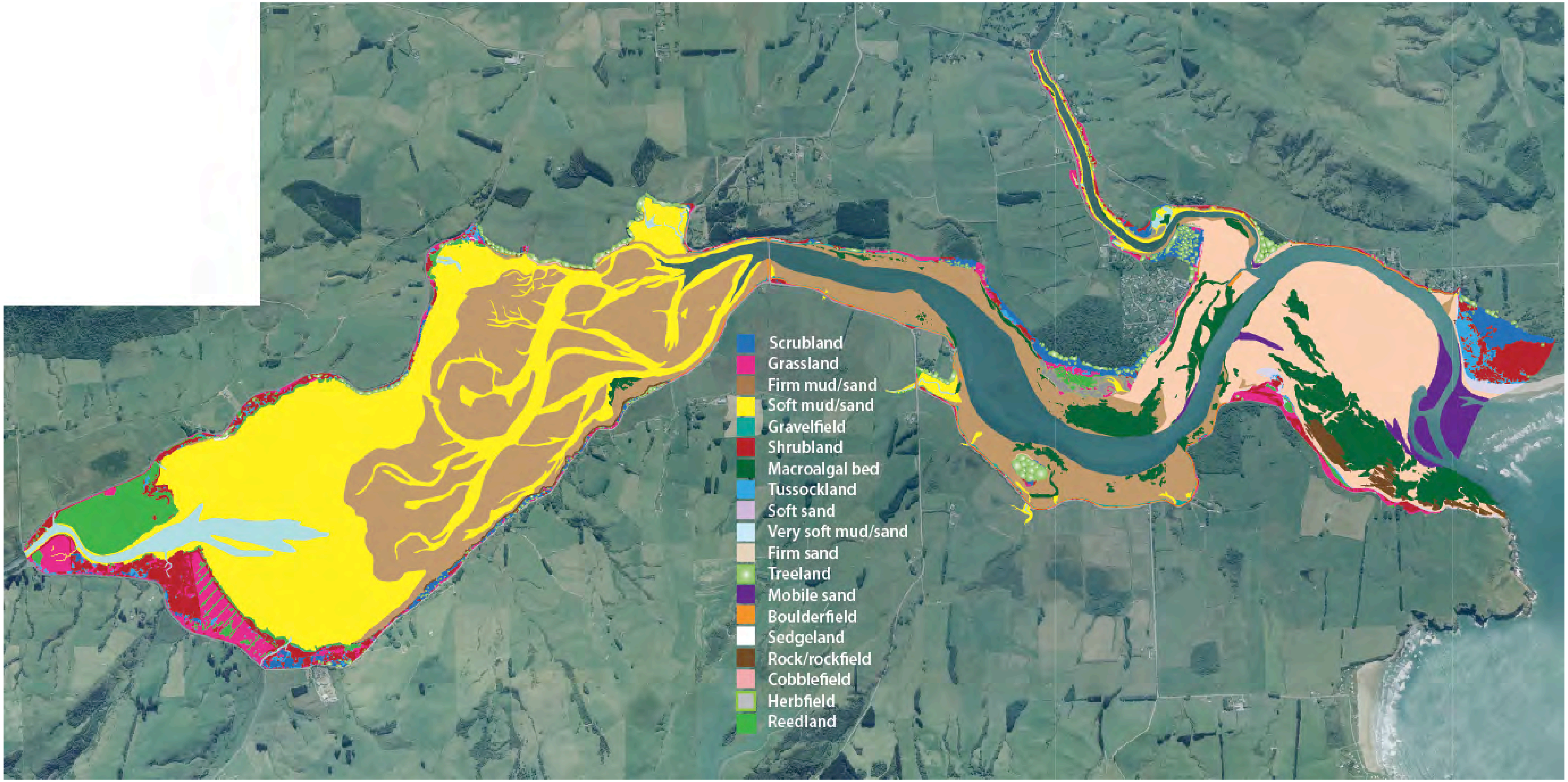

Figure 4. *Catlins Estuary with different habitats mapped. More clarity and detail is available on GIS files lodged with the ORC.*

Table 3. *Proportions of the various habitat types at Catlins Estuary shown as hectares and percentage.*

Habitat type	Area (ha)	% of total area
Boulderfield	2.50	0.29
Cobblefield	0.25	0.03
Firm mud/sand	245.84	28.61
Firm Sand	114.76	13.36
Grassland	43.72	5.09
Gravelfield	2.58	0.30
Herbfield	3.18	0.37
Macroalgal bed	52.72	6.13
Mobile sand	14.88	1.73
Reedland	25.47	2.96
Rock/rockfield	6.26	0.73
Scrubland	21.24	2.47
Sedgeland	0.12	0.01
Shrubland	31.04	3.61
Soft mud/Sand	245.89	28.62
Soft Sand	3.93	0.46
Treeland	15.26	1.78
Tussockland	9.13	1.06
Very Soft Mud/Sand	20.56	2.39
Total	859.29	100.00

Patches of macroalgae are common throughout the lower Catlins Estuary (Figure 4). The rockfield on the true right bank of the estuary mouth is dominated by *Macrocystis* sp., with *Zostera novazelandica* dominant on sandy substrate further upstream. A patch of *Ulva lactuca* is located at the mouth of the Owaka River. The green algae, *Enteromorpha* sp., is found on the true right bank of the Catlins Lake portion of the estuary, especially around areas where there are freshwater inputs.

Reedland is patchy and generally confined to the edges of water channels or wetted ground (Figure 4). Such reedland is generally dominated by jointed wire rush (*Apodasmia similis* previously *Leptocarpus similis*), with hard rush (*Juncus inflexus*) also present in places. The largest area of reedland is on the true left bank of the Catlins Lake near the mouth of the Catlins River.

Scrubland is relatively common along Lakeside Road and Hinahina Road which surround the Catlins Estuary. The roadside scrubland is generally dominated by gorse (*Ulex europaeus*) or tree lupin (*Lupinus arboreus*), with tree lupin slightly more abundant than gorse. The patch of scrubland on the true left bank, near the mouth of the estuary is dominated by mapou (*Myrsine australis*).

Treeland is patchy along both sides of the estuary. The true right and true left bank along the Owaka River are dominated by Hall's totara (*Podocarpus hallii*) interspersed with tree fuschia (*Fuchsia excorticata*) and cabbage tree (*Cordyline australis*) with some *Eucalyptus* spp. However, the treeland on the true left bank of Catlins Lake is weedier than other stands, with these patches consisting predominantly of crack willow (*Salix fragilis*) and Monterey Pine (*Pinus radiata*). Hinahina Island is dominated by Hall's totara.

Tussockland mixed with grassland and scrubland dominate the upstream true right bank and opposite true left bank where the Catlins River meets Catlins Lake (Figure 4). Patches of scattered tussockland are also found along both sides of the lower estuary. Tussockland is generally dominated by flax bush (*Phormium tenax*). However, marram grass (*Ammophila arenaria*) dominates tussockland along the true left and right banks near the estuary mouth.

Herbfield is generally confined to two areas along the Catlins estuary (Figure 4). The largest area of herbfield is located on the true left bank directly opposite Hinahina Island between mid tide and EHWS. The other area is along Lakeside Road on the true right bank near Hinahina Bridge. Herbfield is generally dominated by sea primrose (*Samolus repens*) and swampweed (*Selliera radicans*), with the occasional appearance of glasswort (*Salicornia australis*).

Sedgeland is very rare within Catlins Estuary and is confined to small patch at the head of the embayment closest to the Hinahina Bridge and some additional small patches along the northern shore of Catlins Lake (Figure 4). These sedge patches are dominated by three-square (*Schoenoplectus pungens*).

Substrate near the mouth of the estuary is generally firm clean sand with a firm sand/mud component becoming more pronounced as one moves upstream (Figure 4). Soft sand is largely confined to areas where the sand becomes completely dry, as on the beach at the estuary mouth. Mobile sand is reasonably common over a wide area near the mouth (Figure 4).

In side channels and backwaters the substrate is generally firm mud/sand but becoming soft mud/sand as one moves closer to the main channels (Figure 4). The centre portion of the main channel and parts of the upper estuary carrying very slow moving water is generally very soft mud/sand. Gravel fields are quite common along much of the shore of Catlins Lake, but boulder fields are generally man-formed. The substrate underlying herbfields and grassfields appears to be mainly firm mud/sand.

4.3 Fine Scale mapping – Catlins Estuary

The Catlins Estuary was visited on 21st November 2008. Two sites , selected during the broad scale mapping, were sampled according to the methodology described above. Both sites were located on low tidal sand/mud flats, representative of much of the greater estuarine area (Figure 5).

Figure 5. *Location of fine scale sites at the Catlins Estuary in relation to Pounawea and Hina Hina Island. Downstream site in blue, upstream site in red.*

4.3.1 Sediment Core Profiles

Photographs of sediment cores are presented in Appendix 1. The downstream site (Site 1) comprised predominantly firm sand. A redox discontinuity layer (RDL) appeared in many of the cores (Table 4) and varied in nature from quite diffuse to distinctly discoloured. In no instance was a smell of hydrogen sulphide detectable.

Table 4. *Brief description of sediment cores at downstream site (Site 1), Catlins Estuary.*

Core #	Substrate	RDL begins (mm depth)	RDL ends (mm depth)	Nature of RDL	H_2S detected
1	Fine sand	20	100	Diffuse	No
2	Fine sand	20	110	Diffuse	No
3	Fine sand	25	140	Distinct	No
4	Fine sand	20	>150	Distinct	No
5	Fine sand	15	>150	Diffuse	No
6	Fine sand	10	>150	Diffuse	No
7	Fine sand	50	100	Very diffuse	No
8	Fine sand	50	>150	Diffuse	No
9	Fine sand	60	>150	Distinct	No
10	Fine sand	30	>150	Well defined	No
11	Fine sand	30	>150	Well defined	No
12	Fine sand	50	150	Distinct	No

The upstream site (Site 2) showed a much higher component of mud intermixed with fine sand and a large broken shell component beneath the surface (Table 5, Appendix 1). A redox discontinuity layer was discernible in a number of the cores but was generally quite diffuse.

Table 5. *Brief description of sediment cores at upstream site (Site 2), Catlins Estuary.*

Core #	Substrate	RDL begins (mm depth)	RDL ends (mm depth)	Nature of RDL	H_2S detected
1	Fine sand/mud/shell	Nil	Nil	Nil	No
2	Fine sand/mud/shell	Nil	Nil	Nil	No
3	Fine sand/mud/shell	Nil	Nil	Nil	No
4	Fine sand/mud/shell	Nil	Nil	Nil	No
5	Fine sand/mud/shell	80	120	Diffuse	No
6	Fine sand/mud/shell	Nil	Nil	Nil	No
7	Fine sand/mud/shell	50	>150	Very diffuse	No
8	Fine sand/mud/shell	50	>150	Diffuse	No
9	Fine sand/mud/shell	90	>150	Very diffuse	No
10	Fine sand/mud/shell	95	>150	Diffuse	No
11	Fine sand/mud/shell	70	>150	Diffuse	No
12	Fine sand/mud/shell	70	110	Very diffuse	No

4.3.2 Epifauna

At each sub site a randomly placed 0.25 m^2 quadrat was photographed to assess epifauna. The photographs are presented in Appendix 1. At the downstream site

(Site 1) all sub sites were devoid of macroalgae (see Section 4.3.3) with the substrate surface characterised by fine sand. Epifauna were not evident in any of the quadrats except Quadrat 12 where two mudflat topshells, *Diloma subrostrata*, were present. Amphipod and polychaete burrows were, however, quite common.

Site 2 (upstream) also displayed a relative paucity of epifauna with just a few mudflat topshells, *Diloma subrostrata*, and occasional mud snails, *Amphibola crenata*, seen (see Q2, 3, 4, 7 and 9, Appendix 1). The surface of the substrate was characterised by fine sand with broken shell common (Figure 6).

Figure 6. *Typical substrate at Site 2, Catlins Estuary.*

4.3.3 Macroalgae

At each sub-site the randomly placed $0.25m^2$ quadrat photographed to assess epifauna was used to assess macroalgal cover at the fine scale, in addition to the broad scale mapping of macroalgae already discussed. At both Sites 1 and 2 macroalgae was almost totally absent. Very sparse wisps of filamentous green algae (*Enteromorpha* sp.) were just noticeable at Quadrat 5, Site 2, with <1% cover. In three other quadrats (Q7, 8 and 11) there were small pieces of *Ulva lactuca*, but never more than 4% cover in any quadrat. Beyond the quadrats at Site 1 were sparsely scattered small clumps of the red alga *Gracilaria chilensis*. Around and upstream of Site 2 there were much larger patches of *Gracilaria* and some quite extensive patches of *Ulva*. *Enteromorpha* was common at points where there were freshwater inputs to the estuary.

4.3.4 Infauna

At each sub-site the contents from a 125mm diameter corer, driven into the substrate to a depth of 150mm at three randomly located sites, were sieved through a 0.5mm mesh Endicott® sieve. Retained material was examined in the laboratory using a 10X power dissecting microscope to assess infauna. Infauna at Site 1 were characterised by a variety of burrowing polychaete worms and amphipods with a few scattered bivalve molluscs (Table 6). Quite high numbers of tiny *Austrovenus stutchburyi* indicate that there has been a recent successful clam spatfall.

Mean number of infaunal animals per square metre at Site 1 is 9050 with a mean of 10 taxa present for the site giving quite high diversity (Table 6).

At Site 2 the infauna are dominated by amphipods, burrowing polychaete worms and a few molluscs (Table 7). There are fewer animals per square metre than at Site 1, due largely to the much lower numbers of clams (*Austrovenus stutchbuyri*). Mean number of infaunal animals per square metre at Site 2 is 2175 (Table 7). Overall diversity, however, is not much different to Site 1 with a mean of 9 taxa per core.

Table 6. *Infauna at three sub sites sampled at downstream site (Site 1), Catlins Estuary.*

			GPS	E2256244	E2256250	E2256255
			co-ordinates	N5409920	N5409835	N5409911
			Sample	1	2	3
Phylum		Family	Genus/species			
Annelida						
	Polychaeta					
		Glyceridae		18	13	3
		Oweniidae				
		Nephtyidae	*Aglaophamus macroura*		1	1
		Nereididae		5		
		Opheliidae			1	
		Spionidae		2	2	3
		Maldanidae			7	4
Hemichordata						
	Enteropneusta			1		2
Crustacea						
	Amphipoda					
		Gammaridae		164	8	23
		Haustoriidae		3	2	2
		Lysianassidae				
		Phoxocephalidae		3		1
	Isopoda					
		Scolioidea	*Isocladus armatus*	2	1	
Mollusca						
	Gastropoda					
		Amphibolidae				
			Amphibola crenata			
		Cominellidae				
			Cominella glandiformis	1		
		Trochidae				
			Diloma subrostrata		1	
	Bivalvia					
		Veneridae				
			Austrovenus stutchburyi	8	41	37
		Tellinidae				
			Macomona liliana			1
		Mesodesmatidae				
			Paphies australis			1
Number of Animals				207	77	78
Animals/m^2				15525	5775	5850
Number of Taxa				10	10	11

Table 7. *Infauna at three sub sites sampled at upstream site (Site 2), Catlins Estuary.*

				Upstream site		
			GPS	E2254997	E2254970	E2254960
			co-ordinates	N5408878	N5408890	N5408880
			Sample	1	2	3
Phylum		Family	Genus/species			
Annelida						
	Polychaeta					
		Glyceridae		6	5	4
		Oweniidae		2	6	5
		Nephtyidae	*Aglaophamus macroura*	3	1	
		Nereididae		4	4	
		Spionidae		3		
Crustacea						
	Amphipoda					
		Gammaridae		6	7	4
		Haustoriidae		1		
		Lysianassidae		3	2	
		Phoxocephalidae		3	2	7
Mollusca						
	Gastropoda					
		Amphibolidae				
			Amphibola crenata		1	
		Cominellidae				
			Cominella glandiformis		2	
		Trochidae				
			Micrelenchus tenebrosus			1
	Bivalvia					
		Veneridae				
			Austrovenus stutchburyi	3		1
		Tellinidae				
			Macomona liliana			1
Number of Animals				34	30	23
Animals/m^2				2550	2250	1725
Number of Taxa				10	9	7

4.3.5 Chemical Analysis

Replicate 250ml samples were scooped from the top 20mm of substrate at each of the 12 sub-sites at Sites 1 and 2. The replicate samples were thoroughly combined in a plastic bucket and a 500ml composite sample taken for each site. The composite samples were returned to the laboratory and frozen before being sent to Hill Laboratories in Hamilton for analysis.

All measured parameters were found at very low levels at both the true left bank site and the true right bank site (Table 8).

Observations in the field with respect to the nature of the substrate at each site were confirmed by particle size analysis with the greatest proportion of the sediment being fine sand with a low percentage of mud at the true left bank site (Table 8). As expected, the upstream site (true right bank) showed a greater proportion of very fine material (<63µm) (Table 8).

Table 8. *Chemical analysis of sediments in Catlins Estuary.*

Parameter	ANZECC ISQG-Low Trigger Value	ANZECC ISQG-High Trigger Value	True Left Bank (Site 1)	True Right Bank (Site 2)
Organic Matter (g/100g)	-	-	2.1	1.9
Ash (g/100g)	-	-	98	98
Total Nitrogen (g/100g)	-	-	0.076	0.094
Total Phosphorus (mg/kg)	-	-	220	260
Cadmium (mg/kg)	1.5	10	0.017	0.015
Chromium (mg/kg)	80	370	5.6	6.1
Copper (mg/kg)	65	270	3.7	4.0
Nickel (mg/kg)	21	52	4.9	4.7
Lead (mg/kg)	50	220	1.7	2.5
Zinc (mg/kg)	200	410	16	18
Dry matter sieved (g/100g)			77	80
>2mm fraction (g/100g)	-	-	<0.1	4.4
63μm – 2mm fraction (g/100g)	-	-	94.4	88.5
<63μm fraction (g/100g)	-	-	5.6	7.2

5. Discussion and Recommendations

Although somewhat larger than most, the Catlins Estuary is typical of moderately enriched southern South Island estuaries. There has been some reclamation for farmland, especially at the head of the estuary, but the remaining estuarine area is largely intact with no further reclamation in progress. There are some environmental pressures within the estuary, mainly from nutrient loadings and stock grazing. While the Catlins Estuary is subject to flooding on occasion the large areal extent of the estuary generally limits impacts.

The estuary shows a healthy suite of estuarine flora dominated by grassland generally bordering farmland with the addition of extensive areas of herbfield, scrubland and shrubland. Macroalgae are relatively scarce in the upper estuary (Catlins Lake) and nuisance growths that could be attributed to enrichment are not particularly prevalent. Slightly downstream from the Hina Hina yachtclub there is a large patch of *Gracilaria chilensis* interspersed with *Ulva lactuca*. While the presence of this large patch may be partially encouraged by nutrification, it is suspected that the fact that the patch of macroalgae is located within a very sheltered embayment will also be a factor. Further investigation of this may be warranted.

Fauna too, are representative of typical estuarine animals found in healthy environments (Morton and Miller 1973). Polychaete worms, bivalve molluscs and amphipods are a feature of all estuaries in the Otago region and densities of these animals are as one would expect. Shellfish, such as cockles, are common in the inlet, especially near Pounawea, and there is consequently some pressure from recreational harvesting. Mud crabs and mud snails did not feature prominently in any of the cores sampled, but mud crab burrows were common at both Site 1 and Site 2, and mud snails (*Amphibola crenata*) were abundant (up to $50m^{-2}$), especially in the upper estuary (Catlins Lake).

There is little evidence of contamination of the sediments within the Catlins Estuary. The estuary has very low levels of heavy metals, with no contaminants exceeding the ANZECC (2000) ISQG - low trigger levels at the either fine scale site.

The sediments within the estuary reflect the geology of the Catlins and Owaka River catchments, with there being a high proportion of very fine sediment, especially in Catlins Lake and along the lower reaches of the Owaka River. There are patches of anoxic sediment within the estuary, but nothing that would not be expected in moderately enriched estuaries.

In conclusion the Catlins Estuary appears to be in good health. There are no areas of immediate concern, but the monitoring of nutrient inputs, stock grazing and direct human impacts (vehicles, dumping) may warrant continued monitoring.

6. References

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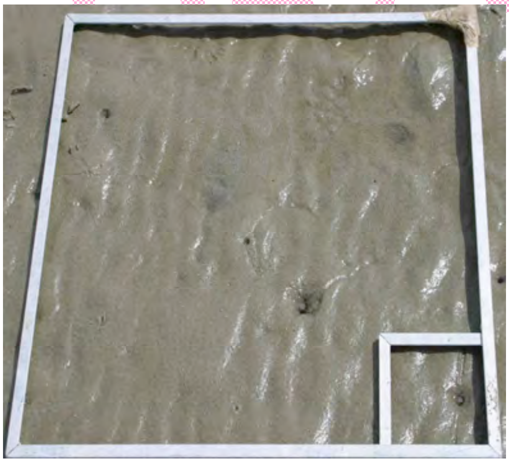
APPENDIX 1

Quadrats and a representative core from each quadrat for fine-scale mapping.

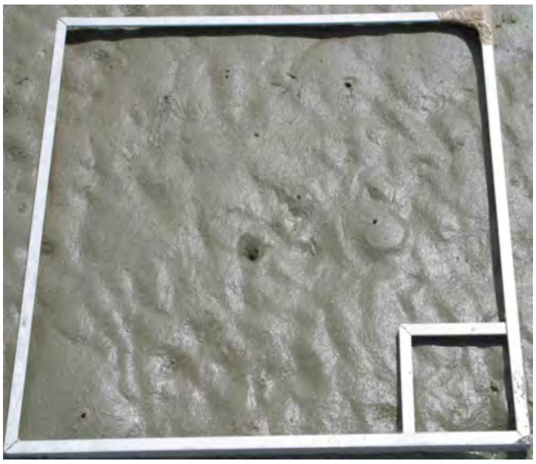
Catlins Estuary
Site 1: True Left Bank (Downstream)

Quadrat 1


Quadrat 2




Quadrat 3




Quadrat 4


Quadrat 5

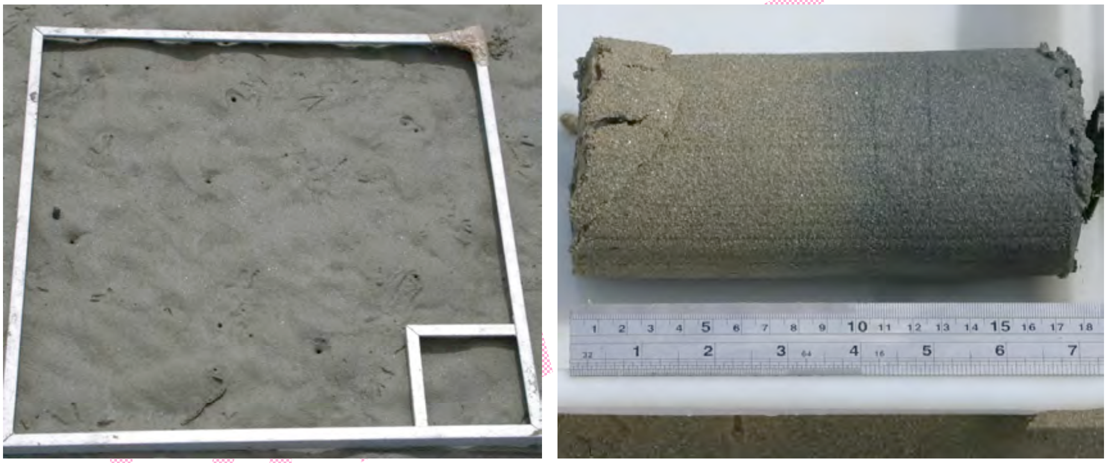

Quadrat 6


Quadrat 7

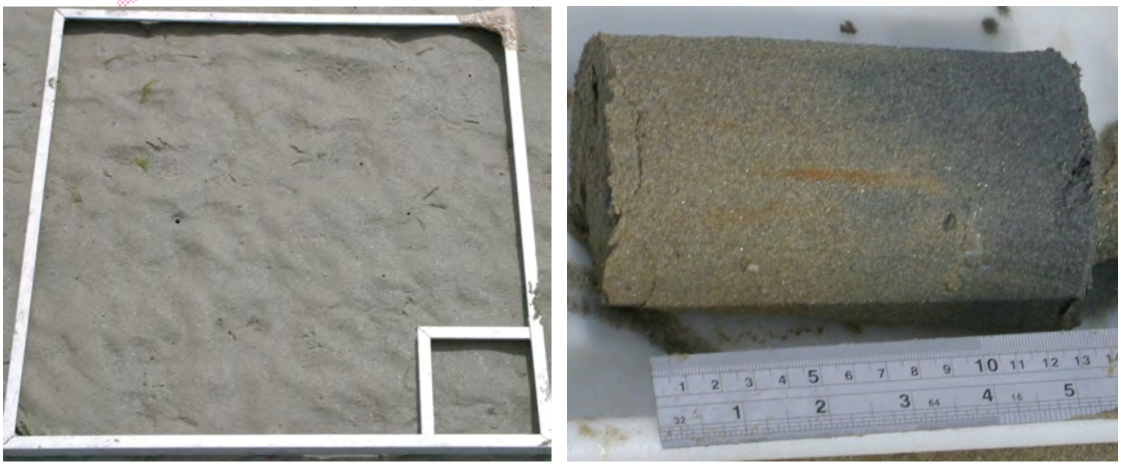

Quadrat 8


Quadrat 9

Quadrat 10



Quadrat 11



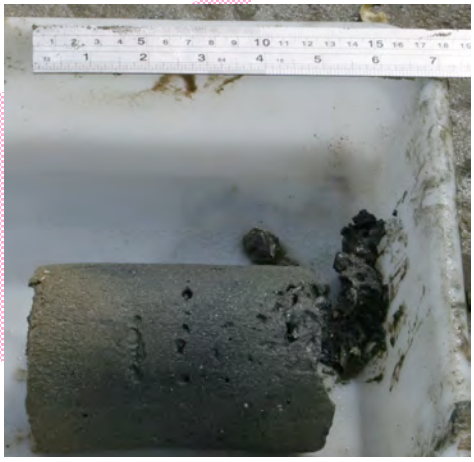
Quadrat 12


Catlins Estuary
Site 2: True Right Bank (Upstream)
Quadrat 1


Quadrat 2

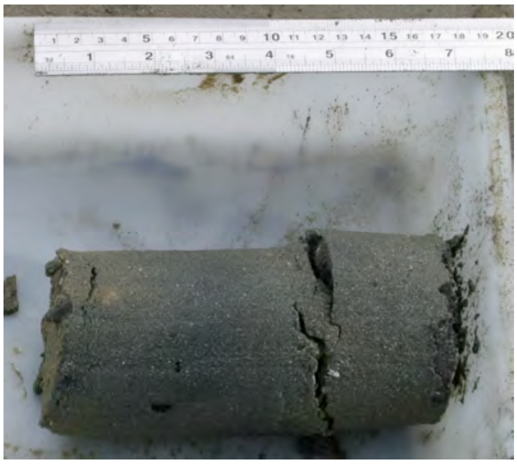

Quadrat 3


Quadrat 4

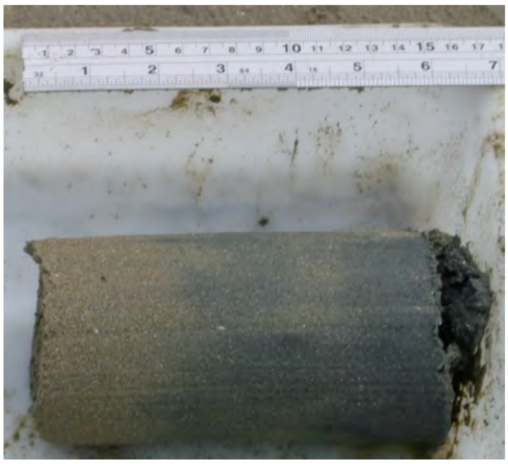
Quadrat 5


Quadrat 6

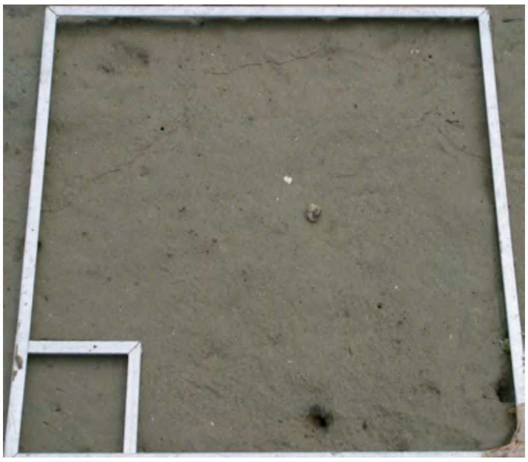



Quadrat 7


Quadrat 8

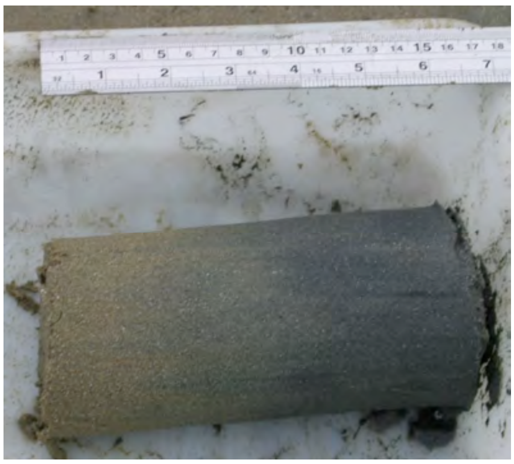



Quadrat 9




Quadrat 10


Quadrat 11

Quadrat 12