Wriggle

coastalmanagement

Southland Coast

Te Waewae Bay to the Catlins

Habitat Mapping, Risk Assessment and Monitoring Recommendations

Prepared for Environment Southland

August 2008

Cover Photo: Oreti Beach marram grass duneland.

Porpoise Bay sunrise

Southland Coast

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By

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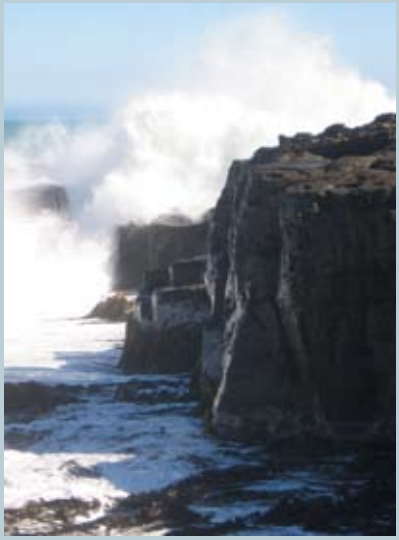
EXECUTIVE SUMMARY

SCOPE



Exposed rocky coastline - Curio Bay

Developing an understanding of the distribution and risks to coastal and estuarine habitats is critical to the management of ecological resources. Recently, Environment Southland (ES) contracted Wriggle Coastal Management to identify the habitat vulnerability and monitoring priorities for coastal ecological resources in the developed section of the Southland coastline using a similar approach to that recently used in the Greater Wellington region (Robertson and Stevens 2007a, 2007b, 2007c). The approach includes 3 main components which produces the following outputs:

- **Coastal Habitat Maps**: An ArcMap GIS dataset depicting current broad-scale habitat cover types along the coast using aerial photographs, and ground truthing techniques (Robertson and Stevens 2007a, 2007b).
- **Vulnerability Assessments**: An assessment of the "vulnerability" of the coastline habitats based on the sensitivity of the receiving environment, human uses, and the upstream catchment area risk factors (stressors) associated with each section of the coast. The approach used is an adaptation of an existing UNESCO methodology (UNESCO 2000) and a risk-based matrix developed for broad scale assessments of beaches, dunes, rocky shores and estuaries (Robertson et al. 2002, Robertson and Stevens 2007a, 2007b) - see Methods for details.
- **Monitoring Priorities:** A recommended coastal monitoring programme for the management of coastline biological resources in the region.

HABITATS

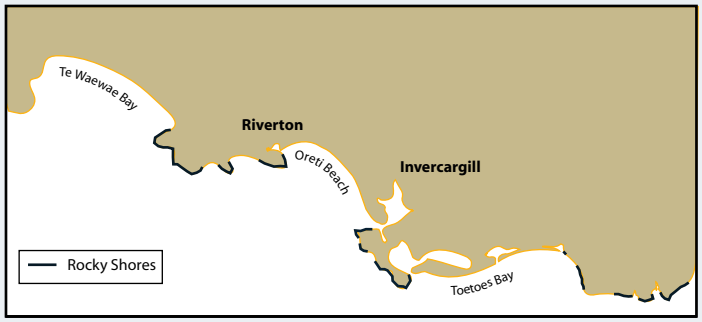
Yellow-eyed penguin (Curio Bay)

Bull kelp (*Durvillaea antarctica*)

The mapping and risk assessment study identified the Southland Coast, from Te Waewae Bay to Waiparau Head, as very ecologically diverse with a broad range of habitat types along an exposed south facing shoreline. The habitats included the following:

ROCKY SHORES

The rocky shores cover 21% of the coastline and generally have very exposed, high-energy shores. Hard igneous rock types are found in the west, and softer sedimentary rock types in the east (often with high cliffs). In many areas, the landward margin is bordered by coastal herbfields (turf and cushion plants). Sheltered rocky shores occur within the confines of Bluff Harbour. The waters bathing the coastline are very productive and consequently the rocks have a very abundant and diverse ecology. Bull kelp (*Durvillaea antarctica*), mussels and barnacles dominate the low water area in most exposed places. These biologically rich and relatively accessible habitats have high value to humans for diving, fishing, fossicking, walking and scenic attraction.



EXECUTIVE SUMMARY

Dissipative beach type, Oreti Beach

Intermediate beach type, Waipapa

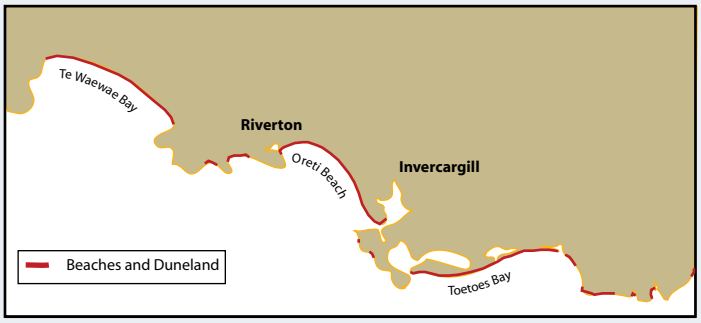
Reflective beach type, Long Beach

Hemipodus simplex - polychaete that lives in sands of Southland beaches

Swimmers at Porpoise Bay

BEACHES AND DUNES

Beaches and dunes are relatively common in Southland - extending along 36% of the Southland coastline study area.



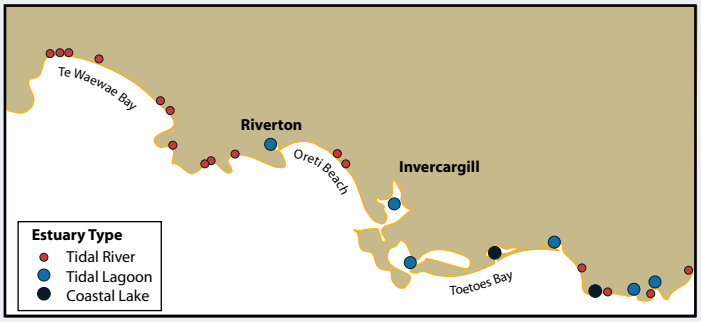
A variety of beach types are present:

- Broad, flat, sandy dissipative beaches with wide surf zones and high ecological richness (e.g. Oreti Beach, and sections of Porpoise Bay, Colac Bay and Te Waewae Bay).
- Steep, coarse grained (generally gravel), reflective type beaches with narrow surf zones and low ecological richness (e.g. Toetoes Beach, much of Te Waewae Bay).
- Intermediate type beach areas which have an intermediate slope and moderate species richness (e.g. Waipapa, Dummys and Long Beach).
- Sheltered beaches in the harbours and estuaries which also tend to have high ecological richness (e.g. Bluff Harbour and Waikawa Estuary).

In general the water quality is good and human use is often moderate or high. Dunes border the top margin of most beaches including at the foot of cliffs in much of Te Waewae Bay. The most extensive areas of duneland tend to be found at the eastern ends of beaches - a product of longshore drift and prevailing wind exposure. Most dunes are relatively narrow, dominated by the introduced and invasive marram grass, and flanked by grazed pasture on old modified dunes (e.g. Oreti Beach). Coastal herbfields are also present on the upper beach crest or downslope along many of the steep gravel beaches (e.g. Toetoes Beach, Te Waewae Bay and the east end of Colac Bay). Only in several isolated locations are there significant areas of native (e.g. pingao) sand-binding species (e.g. Toetoe Spit, Three Sisters near Omaui and at Waipapa Point), although recently the pingao has been displaced by marram grass on some dunes at Three Sisters and Waipapa.

ESTUARIES

Estuaries are also common along the Southland coast and occupy 43% of the coastline. A total of 24 estuaries were mapped in this assessment and they were widely variable in terms of their vulnerabilities. Three estuary types were found:



EXECUTIVE SUMMARY

Tidal river mouth estuary, Longbeach

Tidal lagoon estuary, Jacobs River Estuary

Tidal River Mouth Estuaries: The majority of the Southland estuaries are small tidal river mouth estuaries (e.g. Waimeamea and Waimatuku Estuaries) which experience frequent mouth blockage and salinity shifts. These estuaries have often been channelised and drained, have little saltmarsh or tidal flats, and are susceptible to water and sediment quality degradation when the mouth is blocked. The highly modified nature, and the low habitat diversity of the majority of these estuaries, means that their vulnerability to further change is low. However, when in good condition, they provide good habitat for native fish and other biota.

Tidal Lagoon Estuaries: Tidal lagoons (e.g. New River and Waikawa Estuaries), with their much larger size, and habitat diversity (i.e. extensive tidal flats, seagrass beds and saltmarsh) and strong flushing, tend to have the highest ecological and human use values, and moderate ecological value.

Coastal Lakes Estuaries: The two coastal lakes (Lake Brunton and Waituna Lagoon), have important ecological values (saltmarsh, bird-life and fishery) and contain a mosaic of different habitats. However, because they also experience long periods of mouth closure, they are particularly vulnerable to water quality problems.

TERRESTRIAL MARGIN (INLAND OF BEACHES AND DUNES):
Inland of the shoreline the 200 metre terrestrial margin is predominantly grassland (66%) used for extensive grazing of sheep, dairying or cattle. Forest (8%), scrub (12%) and tussockland (4%) are the other major features.

ISSUES

The Southland coastal vulnerability assessment identified the following as the key ecological issues (in no particular order):

Saltmarsh habitat at risk from sea level rise

River plume from Mataura River (Toetoes Estuary) bathing Frasers Beach (photo Google Earth)

CLIMATE CHANGE - Sea level Rise. Sea level is predicted to increase up to 7mm/year or more in the next 100 years. The most vulnerable coastal areas are low lying, soft-shores with a low tidal range, and a susceptibility to inundation, high erosion, and high wave energy. A large proportion of the developed part of the Southland coastline fits the vulnerable category. The likely response in such low-lying areas is increased erosion of beach ridges and dunes, deltas, tidal flats, saltmarsh and lagoons. If these habitats are not able to migrate and re-establish inland, their ecosystem value will be severely depleted. On a positive note, if allowed to expand naturally, many of Southland's smaller tidal river estuaries (which currently have a single channel, and no tidal flats or saltmarsh) will develop greater habitat values.

POLLUTION. Site-specific problems such as exposure to polluted river plumes, wastewater discharge, oil spills and litter all have an adverse effect on coastal areas. Except for large-scale infrequent discharges such as oil spills, pollution tends mainly to influence embayed coastlines and estuaries. Eutrophication, sedimentation and disease risk are the main pollution issues in Southland. Poorly flushed estuaries (or parts of estuaries) with moderate or high ecological values, and in catchments with intensive landuse, tend to be the most vulnerable (e.g. Waimatuku, Waituna, Lake Brunton, and parts of Jacobs and New River Estuaries). However, also vulnerable from contaminated river plumes are Southland's highly valued beaches (particularly Riverton and Oreti Beaches). Also of concern in relation to pollution, is the predicted 1.9 deg C change in annual average air temperature and 7% increase in the annual average rainfall for Southland by 2090 (induced by climate change). The wetter climate will likely contribute to increased runoff and greater nutrient, sediment and pathogen loads to at-risk coastal waterbodies.

EXECUTIVE SUMMARY

Seawall in Waihopai Arm, New River Estuary

Marram dunes Oreti Beach

Developed estuary margin, Taunamau Estuary

Bikes in dunes and herbfields, Oreti Beach

Rock seawall Colac Bay

FRESHWATER ABSTRACTION. The demand for freshwater has reduced flushing in many of Southland's estuaries (e.g. Waiau, New River) which exacerbates existing problems of eutrophication, sedimentation and disease risk. It also alters coastal sediment and hydrodynamic patterns. The Waiau Estuary and Te Waewae Bay are currently the most highly affected (as a result of the Waiau diversion for hydro-electric power), and are vulnerable to further change given the high demand for water in the catchment.

ESTUARY HABITAT LOSS. Drainage and reclamation has destroyed large areas of Southland's estuaries, both large and small. New River Estuary has lost 26% of its area since 1910 (mainly saltmarsh and freshwater marsh in the Waihopai Arm). This reclamation has destroyed the natural assimilative capacity of that arm of the estuary which has led to elevated sedimentation rates and low habitat quality. In addition, many of the small tidal river estuaries in Southland have been drained which has reduced their ecological values.

INVASION OF MARRAM GRASS. The majority of Southland's dune systems are vegetated by marram grass, an introduced species which tends to outcompete the native sand-binders (e.g. pingao) and this replacement has caused dune instability problems (high dunes with frequent blowouts) and loss of biodiversity and natural character.

LOSS OF NATURAL VEGETATED MARGIN. Coastal shoreline habitats function best with a natural vegetated margin which acts as a buffer from development and "coastal squeeze". This buffer protects against introduced weeds and grasses, naturally filters sediment and nutrients, and provides valuable ecological habitat. Currently, the majority of the coastal terrestrial margin in Southland (mapped area) is highly modified through cattle and sheep grazing.

GRAZING IN DUNES AND COASTAL HERBFIELDS. The effect of stock grazing in dunes reduces the height of plants and encourages mobilisation of dunes. It also leads to a decreased organic and nutrient content of the dune-land. Stock trampling also encourages mobilisation as does sheep rubbing against small blowouts. Stock grazing can be used to control weed growth in dunes, particularly in areas well back from the foredune, although excessive grazing leads to high levels of damage and weed invasion. Grazing in the extensive coastal herbfields in Southland has led to severe pugging and trampling issues in some areas.

VEHICLES ON BEACHES AND DUNES. Vehicle use on Southland beaches and dunes is widespread (e.g. Oreti, Te Waewae, Kawakaputa Bay, Toetoes Beach). Such use, on dunes and the backshore of sandy beaches, has been demonstrated to be highly damaging to plants and animals. Available information for the effect of vehicles on the intertidal section of beaches is limited.

HABITAT LOSS THROUGH SEA WALLS AND STRUCTURES. Currently, only small areas of the Southland coast are protected by seawalls (e.g. Colac Bay). However, in the future, pressure to protect the Southland coastline by artificial structures is expected to increase because of coastal development, associated defences against sea-level rise, and the greater frequency of storms. However, such artificial shoreline hardening if allowed to be undertaken, will reduce the ecological services of shoreline habitats.

LACK OF BASELINE INFORMATION. Baseline information on Southland's high diversity rocky shores, beaches and small tidal river estuaries is extremely limited.

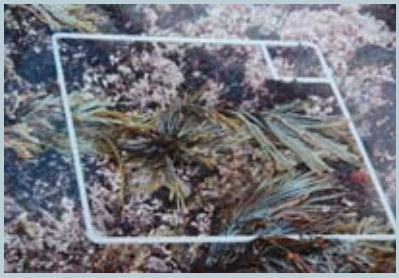
EXECUTIVE SUMMARY

MONITORING AND MANAGEMENT

Monitoring sedimentation rate, New River Estuary

Fine scale monitoring, New River Estuary

Beach fine scale monitoring



Rocky shore monitoring, Pahia

Estuary margin, Garden Bay

ESTUARIES

Long Term Estuary Monitoring

Monitor the long term condition of representative estuaries with highest biodiversity and risk to ecology.

- Estuaries should include those already in the ES estuary programme; (New River, Jacobs River, Bluff/Awarua, Waituna, Toetoes, and Waikawa Estuaries), as well as those new to the estuary programme: e.g. Waituna (see page 47 and Stevens and Robertson 2007 for recommended Waituna monitoring programme).
- Broad scale habitat mapping and risk assessment every 5 years.
- Fine scale, 1-2 sites (incl. sedimentation rates), 3 year baseline then 5 yearly.
- Map intensive catchment landuse (including wetland areas), 5 yearly.
- Monitor disease risk of shellfish and bathing waters near contaminated river plumes and urban SW discharges.

Monitor all other estuaries for long term change by repeating the broad scale synoptic monitoring (i.e. habitat mapping, sediment redox, depth, salinity, open/closed regime) and vulnerability assessment at 10 year intervals.

Intensive Estuary Assessments

Undertake detailed short term synoptic monitoring and risk assessment of at-risk estuaries in which limited existing information is available. This information will be used to develop appropriate monitoring and management plans for these estuaries.

- Target estuaries: Waiau, Waimatuku. Lake Brunton.

BEACHES AND DUNES

Long Term Beach and Dune Monitoring

Monitor long term dune area and condition of all Southland beaches at 10 yearly intervals.

Monitor long term coastal herbfield area and condition at key areas (e.g. Bluff Peninsula to Omaui) at 10 yearly intervals.

Monitor long term condition of high biodiversity beaches.

- One long term monitoring site on each of three dissipative beaches (most species rich), e.g. Porpoise Bay, Oreti Beach, Bluecliffs Beach. Establish 3 year baseline then 5 yearly.

ROCKY SHORES

Monitor long term condition of high biodiversity rocky shores.

- One long term monitoring site on each of three high diversity rocky shores (most species rich), e.g. West of Cosy Nook, Stirling Point and Waipapa Point. Establish 3 year baseline then 5 yearly.

PLAN TO MINIMISE ECOLOGICAL IMPACTS OF SEA LEVEL RISE

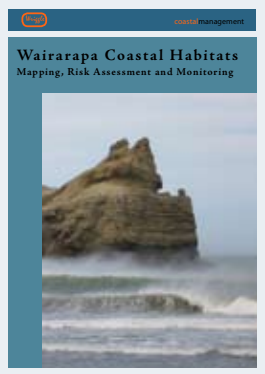
Develop a plan to minimise the loss of ecosystem services of coastal habitats that are vulnerable to climate change effects, particularly sea level rise. A preliminary requirement is a detailed coastline contour map (at approximately 0.2m accuracy).

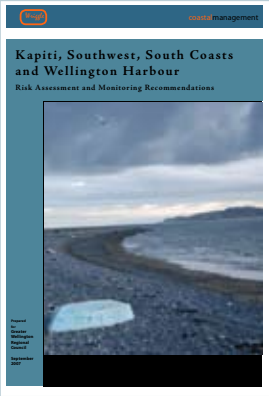
PLAN TO IMPROVE HABITAT DIVERSITY AND CONDITION IN SMALL TIDAL RIVER MOUTH ESTUARIES

Undertake in a staged manner, one estuary at a time.

1. INTRODUCTION

AIM AND SCOPE





Developing an understanding of the distribution and risks to coastal and estuarine habitats is critical to the management of ecological resources. Recently, Environment Southland (ES) contracted Wriggle Coastal Management to identify the habitat vulnerability and monitoring priorities for coastal ecological resources in the Southland Region using a similar approach to that recently used in the Greater Wellington region (Robertson and Stevens 2007a, 2007b, 2007c). The approach targets the highest priority section of the coastline as the first step (i.e. the developed section of the coast from Waiparau Head in the Catlins to Bluecliffs in Te Waewae Bay) and includes 3 main components which produces the following outputs:

- **Coastal Habitat Maps:** An ArcMap GIS dataset depicting current broad-scale habitat cover types along the coast, using aerial photographs and ground truthing techniques (Robertson and Stevens 2007a, 2007b). Completed habitat maps for each section of the coast are presented in Appendix 3.

- **Vulnerability Assessments**: An assessment of the "vulnerability" of the coastline habitats based on the sensitivity of the receiving environment, human uses, and the upstream catchment area risk factors (stressors) associated with each section of the coast. The approach used is an adaptation of an existing UNESCO methodology (UNESCO 2000) and a risk-based matrix developed for broad scale assessments of beaches, dunes, rocky shores and estuaries (Robertson et al. 2002, Robertson and Stevens 2007a, 2007b). Completed vulnerability assessments for each section of the coast are presented in Appendix 2).

- **Monitoring Priorities:** A recommended coastal monitoring programme for the management of coastline biological resources in the region.

The remainder of the ES coastline (i.e. Stewart Island, South Westland and Fiordland) is expected to be assessed using a similar approach sometime in the future.

STRUCTURE

Porpoise Bay

Section 1 provides an introduction to the scope and structure of the study.

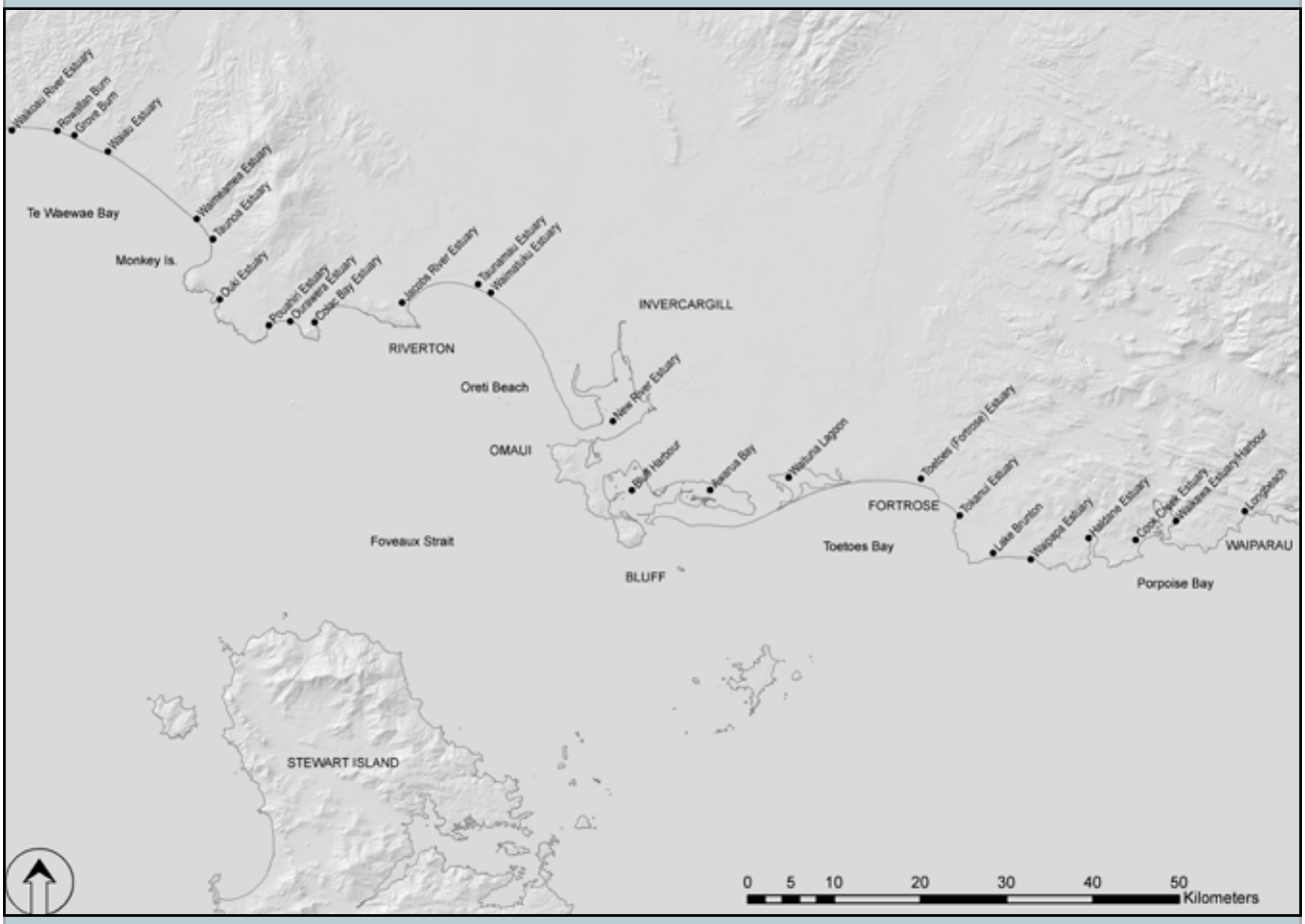
Section 2 introduces the methods used for the habitat mapping, vulnerability assessments and for identifying monitoring recommendations.

Section 3 provides a broad introduction to the coast by identifying the major coastal shoreline habitats (their characteristics, issues, values and uses and key stressors).

Sections 4, 5, 6, 7, 8 , 9 and the conclusions (Section 10) provide the summary detail for the coast in a section by section approach. For each section of the coast, it describes their characteristics, issues, values and uses, recommended monitoring, existing condition and susceptibility ratings. These summary details are derived from the following appendicised outputs:

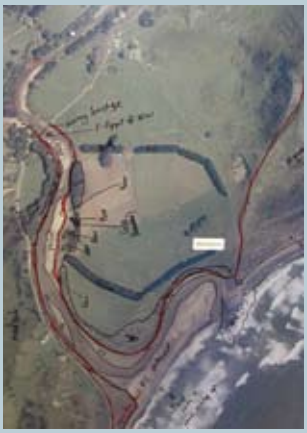
- **Appendix 1**: Detailed summary information on estuaries.
- **Appendix 2:** Vulnerability assessments for coastal habitats.
- **Appendix 3:** Habitat maps.

MAP OF SOUTHLAND - TE WAEWAE BAY TO WAIPARAU HEAD



2. METHODS

COASTAL HABITAT MAPS



Example of laminated aerial photo with ground-truthing details

Broad-scale mapping is a method for describing habitat types based on the dominant surface features present (e.g. substrate: mud, sand, cobble, rock; or vegetation: seagrass, macroalgae, rushland, etc). It follows the EMP approach originally described for use in NZ estuaries by Robertson et al. (2002) and for other sections of the NZ coast by Robertson and Stevens (2006), with a combination of aerial photography, detailed ground-truthing, and GIS-based digital mapping used to record the primary habitat features present. Very simply, the method involves three key steps:

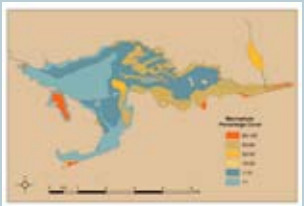
- Obtaining laminated aerial photos for recording dominant habitat features.
- Carrying out field identification and mapping (i.e. ground-truthing).
- Digitising the field data into GIS layers (ArcMap 9.2).

For the 2008 study, ES supplied rectified 0.3m/pixel resolution colour aerial photos flown in 2008. Photos covering the coastline at a scale of 1:10,000 were laminated, and two scientists ground-truthed the spatial extent of dominant habitat and substrate types by walking the extent of the coastline, taking field photographs, and recording features directly onto the laminated aerial photos over a few weeks in April 2008.

Because the main estuaries and harbours had all been previously mapped, the existing habitat maps were used for the present assessment. They were as follows:

- Waiau Estuary (Stevens and Robertson 2008),
- Jacobs River Estuary (Robertson et al. 2003),
- New River Estuary (Stevens and Robertson 2007),
- Bluff Harbour and Awarua Bay (Robertson et al. 2004 and 2004a),
- Waituna Lagoon (Robertson and Stevens 2007),
- Toetoes (Fortrose) Estuary (Robertson et al. 2003a),
- Haldane Estuary (Stevens and Asher 2005) and
- Waikawa Estuary (Robertson et al. 2004b).

Appendix 3 lists the class definitions used to classify substrate and vegetation. Vegetation was further classified using an interpretation of the Atkinson (1985) system, whereby dominant plant species were coded by using the two first letters of their Latin genus and species names e.g. marram grass, *Ammophila arenaria*, was coded as Amar. An indication of dominance is provided by the use of ( ) to distinguish subdominant species e.g. Amar(Caed) indicates that marram grass was dominant over ice plant (*Carpobrotus edulis*). The use of ( ) is not always based on percentage cover, but the subjective observation of which vegetation is the dominant or subdominant species within the patch. A measure of vegetation height can be derived from its structural class (e.g. rushland, scrub, forest).



Broad scale habitat map Waituna Lagoon

Results were entered by digitising features directly off aerial photos in the GIS using a Wacom Intuos3 electronic drawing tablet within ArcMap 9.2. The spatial location, size, and type of broad scale habitat features are provided as ArcMap 9.2 GIS shapefiles on a separate CD. Georeferenced digital field photos (GPS-Photolink) are also supplied as a GIS layer. As the GIS structure allows data to be easily managed, and contains a much greater level of detail than can be concisely presented in a summary report, the GIS should be used as the primary resource for assessing broad scale data. Results are summarised in the current report in Appendix 3.

2. METHODS (CONTINUED)

VULNERABILITY ASSESSMENTS AND MONITORING RECOMMENDATIONS

The Ecological Vulnerability Assessment (EVA) is a tool adapted from a UNESCO methodology (UNESCO 2000) that is designed to be used by experts to represent how coastal ecosystems are likely to react to the effects of potential "stressors" (the causes of coastal issues - often human activities). The EVA consists of:

- a series of matrices (A, B and C) for estuaries, and
- a series of matrices (A, B and C) for beaches, dunes and rocky shores.

The matrices include a series of four background tables (1. Human Uses, 2. Ecological Values, 3. Presence of Stressors, 4. Existing Condition and Susceptibility). The steps to filling in the matrices are summarised below with worked examples presented on pages 6 to 10. The completed matrices for each section of the coast are presented in Appendix 2.

The first step is to determine what are the important human uses and ecological values by providing a rating (high, moderate, low or very low). The second step is to rate the presence of existing stressors or pressures. The third step is to rate the existing condition and the physical susceptibility of the coastal habitat. The fourth step is to identify the major issues and what should be monitored. This is undertaken by assessing which monitoring indicators (e.g. nutrients, chlorophyll a, macroalgal cover) are most likely to be at risk. Those most at risk are the ones where all of the following are rated in the moderate or high category:

- risk of an indicator affecting a particular use/value.
- risk of an indicator being impacted by a particular stressor.
- risk of an indicator of existing condition already being impacted.
- risk of an indicator being impacted by the physical susceptibility of the coastal habitat.

The final step is to provide an overall coastal vulnerability rating based on an expert appraisal of the combined ratings. The "vulnerability" ratings are then used to design a monitoring programme for the priority monitoring indicators using currently available tools (Table 1) including; the National Estuary Monitoring Protocol (EMP) (Robertson et al. 2002), plus recent extensions (Robertson & Stevens 2007a).

Table 1. Coastal Monitoring Tools (Wriggle Coastal Management).

Resource	Tools for Monitoring
Estuaries	Estuary vulnerability matrix. Broad scale estuary and 200m terrestrial margin habitat mapping. Fine scale estuary monitoring. Sedimentation rate measures (using plates buried in sediment). Historical sedimentation rates (using radio-isotope ageing of sediment cores). Macroalgae and seagrass mapping (reported as separate GIS layers). Condition ratings for key indicators. Geo-referenced digital photos (as a GIS layer). Upper estuary monitoring and assessment.
Beaches, Dunes	Beach and dune vulnerability matrix. Broad scale beach, dune and terrestrial margin mapping. Fine scale beach monitoring. Condition ratings for key indicators. Geo-referenced digital photos (as a GIS layer).
Rocky Shores	Rocky shore vulnerability matrix. Broad scale rocky shore and terrestrial margin mapping. Fine scale rocky shore monitoring. Geo-referenced digital photos (as a GIS layer).

2. METHODS (CONTINUED)

A summary of each of the 4 components of the background tables is as follows:

1. Human Uses

Information on the human uses and values of the coastal habitat and its margins were based on local knowledge and available information. The estimated number of persons involved was used to guide the rating:

- Low: < 10 per year.
- Medium: 10 to 50 per year (< 30 per day in summer).
- High: > 30 per day (maybe just in summer) but < 200 per day.
- Very High: > 200 per day.

2. Ecosystem Values

Ecosystem values (richness) defines an ecosystem's natural riches (generally interpreted as habitat diversity and biodiversity). It can be supposed that the more rich and diversified an ecosystem is, the greater the losses will be in the event of a disruption. The ecological richness component is divided into four subcategories; birds, vegetation, fish and other biota.

3. Presence of Stressors (Pressures)

The stressors (or pressures) are activities (often in the catchment) that affect the ecological condition of coastal habitat (e.g. sea level rise, terrestrial runoff, grazing, seawalls, reclamation). Because their harmful effects cause a variety of environmental deteriorations they are identified and their risk characterised according to their estimated effect on relevant condition indicators (e.g. loss of saltmarsh, macroalgal growth). The assignment of risk is based on existing data (e.g. landuse, sediment and nutrient areal loadings, rock type, erosion susceptibility), observation and expert opinion.

4. Ecosystem Existing Condition and Susceptibility

The **"existing condition"** is a measure or estimate of the existing condition of the coastal habitats as assessed by relevant condition indicators (e.g. signs of eutrophication, sedimentation, habitat loss). The existing condition of the coastal area was primarily assessed based on expert opinion, supported by available information and monitoring data.

"Susceptibility" is assessed to provide an estimate of the susceptibility of the ecosystem to degradation. For example, an estuary where the mouth closes regularly and is poorly flushed, is physically susceptible to water and sediment quality degradation. Where uncertainty existed over the presence or potential impact of stressors, a conservative (protective) estimate was used.

The project scope was limited to the use of expert judgement to quickly and cost effectively review existing knowledge and identify what issues are most likely to affect the Southland coastal habitats, and from this make recommendations on monitoring and managing identified issues. A key feature of the methodology is that it can be used with varying levels of detail. Because many potential stressors may be either absent or unlikely to have a significant impact, expert judgement is commonly used to identify what issues are most likely to affect a particular habitat. This then provides a basis for deciding what level of effort should be put into addressing different issues. For example, existing knowledge or a synoptic survey may be sufficient to identify an issue as being both significant and present in a susceptible estuary. If more detailed studies are likely to reach the same conclusion, it may be most appropriate to focus resources on management rather than further study. Conversely, more detailed study may be needed to determine whether management is possible or likely to be effective before it is initiated.

COASTAL ECOLOGICAL VULNERABILITY RATING : MATRIX EXAMPLES

Three matrices are used: Matrix C (this page) is applied across all coastal habitats. Matrix A (Uses and Values) and Matrix B (Stressors, Existing Use, and Susceptibility) are applied to 2 key habitats: 1. Beaches, dunes and rocky shores, and 2. Estuaries.

STEPS FOR FILLING OUT MATRIX A AND MATRIX B:

Matrix A (see examples on pages 7 and 9).	1. Rate the human use and ecological value of each habitat type.
Matrix B (see examples on pages 8 and 10).	2. Rate the presence of existing stressors or pressures. 3. Rate the likelihood of a stressor affecting a particular indicator (and issue). 4. Rate the physical susceptibility for each indicator and overall susceptibility. 5. Rate the existing condition for each indicator and overall existing condition. 6. Rate each indicator for monitoring priority by comparing the Matrix B ratings for stressors, existing condition, and susceptibility with the Matrix A, and the Matrix C pre-calculated ratings for human and ecological values. 7. Identify which are the major issues based on indicator ratings. 8. Determine the overall rating based on average of all ratings.

MATRIX C -Likelihood of Issue Affecting Uses and Values (pre-calculated for all coastal habitats)

Key for Use and Value Rating
High
Moderate
Low
Very Low

ISSUE	MONITORING INDICATORS	HUMAN USES: Bathing, surfing	Shellfish collection	Natural character, aesthetic	Boating	Fishing, white-baiting	ECOLOGICAL VALUES: Birds	Vegetation (dune, saltmarsh, seagrass)	Other Biota (macrinvertebrates)	Fish
		LIKELIHOOD OF ISSUE AFFECTING USE								
Eutrophication	Dissolved Oxygen									
	Clarity									
	Nutrients									
	Chlorophyll/phytoplankton									
	Macroalgal growth									
	Redox Disc. Profile/Smell									
	Org C sediments									
Sediment	Muddiness									
	Sedimentation rate									
	Clarity									
Disease	Faecal Indicators									
Toxicity	Heavy Metals									
	SVOCs									
	Toxic algae									
Habitat Change	Habitat Mapping									
	Macrophyte Mapping									
	Margin Mapping									
	Shellfish									
	Fish									
	Macroinvertabrates									
	Sea Level									

COASTAL ECOLOGICAL VULNERABILITY RATING - BEACH, DUNE AND ROCKY SHORE

LOCATION: TE WAEWAE BAY - Beach and Dunes
DATE: April 2008

OVERALL VULNERABILITY RATING - Te Waewae Bay - Beach and Dunes

Human Use	High
Ecological Value	Moderate
Existing Condition	Good
Susceptibility	Low
Stressors	Low-Mod
OVERALL VULNERABILITY	Low-Mod

Monitoring Recommendations:

- Broadscale mapping of all coastal habitats at 10 year intervals.
- Fine scale monitoring of representative high diversity site - Bluecliffs beach area (Annual baseline for 3 years and every 5 years subsequent).

MATRIX A - Uses and Values (Beaches, Dunes and Rocky Shores)

Key for Use and Value Rating
High
Moderate
Low
Very Low

Key For Issue/Indicator Rating
High
Moderate
Low
Very Low

HABITAT RATING	HUMAN USE: Bathing, surfing	Shellfish collection	Natural character, aesthetic, picnics, walking	Boating	Fishing, white-baiting, duckshooting	ECOLOGICAL VALUES: Birds	Vegetation (dune, saltmarsh, seagrass)	Other Biota	Fish
Dune Active									
Dune Stable									
Beach Sand									
Beach Gravel									
Beach Cobble									
Rock/Boulder									
Cliff									
Coastal Herbfield									
Inshore Water									

COASTAL ECOLOGICAL VULNERABILITY RATING - BEACHES, DUNES, ROCKY SHORES

LOCATION: TE WAEWAE BAY - Beach and Dunes
DATE: APRIL 2008

MATRIX B - Stressors, Existing Condition and Susceptibility

Key For Rating	
Stressors	Existing Condition
High	Poor
Moderate	Fair
Low	Good
Very Low	Very Good

		PRESENCE OF STRESSORS																	CONDITION		RESPONSE
		Sea Level Rise	Catchment runoff	Point Discharges	Climate Change Rain/Temp	Spills (incl. oil)	Grazing	Freshwater abstraction	Reclamation	Erosion control structures	Food collection	Algal blooms (from sea)	Structures (incl. marine farms)	Invasive weeds/pests	Mouth closing/constriction	Vehicle damage	Margin development	Floodgates	Existing Condition	Susceptibility	Comments
HABITAT RATING	Dune Active																				
	Dune Stable																				Revegetate
	Beach Sand																				Protect shellfish
	Beach Gravel																				Maintain FW
	Beach Cobble																				
	Rock/Boulder																				
	Cliff																				Plan for erosion
	Coastal Herbfield																				Protect
	Inshore Water																				
ISSUE	MONITORING INDICATORS	RISK OF STRESSOR AFFECTING INDICATOR																			
Eutrophication	Dissolved Oxygen																				
	Clarity																				
	Nutrients																				
	Chlorophyll/phytopl.																				
	Macroalgal growth																				
	Redox Disc. Profile/Smell																				
	Org C sediments																				
Sediment	Muddiness																				
	Sedimentation rate																				
	Clarity																				
Dis-ease	Faecal Indicators																				
Toxicity	Heavy Metals																				
	SVOCs																				
	Toxic algae																				
Habitat Change	Habitat Mapping																				
	Macrophytes																				
	Margin																				
	Shellfish																				
	Fish																				
	Macro-invertebrates																				
	Sea Level																				

COASTAL ECOLOGICAL VULNERABILITY RATING - ESTUARIES

LOCATION: WAIKOAU ESTUARY
DATE: APRIL 2008

OVERALL VULNERABILITY RATING
Waikoau Estuary

Human Use		Moderate
Ecological Value		Moderate
Existing Condition		Very Good
Susceptibility		Low
Stressors		Very Low
OVERALL VULNERABILITY		Low

Monitoring Recommendations:

- Broadscale mapping of all coastal habitats at 10 year intervals.

MATRIX A - Uses and Values (Estuaries)

Key for Use and Value Rating
High
Moderate
Low
Very Low

Key For Issue/Indicator Rating
High
Moderate
Low
Very Low

		HUMAN USE						ECOLOGICAL VALUES			
		Bathing, surfing	Shellfish collection	Natural character, aesthetic	Boating	Fishing, white-baiting, duckshooting		Birds	Vegetation (dune, saltmarsh, seagrass)	Other Biota	Fish
HABITAT RATING	Estuary Saltmarsh										
	Estuary Soft Mud										
	Estuary Firm Mud/Sand										
	Estuary Gravel/Cobble										
	Aquatic Macrophytes										
	Biogenic Structures										
	Terrestrial Margin										
	Subtidal										

COASTAL ECOLOGICAL VULNERABILITY RATING - ESTUARIES

LOCATION: WAIKOAU ESTUARY
DATE: APRIL 2008

MATRIX B - Stressors, Existing Condition and Susceptibility

Key For Rating	
Stressors	Existing Condition
High	Poor
Moderate	Fair
Low	Good
Very Low	Very Good

		PRESENCE OF STRESSORS																	CONDITION		RESPONSE
		Sea Level Rise	Catchment runoff	Point Discharges	Climate Change Rain/Temp	Spills (incl. oil)	Grazing	Freshwater abstraction	Reclamation	Erosion control structures	Food collection	Algal blooms (from sea)	Structures (incl. marine farms)	Invasive weeds/pests	Mouth closing/constriction	Vehicle damage	Margin development	Floodgates	Existing Condition	Susceptibility	HABITAT RESPONSE
	Estuary Saltmarsh																				
	Estuary Soft Mud																				
	Estuary Firm Mud/Sand																				
	Estuary Gravel/Cobble																				
	Aquatic Macrophytes																				
	Biogenic Structures																				
	Terrestrial Margin																				
	Subtidal																				Mouth constricts
ISSUE	MONITORING INDICATORS	RISK OF STRESSOR AFFECTING INDICATOR																			
Eutrophication	Dissolved Oxygen																				
	Clarity																				
	Nutrients																				
	Chlorophyll/phytopl.																				
	Macroalgal growth																				
	Redox Disc. Profile/Smell																				
	Org C sediments																				
Sediment	Muddiness																				
	Sedimentation rate																				
	Clarity																				
Dis-ease	Faecal Indicators																				
Toxicity	Heavy Metals																				
	SVOCs																				
	Toxic algae																				
Habitat Change	Habitat Mapping																				
	Macrophyte Mapping																				
	Margin Mapping																				
	Shellfish																				
	Fish																				
	Macro-invertebrates																				
	Sea Level																				

3. COASTAL HABITAT TYPES

BEACHES

Dissipative beach type, Oreti Beach

Intermediate beach type, Waipapa

Reflective beach type, Tiwai

Low energy beach type, Toetoes Harbour

Beaches are common along the Southland coast and include 4 broad types described below. The type of beach is important in determining beach ecology (Defeo and McLachlan 2005), key aspects being:

- The number of species decreases as beach slope and grain size increases.
- Abundance varies along a beach (greatest numbers in the centre, fewer at the edges, but environmental gradients (e.g. wave exposure) can cause asymmetries.
- Zonation is generally dynamic and not sharply defined because of short (hourly) or medium term (seasonal) reactions to environmental conditions, passive transport and sorting by the swash (e.g. bivalve recruits getting washed up to the least preferable high tide sands during storms), active micro-habitat selection (e.g. bivalve adults digging in to preferred habitat) and interactions within and between species.
- Intermediate beaches are spatially and temporally the most dynamic (Wright and Short 1984). They undergo rapid changes as wave height fluctuates, causing reversal in onshore/offshore and alongshore sediment transport.
- Such high natural variability means that the design and interpretation of any ecological monitoring must consider carefully the establishment of reference sites and baseline conditions.

(1) Dissipative to Intermediate Type Beaches (e.g. Oreti Beach). Relatively flat, and fronted by a wide surf zone in which waves dissipate much of their energy. They have been formed under conditions of moderate tidal range, high wave energy and fine sand. Their sediments are well sorted (usually fine to medium sand), and they have weak rip currents with undertows. The tidal flat is at the extreme end of dissipative beaches. Compared with other beach types their ecological characteristics include the following:

- Interactions within and between species are generally more intense.
- High level of primary production, diversity and biomass of macrofauna.
- Exporters of organic matter.
- More highly regulated by biological interactions.

(2) Intermediate Type Beaches (e.g. Orepuki Beach). There are a large number of intermediate state beaches in the area, many of them occurring in the semi-exposed areas of long beach sections or embayments. These are characterized by plunging and spilling breakers, steeper than dissipative beaches but less steep than reflective beaches, very mobile sediments, and rip-currents are common. Ecologically, they tend towards intermediate species richness.

(3) Reflective Type Beaches (e.g. Tiwai, Toetoes Beach). Steep, reflective type beaches with sand, gravel and cobble sediments are the main type of beach in Southland. These beaches tend to be accumulating coarse sediments rather than eroding. They have little or no surf zone and wave energy is reflected back to the sea from waves breaking directly on the steep beach face. Their ecological characteristics include the following: low primary production, impoverished macrofauna, low species richness and populations mainly physically controlled, and reliance on organic material imported from sea.

(4) Low Energy Beaches (e.g. Toetoes Harbour).

Moderately steep, often productive and generally narrow beaches, where sand movement is restricted because of low wave action.

The key stressors or threats to beach condition are; pollution, sea level rise, artificial structures, and vehicles on beaches (see following page for details).

3. COASTAL HABITAT TYPES (CONTINUED)

KEY BEACH STRESSORS

Pollution

Site-specific problems such as exposure to polluted river plumes, wastewater discharges, oil spills and litter all have an adverse effect on beaches. Except for large-scale infrequent discharges such as oil spills, pollution tends mainly to influence embayed coastlines. Chronic effects such as eutrophication can have broader-scale impacts over whole coastlines, and elevated nutrient levels have also been implicated in a trend of increasing frequency of catastrophic biota kills due to harmful algal blooms. Siltation is likely to increase due to urbanisation of catchments and estuaries, and changes in agricultural practice can cause considerable impacts.

Wastewater plume - Howells Point near Riverton.

Climate Change and Sea Level Rise

In the past century, sea level rise has averaged approximately 2.1mm/year, but this is predicted to increase up to 7mm/year or more in the next 100 years (Ministry Environment 2008). The 1992 International Panel on Climate Change reports that a 1cm rise in sea level erodes beaches about 1m horizontally. This becomes a large issue for beaches with low-lying margins. If the margin is protected by a seawall, erosion of sand from the beach face occurs and deposits it offshore to maintain constant water depth. If not protected, a 50cm rise in sea level will inundate large areas of dry land, some permanently and some episodically. Areas that have low gradients will be most affected, e.g. beach ridges, deltas, mudflats, estuaries, lagoons, and bays.

Toetoes Beach near Tiwai - such low lying coastal hinterlands will be inundated with sea level rise.

Over-collection of Living Resources

Direct removal of living resources has had major effects on beaches at both local and regional scales and is likely to increase as expanding human populations put further pressure on resources.

MFish signs on recreational harvesting limits and the ban on Toheroa collection in Te Waewae Bay.

Artificial Structures (seawalls, breakwaters, groynes)

Pressure to protect the coastline by artificial structures (breakwaters, seawalls, groynes, wharves, jetties) is expected to increase because of coastal development, and to defend against sea-level rise and the expected greater frequency of storms. However, seawall establishment often leads to erosion of sand from the beach face in front of the wall, depositing it offshore. The resulting loss of sand from in front of the wall can result in increasing wave energy, undermining the wall itself, impacting on beach ecology, and limiting the supply of sand available for dune formation.

Colac Bay seawall.

Vehicles

Vehicle use on dunes and the backshore of sandy beaches (i.e. immediately above the intertidal area) has been demonstrated to be highly damaging to plants and animals, whereas in the intertidal section it appears to be minimal (Stephenson 1999) although available information is limited.

Vehicle on beach at Kawakaputa Bay.

3. COASTAL HABITAT TYPES (CONTINUED)

DUNES

Section A Type dune (Oreti Beach)

Section B Type dune (Oreti Beach)

Section C Type dune (Three Sisters Dune, Omaui Point)

Steep, eroded marram grass foredune (Waipapa Beach)

Most beaches in Southland are backed by vegetated sand ridges called dunes, built up by dry beach sand blown inland and trapped by plants and other obstructions. Dunes are largest where there is a good supply of sand from the sea, and where wind is common. As sand accumulates, the dunes become higher and wider. Dunes that are able to migrate, because they are not completely covered with vegetation, are called active dunes. Once they are covered in plants, they are called stable dunes. Sand dunes play an important part in protecting the coastline as they act as a buffer against wave damage during storms, protecting the land behind from salt water intrusion. This sand barrier allows the development of more complex plant communities in areas protected from salt water inundation, sea spray and strong winds. Given the predicted accelerated sea level rise with climate change, this function of dunes is expected to become even more important.

To function effectively, dunes need to be in good condition. The key stressors or threats to dune condition are; sea level rise, grazing by stock, agricultural development, vehicle and pedestrian damage, weed invasion, displacement of native sand binding grasses by exotic species, and displacement by seawalls, roads and buildings (see following page for details).

The structure and vegetation cover on coastal dune systems vary markedly, dependent on location and exposure. Figure 1 provides cross sections of 3 typical Southland dune systems and the general zones found within them.

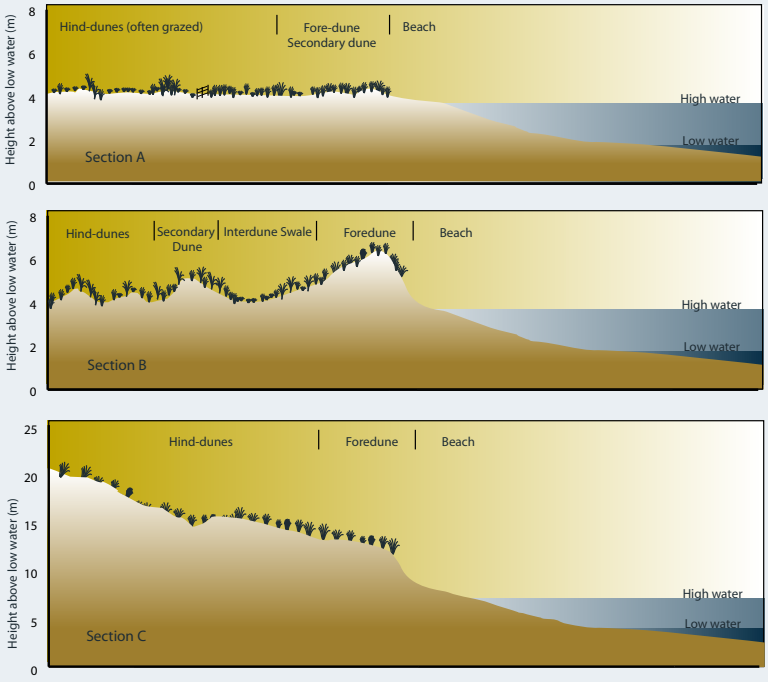


Figure 1. Cross sections of 3 typical Southland dune systems.

The vulnerability of these zones differ. The beach itself is reasonably tolerant but the foredune is extremely fragile and is dependent on healthy vegetation cover for dune stability.

3. COASTAL HABITAT TYPES (CONTINUED)

KEY DUNE STRESSORS

Exotic Dune Vegetation

Heavy grazing of dunes in the past resulted in the reduction of native dune species and subsequent sand movement inland. Marram grass and lupin were introduced for erosion control and to stop the spread of wind blown sand, with exotic forests or pasture often established on stabilised dunes. The dominance of marram grass (which is prolific and has tended to outcompete the native sand-binders spinifex and/or pingao) has caused dune instability problems. This has tended to result from overstabilisation of the dune system resulting in marram dominated dunes that are generally taller, have a steeper front, and occupy more area than native dunes. Such dunes tend to lock up sand, limiting replenishment of sand to the beach and being susceptible to erosion of the dune front during storms. They also tend to contribute to the loss of biodiversity and natural character with blow-outs being common (Hilton 2006).

Grazing and weed invasion

The effect of stock grazing in dunes reduces the height of plants and encourages mobilisation of dunes. It also leads to a decreased organic and nutrient content of the duneland. Stock trampling also encourages mobilisation as does sheep rubbing against small blowouts. Stock grazing can be used to control weed growth in dunes, particularly in areas well back from the foredune, although excessive grazing leads to high levels of damage and weed invasion.

Vehicles

Vehicle use on dunes and the backshore of sandy beaches (i.e. immediately above the intertidal area) has been demonstrated to be highly damaging to plants and animals, whereas in the intertidal section it appears to be minimal (Stephenson 1999) although available information is limited.

Displacement of dunes by seawalls and roads.

A common response to accelerated horizontal erosion is to armour the beach with a seawall. Although this may protect terrestrial property, seawalls can cause damage to the beach and its ecology by eroding at the ends and causing accelerated erosion of the beach in front of the wall, and by the loss of dune habitat.

Climate Change and Sea Level Rise

In the past century, sea level rise has averaged approximately 2.1mm/year, but this is predicted to increase up to 7mm/year or more in the next 100 years (Ministry Environment 2008). The 1992 International Panel on Climate Change reports that a 1cm rise in sea level erodes beaches about 1m horizontally. This becomes a large issue for beaches and dunes with low-lying margins. As sea level rises in the future, free migration of dunes onto low-lying adjacent land will be necessary if duneland is to be maintained.

Exotic marram grass dunes near Ocean Beach.

Weed invasion and cows grazing in fore and backdunes, Riverton end of Oreti Beach.

Motorbike in dunes - Oreti Beach.

Colac Bay seawall.

Low lying pasture behind existing dunes, Oreti Beach

3. COASTAL HABITAT TYPES (CONTINUED)

DUNES (CONTINUED)

Three Sisters Dune, Omaui Point

Kawakaputa Bay from large dunes at eastern end

Porpoise Bay dunes with sandbags used for erosion protection

Once even small patches of the seaward slopes of the foredune, secondary dunes and backdunes lose their vegetation, strong onshore winds can complete the destruction by producing blowouts initially, then transverse mobile dunes and, finally, a completely unstable dune system which moves inland. Loss of sand from the frontal dune system caused by wind action accelerates the landward movement of the coastline. Natural recovery from damage is slow because environmental conditions are unfavourable for plant growth. The presence of introduced marram grass as the dominant sand binder tends to exacerbate this problem in that it promotes dune instability (see explanation in photo caption, previous page).

The landward slopes of the dunes are less fragile but are still only moderately tolerant to the various stressors or threats. The backdune slope is considered the most suitable for development but only if it is not susceptible to erosion. However, there is growing recognition that dunelands are an attractive landscape with unique ecosystems and, in terms of coastal management, they protect low lying coastal areas from flooding and act as a buffer against erosion (they form a reservoir of sand, replenished when beach levels are high and released to nourish the foreshore during storm erosion). They are also areas of considerable scientific, conservation, landscape and recreational value.

As a consequence of this growing recognition of the importance of dunes, the rate of loss of duneland slowed over the 1990's, as dunes have come under the management of the Department of Conservation (DOC) and Regional Councils. In many places, restoration groups are replanting active dunes with native sand-binders spinifex (*Spinifex serceus*) and/or pingao (*Desmoschoenus spiralis*). For example, on Toetoes Harbour spit, DOC has used herbicide to kill marram grass and encourage pīngao.

Within Southland, the largest remaining active dunelands are on Oreti Beach and Stewart Island (Mason Bay). Both are on west-facing coasts, where they are exposed to the prevailing winds. The dunes with the highest biological values were identified by Johnson (1992), and two national priority dune systems were identified on the Southland mapped section of the coast:

- The marram, pingao, sand tussock (*Austrofestuca liitoralis)*, sand pimelia, saltmarsh community on the Toetoes Harbour spit.
- The marram, herb, scrub and rata-kamahi forest communities at Long Beach and Dummys Beach in the Catlins.

However, other sections with moderately high values were identified at Kawakaputa Bay, Colac Bay, Howells Point (near Riverton), Three Sisters (Omaui), Tiwai Beach, Waituna Beach, Waipapa Beach and Point, Waikawa Harbour and Shades Beach (Catlins). In addition, smaller areas of both active and stable duneland are relatively common above high water along many sections of the Southland coast. In the Te Waewae section, duneland is restricted to a narrow strip between the cliffs and the beach. More extensive and partially active dune systems are present at Kawakaputa and Colac Bays. Toetoes Bay has a narrow low dune at the Tiwai end, a narrow beach ridge with turf herbfields, silver tussock, clubrush and sedge heath bogs in the middle Waituna section, and towards the east a long narrow dune that expands to taller dunes near the Toetoes Harbour spit. At most sites, the backdunes have been converted to pasture or developed for other uses, and the foredunes are dominated by the introduced sand-binding grass, marram grass. Relatively few areas have native sand-binders spinifex and pingao, most associated with replanting initiatives.

3. COASTAL HABITAT TYPES (CONTINUED)

ROCKY SHORES

Pahia Point

Near Curio Bay

Dummys Beach

High cliffs, near Frasers Beach

Rocky shores are a dominant, and visually dramatic, part of the Southland coastline. They exist where the effect of waves on the coast is mainly erosive. Softer rocks are worn down, leaving harder rocks exposed. Rocky shores are the most variable coastal habitat in New Zealand; their character depends on the prevailing rock type, and their profile is usually related to strata formation. The habitat is physically complex, with changes of slope and the presence of rockpools, gullies, crevices and boulders increasing the range of habitats and consequently the number of species present. Because most of the substrate is stable, it provides a secure surface for a variety of organisms such as seaweeds, barnacles, mussels and limpets. These shores also act as important fish nurseries and roosting and feeding areas for birds.

The variable physical conditions, including light availability, degree of exposure, changes in temperature and salinity, aspect, substrate type and biotic features lead to the development of a characteristic zonation of species and habitats. The middle shore generally has the greatest species diversity, whilst the lower shore is most prolific. An environmental gradient is present that ranges from almost totally marine to almost completely terrestrial. Conditions on rocky shores are harsh; organisms have to be able to survive to rapidly changing environmental conditions and to be capable of rapid recolonisation.

Key characteristics of Southland's rocky shores are:

- They are generally very exposed, high-energy shores with hard igneous rock types in the west and softer sedimentary rock types (often with cliffs) in the east (i.e. Catlins area). Sheltered rocky shores occur within the confines of Bluff Harbour. In some areas, the rocks are smaller and more mobile (i.e. boulderfields).
- They are bathed by the Southland Current that flows from the south-western end of the South Island and northwards up the east coast. This current has the highest concentrations of chlorophyll-a around NZ (i.e. very productive waters) due to the mixing of the warmer coastal waters that are poor in macronutrients but iron-rich, with the macronutrient-rich but iron-poor subantarctic waters (Murphy et al. 2001, Schiel 2004).
- Vegetation in the more exposed waters near low water is dominated by the giant southern bull kelp (*Durvillaea antarctica)*.
- Mussels and barnacles are common above the bull kelp zone on the hard rocky shores west of Fortrose, but are less abundant on the softer sedimentary rocks of the Catlins area.
- On low tidal benches with considerable sand scour, tough red algae (corallines and *Gigartina* species) dominate.

These biologically rich and relatively accessible habitats have high value to humans as places to use, enjoy, and learn. Rocky shores are also a vulnerable habitat with the main stressors being; pollution, global climate change, sea level rise, over-collection of living resource and introduction of invasive species (see photographs and captions on the following page).

3. COASTAL HABITAT TYPES (CONTINUED)

KEY ROCKY SHORE STRESSORS

Pollution

Site-specific problems such as exposure to polluted river plumes, wastewater discharges, oil spills and litter all have an adverse effect on beaches. Except for large-scale infrequent discharges such as oil spills, pollution tends mainly to influence embayed coastlines. Chronic effects such as eutrophication can have broader-scale impacts over whole coastlines, and elevated nutrient levels have also been implicated in a trend of increasing frequency of catastrophic kills due to harmful algal blooms. Siltation is likely to increase due to urbanisation of catchments and estuaries, and changes in agricultural practice can cause considerable impacts.

Bluff wastewater discharge - near Ocean Beach.

Climate Change and Sea level Rise

Global change in temperature, sea-level rise and increases in the frequency of storms will affect rocky shores throughout the world, but this will occur over a long time scale. Consequently, over the next 25 years, most of the responses by rocky shore communities are expected to be quite subtle. In the long term, the predictions include loss of rare species, reduction in species diversity, reduced habitat area, and the loss of entire communities of organisms in some situations.

Platform reef near Dummys Beach - such low lying reefs will lose intertidal communities with sea level rise.

Over-collection of Living Resources and Recreation

Direct removal of living resources has had major effects on coastlines at both local and regional scales and is likely to increase as expanding human populations put further pressure on resources. Impacts from recreational activities (e.g. trampling) are likely to increase with greater leisure time in wealthier regions of the world.

Collecting rocky shore animals at Cosy Nook - damage can occur if too many plants or animals are taken or trampled.

Introduction of Invasive Species

Increased global transport is responsible for the introduction of invasive plants and animals to our rocky shores which can cause damage to local rocky shore communities. *Undaria* (a golden brown seaweed introduced to NZ in the 1980s) is a prominent marine pest in Southland (Paterson Inlet and Bluff Harbour) that has had extensive effort put into preventing its spread and removing it from the region.

Example of the invasive seaweed *Undaria*.

3. COASTAL HABITAT TYPES (CONTINUED)

ESTUARIES

New River Estuary - sediment monitoring

Jacobs River Estuary - deep muds

Estuaries are coastal waterbodies that are formed when freshwater from rivers flows into, and mixes with, saltwater from the ocean. Because New Zealand is a narrow, mountainous country with good rainfall it has both a large number of estuaries relative to its size and a variety of estuary types (McLay 1976, Kirk and Lauder 2000, Hume et al. in press). Many are highly valued by humans and contain a wide variety of plant and animal life. In good condition, they provide more life per square metre than the richest New Zealand farmland. Their high value lies in two main characteristics;

- The wide diversity of habitats they offer, and
- Their natural ability to collect and assimilate sediment and nutrients from the surrounding catchment and inflowing tidal waters.

If either of these features are degraded, then the estuary condition deteriorates and the value to humans and aquatic life is lessened. The main stressors or threats to estuaries are; runoff from developed catchments, drainage and reclamation, climate change (sea level rise, changes to temperature and rainfall), overcollection of living resources (e.g. shellfish), artificial structures and introduction of invasive species (see photographs and captions on following page). The main problems affecting New Zealand estuaries are; excessive sedimentation, excessive nutrients, disease risk, toxic contamination, and habitat loss (see below).

Key New Zealand Estuary Issues	
Sedimentation	Because estuaries are a sink for sediments, their natural cycle is to slowly infill with fine muds and clays. Prior to European settlement they were dominated by sandy sediments and had low sedimentation rates (<1 mm/year). In the last 150 years, with catchment clearance, wetland drainage, and land development for agriculture and settlements, New Zealand's estuaries have begun to infill rapidly. Today, average sedimentation rates in our estuaries are typically 10 times or more higher than before humans arrived.
Nutrients	Increased nutrient richness of estuarine ecosystems stimulates the production and abundance of fast-growing algae, such as phytoplankton, and short-lived macroalgae (e.g. sea lettuce). Fortunately, because most New Zealand estuaries are well flushed, phytoplankton blooms are generally not a major problem. Of greater concern is the mass blooms of green and red macroalgae, mainly of the genera *Enteromorpha, Cladophora, Ulva,* and *Gracilaria* which are now widespread on intertidal flats and shallow subtidal areas of nutrient-enriched New Zealand estuaries. They present a significant nuisance problem, especially when loose mats accumulate on shorelines and decompose. Blooms also have major ecological impacts on water and sediment quality and the animals that live there.
Disease Risk	Runoff from farmland and human wastewater often carries a variety of disease-causing organisms or pathogens (including viruses, bacteria and protozoans) that, once discharged into the estuarine environment, can survive for some time. Every time humans come into contact with seawater that has been contaminated with human and animal faeces, we expose ourselves to these organisms and risk getting sick. Aside from serious health risks to recreational users and human consumers, pathogen contamination causes economic loss due to closed shellfishing beds, affecting an important industry in some estuaries. Diseases linked to pathogens include gastroenteritis, salmonellosis and hepatitis A.
Toxic Contamination	In the last 60 years, New Zealand has seen a huge range of synthetic chemicals introduced to estuaries through urban and agricultural stormwater runoff, industrial discharges and air pollution. Many of them are toxic in minute concentrations. Of particular concern are polycyclic aromatic hydrocarbons (PAHs), toxic heavy metals, polychlorinated biphenyls (PCBs), and pesticides. These chemicals collect in sediments and bio-accumulate in fish and shellfish, causing health risks to people and marine life.
Habitat Loss	Estuaries have many different types of habitats including shellfish beds, seagrass meadows, saltmarshes (rushlands, herbfields, reedlands etc.), forested wetlands, beaches, river deltas, and rocky shores. The continued health and biodiversity of estuarine systems depends on the maintenance of high-quality habitat. Loss of habitat negatively effects fisheries, animal populations, filtering of water pollutants, and the ability of shorelines to resist storm-related erosion. Within New Zealand, habitat degradation or loss is common-place with the major causes cited as sea level rise, population pressures on margins, dredging, drainage, reclamation, pest and weed invasion, reduced flows (damming and irrigation), over-fishing, polluted runoff and wastewater discharges.

3. COASTAL HABITAT TYPES (CONTINUED)

KEY ESTUARY STRESSORS

Catchment Runoff
Runoff from developed catchments can carry excessive loads of sediment, nutrients, toxins and disease-causing organisms into estuaries. Excessive sediment leads to muddier estuaries which reduces human use and ecological values. Excessive nutrients stimulate algal blooms (e.g. sea lettuce) and nuisance conditions. Excessive toxins collect in sediments and bio-accumulate in fish and shellfish, causing health risks to people and marine life. Excessive disease-causing organisms can cause serious health risks to recreational users and human consumers and economic loss due to closed shellfishing beds.

Point Source Discharges
The discharge of inadequately treated waste water from municipal and heavy industrial plants into estuaries has the potential to cause significant adverse affects on the estuarine environment, aquatic organisms and human health. Discharges can lead to poor water quality, stained shorelines, unpleasant odours and colourations, health risks to humans, mutations and mortality in aquatic organisms, loss of recreational value, and the accumulation of toxins in the food chain. Currently the New River Estuary receives all of Invercargill 's treated wastewater.

Drainage and Reclamation
Drainage and reclamation of estuaries has destroyed large areas of Southland's estuaries. New River Estuary has lost 26% of its area since 1910 (mainly saltmarsh and freshwater marsh in the Waihopai Arm). This reclamation has destroyed the natural assimilative capacity of that arm of the estuary leading to elevated sedimentation rates and low habitat quality.

Climate Change - Sea level Rise
Estuaries are extremely sensitive to changes in sea level as this can drastically alter the dynamic ecological balance. As the sea level rises estuaries will widen, deepen and tidal penetration upstream will be extended. If sea level rise is not too rapid, saltmarsh and tidal flat vegetation and organisms will likely re-establish to favourable habitat. Certainly society will try to mitigate against shoreline retreat and increasingly saline conditions of adjacent land, but care will be needed as such actions can cause more harm than good. One positive note is that many of Southland's small freshwater estuaries could grow into much larger estuaries with greater habitat diversity.

Climate Change - Rainfall and Temperature
NIWA (see website; http://www.niwa.cri.nz/ncc/clivar/scenarios) currently predict a 1.9 deg C change in annual average air temperature and a 7% increase in the annual average rainfall for Southland by 2090. The wetter climate will likely contribute to increased runoff and greater nutrient, sediment, and pathogen loads to at-risk coastal waterbodies. In combination with increased temperatures, the increased loads will mean much greater vulnerability of Southland estuaries to eutrophication and its associated nuisance conditions (e.g. low oxygen, algal blooms), disease risk and sedimentation.

Artificial Structures (seawalls, stopbanks, causeways)
Pressure to protect developed estuary margins by artificial structures is expected to increase to defend existing development and infrastructure against sea-level rise and the greater frequency of storms. Such artificial shoreline hardening will affect the ecological services of shoreline habitats, particularly where coastal squeeze occurs and marginal vegetation is displaced. These habitats provide physical and biogeochemical buffers in estuaries and are essential to sustainable fishery production.

Other stressors:
Introduction of Invasive Species
Over-collection of Living Resources and Recreation
Stock grazing in channels

Jacobs River Estuary - Green algal bloom caused by excessive nutrients in Aparima River.

Invercargill City point source discharge of treated wastewater to New River Estuary.

Measuring sedimentation rates in the highly reclaimed and now very muddy Waihopai Arm

Saltmarsh habitat will be lost with sea level rise and will need room to migrate inland - Jacobs River Estuary.

Sulphide rich muds in estuaries are likely to become more widespread with climate change.

Seawall and stopbank, road on one side and muddy estuary on other - reclaimed section of New River Estuary.

Stock grazing in streamway upstream of Toetoes Estuary.

3. COASTAL HABITAT TYPES (CONTINUED)

ESTUARIES (CONTINUED)

Small tidal river mouth estuary - Colac Bay

Large tidal river mouth estuary - Waiau Lagoon

Large tidal lagoon estuary - Jacobs River Estuary

Large tidal lagoon estuary - New River Estuary

Three types of estuary were found along the mapped section of the Southland coast: coastal lakes (e.g. Waituna Lagoon), tidal lagoons (e.g. Jacobs River Estuary) and tidal river mouths (e.g. Waimatuku Estuary).

TIDAL RIVER MOUTH ESTUARIES

The majority of the estuaries of the studied area of the Southland coast are small or moderate sized and occur where streams approach the coast as a single channel, but their entry is often constricted (or sometimes blocked completely) by a sand or gravel barrier located just short of the ocean (e.g. Waiau, Taunamau, Waimatuku and Ourawera Estuaries west of Invercargill, and Tokanui Estuary to the east). Such estuaries are of the "tidal river mouth" type. In such estuaries, a brackish lagoon may form on the river side of the barrier (e.g. Waiau Lagoon), whose size, salinity and water quality varies depending on the degree of restriction or choking the river mouth may be experiencing at the time, as well as the river flow and the slope of the coastal plain.

The majority of these estuaries are short and narrow, with saline water intrusion extending only a few hundred metres upstream or not at all. In many cases the estuary channels have been modified by past drainage and channelisation actions. The habitats available for aquatic life in such systems are very limited: tidal flats and saltmarsh are generally small or absent and the water and sediments experience regular cycles of degradation and rejuvenation. When the mouth is restricted and streamflows are low, the estuary may experience symptoms of eutrophication and sedimentation (i.e. muddy, anoxic, black sulphide-rich sediments, algal blooms, low dissolved oxygen and low clarity). When the mouth is open and flows are high, the small narrow channel and lagoon is flushed clean. Although they are likely to be a natural occurrence, such low water quality conditions are exacerbated when sediment, nutrient and pathogen loadings to the estuaries are elevated (e.g. in catchments with intensive agriculture, urban development, or catchments with high erosion). Because of the intensification of agriculture and urban development on the mapped section of the Southland coast, estuary loadings are often elevated.

TIDAL LAGOON ESTUARIES

Most of the large Southland estuaries (e.g. New River Estuary, Bluff Harbour Waikawa Estuary) fit the "tidal lagoon estuary" category. These estuaries are shallow, with large basins and simple shorelines with extensive tidal flats. They generally have a narrow entrance to the sea that is often constricted by a sand bar. Most of the estuary water volume in tidal lagoon estuaries is drained each tidal cycle and hence they have low water residence times (often <3 days) and good flushing. The volume of river water inflow is generally small in comparison to marine inputs. Wind has a large influence and affects currents, mixing and sediment resuspension. The combination of wave resuspension and good flushing means that the majority of sediments tend to be sandy and homogeneous. However, muddy sediments can be present near freshwater inputs and in sheltered arms.

Tidal lagoon estuaries are also well-mixed and the salinity is close to that of the sea. The coastal plumes from such estuaries are generally much cleaner than from tidal river lagoons. Biodiversity is generally high.

3. COASTAL HABITAT TYPES (CONTINUED)

ESTUARIES (CONTINUED)

Waituna Lagoon - extensive wetlands

Ruppia - Waituna Lagoon

Lake Brunton - mats of *Ruppia* exposed with mouth open

Ruppia beds - Lake Brunton

COASTAL LAKE ESTUARIES

Coastal lakes are present predominantly on the east and south coasts of the South Island (e.g. Waituna Lagoon, Wainono Lagoon, Lake Ellesmere, Lake Grassmere and Wairau Lagoon) and in terms of the classification proposed by Kjerfve (1994) this type of lagoon is exceedingly restricted, or blocked, with respect to exchanges of water with the ocean via a lagoon mouth. The water body is typically fresh or brackish, and the lagoon is more usually closed from the sea than open to it. Kirk & Lauder (2000) list their distinctive characteristics as:

- Vulnerable to human use of the surrounding lands and contributing catchments through changes to their hydrological regimes, and their sediment and chemical input loads.
- Vulnerable to global climate change through alterations to input river hydrology and through the possibility of accelerated sea level rise that may increase rates of coastal erosion.
- Associated with mixed sand and gravel coasts, with high wave energy, strong long-shore sediment transport, small tides and undergoing long-term erosion.
- Openings to the sea are rare and short-lived unless created by human action.
- Natural water levels are generally higher and have a smaller range than those now occurring through ongoing human intervention. Lower average water levels relate to agricultural uses of low-lying land marginal to lagoons.
- Ocean salt content of the water body is low. It is derived from salt spray, from over-wash of the enclosing barrier beach, or from inlet through-flow by the tide in the later stages of artificial openings.
- Wind waves and currents are an important, if not dominant, agent of mixing within the lagoon.
- They typically possess important ecological values (e.g. saltmarsh, bird-life and fishery) and contain a mosaic of different habitats.

In terms of their ecology, coastal lakes (in their natural state) tend to have high habitat diversity and ecological richness, which is driven to a large extent by the following features:

- **Extensive Saltmarsh Habitat:** Because coastal lakes have a large area of shallow, wet marginal land with relatively low water level fluctuations, they tend to have a large proportion of their total area in saltmarsh vegetation. For example, Waituna Lagoon (1,350ha) was once surrounded by a huge peat bog wetland of 10,000- 20,000ha (Stevens & Robertson 2007).
- **Extensive Aquatic Macrophyte Beds:** Because catchment-specific sediment yields are relatively small (providing good water clarity) and the lakes are shallow (less than 3m deep), they grow extensive beds of aquatic macrophytes (e.g. horse-mane's weed, *Ruppia* sp). *Ruppia* has been suggested as a keystone species in Waituna Lagoon (Schallenberg & Tyrrell 2007) because of its importance as a habitat for invertebrates and fish, as a food source for invertebrates and waterfowl, and its role in regulating water quality.

4. TE WAEWAE BAY

BEACHES AND DUNES

Western end (Bluecliffs), Te Waewae Bay

Middle section Te Waewae Bay

Waiau Lagoon and barrier spit

Eastern end looking towards Monkey Island

Te Waewae Bay is a very exposed, high wave energy, shallow embayment (30km long) at the western end of the mapped area. Its broad sweeping shoreline is famous for its bent over trees and wild seas spraying mist high onto the cliffs. Over most of its length, the beach backs on to sandstone and alluvium cliffs up to 20m high with a narrow sand and gravel barrier between the cliffs and the sea. These cliffs are thought to have been formed by the combination of tectonic uplift and marine erosion. The Waiau River flows into the middle of Te Waewae Bay.

Beach and Dune - Te Waewae Bay

There are four distinct sections of Te Waewae Bay as follows:

- **Western End (Bluecliffs):** A gentle sloping (intermediate to dissipative type) sandy beach (~150m wide) with cobbles near the upper margin. Above high water, a road is sited between the beach and cliff base. The steep mudstone cliffs are densely vegetated with flax (*Phormium tenax)* , *Hebe*, and broadleaf scrub. A narrow vegetated (mostly marram grass, *Ammophila arenaria*) sand dune extends around 4km west from the Rowallan Burn, before it ends in a steep cobble bank. At the mouth of the Waikoau River, a boulder beach provides substrate for wide range of shellfish and seaweed species. Hectors dolphins and whales frequently swim in the bay with some whales known to have stayed there for breeding.
- **Middle Section (excluding Waiau Mouth and Spit):** A steep (reflective type), coarse grained (sand, gravel, cobble) beach. Above high water, there is generally a thin strip of marram grass and sand tussock duneland bordering the upper beach. This strip backs onto a narrow band of flax, lupins and grasses that rises steeply to sandstone and gravel cliffs.
- **Waiau Mouth**: At the Waiau mouth, there is a 5km long cobble barrier beach or spit with the lagoon it creates situated along the inner margin. The spit is partly vegetated with flax, grass, knobby clubrush, saltmarsh herbfields and in some areas the cushion plant *Raoulia spp.* Prior to hydro-electric power development on the river, the mouth moved over a 4 km length of the coast without full closure. Now closures occur when periods of low river flow coincide with big seas.
- **Eastern End (Orepuki to Monkey Island):** A gently sloping (intermediate to dissipative type) sandy beach with cobbles near the upper margin. Above high water, the terrestrial margin consists primarily of partially vegetated cliffs up to 20m high, but narrow sections of marram duneland occur in some areas at the toe of the cliffs. The beach at Monkey Island (Te Puka-a Takitimu, the anchor stone of the great canoe Takitimu, which as legend tells, was wrecked on the bar of the Waiau river) is popular both with locals and tourists for swimming, camping, picnicking, rock fishing and windsurfing. Hectors dolphins are often seen here.

Given the exposed nature of the embayment, the foreshore is very mobile and much of the coast is subject to erosion. While coastal drift along the Southland coast is generally from west to east, longshore drift in the bay in the vicinity of the Waiau mouth is from east to west. As a result, the coastline east of the Waiau mouth exhibits more widespread erosion than that to the west. The coastal lowland generally comprises alluvial gravels and loess deposits and is used predominantly as grazed pasture. The Waiau River flows into the centre of the bay. Prior to the commissioning of the Manapouri Hydro-Electric Power (HEP) Scheme in 1969 and the subsequent diversion of up to 400 cumecs of the Waiau's flow, it was Southland's largest river. Vegetation immediately inland of the cliffs is primarily grassland used for stock grazing. The beach and cliff areas are generally fenced from stock access but vehicles are sometimes driven on the beach.

4. TE WAEWAE BAY (CONTINUED)

BEACHES AND DUNES (CONTINUED)

Grove Burn Estuary

Horse riding on beach

Playing on Gemstone Beach, Orepuki

Fishing at Gemstone Beach

Surfing - Bluecliffs

Shellfish on rocks - Bluecliffs

Various streams and moderate sized rivers cross the lowland and form small, shallow estuaries adjacent to the beach and in one case, the Waiau, a large lagoon. At times of high seas and low river flows, most of these estuaries become constricted or close off to the sea. The main rivers and streams include; Waikoau River, Rowallan Burn, Grove Burn, Waiau River, Waimeamea River and Taunoa Stream. The Waiau River has a large catchment (primarily native forest and high and low producing pasture) and tends to have good to moderate water quality. The Waikoau, Rowallan, Grove and Waimeamea Rivers drain mainly native bush catchments and are expected to have good water quality. The Taunoa stream drains a small catchment dominated by high producing pasture and native forest scrub and is expected to have moderate water quality. The respective estuaries tend to reflect the same conditions unless they are closed to the sea. During such times they are particularly susceptible to water and sediment quality degradation, in particular, enrichment with nutrients, sediment and pathogens.

Human Uses and Values

Human use of the beach areas and dunes is high from both a tourist and local context. It is particularly valued for its scenic qualities, and its natural character, and is used for walking, bathing, surfing, diving, horse riding, scientific interest, surf-casting, whitebaiting, inshore fishing, shellfish collection, picnicing, sitting, fossicking, gemstone collection and bird-watching. Public access is generally good to certain areas, but in some areas (e.g. Monkey Island, Bluecliffs and Waiau Spit) vehicles drive along the beach (often over shellfish or herbfield and bird nesting habitat).

Ecological Values

Ecologically, the animal diversity of the inshore waters, the beach and the vegetated margin is expected to be moderately high at the two ends of the beach but much lower in the steeper and more mobile, coarse-grained middle section. In particular the Bluecliffs end is known to be particularly rich in shellfish and fish and is expected to have an abundant beach macrofauna. The bay contains surf clams, both toheroa (*Paphies ventricosa*) and the smaller tuatua (*Paphies subtriangulata*) which is more widespread. Toheroa are found intertidally on the fine sand dissipative areas of the beach that are fully exposed to surf (Bluecliffs and near Orepuki). The largest beds are generally found midway between low and high water. The current toheroa population, however, is only a small fraction of that in the 1960s and there are concerns for the long term viability of this population (Beentjes et al. 2006). A key factor in this decline has been attributed to ongoing erosion of fine sand from Bluecliffs Beach, exacerbated by the Waiau diversion. In 1980 all harvesting was prohibited except for customary take, and occasional one-day recreational seasons. In terms of vegetation, the presence of a 9km long native bush shoreline margin at the western end of the bay is very significant ecologically. Another significant area is the Waiau Lagoon spit which has small remnant areas of saltmarsh herbfields and cushionfields (e.g. *Raoulia spp.)* which unfortunately have been degraded by vehicles, stock and weed invasion. Duneland, where present, is dominated by introduced marram grass (*Ammophila arenaria*) and is restricted to a narrow strip around 10km long between the Waiau River mouth and Bluecliffs. Overall, because of the dissipative nature of a significant part of the beach, and the elevated loadings of organic matter from the catchment, the ecological productivity and diversity of beach life is expected to be relatively high. This is reflected in elevated numbers of shellfish, fish (including whitebait) and birdlife present along the beaches and estuary mouths. Where the dune system is in good condition (i.e. devoid of outcompeting weeds and human disturbance), it provides sustainable habitat for a variety of fauna (e.g. beetles, sand hoppers, spiders, birds etc).

4. TE WAEWAE BAY (CONTINUED)

BEACHES AND DUNES (CONTINUED)

Soft rock cliffs near Waiau Mouth

Human Use		High
Ecological Value		Moderate
Existing Condition		Good
Susceptibility		Low
Stressors		Low-Mod
OVERALL VULNERABILITY		Low-Mod

Beach and Dune: Existing Condition:
The Te Waewae Bay beach is in relatively good condition. The beach is bathed by clean, low turbidity waters and there are no signs of poorly oxygenated beach sediments. Regular monitoring for disease risk through bathing and shellfish consumption in Te Waewae Bay indicates a very low risk (ES Water Quality for Bathing and Recreational Shellfish Gathering Annual Monitoring Summary 2005-2006). However, the condition of the dunes and shoreline herbfields have been degraded by vehicles, grazing and weed growth (including the presence of marram grass as the dominant sand-binding species).

Presence of Stressors:
The main stressors on beaches, inshore waters and dunes of Te Waewae Bay are:

- Sea level rise and erosion of soft rock cliffs.
- Freshwater abstraction.
- Catchment landuse intensification (e.g. shift to dairying) causing nonpoint and point source inputs of nutrients and faecal bacteria from grazing animals in the coastal lowland catchments causing river plume effects.
- Vehicles driving on the beach.
- Grazing in shoreline habitats.

Given the very exposed and well-flushed nature of Te Waewae Bay, the high human use and ecological values of the beaches and dunes, and the threats to their condition, it is recommended that monitoring and management be undertaken as follows:

Issues	Monitoring	Management
Potential for degradation of beach habitat and water quality through runoff from intensive catchment landuse, and loss of wetland filters (in particular, shellfish quality and bathing near stream and river plumes).	• Map intensive landuse (urban, high production pasture) in all catchments at 5 yearly intervals. • Map area of wetlands in catchments at regular intervals (5 yearly). • Continue to monitor disease risk (shellfish and water).	• Limit intensive landuse development and/or manage to ensure impacts don't degrade beach habitat and WQ. • Maintain and improve habitat diversity and filtering capacity of existing wetlands in all catchments.
Reduction in biodiversity of high biodiversity beaches through multiple stressors.	Monitor physical, chemical and biological parameters on one dissipative beach (most species rich), e.g. Bluecliffs Beach. Establish 3 year baseline then at 5 yearly intervals.	• Develop trigger criteria for beach condition indicators, and an evaluation and response plan should trigger criteria be breached (e.g. impact of vehicles on beaches needs evaluation).
Degradation of duneland through sea level rise, erosion, grazing, weed invasions, property development.	Map dominant species cover and condition of duneland, and change in position of seaward margin of dune. Repeat broad-scale mapping at 5-10 yearly intervals. Identify hot spots for management.	• Undertake remedial management of identified hotspots using soft Best Management Practices (e.g. revegetation with native sand-binders, weed eradication) wherever possible.

Te Waewae Beach, Dunes	Disease Risk	Algal Blooms	Habitat Loss	Contaminants	Clarity Issues	Invaders/Weeds	Shellfish
Existing Condition Rating	Very Good	Very Good	Very Good	Very Good	Very Good	Good	Good
Susceptibility Rating	Very Low	Low	Moderate	Very Low	Very Low	Low	Low
Vulnerability Rating	Very Low	Low	Moderate	Very Low	Very Low	Low	Low

4. TE WAEWAE BAY (CONTINUED)

WAIKOAU ESTUARY

Estuary Type/Area	Tidal River Mouth
Catchment	98 km^2 (forest)
Dairy cows	0 cows
Nitrogen loading	Low: 3 kg/ha/yr
Catchment geology	Gravel, sandstone/siltstone
Saltmarsh (ha)	<0.1ha (dunes on margins)
Salinity	Varies depending on mouth closure
Mean depth (m)	0.5-1m
Tidal flats	Minor (lagoon floods on beach berm)
Uses/Values	Fishing, swimming, birds, whitebaiting, scenic.

Waikoau Estuary

Human Use		Moderate
Ecological Value		Moderate
Existing Condition		Very Good
Susceptibility		Low
Stressors		Very Low
OVERALL VULNERABILITY		Low

The Waikoau Estuary is a small "tidal river mouth" type estuary (area = 1ha), at the western end of Te Waewae Bay (details in Appendix 1). The estuary is narrow and shallow (mean depth ~0.5-1m) and situated between grassland near the beach and further inland bordered by high siltstone cliffs and native scrub and bush.

Uses and Values. Human use of the estuary is moderate; popular for shellfish, whitebaiting, swimming, and scenic beauty.

Ecological Values. Ecologically, habitat diversity is low given the absence of tidal flats and saltmarsh. However, the substrate is dominated by clean sands and gravels which provide good habitat for fish and invertebrates.

Existing Condition. Salinities vary depending on the extent of tidal inflow and constriction of the mouth. The water is generally very clear but humic stained, and the sediments are clean sand with little sign of anoxic conditions. Water quality in the stream is expected to be high given the predominately native forest catchment and absence of point source discharges. Estimated nitrogen (the major driver of eutrophication) loadings are low. Because the estuary is small and dominated by freshwater inputs, its quality is expected to be similar to that of the stream for much of the time.

Presence of Stressors. The presence of stressors is expected to be very low.

Susceptibility to Stressors. The mouth is expected to periodically constrict or close due to high seas. At such times, it is poorly flushed and water quality may deteriorate to a small extent. However, because of its native bush catchment, it is unlikely to experience symptoms of eutrophication during such events (i.e. nuisance algal blooms, low dissolved oxygen and smelly black sediments), muddy sediments, low clarity and high disease risk to bathers. Given these characteristics, the estuary ecology is susceptible to: any increase in the intensity of landuse in the catchment, loss of native vegetation along the margin (including dune area) and constriction of the estuary mouth.

Waikoau Estuary mouth

Issues	Monitoring	Management
Mouth constricting. Natural cycle of low to high water quality as degree of mouth restriction varies. Estuary margin deterioration.	• Map intensive landuse - 5 yearly. • Habitat map estuary every 10 years.	• Limit intensive landuse development and/or manage to ensure low WQ impacts. • Encourage beach margin revegetation with appropriate species. • Assess possibility of artificial mouth opening.

Waikoau Estuary	Sedimentation	Eutrophication	Disease Risk	Contaminants	Habitat Loss	Invaders	Shellfish
Existing Condition Rating	Very Good	Very Good	Very Good	Very Good	Very Good	Very Good	Very Good
Susceptibility Rating	Low	Low	Low	Low	Low	Low	Low
Vulnerability Rating	Low	Low	Very Low	Very Low	Low	Low	Very Low

4. TE WAEWAE BAY (CONTINUED)

ROWALLAN BURN ESTUARY

Estuary Type/Area	Tidal River Mouth
Catchment	146 km² (native forest)
Dairy cows	0 cows
Nitrogen loading	Low: 3 kg/ha/yr
Catchment geology	Gravel, sandstone/siltstone
Saltmarsh (ha)	<0.2ha
Salinity	<1ppt surface, 25ppt bottom
Mean depth (m)	1 to 2m
Tidal flats	Very limited
Uses/Values	Fishing, swimming, birds, whitebaiting, scenic

Rowallan Burn Estuary

Human Use		Moderate
Ecological Value		Moderate
Existing Condition		Very Good
Susceptibility		Moderate
Stressors		Very Low
OVERALL VULNERABILITY		Low-Mod

The Rowallan Burn catchment drains over 145km² of native bush catchment on the western edge of Te Waewae Bay. The Rowallan Burn Estuary is a shallow, medium-sized "tidal river mouth" estuary that is generally open to the sea (details in Appendix 1). Due to the coarse nature of the bed, low habitat diversity (absence of saltmarsh or intertidal flats), strong salinity fluctuations and water currents, the productivity and biodiversity is expected to be low. The estuary margin vegetation is dominated by native bush upstream and a thin margin of marram duneland near the beach.

Uses and Values. Human use is moderate - seasonally popular for whitebaiting, swimming, picnics and its scenic values.

Ecological Values. Ecologically, habitat diversity is low (absence of tidal flats and saltmarsh) but the clean sands and gravel bed provides good habitat for fish and invertebrates.

Existing Condition. Salinities vary depending on the extent of tidal inflow. The water is generally clear, and the sediments mixed (sand, gravel and cobble) with little sign of anoxic conditions. Currently the water quality in the stream is high (low nutrient and *E. coli* concentrations), reflecting the dominant native forest landuse and large catchment area. Estimated nitrogen (the major driver of eutrophication) and suspended sediment loadings are low. Because the estuary is primarily riverine, its surface quality is expected to be similar to that of the river.

Presence of Stressors. The presence of stressors is expected to be very low.

Susceptibility to Stressors. Susceptibility to stressors is expected to be moderate. The estuary experiences salinity stratification during stable baseflows (i.e. salt wedge effect). The resulting high salinity bottom layer is generally more stable (less well-flushed) and is therefore susceptible to nuisance phytoplankton blooms if nutrient inputs are elevated. In addition, the mouth can constrict or close due to high seas and low flows which causes water quality deterioration. However, because of its native bush catchment, it is unlikely to experience symptoms of eutrophication during such events. Given these characteristics, the estuary ecology is susceptible to any increase in the intensity of landuse in the catchment, beach margin development and mouth closure.

Issues	Monitoring	Management
Salt Wedge. Bottom water prone to algal blooms and low DO if nutrients become elevated. Estuary margin deterioration.	• Map intensive landuse - 5 yearly. • Habitat map estuary every 10 yrs. • Assess DO, RPD, in summer baseflow conditions, every 3 years.	• Limit intensive landuse development and/or manage to ensure low WQ impacts. • Encourage beach margin revegetation. • Assess possibility of artificial mouth opening.

Rowallan Burn Estuary	Sedimentation	Eutrophication	Disease Risk	Contaminants	Habitat Loss	Invaders	Shellfish
Existing Condition Rating	Very Good	Very Good	Very Good	Very Good	Good	Good	Very Good
Susceptibility Rating	Low	Moderate	Very Low	Very Low	Moderate	Low	Low
Vulnerability Rating	Low	Low	Very Low	Very Low	Low	Low	Low

4. TE WAEWAE BAY (CONTINUED)

GROVE BURN ESTUARY

Estuary Type/Area	Tidal River Mouth
Catchment	30 km^2 (forest/pasture)
Dairy cows	0 cows
Nitrogen loading	Low: 2 kg/ha/yr
Catchment geology	Gravel, sandstone/siltstone
Saltmarsh (ha)	<0.1ha (a few rushes, flax on margins)
Salinity	Varies depending on mouth closure
Mean depth (m)	<0.5m
Tidal flats	Minor (lagoon floods on beach berm)
Uses/Values	Whitebaiting, scenic.

Grove Burn Estuary upstream from beach

Human Use		Low
Ecological Value		Moderate
Existing Condition		Very Good
Susceptibility		Low
Stressors		Very Low
OVERALL VULNERABILITY		Low

The Grove Burn Estuary is a small "tidal river mouth" type estuary (area = <1ha), at the western end of Te Waewae Bay (details in Appendix 1). The estuary is narrow and shallow (mean depth <0.5m) and situated in a secluded native scrub clad gorge between high siltstone cliffs.

Uses and Values. Human use of the estuary is low but is seasonally popular for whitebaiting, and its scenic beauty.

Ecological Values. Ecologically, habitat diversity is low (absence of tidal flats and saltmarsh) but the clean sands and gravel bed provides good habitat for fish and invertebrates.

Existing Condition. Salinities vary depending on the extent of tidal inflow and constriction of the mouth. The water is generally very clear but humic stained, and the sediments are clean sand with little sign of anoxic conditions. Water quality in the stream is expected to be high given the predominately native forest catchment and absence of point source discharges. Estimated nitrogen (the major driver of eutrophication) loadings are low. Because the estuary is small and dominated by freshwater inputs, its quality is expected to be similar to that of the stream for much of the time.

Presence of Stressors. The presence of stressors is expected to be very low.

Susceptibility to Stressors. The mouth is expected to periodically constrict or close due to high seas. At such times, it is poorly flushed and water quality may deteriorate to a small extent. However, because of its native bush catchment, it is unlikely to experience symptoms of eutrophication during such events (i.e. nuisance algal blooms, low dissolved oxygen and smelly black sediments), muddy sediments, low clarity and high disease risk to bathers. Given these characteristics, the estuary ecology is susceptible to: any increase in the intensity of landuse in the catchment, loss of native vegetation within the gorge and constriction of the estuary mouth.

Grove Burn Estuary, mouth constricted with wood debris

Issues	Monitoring	Management
Mouth constricting. Natural cycle of low to high water quality as degree of mouth restriction varies. Estuary margin deterioration.	• Map intensive landuse - 5 yearly. • Habitat map estuary every 10 years.	• Limit intensive landuse development and/or manage to ensure low WQ impacts. • Encourage margin vegetation maintenance. • Assess possibility of artificial mouth opening.

Grove Burn Estuary	Sedimentation	Eutrophication	Disease Risk	Contaminants	Habitat Loss	Invaders	Shellfish
Existing Condition Rating	Very Good	Very Good	Very Good	Very Good	Very Good	Very Good	Very Good
Susceptibility Rating	Low	Low	Low	Low	Low	Low	Low
Vulnerability Rating	Low	Low	Very Low	Very Low	Low	Low	Very Low

4. TE WAEWAE BAY (CONTINUED)

WAIAU ESTUARY

Estuary Type/Area	Tidal River Mouth (with lagoon arm)
Catchment	7904 km^2 (forest/pasture)
Dairy cows	9,266 cows
Nitrogen loading	Low: 1.1 kg/ha/yr
Catchment geology	Igneous, gravel, sandstone/siltstone
Saltmarsh (ha)	3.1ha (rushland, grassland, flax, herbfield)
Salinity	Varies depending on mouth closure (1ppt)
Mean depth (m)	Estimate 2m
Tidal flats	Minor (lagoon floods, tidal influence minor)
Uses/Values	Whitebaiting, scenic, fishing, birds, swimming, duckshooting, motorbiking.

Waiau Lagoon (looking west towards mouth)

Human Use	High
Ecological Value	Mod-High
Existing Condition	Good
Susceptibility	High
Stressors	Moderate
OVERALL VULNERABILITY	Mod-High

The Waiau Estuary is a moderate-sized "tidal river mouth" type estuary (area = 101ha), in the middle of Te Waewae Bay (details in Appendix 1). Its main feature is a 4km long shallow, brackish lagoon formed on the coastal plain between the barrier beach and mudstone and alluvial cliffs. It also includes several stranded ponds west of the mouth.

Uses and Values. Human use of the estuary is high and is popular for whitebaiting, fishing, birdlife, swimming, duckshooting and its scenic beauty.

Ecological Values. Ecologically, habitat diversity is moderate-high, given the presence of considerable areas of saltmarsh, herbfields, and freshwater aquatic macrophytes. Fish, bird and invertebrate life is also expected to be high.

Existing Condition. Salinities vary depending on the extent of tidal inflow and constriction of the mouth but are generally low (around 1ppt). The water is humic-stained and its clarity varies depending on river flows. The sediments are mixed with little sign of anoxic conditions near the edges. Currently the water quality in the Waiau River is high (low nutrient and *E. coli* concentrations), reflecting the dominant native forest/pasture landuse and large catchment area. Estimated nitrogen (the major driver of eutrophication) loadings are low, but suspended solids loadings are high. Because the estuary is primarily riverine, its surface quality is expected to be similar to that of the river.

Presence of Stressors. The presence of stressors is expected to be moderate. Stressors include; water abstraction, stock grazing saltmarsh, landuse intensification (already have high dairy cow numbers), weed and pest invasions, and sea level rise.

Susceptibility to Stressors. The lagoon is relatively isolated from the main river flow and consequently certain areas may be poorly flushed, which can be exacerbated when the mouth constricts or closes due to high seas. At such times, a salt wedge may form, water quality may deteriorate and cause symptoms of eutrophication. In addition, because the lagoon and coastal plain is low lying, predicted sea level rise may alter lagoon hydrodynamics (shift to higher salinity regime) and cause loss of saltmarsh and aquatic macrophyte habitat. Given these characteristics, the estuary ecology is susceptible to: any increase in the intensity of landuse in the catchment, loss of flushing flows, grazing in the margins, and constriction of the estuary mouth.

Issues	Monitoring	Management
Restricted flushing-low flows. Mouth constricts. Natural cycle poor water quality. Estuary margin deterioration.	• Subtidal Monitoring (low flows) DO, salinity, RPD, sediment, aquatic macrophytes, clarity. • Monitor catchment landuse, freshwater abstraction, mouth opening/closures. • Repeat broadscale survey every 5 yrs.	• Limit intensive landuse • Margin vegetation maintenance. • Artificial mouth opening. • Maintain good flushing flows. • Assess lagoon hydrodynamics.

Waiau Estuary/Lagoon	Sedimentation	Eutrophication	Disease Risk	Contaminants	Habitat Loss	Invaders	Shellfish
Existing Condition Rating	Good	Good	Very Good	Very Good	Good	Good	Very Good
Susceptibility Rating	High	High	Moderate	Low	Moderate	Low	Very Low
Vulnerability Rating	Mod-High	Mod-High	Moderate	Very Low	Low	Low	Very Low

4. TE WAEWAE BAY (CONTINUED)

WAIAU ESTUARY

Waiau Estuary, freshwater aquatic macrophytes (e.g. *Ranunculus trichophyllus*) **dominated the subtidal areas.**

Waiau Estuary - shags on lagoon margin behind gravel barrier beach.

Waiau Estuary -presence of saltmarsh

Waiau Estuary - fishing huts

4. TE WAEWAE BAY (CONTINUED)

WAIMEAMEA ESTUARY

Estuary Type/Area	Tidal River Mouth, closed April 2008
Catchment	57 km^2 (forest/pasture)
Dairy cows	0 cows
Nitrogen loading	Low: 3 kg/ha/yr
Catchment geology	Igneous, gravel, sandstone/siltstone
Saltmarsh (ha)	<0.1ha (a few rushes, flax on margins)
Salinity	Varies depending on mouth closure (<1ppt)
Mean depth (m)	<0.5m
Tidal flats	Minor (floods on beach berm)
Uses/Values	Whitebaiting, scenic, swimming

Waimeamea Estuary behind beach

Human Use		Low
Ecological Value		Moderate
Existing Condition		Very Good
Susceptibility		Low
Stressors		Very Low
OVERALL VULNERABILITY		Low

The Waimeamea Estuary is a small "tidal river mouth" type estuary (area = <1ha), at the eastern end of Te Waewae Bay (details in Appendix 1). The estuary is narrow and shallow (mean depth <0.5m) and situated between the gravel barrier beach and 8m high sedimentary cliffs.

Uses and Values. Human use of the estuary is low but is valued for whitebaiting and its scenic beauty.

Ecological Values. Ecologically, habitat diversity is low (absence of tidal flats and saltmarsh) but the clean sands and gravel bed provides good habitat for fish and invertebrates.

Existing Condition. Salinities vary depending on the extent of tidal inflow and constriction of the mouth. The water is generally very clear but humic stained, and the sediments are clean sand with little sign of anoxic conditions. Water quality in the stream is expected to be high given the predominately native forest catchment and absence of point source discharges. Estimated nitrogen (the major driver of eutrophication) loadings are low. Because the estuary is small and dominated by freshwater inputs, its quality is expected to be similar to that of the stream for much of the time.

Presence of Stressors. The presence of stressors is expected to be very low.

Susceptibility to Stressors. The mouth is expected to periodically constrict or close due to high seas. At such times, it is poorly flushed and water quality may deteriorate to a small extent. However, because of its native bush catchment, it is unlikely to experience symptoms of eutrophication during such events. Given these characteristics, the estuary ecology is susceptible to: any increase in the intensity of landuse in the catchment, and constriction of the estuary mouth.

Waimeamea Estuary, mouth closed

Issues	Monitoring	Management
Mouth constricting. Natural cycle of low to high water quality as degree of mouth restriction varies.	• Map intensive landuse - 5 yearly. • Habitat map estuary every 10 years.	• Limit intensive landuse development and/or manage to ensure low WQ impacts. • Encourage margin vegetation maintenance. • Assess possibility of artificial mouth opening.

Waimeamea Estuary	Sedimentation	Eutrophication	Disease Risk	Contaminants	Habitat Loss	Invaders	Shellfish
Existing Condition Rating	Very Good	Very Good	Very Good	Very Good	Very Good	Very Good	Very Good
Susceptibility Rating	Low	Low	Low	Low	Low	Low	Low
Vulnerability Rating	Low	Low	Very Low	Very Low	Low	Low	Very Low

4. TE WAEWAE BAY (CONTINUED)

TAUNOA ESTUARY

Estuary Type/Area	Tidal River Mouth, open April 2008
Catchment	21 km^2 (forest/pasture)
Dairy cows	78 cows
Nitrogen loading	Low: 3 kg/ha/yr
Catchment geology	Gravel, igneous, sandstone/siltstone
Saltmarsh (ha)	<0.1ha (a few rushes, flax on margins)
Salinity	Varies depending on mouth closure (<1ppt)
Mean depth (m)	<0.5m
Tidal flats	Minor (floods on beach berm)
Uses/Values	Whitebaiting, scenic

Taunoa Estuary showing wood debris blockage

Human Use		Low
Ecological Value		Moderate
Existing Condition		Very Good
Susceptibility		Low
Stressors		Very Low
OVERALL VULNERABILITY		Low

The Taunoa Estuary is a small "tidal river mouth" type estuary (area = <1ha), at the eastern end of Te Waewae Bay (details in Appendix 1). The estuary is narrow and shallow (mean depth <0.5m) and situated near the gravel beach between low sedimentary cliffs.

Uses and Values. Human use of the estuary is low but is valued for whitebaiting and its scenic beauty.

Ecological Values. Ecologically, habitat diversity is low (absence of tidal flats and saltmarsh) but the clean sands and gravel bed provides good habitat for fish and invertebrates.

Existing Condition. Salinities vary depending on the extent of tidal inflow and constriction of the mouth. The water is generally very clear but humic stained, and the sediments are clean sand with little sign of anoxic conditions. Water quality in the stream is expected to be moderate given the predominately pastoral and native forest catchment, and absence of point source discharges. Estimated nitrogen (the major driver of eutrophication) loadings are low. Because the estuary is small and dominated by freshwater inputs, its quality is expected to be similar to that of the stream for much of the time.

Presence of Stressors. The presence of stressors is expected to be low. Landuse intensification is the main threat.

Susceptibility to Stressors. The mouth is expected to periodically constrict or close due to high seas. At such times, it is poorly flushed and water quality may deteriorate. Currently, because of its low intensity landuse, it is unlikely to experience symptoms of eutrophication during such events. Given these characteristics, the estuary ecology is susceptible to: any increase in the intensity of landuse in the catchment, and constriction of the estuary mouth.

Taunoa Estuary, mouth open, people searching for gemstones

Issues	Monitoring	Management
Mouth constricting. Natural cycle of low to high water quality as degree of mouth restriction varies.	• Map intensive landuse - 5 yearly. • Habitat map estuary every 10 years.	• Limit intensive landuse development and/or manage to ensure low WQ impacts. • Encourage margin vegetation maintenance. • Assess possibility of artificial mouth opening.

Taunoa Estuary	Sedimentation	Eutrophication	Disease Risk	Contaminants	Habitat Loss	Invaders	Shellfish
Existing Condition Rating	Very Good	Very Good	Very Good	Very Good	Very Good	Very Good	Very Good
Susceptibility Rating	Low	Low	Low	Low	Low	Low	Very Low
Vulnerability Rating	Low	Low	Low	Very Low	Low	Low	Very Low

5. MONKEY ISLAND TO RIVERTON

BEACHES, DUNES AND ROCKY SHORES

Pahia Point

Cosy Nook

Kawakaputa Bay from large dunes at eastern end

Kawakaputa Bay large dunes at eastern end

Between Monkey Island and Riverton the coastline is generally rocky and very exposed to high wave energy and southerly and westerly winds. However, it also includes two south-facing, sheltered sandy embayments, Colac and Kawakaputa Bays. Marram-covered duneland is common in parts of these embayments. The rocky sections of the coast are dominated by hard volcanic rocks which have high plant and animal biodiversity. A number of small estuaries discharge to the coast, the largest being the Ourawera which empties into Kawakaputa Bay.

Rocky Shore - Monkey Island to Kawakaputa Bay

This 20km stretch of coastline consists of hard, rocky shores, offshore reefs and sheltered rocky embayments. The rocky shores border grazed farmland and in some places a thin strip of marram duneland or flax dominated habitat.

Human Use. Human use is moderate-high being very popular for diving, shellfish collection, surfing, boating, fishing, walking, and scenic beauty.

Ecological Value. Ecological value is high given the high habitat diversity and the high biodiversity of the intertidal and subtidal areas, including a wide range of seaweed and animal types.

Existing Condition. Existing condition is very good given the high water clarity, low nutrients and low disease risk of water bathing the area.

Presence of Stressors. The key stressors for this area are human seafood collection and offshore spills or algal blooms.

Susceptibility to Stressors. Susceptibility to stressors is very low given that the area is well-flushed and isolated.

Beach and Dune - Kawakaputa Bay

Kawakaputa Bay is a 4km long firm sand/gravel beach that is broad and gently sloping (dissipative-intermediate beach type) at the western end, and narrower, steeper and coarser grained (reflective type) at the eastern end. Marram dominated duneland appears as a thin strip along the western margin but is much more extensive to the east, where a couple of small herbfields were present on the beach berm. Foredunes are high and densely covered in marram in a zone 100m wide. Behind this zone are more stable dunes with lupin, flax and broom. Forest also occurs further back from the beach on the dune ridges (mainly kamahi and fuschia) and dune hollows (mainly kahikatea, rimu and broadleaf). This forest extends over to boggy sedgeland, rushland and scrub surrounding Lake George. Johnson (1992) rated this dune relatively highly at 13 out of 20 in terms of botanical value for conservation.

Human Use. Human use is generally moderate-high being very popular for diving, swimming, boating, fishing, walking, and its scenic beauty.

Ecological Value. Ecological value is moderate given the intermediate dissipative beach type, the extensive dune system, and moderately productive inshore waters.

Existing Condition. Existing condition of the beach is very good given the high water clarity, low nutrients and low disease risk of water bathing the area. Dune condition is moderate, being affected by overstabilisation and reduced ability to release sand to the foreshore (a common feature of marram dominated dunes), as well as grazing. Vehicles are sometimes driven on the beach.

BEACHES, DUNES AND ROCKY SHORES (CONTINUED)

Oraka Point

Colac Bay western end

Colac Bay, large marram dunes in middle of bay

Colac Bay eastern end

Presence of Stressors. The key stressors for this area are; catchment landuse intensification, marram dominated dunes, grazing in dunes, driving on the beach, and sea level rise.

Susceptibility to Stressors. Susceptibility to stressors is moderate given the fragile nature of dune systems.

Rocky Shore - Oraka Point and Howell Point

These two points consist of hard, rocky shores, offshore reefs and sheltered rocky/cobble embayments. The rocky shores border grazed farmland and in some places a thin strip of marram duneland or flax dominated habitat.

Human Use. Human use is moderate-high being very popular for diving, shellfish collection, surfing, boating, fishing, walking, and scenic beauty.

Ecological Value. Ecological value is high given the high habitat diversity and the high biodiversity of the intertidal and subtidal areas, including a wide range of seaweed and animal types.

Existing Condition. Existing condition is very good given the high water clarity, low nutrients and low disease risk of water bathing the area.

Presence of Stressors. The key stressors for this area are human seafood collection and offshore spills or algal blooms. In addition, Riverton's urban wastewater is discharged near Howell Point.

Susceptibility to Stressors. Susceptibility to stressors is very low given that the area is well-flushed and isolated.

Beach and Dune - Colac Bay

Colac Bay is a 6km long broad gravel/sand beach (intermediate/reflective type) with marram sand dunes bordering the middle section and a rock seawall, road and the township of Colac Bay bordering the western end. The flat crest of the gravel beach at the eastern end and the adjacent hollow have a rich herbfield vegetation e.g. shore convolvulus, *Selliera radicans*, and native celery. Running alongside is a grassy duneland with marram, knobby clubrush and silver tussock. At the end of the beach is a headland, with flax and *Hebe*. In the middle of the beach is a much higher and broader, relatively stable dune complex with marram, clubrush and introduced grasses (e.g. cocksfoot). The rear dune has more grasses and patches of gorse, lupin and flax. The duneland borders grazed pasture and areas being developed for residential landuse.

Human Use. Human use is generally high being very popular for surfing, swimming, diving, boating, fishing, walking, picnicing and scenic beauty.

Ecological Value. Ecological value is moderate given the intermediate reflective beach type, the moderate dune system, and moderately productive inshore waters.

Existing Condition. Existing condition of the beach is very good given the high water clarity, low nutrients and low disease risk of water bathing the area. Dune condition is moderate, being affected by weed growth, grazing, and overstabilisation and reduced ability to release sand to the foreshore (a common feature of marram dominated dunes).

Presence of Stressors. The key stressors for this area are; catchment landuse intensification, marram dominated dunes, grazing in dunes, property development, and roads through dunes.

Susceptibility to Stressors. Susceptibility to stressors is moderate given the fragile nature of dune systems.

5. MONKEY ISLAND TO RIVERTON (CONTINUED)

BEACHES, DUNES AND ROCKY SHORES (CONTINUED)

Beach at Howells Point (treated wastewater plume visible near shore all along beach)

Human Use		High
Ecological Value		Moderate
Existing Condition		Good
Susceptibility		Low
Stressors		Moderate
OVERALL VULNERABILITY		Moderate

Beach and Dune - Howell Point

The eastern end of Howell Point has several small, steep, gravel beaches (reflective type) with adjacent marram dominated dunes and sand blown uphill. On the headlands, turf plants such as *Crassula* are present, as well as coastal scrub (*Brachyglottis rotundifolia*, *Fuschia colensoi* and *Muehlenbeckia australis*), iceplant, prickly shield fern, and *Hebe* shrubs. Johnson (1992) rated this dune relatively highly at 13 out of 20 in terms of botanical value for conservation.

Human Use. Human use is generally moderate-high being very popular for walking, diving, shellfish collection, surfing, boating, fishing, and scenic beauty. Riverton's treated wastewater is discharged to the area.

Ecological Value. Ecological value is moderate given the habitat diversity, the extensive dune system, and moderately productive inshore waters.

Existing Condition. Existing condition of the beach is good but water quality is compromised by the discharge of treated wastewater. Dune condition is good, but is impacted by roads, grazing and weeds.

Presence of Stressors. The key stressors for this area are; treated wastewater, marram dominated dunes, grazing in dunes, sea level rise and roads through dunes.

Susceptibility to Stressors. Susceptibility to stressors is moderate given the fragile nature of dune systems and the generally well-flushed inshore area.

Issues	Monitoring	Management
Potential for degradation of beach habitat and water quality through runoff from intensive landuse, loss of wetland filters (in particular, shellfish quality and bathing near river plumes).	• Map intensive landuse (urban, high production pasture) in all catchments at 5 yearly intervals. • Map area of wetlands in catchments at regular intervals (5 yearly). • Monitor disease risk (shellfish and water)	• Limit intensive landuse development and/or manage to ensure impacts don't degrade beach habitat and WQ. • Maintain and improve habitat diversity and filtering capacity of existing wetlands in all catchments.
Treated wastewater discharge, (plume visible for 2km). Consent conditions breached 2005/06.	• Monitor area of visible plume and proximity to high value surf zone. • Monitor/restrict effluent bacterial conc.	• Assess options to extend outfall to eliminate surf zone contamination.
Degradation of duneland through sea level rise, erosion, grazing, roads, weed invasions, property development.	• Map dominant species cover and condition of duneland, and change in position of seaward margin of dune. Repeat broadscale mapping at 5-10 yearly intervals. Identify hot spots for management.	• Undertake remedial management of identified hotspots using soft Best Management Practices (e.g. revegetation with native sand-binders, weed eradication) wherever possible.
Lack of baseline information for high diversity beaches and rocky shores	• Monitor representative beach and rocky shore habitat within the region (3 yr baseline then 5 yrly).	• Assess potential impact of long term changes in biodiversity.

Monkey Is to Riverton Beach, Dune, Rocky Shore	Disease Risk	Algal Blooms	Habitat Loss	Contaminants	Clarity Issues	Invaders/Weeds	Shellfish
Existing Condition Rating	Good	Very Good	Good	Very Good	Good	Fair	Good
Susceptibility Rating	Good	Very Low	Moderate	Very Low	Good	Moderate	Low
Vulnerability Rating	Good	Very Low	Moderate	Very Low	Good	Moderate	Low

OUKI ESTUARY

Estuary Type/Area	Tidal River Mouth, open April 2008
Catchment	22 km^2 (pasture, dairy)
Dairy cows	970 cows
Nitrogen loading	High: 17 kg/ha/yr
Catchment geology	Gravel, igneous, sandstone/siltstone
Saltmarsh (ha)	<0.1ha (a few rushes)
Salinity	Varies with tide, Low tide <1ppt
Mean depth (m)	<0.5m
Tidal flats	None (floods on beach berm)
Uses/Values	Whitebaiting

Ouki Estuary

Human Use		Low
Ecological Value		Low
Existing Condition		Fair
Susceptibility		Moderate
Stressors		Moderate
OVERALL VULNERABILITY		Low-Mod

The Ouki Estuary is a small "tidal river mouth" type estuary (area = <1ha), that discharges to a small rocky embayment near Pahia (details in Appendix 1). The estuary is narrow and shallow (mean depth <0.5m) and bordered by grazed pasture. A small area of jointed wire rushland occurs near the mouth.

Uses and Values. Human use of the estuary is low but is used for whitebaiting.

Ecological Values. Ecologically, habitat diversity is low, given historical channelisation and drainage which has removed gradual sloping rushland margins. Such conditions provide poor habitat for native fish and tidal flat organisms.

Existing Condition. Salinities vary depending on the extent of tidal inflow and constriction of the mouth. The water is generally very clear but humic stained, and the sediments are clean sand/mud with little sign of anoxic conditions. Water quality in the stream is expected to be fair given the predominately dairy catchment. Estimated nitrogen (the major driver of eutrophication) loadings are high. Because the estuary is small and dominated by freshwater inputs, its quality is expected to be similar to that of the stream for much of the time.

Presence of Stressors. The presence of stressors is expected to be "moderate". Landuse intensification, absence of natural vegetated margins, grazed margins and weed and pest invasions are the main threats.

Susceptibility to Stressors. Currently, because of growing high intensity landuse in the catchment, it may experience symptoms of eutrophication during low flows events. Given these characteristics, the estuary ecology is susceptible to: any increase in the intensity of landuse in the catchment, weed growth and constriction of the estuary mouth.

Ouki Estuary, channelised and grazed to margin.

Issues	Monitoring	Management
• Landuse intensification. • Grazing near margin. • Weed growth. • Channelised profile.	• Map intensive landuse - 5 yearly. • Habitat map estuary every 10 years.	• Limit intensive landuse development and/or manage to ensure low WQ impacts. • Fence margins. • Encourage margin profile shallowing and vegetation maintenance.

Ouki Estuary	Sedimentation	Eutrophication	Disease Risk	Contaminants	Habitat Loss	Invaders	Shellfish
Existing Condition Rating	Good	Fair	Fair	Good	Fair	Fair	Very Good
Susceptibility Rating	Moderate	Moderate	Moderate	Low	Low	Low	Very Low
Vulnerability Rating	Low	Moderate	Moderate	Very Low	Low	Low	Low

5. MONKEY ISLAND TO RIVERTON (CONTINUED)

POUAHIRI ESTUARY

Estuary Type/Area	Tidal River Mouth, open April 2008
Catchment	11 km^2 (pasture, dairy)
Dairy cows	610 cows
Nitrogen loading	Moderate: 10 kg/ha/yr
Catchment geology	Gravel, peat, igneous, sand
Saltmarsh (ha)	<0.1ha (a few rushes)
Salinity	Varies with tide, Low tide <1ppt
Mean depth (m)	<0.5m
Tidal flats	None (floods on beach berm)
Uses/Values	Whitebaiting, bathing

Pouahiri Estuary

Human Use		Low
Ecological Value		Low
Existing Condition		Fair
Susceptibility		Moderate
Stressors		Moderate
OVERALL VULNERABILITY		Low-Mod

The Pouahiri Estuary is a small "tidal river mouth" type estuary (area = <1ha), that discharges to the beach at the western end of Kawakaputa Bay (details in Appendix 1). The estuary is narrow and shallow upstream (mean depth <0.5m) and bordered by grazed pasture. As it discharges onto the beach it forms a broad shallow lagoon that is used for swimming and paddling.

Uses and Values. Human use of the estuary is low but is used for whitebaiting and bathing.

Ecological Values. Ecologically, habitat diversity is low, given historical channelisation and drainage which has removed gradual sloping rushland margins.

Existing Condition. Salinities vary depending on the extent of tidal inflow and constriction of the mouth. The water is generally very clear but humic stained, and the sediments are clean sand with little sign of anoxic conditions. Water quality in the stream is expected to be fair given the predominately dairy catchment. Estimated nitrogen (the major driver of eutrophication) loadings are high. Because the estuary is small and dominated by freshwater inputs, its quality is expected to be similar to that of the stream for much of the time.

Presence of Stressors. The presence of stressors is expected to be "moderate". Landuse intensification, absence of natural vegetated margins, grazed margins and weed and pest invasions are the main threats.

Susceptibility to Stressors. The mouth is expected to periodically constrict and possibly close. Currently, because of growing high intensity landuse in the catchment, it may experience symptoms of eutrophication during low flows events. Given these characteristics, the estuary ecology is susceptible to: any increase in the intensity of landuse in the catchment, weed growth and constriction of the estuary mouth.

Pouahiri Estuary (centre), channelised and grazed to near the margin.

Issues	Monitoring	Management
• Landuse intensification. • Grazing near margin. • Channelised profile. • Mouth constricts, low WQ. • Weeds.	• Map intensive landuse - 5 yearly. • Habitat map estuary every 10 years.	• Limit intensive landuse development • Fence margins. • Encourage margin profile shallowing and vegetation maintenance. • Assess possibility of artificial mouth opening.

Pouahiri Estuary	Sedimentation	Eutrophication	Disease Risk	Contaminants	Habitat Loss	Invaders	Shellfish
Existing Condition Rating	Good	Fair	Fair	Good	Fair	Fair	Very Good
Susceptibility Rating	Moderate	Moderate	Moderate	Low	Low	Low	Very Low
Vulnerability Rating	Low	Moderate	Moderate	Very Low	Low	Low	Low

5. MONKEY ISLAND TO RIVERTON (CONTINUED)

OURAWERA ESTUARY

Estuary Type/Area	Tidal River Mouth, open April 2008
Catchment	53 km^2 (native forest/scrub, pasture)
Dairy cows	100 cows
Nitrogen loading	Low: 4 kg/ha/yr
Catchment geology	Igneous, gravel, sandstone/siltstone
Saltmarsh (ha)	<0.1ha (a few rushes)
Salinity	Varies with tide, Low tide <1ppt
Mean depth (m)	<0.5m
Tidal flats	None (floods on beach berm)
Uses/Values	Whitebaiting, bathing

Ourawera Estuary

Human Use		Mod-High
Ecological Value		Low
Existing Condition		Good
Susceptibility		Low
Stressors		Moderate
OVERALL VULNERABILITY		Low

The Ourawera Estuary is a small "tidal river mouth" type estuary (area = <1ha), that discharges to the beach in the middle of Kawakaputa Bay (details in Appendix 1). The estuary is narrow and shallow upstream (mean depth <0.5m) and bordered by grazed pasture. As it discharges onto the beach it forms a long and meandering shallow lagoon along the upper beach margin in front of marram dunes.

Uses and Values. Human use of the estuary is moderate - mainly whitebaiting and bathing.

Ecological Values. Ecologically, habitat diversity is low (modified upstream channel, extensive weed growth and absence of tidal flats and saltmarsh vegetation). Such conditions provide limited habitat for native fish and tidal flat organisms.

Existing Condition. Salinities vary depending on the extent of tidal inflow and constriction of the mouth. The water is generally very clear but humic stained, and the sediments are clean sand with little sign of anoxic conditions. Water quality in the stream is expected to be good given the predominately native bush catchment. Estimated nitrogen (the major driver of eutrophication) loadings are low. Because the estuary is small and dominated by freshwater inputs, its quality is expected to be similar to that of the stream for much of the time.

Presence of Stressors. The presence of stressors is expected to be "moderate". Landuse intensification, absence of natural vegetated margins, grazed margins and weed and pest invasions are the main threats.

Susceptibility to Stressors

Susceptibility to stressors is expected to be low-moderate given that the area is well flushed, and already highly modified.

Ourawera Estuary - extensive weed growth near margins.

Issues	Monitoring	Management
Grazing near margin. Channelised profile.	• Map intensive landuse - 5 yearly. • Habitat map estuary every 10 years.	• Limit intensive landuse development • Encourage margin vegetation maintenance. • Encourage shallowing margin profile and revegetation.

Ourawera Estuary	Sedimentation	Eutrophication	Disease Risk	Contaminants	Habitat Loss	Invaders	Shellfish
Existing Condition Rating	Very Good	Very Good	Very Good	Very Good	Fair	Fair	Very Good
Susceptibility Rating	Low	Low	Low	Very Low	Low	Low	Very Low
Vulnerability Rating	Low	Low	Low	Very Low	Low	Low	Very Low

COLAC BAY ESTUARY

Estuary Type/Area	Tidal River Mouth, open April 2008
Catchment	16 km^2 (pasture, dairy)
Dairy cows	395 cows
Nitrogen loading	Moderate: 10 kg/ha/yr
Catchment geology	Gravel, sandstone/siltstone, igneous
Saltmarsh (ha)	<0.1ha (a few rushes)
Salinity	Varies with tide, Low tide <1ppt
Mean depth (m)	<0.5m
Tidal flats	None (floods on beach berm)
Uses/Values	Whitebaiting, shellfish gathering, bathing

Colac Bay Estuary

Human Use		Moderate
Ecological Value		Low
Existing Condition		Good
Susceptibility		Low
Stressors		Moderate
OVERALL VULNERABILITY		Low

The Colac Bay Estuary is a small "tidal river mouth" type estuary (area = <1ha), that discharges to the beach at the western end of Colac Bay (details in Appendix 1). The estuary is narrow and shallow upstream (mean depth <0.5m) and bordered by a narrow margin of low shrubs (mainly flax, tall fescue and broom) and then grazed pasture. As it discharges onto the beach it forms a shallow pool in the upper beach margin.

Uses and Values. Human use of the estuary is moderate - mainly whitebaiting, shellfish gathering and paddling.

Ecological Values. Ecologically, habitat diversity is low, given historical drainage, extensive weed growth, grazing of margins and absence of tidal flats and saltmarsh vegetation. Such conditions provide limited habitat for native fish and tidal flat organisms.

Existing Condition. Salinities vary depending on the extent of tidal inflow and constriction of the mouth. The water is generally very clear but humic stained, and the sediments are clean sand with little sign of anoxic conditions. Water quality in the stream is expected to be fair given the predominately intensive pastoral catchment (elevated nutrients and faecal coliforms). Estimated nitrogen (the major driver of eutrophication) loadings are moderate. Because the estuary is small and dominated by freshwater inputs, its quality is expected to be similar to that of the stream for much of the time.

Presence of Stressors. The presence of stressors is expected to be "moderate". Landuse intensification, mouth constriction, absence of natural vegetated margins, grazed margins and weed and pest invasions are the main threats.

Susceptibility to Stressors

Susceptibility to stressors is expected to be low-moderate given that the area is well flushed, and already highly modified.

Colac Bay Estuary - extensive flax growth near margins.

Issues	Monitoring	Management
• Mouth constricting. • Grazing near margin. • Channelised profile.	• Map intensive landuse - 5 yearly. • Habitat map estuary every 10 years.	• Limit intensive landuse development and/or manage to ensure low WQ impacts. • Encourage margin vegetation maintenance. • Assess possibility of artificial mouth opening.

Colac Bay Estuary	Sedimentation	Eutrophication	Disease Risk	Contaminants	Habitat Loss	Invaders	Shellfish
Existing Condition Rating	Very Good	Good	Fair	Very Good	Fair	Fair	Very Good
Susceptibility Rating	Low	Low	Moderate	Very Low	Low	Low	Very Low
Vulnerability Rating	Low	Low	Moderate	Very Low	Low	Low	Very Low

6. RIVERTON TO OMAUI

BEACHES AND DUNES

Oreti Beach western end

Oreti Beach

Human Use		High
Ecological Value		High
Existing Condition		Good
Susceptibility		Moderate
Stressors		Moderate
OVERALL VULNERABILITY		Moderate

Beach and Dune - Oreti Beach

Oreti Beach, a 32km long, very exposed, gently sloping, sandy, dissipative type beach, stretches from the outlet of Jacobs River Estuary at Riverton to the outlet of the New River Estuary just west of Omaui Peninsula. The beach borders the low-lying Southland coastal plain and is backed by marram duneland as follows.

- Near Riverton, foredunes are low (1m high), narrow, and vegetation is dominated by marram, lupins, broom and gorse. The margin bordering the dune is used for pasture or forestry.
- South-east of Taunamau Creek, marram foredunes rise to 6-8m. Back-dunes are covered with introduced grasses, marram, lupins, gorse and broom and hollows with clubrush, herbs and grasses. Several small eutrophic ponds exist behind the dunes near Waimatuku Estuary mouth with areas of herb and rushland. The margin bordering the dune is used for pasture or forestry.
- The dense marram foredunes east of the ponds (for 12 km), are broad, with increasing amounts of lupins in the hind-dunes. Grazed pasture borders the west section, and the extensive dunes and flats of the Sandy Point Recreation Reserve to the east.
- Two small estuaries discharge to the coast along the beach, the Taunamau and Waimatuku.

Human Use. Human use is generally moderate-high being popular for swimming, surfing, shellfish collection, boating, fishing, walking, driving, illegal motorcycling and its scenic beauty.

Ecological Value. Ecological value is high given the dissipative beach type, extensive dune system and extensive habitat diversity. Toheroa, surf clams and flounders are particularly valued.

Existing Condition. Existing condition is good - water quality degraded at times, and dunes damaged by motorbikes.

Presence of Stressors. The key stressors for this area are pollution from estuary plumes (which include large point source discharges), sea level rise causing erosion and migration of dunes and beach into low lying land, invasion of weeds, grazing in dunes and vehicles in dunes and on the beach.

Susceptibility to Stressors. Susceptibility to stressors is moderate to high given the proximity to urban areas and its low lying hinterland, however, because the area is well-flushed its susceptibility to water quality problems is moderate.

Issues	Monitoring	Management
Exposure to river plumes. Vehicle damage - dunes, toheroa. Sea level rise (dune migration). Grazing and weed invasion.	• Map intensive landuse (5 yearly). • Map area of catchment wetlands - 5 yrly. • Model estuary plume behaviour. • Monitor vehicle impacts. • Broad scale map duneland - 10 yrly. • Monitor for disease risk.	• Limit intensive landuse development. • Maintain existing catchment wetlands. • Limit point discharges into estuaries. • Reduce vehicles in toheroa & dune areas. • Encourage dune maintenance.

Oreti Beach	Disease Risk	Algal Blooms	Habitat Loss	Contaminants	Clarity Issues	Invaders/Weeds	Shellfish
Existing Condition Rating	Good	Good	Good	Very Good	Good	Fair	Good
Susceptibility Rating	Moderate	Moderate	Moderate	Very Low	Moderate	Moderate	Moderate
Vulnerability Rating	Moderate	Moderate	Moderate	Very Low	Good	Moderate	Moderate

6. RIVERTON TO OMAUI (CONTINUED)

JACOBS RIVER ESTUARY

Estuary Type/Area	Tidal Lagoon
Catchment	1527 km^2
Dairy cows	64,611 cows
Nitrogen loading	Low-Mod: 7 kg/ha/yr
Catchment geology	Gravel, sandstone/siltstone, igneous
Saltmarsh (ha)	70 ha primarily *Leptocarpus*
Salinity	Well mixed, sea water dominated
Mean depth (m)	1-2m
Tidal flats	High
Uses/Values	Walking, shellfish, birds, scenic, fishing, wharves, duckshooting, whitebaiting, bathing.

Jacobs River Estuary - whitebait stands and macroalgal blooms in Aparima Arm.

Human Use		High
Ecological Value		Moderate
Existing Condition		Fair
Susceptibility		Moderate
Stressors		Moderate
OVERALL VULNERABILITY		Moderate

Jacobs River Estuary is a medium-sized "tidal lagoon" type estuary (area 720 ha), that discharges to the Oreti Beach at Riverton (details in Appendix 1). Situated at the confluence of the Pourakino and Aparima Rivers, it drains a primarily agricultural catchment. The estuary is triangular shaped and relatively shallow (mean depth approximately 2m) and bordered by a mix of vegetation and landuses (urban and grazed pasture). The estuary has extensive mudflats (80% of estuary exposed at low tide), seagrass and saltmarsh areas. The township of Riverton, its fishing wharves, and a road bridge are located near the mouth. This estuary is regularly monitored by Environment Southland. Nuisance blooms of macroalgae (*Enteromorpha* and *Gracilaria*) are common within the estuary.

Uses and Values. Human use of the estuary is high - mainly walking, shellfish collection, bird study, scenic, fishing, duckshooting, whitebaiting, bathing and for wharf facilities.

Ecological Values. Ecologically, habitat diversity is moderate, given benefits of tidal flats and saltmarsh and detriments of historical drainage, extensive weed growth, grazing of margins, and eutrophication. Such conditions provide moderate habitat for native fish, birdlife and tidal flat organisms.

Existing Condition. Water quality is moderately degraded (low clarity, elevated faecal coliforms, elevated nutrients), particularly in high river flows. Nuisance macroalgal blooms are common and the water often has a greenish tinge. Sediment type is mixed with areas of firm muddy sands plus soft and very soft muds - often poor in oxygen with elevated sulphide concentrations. Several very eutrophic arms tend to collect organic matter. Metal concentrations are low. Estimated nitrogen (the major driver of eutrophication) loadings are moderate.

Presence of Stressors. The presence of stressors is expected to be "moderate". Landuse intensification, absence of natural vegetated margins, grazed margins and weed and pest invasions are the main threats.

Susceptibility to Stressors

Susceptibility to stressors is expected to be moderate given that the estuary is well flushed (low residence time), and already modified.

Issues	Monitoring	Management
Algal blooms, eutrophic arms. Grazing near margin. Developed margin. Weed invasions.	• Map intensive landuse - 5 yearly • Habitat map estuary every 5 years. • Fine scale monitoring 5 yearly (after baseline est.). • Sedimentation rate monitoring. • Map macroalgal cover annually.	• Limit intensive landuse development. • Low impact point source discharges only. • Encourage margin vegetation enhancement. • Plan for estuary expansion with sea level rise.

Jacobs River Estuary	Sedimentation	Eutrophication	Disease Risk	Contaminants	Habitat Loss	Invaders	Shellfish
Existing Condition Rating	Fair	Fair	Good	Very Good	Fair	Good	Good
Susceptibility Rating	Low	Low	Low	Very Low	Low	Low	Very Low
Vulnerability Rating	Moderate	Moderate	Low	Very Low	Moderate	Low	Very Low

6. RIVERTON TO OMAUI (CONTINUED)

WAIMATUKU ESTUARY (AND TAUNAMAU ESTUARY)

Estuary Type/Area	Tidal River Mouth
Catchment	150 km^2 (39 km^2)
Dairy cows	14,015 (4,270) cows
Nitrogen loading	Mod-High: 13-20 kg/ha/yr
Catchment geology	Gravel, sand, peat
Saltmarsh (ha)	1 -5 ha dune
Salinity	Salt wedge (surf 1ppt, bottom 29 ppt)
Mean depth (m)	1-2m
Tidal flats	Floods onto beach backslope
Uses/Values	Duckshooting, whitebaiting, fishing.

Waimatuku Estuary

Human Use		High
Ecological Value		Low-Mod
Existing Condition		Poor
Susceptibility		High
Stressors		Moderate
OVERALL VULNERABILITY		Moderate

The Waimatuku Estuary, and its interconnected neighbour the Taunamau Estuary, are moderately small "tidal river mouth" type estuaries (area 2-3ha), that discharge to the middle section of Oreti Beach (details in Appendix 1). Both drain primarily agricultural catchments with large dairy herds. The Waimatuku is the larger of the two estuaries and forms a long meandering lagoon on the upper beach backslope. Both experience regular mouth constrictions that cause poor flushing and water quality problems. Nuisance blooms of macroalgae (*Enteromorpha*) are common within the estuary.

Uses and Values. Human use of the estuaries is high - mainly fishing, duckshooting, scenic and whitebaiting.

Ecological Values. Ecologically, habitat diversity is low-moderate, given the modified upstream channel, extensive weed growth and low incidence of tidal flats and salt marsh vegetation. Such conditions provide moderate habitat for native fish, birds, tidal flat organisms and a nursery area for flatfish.

Existing Condition. Salinities vary depending on the extent of tidal inflow and constriction of the mouth. In April 2008, the water in the Waimatuku was turbid below 0.3m, humic stained, and a salt wedge with high salinity bottom water and low dissolved oxygen concentrations was present. The sediments were extremely anoxic, sulphide rich, muddy sands with the surface covered by white sulphur bacteria (*Beggiatoa* spp). In the Taunamau Estuary (upper) conditions were similar but perhaps less extreme. Estimated nitrogen (the major driver of eutrophication) loadings are moderate to high.

Presence of Stressors. The presence of stressors is expected to be "moderate". Landuse intensification, absence of natural vegetated margins, grazed margins and weed and pest invasions are the main threats. Sea level rise is expected to increase the size of these estuaries.

Susceptibility to Stressors

Susceptibility to stressors is expected to be high given that the estuaries constrict or block and the area is low lying.

Issues	Monitoring	Management
• Mouth constricts, cycles of poor water quality. • Landuse intensification. • Grazing near margin. • Channelised profile.	• Map intensive landuse - 5 yearly • Habitat map estuary every 10 years. • Intensive synoptic monitoring and vulnerability assessment to assess future priorities.	• Limit intensive landuse development. • Low impact point source discharges only. • Encourage margin vegetation and profile enhancement. • Plan for estuary expansion with sea level rise.

Waimatuku Estuary	Sedimentation	Eutrophication	Disease Risk	Contaminants	Habitat Loss	Invaders	Shellfish
Existing Condition Rating	Fair	Poor	Fair	Good	Poor	Fair	Very Good
Susceptibility Rating	Moderate	High	Moderate	Low	High	Moderate	Very Low
Vulnerability Rating	Moderate	High	Moderate	Low	High	Moderate	Very Low

6. RIVERTON TO OMAUI (CONTINUED)

NEW RIVER ESTUARY

Estuary Type/Area	Tidal Lagoon
Catchment	1527 km^2
Dairy cows	64,611 cows
Nitrogen loading	Low-Mod: 7 kg/ha/yr
Catchment geology	Gravel, sandstone/siltstone, igneous
Saltmarsh (ha)	70 ha primarily jointed wire rush
Salinity	Well mixed, sea water dominated
Mean depth (m)	1-2m
Tidal flats	High
Uses/Values	Walking, shellfish collection, birds, scenic, fishing, duckshooting, whitebaiting, bathing.

New River Estuary - monitoring sedimentation in the muddy Waihopai Arm.

Human Use		High
Ecological Value		High
Existing Condition		Fair
Susceptibility		Moderate
Stressors		Moderate
OVERALL VULNERABILITY		Moderate

New River Estuary is a large "tidal lagoon" type estuary (area 4,100ha), discharging to the east end of Oreti Beach (details in Appendix 1). Situated at the confluence of the Oreti and Waihopai Rivers, it drains a primarily agricultural catchment. This shallow estuary (mean depth ~2m) is bordered by a mix of vegetation and landuses (urban, bush and grazed pasture). It has a wide range of habitats (extensive mudflats, seagrass and saltmarsh areas) but has also lost large areas through drainage and reclamation in the Waihopai Arm. Invercargill City is located adjacent to the Waihopai Arm and discharges its treated wastewater to the estuary. The estuary is regularly monitored by Environment Southland. Nuisance blooms of macroalgae (*Enteromorpha* and *Gracilaria*) and sedimentation problems are common within the estuary.

Uses and Values. Human use of the estuary is high - mainly walking, shellfish collection, bird study, scenic values, fishing, duckshooting, whitebaiting and bathing.

Ecological Values. Ecologically, habitat diversity is high; driven by the benefits of existing tidal flats and saltmarsh, and detriments of historical drainage/reclamation, extensive weed growth, grazing of margins, and eutrophication. Such conditions provide good habitat for estuarine biota (particularly rushland, birdlife, flounder, whitebait and shellfish).

Existing Condition. Water quality is moderately degraded (low clarity, elevated faecal coliforms, elevated nutrients), particularly in high river flows. Nuisance macroalgal blooms are common. Sediment type is mixed with areas of firm muddy sands and soft and very soft muds - often oxygen-poor and sulphide-rich. Several areas exist with very eutrophic arms. Metal concentrations are low. Estimated nitrogen (the major driver of eutrophication) loadings are moderate.

Presence of Stressors. The presence of stressors is moderate. Landuse intensification, point source pollution (Invercargill treated wastewater, and several industrial discharges), sea level rise and habitat migration, absence of natural vegetated margins, grazed margins and weed invasions are the main threats.

Susceptibility to Stressors

Susceptibility to stressors is expected to be moderate as the estuary is well flushed (low residence time), and already modified.

Issues	Monitoring	Management
Algal blooms, eutrophic arms. Grazing near margin. Developed margin. Sea level rise.	• Map intensive landuse - 5 yearly • Habitat map estuary every 5 years. • Fine scale monitoring 5 yearly (after baseline est.). • Sedimentation rate monitoring. • Map macroalgal cover annually.	• Limit intensive landuse development. • Low impact point source discharges only. • Encourage margin vegetation enhancement. • Plan for estuary expansion with sea level rise.

New River Estuary	Sedimentation	Eutrophication	Disease Risk	Contaminants	Habitat Loss	Invaders	Shellfish
Existing Condition Rating	Fair	Fair	Fair	Good	Fair	Fair	Good
Susceptibility Rating	Low	Low	Low	Low	Moderate	Moderate	Low
Vulnerability Rating	Moderate	Moderate	Moderate	Low	Moderate	Moderate	Low

7. OMAUI TO BLUFF

BEACHES, DUNES AND ROCKY SHORES

Rocky shore near Greenhills area, south of Omaui

Three Sisters dune

Dune north of Shag Rock

Stock pugging of coastal herbfield area

Between Omaui and Bluff the coastline is generally rocky (including bluffs, cliffs, rock stacks and rocky bays) and very exposed to high wave energy and southerly and westerly winds. This section also includes two small south-west facing, steep (reflective type) sandy beaches and dune systems.

Most of the access to this section of coast is by foot but for a large part this access is difficult. However, a popular walkway exists between Stirling Point and Lookout Point, and continues along the coastline around Bluff Hill to Ocean Beach. There are plans to extend this to Invercargill. The coastline from Stirling Point to Omaui Island is an important recreational paua fishery where commercial diving is prohibited within half a nautical mile of mean high water mark. The seabed offshore of Bluff Peninsula, forms part of the local rock lobster and blue cod fishery. A few fur-seals may been seen on rock promontories or outcrops from Omaui Island to Stirling Point, and yellow-eyed penguins at Lookout Point.

Omaui Island, a small conservation area off Steep Head, is the breeding ground for several species of birds, especially shags, gulls, blue penguins, sooty shearwaters, and royal spoonbills.

Beaches and Dunes - Omaui to Bluff

The first beach and dune system is located north of Shag Rock where the steep sand beach is bordered by a large area of marram duneland which is present as two areas of sand blown 70m up the hill slopes and 1.8km inland. It includes numerous wet areas with wetland and turf plants. A much larger, more complex and ecologically valuable dune system is located at Three Sisters, where sand has been blown up a gully to 130m and 1.3km inland. Marram is dominant but some pingao is present, which is contrary to the situation in the early 1990s when pingao was dominant (Johnson 1992). The dune also has rare plant (e.g. *Gunnera hamiltonii* and *Mazus arenarius*) and insect species (*Meterana* and *Notoreas)*. The reason for the reduction in pingao vegetation and expansion of marram in the Three Sisters dune is unknown - but likely to be the result of marram out-competing the native dune species. Also of importance along this much of this section of the coast are carpets of low, salt-tolerant plants (coastal herbfields) adjoining the mean high water mark. Currently, the coastal herbfields show extensive pugging damage from stock grazing.

Human Use. Human use is generally low (because of isolation). Uses include surfing, shellfish collection, boating, fishing, walking, and its scenic beauty.

Ecological Value. Ecological value is high to moderate given the reflective beach type, the partially modified but ecologically diverse dune and coastal herbfield systems, and productive inshore waters.

Existing Condition. Existing condition of the beaches is good given the well flushed nature of the coast despite being bathed by the New River Estuary plume (often enriched), and the Bluff wastewater discharge. Dune condition is moderate, being affected by weed growth, grazing, and over-stabilisation with marram.

Presence of Stressors. The key stressors for this area are: catchment landuse intensification, marram dominated dunes, grazing in dunes and coastal herbfields, and proximity to river plumes and point source discharges.

Susceptibility to Stressors. Susceptibility to stressors is moderate given the fragile nature of dune systems.

Abundant sea-life on rocky coast near Steep Head

Rocky shore towards Lookout Point.

Human Use		Moderate
Ecological Value		High
Existing Condition		Good
Susceptibility		Low
Stressors		Moderate
OVERALL VULNERABILITY		Moderate

Rocky Shore - Omaui to Bluff

The rocky sections of the coast are dominated by hard volcanic rocks which have high plant and animal biodiversity and have strong human use and ecological values.

Human Use. Human use is generally moderate-high being very popular for walking, diving, surfing, boating, fishing, and its scenic beauty.

Ecological Value. Ecological value is high given the high habitat diversity and the high biodiversity of the intertidal and subtidal areas, including a wide range of seaweed and animal types.

Existing Condition. Existing condition is good given the high water clarity, low nutrients and low disease risk of water that is expected to usually bathe the area (except perhaps in high river flows).

Presence of Stressors. The key stressors for this area are: proximity to the New River Estuary and Bluff treated wastewater plumes, human seafood collection and offshore spills or algal blooms.

Susceptibility to Stressors. Susceptibility to stressors is low given that the area is well-flushed.

Coastal herbfield

Issues	Monitoring	Management
Exposure to river plumes. Sea level rise (dune migration). Grazing and weed invasion. Lack of baseline information for high diversity beaches and rocky shores.	• Map intensive landuse (5 yearly). • Model river plume behaviour. • Broad scale habitat map - 10 yrly. • Monitor representative high diversity beach and rocky shore habitat within the region (3 yr baseline then 5 yearly).	• Limit intensive landuse development. • Maintain existing catchment wetlands. • Limit point discharges into estuaries. • Reduce grazing damage to foreshore. • Encourage dune maintenance. • Assess potential impact of long term changes in biodiversity.

Omaui to Bluff Beach, Dune, Rocky Shore	Disease Risk	Algal Blooms	Habitat Loss	Contaminants	Clarity Issues	Invaders/Weeds	Shellfish
Existing Condition Rating	Good	Very Good	Good	Very Good	Good	Fair	Good
Susceptibility Rating	Moderate	Low	Moderate	Very Low	Low	Moderate	Low
Vulnerability Rating	Moderate	Low	Moderate	Very Low	Low	Moderate	Low

BLUFF HARBOUR, AWARUA BAY

Estuary Type/Area	Tidal Lagoon
Catchment	85 km^2
Dairy cows	800 cows
Nitrogen loading	Low
Catchment geology	Peat, gravel, sands
Saltmarsh (ha)	200 ha primarily jointed wire rush
Salinity	Well mixed, sea water dominated
Mean depth (m)	Mostly less than 5m
Tidal flats	High
Uses/Values	Shipping, bathing, fishing, scientific, boating, walking, picnics, scenic, shellfish, diving, windsurfing.

Bluff Harbour - extensive tidal flats.

Human Use		High
Ecological Value		High
Existing Condition		Very Good
Susceptibility		Low
Stressors		Moderate
OVERALL VULNERABILITY		Low

Bluff Harbour (including Awarua Bay) (5,500ha) is a large sea-filled basin, mostly less than 5m deep, with the exit to Foveaux Strait to the southeast (details in Appendix 1). The catchment is small and consists primarily of peat, gravel and sands with native scrub vegetation. The harbour has large areas of salt-marsh, seagrass and tidal flats. Because it has no major point source, river or stream inputs, its water and sediment quality is very high. The township of Bluff and its port (8 main berths) are located along the western margin of the harbour and the Tiwai Point aluminium smelter wharf on the eastern side.

Uses and Values. High Use. Shipping, bathing, fishing, scientific, boating, walking, picnics, scenic, shellfish, diving, windsurfing and aquaculture.

Ecological Values. Ecologically, habitat diversity is high, given benefits of extensive tidal flats, saltmarsh, beach, seagrass, rock and subtidal habitats all in good condition. The harbour also includes extensive areas of artificial hard substrate which acts as habitat for biota.

Existing Condition. Very good water and sediment quality except near stormwater outfalls at times. Harbour plants and animals have been affected by the proximity to a large shipping wharf and consequently a recent survey (Inglis et al. 2005) found 12 non-indigenous organisms present in the harbour, although none are on the New Zealand register of unwanted organisms.

Presence of Stressors. Some of the coast has been modified by urban and port development and this has altered the habitat values of the margin. Point source discharges are minor, primarily urban stormwater and small marine farms. The highly invasive alga, *Undaria pinnatifida*, was present in Bluff Harbour in 1998, but has since been eradicated. The threat of spills and further pest introductions from ships and boats is relatively high. Sea level rise will likely have a large impact on low lying margins and cause habitat migration inland.

Susceptibility to Stressors

Because the harbour is relatively deep and sheltered, it acts as a natural settling basin for sediment, nutrients, pathogens and toxicants. However, it is also relatively well flushed with clean seawater each tide and so has a certain resilience to degradation.

Issues	Monitoring	Management
Developed margin. Sea level rise. Commercial development.	• Map intensive landuse - 5 yearly • Habitat map estuary every 5 years. • Fine scale phys/chem/biota monitoring 5 yearly (after baseline est.).	• Limit intensive landuse development. • Low impact point source discharges only. • Encourage margin vegetation enhancement. • Plan for estuary expansion with sea level rise.

Bluff Harbour, Awarua Bay	Sedimentation	Eutrophication	Disease Risk	Contaminants	Habitat Loss	Invaders	Shellfish
Existing Condition Rating	Very Good	Very Good	Very Good	Very Good	Good	Good	Very Good
Susceptibility Rating	Very Low	Very Low	Very Low	Very Low	Low	Moderate	Very Low
Vulnerability Rating	Very Low	Very Low	Very Low	Very Low	Moderate	Moderate	Very Low

8. BLUFF TO FORTROSE

BEACHES AND DUNES

Dune system near Tiwai

Pingao dunes, Toetoes Estuary Spit

Pimelia lyallii on Toetoes Estuary Spit

Human Use		Moderate
Ecological Value		Moderate
Existing Condition		Good
Susceptibility		Moderate
Stressors		Moderate
OVERALL VULNERABILITY		Moderate

Beach and Dune - Toetoes Beach

Toetoes Beach, a 32km long, very exposed, steep, gravel/sand beach (reflective type), stretches from Bluff Harbour to Toetoes Estuary at Fortrose. The beach sits on the edge of the low-lying Southland coastal plain and is bordered by low coastal vegetation.

- Near Bluff, the 12km Tiwai beach section has a reflective to intermediate type gravel/sand beach, low narrow dunes with vegetation dominated by marram at the western end, and silver tussock and coastal herb/turf plants (e.g. *Raoulia hookeri)*. The margin bordering the dune is red tussock and manuka scrub.
- Further east for 14km, the steep gravel beach backs onto either an eroding peat bank or low gravel bar, the rear slope of which has successive zones of low vegetation (silver tussock, clubrush and herbs and mosses bordering denser silver tussock, flax, bracken and backing on to low manuka scrub, sedges, heaths and cushion plants of the Waituna wetland complex.
- The 3km section between Waituna Lagoon and the Mataura River huts has a low narrow dune in the west (marram dominated then a zone of flax, clubrush, grasses bordered by grazed pasture).
- The next 6km is a more ecologically diverse dune system which is managed by DOC. It has progressively taller and sandier dunes with pingao, *Austrofestuca*, sand herbs, mats of *Raoulia*, cushions of *Pimelia lyallii* at the west end, and more marram and less pingao at the east end. A bog system behind the dunes has *Apodasmia*, red tussock and gorse.

Human Use. Human use is moderate being popular for walking, 4-wheel biking, fossicking, fishing and its scenic beauty.

Ecological Value. Ecological value is moderate given the reflective beach type and extensive dune/herbfield system and moderate habitat diversity.

Existing Condition. Existing condition is good - high water quality, but herbfields damaged by bikes and some dunes with marram and weeds.

Presence of Stressors. The key stressors are: sea level rise causing erosion and migration of dunes, weeds, exposure to river plume, grazing and vehicles in dunes.

Susceptibility to Stressors. Susceptibility to stressors is moderate given the proximity to urban areas and its low lying hinterland, however, because the area is well-flushed its susceptibility to water quality problems is moderate.

Issues	Monitoring	Management
Exposure to river plumes. Vehicle damage - dunes. Sea level rise (dune migration). Grazing and weed invasion.	• Map intensive landuse (5 yearly). • Map area of catchment wetlands - 5 yrly. • Broad scale map duneland - 10 yrly.	• Limit intensive landuse development. • Maintain existing catchment wetlands. • Reduce vehicle damage to dunes. • Encourage dune maintenance (marram and other weeds).

Toetoes Beach	Disease Risk	Algal Blooms	Habitat Loss	Contaminants	Clarity Issues	Invaders/Weeds	Shellfish
Existing Condition Rating	Very Good	Very Good	Good	Very Good	Very Good	Fair	Very Good
Susceptibility Rating	Moderate	Moderate	Moderate	Very Low	Very Low	Moderate	Very Low
Vulnerability Rating	Low	Low	Moderate	Very Low	Very Low	Moderate	Very Low

8. BLUFF TO FORTROSE (CONTINUED)

WAITUNA LAGOON

Estuary Type/Area	Coastal Lake
Catchment	212 km^2
Dairy cows	19,000 cows
Nitrogen loading	High 22 kg/ha/yr
Catchment geology	Peat, gravel, sand, sandstone/siltstone
Saltmarsh (ha)	472 ha
Salinity	<2ppt to 32ppt
Mean depth (m)	Approximately 1m
Tidal flats	High, when open
Uses/Values	Duck shooting, aesthetic, fishing, boating, walking, scientific, appreciation of rich biodiversity.

Eastern end of Waituna Lagoon

Human Use		High
Ecological Value		High
Existing Condition		Fair
Susceptibility		High
Stressors		High
OVERALL VULNERABILITY		High

Waituna is a large, intermittently open/closed coastal lake separated from the sea by a barrier beach (details in Appendix 1). It is fed by 3 streams and drains to the sea through a managed opening. Historically, the lagoon was surrounded by peat bog wetland (area ~20,000ha) whose drainage gave the lagoon water its characteristic clear brown humic stain, low nutrient status, and low pH. Now the catchment is dominated by farmland (intensive sheep, beef and dairying) and the drainage has elevated nutrient concentrations. Because it is largely unmodified and its remaining coastal wetland system is mostly intact, it has been designated as being of international significance under the RAMSAR Convention.

Uses and Values. High use. It is valued for its aesthetic appeal, its rich biodiversity, duck shooting, fishing (for brown trout primarily), boating, walking, and scientific appeal.

Ecological Values. Ecologically, habitat diversity is high, it has a unique submerged aquatic plant community (*Ruppia*-dominated), internationally important birdlife, and large areas of relatively unmodified wetland and terrestrial vegetation.

Existing Condition. Condition is fair. Problems are:

- It is eutrophic (high nutrient levels and both phytoplankton and macrophyte blooms).
- It has large areas of muddy sediments, particularly around rushland margins, stream plumes and sheltered embayments. Water clarity is low at times (although data is poor).
- Faecal coliform levels are expected to be elevated near stream outlets.
- It has localised areas of anoxic sediments.
- The area of rushland is changing (expanding at present).

Presence of Stressors. The major threats are: catchment runoff, sea level rise, salinity shifts from variable lagoon opening regimes and less importantly; drainage of margin areas, invasive weeds, and fire.

Susceptibility to Stressors. Because Waituna Lagoon is shallow, poorly flushed, has a long residence time, and is artificially opened and closed, it is very susceptible to having water quality problems that would adversely affect habitats if the relevant stressors (e.g. terrestrial runoff, climate change, invasive weeds) were present. Available information indicates that these stressors are present and have already adversely affected existing condition.

See Stevens and Robertson (2007) *"Waituna Lagoon 2007 Ecological Vulnerability Assessment and Monitoring Recommendations"*, for detailed assessment and monitoring recommendations.

Issues	Monitoring (see p96 for details)	Management
Water quality, sea level rise. Loss of *Ruppia*. Loss of biota, fish. Change in saltmarsh area.	• Map intensive landuse. • Map habitat regularly. • Phys/chem/biota in water and seds. • *Ruppia* and macroalgal mapping.	• Limit intensive landuse development. • Manage lagoon level for ecology. • Encourage margin vegetation enhancement. • Plan for estuary expansion with sea level rise.

Waituna Lagoon	Sedimentation	Eutrophication	Disease Risk	Contaminants	Habitat Loss	Invaders	Shellfish
Existing Condition Rating	Fair	Fair	Very Good	Very Good	Good	Good	Very Good
Susceptibility Rating	High	High	Moderate	Moderate	Moderate	Moderate	Very Low
Vulnerability Rating	High	High	Low	Low	Low	Low	Very Low

8. BLUFF TO FORTROSE (CONTINUED)

TOETOES (FORTROSE) ESTUARY

Estuary Type/Area	Tidal Lagoon
Catchment	5520 km^2
Dairy cows	117,960 cows
Nitrogen loading	Low: 5 kg/ha/yr
Catchment geology	Sandstone/siltstone, gravel, peat, igneous
Saltmarsh (ha)	100 ha primarily jointed wire rush
Salinity	Mixed, high freshwater input
Mean depth (m)	1-2m
Tidal flats	High 50% of estuary
Uses/Values	Walking, shellfish collection, birds, scenic, fishing, duckshooting, whitebaiting, bathing.

Toetoes Estuary from sandspit

Human Use		Moderate
Ecological Value		Moderate
Existing Condition		Fair
Susceptibility		Low
Stressors		Moderate
OVERALL VULNERABILITY		Moderate

Toetoes or Fortrose Estuary is a medium-sized "tidal lagoon" type estuary (area 497ha) that discharges to Toetoes Beach at Fortrose (details in Appendix 1). Situated at the mouth of the Mataura and Titiroa Rivers, it drains a primarily high productivity agricultural catchment, and the estuary is small in relation to the freshwater input. The estuary is bordered by a grazed pasture and duneland and has extensive mudflats (50% of estuary exposed at low tide) and saltmarsh areas. This estuary is regularly monitored by Environment Southland. Localised blooms of the green macroalgae (*Enteromorpha* sp.) are common within the estuary.

Uses and Values. Human use of the estuary is moderate and is mainly used for walking, shellfish collection, bird study, scenic, fishing, duckshooting, whitebaiting, and bathing.

Ecological Values. Ecologically, habitat diversity is moderate-high, given benefits of extensive tidal flats and saltmarsh and detriments of historical drainage, extensive weed growth, grazing of margins, and enrichment from catchment inputs. The estuary provides good habitat for fish (including breeding areas for whitebait and flatfish), birdlife and tidal flat organisms. In the "Wetlands of National Importance to Fisheries Database", the estuary is rated as outstanding.

Existing Condition. Water quality is moderately degraded (reduced clarity, elevated faecal coliforms, elevated nutrients), particularly in high river flows. Localised macroalgal blooms are common. Sediment type is mixed with areas of firm muddy sands and gravels plus soft and very soft muds - with some areas poor in oxygen with elevated sulphide concentrations. Metal concentrations are low. Estimated nitrogen (the major driver of eutrophication) loadings are low.

Presence of Stressors. The presence of stressors is expected to be "moderate". Landuse intensification, upstream point source discharges, absence of natural vegetated margins, grazed margins and weed and pest invasions are the main threats. Sea level rise is expected to cause expansion of estuary margins and migration of habitats.

Susceptibility to Stressors

Susceptibility to stressors is expected to be low-moderate given that the estuary is well flushed (low residence time), and has a wide range of habitat types.

Issues	Monitoring	Management
Algal blooms. Grazing near margin. Developed margin. Sea level rise. Weeds and pests.	• Map intensive landuse - 5 yearly • Habitat map estuary every 5 years. • Fine scale monitoring 5 yearly (after baseline est.). • Map macroalgal cover 5 yearly.	• Limit intensive landuse development. • Low impact point source discharges only. • Encourage margin vegetation enhancement. • Plan for estuary expansion with sea level rise. • Manage weeds and pests.

Toetoes Estuary	Sedimentation	Eutrophication	Disease Risk	Contaminants	Habitat Loss	Invaders	Shellfish
Existing Condition Rating	Fair	Fair	Good	Very Good	Fair	Good	Good
Susceptibility Rating	Low	Low	Low	Very Low	Low	Low	Very Low
Vulnerability Rating	Moderate	Moderate	Low	Very Low	Moderate	Low	Very Low

9. FORTROSE TO WAIPARAU HEAD

BEACHES, DUNES AND ROCKY SHORES

Frasers Beach - steep gravel beach and narrow marram dune

Waipapa Point - where marram invasion has displaced rare sand sedge

Waipapa Beach - steep eroding marram dunes

Haldane Beach - steep eroding marram dunes

Porpoise Bay

Long Beach

Between Fortrose and Porpoise Bay the coastline consists of rocky bluffs, cliffs, coastal platforms, a number of estuaries (two that are large, Waikawa and Haldane), various beaches (the most prominent located in Porpoise Bay), and dune systems. The coastline is generally very exposed to high wave energy and southerly winds. The area also contains significant populations of yellow-eyed penguins, Hector's dolphins and Hooker's sealions. The exposed fossil sediments, which are present along a large portion of the coast, notably Curio Bay and its petrified fossil forest on an intertidal shore platform, are rated as nationally significant.

Beaches and Dunes - Fortrose to Waiparau

Frasers Beach. The first major beach and dune system is at Frasers Beach where there is a steep gravel beach bordered by a 10m strip of marram dune-land which is backed by a low scrubby cliff. The clifftop has coastal herbfield (turf and sedge) communities near the edge and pasture behind. At the eastern end, 6m high sandy marram foredunes extend for 100m and are backed by lupin and gorse. Wind-blown sand extends up the hill slopes onto the pasture and cliff tops. The Tokanui Estuary discharges to the beach at the eastern end.

Frasers Beach To Waipapa Point. Between Frasers Beach and Waipapa Point there are a series of small steep gravel beaches bordered by narrow strips of marram and clubrush dunes, then low cliff in some areas, then coastal herbfields (similar to those on the Bluff Peninsula), and pasture. The last of these beaches, just northwest of Waipapa Point, has a more extensive marram clubrush border (especially at the western end). Interestingly, marram was not recorded on this beach in the early 1990s survey by Johnson (1992). Instead, the beach was bordered by a thin strip of the rare, native sand-binding sedge (*Carex pumilla*) and coastal herbfields.

Waipapa Beach. This intermediate to steep sandy beach is bordered to the west by 10-12m high eroding marram foredunes (with clubrush and gorse in the hind dunes) and backed by pasture. Lake Brunton, a shallow coastal lake, discharges to the middle of the beach. East of Lake Brunton, the marram dunes are much wider, with backdunes vegetated with marram, lupin, flax, clubrush and gorse. The Waipapa Estuary discharges to the beach at the western end. The Waipapa Point beaches contain some safe bathing areas behind rocky reefs.

Haldane Beach. This steep coarse sandy beach is bordered by extensive tall, marram-covered, eroding sand dunes (8-15m high) with many blow-outs. Further inland, the backdunes are vegetated with lupin, flax and marram. Flax dominates the eastern headland. The Haldane Estuary discharges to the bay at the western end.

Porpoise Bay. Porpoise Bay is a fairly sheltered, long curving bay with a broad, shallow gradient beach (dissipative-intermediate type). The beach is backed by 4-5m high marram-covered, eroding sand dunes. The backdunes are grazed and dominated by flax, marram and grasses. At the eastern end, the dunes are taller and wider and more ecologically diverse. The western end of Porpoise Bay is a popular swimming and surfing beach where Hector's dolphins often swim close to bathers. The endemic Hector's dolphins are resident in the Porpoise Bay area during the months of October to March.

Little, Shades, Dummys and Long Beach. The first three are isolated, steep sandy beaches (reflective type) with a thin margin of marram dune bordering native scrub and grassland. The adjoining, steep Longbeach is more extensive than its neighbours. It has a Pingao patch at the eastern end and low marram dunes along the remainder. The Longbeach estuary discharges at the eastern end.

Steep cliffs and cliff vegetation, Slope Point area

Typical platform reefs covered with *Durvillea*

Human Use		Mod-High
Ecological Value		High
Existing Condition		Good
Susceptibility		Low
Stressors		Moderate
OVERALL VULNERABILITY		Moderate

Rocky Shores - Fortrose to Waiparau Head

The section from Fortrose to Waipapa Point is characterised by a series of low headlands with offshore reefs interspersed with beaches (described above) with rocky reefs extending well offshore at Waipapa Point. At the eastern end of Waipapa Beach, the coastline becomes much steeper and features long headlands with steep rocky sea cliffs and platform reefs (sedimentary rock type), backed by "drowned" coastal features. The continuity of the sea cliffs is interrupted by the indented sandy bay, Haldane Beach, at the mouth of the Haldane Estuary. Vegetation on the steep cliffs is dominated by *Hebe elliptica*, flax, tussocks (*Poa astonii*), and various smaller plants such as *Crassula* and native ice plant. A mat of grazed coastal herbfields dominate the top of the cliff, backed by grazed pasture. The section from Porpoise Bay to Long Beach is similar to the Haldane section with steep rocky cliffs, platform reefs, and several steep beaches (Little, Shades, Dummys and Long beaches). Native bush borders the coastline at Dummys and Long Beach.

Beach, Dune and Rocky Shore Vulnerability

Human Use. Human use is generally moderate-high being very popular for walking, picnicing, diving, surfing, bathing, boating, fishing, and its scenic beauty.

Ecological Value. Ecological value of the rocky shore is high (high biodiversity and habitat types). Beaches tend to be steep (except for Porpoise Bay) therefore less ecologically rich. Dunes are extensive in places but dominated by the invasive marram grass and therefore prone to erosion. More valued plant communities exist on the cliff faces and cliff edges.

Existing Condition. Existing condition is high for the rocky shores and beaches given the high water clarity, low nutrients and low disease risk of water that is expected to usually bathe the area. Dune condition is fair given dominance by marram.

Presence of Stressors. The key stressors for this area are human seafood collection, sea level rise affecting dunes, weed growth, and grazing of dunes and herbfields.

Susceptibility to Stressors. Susceptibility to stressors is low given that the area is well-flushed, and the coast is generally elevated, but because the dunes are marram dominated they are susceptible to erosion and are less biodiverse.

Issues	Monitoring	Management
Sea level rise (dune migration). Grazing dunes and herbfields. Weed invasion (esp. marram). Lack of high diversity rocky shore and beach baseline.	• Map intensive landuse (5 yearly). • Broad scale map duneland - 10 yrly. • High biodiversity beach and rocky shores (3 yr baseline then 5 yearly).	• Limit intensive landuse development. • Reduce grazing damage to dunes. • Encourage dune maintenance and revegetation with natives. • Assess long term biodiversity changes.

Fortrose to Waiparau Head Beach, Dune, Rocky Shore	Disease Risk	Algal Blooms	Habitat Loss	Contaminants	Clarity Issues	Invaders/Weeds	Shellfish
Existing Condition Rating	Very Good	Very Good	Good	Very Good	Very Good	Fair	Very Good
Susceptibility Rating	Very Low	Very Low	Moderate	Very Low	Very Low	Moderate	Very Low
Vulnerability Rating	Very Low	Very Low	Moderate	Very Low	Very Low	Moderate	Very Low

TOKANUI ESTUARY

Estuary Type/Area	Tidal River Mouth, open April 2008
Catchment	74 km^2 (forest/pasture)
Dairy cows	266 cows
Nitrogen loading	Moderate: 8-9 kg/ha/yr
Catchment geology	Sandstone/siltstone, gravel, sand
Saltmarsh (ha)	<0.1ha drained
Salinity	Varies depending on mouth closure (<1ppt)
Mean depth (m)	0.5-1.5m
Tidal flats	Minor (floods on beach berm)
Uses/Values	Whitebaiting, fishing, scenic.

Tokanui Estuary behind Waipapa Beach

Human Use		Low
Ecological Value		Moderate
Existing Condition		Fair
Susceptibility		Moderate
Stressors		Moderate
OVERALL VULNERABILITY		Moderate

The Tokanui Estuary is a small "tidal river mouth" type estuary (area ~1ha), at the eastern end of Frasers Beach (details in Appendix 1). The estuary is U-shaped, narrow and shallow (mean depth 0.5-1.5m) and situated at the base of a moderately steep, grazed valley. The estuary discharges onto the upper beach, between a low grazed headland and marram duneland, where it forms a shallow lagoon, whose size varies depending on the extent of mouth constriction.

Uses and Values. Human use of the estuary is expected to be moderate (valued for whitebaiting and its scenic beauty).

Ecological Values. Ecologically, habitat diversity is low, given the absence of significant areas of tidal flats and saltmarsh. However, the clean sandy sediments provide good habitat for fish and invertebrates.

Existing Condition. Salinities vary depending on the extent of tidal inflow and constriction of the mouth. The water is generally very clear but humic stained, and the sediments are clean sand with little sign of anoxic conditions. Water quality in the stream is expected to be fair given the predominately high productivity pasture catchment and presence of intensive grazing. Estimated nitrogen (the major driver of eutrophication) loadings are moderate. Because the estuary is small and dominated by freshwater inputs, its quality is expected to be similar to that of the stream for much of the time.

Presence of Stressors. The presence of stressors is expected to be moderate - catchment runoff, grazed margins, sea level rise and historical drainage of saltmarsh areas.

Susceptibility to Stressors. The mouth is expected to periodically constrict or close due to high seas. At such times, it is poorly flushed and may become eutrophic. Given these characteristics, the estuary ecology is susceptible to: any increase in the intensity of landuse in the catchment, and constriction of the estuary mouth. Sea level rise is likely to expand the estuary and improve habitat diversity.

Issues	Monitoring	Management
Mouth constricting - eutrophic. Grazing near margin. Developed margin. Sea level rise.	• Map intensive landuse - 5 yearly. • Habitat map estuary every 10 yrs. • Assess DO, RPD, in summer baseflow conditions, every 3 years.	• Limit intensive landuse development. • Low impact point source discharges only. • Encourage margin vegetation enhancement. • Plan for estuary expansion with sea level rise.

Tokanui Estuary	Sedimentation	Eutrophication	Disease Risk	Contaminants	Habitat Loss	Invaders	Shellfish
Existing Condition Rating	Good	Fair	Good	Very Good	Poor	Fair	Very Good
Susceptibility Rating	Moderate	Moderate	Moderate	Very Low	Low	Low	Very Low
Vulnerability Rating	Moderate	Moderate	Moderate	Very Low	Low	Low	Very Low

LAKE BRUNTON

Estuary Type/Area	Coastal Lake
Catchment	24 km^2
Dairy cows	780 cows
Nitrogen loading	Mod-High 14 kg/ha/yr
Catchment geology	Sandstone/siltstone, peat, gravel, sand
Saltmarsh (ha)	High 50 ha
Salinity	Varies, 25ppt when open April 2008
Mean depth (m)	Approximately 0.5-1m
Tidal flats	High, when open
Uses/Values	Duck shooting, aesthetic, boating, walking, scientific, biodiversity.

Lake Brunton - exposed *Ruppia* beds.

Human Use		Low
Ecological Value		High
Existing Condition		Fair
Susceptibility		High
Stressors		High
OVERALL VULNERABILITY		High

Lake Brunton is a small (25ha), intermittently open/closed coastal lake separated from the sea by a barrier beach (details in Appendix 1). It is fed by three small streams and drains to the sea through an unmanaged opening. The lake is bordered by extensive areas of saltmarsh and its bed has a unique submerged aquatic plant community (*Ruppia*-dominated). The catchment is dominated by farmland (sheep, beef and dairying) and drainage is expected to have elevated nutrient concentrations.

Uses and Values. Low use. It is valued for its aesthetic appeal, biodiversity, duck shooting, and scientific appeal.

Ecological Values. Ecologically, habitat diversity is high, it has a unique submerged aquatic plant community (*Ruppia*-dominated), internationally important birdlife, and large areas of relatively unmodified wetland and terrestrial vegetation.

Existing Condition. Condition is fair given its exposure to likely problems such as eutrophication, sedimentation, disease risk - generated when the lake is closed and poorly flushed.

Presence of Stressors. The major threats are: catchment runoff, sea level rise, salinity shifts from variable lagoon opening regimes and less importantly; drainage of margin areas, and invasive weeds.

Susceptibility to Stressors. Because Lake Brunton is shallow, poorly flushed, has a long residence time, and experiences cycles of open and closed regimes, it is very susceptible to having water quality problems that would adversely affect the unique community if the relevant stressors (e.g. terrestrial runoff, climate change, invasive weeds) were present. Available information indicates that these stressors are likely to be present and may already be adversely affecting existing conditions. In particular, the catchment has increasing intensive agriculture, and there is pressure to drain saltmarsh margins further. In addition, current high salinity and shallow depth conditions are causing stress to existing *Ruppia* communities. Available information indicates *Ruppia* is dependent on a low salinity habitat for its survival (i.e. will only survive high salinities for short periods) and does not like being exposed for long periods. When the lake was visited in April 2008, the mouth was open, salinity was 24 ppt and many *Ruppia* beds were exposed. Sea level rise is expected to increase the extent of the lake and cause habitat migration, but also threaten the *Ruppia* community with an increased salinity regime.

Issues	Monitoring	Management
Loss of *Ruppia*. Loss of biota, fish. Loss of saltmarsh. Sea level rise - salinity shift.	Undertake detailed short term synoptic monitoring and risk assessment. Results used to design ongoing monitoring and management.	• Develop monitoring and management plan. • Limit intensive landuse development. • Encourage margin vegetation enhancement. • Plan for lake expansion with sea level rise.

Lake Brunton	Sedimentation	Eutrophication	Disease Risk	Contaminants	Habitat Loss	Invaders	Shellfish
Existing Condition Rating	Fair	Fair	Very Good	Very Good	Good	Good	Very Good
Susceptibility Rating	High	High	Moderate	Low	Moderate	Moderate	Very Low
Vulnerability Rating	High	High	Low	Low	Moderate	Low	Very Low

WAIPAPA ESTUARY

Estuary Type/Area	Tidal River Mouth, open April 2008
Catchment	36 km^2 (forest/pasture)
Dairy cows	134 cows
Nitrogen loading	Low-Mod: 7-8 kg/ha/yr
Catchment geology	Sandstone/siltstone, gravel, sand
Saltmarsh (ha)	Dune, no marsh (drained)
Salinity	Salt wedge, surface 3ppt, bottom 27ppt
Mean depth (m)	1-2m
Tidal flats	Minor (floods on beach berm)
Uses/Values	Whitebaiting, fishing, scenic.

Waipapa Estuary east end Waipapa Beach

Human Use		Low
Ecological Value		Moderate
Existing Condition		Fair
Susceptibility		Moderate
Stressors		Moderate
OVERALL VULNERABILITY		Moderate

The Waipapa Estuary is a small "tidal river mouth" type estuary (area ~1ha), at the eastern end of Waipapa Bay (details in Appendix 1). The estuary is elongated, narrow and shallow (mean depth 1-2m) and discharges onto the upper beach, between a low grazed headland and marram duneland where it forms a shallow lagoon, whose size varies depending on the extent of mouth constriction. In the past it likely had extensive saltmarsh areas which have been drained.

Uses and Values. Human use of the estuary is expected to be moderate (valued for whitebaiting, fishing and scenic beauty).

Ecological Values. Ecologically, habitat diversity is currently low, given the absence of significant areas of tidal flats and saltmarsh. However, the clean sediments provide good habitat for fish and invertebrates.

Existing Condition. Salinities vary depending on the extent of tidal inflow and constriction of the mouth. The water is generally clear but humic stained, and the sediments are clean sand with little sign of anoxic conditions. Water quality in the stream is expected to be fair given the predominately high productivity pasture catchment and presence of intensive grazing. Estimated nitrogen (the major driver of eutrophication) loadings are low-moderate. Because the estuary is small and dominated by freshwater inputs, its quality is expected to be similar to that of the stream for much of the time.

Presence of Stressors. The presence of stressors is expected to be moderate - catchment runoff, grazed margins, sea level rise and historical drainage of saltmarsh areas.

Susceptibility to Stressors. The mouth is expected to periodically constrict or close due to high seas. At such times, it is poorly flushed and water quality is expected to become eutrophic. Given these characteristics, the estuary ecology is susceptible to: any increase in the intensity of landuse in the catchment, and constriction of the estuary mouth. Sea level rise is likely to expand the estuary and improve habitat diversity.

Issues	Monitoring	Management
Mouth constricting - eutrophic. Grazing near margin. Developed margin. Sea level rise.	• Map intensive landuse - 5 yearly. • Habitat map estuary every 10 yrs. • Assess DO, RPD, in summer baseflow conditions, every 3 years.	• Limit intensive landuse development. • Low impact point source discharges only. • Encourage margin vegetation enhancement. • Plan for estuary expansion with sea level rise.

Waipapa Estuary	Sedimentation	Eutrophication	Disease Risk	Contaminants	Habitat Loss	Invaders	Shellfish
Existing Condition Rating	Good	Fair	Good	Very Good	Fair	Fair	Very Good
Susceptibility Rating	Moderate	Moderate	Moderate	Very Low	Low	Low	Very Low
Vulnerability Rating	Moderate	Moderate	Moderate	Very Low	Low	Low	Very Low

HALDANE ESTUARY

Estuary Type/Area	Tidal Lagoon
Catchment	70 km^2
Dairy cows	0 cows
Nitrogen loading	Low-Mod: 6 kg/ha/yr
Catchment geology	Sandstone/siltstone, gravel, sand
Saltmarsh (ha)	10 ha (large area cut-off from estuary by road)
Salinity	Well mixed, sea water dominated
Mean depth (m)	1-2m
Tidal flats	High
Uses/Values	Walking, shellfish collection, birds, scenic, fishing, duckshooting, whitebaiting, bathing.

Haldane Estuary showing loss of saltmarsh with road development at top end.

Human Use		Moderate
Ecological Value		Moderate
Existing Condition		Good
Susceptibility		Moderate
Stressors		Moderate
OVERALL VULNERABILITY		Moderate

Haldane Estuary is a medium-sized "tidal lagoon" type estuary (area 206ha), that discharges to the beach at the western end of Haldane Bay (details in Appendix 1). Situated at the confluence of several streams, it drains a primarily native bush catchment. The estuary is relatively shallow (mean depth approximately 1-2m) and bordered primarily by grazed pasture. The estuary has extensive tidal flats (>80% of estuary exposed at low tide), but much of its saltmarsh habitat (>30ha) was cutoff from the estuary when a road was established within it. This estuary is regularly monitored by Environment Southland.

Uses and Values. Human use of the estuary is moderate - mainly walking, shellfish collection, bird study, scenic values, fishing, duckshooting, whitebaiting, bathing.

Ecological Values. Ecologically, habitat diversity is moderate, given benefits of tidal flats and saltmarsh, and detriments of historical drainage, extensive margin weed growth, and grazing of margins. Such conditions provide moderate habitat for native fish, birdlife and tidal flat organisms.

Existing Condition. Water quality is expected to be good based on the high quality of the input stream and absence of macroalgal blooms. Sediment is mixed with large sandy and firm muddy sand areas plus soft and very soft muds near the stream inputs. Metal concentrations are low. Estimated nitrogen (the major driver of eutrophication) loadings are low-moderate.

Presence of Stressors. The presence of stressors is "moderate". Historical drainage of wetlands, landuse intensification, absence of natural vegetated margins, grazed margins and weed and pest invasions are the main threats.

Susceptibility to Stressors.
Susceptibility to stressors is expected to be moderate given that the estuary is well flushed (low residence time), but already modified (loss of large areas of saltmarsh which means ecosystem functions are impaired). Sea level rise is likely to expand the estuary and improve habitat diversity.

Saltmarsh habitat

Issues	Monitoring	Management
Loss of saltmarsh. Grazing near margin. Developed margin.	• Map intensive landuse - 5 yearly • Habitat map estuary every 5 years. • Fine scale monitoring 5 yearly (after baseline est.). • Map macroalgal cover 5 yearly.	• Limit intensive landuse development. • Re-establish saltmarsh cutoff by road. • Encourage margin vegetation enhancement. • Plan for estuary expansion with sea level rise.

Haldane Estuary	Sedimentation	Eutrophication	Disease Risk	Contaminants	Habitat Loss	Invaders	Shellfish
Existing Condition Rating	Good	Good	Good	Very Good	Poor	Good	Good
Susceptibility Rating	Moderate	Moderate	Low	Very Low	Low	Low	Low
Vulnerability Rating	Low	Low	Low	Very Low	Moderate	Low	Low

COOK CREEK ESTUARY

Estuary Type/Area	Tidal River Mouth, open April 2008
Catchment	17 km^2 (forest/pasture)
Dairy cows	0 cows
Nitrogen loading	Moderate: 10kg/ha/yr
Catchment geology	Sandstone/siltstone, sand
Saltmarsh (ha)	<0.1ha drained
Salinity	Varies depending on mouth closure (<1ppt)
Mean depth (m)	0.5-1m
Tidal flats	Minor (floods on beach berm)
Uses/Values	Whitebaiting, paddling, scenic.

Cooks Creek Estuary - grazed unfenced margins.

Human Use		Low
Ecological Value		Low
Existing Condition		Good
Susceptibility		Moderate
Stressors		Moderate
OVERALL VULNERABILITY		Low

The Cook Creek Estuary is a small "tidal river mouth" type estuary (area ~1ha) near Curio Bay (details in Appendix 1). The estuary is narrow and shallow (mean depth 0.5-1m) and situated in lowland grazed pasture and dunes. The estuary discharges onto the upper beach at Porpoise Bay, where it forms a shallow lagoon, whose size varies depending on the extent of mouth constriction.

Uses and Values. Human use of the estuary is low-moderate but is valued for whitebaiting, paddling and its scenic beauty.

Ecological Values. Ecologically, habitat diversity is low, given channelisation and the absence of significant areas of tidal flats and saltmarsh.

Existing Condition. Salinities vary depending on the extent of tidal inflow and constriction of the mouth. The water is generally clear but humic stained, and the sediments are clean sand with little sign of anoxic conditions. Water quality in the stream is expected to be fair given the predominately high productivity pasture catchment, native bush and presence of intensive grazing. Estimated nitrogen (the major driver of eutrophication) loadings are moderate. Because the estuary is small and dominated by freshwater inputs, its quality is expected to be similar to that of the stream for much of the time.

Presence of Stressors. The presence of stressors is expected to be moderate - catchment runoff, grazed margins, sea level rise and historical drainage of saltmarsh areas.

Susceptibility to Stressors. The mouth is expected to periodically constrict or close due to high seas. At such times, it is poorly flushed and water quality is expected to become eutrophic. Given these characteristics, the estuary ecology is susceptible to: any increase in the intensity of landuse in the catchment, and constriction of the estuary mouth. Sea level rise is likely to expand the estuary and improve habitat diversity.

Cooks Creek Estuary - Porpoise Bay.

Issues	Monitoring	Management
Mouth constricting - eutrophic. Grazing near margin. Developed margin. Sea level rise.	• Map intensive landuse - 5 yearly. • Habitat map estuary every 10 years.	• Limit intensive landuse development. • Low impact point source discharges only. • Encourage margin vegetation enhancement. • Plan for estuary expansion with sea level rise.

Cooks Creek Estuary	Sedimentation	Eutrophication	Disease Risk	Contaminants	Habitat Loss	Invaders	Shellfish
Existing Condition Rating	Good	Good	Good	Very Good	Fair	Fair	Very Good
Susceptibility Rating	Moderate	Moderate	Moderate	Low	Low	Low	Very Low
Vulnerability Rating	Low	Low	Low	Low	Low	Low	Very Low

WAIKAWA ESTUARY (HARBOUR)

Estuary Type/Area	Tidal Lagoon
Catchment	237 km^2
Dairy cows	599 cows
Nitrogen loading	Low-Mod: 7 kg/ha/yr
Catchment geology	Gravel, sandstone/siltstone, peat
Saltmarsh (ha)	40 ha primarily *Leptocarpus*
Salinity	Well mixed, sea water dominated
Mean depth (m)	1-2m
Tidal flats	High
Uses/Values	Walking, shellfish collection, birds, scenic, fishing, duckshooting, whitebaiting, bathing.

Waikawa Estuary

Human Use		High
Ecological Value		High
Existing Condition		Fair
Susceptibility		Low
Stressors		Low
OVERALL VULNERABILITY		Moderate

Waikawa Estuary is a moderate-sized "tidal lagoon" type estuary (760ha), that discharges to the east end of Porpoise Bay (details in Appendix 1). Situated at the mouth of the Waikawa River, it drains a mixed catchment of high production pasture and native bush. The estuary is relatively shallow (mean depth approximately 2m) and bordered by a mix of vegetation and landuses (bush and grazed pasture). The estuary has a wide range of habitats (extensive tidal flats, seagrass and saltmarsh areas) but has lost areas through drainage and reclamation. It has a 3m spring tidal range and serves as a port for several fishing boats which operate from the jetties near the centre of the Waikawa township. The estuary is regularly monitored by Environment Southland.

Uses and Values. Human use of the estuary is high - mainly shellfish gathering, swimming, boating, bird study, fishing, walking, and aesthetics.

Ecological Values. Ecologically, it is valued for it's high biodiversity including fish and birdlife. In addition, the endemic Hector's dolphins, which are resident in the Porpoise Bay area during the months of October to March, are dependent on the Waikawa Estuary and Porpoise Bay for food.

Existing Condition. Water quality is expected to be good. Nuisance macroalgal blooms are rated relatively low and the sediments are well-oxygenated. Sediment type is mixed, but approximately half of the estuary surface is covered by soft muds and recent sedimentation rates are high. Metal concentrations are low. Estimated nitrogen (the major driver of eutrophication) loadings are low-moderate.

Presence of Stressors. The presence of stressors is moderate. Landuse intensification, sea level rise and habitat migration, absence of natural vegetated margins, grazed margins and weed invasions are the main threats.

Susceptibility to Stressors.
Susceptibility to stressors is expected to be low given that the estuary is well flushed (low residence time), and already modified.

Waikawa Estuary - soft muds

Issues	Monitoring	Management
Catchment runoff. Grazing near margin. Developed margin. Sea level rise.	• Map intensive landuse - 5 yearly • Habitat map estuary every 5 years. • Fine scale monitoring 5 yearly. • Sedimentation rate monitoring. • Map macroalgal cover 5 yearly.	• Limit intensive landuse development. • Encourage margin vegetation enhancement. • Plan for estuary expansion with sea level rise. • Reduce sediment inputs.

Waikawa Estuary	Sedimentation	Eutrophication	Disease Risk	Contaminants	Habitat Loss	Invaders	Shellfish
Existing Condition Rating	Fair	Good	Good	Very Good	Fair	Good	Good
Susceptibility Rating	Low	Low	Low	Low	Low	Low	Low
Vulnerability Rating	Moderate	Low	Low	Low	Moderate	Low	Low

LONGBEACH ESTUARY

Estuary Type/Area	Tidal River Mouth, open April 2008
Catchment	25 km^2 (forest/pasture)
Dairy cows	0 cows
Nitrogen loading	Low: 5 kg/ha/yr
Catchment geology	Sandstone/siltstone, gravel, sand
Saltmarsh (ha)	Dune, small area saltmarsh
Salinity	Salt wedge, surface 1.5ppt, bottom 25ppt
Mean depth (m)	0.5-1m
Tidal flats	Minor (floods on beach berm)
Uses/Values	Whitebaiting, fishing, scenic.

Longbeach Estuary, east end of Long Beach

Human Use		Low
Ecological Value		Moderate
Existing Condition		Very Good
Susceptibility		Moderate
Stressors		Low
OVERALL VULNERABILITY		Low

Longbeach Estuary is a small "tidal river mouth" type estuary (area ~1ha), at the eastern end of Long Beach (details in Appendix 1). The estuary is elongated, narrow and shallow (mean depth 0.5-1m) and discharges onto the upper beach, between a native forest headland and marram duneland, where it forms a shallow lagoon, whose size varies depending on the extent of mouth constriction. The estuary is bordered by a mix of vegetation (native bush, dunes, flax, and grass) and has a primarily native bush catchment (97%). The estuary has a moderate range of habitats (small areas of tidal flat and saltmarsh areas).

Uses and Values. Human use of the estuary is low-moderate but is valued for whitebaiting, fishing and its scenic beauty.

Ecological Values. Ecologically, habitat diversity and value is currently moderate, given the predominantly native bush catchment, but the absence of significant areas of tidal flats and saltmarsh.

Existing Condition. Salinities vary depending on the extent of tidal inflow and constriction of the mouth. The water is generally clear but humic stained, and the sediments are clean sand with little sign of anoxic conditions. Water quality in the stream is expected to be very good given the predominately native bush catchment (but the margins of the estuary are currently grazed). Estimated nitrogen (the major driver of eutrophication) loadings are low. Because the estuary is small and dominated by freshwater inputs, its quality is expected to be similar to that of the stream for much of the time.

Presence of Stressors. The presence of stressors is expected to be low - mouth constriction, catchment runoff, grazed margins, and sea level rise.

Susceptibility to Stressors. The mouth is expected to periodically constrict or close due to high seas. At such times, it is poorly flushed and water quality is expected to become eutrophic if excessive nutrients were to enter the estuary. Given these characteristics, the estuary ecology is susceptible to: any increase in the intensity of landuse in the catchment, and constriction of the estuary mouth. Sea level rise is likely to expand the estuary and improve habitat diversity.

Longbeach Estuary margin

Issues	Monitoring	Management
Mouth constricting. Grazing near margin. Sea level rise.	• Map intensive landuse - 5 yearly. • Habitat map estuary every 10 years.	• Limit intensive landuse development. • Encourage margin vegetation enhancement. • Plan for estuary expansion with sea level rise.

Longbeach Estuary	Sedimentation	Eutrophication	Disease Risk	Contaminants	Habitat Loss	Invaders	Shellfish
Existing Condition Rating	Very Good	Very Good	Very Good	Very Good	Very Good	Very Good	Very Good
Susceptibility Rating	Moderate	Moderate	Moderate	Low	Low	Low	Very Low
Vulnerability Rating	Low	Low	Low	Low	Low	Low	Very Low

10. CONCLUSIONS

The broad-scale habitat mapping, synoptic monitoring and risk assessment study of the Southland coastline (Te Waewae to Waiparau Head) was undertaken to identify ecological monitoring and management priorities for Environment Southland. The study identified both sheltered and exposed coastlines with a wide range of coastal shoreline habitats including: estuaries, beaches, dunes, rocky shores, with a variety of hinterlands. For each of these broad habitats, the study has provided three main outputs: habitat summaries, vulnerability assessments, and monitoring priorities which are summarised as follows:

ESTUARIES

Eel net Jacobs River Estuary

Longbeach Estuary

Native bush margin, Rowallan Burn Estuary

Eutrophic Waiau Ponds

(i) Habitat Mapping

Estuaries occupied 43% of the coastline and included six large tidal lagoon estuaries (Jacobs River, New River, Bluff/Awarua, Toetoes, Haldane and Waikawa), two coastal lake estuaries (Waituna and Lake Brunton), one large tidal river mouth estuary (Waiau Lagoon) and 15 small tidal river mouth estuaries (eg. Waimeamea). These latter estuaries generally exhibited low habitat diversity, with saltmarsh and tidal flats virtually absent, and lagoon size varying throughout the year (depending on mouth blockage). The tidal lagoon and coastal lake estuaries exhibited the greatest habitat diversity.

(ii) Vulnerability Assessment

Vulnerability assessments of the small tidal river mouth estuaries indicated mainly low or low-moderate vulnerability to ecological damage from the major stressors (primarily because they are small and already highly modified), except for the larger Waimatuku Estuary which exhibited moderate vulnerability (has greater habitat diversity and is in poor condition). Both coastal lakes (Waituna and Brunton) had high vulnerability (high habitat diversity and susceptibility to stressors). The tidal lagoon estuaries (large shallow, lagoons with broad habitat diversity and uses - e.g. New River) had moderate ratings.

(iii) Monitoring Recommendations

Long Term Estuary Monitoring

Monitor long term condition of representative estuaries with highest biodiversity and risk to ecology.

- Estuaries should include those already in the ES estuary programme; (New River, Jacobs River, Bluff/Awarua, Waituna, Toetoes, and Waikawa), as well as those new to the estuary programme: e.g. Waiau, Waituna (see Stevens and Robertson 2007 for recommended Waituna monitoring).
- Broad scale habitat mapping and risk assessment every 5 years.
- Fine scale, 1-2 sites (incl. sedimentation rates), 3 year baseline then 5 yearly.
- Map intensive catchment landuse (including wetland areas), 5 yearly.
- Monitor disease risk of shellfish and bathing waters near contaminated river plumes and urban SW discharges.

Monitor all other estuaries for long term change by repeating the broad scale synoptic monitoring (i.e. habitat mapping, sediment redox, depth, salinity, open/closed regime) and vulnerability assessment at 10 year intervals.

Intensive Estuary Assessments

Undertake short term synoptic monitoring and risk assessment of at risk estuaries in which limited existing information is available. This information will be used to develop appropriate monitoring and management plans for these estuaries. Target estuaries: Waiau, Waimatuku, L Brunton.

10. CONCLUSIONS (CONTINUED)

BEACHES

Bluecliffs Beach

Gemstone Beach at Orepuki

(i) Habitat Mapping

Beaches and dunes occupied 36% of the coastline, including a range of types;

- Broad, flat, sandy dissipative beaches with wide surf zones and high ecological richness (e.g. Oreti Beach, and sections of Porpoise Bay, Colac Bay and Te Waewae Bay).
- Steep, coarse grained (generally gravel), reflective type beaches with narrow surf zones and low ecological richness (e.g. Toetoes Beach, much of Te Waewae Bay).
- Intermediate type beach areas which have an intermediate slope and moderate species richness (e.g. Waipapa, Dummys and Long Beach).
- Sheltered beaches in the harbours and estuaries which also tend to have high ecological richness (e.g. Bluff Harbour and Waikawa Estuary).

(ii) Vulnerability Assessment

The beaches had low or moderate vulnerability to ecological damage. Habitat degradation through sea level rise, vehicle access, stormwater discharges, river plumes, property development on dunes, and seawalls were the major stressors.

(iii) Monitoring Recommendations

Monitor long term condition of high biodiversity beaches.

- One long term monitoring site on each of three dissipative beaches (most species rich), e.g. Porpoise Bay, Oreti Beach, Bluecliffs Beach. Establish 3 year baseline then 5 yearly.

DUNES

Eroding marram dunes at Ocean Beach

Pingao dominated dunes on Toetoes Spit

(i) Habitat Mapping

Dunes bordered the top margin of most beaches including at the foot of cliffs in much of Te Waewae Bay. The most extensive areas of duneland tended to be found at the eastern ends of beaches - a product of longshore drift and prevailing wind exposure. Most dunes were relatively narrow, dominated by the introduced and invasive marram grass, and flanked by grazed pasture on old modified dunes (e.g. Oreti Beach). Coastal herbfields were also present on the upper beach crest or downslope along many of the steep gravel beaches (e.g. Toetoes Beach, Te Waewae Bay and the east end of Colac Bay). Only in several isolated locations were there significant areas of native (e.g. pingao) sand-binding species (e.g. Toetoe Spit, Three Sisters near Omaui and at Waipapa Point), although previously pingao-dominated dunes at Three Sisters and Waipapa have recently had the pingao displaced by marram grass. Biodiversity is expected to be greatest in the native dominated dunes and herbfields, where a more diverse range of habitats are present.

(ii) Vulnerability Assessment

Vulnerability assessments of the dune habitat indicated mainly low or moderate vulnerability. However, because these assessments were included in a combined beach, dune and rocky shore assessment for different sections of the coast, they will generally underestimate individual duneland vulnerability at a local scale (given that dunes are the most vulnerable of the three). The major stressors on the Southland dune habitat include: invasion of marram grass, stock grazing, vehicle damage and sea level rise (causing erosion and migration inland).

(iii) Monitoring Recommendations

Monitor long term dune area and condition of all Southland beaches at 10 yearly intervals.

Monitor long term coastal herbfield area and condition at key areas (e.g. Bluff Peninsula to Omaui) at 10 yearly intervals.

ROCKY SHORES

Rocky shore and coastal herbfields, Ocean Beach

Productive plant and animal life on rocks near Riverton

(i) Habitat Mapping

Rocky shores covered 21% of the coastline and generally had very exposed, high-energy shores. Hard igneous rock types were found in the west, and softer sedimentary rock types in the east (often with high cliffs). In many areas, the landward margin was bordered by coastal herbfields (turf and cushion plants). Sheltered rocky shores occurred within the confines of Bluff Harbour. The waters bathing the coastline were very productive and consequently the rocks had a very abundant and diverse ecology. Bull kelp (*Durvillaea antarctica*), mussels and barnacles dominated the low water area in most exposed places. These biologically rich and relatively accessible habitats had high value to humans for diving, fishing, fossicking, walking and scenic attraction.

(ii) Vulnerability Assessment

Vulnerability assessments of the rocky shore habitat indicated mainly low or low-moderate vulnerability. The key stressors were identified as: sea level and sea temperature increases, exposure to river plumes, and seafood collection. Habitat change and effects on rocky shore biodiversity was the primary ecological threat.

(iii) Monitoring Recommendations

Monitor long term condition of high biodiversity rocky shores.

- One long term monitoring site on each of three high diversity rocky shores (most species rich), e.g. West of Cosy Nook, Stirling Point and Waipapa Point. Establish 3 year baseline then 5 yearly.

TERRESTRIAL MARGIN (200M)

Coastal margin at risk from sea level rise - low-lying, grazed pasture

(i) Habitat Mapping

Inland of the shoreline the 200 metre terrestrial margin was predominantly grassland (66%), used for extensive grazing of sheep, dairying or cattle. Urban development of the coastal margin was relatively localised (particularly around New River Estuary, Bluff Harbour and Riverton), but increasingly a shift towards coastal sprawl along the margin in relatively isolated areas was noted. Forest (8%) and scrub (12%) were other major margin features, most common near Long Beach in the Catlins.

(ii) Vulnerability Assessment

Vulnerability assessments were not undertaken specifically on hinterland. However, margin landuse was one of the stressors used in the vulnerability assessment. In general, it was an issue in relation to grazing pressure on dunelands (absence of fencing), property development on old dunelands and shore margins, and spread of weeds.

(iii) Monitoring Recommendations

Monitor landuse of coastal margin land at 10 yearly intervals.

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APPENDIX 1. ESTUARY CHARACTERISTICS

KEY TO TERMS	
Catchment Rock Type	Gr= gravel, Sd= sand, Pt= peat, Ig= igneous, SS= sandstone-siltstone.
Input Water Quality	Values are: mean TN mg/l, TP mg/l, turb NTU, *E.coli* cfu/100ml] respectively, data from ES monitoring.
Landuse	Values are: native forest-scrub %, Hi prod/Lo Prod Pasture %, Crop %, Exotic forest-scrub %, urban %, sand-gravel-rock % respectively (data from ES).
Mouth Closure	cl= closed, o= open, man= managed, con= constricts
Residence Time and Flushing	Time in days if available; otherwise poor, moderate or well flushed, Cl= periodically poorly flushed due to lagoon closure or constriction.
SOURCES OF INFORMATION	
Suspended Solids and Total Nitrogen yields	WRENZ Model available from NIWA website.
Water quality, landuse, dairy cow numbers, geology	Environment Southland.

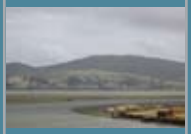
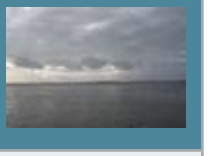
APPENDIX 1. ESTUARY CHARACTERISTICS

		Waikoau	Rowallan Burn	Grove Burn	Waiau	Waimeamea
						
General	Type	Tidal river mouth B	Tidal river mouth B	Tidal river mouth B	Tidal river mouth C	Tidal river mouth B
	Mouth Closure April 2008	Open, constricts	Open, constricts	Open, constricts	Open, constricts	Closed, constricts
	Mean depth (m)	0.5-1m	1-2m	<0.5m	2-3m	<0.5m
	Depth of central basin (m)	1-1.5m	2m	1m	2-4m	1m
	Estuary Area (ha)	<1ha	1 ha	<1ha	101ha	<1ha
	Salinity regime April 2008	Surf <1ppt, Bottom <1ppt.	Surf <1ppt, Bottom 25ppt.	Surf <1ppt, Bottom <1ppt.	Surf <1ppt, Bottom 25ppt.	Surf <1ppt, Bottom <1ppt.
	Length of salinity intrusion	<200m	<200m	<200m	4km into lagoon	<200m
	Residence Time and Flushing	<1 day Cl	<1 day Cl	<1day Cl	Uncertain	<1 day Cl
	Slope of Catchment	Moderate	Moderate	Moderate	Moderate	Moderate
	Wind Exposure	Mod	Mod	Mod	Mod-High	Mod
	Mean Tidal Range (m)	Small	Small	Small	Small	Small
	Mean Freshwater Inflow (l/s) estimated	1800	2611	500	156,000	1200
	Catchment Area (km2)	98	146	30	7904	57
	Limiting Nutrient (N or P)	Possibly N and P	Possibly N and P	Possibly N and P	Possibly N and P	Possibly N and P
Habitat Diversity	Sheltered fringe areas	Nil	Nil	Nil	Lagoon	Nil
	Salt Marsh/Dune Area (ha)	<0.1ha	<0.1ha	<0.1ha	3.1ha	<0.1ha
	Seagrass/Macrophyte Abundance	Nil	Nil	Nil	High	Nil
	Tidal Flats present	Low	Low	Low	Low-Mod	Low
	Sediments in Estuary	Sand/cobbles	Sands	Sands	Mixed	Cobble/gravel
	Margin buffer	Native bush	Cliffs Native Bush	Cliffs/Pasture	Pasture	Pasture
Stressors	Catchment Rock Type	Gr, SS	Gr, SS	Gr, SS	Ig, Gr, SS	Ig, Gr, SS
	Landuse	84, 0.1/4, 0, 11, 0, 0.3	76, 0.9/1.0, 0, 22, 0, 0	56, 24/5, 0, 15, 0, 0.2	43, 17/26, 0, 5, 0, 0.4	83, 14/3, 0, 0.2, 0, 0.1
	Number Dairy Cows	0	0	0	9266	0
	Catchment SS yield (t/km2/yr)	Mod 242	Mod 186	Mod-High 1000	Mod 157	Low 75
	Catchment TN yield (kg/ha/yr)	Low 3.3	Low 3.2	Low 2	Low 1.1	Low 3
	Point Source Inputs	None	None	None	U/S dairy effluent	None
	Input Water Quality	No Data	0.26, 0.064, 9.7, 81.5	No Data	0.30, 0.014, 2.3, 135	No Data
	Sea Level Rise	Expand estuary	Expand estuary	Expand estuary	Expand estuary	Expand estuary
	Other Stressors				Vehicles, weeds	
Existing Condition	Macroalgal Blooms	Low	Low	Low	Low	Low
	Phyto blooms	Low	Low	Low	Low	Low
	DO depletion	Low	Low	Low	Low	Low
	HABs offshore	Low	Low	Low	Low	Low
	Anoxic sediments April 2008	Clean oxic sands	Clean oxic sands	Clean oxic sands	Clean oxic mud	Clean oxic gravels
	Sediment Quality	No Data	No Data	No Data	No Data	No Data
	Water Quality	No Data	No Data	No Data	No Data	No Data
Potential	Potential for Habitat Improvement	Estuary mouth revegetation	Estuary mouth revegetation	Minor estuary margin revegetation	Protection of Waiau Spit herbfields and revegetation	Estuary mouth revegetation

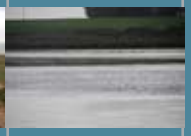
APPENDIX 1. ESTUARY CHARACTERISTICS

		Taunoa	Ouki	Pouahiri	Ourawera	Colac Bay
						
General	Type	Tidal river mouth B	Tidal river mouth B	Tidal river mouth B	Tidal river mouth B	Tidal river mouth B
	Mouth Closure	Open, constricts	Open, constricts	Open, constricts	Open, constricts	Open, constricts
	Mean depth (m)	0.5m	0.5m	0.5m	0.5m	0.5m
	Depth of central basin (m)	1m	<1m	<1m	<1m	<1m
	Estuary Area (ha)	<1ha	<1ha	<1ha	<1ha	<1ha
	Salinity regime	Surf <1ppt, Bottom <1ppt.	Surf <1ppt, Bottom <1ppt.	Surf <1ppt, Bottom <1ppt.	Surf <1ppt, Bottom <1ppt.	Surf <1ppt, Bottom <1ppt.
	Length of salinity intrusion	<200m	<200m	<500m	<500m	<500m
	Residence Time and Flushing	<1 day Cl	<1 day Cl	<1 day Cl	<1 day Cl	<1 day Cl
	Slope of Catchment	Moderate	Moderate	Moderate	Moderate	Moderate
	Wind Exposure	Moderate	Moderate	Moderate	Moderate	Moderate
	Mean Tidal Range (m)	Small	Low approx 0.2m	Low approx 0.2m	Low approx 0.2m	Low approx 0.2m
	Mean Freshwater Inflow (l/s) estimated	300	300	100	1100	200
	Catchment Area (km2)	21	22	11	53	16
	Limiting Nutrient (N or P)	Possibly N and P	Possibly N and P	Possibly N and P	Possibly N and P	Possibly N and P
Habitat Diversity	Sheltered fringe areas	Nil	Nil	Nil	Nil	Nil
	Salt Marsh/Dune Area (ha)	<0.1ha	<0.1ha	<0.1ha	<0.1ha	<0.1ha
	Seagrass Abundance	Nil	Nil	Nil	Nil	Nil
	Tidal Flats present	Low	Low	Low	Low	Low
	Sediments in Estuary	Sands	Sands	Sands	Sands	Sands
	Margin buffer	Pasture	Pasture	Pasture	Pasture	Pasture
Stressors	Catchment Rock Type	Gr, Ig, SS, Sd	Gr, SS, Ig, Pt, Sd	Gr, Pt, Ig, Sd	Ig, Gr, SS, Sd	Gr, SS, Ig, Sd, Pt
	Landuse	42, 53/0.6, 0, 4, 0.4, 0.4	5, 89/0.8, 1, 2.3, 0, 0.1	3, 88/2, 0, 3.3, 0, 0.3	55, 34/2, 0, 3, 0, 0.1	15, 65/10, 0, 6, 1.4, 1.5
	Number Dairy Cows	78	969	607	100	395
	Catchment SS yield (t/km2/yr)	Low 66	Low 38	Low 33	Low 48	Low 50
	Catchment TN yield (kg/ha/yr)	Low 3	Mod-High 17	Mod 10	Low 4	Mod 10
	Point Source Inputs	None	None	None	None	None
	Input Water Quality	No Data	No Data	No Data	No Data	No Data
	Sea Level Rise	Expand estuary	Expand estuary	Expand estuary	Expand estuary	Expand estuary
	Other Stressors		Channelised, drained historical	Channelised, drained historical	Channelised, drained historical	Channelised, drained historical
Existing Condition	Macroalgal Blooms	Low	Low	Low	Low	Low
	Phyto blooms	Low	Low	Low	Low	Low
	DO depletion	Low	Low	Low	Low	Low
	HABs offshore	Low	Low	Low	Low	Low
	Anoxic sediments	Clean oxic sands	Clean oxic sands	Clean oxic sands	Clean oxic sands	Clean oxic sands
	Sediment Quality	No Data	No Data	No Data	No Data	No Data
	Water Quality	No Data	No Data	No Data	No Data	No Data
Potential	Potential for Habitat Improvement	None	Margin reshaped and vegetated	Margin reshaped and vegetated	Margin reshaped and vegetated	Margin reshaped and vegetated

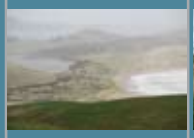
APPENDIX 1. ESTUARY CHARACTERISTICS

		Jacobs River	Taunamau	Waimatuku	New River	Bluff/Awarua
						
General	Type	Tidal Lagoon	Tidal river mouth B	Tidal river mouth B	Tidal Lagoon	Tidal Lagoon
	Mouth Closure	Open	Open, constricts	Open, constricts	Open	Open
	Mean depth (m)	1-2m	1-2m	1-2m	approx 1.5m	<4m
	Depth of central basin (m)	3m	<2-3m	<2-3m	approx 3m	5-8m
	Estuary Area (ha)	720ha	<1ha	~10ha	4,100ha	5,500ha
	Salinity regime	Well-mixed, near seawater at HW	Surf 3.7ppt, Bottom <29ppt.	Surf 3.7ppt, Bottom <29ppt.	Well-mixed, near seawater at HW	Seawater
	Length of salinity intrusion	3km up Aparima R	500m	500-1000m	3km up river arms	No inflows
	Residence Time and Flushing	<3 days	Varies Cl	Varies Cl	3days	Unknown
	Slope of Catchment	Varies	Low	Low	Low	Low
	Wind Exposure	Moderate	Moderate-High	Moderate-High	Moderate-High	Moderate-High
	Mean Tidal Range (m)	2m	Varies	Varies	2m	2m
	Mean Freshwater Inflow (l/s) estimated	20,600	400 connected to Waimatuku	1,700	44,000 Oreti 2,800 Waihopai	Very low
	Catchment Area (km2)	1527	39	150	4314	85
	Limiting Nutrient (N or P)	N	Possibly N and P	Possibly N and P	N	N
Habitat Diversity	Sheltered fringe areas	High	Low	Low	High	Moderate
	Salt Marsh/Dune Area (ha)	70ha	<0.1ha	<1ha (dune)	460ha	High 200ha
	Seagrass Abundance	Low-Mod (4ha)	Nil	Nil	High 170ha	High 750ha
	Tidal Flats present	High	Low	Yes on beach	High	High
	Sediments in Estuary	Mixed	Sands	Sand	Mixed	Mixed
	Margin buffer	Pasture, urban	Pasture	Pasture	Past, urb, for	Past, urb, wharves
Stressors	Catchment Rock Type	Gr, SS, Ig, Pt, Sd	Gr, Sd, Pt	Gr, Pt, Sd	Gr, SS, Pt, Ig, Sd	Pt, Gr, Ig, Sd
	Landuse	20, 55/14, 0.1, 9, 0.2, 0.5	0, 93/1.4, 4, 1, 0, 0.5	0.1, 86/0.3, 4, 1, 0.1, 0.5	13, 60/17, 0.3, 8, 0.7, 0.5	74, 18/3, 0, 2.7, 0.1, 0.2
	Number Dairy Cows	64611	4270	14015	180839	800
	Catchment SS yield (t/km2/yr)	Low 63	Low 39	Low 39	Low 70	Very Low
	Catchment TN yield (kg/ha/yr)	Low-Mod 7	Uncertain	Mod-High 13-20	Mod 9	Low
	Point Source Inputs	U/S dairy effluent	U/S dairy effluent	U/S dairy effluent	U/S dairy effluent	U/S dairy effluent
	Input Water Quality	0.9, 0.02, 4.0, 280	No Data	3.6, 0.054, 4.1, 585	0.9, 0.06, 4.0, 700	No Data
	Sea Level Rise	Expand estuary	Expand estuary	Expand estuary	Expand estuary	Expand estuary
	Other Stressors	Drainage	Drainage,	Drainage	Drainage, seawalls	Marine farms
Existing Condition	Macroalgal Blooms	Common	*Enteromorpha*	*Enteromorpha*	Low-Mod	Low
	Phyto blooms	Low	Expected	Expected	Low	Low
	DO depletion	Low	Possible	Expected	Low	Low
	HABs offshore	Low	Low	Low	Low	Low
	Anoxic sediments	Moderate	Sulphide rich, RPD <1cm	Sulphide rich, RPD 0 cm, H_2S gas bubbles	Low-Mod	Low
	Sediment Quality	Metals Low.	No Data	No data	Metals Low. Mud.	No data
	Water Quality	N elevated	No Data	No data	N 0.8-1.5 mg/l E coli low	No data
	Potential for Habitat Improvement	Reduce non-point.	Margin reshaped and vegetated	Reduce non-point. Margin reshaped and vegetated	Reduce non-point. Waihopai facelift	

APPENDIX 1. ESTUARY CHARACTERISTICS

		Waituna	Toetoes	Tokanui	Lake Brunton	Waipapa
						
General	Type	Coastal Lake	Tidal Lagoon	Tidal River Mouth	Coastal Lake	Tidal River Mouth
	Mouth Closure	Cl, man	Open	Open, constricts	Open, constricts	Open, constricts
	Mean depth (m)	approx 1m	1-2m	0.5-1.5m	<1m	1-2m
	Depth of central basin (m)	3m	3m	2m	0.5-1m	2m
	Estuary Area (ha)	1,350ha	497ha	<1ha	25ha approx	1ha
	Salinity regime	<2ppt to 32 ppt	Varies	Surf <1ppt, Bottom <1ppt.	25ppt when open	Surf 3ppt, Bottom 27ppt.
	Length of salinity intrusion	Throughout		<500m	NA	approx 500m
	Residence Time and Flushing	Long when closed	<3days	Varies	Long when closed	Long when closed
	Slope of Catchment	Low	Moderate	Moderate	Low	Low-mod
	Wind Exposure	High	High	Moderate	Mod-High	Mod-High
	Mean Tidal Range (m)	Varies	1-1.5m	Varies <1m	Uncertain	Uncertain
	Mean Freshwater Inflow (l/s) estimated	1,500-2,000 (surf)	76,000	2,000	200	800
	Catchment Area (km2)	212	5520	74	24	36
	Limiting Nutrient (N or P)	Both	N	N and P	N and P	N and P
Habitat Diversity	Sheltered fringe areas	Yes	Yes	Low	Low	Low
	Salt Marsh/Dune Area (ha)	472ha	High 100ha	Low (drained)	approx 50ha	Dune, no marsh
	Seagrass/Macrophyte Abundance	High (*Ruppia*)	Very low	Low	High (*Ruppia*)	Low
	Tidal Flats present	When open, high	50% of estuary	Floods on beach	Yes when open	Floods on beach
	Sediments in Estuary	Gravel, sand, mud	Gravel, sand, mud	Sand	Sand/mud	Sand
	Margin buffer	Unmodified, diverse	Pasture, dune	Pasture, dune	Pasture	Pasture
Stressors	Catchment Rock Type	Gr, Pt, Sd, SS	SS, Gr, Pt, Ig, Sd	SS, Gr, Sd	SS, Pt, Sd, Gr	SS, Sd, Gr
	Landuse	18, 57/1.1, 0, 3.2, 0.4, 0.4	9, 53/31, 0.6, 5, 0.2, 0.2	12, 77/3, 0, 6, 0.2, 0.1	4, 85/4, 0, 2, 0, 2.2	20, 71/2, 0, 6, 0, 0.6
	Number Dairy Cows	18884	117960	266	780	134
	Catchment SS yield (t/km2/yr)	Low 50	Low-mod 128	Low 58	Low 46	Low 54
	Catchment TN yield (kg/ha/yr)	High 22	Low 5	Mod 8-9	Mod 14	Low-Mod 7.5
	Point Source Inputs	U/S dairy effluent	U/S dairy effluent	U/S dairy effluent?	U/S dairy effluent?	Low
	Input Water Quality	1.3, 0.096, 13.0, 300	0.99, 0.042, 7.0, 390	1.3, 0.057, 13.0, 350	No Data	No Data
	Sea Level Rise	Expand lagoon	Expand estuary	Expand estuary	Expand lagoon	Expand estuary
	Other Stressors			Channelised	Marsh drainage	Marsh drainage
Existing Condition	Macroalgal Blooms	Yes when open	Low-Mod	Likely when closed	Possible	Possible
	Phyto blooms	Low-mod	Low	Possible	Possible	Possible
	DO depletion	No	Low	Possible	Possible	Possible
	HABs offshore	Low	Low	Low	Low	Low
	Anoxic sediments	Low	Low-Mod	Low	Low	Low
	Sediment Quality	Good	Good	No data	No data	No data
	Water Quality	N 0.6, P 0.4, *e.coli* <100.	No data	No data	No data	No data
	Potential for Habitat Improvement			Margin improve-ment	Lagoon opening/ closing	Margin improvement

APPENDIX 1. ESTUARY CHARACTERISTICS

		Haldane	Cook Creek	Waikawa	Longbeach
					
General	Type	Tidal Lagoon	Tidal River Mouth	Tidal Lagoon	Tidal River Mouth
	Mouth Closure	Open	Open, constricts	Open	Open, constricts
	Mean depth (m)	1-2m	0.5-1m	1-2m	0.5-1m
	Depth of central basin (m)	3m	1.5m	3-5m	2-3m
	Estuary Area (ha)	206ha	<0.5ha	705ha	1ha
	Salinity regime	Close to seawater	Surf <1ppt, Bottom <1ppt.	Close to seawater	Surf 1.5ppt, Bottom 25ppt.
	Length of salinity intrusion	NA	approx 500m	NA	approx 500m
	Residence Time and Flushing	<3 days	Long when closed	<3 days	Long when closed
	Slope of Catchment	Moderate	Low-mod	Moderate	Low-mod
	Wind Exposure	Moderate	Mod-High	Moderate	Mod-High
	Mean Tidal Range (m)	1.5-2m	Uncertain	1.5-2m	Uncertain
	Mean Freshwater Inflow (l/s) estimated	1,800	600	5,700	200
	Catchment Area (km2)	70	17	237	25
	Limiting Nutrient (N or P)	N	Both	N	Both
Habitat Diversity	Sheltered fringe areas	Low	Low	Moderate	Low
	Salt Marsh/Dune Area (ha)	Low 10ha	Nil	Mod 40ha	Dune, low marsh
	Seagrass Abundance	Low	Nil	Moderate 7ha	Nil
	Tidal Flats present	High 180ha	Floods on beach	High 600ha	Floods on beach
	Sediments in Estuary	Sand, mud	Sand	Sand, mud	Sand
	Margin buffer	Pasture, scrub	Pasture,	Pasture, scrub	Pasture,
Stressors	Catchment Rock Type	SS, Sd, Gr	SS, Sd, Sd	SS, Gr, Pt, Sd	SS, Gr, Sd
	Landuse	70, 29/0, 0, 0.8, 0, 0	40, 48/8, 0, 0.3, 0.1, 0.9	42, 51/0.3, 0, 7, 0, 0	97, 3/0.5, 0, 0.1, 0, 0.3
	Number Dairy Cows	0	0	599	0
	Catchment SS yield (t/km2/yr)	Low 55	Low 50	Low 65	Low 50
	Catchment TN yield (kg/ha/yr)	Low-Mod 6	Mod 10	Low-Mod 7	Low 5
	Point Source Inputs	Nil	Nil	Nil	Nil
	Input Water Quality	0.37, 0.022, 3.5, 110	No Data	0.92, 0.043, 9.1, 650	No Data
	Sea Level Rise	Expand estuary	Expand estuary	Expand estuary	Expand estuary
	Other Stressors		Drained		Drained
Existing Condition	Macroalgal Blooms	Low	Low	Low-Mod	Low
	Phyto blooms	Low	Low	Low	Low
	DO depletion	Low	Low	Low	Low
	HABs offshore	Low	Low	Low	Low
	Anoxic sediments	Low	Low	Low	Low
	Sediment Quality	No data	No data	Good, mud	No data
	Water Quality	No data	No data	No data	No data
Potential	Potential for Habitat Improvement		Margin improve-ment		Margin improvement

APPENDIX 2. COASTAL VULNERABILITY ASSESSMENTS

COASTAL ECOLOGICAL VULNERABILITY RATING - BEACH, DUNE AND ROCKY SHORE

LOCATION: TE WAEWAE BAY - Beach and Dunes
DATE: April 2008

OVERALL VULNERABILITY RATING - Te Waewae Bay - Beach and Dunes

Human Use	High
Ecological Value	Moderate
Existing Condition	Good
Susceptibility	Low
Stressors	Low-Mod
OVERALL VULNERABILITY	Low-Mod

Monitoring Recommendations:

- Broadscale mapping of all coastal habitats at 10 year intervals.
- Map intensive landuse (urban, high production pasture) and wetlands in all catchments at 5 yearly intervals.
- Monitor disease risk (shellfish and water).
- Fine scale monitoring of representative high diversity beach site - Bluecliffs beach area (Annual baseline for 3 years and every 5 years subsequent).

MATRIX A - Uses and Values (Beaches, Dunes and Rocky Shores)

Key for Use and Value Rating
High
Moderate
Low
Very Low

Key For Issue/Indicator Rating
High
Moderate
Low
Very Low

HABITAT RATING	HUMAN USE: Bathing, surfing	Shellfish collection	Natural character, aesthetic, picnics, walking	Boating	Fishing, white-baiting, duckshooting	ECOLOGICAL VALUES: Birds	Vegetation (dune, saltmarsh, seagrass)	Other Biota	Fish
Dune Active									
Dune Stable									
Beach Sand									
Beach Gravel									
Beach Cobble									
Rock/Boulder									
Cliff									
Coastal Herbfield									
Inshore Water									

COASTAL ECOLOGICAL VULNERABILITY RATING - BEACHES, DUNES, ROCKY SHORES

LOCATION: TE WAEWAE BAY - Beach and Dunes
DATE: APRIL 2008

MATRIX B - Stressors, Existing Condition and Susceptibility

Key For Rating	
Stressors	Existing Condition
High	Poor
Moderate	Fair
Low	Good
Very Low	Very Good

		PRESENCE OF STRESSORS																	CONDITION		RESPONSE
		Sea Level Rise	Catchment runoff	Point Discharges	Climate Change Rain/Temp	Spills (incl. oil)	Grazing	Freshwater abstraction	Reclamation	Erosion control structures	Food collection	Algal blooms (from sea)	Structures (incl. marine farms)	Invasive weeds/pests	Mouth closing/constriction	Vehicle damage	Margin development	Floodgates	Existing Condition	Susceptibility	Comments
HABITAT RATING	Dune Active																				
	Dune Stable																				Revegetate
	Beach Sand																				Protect shellfish
	Beach Gravel																				Maintain FW
	Beach Cobble																				
	Rock/Boulder																				
	Cliff																				Plan for erosion
	Coastal Herbfield																				Protect
	Inshore Water																				
ISSUE	MONITORING INDICATORS	RISK OF STRESSOR AFFECTING INDICATOR																			
Eutrophication	Dissolved Oxygen																				
	Clarity																				
	Nutrients																				
	Chlorophyll/phytopl.																				
	Macroalgal growth																				
	Redox Disc. Profile/Smell																				
	Org C sediments																				
Sediment	Muddiness																				
	Sedimentation rate																				
	Clarity																				
Dis-ease	Faecal Indicators																				
Toxicity	Heavy Metals																				
	SVOCs																				
	Toxic algae																				
Habitat Change	Habitat Mapping																				
	Macrophytes																				
	Margin																				
	Shellfish																				
	Fish																				
	Macro-invertebrates																				
	Sea Level																				

COASTAL ECOLOGICAL VULNERABILITY RATING - ESTUARIES

LOCATION: WAIKOAU ESTUARY
DATE: APRIL 2008

OVERALL VULNERABILITY RATING
Waikoau Estuary

Human Use		Moderate
Ecological Value		Moderate
Existing Condition		Very Good
Susceptibility		Low
Stressors		Very Low
OVERALL VULNERABILITY		Low

Monitoring Recommendations:

- Map intensive landuse - 5 yearly.
- Habitat map estuary every 10 years.

MATRIX A - Uses and Values (Estuaries)

Key for Use and Value Rating
High
Moderate
Low
Very Low

Key For Issue/Indicator Rating
High
Moderate
Low
Very Low

		HUMAN USE					ECOLOGICAL VALUES			
		Bathing, surfing	Shellfish collection	Natural character, aesthetic	Boating	Fishing, white-baiting, duckshooting	Birds	Vegetation (dune, saltmarsh, seagrass)	Other Biota	Fish
HABITAT RATING	Estuary Saltmarsh									
	Estuary Soft Mud									
	Estuary Firm Mud/Sand									
	Estuary Gravel/Cobble									
	Aquatic Macrophytes									
	Biogenic Structures									
	Terrestrial Margin									
	Subtidal									

COASTAL ECOLOGICAL VULNERABILITY RATING - ESTUARIES

LOCATION: WAIKOAU ESTUARY
DATE: APRIL 2008

MATRIX B - Stressors, Existing Condition and Susceptibility

Key For Rating		
Stressors		Existing Condition
High		Poor
Moderate		Fair
Low		Good
Very Low		Very Good

		PRESENCE OF STRESSORS																	CONDITION		RESPONSE
		Sea Level Rise	Catchment runoff	Point Discharges	Climate Change Rain/Temp	Spills (incl. oil)	Grazing	Freshwater abstraction	Reclamation	Erosion control structures	Food collection	Algal blooms (from sea)	Structures (incl. marine farms)	Invasive weeds/pests	Mouth closing/constriction	Vehicle damage	Margin development	Floodgates		Existing Condition	Susceptibility	HABITAT RESPONSE
	Estuary Saltmarsh																					
	Estuary Soft Mud																					
	Estuary Firm Mud/Sand																					
	Estuary Gravel/Cobble																					
	Aquatic Macrophytes																					
	Biogenic Structures																					
	Terrestrial Margin																					
	Subtidal																					Mouth constricts
ISSUE	MONITORING INDICATORS	RISK OF STRESSOR AFFECTING INDICATOR																				
Eutrophication	Dissolved Oxygen																					
	Clarity																					
	Nutrients																					
	Chlorophyll/phytopl.																					
	Macroalgal growth																					
	Redox Disc. Profile/Smell																					
	Org C sediments																					
Sediment	Muddiness																					
	Sedimentation rate																					
	Clarity																					
Dis-ease	Faecal Indicators																					
Toxicity	Heavy Metals																					
	SVOCs																					
	Toxic algae																					
Habitat Change	Habitat Mapping																					
	Macrophyte Mapping																					
	Margin Mapping																					
	Shellfish																					
	Fish																					
	Macro-invertebrates																					
	Sea Level																					

COASTAL ECOLOGICAL VULNERABILITY RATING - ESTUARIES

LOCATION: GROVEBURN ESTUARY, WAIMEAMEA ESTUARY, TAUNOA ESTUARY
DATE: APRIL 2008

OVERALL VULNERABILITY RATING
Grove Burn Estuary, Waimeamea Estuary and Taunoa Estuary

Human Use		Low
Ecological Value		Moderate
Existing Condition		Very Good
Susceptibility		Low
Stressors		Very Low
OVERALL VULNERABILITY		Low

Monitoring Recommendations:

- Map intensive landuse - 5 yearly.
- Habitat map estuary every 10 years.

MATRIX A - Uses and Values (Estuaries)

Key for Use and Value Rating
High
Moderate
Low
Very Low

Key For Issue/Indicator Rating
High
Moderate
Low
Very Low

		HUMAN USE						ECOLOGICAL VALUES			
		Bathing, surfing	Shellfish collection	Natural character, aesthetic	Boating	Fishing, white-baiting, duckshooting		Birds	Vegetation (dune, saltmarsh, seagrass)	Other Biota	Fish
HABITAT RATING	Estuary Saltmarsh										
	Estuary Soft Mud										
	Estuary Firm Mud/Sand										
	Estuary Gravel/Cobble										
	Aquatic Macrophytes										
	Biogenic Structures										
	Terrestrial Margin										
	Subtidal										

COASTAL ECOLOGICAL VULNERABILITY RATING - ESTUARIES

LOCATION: GROVEBURN ESTUARY, WAIMEAMEA ESTUARY, TAUNOA ESTUARY
DATE: APRIL 2008

MATRIX B - Stressors, Existing Condition and Susceptibility

Key For Rating	
Stressors	Existing Condition
High	Poor
Moderate	Fair
Low	Good
Very Low	Very Good

		PRESENCE OF STRESSORS																	CONDITION		RESPONSE
		Sea Level Rise	Catchment runoff	Point Discharges	Climate Change Rain/Temp	Spills (incl. oil)	Grazing	Freshwater abstraction	Reclamation	Erosion control structures	Food collection	Algal blooms (from sea)	Structures (incl. marine farms)	Invasive weeds/pests	Mouth closing/constriction	Vehicle damage	Margin development	Floodgates	Existing Condition	Susceptibility	HABITAT RESPONSE
	Estuary Saltmarsh																				
	Estuary Soft Mud																				
	Estuary Firm Mud/Sand																				
	Estuary Gravel/Cobble																				
	Aquatic Macrophytes																				
	Biogenic Structures																				
	Terrestrial Margin																				
	Subtidal																				Mouth constricts
ISSUE	MONITORING INDICATORS	RISK OF STRESSOR AFFECTING INDICATOR																			
Eutrophication	Dissolved Oxygen																				
	Clarity																				
	Nutrients																				
	Chlorophyll/phytopl.																				
	Macroalgal growth																				
	Redox Disc. Profile/Smell																				
	Org C sediments																				
Sediment	Muddiness																				
	Sedimentation rate																				
	Clarity																				
Dis-ease	Faecal Indicators																				
Toxicity	Heavy Metals																				
	SVOCs																				
	Toxic algae																				
Habitat Change	Habitat Mapping																				
	Macrophyte Mapping																				
	Margin Mapping																				
	Shellfish																				
	Fish																				
	Macro-invertebrates																				
	Sea Level																				

COASTAL ECOLOGICAL VULNERABILITY RATING - ESTUARIES

LOCATION: ROWALLAN BURN ESTUARY
DATE: APRIL 2008

OVERALL VULNERABILITY RATING - Rowallan Burn Estuary

Human Use	Moderate
Ecological Value	Moderate
Existing Condition	Very Good
Susceptibility	Moderate
Stressors	Very Low
OVERALL VULNERABILITY	Low-Mod

Monitoring Recommendations:

- Map intensive landuse - 5 yearly.
- Habitat map estuary every 10 years.
- Assess bottom water DO, and sediment anoxia (RPD) during prolonged summer baseflow conditions every 3 years.

MATRIX A - Uses and Values (Estuaries)

Key for Use and Value Rating
High
Moderate
Low
Very Low

Key For Issue/Indicator Rating
High
Moderate
Low
Very Low

	HUMAN USE					ECOLOGICAL VALUES			
	Bathing, surfing	Shellfish collection	Natural character, aesthetic	Boating	Fishing, white-baiting, duckshooting	Birds	Vegetation (dune, saltmarsh, seagrass)	Other Biota	Fish
HABITAT RATING									
Estuary Saltmarsh									
Estuary Soft Mud									
Estuary Firm Mud/Sand									
Estuary Gravel/Cobble									
Aquatic Macrophytes									
Biogenic Structures									
Terrestrial Margin									
Subtidal									

COASTAL ECOLOGICAL VULNERABILITY RATING - ESTUARIES

LOCATION: ROWALLAN BURN ESTUARY
DATE: APRIL 2008

MATRIX B - Stressors, Existing Condition and Susceptibility

Key For Rating		
Stressors		Existing Condition
High		Poor
Moderate		Fair
Low		Good
Very Low		Very Good

		PRESENCE OF STRESSORS																	CONDITION		COMMENTS
		Sea Level Rise	Catchment runoff	Point Discharges	Climate Change Rain/Temp	Spills (incl. oil)	Grazing	Freshwater abstraction	Reclamation	Erosion control structures	Food collection	Algal blooms (from sea)	Structures (incl. marine farms)	Invasive weeds/pests	Mouth closing/constriction	Vehicle damage	Margin development	Floodgates		Existing Condition	Susceptibility	Comments
	Estuary Saltmarsh																					
	Estuary Soft Mud																					
	Estuary Firm Mud/Sand																					
	Estuary Gravel/Cobble																					
	Aquatic Macrophytes																					
	Biogenic Structures																					
	Terrestrial Margin																					
	Subtidal																					Mouth constricts
ISSUE	MONITORING INDICATORS	RISK OF STRESSOR AFFECTING INDICATOR																				
Eutrophication	Dissolved Oxygen																					Salt wedge
	Clarity																					
	Nutrients																					
	Chlorophyll/phytopl.																					
	Macroalgal growth																					
	Redox Disc. Profile/Smell																					
	Org C sediments																					
Sediment	Muddiness																					
	Sedimentation rate																					
	Clarity																					
Dis-ease	Faecal Indicators																					
Toxicity	Heavy Metals																					
	SVOCs																					
	Toxic algae																					
Habitat Change	Habitat Mapping																					
	Macrophyte Mapping																					
	Margin Mapping																					
	Shellfish																					
	Fish																					
	Macro-invertebrates																					
	Sea Level																					

COASTAL ECOLOGICAL VULNERABILITY RATING - ESTUARIES

LOCATION: WAIAU ESTUARY/LAGOON
DATE: APRIL 2008

OVERALL VULNERABILITY RATING - Waiau Estuary/Lagoon

Human Use	High
Ecological Value	Mod-High
Existing Condition	Good
Susceptibility	High
Stressors	Moderate
OVERALL VULNERABILITY	Mod-High

Monitoring Recommendations:

- Broadscale mapping at 5 year intervals.
- Synoptic subtidal survey during low flow/neap tides to map macrophytes, sediment type, depth, RPD, DO, salinity and macroalgae.
- Monitor changes in catchment land use, freshwater abstraction, and mouth openings/closures. Because of the susceptibility of the lagoon, any changes in the key stressors should trigger an evaluation of the likely impact on the lagoon.

MATRIX A - Uses and Values (Estuaries)

Key for Use and Value Rating
High
Moderate
Low
Very Low

Key For Issue/Indicator Rating
High
Moderate
Low
Very Low

		HUMAN USE					ECOLOGICAL VALUES			
		Bathing, surfing, diving	Shellfish collection	Natural character, aesthetic	Boating	Fishing, white-baiting, duckshooting,	Birds	Vegetation (dune, saltmarsh, seagrass)	Other Biota	Fish
HABITAT RATING	Estuary Saltmarsh									
	Estuary Soft Mud									
	Estuary Firm Mud/Sand									
	Estuary Gravel/Cobble									
	Aquatic Macrophytes									
	Biogenic Structures									
	Terrestrial Margin									
	Subtidal									

COASTAL ECOLOGICAL VULNERABILITY RATING - ESTUARIES

LOCATION: WAIAU ESTUARY/LAGOON
DATE: APRIL 2008

MATRIX B - Stressors, Existing Condition and Susceptibility

Key For Rating		
Stressors		Existing Condition
High		Poor
Moderate		Fair
Low		Good
Very Low		Very Good

		PRESENCE OF STRESSORS																	CONDITION		RESPONSE
		Sea Level Rise	Catchment runoff	Point Discharges	Climate Change Rain/Temp	Spills (incl. oil)	Grazing	Freshwater abstraction	Reclamation	Erosion control structures	Food collection	Algal blooms (from sea)	Structures (incl. marine farms)	Invasive weeds/pests	Mouth closing/constriction	Vehicle damage	Margin development	Floodgates	Existing Condition	Susceptibility	HABITAT RESPONSE
	Estuary Saltmarsh																				
	Estuary Soft Mud																				
	Estuary Firm Mud/Sand																				
	Estuary Gravel/Cobble																				
	Aquatic Macrophytes																				
	Biogenic Structures																				
	Terrestrial Margin																				
	Subtidal																				
ISSUE	MONITORING INDICATORS	RISK OF STRESSOR AFFECTING INDICATOR																			
Eutrophication	Dissolved Oxygen																				
	Clarity																				
	Nutrients																				
	Chlorophyll/phytopl.																				
	Macroalgal growth																				
	Redox Disc. Profile/Smell																				
	Org C sediments																				
Sediment	Muddiness																				
	Sedimentation rate																				
	Clarity																				
Dis-ease	Faecal Indicators																				
Toxicity	Heavy Metals																				
	SVOCs																				
	Toxic algae																				
Habitat Change	Habitat Mapping																				
	Macrophyte Mapping																				
	Margin Mapping																				
	Shellfish																				
	Fish																				
	Macro-invertebrates																				
	Sea Level																				

COASTAL ECOLOGICAL VULNERABILITY RATING - BEACH, DUNE AND ROCKY SHORE

LOCATION: MONKEY ISLAND TO RIVERTON - Beach, Dunes and Rocky Shores
DATE: April 2008

OVERALL VULNERABILITY RATING

MONKEY ISLAND TO RIVERTON - Beach, Dunes and Rocky Shores

Human Use	High
Ecological Value	Moderate
Existing Condition	Good
Susceptibility	Low
Stressors	Moderate
OVERALL VULNERABILITY	Moderate

Monitoring Recommendations:

- Map intensive landuse - 5 yearly.
- Habitat map estuary every 10 years.
- Monitor disease risk (shellfish and water)
- Riverton treated wastewater discharge;
  - monitor area of visible plume and proximity to high value surf zone.
  - Monitor and restrict effluent bacterial concentration.

MATRIX A - Uses and Values (Beaches, Dunes and Rocky Shores)

Key for Use and Value Rating
High
Moderate
Low
Very Low

Key For Issue/Indicator Rating
High
Moderate
Low
Very Low

HABITAT RATING	HUMAN USE: Bathing, surfing	Shellfish collection	Natural character, aesthetic, picnics	Boating	Fishing, white-baiting, duckshooting	ECOLOGICAL VALUES: Birds	Vegetation (dune, saltmarsh, seagrass)	Other Biota	Fish
Dune Active									
Dune Stable									
Beach Sand									
Beach Gravel									
Beach Cobble									
Rock/Boulder									
Cliff									
Coastal Herbfield									
Inshore Water									

COASTAL ECOLOGICAL VULNERABILITY RATING - BEACHES, DUNES, ROCKY SHORES

LOCATION: MONKEY ISLAND TO RIVERTON - Beach, Dunes and Rocky Shores
DATE: APRIL 2008

MATRIX B - Stressors, Existing Condition and Susceptibility

Key For Rating	
Stressors	Existing Condition
High	Poor
Moderate	Fair
Low	Good
Very Low	Very Good

		PRESENCE OF STRESSORS																CONDITION		RESPONSE
		Sea Level Rise	Catchment runoff	Point Discharges	Climate Change Rain/Temp	Spills (incl. oil)	Grazing	Freshwater abstraction	Reclamation	Erosion control structures	Food collection	Algal blooms (from sea)	Structures (incl. marine farms)	Invasive weeds/pests	Mouth closing/constriction	Vehicle damage	Margin development	Floodgates	Existing Condition	Susceptibility	Comments
HABITAT RATING	Dune Active																				
	Dune Stable																				
	Beach Sand																				
	Beach Gravel																				
	Beach Cobble																				
	Rock/Boulder																				
	Cliff																				
	Coastal Herbfield																				
	Inshore Water																				
ISSUE	MONITORING INDICATORS	RISK OF STRESSOR AFFECTING INDICATOR																			
Eutrophication	Dissolved Oxygen																				
	Clarity																				
	Nutrients																				
	Chlorophyll/phytopl.																				
	Macroalgal growth																				
	Redox Disc. Profile/Smell																				
	Org C sediments																				
Sediment	Muddiness																				
	Sedimentation rate																				
	Clarity																				
Dis-ease	Faecal Indicators																				Surf zone outfall
Toxicity	Heavy Metals																				
	SVOCs																				
	Toxic algae																				
Habitat Change	Habitat Mapping																				
	Macrophytes																				
	Margin																				
	Shellfish																				
	Fish																				
	Macro-invertebrates																				
	Sea Level																				

COASTAL ECOLOGICAL VULNERABILITY RATING - ESTUARIES

LOCATION: OUKI ESTUARY, POUAHIRI ESTUARY, OURAWERA ESTUARY, COLAC BAY ESTUARY
DATE: APRIL 2008

OVERALL VULNERABILITY RATING

LOCATION: OUKI ESTUARY, POUAHIRI ESTUARY, OURAWERA ESTUARY, COLAC BAY ESTUARY

Human Use	Low
Ecological Value	Low
Existing Condition	Fair
Susceptibility	Moderate
Stressors	Moderate
OVERALL VULNERABILITY	Low-Mod

Monitoring Recommendations:

- Map intensive landuse - 5 yearly.
- Habitat map estuary every 10 years.

MATRIX A - Uses and Values (Estuaries)

Key for Use and Value Rating
High
Moderate
Low
Very Low

Key For Issue/Indicator Rating
High
Moderate
Low
Very Low

		HUMAN USE					ECOLOGICAL VALUES			
		Bathing, surfing	Shellfish collection	Natural character, aesthetic	Boating	Fishing, white-baiting, duckshooting	Birds	Vegetation (dune, saltmarsh, seagrass)	Other Biota	Fish
HABITAT RATING	Estuary Saltmarsh									
	Estuary Soft Mud									
	Estuary Firm Mud/Sand									
	Estuary Gravel/Cobble									
	Aquatic Macrophytes									
	Biogenic Structures									
	Terrestrial Margin									
	Subtidal									

COASTAL ECOLOGICAL VULNERABILITY RATING - ESTUARIES

LOCATION: OUKI ESTUARY, POUAHIRI ESTUARY, OURAWERA ESTUARY, COLAC BAY ESTUARY
DATE: APRIL 2008

MATRIX B - Stressors, Existing Condition and Susceptibility

Key For Rating	
Stressors	Existing Condition
High	Poor
Moderate	Fair
Low	Good
Very Low	Very Good

		PRESENCE OF STRESSORS																	CONDITION		RESPONSE
		Sea Level Rise	Catchment runoff	Point Discharges	Climate Change Rain/Temp	Spills (incl. oil)	Grazing	Freshwater abstraction	Reclamation	Erosion control structures	Food collection	Algal blooms (from sea)	Structures (incl. marine farms)	Invasive weeds/pests	Mouth closing/constriction	Vehicle damage	Margin development	Floodgates	Existing Condition	Susceptibility	HABITAT RESPONSE
	Estuary Saltmarsh																				
	Estuary Soft Mud																				
	Estuary Firm Mud/Sand																				
	Estuary Gravel/Cobble																				
	Aquatic Macrophytes																				
	Biogenic Structures																				
	Terrestrial Margin																				
	Subtidal																				Mouth constricts
ISSUE	MONITORING INDICATORS	RISK OF STRESSOR AFFECTING INDICATOR																			
Eutrophication	Dissolved Oxygen																				
	Clarity																				
	Nutrients																				
	Chlorophyll/phytopl.																				
	Macroalgal growth																				
	Redox Disc. Profile/Smell																				
	Org C sediments																				
Sediment	Muddiness																				
	Sedimentation rate																				
	Clarity																				
Dis-ease	Faecal Indicators																				
Toxicity	Heavy Metals																				
	SVOCs																				
	Toxic algae																				
Habitat Change	Habitat Mapping																				
	Macrophyte Mapping																				
	Margin Mapping																				
	Shellfish																				
	Fish																				
	Macro-invertebrates																				
	Sea Level																				

COASTAL ECOLOGICAL VULNERABILITY RATING - ESTUARIES

LOCATION: JACOBS RIVER ESTUARY
DATE: APRIL 2008

OVERALL VULNERABILITY RATING - Jacobs River Estuary

Human Use		High
Ecological Value		Moderate
Existing Condition		Fair
Susceptibility		Moderate
Stressors		Moderate
OVERALL VULNERABILITY		Moderate

Monitoring Recommendations:

- Broadscale estuary habitat mapping at 5 year intervals.
- Fine scale physical, chemical and biological monitoring (4yr baseline then every 5 years).
- Sedimentation rate monitoring.
- Macroalgal cover mapping annually.

MATRIX A - Uses and Values (Estuaries)

Key for Use and Value Rating
High
Moderate
Low
Very Low

Key For Issue/Indicator Rating
High
Moderate
Low
Very Low

		HUMAN USE					ECOLOGICAL VALUES			
		Bathing, surfing	Shellfish collection	Natural character, aesthetic	Boating	Fishing, white-baiting, duckshooting	Birds	Vegetation (dune, saltmarsh, seagrass)	Other Biota	Fish
HABITAT RATING	Estuary Saltmarsh									
	Estuary Soft Mud									
	Estuary Firm Mud/Sand									
	Estuary Gravel/Cobble									
	Aquatic Macrophytes									
	Biogenic Structures									
	Terrestrial Margin									
	Subtidal									

COASTAL ECOLOGICAL VULNERABILITY RATING - ESTUARIES

LOCATION: JACOBS RIVER ESTUARY
DATE: APRIL 2008

MATRIX B - Stressors, Existing Condition and Susceptibility

Key For Rating	
Stressors	Existing Condition
High	Poor
Moderate	Fair
Low	Good
Very Low	Very Good

		PRESENCE OF STRESSORS																	CONDITION		RESPONSE
		Sea Level Rise	Catchment runoff	Point Discharges	Climate Change Rain/Temp	Spills (incl. oil)	Grazing	Freshwater abstraction	Reclamation	Erosion control structures	Food collection	Algal blooms (from sea)	Structures (incl. marine farms)	Invasive weeds/pests	Mouth closing/constriction	Vehicle damage	Margin development	Floodgates	Existing Condition	Susceptibility	HABITAT RESPONSE
	Estuary Saltmarsh																				
	Estuary Soft Mud																				
	Estuary Firm Mud/Sand																				
	Estuary Gravel/Cobble																				
	Aquatic Macrophytes																				
	Biogenic Structures																				
	Terrestrial Margin																				
	Subtidal																				
ISSUE	MONITORING INDICATORS	RISK OF STRESSOR AFFECTING INDICATOR																			
Eutrophication	Dissolved Oxygen																				
	Clarity																				
	Nutrients																				
	Chlorophyll/phytopl.																				
	Macroalgal growth																				
	Redox Disc. Profile/Smell																				
	Org C sediments																				
Sediment	Muddiness																				
	Sedimentation rate																				
	Clarity																				
Dis-ease	Faecal Indicators																				
Toxicity	Heavy Metals																				
	SVOCs																				
	Toxic algae																				
Habitat Change	Habitat Mapping																				
	Macrophyte Mapping																				
	Margin Mapping																				
	Shellfish																				
	Fish																				
	Macro-invertebrates																				
	Sea Level																				

COASTAL ECOLOGICAL VULNERABILITY RATING - BEACH, DUNE AND ROCKY SHORE

LOCATION: Oreti Beach - Beach, Dunes
DATE: April 2008

OVERALL VULNERABILITY RATING

Oreti Beach - Beach, Dunes

Human Use	High
Ecological Value	High
Existing Condition	Good
Susceptibility	Moderate
Stressors	Moderate
OVERALL VULNERABILITY	Moderate

Monitoring Recommendations:

- Map intensive landuse - 5 yearly.
- Habitat map every 10 years.
- Monitor disease risk (shellfish and water)

MATRIX A - Uses and Values (Beaches, Dunes and Rocky Shores)

Key for Use and Value Rating	
High	
Moderate	
Low	
Very Low	

Key For Issue/Indicator Rating	
High	
Moderate	
Low	
Very Low	

HABITAT RATING	HUMAN USE					ECOLOGICAL VALUES			
	Bathing, surfing	Shellfish collection	Natural character, aesthetic, picnics	Boating	Fishing, white-baiting, duckshooting	Birds	Vegetation (dune, saltmarsh, seagrass)	Other Biota	Fish
Dune Active									
Dune Stable									
Beach Sand									
Beach Gravel									
Beach Cobble									
Rock/Boulder									
Cliff									
Coastal Herbfield									
Inshore Water									

COASTAL ECOLOGICAL VULNERABILITY RATING - BEACHES, DUNES, ROCKY SHORES

LOCATION: Oreti Beach - Beach, Dunes
DATE: APRIL 2008

MATRIX B - Stressors, Existing Condition and Susceptibility

Key For Rating		
Stressors		Existing Condition
High		Poor
Moderate		Fair
Low		Good
Very Low		Very Good

		PRESENCE OF STRESSORS																CONDITION		RESPONSE
		Sea Level Rise	Catchment runoff	Point Discharges	Climate Change Rain/Temp	Spills (incl. oil)	Grazing	Freshwater abstraction	Reclamation	Erosion control structures	Food collection	Algal blooms (from sea)	Structures (incl. marine farms)	Invasive weeds/pests	Mouth closing/constriction	Vehicle damage	Margin development	Floodgates	Existing Condition	Susceptibility	Comments
HABITAT RATING	Dune Active																				
	Dune Stable																				
	Beach Sand																				
	Beach Gravel																				
	Beach Cobble																				
	Rock/Boulder																				
	Cliff																				
	Coastal Herbfield																				
	Inshore Water																				
ISSUE	MONITORING INDICATORS	RISK OF STRESSOR AFFECTING INDICATOR																			
Eutrophication	Dissolved Oxygen																				
	Clarity																				
	Nutrients																				
	Chlorophyll/phytopl.																				
	Macroalgal growth																				
	Redox Disc. Profile/Smell																				
	Org C sediments																				
Sediment	Muddiness																				
	Sedimentation rate																				
	Clarity																				
Dis-ease	Faecal Indicators																				
Toxicity	Heavy Metals																				
	SVOCs																				
	Toxic algae																				
Habitat Change	Habitat Mapping																				
	Macrophytes																				
	Margin																				
	Shellfish																				
	Fish																				
	Macro-invertebrates																				
	Sea Level																				

COASTAL ECOLOGICAL VULNERABILITY RATING - ESTUARIES

LOCATION: TAUNAMAU ESTUARY, WAIMATUKU ESTUARY
DATE: APRIL 2008

OVERALL VULNERABILITY RATING

LOCATION: TAUNAMAU ESTUARY, WAIMATUKU ESTUARY

Human Use	High
Ecological Value	Low-Mod
Existing Condition	Poor
Susceptibility	High
Stressors	Moderate
OVERALL VULNERABILITY	Moderate

Monitoring Recommendations:

- Map intensive landuse - 5 yearly.
- Habitat map estuary every 10 years.
- Intensive synoptic monitoring and vulnerability assessment to assess existing state and priorities for ongoing monitoring and management (e.g. keep mouth open; improve margin slope and revegetation; limit nutrients, sediment and pathogen loads entering estuary).

MATRIX A - Uses and Values (Estuaries)

Key for Use and Value Rating
High
Moderate
Low
Very Low

Key For Issue/Indicator Rating
High
Moderate
Low
Very Low

		HUMAN USE						ECOLOGICAL VALUES			
		Bathing, surfing	Shellfish collection	Natural character, aesthetic	Boating	Fishing, white-baiting, duckshooting		Birds	Vegetation (dune, saltmarsh, seagrass)	Other Biota	Fish
HABITAT RATING	Estuary Saltmarsh										
	Estuary Soft Mud										
	Estuary Firm Mud/Sand										
	Estuary Gravel/Cobble										
	Aquatic Macrophytes										
	Biogenic Structures										
	Terrestrial Margin										
	Subtidal										

COASTAL ECOLOGICAL VULNERABILITY RATING - ESTUARIES

LOCATION: TAUNAMAU ESTUARY, WAIMATUKU ESTUARY
DATE: APRIL 2008

MATRIX B - Stressors, Existing Condition and Susceptibility

Key For Rating		
Stressors		Existing Condition
High		Poor
Moderate		Fair
Low		Good
Very Low		Very Good

		PRESENCE OF STRESSORS																	CONDITION		RESPONSE
		Sea Level Rise	Catchment runoff	Point Discharges	Climate Change Rain/Temp	Spills (incl. oil)	Grazing	Freshwater abstraction	Reclamation	Erosion control structures	Food collection	Algal blooms (from sea)	Structures (incl. marine farms)	Invasive weeds/pests	Mouth closing/constriction	Vehicle damage	Margin development	Floodgates	Existing Condition	Susceptibility	HABITAT RESPONSE
	Estuary Saltmarsh																				
	Estuary Soft Mud																				
	Estuary Firm Mud/Sand																				
	Estuary Gravel/Cobble																				
	Aquatic Macrophytes																				
	Biogenic Structures																				
	Terrestrial Margin																				
	Subtidal																				Mouth constricts
ISSUE	MONITORING INDICATORS	RISK OF STRESSOR AFFECTING INDICATOR																			
Eutrophication	Dissolved Oxygen																				
	Clarity																				
	Nutrients																				
	Chlorophyll/phytopl.																				
	Macroalgal growth																				
	Redox Disc. Profile/Smell																				
	Org C sediments																				
Sediment	Muddiness																				
	Sedimentation rate																				
	Clarity																				
Dis-ease	Faecal Indicators																				
Toxicity	Heavy Metals																				
	SVOCs																				
	Toxic algae																				
Habitat Change	Habitat Mapping																				
	Macrophyte Mapping																				
	Margin Mapping																				
	Shellfish																				
	Fish																				
	Macro-invertebrates																				
	Sea Level																				

COASTAL ECOLOGICAL VULNERABILITY RATING - ESTUARIES

LOCATION: NEW RIVER ESTUARY
DATE: APRIL 2008

OVERALL VULNERABILITY RATING - New River Estuary

Human Use	High
Ecological Value	High
Existing Condition	Fair
Susceptibility	Moderate
Stressors	Moderate
OVERALL VULNERABILITY	Moderate

Monitoring Recommendations:

- Broadscale estuary habitat mapping at 5 year intervals.
- Fine scale physical, chemical and biological monitoring (4yr baseline then every 5 years).
- Sedimentation rate monitoring.
- Macroalgal cover mapping annually.
- Map intensive landuse - 5 yearly.

MATRIX A - Uses and Values (Estuaries)

Key for Use and Value Rating
High
Moderate
Low
Very Low

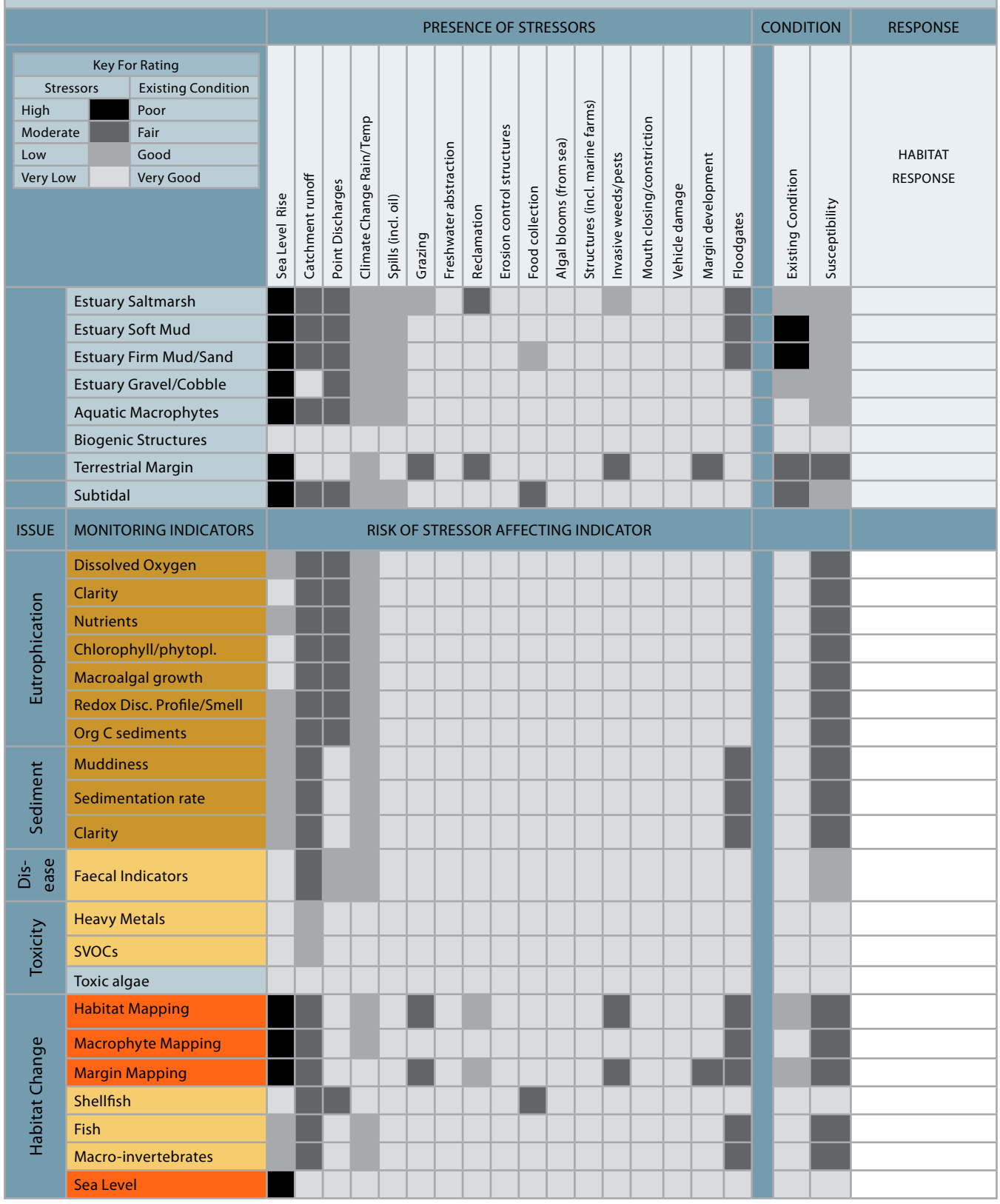
Key For Issue/Indicator Rating
High
Moderate
Low
Very Low

HABITAT RATING	Bathing, surfing	Shellfish collection	Natural character, aesthetic	Boating	Fishing, white-baiting, duckshooting	Birds	Vegetation (dune, saltmarsh, seagrass)	Other Biota	Fish
	HUMAN USE					ECOLOGICAL VALUES			
Estuary Saltmarsh			High		High	High	Moderate	High	Moderate
Estuary Soft Mud			High		High	High	Moderate	Moderate	Moderate
Estuary Firm Mud/Sand	Moderate	High	High		High	High	High	Moderate	Moderate
Estuary Gravel/Cobble			High		High	High	Moderate	High	Moderate
Aquatic Macrophytes			High		High	High	Moderate	High	Moderate
Biogenic Structures									
Terrestrial Margin			Low		Moderate	High	Low	Moderate	Very Low
Subtidal	Moderate	High	High	High	High	High	Moderate	High	High

COASTAL ECOLOGICAL VULNERABILITY RATING - ESTUARIES

LOCATION: NEW RIVER ESTUARY
DATE: APRIL 2008

MATRIX B - Stressors, Existing Condition and Susceptibility



COASTAL ECOLOGICAL VULNERABILITY RATING - BEACH, DUNE AND ROCKY SHORE

LOCATION: OMAUI TO BLUFF - Beach, Dunes and Rocky Shores
DATE: April 2008

OVERALL VULNERABILITY RATING

OMAUI TO BLUFF - Beach, Dunes and Rocky Shores

Human Use	Moderate
Ecological Value	High
Existing Condition	Good
Susceptibility	Low
Stressors	Moderate
OVERALL VULNERABILITY	Moderate

Monitoring Recommendations:

- Broadscale mapping of all coastal habitats at 10 year intervals.
- Map intensive landuse (5 yearly).
- Model river plume behaviour.
- Monitor representative high diversity beach and rocky shore habitat within the region (3 yr baseline then 5 yearly).

MATRIX A - Uses and Values (Beaches, Dunes and Rocky Shores)

Key for Use and Value Rating
High
Moderate
Low
Very Low

Key For Issue/Indicator Rating
High
Moderate
Low
Very Low

HABITAT RATING	HUMAN USE: Bathing, surfing	Shellfish collection	Natural character, aesthetic, picnics	Boating	Fishing, white-baiting, duckshooting	ECOLOGICAL VALUES: Birds	Vegetation (dune, saltmarsh, seagrass)	Other Biota	Fish
Dune Active									
Dune Stable									
Beach Sand									
Beach Gravel									
Beach Cobble									
Rock/Boulder									
Cliff									
Coastal Herbfield									
Inshore Water									

COASTAL ECOLOGICAL VULNERABILITY RATING - BEACHES, DUNES, ROCKY SHORES

LOCATION: OMAUI TO BLUFF - Beach, Dunes and Rocky Shores
DATE: APRIL 2008

MATRIX B - Stressors, Existing Condition and Susceptibility

Key For Rating	
Stressors	Existing Condition
High	Poor
Moderate	Fair
Low	Good
Very Low	Very Good

		PRESENCE OF STRESSORS																CONDITION		RESPONSE
		Sea Level Rise	Catchment runoff	Point Discharges	Climate Change Rain/Temp	Spills (incl. oil)	Grazing	Freshwater abstraction	Reclamation	Erosion control structures	Food collection	Algal blooms (from sea)	Structures (incl. marine farms)	Invasive weeds/pests	Mouth closing/constriction	Vehicle damage	Margin development	Floodgates	Existing Condition	Susceptibility	Comments
HABITAT RATING	Dune Active																				
	Dune Stable																				
	Beach Sand																				
	Beach Gravel																				
	Beach Cobble																				
	Rock/Boulder																				
	Cliff																				
	Coastal Herbfield																				
	Inshore Water																				
ISSUE	MONITORING INDICATORS	RISK OF STRESSOR AFFECTING INDICATOR																			
Eutrophication	Dissolved Oxygen																				
	Clarity																				
	Nutrients																				
	Chlorophyll/phytopl.																				
	Macroalgal growth																				
	Redox Disc. Profile/Smell																				
	Org C sediments																				
Sediment	Muddiness																				
	Sedimentation rate																				
	Clarity																				
Dis-ease	Faecal Indicators																				River plume, outfall
Toxicity	Heavy Metals																				
	SVOCs																				
	Toxic algae																				
Habitat Change	Habitat Mapping																				
	Macrophytes																				
	Margin																				
	Shellfish																				
	Fish																				
	Macro-invertebrates																				
	Sea Level																				

COASTAL ECOLOGICAL VULNERABILITY RATING - ESTUARIES

LOCATION: BLUFF HARBOUR/AWARUA BAY
DATE: APRIL 2008

OVERALL VULNERABILITY RATING - BLUFF HARBOUR/AWARUA BAY

Human Use	High
Ecological Value	High
Existing Condition	Very Good
Susceptibility	Low
Stressors	Moderate
OVERALL VULNERABILITY	Low

Monitoring Recommendations:

- Broadscale estuary habitat mapping at 5 year intervals.
- Fine scale physical, chemical and biological monitoring (4yr baseline then every 5 years).
- Map intensive landuse (5 yearly).

MATRIX A - Uses and Values (Estuaries)

Key for Use and Value Rating
High
Moderate
Low
Very Low

Key For Issue/Indicator Rating
High
Moderate
Low
Very Low

HABITAT RATING	HUMAN USE: Bathing, surfing	Shellfish collection	Natural character, aesthetic	Boating	Fishing, white-baiting, duckshooting	ECOLOGICAL VALUES: Birds	Vegetation (dune, saltmarsh, seagrass)	Other Biota	Fish
Estuary Saltmarsh	Very Low	High	High	Very Low	High	Moderate	Moderate	High	High
Estuary Soft Mud	Very Low	High	High	Very Low	High	Moderate	Moderate	High	High
Estuary Firm Mud/Sand	Very Low	High	High	Very Low	High	Moderate	High	High	High
Estuary Gravel/Cobble	Very Low	High	High	Very Low	High	Moderate	Moderate	High	High
Aquatic Macrophytes	Very Low	Very Low	High	Very Low	High	Moderate	Moderate	High	High
Biogenic Structures	Very Low	Very Low	Moderate	Very Low	Very Low	Very Low	Very Low	Very Low	Very Low
Terrestrial Margin	Very Low	Very Low	High	Very Low	Very Low	Moderate	Low	Moderate	Very Low
Subtidal	Moderate	Very Low	High	High	High	Moderate	Moderate	High	High

COASTAL ECOLOGICAL VULNERABILITY RATING - ESTUARIES

LOCATION: BLUFF HARBOUR/AWARUA BAY
DATE: APRIL 2008

MATRIX B - Stressors, Existing Condition and Susceptibility

Key For Rating	
Stressors	Existing Condition
High	Poor
Moderate	Fair
Low	Good
Very Low	Very Good

		PRESENCE OF STRESSORS																	CONDITION		RESPONSE
		Sea Level Rise	Catchment runoff	Point Discharges	Climate Change Rain/Temp	Spills (incl. oil)	Grazing	Freshwater abstraction	Reclamation	Erosion control structures	Food collection	Algal blooms (from sea)	Structures (incl. marine farms)	Invasive weeds/pests	Mouth closing/constriction	Vehicle damage	Margin development	Floodgates	Existing Condition	Susceptibility	HABITAT RESPONSE
	Estuary Saltmarsh																				
	Estuary Soft Mud																				
	Estuary Firm Mud/Sand																				
	Estuary Gravel/Cobble																				
	Aquatic Macrophytes																				
	Biogenic Structures																				
	Terrestrial Margin																				
	Subtidal																				
ISSUE	MONITORING INDICATORS	RISK OF STRESSOR AFFECTING INDICATOR																			
Eutrophication	Dissolved Oxygen																				
	Clarity																				
	Nutrients																				
	Chlorophyll/phytopl.																				
	Macroalgal growth																				
	Redox Disc. Profile/Smell																				
	Org C sediments																				
Sediment	Muddiness																				
	Sedimentation rate																				
	Clarity																				
Dis-ease	Faecal Indicators																				
Toxicity	Heavy Metals																				
	SVOCs																				
	Toxic algae																				
Habitat Change	Habitat Mapping																				
	Macrophyte Mapping																				
	Margin Mapping																				
	Shellfish																				
	Fish																				
	Macro-invertebrates																				
	Sea Level																				

COASTAL ECOLOGICAL VULNERABILITY RATING - BEACH, DUNE AND ROCKY SHORE

LOCATION: TOETOES BEACH - Beach, Dunes
DATE: April 2008

OVERALL VULNERABILITY RATING

TOETOES BEACH - Beach, Dunes

Human Use		Moderate
Ecological Value		Moderate
Existing Condition		Good
Susceptibility		Moderate
Stressors		Moderate
OVERALL VULNERABILITY		Moderate

Monitoring Recommendations:

- Broadscale mapping of all coastal habitats at 10 year intervals.
- Map intensive landuse (urban, high production pasture) in all catchments at 5 yearly intervals.
- Map area of wetlands in catchments at regular intervals (5 yearly).
- Monitor disease risk (shellfish and water)
- Tiwai treated wastewater discharge;
    - monitor as in consent

MATRIX A - Uses and Values (Beaches, Dunes and Rocky Shores)

Key for Use and Value Rating	
High	
Moderate	
Low	
Very Low	

Key For Issue/Indicator Rating	
High	
Moderate	
Low	
Very Low	

HABITAT RATING	HUMAN USE					ECOLOGICAL VALUES			
	Bathing, surfing	Shellfish collection	Natural character, aesthetic, picnics	Boating	Fishing, white-baiting, duckshooting	Birds	Vegetation (dune, saltmarsh, seagrass)	Other Biota	Fish
Dune Active									
Dune Stable									
Beach Sand									
Beach Gravel									
Beach Cobble									
Rock/Boulder									
Cliff									
Coastal Herbfield									
Inshore Water									

COASTAL ECOLOGICAL VULNERABILITY RATING - BEACHES, DUNES, ROCKY SHORES

LOCATION: TOETOES BEACH - Beach, Dunes
DATE: APRIL 2008

MATRIX B - Stressors, Existing Condition and Susceptibility

Key For Rating			
Stressors		Existing Condition	
High		Poor	
Moderate		Fair	
Low		Good	
Very Low		Very Good	

		PRESENCE OF STRESSORS																CONDITION		RESPONSE
		Sea Level Rise	Catchment runoff	Point Discharges	Climate Change Rain/Temp	Spills (incl. oil)	Grazing	Freshwater abstraction	Reclamation	Erosion control structures	Food collection	Algal blooms (from sea)	Structures (incl. marine farms)	Invasive weeds/pests	Mouth closing/constriction	Vehicle damage	Margin development	Floodgates		Existing Condition	Susceptibility	Comments
HABITAT RATING	Dune Active																					
	Dune Stable																					
	Beach Sand																					
	Beach Gravel																					
	Beach Cobble																					
	Rock/Boulder																					
	Cliff																					
	Coastal Herbfield																					
	Inshore Water																					
ISSUE	MONITORING INDICATORS	RISK OF STRESSOR AFFECTING INDICATOR																				
Eutrophication	Dissolved Oxygen																					
	Clarity																					
	Nutrients																					
	Chlorophyll/phytopl.																					
	Macroalgal growth																					
	Redox Disc. Profile/Smell																					
	Org C sediments																					
Sediment	Muddiness																					
	Sedimentation rate																					
	Clarity																					
Dis-ease	Faecal Indicators																					
Toxicity	Heavy Metals																					
	SVOCs																					
	Toxic algae																					
Habitat Change	Habitat Mapping																					
	Macrophytes																					
	Margin																					
	Shellfish																					
	Fish																					
	Macro-invertebrates																					
	Sea Level																					

COASTAL ECOLOGICAL VULNERABILITY RATING - ESTUARIES

LOCATION: WAITUNA LAGOON
DATE: APRIL 2008

OVERALL VULNERABILITY RATING - WAITUNA LAGOON

Human Use	High
Ecological Value	High
Existing Condition	Fair
Susceptibility	High
Stressors	High
OVERALL VULNERABILITY	High

Monitoring Recommendations (details see Stevens and Robertson 2007):

- Broad scale mapping of sediment type at five yearly intervals (repeat 2007 survey in 2012).
- Fine scale monitoring of surface sediment grain size along selected transects at five yearly intervals (beginning 2008). Assessment of sedimentation rate (using buried sedimentation plates) at two high deposition areas (including rushland). Ideally measured at annual intervals.
- Measure water clarity (Secchi disc - SD) at monthly intervals at representative sites.
- Broad scale mapping of lagoon macroalgal percent cover annually in January-March (when the lagoon mouth is open).
- Monthly monitoring during the main growing period (September-April) for the following parameters: lagoon light penetration or SD, chlorophyll-*a*, phyto-plankton, total nitrogen, nitrate, ammonia, total phosphorus, dissolved reactive phosphorus, salinity, dissolved oxygen, temperature, and water level. In addition, establish a baseline of sediment organic carbon (determined from ash free dry weight) at representative sites.
- Monthly monitoring during the main periods of contact recreation for *E. coli*.
- Repeat broad scale mapping of percent cover of *Ruppia* at annual intervals.
- Broad scale mapping of wetland and terrestrial margin vegetation at five yearly intervals (repeat 2007 survey in 2012).

MATRIX A - Uses and Values (Estuaries)

Key for Use and Value Rating
High
Moderate
Low
Very Low

Key For Issue/Indicator Rating
High
Moderate
Low
Very Low

	HUMAN USE					ECOLOGICAL VALUES			
HABITAT RATING	Bathing, surfing	Shellfish collection	Natural character, aesthetic	Boating	Fishing, white-baiting, duckshooting	Birds	Vegetation (dune, saltmarsh, seagrass)	Other Biota	Fish
Estuary Saltmarsh			High		High	High	High	High	High
Estuary Soft Mud			High		High	High	High	High	High
Estuary Firm Mud/Sand			High		High	High	High	High	High
Estuary Gravel/Cobble			High		High	High	High	High	High
Aquatic Macrophytes			High		High	High	High	High	High
Biogenic Structures									
Terrestrial Margin			Moderate			Moderate	Moderate	Moderate	
Subtidal			High	Moderate	High	High	High	High	High

COASTAL ECOLOGICAL VULNERABILITY RATING - ESTUARIES

LOCATION: WAITUNA LAGOON
DATE: APRIL 2008

MATRIX B - Stressors, Existing Condition and Susceptibility

Key For Rating	
Stressors	Existing Condition
High	Poor
Moderate	Fair
Low	Good
Very Low	Very Good

		PRESENCE OF STRESSORS																	CONDITION		RESPONSE
		Sea Level Rise	Catchment runoff	Point Discharges	Climate Change Rain/Temp	Spills (incl. oil)	Grazing	Freshwater abstraction	Reclamation	Erosion control structures	Food collection	Algal blooms (from sea)	Structures (incl. marine farms)	Invasive weeds/pests	Mouth closing/constriction	Vehicle damage	Margin development	Floodgates		Existing Condition	Susceptibility	HABITAT RESPONSE
	Estuary Saltmarsh																					
	Estuary Soft Mud																					
	Estuary Firm Mud/Sand																					
	Estuary Gravel/Cobble																					
	Aquatic Macrophytes																					
	Biogenic Structures																					
	Terrestrial Margin																					
	Subtidal																					
ISSUE	MONITORING INDICATORS	RISK OF STRESSOR AFFECTING INDICATOR																				
Eutrophication	Dissolved Oxygen																					
	Clarity																					
	Nutrients																					
	Chlorophyll/phytopl.																					
	Macroalgal growth																					
	Redox Disc. Profile/Smell																					
	Org C sediments																					
Sediment	Muddiness																					
	Sedimentation rate																					
	Clarity																					
Dis-ease	Faecal Indicators																					
Toxicity	Heavy Metals																					
	SVOCs																					
	Toxic algae																					
Habitat Change	Habitat Mapping																					
	Macrophyte Mapping																					
	Margin Mapping																					
	Shellfish																					
	Fish																					
	Macro-invertebrates																					
	Sea Level																					

COASTAL ECOLOGICAL VULNERABILITY RATING - ESTUARIES

LOCATION: TOETOES ESTUARY
DATE: APRIL 2008

OVERALL VULNERABILITY RATING - Toetoes Estuary

Human Use		Moderate
Ecological Value		Moderate
Existing Condition		Fair
Susceptibility		Low
Stressors		Moderate
OVERALL VULNERABILITY		Moderate

Monitoring Recommendations:

- Broadscale estuary habitat mapping at 5 year intervals.
- Fine scale physical, chemical and biological monitoring (4yr baseline then every 5 years).
- Sedimentation rate monitoring.
- Macroalgal cover mapping annually.

MATRIX A - Uses and Values (Estuaries)

Key for Use and Value Rating
High
Moderate
Low
Very Low

Key For Issue/Indicator Rating
High
Moderate
Low
Very Low

		HUMAN USE						ECOLOGICAL VALUES			
		Bathing, surfing	Shellfish collection	Natural character, aesthetic	Boating	Fishing, white-baiting, duckshooting		Birds	Vegetation (dune, saltmarsh, seagrass)	Other Biota	Fish
HABITAT RATING	Estuary Saltmarsh										
	Estuary Soft Mud										
	Estuary Firm Mud/Sand										
	Estuary Gravel/Cobble										
	Aquatic Macrophytes										
	Biogenic Structures										
	Terrestrial Margin										
	Subtidal										

COASTAL ECOLOGICAL VULNERABILITY RATING - ESTUARIES

LOCATION: TOETOES ESTUARY
DATE: APRIL 2008

MATRIX B - Stressors, Existing Condition and Susceptibility

Key For Rating	
Stressors	Existing Condition
High	Poor
Moderate	Fair
Low	Good
Very Low	Very Good

		PRESENCE OF STRESSORS																	CONDITION		RESPONSE
		Sea Level Rise	Catchment runoff	Point Discharges	Climate Change Rain/Temp	Spills (incl. oil)	Grazing	Freshwater abstraction	Reclamation	Erosion control structures	Food collection	Algal blooms (from sea)	Structures (incl. marine farms)	Invasive weeds/pests	Mouth closing/constriction	Vehicle damage	Margin development	Floodgates	Existing Condition	Susceptibility	HABITAT RESPONSE
	Estuary Saltmarsh																				
	Estuary Soft Mud																				
	Estuary Firm Mud/Sand																				
	Estuary Gravel/Cobble																				
	Aquatic Macrophytes																				
	Biogenic Structures																				
	Terrestrial Margin																				
	Subtidal																				
ISSUE	MONITORING INDICATORS	RISK OF STRESSOR AFFECTING INDICATOR																			
Eutrophication	Dissolved Oxygen																				
	Clarity																				
	Nutrients																				
	Chlorophyll/phytopl.																				
	Macroalgal growth																				
	Redox Disc. Profile/Smell																				
	Org C sediments																				
Sediment	Muddiness																				
	Sedimentation rate																				
	Clarity																				
Dis-ease	Faecal Indicators																				
Toxicity	Heavy Metals																				
	SVOCs																				
	Toxic algae																				
Habitat Change	Habitat Mapping																				
	Macrophyte Mapping																				
	Margin Mapping																				
	Shellfish																				
	Fish																				
	Macro-invertebrates																				
	Sea Level																				

COASTAL ECOLOGICAL VULNERABILITY RATING - BEACH, DUNE AND ROCKY SHORE

LOCATION: FORTROSE TO WAIPARAU HEAD - Beach, Dunes and Rocky Shores
DATE: April 2008

OVERALL VULNERABILITY RATING

FORTROSE TO WAIPARAU HEAD - Beach, Dunes and Rocky Shores

Human Use	Mod-High
Ecological Value	High
Existing Condition	Good
Susceptibility	Low
Stressors	Moderate
OVERALL VULNERABILITY	Moderate

Monitoring Recommendations:

- Map intensive landuse - 5 yearly.
- Habitat map every 10 years.

MATRIX A - Uses and Values (Beaches, Dunes and Rocky Shores)

Key for Use and Value Rating
High
Moderate
Low
Very Low

Key For Issue/Indicator Rating
High
Moderate
Low
Very Low

HABITAT RATING	HUMAN USE					ECOLOGICAL VALUES			
	Bathing, surfing	Shellfish collection	Natural character, aesthetic, picnics	Boating	Fishing, white-baiting, duckshooting	Birds	Vegetation (dune, saltmarsh, seagrass)	Other Biota	Fish
Dune Active	Very Low	Very Low	Moderate	Very Low	Very Low	Low	Moderate	Low	Very Low
Dune Stable	Very Low	Very Low	High	Very Low	Very Low	Low	High	Low	Very Low
Beach Sand	Moderate	Low	Moderate	Very Low	Moderate	Low	Very Low	Low	Very Low
Beach Gravel	Moderate	Low	Moderate	Very Low	Moderate	Low	Very Low	Low	Very Low
Beach Cobble	Low	Very Low	Moderate	Very Low	Moderate	Low	Very Low	Low	Very Low
Rock/Boulder	Moderate	High	High	Very Low	High	Moderate	High	High	Moderate
Cliff	Very Low	Very Low	High	Very Low	Very Low	Moderate	High	Moderate	Very Low
Coastal Herbfield	Very Low	Very Low	High	Very Low	Very Low	Low	Moderate	Moderate	Very Low
Inshore Water	Moderate	High	High	High	High	Low	Moderate	Moderate	High

COASTAL ECOLOGICAL VULNERABILITY RATING - BEACHES, DUNES, ROCKY SHORES

LOCATION: FORTROSE TO WAIPARAU HEAD - Beach, Dunes and Rocky Shores
DATE: APRIL 2008

MATRIX B - Stressors, Existing Condition and Susceptibility

Key For Rating	
Stressors	Existing Condition
High	Poor
Moderate	Fair
Low	Good
Very Low	Very Good

		PRESENCE OF STRESSORS																	CONDITION		RESPONSE
		Sea Level Rise	Catchment runoff	Point Discharges	Climate Change Rain/Temp	Spills (incl. oil)	Grazing	Freshwater abstraction	Reclamation	Erosion control structures	Food collection	Algal blooms (from sea)	Structures (incl. marine farms)	Invasive weeds/pests	Mouth closing/constriction	Vehicle damage	Margin development	Floodgates	Existing Condition	Susceptibility	Comments
HABITAT RATING	Dune Active																				
	Dune Stable																				
	Beach Sand																				
	Beach Gravel																				
	Beach Cobble																				
	Rock/Boulder																				
	Cliff																				
	Coastal Herbfield																				
	Inshore Water																				
ISSUE	MONITORING INDICATORS	RISK OF STRESSOR AFFECTING INDICATOR																			
Eutrophication	Dissolved Oxygen																				
	Clarity																				
	Nutrients																				
	Chlorophyll/phytopl.																				
	Macroalgal growth																				
	Redox Disc. Profile/Smell																				
	Org C sediments																				
Sediment	Muddiness																				
	Sedimentation rate																				
	Clarity																				
Dis-ease	Faecal Indicators																				
Toxicity	Heavy Metals																				
	SVOCs																				
	Toxic algae																				
Habitat Change	Habitat Mapping																				
	Macrophytes																				
	Margin																				
	Shellfish																				
	Fish																				
	Macro-invertebrates																				
	Sea Level																				

COASTAL ECOLOGICAL VULNERABILITY RATING - ESTUARIES

LOCATION: TOKANUI ESTUARY, WAIPAPA ESTUARY
DATE: APRIL 2008

OVERALL VULNERABILITY RATING

LOCATION: TOKANUI ESTUARY, WAIPAPA ESTUARY

Human Use		Low-Mod
Ecological Value		Moderate
Existing Condition		Fair
Susceptibility		Moderate
Stressors		Moderate
OVERALL VULNERABILITY		Moderate

Monitoring Recommendations:

- Map intensive landuse - 5 yearly.
- Habitat map estuary every 10 years.
- Assess bottom water DO, and sediment anoxia (RPD) during prolonged summer baseflow conditions every 3 years.

MATRIX A - Uses and Values (Estuaries)

Key for Use and Value Rating
High
Moderate
Low
Very Low

Key For Issue/Indicator Rating
High
Moderate
Low
Very Low

		HUMAN USE						ECOLOGICAL VALUES			
		Bathing, surfing	Shellfish collection	Natural character, aesthetic	Boating	Fishing, white-baiting, duckshooting		Birds	Vegetation (dune, saltmarsh, seagrass)	Other Biota	Fish
HABITAT RATING	Estuary Saltmarsh										
	Estuary Soft Mud										
	Estuary Firm Mud/Sand										
	Estuary Gravel/Cobble										
	Aquatic Macrophytes										
	Biogenic Structures										
	Terrestrial Margin										
	Subtidal										

COASTAL ECOLOGICAL VULNERABILITY RATING - ESTUARIES

LOCATION: TOKANUI ESTUARY, WAIPAPA ESTUARY
DATE: APRIL 2008

MATRIX B - Stressors, Existing Condition and Susceptibility

Key For Rating		
Stressors		Existing Condition
High		Poor
Moderate		Fair
Low		Good
Very Low		Very Good

		PRESENCE OF STRESSORS																	CONDITION		RESPONSE
		Sea Level Rise	Catchment runoff	Point Discharges	Climate Change Rain/Temp	Spills (incl. oil)	Grazing	Freshwater abstraction	Reclamation	Erosion control structures	Food collection	Algal blooms (from sea)	Structures (incl. marine farms)	Invasive weeds/pests	Mouth closing/constriction	Vehicle damage	Margin development	Floodgates		Existing Condition	Susceptibility	HABITAT RESPONSE
	Estuary Saltmarsh																				
	Estuary Soft Mud																				
	Estuary Firm Mud/Sand																				
	Estuary Gravel/Cobble																				
	Aquatic Macrophytes																				
	Biogenic Structures																				
	Terrestrial Margin																				
	Subtidal																				Mouth constricts
ISSUE	MONITORING INDICATORS	RISK OF STRESSOR AFFECTING INDICATOR																			
Eutrophication	Dissolved Oxygen																				
	Clarity																				
	Nutrients																				
	Chlorophyll/phytopl.																				
	Macroalgal growth																				
	Redox Disc. Profile/Smell																				
	Org C sediments																				
Sediment	Muddiness																				
	Sedimentation rate																				
	Clarity																				
Dis-ease	Faecal Indicators																				
Toxicity	Heavy Metals																				
	SVOCs																				
	Toxic algae																				
Habitat Change	Habitat Mapping																				
	Macrophyte Mapping																				
	Margin Mapping																				
	Shellfish																				
	Fish																				
	Macro-invertebrates																				
	Sea Level																				Expand salt marsh

COASTAL ECOLOGICAL VULNERABILITY RATING - ESTUARIES

LOCATION: LAKE BRUNTON
DATE: APRIL 2008

OVERALL VULNERABILITY RATING - LAKE BRUNTON

Human Use		Low
Ecological Value		High
Existing Condition		Fair
Susceptibility		High
Stressors		High
OVERALL VULNERABILITY		High

Monitoring Recommendations (see Stevens and Robertson 2007 for examples):

- Undertake detailed short term synoptic monitoring and risk assessment of at-risk estuaries in which limited existing information is available. This information will be used to develop appropriate monitoring and management plans for these estuaries.

MATRIX A - Uses and Values (Estuaries)

Key for Use and Value Rating	
High	
Moderate	
Low	
Very Low	

Key For Issue/Indicator Rating	
High	
Moderate	
Low	
Very Low	

		HUMAN USE					ECOLOGICAL VALUES			
		Bathing, surfing	Shellfish collection	Natural character, aesthetic	Boating	Fishing, white-baiting, duckshooting	Birds	Vegetation (dune, saltmarsh, seagrass)	Other Biota	Fish
HABITAT RATING	Estuary Saltmarsh									
	Estuary Soft Mud									
	Estuary Firm Mud/Sand									
	Estuary Gravel/Cobble									
	Aquatic Macrophytes									
	Biogenic Structures									
	Terrestrial Margin									
	Subtidal									

COASTAL ECOLOGICAL VULNERABILITY RATING - ESTUARIES

LOCATION: LAKE BRUNTON
DATE: APRIL 2008

MATRIX B - Stressors, Existing Condition and Susceptibility

Key For Rating	
Stressors	Existing Condition
High	Poor
Moderate	Fair
Low	Good
Very Low	Very Good

		PRESENCE OF STRESSORS																	CONDITION		RESPONSE
		Sea Level Rise	Catchment runoff	Point Discharges	Climate Change Rain/Temp	Spills (incl. oil)	Grazing	Freshwater abstraction	Reclamation	Erosion control structures	Food collection	Algal blooms (from sea)	Structures (incl. marine farms)	Invasive weeds/pests	Mouth closing/constriction	Vehicle damage	Margin development	Floodgates	Existing Condition	Susceptibility	HABITAT RESPONSE
	Estuary Saltmarsh																				
	Estuary Soft Mud																				
	Estuary Firm Mud/Sand																				
	Estuary Gravel/Cobble																				
	Aquatic Macrophytes																				
	Biogenic Structures																				
	Terrestrial Margin																				
	Subtidal																				
ISSUE	MONITORING INDICATORS	RISK OF STRESSOR AFFECTING INDICATOR																			
Eutrophication	Dissolved Oxygen																				
Eutrophication	Clarity																				
Eutrophication	Nutrients																				
Eutrophication	Chlorophyll/phytopl.																				
Eutrophication	Macroalgal growth																				
Eutrophication	Redox Disc. Profile/Smell																				
Eutrophication	Org C sediments																				
Sediment	Muddiness																				
Sediment	Sedimentation rate																				
Sediment	Clarity																				
Dis-ease	Faecal Indicators																				
Toxicity	Heavy Metals																				
Toxicity	SVOCs																				
Toxicity	Toxic algae																				
Habitat Change	Habitat Mapping																				
Habitat Change	Macrophyte Mapping																				
Habitat Change	Margin Mapping																				
Habitat Change	Shellfish																				
Habitat Change	Fish																				
Habitat Change	Macro-invertebrates																				
Habitat Change	Sea Level																				

COASTAL ECOLOGICAL VULNERABILITY RATING - ESTUARIES

LOCATION: HALDANE ESTUARY
DATE: APRIL 2008

OVERALL VULNERABILITY RATING - HALDANE ESTUARY

Human Use		Moderate
Ecological Value		Moderate
Existing Condition		Good
Susceptibility		Moderate
Stressors		Moderate
OVERALL VULNERABILITY		Moderate

Monitoring Recommendations:

- Broadscale estuary habitat mapping at 5 year intervals.
- Fine scale physical, chemical and biological monitoring (4yr baseline then every 5 years).
- Sedimentation rate monitoring.
- Macroalgal cover mapping 5 yearly.

MATRIX A - Uses and Values (Estuaries)

Key for Use and Value Rating
High
Moderate
Low
Very Low

Key For Issue/Indicator Rating
High
Moderate
Low
Very Low

		HUMAN USE					ECOLOGICAL VALUES			
		Bathing, surfing	Shellfish collection	Natural character, aesthetic	Boating	Fishing, white-baiting, duckshooting	Birds	Vegetation (dune, saltmarsh, seagrass)	Other Biota	Fish
HABITAT RATING	Estuary Saltmarsh									
	Estuary Soft Mud									
	Estuary Firm Mud/Sand									
	Estuary Gravel/Cobble									
	Aquatic Macrophytes									
	Biogenic Structures									
	Terrestrial Margin									
	Subtidal									

COASTAL ECOLOGICAL VULNERABILITY RATING - ESTUARIES

LOCATION: HALDANE ESTUARY
DATE: APRIL 2008

MATRIX B - Stressors, Existing Condition and Susceptibility

Key For Rating	
Stressors	Existing Condition
High	Poor
Moderate	Fair
Low	Good
Very Low	Very Good

		PRESENCE OF STRESSORS																	CONDITION		RESPONSE
		Sea Level Rise	Catchment runoff	Point Discharges	Climate Change Rain/Temp	Spills (incl. oil)	Grazing	Freshwater abstraction	Reclamation	Erosion control structures	Food collection	Algal blooms (from sea)	Structures (incl. marine farms)	Invasive weeds/pests	Mouth closing/constriction	Vehicle damage	Margin development	Floodgates		Existing Condition	Susceptibility	HABITAT RESPONSE
	Estuary Saltmarsh																					
	Estuary Soft Mud																					
	Estuary Firm Mud/Sand																					
	Estuary Gravel/Cobble																					
	Aquatic Macrophytes																					
	Biogenic Structures																					
	Terrestrial Margin																					
	Subtidal																					
ISSUE	MONITORING INDICATORS	RISK OF STRESSOR AFFECTING INDICATOR																				
Eutrophication	Dissolved Oxygen																					
	Clarity																					
	Nutrients																					
	Chlorophyll/phytopl.																					
	Macroalgal growth																					
	Redox Disc. Profile/Smell																					
	Org C sediments																					
Sediment	Muddiness																					
	Sedimentation rate																					
	Clarity																					
Dis-ease	Faecal Indicators																					
Toxicity	Heavy Metals																					
	SVOCs																					
	Toxic algae																					
Habitat Change	Habitat Mapping																					
	Macrophyte Mapping																					
	Margin Mapping																					
	Shellfish																					
	Fish																					
	Macro-invertebrates																					
	Sea Level																					

COASTAL ECOLOGICAL VULNERABILITY RATING - ESTUARIES

LOCATION: COOKS CREEK ESTUARY
DATE: APRIL 2008

OVERALL VULNERABILITY RATING

LOCATION: COOKS CREEK ESTUARY

Human Use		Low
Ecological Value		Low
Existing Condition		Good
Susceptibility		Moderate
Stressors		Moderate
OVERALL VULNERABILITY		Low

Monitoring Recommendations:

- Map intensive landuse - 5 yearly.
- Habitat map estuary every 10 yrs.

MATRIX A - Uses and Values (Estuaries)

Key for Use and Value Rating
High
Moderate
Low
Very Low

Key For Issue/Indicator Rating
High
Moderate
Low
Very Low

		HUMAN USE						ECOLOGICAL VALUES			
		Bathing, surfing	Shellfish collection	Natural character, aesthetic	Boating	Fishing, white-baiting, duckshooting		Birds	Vegetation (dune, saltmarsh, seagrass)	Other Biota	Fish
HABITAT RATING	Estuary Saltmarsh										
	Estuary Soft Mud										
	Estuary Firm Mud/Sand										
	Estuary Gravel/Cobble										
	Aquatic Macrophytes										
	Biogenic Structures										
	Terrestrial Margin										
	Subtidal										

COASTAL ECOLOGICAL VULNERABILITY RATING - ESTUARIES

LOCATION: COOKS CREEK ESTUARY
DATE: APRIL 2008

MATRIX B - Stressors, Existing Condition and Susceptibility

Key For Rating	
Stressors	Existing Condition
High	Poor
Moderate	Fair
Low	Good
Very Low	Very Good

		PRESENCE OF STRESSORS																	CONDITION		RESPONSE
		Sea Level Rise	Catchment runoff	Point Discharges	Climate Change Rain/Temp	Spills (incl. oil)	Grazing	Freshwater abstraction	Reclamation	Erosion control structures	Food collection	Algal blooms (from sea)	Structures (incl. marine farms)	Invasive weeds/pests	Mouth closing/constriction	Vehicle damage	Margin development	Floodgates	Existing Condition	Susceptibility	HABITAT RESPONSE
	Estuary Saltmarsh																				
	Estuary Soft Mud																				
	Estuary Firm Mud/Sand																				
	Estuary Gravel/Cobble																				
	Aquatic Macrophytes																				
	Biogenic Structures																				
	Terrestrial Margin																				
	Subtidal																				Mouth constricts
ISSUE	MONITORING INDICATORS	RISK OF STRESSOR AFFECTING INDICATOR																			
Eutrophication	Dissolved Oxygen																				
	Clarity																				
	Nutrients																				
	Chlorophyll/phytopl.																				
	Macroalgal growth																				
	Redox Disc. Profile/Smell																				
	Org C sediments																				
Sediment	Muddiness																				
	Sedimentation rate																				
	Clarity																				
Dis-ease	Faecal Indicators																				
Toxicity	Heavy Metals																				
	SVOCs																				
	Toxic algae																				
Habitat Change	Habitat Mapping																				
	Macrophyte Mapping																				
	Margin Mapping																				
	Shellfish																				
	Fish																				
	Macro-invertebrates																				
	Sea Level																				

COASTAL ECOLOGICAL VULNERABILITY RATING - ESTUARIES

LOCATION: WAIKAWA ESTUARY
DATE: APRIL 2008

OVERALL VULNERABILITY RATING - Waikawa Estuary

Human Use	High
Ecological Value	High
Existing Condition	Fair
Susceptibility	Low
Stressors	Low
OVERALL VULNERABILITY	Moderate

Monitoring Recommendations:

- Broadscale estuary habitat mapping at 5 year intervals.
- Fine scale physical, chemical and biological monitoring (4yr baseline then every 5 years).
- Sedimentation rate monitoring.
- Macroalgal cover mapping annually.
- Map intensive landuse - 5 yearly.

MATRIX A - Uses and Values (Estuaries)

Key for Use and Value Rating
High
Moderate
Low
Very Low

Key For Issue/Indicator Rating
High
Moderate
Low
Very Low

HABITAT RATING	HUMAN USE: Bathing, surfing	Shellfish collection	Natural character, aesthetic	Boating	Fishing, white-baiting, duckshooting	ECOLOGICAL VALUES: Birds	Vegetation (dune, saltmarsh, seagrass)	Other Biota	Fish
Estuary Saltmarsh									
Estuary Soft Mud									
Estuary Firm Mud/Sand									
Estuary Gravel/Cobble									
Aquatic Macrophytes									
Biogenic Structures									
Terrestrial Margin									
Subtidal									

COASTAL ECOLOGICAL VULNERABILITY RATING - ESTUARIES

LOCATION: WAIKAWA ESTUARY
DATE: APRIL 2008

MATRIX B - Stressors, Existing Condition and Susceptibility

Key For Rating	
Stressors	Existing Condition
High	Poor
Moderate	Fair
Low	Good
Very Low	Very Good

		PRESENCE OF STRESSORS																	CONDITION		RESPONSE
		Sea Level Rise	Catchment runoff	Point Discharges	Climate Change Rain/Temp	Spills (incl. oil)	Grazing	Freshwater abstraction	Reclamation	Erosion control structures	Food collection	Algal blooms (from sea)	Structures (incl. marine farms)	Invasive weeds/pests	Mouth closing/constriction	Vehicle damage	Margin development	Floodgates	Existing Condition	Susceptibility	HABITAT RESPONSE
	Estuary Saltmarsh																				
	Estuary Soft Mud																				
	Estuary Firm Mud/Sand																				
	Estuary Gravel/Cobble																				
	Aquatic Macrophytes																				
	Biogenic Structures																				
	Terrestrial Margin																				
	Subtidal																				
ISSUE	MONITORING INDICATORS	RISK OF STRESSOR AFFECTING INDICATOR																			
Eutrophication	Dissolved Oxygen																				
	Clarity																				
	Nutrients																				
	Chlorophyll/phytopl.																				
	Macroalgal growth																				
	Redox Disc. Profile/Smell																				
	Org C sediments																				
Sediment	Muddiness																				
	Sedimentation rate																				
	Clarity																				
Dis-ease	Faecal Indicators																				
Toxicity	Heavy Metals																				
	SVOCs																				
	Toxic algae																				
Habitat Change	Habitat Mapping																				
	Macrophyte Mapping																				
	Margin Mapping																				
	Shellfish																				
	Fish																				
	Macro-invertebrates																				
	Sea Level																				

COASTAL ECOLOGICAL VULNERABILITY RATING - ESTUARIES

LOCATION: LONGBEACH ESTUARY
DATE: APRIL 2008

OVERALL VULNERABILITY RATING - LONGBEACH ESTUARY

Human Use	Low
Ecological Value	Moderate
Existing Condition	Very Good
Susceptibility	Moderate
Stressors	Very Low
OVERALL VULNERABILITY	Low-Mod

Monitoring Recommendations:

- Map intensive landuse - 5 yearly.
- Habitat map estuary every 10 years.

MATRIX A - Uses and Values (Estuaries)

Key for Use and Value Rating
High
Moderate
Low
Very Low

Key For Issue/Indicator Rating
High
Moderate
Low
Very Low

		HUMAN USE					ECOLOGICAL VALUES			
		Bathing, surfing	Shellfish collection	Natural character, aesthetic	Boating	Fishing, white-baiting, duckshooting	Birds	Vegetation (dune, saltmarsh, seagrass)	Other Biota	Fish
HABITAT RATING	Estuary Saltmarsh									
	Estuary Soft Mud									
	Estuary Firm Mud/Sand									
	Estuary Gravel/Cobble									
	Aquatic Macrophytes									
	Biogenic Structures									
	Terrestrial Margin									
	Subtidal									

COASTAL ECOLOGICAL VULNERABILITY RATING - ESTUARIES

LOCATION: LONGBEACH ESTUARY
DATE: APRIL 2008

MATRIX B - Stressors, Existing Condition and Susceptibility

Key For Rating		
Stressors		Existing Condition
High		Poor
Moderate		Fair
Low		Good
Very Low		Very Good

		PRESENCE OF STRESSORS																	CONDITION		COMMENTS
		Sea Level Rise	Catchment runoff	Point Discharges	Climate Change Rain/Temp	Spills (incl. oil)	Grazing	Freshwater abstraction	Reclamation	Erosion control structures	Food collection	Algal blooms (from sea)	Structures (incl. marine farms)	Invasive weeds/pests	Mouth closing/constriction	Vehicle damage	Margin development	Floodgates		Existing Condition	Susceptibility	Comments
	Estuary Saltmarsh																					
	Estuary Soft Mud																					
	Estuary Firm Mud/Sand																					
	Estuary Gravel/Cobble																					
	Aquatic Macrophytes																					
	Biogenic Structures																					
	Terrestrial Margin																					
	Subtidal																					Mouth constricts
ISSUE	MONITORING INDICATORS	RISK OF STRESSOR AFFECTING INDICATOR																				
Eutrophication	Dissolved Oxygen																					Salt wedge
	Clarity																					
	Nutrients																					
	Chlorophyll/phytopl.																					
	Macroalgal growth																					
	Redox Disc. Profile/Smell																					
	Org C sediments																					
Sediment	Muddiness																					
	Sedimentation rate																					
	Clarity																					
Dis-ease	Faecal Indicators																					
Toxicity	Heavy Metals																					
	SVOCs																					
	Toxic algae																					
Habitat Change	Habitat Mapping																					
	Macrophyte Mapping																					
	Margin Mapping																					
	Shellfish																					
	Fish																					
	Macro-invertebrates																					
	Sea Level																					

APPENDIX 3. HABITAT MAPS

The following tables provide a broad overview of the dominant habitat features of the coast (top), and the 200 metre terrestrial margin (bottom), subdivided into the 6 broad coastal regions discussed in the report. The data are drawn from the GIS dataset that accompanies this report and are based on the features visible on aerial photographs. As such, predominantly vertical features like cliffs are underrepresented in terms of surface area.

Summary of dominant coastal habitat features on the Southland coast, April 2008.

	Te Waewae Bay		Monkey Island to Riverton		Riverton to Omaui		Omaui to Bluff		Bluff to Fortrose		Fortrose to Waiparau Head		Grand Total	
Coastal Feature	Ha	%	Ha	%	Ha	%	Ha	%	Ha	%	Ha	%	Ha	%
Cliff	0.0	0.0	0.0	0.0	0.0	0.0	11.7	3.9	0.0	0.0	161.3	14.0	173.0	4.3
Rock/boulder	5.9	1.6	224.1	39.8	0.0	0.0	128.9	42.6	6.8	1.3	97.2	8.4	462.8	11.5
Beach	358.3	96.2	244.2	43.4	668.8	59.1	21.8	7.2	251.7	49.0	320.8	27.8	1865.5	46.2
Saltmarsh	0.1	0.0	0.5	0.1	0.9	0.1	0.1	0.0	2.2	0.4	0.2	0.0	4.0	0.1
Coastal Herbfield	0	0	0.1	0.0	1.0	0.1	23.5	7.8	101.7	19.8	31.3	2.7	157.6	3.9
Duneland - Stable	0.4	0.1	0.0	0.0	2.8	0.2	0.0	0.0	5.9	1.1	223.6	19.4	232.6	5.8
Duneland - Active	4.2	1.1	93.0	16.5	446.0	39.4	116.6	38.5	139.6	27.2	307.2	26.6	1106.5	27.4
Unvegetated	3.7	1.0	1.5	0.3	12.5	1.1	0.0	0.0	6.1	1.2	13.5	1.2	37.2	0.9
TOTAL	372.5	100	563.3	100	1131.9	100	302.6	100	513.9	100	1155.0	100	4039.2	100

Summary of dominant 200 metre terrestrial margin habitat features on the Southland coast, April 2008.

	Te Waewae Bay		Monkey Island to Riverton		Riverton to Omaui		Omaui to Bluff		Bluff to Fortrose		Fortrose to Waiparau Head		Grand Total	
Margin Feature	Ha	%	Ha	%	Ha	%	Ha	%	Ha	%	Ha	%	Ha	%
Cliff - TOTAL	100.8	13.2	1.7	0.2	0.0	0.0	1.2	0.2	0.0	0.0	4.3	0.3	107.0	2.0
Cliff - Forest	*7.5*	*1.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*7.5*	*0.1*
Cliff - Scrubland	*26.3*	*3.5*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*3.2*	*0.2*	*29.6*	*0.6*
Cliff - Tussockland	*13.0*	*1.7*	*1.7*	*0.2*	*0.0*	*0.0*	*1.2*	*0.2*	*0.0*	*0.0*	*1.0*	*0.1*	*17.0*	*0.3*
Cliff - Grassland	*53.0*	*6.9*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*53.0*	*1.0*
Forest	194.1	25.4	7.4	0.7	51.9	7.4	50.5	8.2	12.9	1.7	94.2	6.6	411.0	7.8
Scrubland	23.3	3.1	42.1	4.1	20.0	2.8	84.9	13.8	319.5	42.8	124.5	8.8	614.3	11.7
Tussockland	15.7	2.1	17.9	1.8	38.4	5.5	52.8	8.6	51.7	6.9	13.8	1.0	190.3	3.6
Sedgeland	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.0
Grassland	404.0	53.0	829.8	81.2	518.4	73.7	391.3	63.7	128.2	17.2	691.4	48.6	2963.1	56.2
Rushland	0.3	0.0	0.8	0.1	0.0	0.0	15.2	2.5	15.9	2.1	0.0	0.0	32.2	0.6
Duneland - Stable	2.6	0.3	44.1	4.3	9.7	1.4	0.0	0.0	0.6	0.1	423.0	29.8	479.9	9.1
Unvegetated	22.0	2.9	78.7	7.7	64.7	9.2	18.3	3.0	216.9	29.1	70.5	5.0	471.1	8.9
TOTAL	762.8	100.0	1022.4	100.0	703.0	100.0	614.3	100.0	745.7	100.0	1421.7	100.0	5269.9	100.0

APPENDIX 3. CLASSIFICATION DEFINITIONS

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 ≥10cm dbh are treated as trees. Commonly sub-grouped into native, exotic or mixed forest.

Treeland: Cover of trees in the canopy is 20-80%. Trees are woody plants >10cm dbh. Commonly sub-grouped into native, exotic or mixed treeland.

Scrub: 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 dbh. Commonly sub-grouped into native, exotic or mixed scrub.

Shrubland: Cover of shrubs in the canopy is 20-80%. Shrubs are woody plants <10 cm dbh. Commonly sub-grouped into native, exotic or mixed shrubland.

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.

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.

Grassland: Vegetation in which the cover of grass (excluding tussock-grasses) in the canopy is 20-100%, and in which the grass cover exceeds that of any other growth form or bare ground.

Sedgeland: Vegetation in which the cover of sedges (excluding tussock-sedges and reed-forming 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.

Rushland: Vegetation in which the cover of rushes (excluding tussock-rushes) in the canopy is 20-100% and where rush cover exceeds that of any other growth form or bare ground. A tall grasslike, often hollow-stemmed plant, included in rushland are some species of Juncus and all species of Leptocarpus.

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 round and hollow – somewhat like a soda straw, or have a very spongy pith. Unlike grasses or sedges, reed flowers will each bear six tiny petal-like structures. Examples include Typha, Bolboschoenus, Scirpus lacutris, Eleocharis sphacelata, and Baumea articulata.

Cushionfield: Vegetation in which the cover of cushion plants in the canopy is 20-100% and in which the cushion-plant cover exceeds that of any other growth form or bare ground. Cushion plants include herbaceous, semi-woody and woody plants with short densely packed branches and closely spaced leaves that together form dense hemispherical cushions.

Herbfield: Vegetation in which the cover of herbs in the canopy is 20-100% and where 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 where lichen cover exceeds that of any other growth form or bare ground.

Introduced weeds: Vegetation in which the cover of introduced weeds in the canopy is 20-100% and in which the weed cover exceeds that of any other growth form or bare ground.

Seagrass meadows: Seagrasses are the sole marine representatives of the Angiospermae. They all belong to the order Helobiae, in two families: Potamogetonaceae and Hydrocharitaceae. Although they may occasionally be exposed to the air, they are predominantly submerged, and their flowers are usually pollinated underwater. A notable feature of all seagrass plants is the extensive underground root/rhizome system which anchors them to their substrate. Seagrasses are commonly found in shallow coastal marine locations, salt-marshes and estuaries.

Macroalgal bed: Algae are relatively simple plants that live in freshwater or saltwater environments. In the marine environment, they are often called seaweeds. Although they contain cholorophyll, 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.

Cliff: A steep face of land which exceeds the area covered by any one class of plant growth-form. Cliffs are named from the dominant substrate type when unvegetated or the leading plant species when plant cover is ≥1%.

Rock field: Land in which the area of residual rock exceeds the area covered by any one class of plant growth-form. They are named from the leading plant species when plant cover is ≥1%.

Boulder field: Land in which the area of unconsolidated boulders (>200mm diam.) exceeds the area covered by any one class of plant growth-form. Boulder fields are named from the leading plant species when plant cover is ≥1%.

Cobble field: Land in which the area of unconsolidated cobbles (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%.

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 is ≥1%.

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 <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 difficult.

Soft sand: Substrate containing greater than 99% sand. When walking on the substrate you'll sink >2 cm.

Firm mud/sand: A mixture of mud and sand, the surface appears brown, and may have a black anaerobic layer below. When walking 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 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 you'll sink >5 cm.

Cockle bed: Area that is dominated by both live and dead cockle shells.

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

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

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

Shell bank: Area that is dominated by dead shells.

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.

APPENDIX 3. HABITAT MAPS

Location of numbered GIS maps of the Southland coastline.