

Otago estuaries

State of the environment report
2009

Introduction



Kakanui estuary (Source: B Stewart)

An estuary can be defined as the mouth of a river where tidal effects are evident and where freshwater and seawater mix. Estuary systems are dynamic, complex, and variable environments reflecting their position at the boundary between land and sea. Estuaries are highly-valued ecosystems.

They provide productive habitat for many species: they are the breeding and/or feeding ground for many types of fish, birds, and invertebrates; as well as home to a variety of plants. They are also highly valued to people for their amenity and recreational value. Estuaries act as a sink for the catchments which feed them; receiving land-generated sediments and contaminants. These contaminants can have significant influence on coastal ecosystems.

Despite their importance, little was known about the condition and functioning of estuaries in the Otago region until a comprehensive monitoring programme began in 2005. The seven estuaries monitored by the Otago Regional Council were the Kakanui, Shag, Waikouaiti, Kaikorai, Taieri, Tokomairiro and Catlins.

Monitoring methods

Broad-scale monitoring

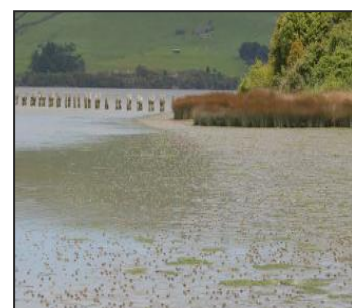
Defined and mapped the estuaries according to the dominant intertidal habitats.

Fine-scale monitoring

Measured a suite of physical, chemical and biological parameters.

Water quality monitoring

Consisted of continuous monitoring and grab samples. Samples were analysed for nitrite-nitrate nitrogen (NNN), dissolved reactive phosphorus (DRP), total nitrogen (TN), total phosphorus (TP), ammoniacal nitrogen (NH₄) and *Enterococci*. Temperature, salinity, chlorophyll, turbidity and pH were also continuously recorded during this period.



Catlins estuary
(Source: B Stewart)

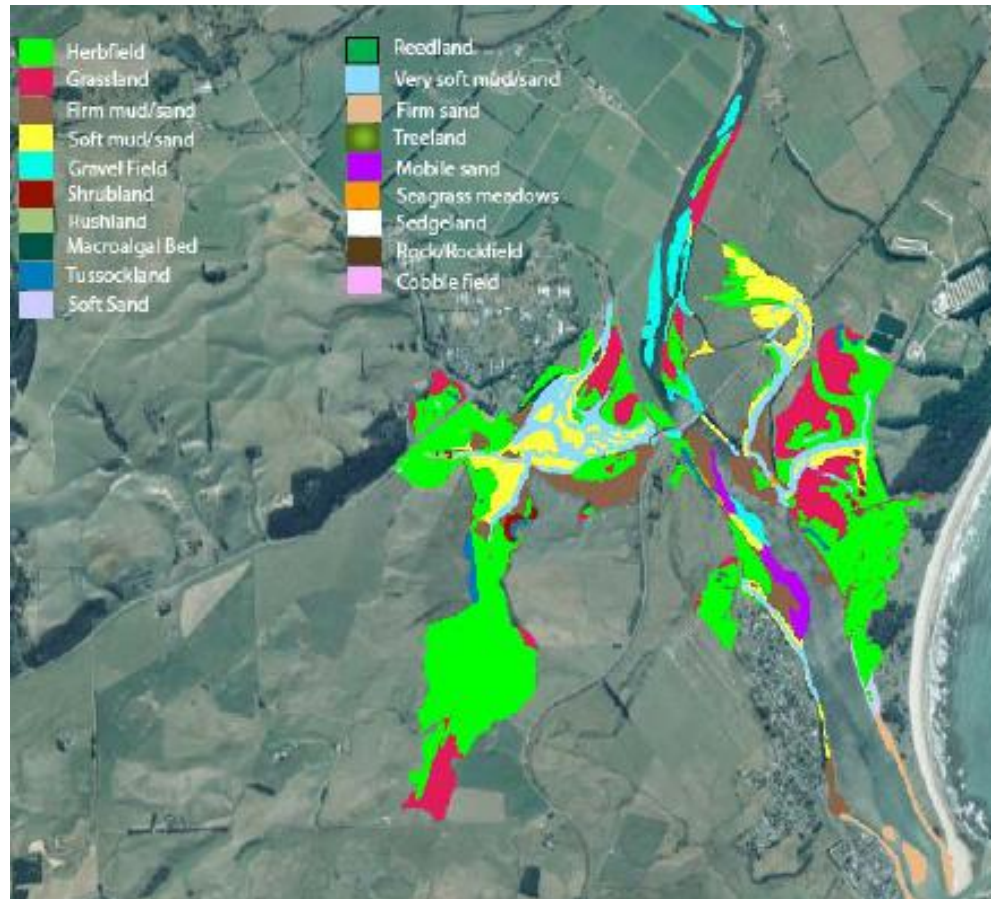
Shag estuary ground truthing sites



(Source: B Stewart)

Broad scale monitoring results

Each estuary was visited to record and ground truth the key habitat types and substrate features. GIS maps were created to show the spatial distribution of intertidal estuarine habitats, an example is shown in the figure below. Each estuary was also analysed for abundance (%) of habitat types (see table below)



Shag estuary habitat map November 2006 (Source: B Stewart)

Salt marshes

Salt marshes are one of the most biologically productive habitats on the planet. They are important for spawning, a nursery and refuge habitat for many fish and shellfish species; as well as nesting, feeding and resting areas for birds and wildlife. Salt marshes were well established (>20%) on four of the estuaries (Waikouaiti, Tokomairiro, Shag and Kaikorai)

Habitat type (%) for each estuary

	Kakanui	Shag	Waikouaiti	Kaikorai	Taieri	Tokomairiro	Catlins
	%	%	%	%	%	%	%
Cobble/rock	32	0	0	0	2	0	1
Mud/Sand	17	24	36	36	13	12	60
Sand	5	5	5	15	39	2	15
Grassland	34	29	16	21	33	38	5
Gravelfield	3	10	4	0	0	0	0
Macroalgae	0	1	0	4	0	0	6
Treeland	4	0	0	1	0	1	2
Saltmarsh	4	31	40	24	13	28	10

Fine scale monitoring results

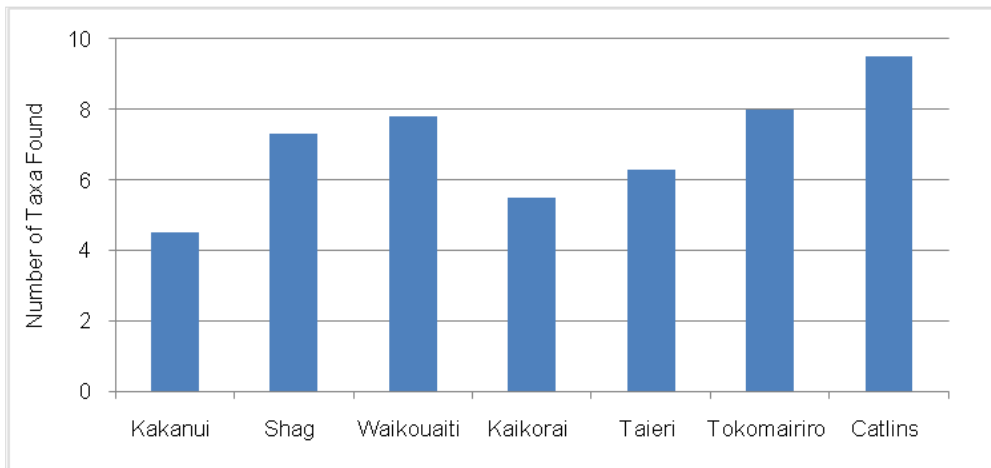
Animals living in the estuaries

Parameter	Sampling method
Epifauna - animals living on the surface	All animals observed within a defined area were identified and counted
Infauna - animals living in the sediment	Sediment cores were taken and the invertebrate species within were identified and counted

The health of the animals living in estuarine sediment (benthic community) reflects their exposure to their environment, particularly as most species live in the same place for several months or years. Therefore changes in oxygen levels, habitat, temperature, salinity or contaminant levels will all affect estuarine fauna. The fauna of all the estuaries were representative of typical estuarine animals found in healthy environments.



Mud snails, *Amphibola crenata*
(Source: B Stewart)



Number of taxa found in each estuary

Number of taxa found in each estuary

The figure to the left shows that the Kakanui estuary had the lowest number of fauna species. Mud crabs, mud snails, polychaete worms and amphipods are a feature of all estuaries in the Otago region and densities of these animals were typical. Shellfish, such as cockles, were present in the Catlins, Shag and Waikouaiti, but relatively scarce in the Taieri and Kaikorai estuaries.

Estuarine sediment composition

The table below indicates the sediment monitoring undertaken in the estuaries

Parameter	Sampling method
Sediment	The anoxic layer was identified and sediments were analysed for particle size, nutrients, ash free dry weight, trace metals

The figure overleaf shows that the Catlins estuary had the highest percentage (29%) of soft mud in the sediments (due to the Catlins lake), the Kaikorai estuary also had a high percentage (21%).

Sediment composition

An increase in sediment runoff from the land will change the ecology of an estuary resulting in an increase in the rate of infilling and a change in the balance of terrestrial-sourced mud and marine sands. A coarse indication of which estuaries should be targeted for more intensive investigation are those with large areas of soft mud and changes in the area of mud over time.



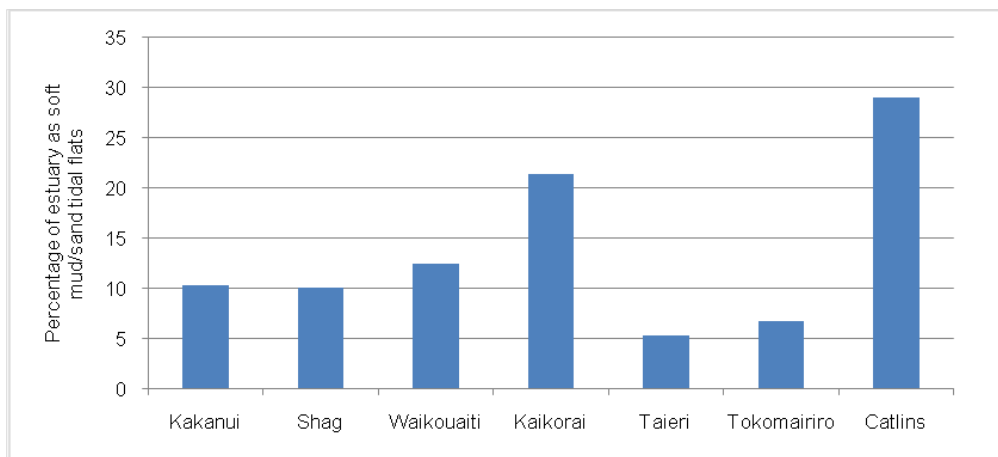
Kakanui estuary sediment core
(Source: B Stewart)

ANZECC: Australian and New Zealand guidelines for fresh and marine water quality ISQG interim sediment quality guidelines

Sediment

Estuaries provide ideal conditions for accumulating sediment which may have elevated trace element concentrations. For each trace element and organic compound, ANZECC has derived a low interim sediment quality guideline value (ISQG-Low) and a high interim sediment quality guideline value (ISQG-High), these are shown in the table below. The ISQGs relate to the toxic impact of trace elements and organic compounds on sediment-dwelling organisms

The results presented in the table opposite are the average values from two sites within each estuary. No estuary had trace metals that exceeded the ANZECC (2000) ISQG sediment guidelines. However, when looking at individual sites, lead and zinc at the upstream site in the Kaikorai estuary exceeded the ANZECC (2000) ISQG - low trigger levels.



Percentage of soft mud/sand in each estuary

Sediment organic matter

Organic matter in estuarine sediments is generally rich in nutrients derived from land runoff. Significant changes in benthic community structure can occur when sediments accumulate high levels of organic matter.

The Kaikorai estuary had the most organic carbon, and a relatively high Total Organic Carbon:Total Nitrogen (TOC:TN) ratio, indicating a terrestrial source of organic matter. The Kakanui estuary on the other hand, had a very low TOC:TN ratio, indicating a marine source of organic carbon.

Estuarine sediment contamination

ISQG sediment guideline values

	Arsenic	Cadmium	Chromium	Copper	Nickel	Lead	Zinc
ISQG Low (mg/kg)	20	1.5	80	65	21	50	200
ISQG High (mg/kg)	70	10	370	270	52	220	410

Nutrient and heavy metal contamination in the estuaries monitored

	Kakanui	Shag	Waikouaiti	Kaikorai	Taieri	Tokomairiro	Catlins
Total Nitrogen	0	0.1	0.1	0.1	0.1	0.1	0.1
Total Phosphorus	255	523.5	466	705	450	380	240
Arsenic	4.8	10.1	6.5	0	0	3.7	5
Cadmium	0	0	0	0.1	0	0.1	0
Chromium	4.4	10.4	5.8	18.7	5.1	6.6	5.9
Copper	1.9	4.5	4.7	12	3.2	3.9	3.9
Nickel	4.6	6.9	6	9.2	4.8	5.1	4.8
Lead	5.9	5.2	4.2	27.4	3.7	4.2	2.1
Zinc	14.4	31.9	26.3	127	19.5	26.5	17

Water quality monitoring results

The four key parameters are turbidity, chlorophyll, NNN and DRP. The table below shows how these key parameters have been divided into four categories to show low, medium, high and very high concentrations.

Water quality classification categories.

Category	Turb NTU	Chlorophyll mg/l	NNN mg/l	DRP mg/l
Low	0 to 4	0 to 2	0 to 20	0 to 5
Medium	>4 to 10	>2 to 5	>20 to 50	>5 to 15
High	>10 to 20	>5 to 10	>50 to 100	>15 to 30
Very High	>20	>10	>100	>30

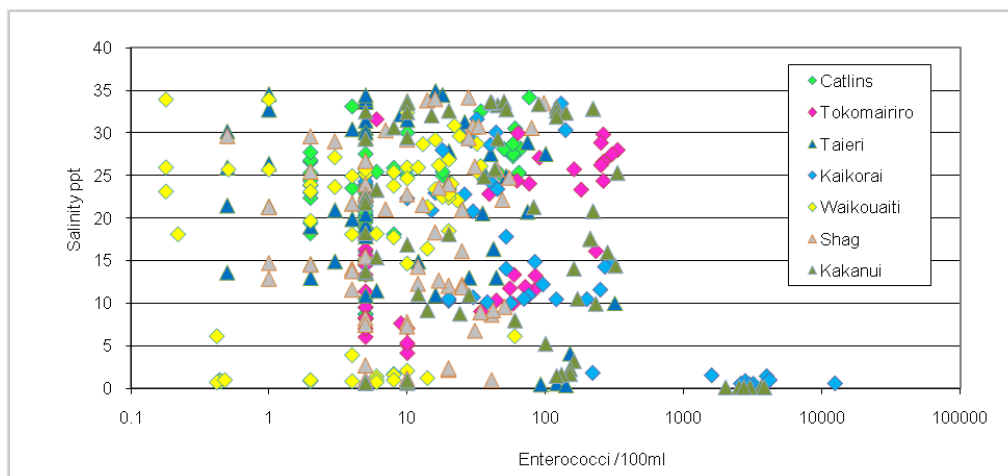
These four categories have been used to classify each estuary according to the median values each estuary attained for turbidity, chlorophyll, NNN and DRP. The table below shows results

Water quality results and allocated categories.

Category	Turb NTU	Chlorophyll mg/l	NNN mg/l	DRP mg/l
Catlins	5.7	2.71	26.5	25
Tokomairiro	5.8	1.66	46	25
Taieri	5.4	1.36	25	25
Kaikorai	10	3.39	56	22
Waikouaiti	2.1	0.99	25	25
Shag	3.2	0.88	48	25
Kakanui	2.5	0.98	40	25

Of the seven estuaries three had median turbidity values in the low category, median chlorophyll concentrations were low for most estuaries. None of the estuaries had median NNN or DRP values that fell in the low category and all the estuaries had median NNN values categorised as high.

Bacteria: The MFE guideline for satisfactory levels of *Enterococci*, (with regard to swimming) is between 140 and 280 cfu/100ml. The graph below shows all the results for each estuary, plotted against salinity.



Concentration of enterococci found in each estuary, plotted against salinity

Why we monitor water quality parameters

Turbidity affects photosynthesis and fish and aquatic life through clogging of fish gills and obscuring fish vision, and smothering bottom-dwelling animals.

Chlorophyll is an indication of algal density, which contributes to the turbidity of the water, and increases suspended solids

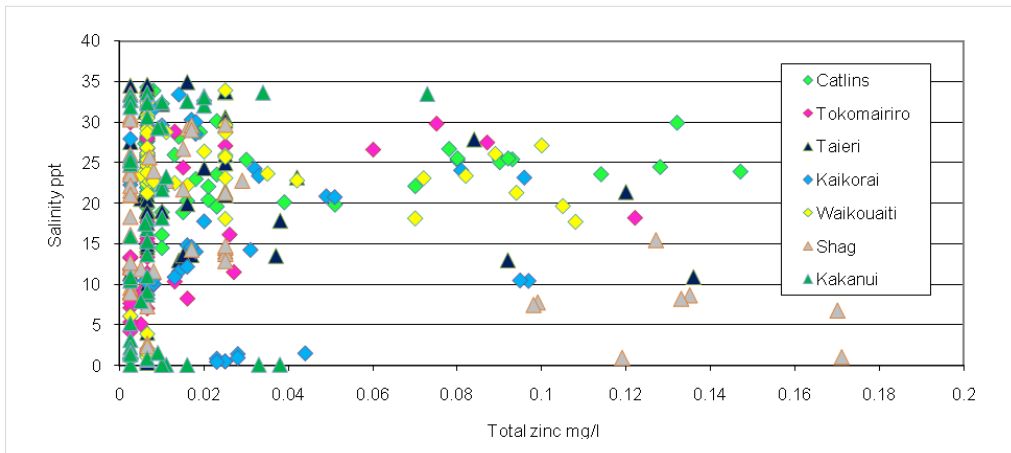
Nutrients are key water quality parameters in estuaries as they influence plant growth, oxygen concentrations, water clarity and sedimentation rates.

Bacteria are also of concern in areas where waters are used for swimming, boating, shellfishing or other contact recreation activities

Bacteria results

The Catlins, Shag and Waikouaiti estuaries record concentrations of *Enterococci* below 140 cfu/100ml at all times. The Tokomairiro, Kaikorai and Kakanui estuaries have the most elevated concentrations of *Enterococci* compared to the other estuaries, however some of these high values are at low tide when the water is predominantly river water.

The only metal monitored was zinc, as it was intended to be used as an 'indicator' for the presence of other metals, results are shown in the figure below. The ANZECC 2000 guideline for total zinc is 0.015 mg/l (marine water) and 0.008 mg/l for freshwater. Only the Kaikorai estuary had a median zinc concentration which did not meet the higher marine guideline value. It should be noted that the geology of the Catlins estuary means that this estuary has naturally elevated zinc concentrations.



Concentration of zinc found in each estuary, plotted against salinity

What next?

The National Estuary Monitoring Protocol, as used in this report, provides a simple, defensible and cost-effective strategy to assess and monitor estuary condition. The baseline monitoring has been undertaken for seven estuaries, and it is envisaged that the process will be repeated in the future in order to monitor any change.

In conclusion the broad scale monitoring, fine scale monitoring and water quality monitoring undertaken between 2005/2008 have indicated that all the estuaries appear to be in good health. It is hoped that the monitoring undertaken will contribute information and knowledge that will assist in protecting and sustaining Otago's numerous and important estuary systems.

Bacteria results

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Kakanui estuary (Source B Stewart)

Summary characteristics of the seven estuaries monitored

Catlins Estuary



The Catlins Estuary comprises the estuaries of two rivers - the Catlins and the Owaka. The estuary is approximately 7.65km long and quite broad in places (up to 1.53 km across Catlins Lake) and overall covers slightly more than 859ha, excluding deep water (Ryder 2009). A high percentage of the estuary area is exposed at low water and there is a high degree of flushing of the estuary with each tidal cycle. Some small areas of the remaining estuary are still exposed to stock from time to time. The Catlins Estuary is listed as a coastal protection area with Kai Tahu cultural and spiritual values. A large wetland is located at the head of the estuary which is an important habitat for waterfowl and for fish breeding. The estuary is an important habitat for marine and freshwater fish such as giant bully, black flounder, brown trout, eels and shellfish. It is also a coastal recreation area with boating, swimming, fishing and walking. (Otago Regional Council, 2004).

Kakanui Estuary



The Kakanui Estuary is a long (2.2km) and relatively narrow (no more than 230m wide) estuary covering slightly less than 27ha, excluding deep water. (Ryder 2009) The estuary mouth is quite mobile. A small percentage of the estuary is exposed at low water. Little of the area has been reclaimed for farming, but some land used for grazing on the true left bank near the mouth can be described as flood plain. Some of this area is being replanted with native trees and shrubs. The Kakanui Estuary is listed as a coastal recreation area in the Regional Plan: Water being important for swimming, walking, fishing, scuba diving, snorkelling and boating (Otago Regional Council, 2004).

Waikouaiti Estuary



The Waikouaiti River has a long and very irregularly- shaped estuary covering more than 200ha with a high percentage of the estuary area being exposed at low water (Ryder 2007). It is apparent that large tracts of the estuary have been reclaimed over past years. Some areas of the remaining estuary are still exposed to stock from time to time. In the Regional Plan: Water, the Waikouaiti Estuary is listed as a coastal protection area with Kai Tahu cultural and spiritual values, it is also important for coastal birds such as the eastern bar-tailed godwit and oystercatchers. It is listed as a coastal development area with fishing facilities, recreational facilities and moorings and it is also a coastal recreation area with swimming, walking and surfing (Otago Regional Council, 2004).

Kaikorai Estuary



The Kaikorai Stream has a long and relatively narrow estuary covering slightly more than 140ha with a high percentage of the estuary area being exposed at low water (Ryder 2008). The bar at the estuary mouth is regularly blocked meaning that a large proportion of the estuary is often inundated for extended time periods. Some tracts of the estuary have been reclaimed over past years, including the golf course and land fills with additional areas for farming (Ryder 2008). The Kaikorai estuary is listed as a coastal protection area in the Regional Plan: Water, it has Kai Tahu cultural and spiritual values and estuarine values such as a diversity of species and communities which support a diverse bird population. Up to 50 bird species have been identified in the estuary. There is a wide variety of estuarine plants such as tall rushland and saltmarsh ribbonwood. It is also a juvenile rearing area for whitebait and a breeding area for yellow belly flounder (Otago Regional Council, 2004).

Taieri Estuary



The Taieri River has a long, generally narrow and irregularly shaped estuary that covers more than 270ha with a low percentage of the estuary area being exposed at low water (Ryder 2008). It is apparent that large areas of what was estuary or flood plain along the margins of the upper estuary have been developed for farming at some time in the past. The Taieri Estuary is listed as a coastal development area in the Regional Plan: Water with fishing facilities and recreational facilities (Otago Regional Council, 2004).

Shag Estuary



The Shag River has a long and irregularly shaped estuary and covers more than 130 ha. (Ryder 2007). A high percentage of the estuary area is exposed at low water. Large areas of what was once estuary or flood plain have been developed for farming. The Shag Estuary is listed as a coastal protection area in the Regional Plan: Water (see Section 3.0). The estuary has Kai Tahu cultural and spiritual values. It has an extensive subtidal reef system with luxuriant bladder kelp. There are mudstone wave cut platforms containing fossils, and very good examples of spherical boulders (Katiki concretions). Its estuarine values include large mudflats used for feeding birds which are roosting or stopping over. It is an important whitebait spawning area, and is a habitat for lamprey. The spit is an occasional haul out location for Hookers sea-lions and elephant seals (Otago Regional Council, 2004).

Tokomairiro Estuary



The Tokomairiro has a long (12.5km) and narrow (370m wide) estuary covering more than 240 ha. A small percentage of the estuary area is exposed at low water indicating that a considerable amount has been reclaimed for farming. The sand bar at the mouth of the estuary has led to rapid siltation within the estuary, and it also limits the tidal range to approximately one metre. The estuary is dominated by a shallow mudflat habitat which acts as sediment trap. The Tokomairiro Estuary is listed as a coastal protection area in the Regional Plan: Water as it has Kai Tahu cultural and spiritual values, as well as estuarine values. (Otago Regional Council, 2004).

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