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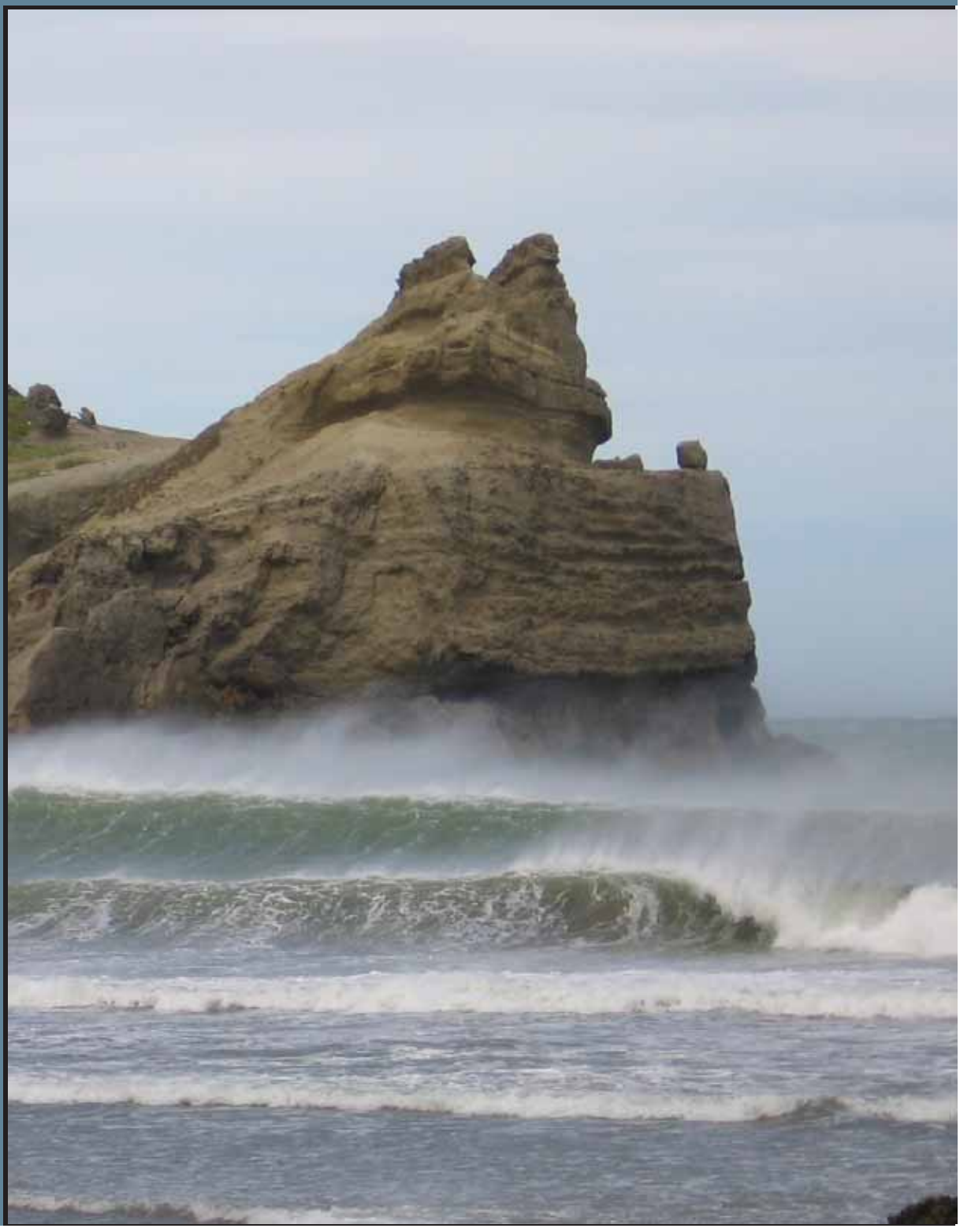
Wairarapa Coastal Habitats

Mapping, Risk Assessment and Monitoring



Prepared for Greater Wellington Regional Council

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Prepared for
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By

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Cover Photo: The Gap at Castlepoint, Wairarapa Coast

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EXECUTIVE SUMMARY

SCOPE

Developing an understanding of the distribution and risks to coastal and estuarine habitats is critical to the management of biological resources in the Greater Wellington Region. The Wairarapa Coastal Habitat Mapping and Risk Assessment study was initiated in 2006 to produce:

- **COASTAL HABITAT MAPS:** An ArcMap GIS data set depicting current habitat cover types along the Wairarapa coast using aerial photographs and ground truthing techniques.
- **VULNERABILITY ASSESSMENTS:** An assessment of the "vulnerability" of the Wairarapa 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..
- **MONITORING RECOMMENDATIONS:** A recommended coastal monitoring programme for management of coastline biological resources in the Wairarapa region.

HABITATS

The mapping and risk assessment study of the Wairarapa coast identified an exposed and rugged coastline backed by erosion-prone, soft rock and primarily grassland catchments except for the southern section where some hard rock catchments appeared and scrub and forest became more dominant. The soft rock catchments and absence of scrub or forest cover cause high sediment runoff to the estuaries and coast (particularly north of Tora and in Palliser Bay). Erosion of cliffs, duneland and grassland was also evident in many sections. The study identified a wide range of coastal shoreline habitats including:

- **Rocky Shores:** Primarily soft sedimentary rock platform reefs and turbid water to the north, and hard boulder and rockfield shores and mainly clear waters to the south. Each rock type is expected to be inhabited by its own diverse assemblage of plant and animal species.
- **Beaches:** Primarily broad, flat, sandy beaches with white sand and wide surf zones to the north (bathed by cloudy waters) which progressively change towards the south to moderately steep beaches, with dark coarser grained sand and ultimately to very steep, gravel beaches (no surf zone) and clear waters. Biodiversity is greatest in the less harsh environment of the dissipative and intermediate type beaches to the north.
- **Dunes:** Present along much of the Wairararpa coast but are very thin or absent in some sections. Most are dominated by the introduced and invasive marram grass and are grazed by stock. Only in the Cape Palliser area were there significant areas of duneland where native duneland species were dominant. Biodiversity is expected to be greatest in the native dominated dunes where a more diverse range of habitats are available.
- **Estuaries:** The Wairarapa coast has a large number of small river mouth lagoon (hapua) type estuaries, one larger tidal river estuary (the Whareama estuary) and one shallow coastal lake estuary (Lake Onoke). Because of the exposure to high seas, the majority of the estuaries block at the mouth regularly (particularly in summer). Because of the uplifted nature of the Wairarapa coastline, the lagoons so created tend to be small with saline water intrusion extending only a few hundred meters upstream or not at all. Tidal flats and salt marsh are generally absent and biodiversity is low. In addition, such estuaries are extremely susceptible to water and sediment quality degradation during periods of mouth closure or restriction. However, during high flows the mouth unblocks and they are often flushed clean again.
- **Hinterland (inland of beaches and dunes):** Inland of the shoreline the land was predominantly grassland used for extensive grazing of sheep and cattle but in some areas exotic forestry or scrub was present. In general the coast is isolated and remote, with limited road access to and within the area. Only one catchment, the large inland Ruamahanga River catchment that drains to Lake Onoke, is farmed intensively and includes dairying.

EXECUTIVE SUMMARY (continued)

ISSUES

The major issues in terms of ecological vulnerability of coastal habitat in the area were identified as:

- **CLIMATE CHANGE:** Loss of habitat and biodiversity through sea level rise and temperature change. Sea level rise is foreseen to lead to removal or inland migration of sea-cliffs, shingle beaches, sandy shores and salt marsh habitats due to enhanced erosion.
- **COASTAL EROSION:** In soft rock areas causing loss of dune, beach and cliff habitat
- **ESTUARY WATER AND SEDIMENT QUALITY:** Threats to water and sediment quality of Wairarapa estuaries from landuse intensification.
- **INVASION OF MARRAM GRASS:** Invasion of introduced marram grass which overstabilises dunes and results in a reduction of sand released to the foreshore during storm erosion.

Despite these issues, the majority of the coastal habitats along the Wairarapa coast rated in the low or low to moderate class for ecological vulnerability.

MONITORING

A long term coastal monitoring programme is recommended to address the major issues and includes:

Monitoring the major stressor leading to degradation of estuaries on Wairarapa coast.
Monitor landuse in all estuary catchments at 5 yearly intervals.

Monitor and manage long term condition of high biodiversity coastal lakes (Lake Onoke) with high susceptibility to ecological change.
Step 1. Undertake synoptic study and risk analysis to identify appropriate monitoring and management options.
Step 2. Long term monitoring. Likely to include:

- Fine scale water quality and sediment quality component targeting nutrient loadings, plant and algal assemblages, and sediment mapping
- Broad scale intertidal and subtidal habitat mapping and risk assessment every 5 yrs.

Monitor long term condition of representative Wairarapa estuaries with highest biodiversity and risk to ecology (e.g. Whareama Estuary).
Broad scale habitat mapping and risk assessment every 5 yrs.
Fine scale monitoring of 1-2 sites in lower estuary.
Establish 3 yr baseline then at 5 yearly intervals.
Monitor catchment landuse every 5 years.

Marram grass invasion of dunes:
Measure presence of aggressive weed species (particularly marram and lupins). Measure as part of broadscale mapping of dunes in box below.

Reduction in dune area through sea level rise, erosion, grazing, property development:
Measure change in area of duneland, beaches and change in position of seaward margin of dune. Repeat broadscale mapping at 5-10 yearly intervals.

Reduction in biodiversity of high biodiversity beaches through climate change
One long term monitoring site on dissipative beach (most species rich), e.g. between Castlepoint and Whakataki River mouth.
Establish 3 yr baseline then at 5 yearly intervals.

Reduction in biodiversity of high biodiversity rocky shores through climate change
Two long term monitoring sites sampled at 5 yearly intervals.
(1) Soft rock substrate (e.g. near Flat Point)
(2) Hard greywacke substrate (e.g. near Cape Palliser).

SECTION 1 INTRODUCTION

SCOPE

Developing an understanding of the distribution and risks to coastal and estuarine habitats is critical to the management of biological resources in the Greater Wellington Region. In 2004 and 2005, coastal habitat mapping and risk assessment studies of the Wellington Harbour and South Coast, and the Kapiti Coast (Stevens and Robertson 2004 and 2006) were undertaken for the Greater Wellington Regional Council (GWRC). In 2006, the GWRC contracted Wriggle Coastal Management to undertake the Wairarapa Coastal Habitat Mapping and Risk Assessment study to produce the following outputs:

- **Coastal Habitat Map**: An ArcMap GIS data set depicting current habitat cover types along the Wairarapa coast using aerial photographs, and ground truthing techniques.
- **Vulnerability Assessments**: An assessment of the "vulnerability" of the Wairarapa 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 2006a, 2006b).
- **Monitoring Priorities:** A recommended coastal monitoring programme for management of coastline biological resources in the Wairarapa region.

The data for the current study was collected during December 2006 when the whole Wairarapa coast was visited over a 2-3 wk period. Habitat cover was recorded onto laminated aerial photographs and subsequently digitised and entered into a GIS framework. Information used for the vulnerability assessments (i.e. uses and values, stressors, existing condition, susceptibility and indicators) was collected and recorded and later used to assign "high", "medium" or "low" ratings into pre-developed vulnerability matrices.

The data sets and vulnerability assessments produced for this project fill a critical information gap by creating a current description of the distribution, condition, and extent of shoreline coastal habitats in the Wairarapa, their vulnerability to stressors and identification of monitoring priorities.

STRUCTURE

Spinifex dominated duneland at Te Humenga (Palliser Bay)

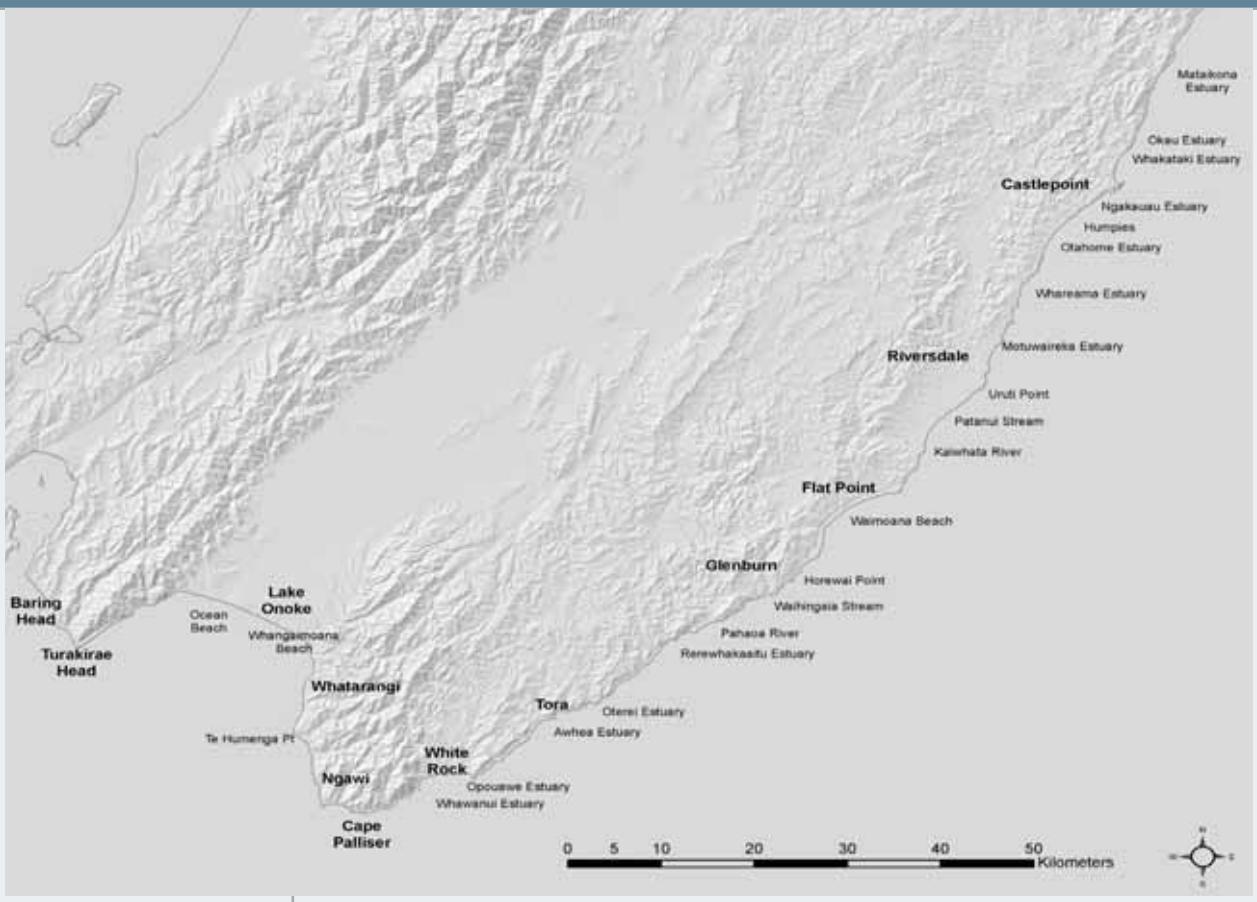
Section 1 provides an introduction to the scope and structure of the study.

Section 2 provides the broad introduction to the Wairarapa coast by identifying the major coastal shoreline habitat types in the Wairarapa region (Omahanga Estuary to Baring Head), and describes their characteristics, issues, values and uses, recommended monitoring, and existing condition and susceptibility ratings.

Sections 3, 4, 5, 6, 7, 8, 9 and 10 provide the summary detail for the coast in a section by section approach, starting just south of the Omahanga estuary mouth and finishing down near Wellington at Baring Head (see page 2 for map of Wairarapa coast). 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 Wairarapa estuaries.
- **Appendix 2:** Vulnerability assessments and methods for Wairarapa coastal habitats.
- **Appendix 3**: Methodology for broad-scale habitat mapping, habitat classification definitions and hard copy summary figures of current coastal habitat type presented in sequential sections along the coast (starting at Baring Head).
- **Appendix 4:** ARC Map GIS layers of habitat type which are presented in the accompanying CDRom ("Wairarapa Coastal Habitats - Mapping, Risk Assessment and Monitoring").

Map of Coastal Wairarapa



Sand tussock

Intermediate type beach near Uruti Point

Steep gravel dissipative beach type near Turakirae Head

SECTION 2 COASTAL HABITAT TYPES

BEACHES

Dissipative-intermediate type beach north of Castlepoint

ECOLOGICAL VULNERABILITY

Sedimentation	Low
Eutrophication	Low
Disease Risk	Low
Contaminants	Low
Habitat Loss	Moderate
Seawalls	Low
Erosion	Moderate
Sea level	Moderate

Beaches are relatively common on the Wairarapa coast and generally fall into the category of "open coast, wave dominated, microtidal beaches" (i.e. medium to coarse sand and gravel, mobile, and exposed to wave attack) and include 3 broad types.

(1) Dissipative to Intermediate Type Beaches (Owahanga Estuary to Castlepoint). Relatively flat, and fronted by a wide surf zone in which waves dissipate much of their energy (some have platform reefs offshore). 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, higher diversity and biomass of macrofauna.
- Exporters of organic matter.
- More highly regulated by biological interactions.

(2) Intermediate Type Beaches (Castlepoint to Pahaoa River Mouth). There are a variety of intermediate state beaches in the Wairarapa which are characterized by plunging & 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.

SUMMARY

Exposed coastline. Broad range of types. Flat sandy beaches and turbid waters to the north and steep gravel beaches with clearer waters to the south.

RECOMMENDED MONITORING

Objective: Monitor influence of sea level and temperature rise on high biodiversity coastal areas.

Design:

One long term monitoring site on dissipative - intermediate beach (most species rich), e.g. between Castlepoint and Whakataki River mouth. Establish 3 yr baseline then at 5 yearly intervals.

(3) Reflective Type Beaches (Pahaoa River Mouth to Baring Head).

Steep, reflective type beaches with sand, gravel and cobble sediments are the main type of beach south of Pahaoa River mouth (i.e. the lower half of the Wairarapa coastline). These beaches tend to be accumulating coarse sediments rather than eroding. They have 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 rely on organic material imported from sea. The type of beach is important in determining beach ecology (Defeo and McLachlan 2005). For example, the number of species decreases as the beach slope and grain size increases. In addition, there is generally a strong natural variation in abundance within a beach, with greatest numbers in the centre and fewer at the boundaries, even though environmental gradients (e.g. wave exposure and salinity) can cause asymmetries. Such zonation is generally highly dynamic and not sharply defined. This is attributed to 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. 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. Intermediate beaches are spatially and temporally the most dynamic (Wright and Short 1984). They can undergo rapid changes as wave height fluctuates, causing reversal in onshore/offshore and alongshore sediment transport.

For the Wairarapa beaches, sea level rise and erosion are the major stressors. Sea level rise is foreseen to lead to removal or inland migration of sandy and gravel beaches due to enhanced erosion or narrowing of beaches through sea-wall developments.

Monitoring recommendations for these issues is summarised in the inset box.

DUNES AND GRAVEL BERMS

Extensive marram dunes at Mataikona

Narrow marram dunes north of Riversdale

ECOLOGICAL VULNERABILITY

Erosion	High
Introduced Weeds	High
Grazing	Moderate
Vehicles	Low
Contaminants	Low
Property development	Moderate
Sea Level Rise	Moderate

Areas of duneland are relatively common above high water along many sections of the Wairarapa coast (??% of the Wairarapa coast is bounded by a generally narrow band of duneland). They occupy 3 situations (Partridge 1992): narrow sheltered bays, thin strips bordering long sections of the coast (often at the base of cliffs), and wider dune systems.

In the northern section of coastal Wairarapa, the broadest and most extensive duneland areas are located at Mataikona, Castlepoint, Riversdale Beach, Uruti Point, Flat Point, Tora and White Rock. In the southern section, the most extensive dune areas are located inland of steep reflective gravel beaches in Palliser Bay and Cape Palliser (e.g. Whatarangi, Te Humenga Point, South of Otakaha Stream, Te Kawakawa, and East of Mangatoetoe Stream). At most sites, the backdunes have been converted to agriculture and are now grazed, and the foredunes are dominated by the introduced sand-binding grass, marram grass (*Ammophila arenaria*). Only two areas on the eastern side of Palliser Bay (e.g. Whatarangi and Te Humenga Pt), were dominated by the native sand-binders spinifex (*Spinifex serceus*) and pingao (*Desmoschoenus spiralis*).
In a 1990 survey (Partridge 1992), one dune system was rated with high botanical value, Te Humenga Point (where marram grass was absent and spinifex and pingao dominated). In 2006, patches of marram grass were present.

From the perspective of coastal management, dunes protect low lying coastal areas from flooding and also 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. Because of these attributes they are important to a wide range of human activities, and their monitoring and management is seen as an important objective in planning and usage of the coastal zone.

SUMMARY
Broad range of types.
Extensively modified.
Major stressors: marram invasion, erosion, climate change, grazing, property development.
Marram dominates.
Native species dominant Cape Palliser and Palliser Bay areas.
Te Humenga Pt high botanical value.
Monitoring recommended.

RECOMMENDED MONITORING

Marram grass invasion of dunes:
Measure presence of aggressive weed species (particularly marram and lupins)

Reduction in dune area through sea level rise, erosion, grazing, property development:
Measure change in area of duneland and change in position of seaward margin. Repeat broadscale mapping of duneland at 5-10 yearly intervals.

In NZ history, early heavy grazing of dunes resulted in the disappearance of native dune cover and subsequent sand movement inland. To stop the sand drift, dune reclamation through marram grass and lupin (to provide nitrogen) plantings were undertaken. Marram was more prolific than the native sand-binders, so tended to outcompete them. Since their introduction, marram grass and lupin have become the major sand binders and dune builders in New Zealand and have been the dominant species used for erosion control and dune stabilisation. Although they have been relatively successful at limiting coastal erosion and stabilising sand drift they do have drawbacks of which the main one is that because marram dunes are generally taller, have a steeper front and occupy more area than either spinifex or pingao, they have tended to result in overstabilisation and a consequent reduced ability of active dunes to release sand to the foreshore during storm erosion. They also tend to contribute to the loss of biodiversity and natural character (Hilton 2006). As a consequence of their invasive nature and threat to active dune function, as well as threats to ecology and biodiversity, there is now a growing move to minimize any further marram grass invasion of active dunes and to replant with native species.
For the Wairarapa, two issues or stressors dominate in terms of the need for management of dunelands:

- Introduced weeds (i.e. marram grass) outcompeting natives.
- Reduction in dune area through sea level rise, erosion, grazing, property development.

Monitoring recommendations for each of these issues are summarised in the inset box.

ROCKY SHORES

Soft rock ecology near Glenburn

Greywacke boulder shore near Turakirae Head

The rocky shores of the Wairarapa coast can be classified as exposed, high-energy shores. They can be divided into two main categories based on rock type and clarity of the surrounding seawater.

(1) **Soft rock types (sandstones, mudstones and fine-grained limestones often as broad intertidal platforms).** These occur to the north in the upper half of the Wairarapa coast (above the Pahaoa River mouth) where the waters are generally turbid. Such soft rock types are less stable, more susceptible to weathering and have a characteristic and diverse ecology. They are easier to bore into by organisms like bivalve molluscs at low tide and amphipod crustaceans at mid tide level.

(2) **Harder greywacke type rocks.** These occur to the south in the lower half of the Wairarapa coast (around Cape Palliser and Baring Head) with strata much tilted or upended. Currents are strong and wave impact can be broken by outer reefs in some areas. Biodiversity is high and the outer rocks are generally covered with bull-kelp (*Durvillea antarctica*) near low water.

In general, the human pressure on shellfish, crayfish and fish through harvesting from inshore rocky areas was high throughout the Wairarapa region. But considering the fact that they are harvested under strict fishery management guidelines, the ecological effect of this harvesting was considered relatively low.

For the Wairarapa, the following issues or stressors dominate in terms of the need for monitoring of rocky shores:

- Change in habitat through predicted sea level and sea temperature increases **with resultant habitat changes and** effects on rocky shore biodiversity.

Monitoring recommendations for these issues are summarised in the inset box.

SUMMARY

Typically rugged, rocky and exposed coastline. Very strong wave energy due to exposure to Southern Ocean swells. Broad range of rocky shore types.
Soft rock platforms and boulders to north and harder greywacke shores to the south.

RECOMMENDED MONITORING

Objective: Monitor influence of sea level and temperature rise on high biodiversity coastal areas.

Design:

Two long term monitoring sites.
5 yearly intervals.
(1) Soft rock substrate (e.g. near Flat Point)
(2) Hard greywacke substrate (e.g. near Cape Palliser).

ECOLOGICAL VULNERABILITY

Temperature	Moderate
Sea level	Moderate
Sedimentation	Low
Eutrophication	Low
Disease Risk	Low
Contaminants	Low
Habitat Loss	Low
Seawalls	Low

RIVER MOUTH LAGOONS (HAPUA)

Rerewhakaaitu Estuary and beach

Okau Stream Estuary and beach

ECOLOGICAL VULNERABILITY

Sedimentation	Moderate
Eutrophication	Moderate
Disease Risk	Moderate
Contaminants (incl oil spills)	Low
Habitat Loss	Low
Introduced species	Low
Sea level rise	Low

A large number of rivers and streams of various sizes enter the ocean along the Wairarapa coast. Almost all approach the ocean as a single channel, but their entry is restricted (or sometimes blocked completely) by a sand or gravel barrier located just short of the ocean. In such "river mouth lagoon" estuaries, a small brackish lagoon may form on the river side of the barrier, 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. Such river mouth lagoons are common on a coast like the Wairarapa which experiences high wave energy and significant longshore drift.

Because of the uplifted nature of the Wairarapa coastline, the majority of the estuaries are short and narrow, with saline water intrusion extending only a few hundred meters upstream or not at all.

The habitats available for aquatic life in such systems are very limited: tidal flats and salt marsh 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 estuarine lagoon experiences symptoms of eutrophication and sedimentation (i.e. muddy, anoxic, black sulphide-rich sediments, algal blooms, low dissolved oxygen and low clarity). When flows are high and the mouth is open, 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, or catchments with high erosion). Because of historical forest clearance in the erosion prone Wairarapa catchments, sediment loadings to the Wairarapa coast north of Pahaoa estuary are generally elevated. Fortunately, nutrient and pathogen loadings are likely to be less elevated because landuse is dominated by extensive sheep and cattle grazing.

The combination of the following characteristics of "river mouth lagoons" trigger the need for a watching brief on the main drivers of water and sediment quality deterioration rather than a comprehensive estuary monitoring programme for river mouth lagoons:

- high susceptibility to regular cycles of water and sediment quality degradation
- the cycles are natural, but exacerbated by intensification of landuse
- low habitat diversity and biodiversity, and
- low intensity catchment landuse

In order to address this need, it is recommended that landuse is monitored in all river mouth lagoon catchments and that a management plan be developed to address areas where landuse intensifies.

SUMMARY

- Wairarapa river mouths dominated by small riverine estuaries with a single narrow channel at the mouth.
- Mouth restricted by gravel or sand barrier.
- Saltmarshes generally absent.
- Tidal flats absent.
- Habitats and biodiversity limited. **Naturally** experience regular cycles of water quality degradation and rejuvenation as mouth opens and closes.
- In summer often experience; **macroalgal** blooms, black-sulphide rich sediments, muddiness, low clarity, low oxygen.

RECOMMENDED MONITORING

Objective: Monitor major stressor leading to eutrophication of river mouth lagoon estuaries on Wairarapa coast.

Design:
Monitor landuse in river mouth lagoon estuary catchments. If landuse intensifies significantly, introduce management actions.
5 yearly intervals.

COASTAL LAKE ESTUARIES

(Intermittently Open/ Closed Coastal Lakes and Lagoons)
Photo

Opening Lake Onoke (Photo GWRC)

One of the Wairarapa estuaries fits into the "coastal lake" category (i.e. Lake Onoke). They have a broad and shallow central basin, but still have a sand or gravel barrier at the mouth that is closed for much of the time. The barrier creates a constricted entrance (which can be periodically closed) that allows the exchange of water between the central basin and the sea. Many lakes (including Lake Onoke) are kept open artificially to improve water quality and mitigate the effects of floods. Intermittently open/closed coastal lakes and lagoons (ICOLLs) are common in New Zealand (e.g. Lake Ellesmere, Waituna Lagoon). They typically possess important ecological values (e.g. salt marsh, birdlife and fishery) and contain a mosaic of different habitats. However, isolation from the sea and their shallow, poorly flushed nature, makes them very susceptible to nutrient and sediment enrichment, leading to their progressing eutrophication. The greatest load of nutrients and sediments is generally brought in with the inflow of river waters (Paturej 2006) as well as with surface run-off from the agricultural catchment area. On the other hand, periodic intrusions of marine waters to coastal lake estuaries inhibit eutrophication. As a consequence of their high ecological value and their sensitivity to nutrients and other contaminants, it is a top priority to understand their ecology, and the effects of human activity.

Other studies in New Zealand have shown that as the nutrient loads increase to a coastal lake, the initial response is the loss of the natural thick bed of rooted aquatic plants and clear water around the margins. These rooted plants are replaced with green slimy nuisance macroalgal blooms and lowered water and sediment quality (e.g. Lake Ellesmere). If the loads increase further, toxic microalgal blooms can result.

Because we know very little about the enrichment or trophic state of Lake Onoke, its water and sediment quality, or its existing ecology, it is recommended that a comprehensive synoptic study and risk analysis be undertaken to identify appropriate monitoring and management options for this ecologically sensitive coastal lake estuary. The likely consequence is a longer term monitoring programme that includes a:

- Fine scale water quality and sediment quality component targeting nutrient loadings, plant and algal assemblages and sediment mapping.
- Broad scale intertidal and subtidal habitat mapping and risk assessment every 5 yrs.

ECOLOGICAL VULNERABILITY

Sedimentation	Moderate
Eutrophication	High
Disease Risk	Moderate
Contaminants (incl oil spills)	Low
Habitat Loss	Moderate
Introduced species	Moderate
Sea level rise	Moderate

SUMMARY

Coastal Lake estuaries with broader central basins not common in Wairarapa (only Lake Onoke).
Mouth opened manually.
High ecological values (saltmarsh, birdlife, fishery).
Generally shallow and poorly flushed.
Easily degraded through oversupply of nutrients, sediment, pathogens etc.

RECOMMENDED MONITORING

Objective: Monitor and manage long term condition of coastal lakes with high susceptibility to ecological change.

Design:

Step 1. Undertake synoptic study and risk analysis to identify appropriate monitoring and management options.

Step 2. Long term monitoring likely to include:

- Fine scale water quality and sediment quality component targeting nutrient loadings, plant and algal assemblages and sediment mapping.
- Broad scale intertidal and subtidal habitat mapping and risk assessment every 5 yrs.

TIDAL RIVER ESTUARIES

One of the Wairarapa estuaries fits into the "tidal river estuary" category (i.e. Whareama Estuary). They are characterised by an elongated shallow basin, with river-dominated (rather than tide-dominated) circulation. Flushing is good because the mouth is always open and river flow relatively large. Tidal flats are present but not broad and expansive. Salinity is generally much less than the sea and waters can be fresh during floods (Kirk and Lauder 2000). Such estuaries can be quite productive and have good fisheries but the absence of large areas of salt marsh limits their ecological value, particularly for birdlife.

The Whareama River is large enough to keep the sand or gravel barrier at the mouth permanently open. In addition, it is a very low slope on the tidal plain which allows for much greater tidal intrusion (tidal waters extend up to 12 km inland in the Whareama Estuary), and larger parts of the lower estuary become tidal mudflats at low water. This estuary, with its more regular patterns of tidal inundation and presence of mudfllats, favours greater biodiversity than riverine lagoon estuaries and is less prone to degradation of water and sediment quality. Sediment in the Whareama ranges from fine to coarse sands/gravels in the barrier and tidal inlet deposits, fine organic muds and sandy muds in the central basin, to coarse, unsorted gravels, sands and muds (mostly of terrigenous origin) in the fluvial bayhead delta.

River flow is typically high, and flooding may expel marine water and flush material from the estuary. Turbidity, in terms of suspended sediment, is naturally elevated given the soft rock type catchment. The central basin is generally an efficient 'trap' for terrigenous sediment and pollutants, except in shallow estuaries.

ECOLOGICAL VULNERABILITY

Sedimentation	Moderate
Eutrophication	High
Disease Risk	Moderate
Contaminants (incl oil spills)	Low
Habitat Loss	Moderate
Sea level rise	Moderate

SUMMARY

Tidal River estuaries with broader central basins not common in Wairarapa.

Those that are tend towards being more riverine than marine.

Saltmarshes present but small in area.

Tidal flats present but limited in area.

Habitats and biodiversity greater than riverine.

Water and sediment quality dependent on river quality and catchment inputs.

RECOMMENDED MONITORING

Objective: Monitor long term condition of representative Wairarapa estuaries with highest biodiversity and risk to ecology (e.g. Whareama Estuary).

Design:

- Broad scale habitat mapping and risk assessment every 5 yrs.
- Fine scale monitoring of 1-2 sites in lower estuary at 5 yearly intervals after baseline established.
- Monitor catchment landuse every 5 years.

SECTION 3 OWAHANGA ESTUARY TO CASTLEPOINT

BEACHES AND ROCKY SHORES

Shoreline south of Owahanga estuary

Soft sandstone rocks

Mataikona baches and rocky shore

OVERALL VULNERABILITY RATING

LOW
MODERATE

This relatively isolated area of the Wairarapa shoreline sits between the Owahanga Estuary to the north and Castlepoint 25kms to the south. Below high water it generally consists of a thin band of firm sand, grading to wide, flat platforms of soft sedimentary rock and boulders exposed at low water. In several areas (e.g. the beach at Castlepoint), the rock platform is absent or only partially present, and the sandy beach is wider. This places the beach in a "dissipative" beach type category (i.e. it is generally flat and fronted by a wide surf zone in which waves dissipate much of their energy). However, it is not a normal dissipative type because the intertidal is often dominated by rock reef platforms. Wave and wind exposure is high, and coastal erosion is strongly evident.

Above high water, the terrestrial margin consists primarily of a narrow band of dune-land dominated by introduced marram grass (*Ammophila arenaria*) and the native knobby club-rush (*Isolepis nodosa*). A larger and steeper section of duneland exists just north of Mataikona. Vegetation immediately inland of the dune area is primarily grassland used for extensive, but low density, sheep and beef grazing. The dune and beach areas are generally not fenced.

The coastal rock types in the area are generally soft sandstones and mudstones which are easily eroded in the high energy wave environment of the Wairarapa coast. As a consequence, some of the land margin is eroding, and the sea discoloured to a light milky brown colour with low clarity. A number of small to moderately sized rivers and streams discharge to this section of the coast. They undergo a natural pattern of mouth opening and closure, and generally experience poor water quality when the mouth is blocked or restricted (i.e. low oxygen, sulphide rich sediments and algal blooms) and good quality when river flows increase. The Owahanga and Mataikona rivers are the largest, and drain erosion-prone catchments. As a consequence, sediment loads are elevated and turbid waters often bathe this section of the coast. Apart from farming, human use is relatively low (walking, quad-biking, surfing, diving, inshore fishing) except during holiday periods when bathing and other activities increase. There is no road access along this shoreline north of Mataikona Estuary.

ISSUES

Shoreline erosion.
Sea discoloured.
High sediment loads in rivers and streams.
Access to rocky shore areas limited.
Introduced marram grass dominant in dunes.
Seawall at Castlepoint.

VALUES

High-moderate use for fishing, swimming, birdlife, diving, scientific, landform appreciation.

RECOMMENDED MONITORING

Objective: Monitor influence of climate change on high biodiversity coastal areas.

Design:

Establish one long term monitoring site on dissipative beach (most species rich) e.g. between Castlepoint and Whakataki River mouth.
Establish 3 yr baseline then at 5 yearly intervals.

OWAHANGA TO CASTLEPOINT	Disease Risk	Algal Blooms	Habitat Loss	Contamination	Clarity Issues	Invaders	Shellfish Issues
Existing Condition Rating	Low	Low	Low	Low	Moderate	Moderate	Low
Susceptibility Rating	Low	Low	Moderate	Low	Moderate	Moderate	Low

BEACHES AND ROCKY SHORES

Castlepoint beach

Castlepoint

Castlepoint beach and holiday huts (Photo; BreakawayNZ)

OVERALL VULNERABILITY RATING

LOW

MODERATE

CASTLEPOINT BEACH

The north beach at Castlepoint is a long, broad and relatively flat (dissipative) sandy beach type, sheltered from the prevailing southerly swells, but exposed to strong winds. Seawalls border the properties and roadside adjacent to the beach in the township of Castlepoint. Above high water, the terrestrial margin consists primarily of baches that are most commmonly occupied only during holiday periods. Vegetation immediately inland of the township is primarily grassland used for extensive sheep and beef grazing.

The beach to the south of the township is a protected sand beach and lagoon enclosed within a limestone reef system. A 6m high dune complex is situated at the base of farmed rolling hills between the Castlepoint island and the mainland. The dune vegetation is dominated by marram grass and lupin but scattered patches of pingao and spinifex are also present.

The reef, lagoon, sand dunes, and Castle Rock are all part of Castlepoint Scenic Reserve. As well as protecting outstanding landforms, the reserve is the only location in the world of the Castlepoint daisy (*Brachyglottis compactus)* which grows on the crumbled limestone of the reef and Castle Rock. Apart from farming and commercial fishing, the area is popular for surfing, recreational fishing and swimming, walking and quad-biking, primarily during holiday periods. Stormwater from the village does cross the beach but is relatively minor. Sewage from the township is reticulated and treated via oxidation ponds and discharged to the Castlepoint Stream and hence to the coast. Monitoring results for enterococci bacteria at Castlepoint Beach near this stream show alert levels are often reached during the summer holiday period.

Human use of the beach and associated rocky areas at Castlepoint Beach is low-moderate in a national context, but is high in a local Wairarapa context. It is used for walking, quad-biking, surfing, diving, scientific interest and inshore fishing. Public access is generally good. Commercial fishing boats are launched off the beach at the south end of the beach (through the Gap).

ISSUES

Shoreline erosion.
Sea discoloured.
Introduced marram grass dominant in dunes.
Seawall at Castlepoint.
Property development in dunes.

VALUES

High-moderate use for fishing, boating, swimming, birdlife, diving, scientific, landform appreciation.

RECOMMENDED MONITORING

Objective: Monitor influence of climate change on high biodiversity coastal areas.

Design:

Establish one long term monitoring site on dissipative beach (most species rich) e.g. between Castlepoint and Whakataki River mouth.

Establish 3 yr baseline then at 5 yearly intervals.

	Disease Risk	Algal Blooms	Habitat Loss	Contamination	Clarity Issues	Invaders	Shellfish Issues
Existing Condition Rating	Moderate	Low	Moderate	Low	Moderate	Moderate	Low
Susceptibility Rating	Moderate	Low	Moderate	Low	Moderate	Moderate	Low

ESTUARIES

Mataikona estuary mouth showing gravel barrier

MATAIKONA ESTUARY

The Mataikona Estuary is a small "river mouth lagoon" that is almost always open to the sea, but regularly experiences constriction (and sometimes closure) as high seas push the gravel bar across the mouth. The estuary is narrow and shallow (mean depth approx 1m) with high banks bordering the southern shoreline. Tidal influence extends approximately 1km inland. Salinities vary depending on the extent of tidal inflow, but generally are more freshwater than saline.

On 6 Dec 2006, the estuary was open but the mouth constricted, with virtually no tidal inflow. Salinity was <5ppt at high water in the lower estuary and <1ppt 500m upstream. The water was relatively turbid, but the bed consisted of clean sand and silts, and there was no evidence of recent nutrient enrichment issues such as macroalgal blooms. Salt marsh vegetation was absent, with the estuary margins being dominated by scrub, willows and grassland.

At times when the estuary is poorly flushed due to mouth restrictions, it is particularly susceptible to water and sediment quality degradation, in particular, enrichment with nutrients, sediment and pathogens. A temporary shift (during summer usually) towards eutrophication (nuisance algal blooms, low dissolved oxygen and smelly black sediments), muddy sediments, low clarity and high disease risk to bathers are the possible consequences. Fortunately, current landuse is not intensive and therefore estimated nitrogen (the major driver of eutrophication) loadings are low. However, sediment inputs are naturally elevated because of the predominantly soft rock, grassland catchment. Given these characteristics, the estuary is categorised as being susceptible to any increase in the intensity of landuse in the catchment. Landuse monitoring is therefore recommended as a means of identifying potential threats to the values of this estuary.

Estuary Type	River Mouth Lagoon
Estuary area (ha)	12.3
Catchment area (km²)	190
Catchment landuse	Sheep and Beef extensive
Area dairying (ha)	None
Nitrogen loading	Low: 4.5 kg/ha/yr Source: NIWA Sparrow Model
Catchment rock type	Soft rock
Saltmarsh area (ha)	0
Mean Salinity (@HW)	<1 ppt - 5 ppt depending on mouth closure
Mean depth (m)	1m at high water (depends on mouth closure)
Tidal flats	None (gravel flats only near mouth)

OVERALL VULNERABILITY RATING

LOW

ISSUES

Mouth silting up. Natural cycle of low to high water quality as degree of mouth restriction varies. High sediment load.

VALUES

Fishing, swimming, bird nesting/feeding.

RECOMMENDED MONITORING

Objective: Monitor major stressor leading to degradation of estuary.

Design: Monitor landuse in rivermouth lagoon estuary catchment. If landuse intensifies significantly introduce management actions.

5 yearly intervals.

MATAIKONA ESTUARY	Sedimentation	Eutrophication	Disease Risk	Contaminants	Habitat Loss	Invaders	Shellfish Issues
Existing Condition Rating	Moderate	Moderate	Moderate	Low	Low	Low	Low
Susceptibility Rating	Moderate	Moderate	Moderate	Low	Low	Low	Low

ESTUARIES

Okau stream mouth showing sand barrier

OKAU ESTUARY

The Okau Stream mouth is a very small "riverine estuary" (area = 0.6 ha) that is periodically closed to the sea. **The estuary is narrow and** shallow, with a thin band of sedges around the margin (primarily three square *Schoenoplectus pungens*). Salinities vary depending on the extent of tidal inflow, but generally are more freshwater than saline. On 6 Dec 2006, the estuary was open but the mouth constricted, with virtually no tidal inflow. Salinity was <1ppt at high water in lower estuary. The water was relatively clear, the bed consisted of clean sand and silts, and there was no evidence of nutrient enrichment issues such as macroalgal blooms. Beyond the thin sedge band the estuary margins were dominated by grassland.

At times when the estuary is poorly flushed due to mouth restrictions, it is particularly susceptible to water and sediment quality degradation, in particular, enrichment with nutrients, sediment and pathogens. A temporary shift (during summer usually) towards eutrophication (nuisance algal blooms, low dissolved oxygen and smelly black sediments), muddy sediments, low clarity and high disease risk to bathers are the possible consequences. Fortunately, current landuse is not intensive and therefore estimated nitrogen (the major driver of eutrophication) loadings are low. However, sediment inputs are naturally elevated because of the predominantly soft rock, grassland catchment. Given these characteristics, the estuary is categorised as being susceptible to any increase in the intensity of landuse in the catchment. Landuse monitoring is therefore recommended as a means of identifying potential threats to the values of this estuary.

ISSUES

Mouth silting up.
Natural cycle of low to high water quality as degree of mouth restriction varies.
High sediment load.

VALUES

Swimming, fishing.

RECOMMENDED MONITORING

Objective: Monitor major stressor leading to degradation of estuary.

Design:
Monitor landuse in rivermouth lagoon estuary catchment.
If landuse intensifies significantly introduce management actions.
5 yearly intervals.

Estuary Type	River Mouth Lagoon
Estuary area (ha)	0.6
Catchment area (km²)	12.6
Catchment landuse	Extensive sheep
Area dairying (ha)	None
Nitrogen loading	Low: 4 kg/ha/yr Source: NIWA Sparrow Model
Catchment rock type	Soft rock
Saltmarsh area (ha)	0.12
Mean Salinity (@HW)	<1 ppt - 10 ppt depending on mouth closure
Mean depth (m)	0.3m at high water (depends on mouth closure)
Tidal flats	None (gravel flats only near mouth)

OVERALL VULNERABILITY RATING

LOW

OKAU ESTUARY	Sedimentation	Eutrophication	Disease Risk	Contaminants	Habitat Loss	Invaders	Shellfish Issues
Existing Condition Rating	Moderate	Moderate	Moderate	Low	Low	Low	Low
Susceptibility Rating	Moderate	Moderate	Moderate	Low	Low	Low	Low

ESTUARIES

Whakataki estuary mouth showing sand barrier

WHAKATAKI ESTUARY

The Whakataki Estuary is a small "river mouth lagoon" type estuary (area = 5ha) that is periodically closed to the sea. The estuary is narrow and shallow (mean depth approx 0.5m) with a thin margin of marram grass and knobby club-rush near the sea and three square and raupo further upstream. Salinities vary depending on the extent of tidal inflow but access to sea water is restricted by the steep gradient between the sea and the estuary. On 6 Dec 2006, the estuary was open and salinity was 15ppt at high water in the lower estuary. The water was turbid, the subtidal bed consisted of anoxic sediments covered by decaying macroalgal blooms (*Enteromorpha* sp). Beyond the thin marginal band of estuarine vegetation the landuse was grassland.

At times when the estuary is poorly flushed due to mouth restrictions, it is particularly susceptible to water and sediment quality degradation, in particular, enrichment with nutrients, sediment and pathogens. A temporary shift (during summer usually) towards eutrophication (nuisance algal blooms, low dissolved oxygen and smelly black sediments), muddy sediments, low clarity and high disease risk to bathers are the possible consequences. Fortunately, current landuse is not intensive and therefore estimated nitrogen (the major driver of eutrophication) loadings are low. However, sediment inputs are naturally elevated because of the predominantly soft rock, grassland catchment. Given these characteristics, the estuary is categorised as being very susceptible to any increase in the intensity of landuse in the catchment. Landuse monitoring is therefore recommended as a means of identifying potential threats to the values of this estuary.

Estuary Type	River Mouth Lagoon
Estuary area (ha)	5
Catchment area (km²)	40.3
Catchment landuse	Extensive sheep and beef
Area dairying (ha)	None
Nitrogen loading	Low: 3.2 kg/ha/yr Source: NIWA Sparrow Model
Catchment rock type	Soft rock
Saltmarsh area (ha)	0.34
Mean Salinity (@HW)	<1 ppt - 10 ppt depending on mouth closure
Mean depth (m)	0.5 m at high water (depends on mouth closure)
Tidal flats	None (lagoon floods sand flats on beach berm)

OVERALL VULNERABILITY RATING

LOW

ISSUES

Mouth silting up.
Natural cycle of low to high water quality as degree of mouth restriction varies.
High sediment load.

VALUES

Fishing, swimming, bird nesting/feeding.

RECOMMENDED MONITORING

Objective: Monitor major stressor leading to degradation of estuary.

Design:
Monitor landuse in rivermouth lagoon estuary catchment.
If landuse intensifies significantly introduce management actions.
5 yearly intervals.

WHAKATAKI ESTUARY	Sedimentation	Eutrophication	Disease Risk	Contaminants	Habitat Loss	Invaders	Shellfish Issues
Existing Condition Rating	Moderate	Moderate	Moderate	Low	Low	Low	Low
Susceptibility Rating	Moderate	Moderate	Moderate	Low	Low	Low	Low

SECTION 4 CASTLEPOINT TO WHAREAMA ESTUARY

BEACHES AND ROCKY SHORES

South of Castlepoint

South of Otahome Stream

This isolated shoreline between Castlepoint to the north and Whareama Estuary 20kms to the south is dominated by eroding cliffs and shallow rock (soft sandstone) platform reefs. Sandy beaches occur in several areas (e.g. where the Otahome and Ngakaukau streams discharge) and in these areas a thin band of duneland is common with the dominant vegetation consisting of introduced marram grass and knobby clubrush. Such duneland is also common around the beaches adjacent to the Whareama Estuary. Vegetation immediately inland of the dune area is primarily grassland used for extensive sheep and beef grazing. The dune and beach areas are generally not fenced.

Apart from farming, human use is low. There is no road access along most of this shoreline.

Only small streams discharge to this section of the coast except for the Whareama River which drains an extensive and very erosion-prone catchment with a high suspended sediment yield. As a consequence, sediment loads are elevated and turbid waters often bathe this section of the coast.

Erosion near Otahome

ISSUES
Shoreline erosion.
Sea discoloured.
High sediment loads in rivers and streams.
Introduced marram grass dominant in dunes.

VALUES
Swimming, fishing, boating.

RECOMMENDED MONITORING

Beaches. None.

Dunes. Measure change in area of duneland and change in position of seaward margin. Repeat broadscale mapping of duneland at 5-10 yearly intervals.

Rocky Shores. None.

OVERALL VULNERABILITY RATING

LOW

CASTLEPOINT TO WHAREAMA	Disease Risk	Algal Blooms	Habitat Loss	Contamination	Clarity Issues	Invaders	Shellfish Issues
Existing Condition Rating	Low	Low	Low	Low	Moderate	Moderate	Low
Susceptibility Rating	Low	Low	Low	Low	Moderate	Moderate	Low

ESTUARIES

Ngakauau Stream lagoon

Humpies Stream lagoon

Otahome Stream lagoon

OVERALL VULNERABILITY RATING

LOW

NGAKAUAU, HUMPIES AND OTAHOME RIVER MOUTH LAGOONS

The Ngakauau, Humpies and Otahome estuaries are very small, narrow "river mouth lagoons" that are often closed to the sea due to their very small flows. They are often poorly flushed and experience water quality issues (e.g. low oxygen levels, anoxic sediments, and blooms of macroalgae and phytoplankton). Although some estuarine vegetation occurs around the margins, it is generally limited to a narrow band of rushes or sedges within paddocks used for cultivation and hay cropping. They have no significant areas of tidal flats. These estuaries are all relatively narrow and shallow (mean depth approx 0.5m). Salinities vary depending on the extent of tidal inflow, but generally are more freshwater than saline. On 7 Dec 2006, the estuaries were all open to the sea but their mouths were constricted. Salinity was 11, <1 and 17 ppt at high water in the lower reaches of each of the Ngakauau, Humpies and Otahome estuaries respectively. The water in each was turbid, had a green discoloration, and had mats of rotting green macroalgae in the water column. In many areas, the bed of the estuaries consisted of anoxic, sulphide rich muds and rotting macroalgae. A large landslide of mud extended from the bordering cliffs into the north end of the Otahome river mouth lagoon. These estuaries are particularly susceptible to water and sediment quality degradation, in particular, enrichment with nutrients, sediment and pathogens. A temporary shift (during summer usually) towards eutrophication, muddy sediments, low clarity and high disease risk to bathers already exists. Current landuse is not intensive and therefore estimated nitrogen (the major driver of eutrophication) loadings are low. However, sediment inputs are naturally elevated because of the predominantly soft rock, grassland catchment. Given these characteristics, the estuary is categorised as being very susceptible to any increase in the intensity of landuse in the catchment. Landuse monitoring is therefore recommended as a means of identifying potential threats to the values of this estuary.

Estuary Type	River Mouth Lagoons
Estuary area (ha)	2.5, 0.3, 1.5 respectively
Catchment area (km²)	15.7, 4.2, 7.3
Catchment landuse (ha)	Sheep:forestry; 6.1:8.8, 2.7:1.4, 1.5:7.3.
Area dairying (ha)	None
Nitrogen loading	Low: 4.4, 5.4, 5.5 kg/ha/yr Source: NIWA Sparrow Model
Catchment rock type	Soft rock
Saltmarsh area (ha)	0.34
Mean Salinity (@HW)	<1 ppt - 10 ppt depending on mouth closure
Mean depth (m)	0.5 m at high water (depends on mouth closure)
Tidal flats	None (lagoon floods sand flats on beach berm)

ISSUES

Mouth silting up. Natural cycle of low to high water quality as degree of mouth restriction varies. Particularly sensitive to nutrient inputs. Cropping around margins.

VALUES

Swimming, fishing (low use due to access limitations).

RECOMMENDED MONITORING

Objective: Monitor major stressor leading to degradation of estuary.

Design:

Monitor landuse in rivermouth lagoon estuary catchment. If landuse intensifies significantly introduce management actions.

5 yearly intervals.

NGAKAUAU, HUMPIES, OTAHOME	Sedimentation	Eutrophication	Disease Risk	Contaminants	Habitat Loss	Invaders	Shellfish Issues
Existing Condition Rating	Moderate	Moderate	Moderate	Low	Low	Low	Low
Susceptibility Rating	Moderate	Moderate	Moderate	Low	Low	Low	Low

ESTUARIES

Lower Whareama Estuary

Soft muds Whareama Estuary

Mid reaches of Whareama Estuary

Upper reaches of Whareama Estuary

OVERALL VULNERABILITY RATING

MODERATE

WHAREAMA ESTUARY

The Whareama Estuary is a long, narrow "tidal river" estuary that is always open to the sea. The estuary is relatively shallow (mean depth approx 2-3m) and enclosed within a steep river valley. The estuary margin is dominated by grassland (used for extensive grazing of sheep and cattle) and is generally devoid of saltmarsh vegetation except for a narrow strip of sea rush (*Juncus kraussi*) in the lower-mid estuary area. The bed of the estuary is dominated by very soft (well oxygenated) muds, except for the very lower reaches where firm sands dominate. At times, saltwater is known to extend up to 17 kms inland. Typical estuarine macroinvertebrates (e.g. mud snails) are present on the tidal flats in the lower estuary. The waters are turbid and there is no sign of any nuisance macroalgal growth. On 8 Dec 2006 (HW), the estuary was open, salinity 30ppt (16˚C) in lower estuary. The water was turbid, discoloured with a greenish tinge, and although there was no evidence of macroalgal blooms, the cobbles at mid-low water level were discoloured by a green microalgal film. At low flows when the estuary is poorly flushed and temperatures are elevated, this estuary is moderately susceptible to water and sediment quality degradation, in particular, enrichment with nutrients, sediment (low clarity) and pathogens. Fortunately, current landuse is not intensive (but is intensifying) and therefore estimated nitrogen (the major driver of eutrophication) is still only at moderate levels. Pathogen levels are also likely to be in the low-moderate range. However, sediment inputs are naturally elevated because of the predominantly soft rock, grassland catchment. Given these characteristics, the estuary is categorised as being susceptible to any increase in the intensity of landuse in the catchment. Combined with the relatively high ecological values of this estuary, it is recommended that the long term condition of the estuary be monitored. Landuse monitoring is also recommended as a means of identifying potential threats to the values of this estuary.

Estuary Type	Tidal river
Estuary area (ha)	113
Catchment area (km²)	251
Catchment landuse	50% sheep, 15% beef, 25% native forest/scrub, 10% exotic forest.
Area dairying (ha)	None
Nitrogen loading	Moderate; 9.6 kg/ha/yr Source: NIWA Sparrow Model
Catchment rock type	Soft rock
Saltmarsh area (ha)	5.5
Mean Salinity (@HW)	5-15 ppt depending on river flow
Mean depth (m)	2-3 m at high water
Tidal flats	Moderate in lower estuary

ISSUES

Sedimentation and low turbidity naturally.
Elevated phytoplankton growth in summer - possible blooms.
More riverine than marine.
Saltmarshes present but small in area.
Tidal flats present but limited in area.
Habitats and biodiversity moderate.
Water and sediment quality dependent on river quality and catchment inputs.

VALUES

Swimming, fishing, boating, aquatic ecology.

RECOMMENDED MONITORING

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

- Broad scale habitat mapping and risk assessment every 5 yrs.
- Fine scale monitoring of 1-2 sites in lower estuary at 5 yearly intervals after baseline established.
- Monitor catchment landuse every 5 years.

WHAREAMA ESTUARY	Sedimentation	Eutrophication	Disease Risk	Contaminants	Habitat Loss	Invaders	Shellfish Issues
Existing Condition Rating	Moderate	Moderate	Moderate	Low	Low	Low	Low
Susceptibility Rating	Moderate	Moderate	Moderate	Low	Low	Low	Low

SECTION 5 WHAREAMA ESTUARY TO FLAT POINT

BEACHES AND ROCKY SHORES

Rock platform and beach between Whareama and Riversdale

Dunes in front of Riversdale homes

Beach between Riversdale and Uruti Pt

North of Patanui Stream

OVERALL VULNERABILITY RATING

LOW
MODERATE

This isolated shoreline between Whareama Estuary to the north and Flat Point 31kms to the south includes the holiday town of Riversdale and is dominated by narrow, steepening sand or cobble beaches and shallow rock platform reefs exposed at low water. The rocks along the coast from Flat Point to the Whareama River are, almost without exception, soft (easily eroded) sandstones and mudstones, usually in alternating bands about 15 cm thick.

From Whareama to Uruti Point, a well-developed sandy beach is in evidence, at the south end it is fine and hard, at the north coarse and very soft. Above high water, there are extensive areas of duneland whose vegetation is dominated by introduced marram grass (*Ammophila arenaria)* near the beach, and knobby clubrush (*Isolepis nodosa*) and harestail (*Lagurus ovata)* further inland. Freshwater seeps are common, and in these areas raupo (*Typha orientalis*), flax (*Phormium tenax*), and giant umbrella sedge (*Cyperus ustulatus*) and various rushes dominate the vegetation. Vegetation immediately inland of the dune area is primarily grassland used for extensive sheep and beef grazing. The dune and beach areas are generally not fenced.

The dune complex (which includes ridges and sand plains) at Uruti Point is the largest such system in the eastern Wairarapa, extending up to 300m inland. Vegetation is dominated by marram grass and knobby clubrush. Uruti Point is also well-known for its extensive areas of broad terraces extending inland from the Point and its exposed sandstone and mudstone beds on the beach. The township of Riversdale is spread out along a section of sandy beach at the northern end of this section. A narrow band of duneland dominated by marram grass and spinifex (*Spinifex sericeus*) runs between the beach and the residential properties and is currently cared for by a community-based dune management group.

Between Uruti Point and the Kaiwhata River mouth the shoreline is dominated by eroding cliffs, long expanses of steepening sandy beaches and rocky areas, which border onto extensive dune areas. Between Kaiwhata River mouth and Flat Point (approximately 5kms), the coastline is mainly a steep beach of boulders with the base of the hills extending to the edge of the beach. Dune features are absent and hills are primarily grassed and used for extensive sheep and cattle grazing.

Human use of the beach and associated rock platforms at Riversdale is low-moderate in a national context, but is high in a local Wairarapa context. It is used for walking, quad-biking, surfing, diving, scientific interest and inshore fishing. Public access is generally good, particularly at the Riversdale end. Commercial fishing boats are launched off the beach at Uruti Point.

A number of small streams and rivers discharge to this section of the coast. They generally fall into the same small "river mouth lagoon" category with characteristics as discussed previously.

ISSUES

Shoreline erosion.
High sediment loads in rivers and streams.
Natural cycle of low to high water quality in estuaries/river mouths as degree of mouth restriction varies.
Introduced marram grass dominant in dunes.

VALUES

Fishing, swimming, surfing, birdlife, diving, scientific/geology, landform appreciation, walking.

RECOMMENDED MONITORING

Beaches. None.

Dunes. Measure change in area of duneland and change in position of seaward margin. Repeat broadscale mapping of duneland at 5-10 yearly intervals.

Rocky Shores. None.

WHAREAMA TO FLAT POINT Beaches	Disease Risk	Algal Blooms	Habitat Loss	Contamination	Clarity Issues	Invaders	Shellfish Issues
Existing Condition Rating	Low	Low	Low	Low	Moderate	Moderate	Low
Susceptibility Rating	Low	Low	Low	Low	Moderate	Moderate	Low

ESTUARIES

Upper Motuwaireka Estuary

Motuwaireka Estuary

MOTUWAIREKA ESTUARY

The Motuwaireka Estuary is situated beside the primarily holiday township of Riversdale. It is a very small, narrow "river mouth lagoon" estuary that is often closed to the sea (particularly during summer) due to its very small flows and catchment areas. As a consequence, during such times it is poorly flushed and experiences nutrient enrichment issues (low oxygen levels, anoxic sediments, and blooms of macroalgae and phytoplankton), **muddy sediments, low** clarity and disease risk to bathers. **In order to improve water quality,** the mouth of the estuary is at times manually opened. Although some estuarine vegetation occurs around the margins, it is generally limited to a narrow band.

Studies have been carried out on the water quality of the Motuwaireka Stream and its estuary/lagoon, and there is concern at the deteriorating quality of the lagoonal reach. These studies show both salinity and bacteriological counts rising over summer and autumn, due to a relative and progressive lack of flushing. A number of measures have been proposed to improve water quality (Williams 2001) including deepening of the lagoon, and various engineered mouth options.

Although landuse in the catchment is intensifying, current landuse is not intensive and therefore estimated nitrogen (the major driver of eutrophication) loadings are low to moderate. However, sediment inputs are naturally elevated because of the predominantly soft rock, grassland catchment. Given these characteristics, the estuary is categorised as being susceptible to any increase in the intensity of landuse in the catchment. Landuse monitoring is therefore recommended as a means of identifying potential threats to the values of this estuary. Because the estuary is popular for bathing in the summer period, it is recommended that the current bacteriological monitoring of water quality continue.

ISSUES
Mouth restrictions. Natural cycle of low to high water quality as degree of mouth restriction varies. Particularly sensitive to nutrient and pathogen inputs.

VALUES
Fishing, swimming, birdlife, scientific, walking.

RECOMMENDED MONITORING
Objective: Monitor major stressor leading to degradation of estuary. Monitor disease risk.
Design:
(i) Monitor landuse in rivermouth lagoon estuary catchment. If landuse intensifies significantly introduce management actions at 5 yearly intervals.
(ii) Monitor bacteriological quality.

OVERALL VULNERABILITY RATING

LOW
MODERATE

Estuary Type	River mouth lagoon
Estuary area (ha)	6
Catchment area (km²)	33.2
Catchment landuse	74% sheep, 7% beef, 7% native forest/scrub, 12% exotic forest.
Area dairying (ha)	None
Nitrogen loading	Low: 6 kg/ha/yr Source: NIWA Sparrow Model
Catchment rock type	Soft rock
Saltmarsh area (ha)	1.1
Mean Salinity (@HW)	1-15 ppt depending on mouth closure
Mean depth (m)	0.5-1 m at high water
Tidal flats	None - lagoon floods beach berm

	Sedimentation	Eutrophication	Disease Risk	Contaminants	Habitat Loss	Invaders	Shellfish Issues
Existing Condition Rating	Moderate	Moderate	Moderate	Low	Low	Low	Low
Susceptibility Rating	Moderate	Moderate	Moderate	Low	Low	Low	Low

ESTUARIES

Patanui Estuary (photo Google Earth)

PATANUI ESTUARY (NOT VISITED)

The Patanui estuary is situated just south of Uruti Point. It is a small, narrow "river mouth lagoon" estuary whose mouth closes, particularly during summer. As a consequence, it is at times poorly flushed and may experience nutrient enrichment issues (low oxygen levels, anoxic sediments, and blooms of macroalgae and phytoplankton). Salt marsh vegetation occurs around the margins, but is primarily limited to moderate sized areas near the beach.

At times when the estuary is poorly flushed due to mouth restrictions, it is particularly susceptible to water and sediment quality degradation, in particular, enrichment with nutrients, sediment and pathogens. A temporary shift (during summer usually) towards eutrophication (nuisance algal blooms, low dissolved oxygen and sulphide-rich, black sediments), muddy sediments, low clarity and high disease risk to bathers are the possible consequences.

Current landuse is not intensive and therefore estimated nitrogen (the major driver of eutrophication) loadings are low. However, sediment inputs are naturally elevated because of the predominantly soft rock, grassland catchment. Given these characteristics, the estuary is categorised as being very susceptible to any increase in the intensity of landuse in the catchment. Landuse monitoring is therefore recommended as a means of identifying potential threats to the values of this estuary.

ISSUES
Mouth restrictions. Natural cycle of low to high water quality as degree of mouth restriction varies. Particularly sensitive to nutrient inputs.

VALUES
Minor fishing, swimming, and birdlife values, walking. Saltmarsh ecology low-moderate.

RECOMMENDED MONITORING
Objective: Monitor major stressor leading to degradation of estuary.
Design:
Monitor landuse in river mouth lagoon estuary catchment. If landuse intensifies significantly introduce management actions.
5 yearly intervals.

OVERALL VULNERABILITY RATING

LOW

Estuary Type	River mouth lagoon
Estuary area (ha)	5.4
Catchment area (km²)	35.7
Catchment landuse	80% sheep and beef, 20% exotic forest
Area dairying (ha)	None
Nitrogen loading	5.3 kg/ha/yr Source: NIWA Sparrow Model
Catchment rock type	Soft rock
Saltmarsh area (ha)	4
Mean Salinity (@HW)	<1-10 ppt depending on mouth closure
Mean depth (m)	0.5-1m estimated at high water
Tidal flats	Not present

	Sedimentation	Eutrophication	Disease Risk	Contaminants	Habitat Loss	Invaders	Shellfish Issues
Existing Condition Rating	Moderate	Moderate	Low	Low	Low	Low	Low
Susceptibility Rating	Moderate	Moderate	Low	Low	Low	Low	Low

ESTUARIES

Kaiwhata Estuary (photo GWRC)

OVERALL VULNERABILITY RATING

LOW

KAIWHATA ESTUARY (NOT VISITED)

The Kaiwhata estuary is situated 15km south of Riversdale. It is a small, narrow "river mouth lagoon" estuary whose mouth may be restricted or closed at times (yet to be confirmed). As a consequence, it is at times poorly flushed and may experience nutrient enrichment issues (low oxygen levels, anoxic sediments, and blooms of macroalgae and phytoplankton). Although some estuarine vegetation occurs around the margins, it is generally limited to a narrow band. A fossilized forest (8000 years old) exists 40 metres offshore of the Kaiwhata River mouth in which more than 20 tree stumps are exposed at low water. Access to the river mouth and fossil forest is via a 45 minute walk. The Kaiwhata River has been chosen as part of the "*Streams Alive*" programme which is designed to improve the health and attractiveness of selected streams. The Kaiwhata River was selected because: 59% of its 10,100 ha catchment is in native bush or exotic forest, around 11% of the catchment is protected by covenants and the variety of habitats in the catchment provide home for a wide variety of native fish.

At times when the estuary is poorly flushed due to mouth restrictions, it is likely to be susceptible to water and sediment quality degradation, in particular, enrichment with nutrients, sediment and pathogens. A temporary shift (during summer usually) towards eutrophic conditions, muddy sediments, low clarity and disease risk to bathers are the possible consequences. Fortunately, current landuse is not intensive and therefore estimated nitrogen (the major driver of eutrophication) loadings are low. However, sediment inputs are naturally elevated because of the predominantly soft rock, grassland catchment. Given these characteristics, the estuary is categorised as being very susceptible to any increase in the intensity of landuse in the catchment. Landuse monitoring is therefore recommended as a means of identifying potential threats to the values of this estuary.

Estuary Type	River mouth lagoon
Estuary area (ha)	5
Catchment area (km²)	101
Catchment landuse	Bush dominant 7000ha, Sheep 1500ha, Beef 500ha.
Area dairying (ha)	None
Nitrogen loading	Low: 3.8 kg/ha/yr Source: NIWA Sparrow Model
Catchment rock type	Soft Rock
Saltmarsh area (ha)	Very little
Mean Salinity (@HW)	Estimate 1-10 ppt depending on mouth closure
Mean depth (m)	Estimate <1m
Tidal flats	Likely none

ISSUES

Mouth restrictions. Natural cycle of low to high water quality as degree of mouth restriction varies. Particularly sensitive to nutrient inputs.

VALUES

Fishing, swimming, birdlife, scientific/geology, landform appreciation, walking.

RECOMMENDED MONITORING

Objective: Monitor major stressor leading to degradation of estuary.

Design:

Monitor landuse in rivermouth lagoon estuary catchment. If landuse intensifies significantly introduce management actions.

5 yearly intervals.

	Sedimentation	Eutrophication	Disease Risk	Contaminants	Habitat Loss	Invaders	Shellfish Issues
Existing Condition Rating	Moderate	Moderate	Low	Low	Low	Low	Low
Susceptibility Rating	Moderate	Moderate	Low	Low	Low	Low	Low

SECTION 6 FLAT POINT TO PAHAOA

BEACHES AND ROCKY SHORES

Beach shoreline towards Flat Point

Beach shoreline towards Waikekino Stream

Rocky shoreline south of Waihingaia Stream

OVERALL VULNERABILITY RATING

LOW

The shoreline between Flat Point and the Pahaoa River (26 km to the south) is more varied than that farther south. The first section, between Flat Point and the Waikekino Stream consists of a relatively wide coastal plain or terrace separated from the sea by an extensive intermediate type, sandy and at times smooth pebble beach for about 11 kms. The beach is backed by duneland, the vegetation of which is dominated by marram grass (*Ammophila arenaria).*

South of Waikekino Stream the coastal plain becomes gradually narrower, and the shoreline much rockier (boulders, cobbles and rock features) and this extends all the way to the Pahaoa River Mouth. Although there are some sandy beach areas within this latter stretch of coast, they are all small and restricted to small embayments. Duneland is generally absent from this section, except at Flat Point, and near Arawhata, Waihingaia and Pahaoa River mouths. Instead, the landward margin of the shore is predominantly grassland used for extensive sheep and cattle grazing, except for a small area of native bush a few kms north of the Pahaoa River mouth.

The coastal rock types in the area are generally soft sandstones and mudstones which are easily eroded in the high energy wave environment of the Wairarapa coast. As a consequence, much of the land margin is eroding and the sea discoloured to a light milky brown colour with low clarity. At the mouth of the Pahaoa (north bank), there is a ridge of limestone and between Pahaoa and Flat Point, outcrops of this and a similar limestone are not infrequent.

A number of small streams and rivers discharge to this section of the coast. They generally fall into the same small "river mouth lagoon" category with characteristics as discussed previously.

Human use of the beach, dunes and rocky shores in this section of the coast is low. However, landscape appreciation and scientific interest in the geology of the area, particulary Honeycomb Rock, is high. Apart from these uses, the coastline area is valued for walking, quad-biking, surfing, diving, and inshore fishing. The duneland and beach margin areas are generally unfenced and grazed by sheep and cattle. Public access is generally good in the beach section but more restricted in the rocky section. There is no public road access along the shoreline past Glenburn Station (just south of the Waikekino River mouth). Holiday housing is sparse with some more recent developments at Flat Point.

ISSUES

Shoreline erosion.
Sea discoloured.
High sediment loads in rivers and streams.
Natural cycle of low to high water quality in estuaries/river mouths as degree of mouth restriction varies.
Overfishing (paua and crayfish).
Access to rocky shore areas limited.

VALUES

Low use for fishing, swimming, surfing, birdlife, diving, scientific/geology, landform appreciation, walking.

RECOMMENDED MONITORING

Beaches. None.

Dunes. Measure change in area of duneland and change in position of seaward margin. Repeat broadscale mapping of duneland at 5-10 yearly intervals.

Rocky Shores. None.

FLAT POINT TO PAHAOA ESTUARY	Disease Risk	Algal Blooms	Habitat Loss	Contamination	Clarity Issues	Invaders	Shellfish Issues
Existing Condition Rating	Low	Low	Low	Low	Moderate	Moderate	Low
Susceptibility Rating	Low	Low	Low	Low	Moderate	Moderate	Low

ESTUARIES

Pahaoa Estuary

Upper Pahaoa Estuary

PAHAOA ESTUARY

The Pahaoa Estuary is situated 45km south of Riversdale. It is a relatively large "river mouth lagoon" estuary (area =35.7ha) whose mouth is restricted to the sea due to its low flows and the presence of a gravel bar at its mouth. Like the estuaries further north, the estuary bed is dominated by silt in the main basin and sands and gravel around the margins. The tidal influence extends approximately 1.5 km upstream and its average depth is between 0.5-1.5m. Most summers the lagoon entrance blocks up, the bed gets siltier and in places turns anoxic with black sediments and green algal growths appearing near the margins. Further upstream, green algal slime growths are visible on the river margins. Local residents report such visible signs of eutrophication only began to appear after fertiliser first started to be used in the catchment. During high flows the bed is flushed of accumulated silts and any algal growths. Although some estuarine vegetation occurs around the margins, it is generally limited to a narrow band near the sea. Catchment landcover is predominantly scrubland and grassland which is used for extensive grazing of sheep and cattle. Catchment rock type is a mix of soft and hard sedimentary rock and overall the catchment has a moderate to severe susceptibility to erosion.

Fortunately, current landuse is not intensive and therefore estimated nitrogen (the major driver of eutrophication), and pathogen loadings are low. However, sediment inputs are naturally elevated because of significant areas of soft rock, grassland catchment. Given these characteristics, the estuary is categorised as being susceptible to any increase in the intensity of landuse in the catchment. Landuse monitoring is therefore recommended as a means of identifying potential threats to the values of this estuary.

Estuary Type	River mouth lagoon
Estuary area (ha)	35.7
Catchment area (km²)	272
Catchment landuse	65 % Sheep and beef ; 35 % scrub/forest
Area dairying (ha)	Zero or low
Nitrogen loading	Moderate; 9.7 kg/ha/yr Source: NIWA Sparrow Model
Catchment rock type	Mix soft and hard rock
Saltmarsh area (ha)	4
Mean Salinity (@HW)	1-10 ppt depending on mouth closure
Mean depth (m)	<1 m at high water
Tidal flats	Some gravel sand flats

OVERALL VULNERABILITY RATING

LOW

ISSUES

Mouth closed in summer.
Natural cycle of low to high water quality.
Threat of algal blooms each summer if nutrient load increases.
Disease risk to bathers if catchment pathogen load increases.

VALUES

Low -moderate fishing, swimming, birdlife, walking.

RECOMMENDED MONITORING

Objective: Monitor major stressor leading to degradation of estuary.
Design:
Monitor landuse in river mouth lagoon estuary catchment.
If landuse intensifies significantly introduce management actions.
5 yearly intervals.

	Sedimentation	Eutrophication	Disease Risk	Contaminants	Habitat Loss	Invaders	Shellfish Issues
Existing Condition Rating	Moderate	Moderate	Low	Low	Low	Low	Low
Susceptibility Rating	Moderate	Moderate	Low	Low	Low	Low	Low

SECTION 7 PAHAOA RIVER MOUTH TO CAPE PALLISER

BEACHES AND ROCKY SHORES

Grassland platform and beach at Tora

Beach at White Rock

White Rock towards Cape Palliser

Shoreline east of Cape Palliser

OVERALL VULNERABILITY RATING

LOW

The shoreline inland of high water between Pahaoa River mouth to the north and Cape Palliser, 55km to the south, is very remote and exposed. It is dominated by towering greywacke cliffs fringed by a narrow strip of uplifted rock-and-gravel platform. The platform is primarily grassland with various scrub species, particularly tauhinu, gorse and kanuka. Below high water, the shores are exposed gravel, cobble, boulder and rock fields with the occasional shingle fan and longer stretches of steep cliffs. At only a few localities are the younger and softer Tertiary rocks present, mainly limestones (e.g. opposite White Rock Station, at the mouth of the Opouawe River, at the mouth of the Awhea River, and at the mouth of the Hangaroa River).

Steep to intermediate gravel/sand beaches are present in several areas with the most extensive occurring at White Rock. Dunelands tend to be absent except for a short and relatively narrow strip of marram grass dominated dunes at Tora and a much longer (5km) and wider (up to 1km) area at White Rock. Several patches of lowland swamp were also present on the grassland above the beach at Tora. In these areas raupo (*Typha orientalis*), flax (*Phormium tenax*), and giant umbrella sedge (*Cyperus ustulatus*) and various rushes (*Juncus sarophorus, Juncus gregiflorus*) dominate the vegetation.

Human use of the area is low and restricted to farming, walking, quad-biking, surfing, diving, scientific interest and inshore fishing. Public access is limited, particularly between White Rock and Cape Palliser.

A number of streams and rivers discharge to this section of the coast. All drain predominantly hard rock catchments and consequently they tend to have low sediment loadings. All are river mouth lagoon type estuaries and experience various levels of mouth constriction depending on swell size, direction and river flows. Given that the catchments are generally bush-clad or extensively grazed grassland, nutrient and pathogen loadings are expected to be low. Consequently, although the estuaries may block at times, their water quality is not expected to degrade to low levels.

SUMMARY/ISSUES

Clear inshore waters.
Hard rock and gravel shores and reefs.
Steep beaches.
Dunes absent.
Towering greywacke cliffs fringed by uplifted platform used for grazing stock.
Very narrow surf zone.
Hard rock catchments.
Very exposed.

VALUES

Fishing, swimming, surfing, birdlife, diving, scientific/geology, landform appreciation, walking, camping.

RECOMMENDED MONITORING

Beaches. None.

Dunes. Measure change in area of duneland and change in position of seaward margin. Repeat broadscale mapping of duneland at 5-10 yearly intervals.

Rocky Shores. Monitor high biodiversity rocky shore and reef areas
e.g. Hard greywacke substrate near Cape Palliser.

PAHAOA TO CAPE PALLISER	Disease Risk	Algal Blooms	Habitat Loss	Contamination	Clarity Issues	Invaders	Shellfish Issues
Existing Condition Rating	Low	Low	Low	Low	Low	Moderate	Low
Susceptibility Rating	Low	Low	Low	Low	Low	Moderate	Low

ESTUARIES

Rerewhakaaitu Estuary with mouth closed

Upper reaches of Rerewhakaaitu Estuary

OVERALL VULNERABILITY RATING

LOW

REREWHAKAAITU ESTUARY

(4km south of Pahaoa Estuary)

The Rerewhakaaitu estuary is a small "river mouth lagoon " estuary, set in a deep and relatively remote valley, whose mouth blocks or becomes restricted most summers. As a consequence, it is poorly flushed at times and can be expected to experience nutrient enrichment issues (low oxygen levels, anoxic sediments, and blooms of macroalgae and phytoplankton) depending on the length of time that the mouth is restricted. The estuary is narrow and shallow and has no saltmarsh habitat. Beyond the estuary margins the land was dominated by grazed pasture and scrub. Because access to the estuary itself was difficult, no salinity or depth measurements were taken. Instead, the estuary was viewed through binoculars from a track high up on the steep hills bordering the estuary. Based on what occurs in similar river mouth lagoon estuaries in the area, it is expected that saline intrusion would not extend more than a few hundred meters inland, and that the mean depth would be around 1m and salinities would vary depending on the extent of tidal inflow, but generally would be more freshwater than saline. On 13 Dec 2006, the estuary was closed and the mouth constricted by a sand/gravel bar. The water was relatively turbid and had a greenish tinge.

Current landuse is not intensive and therefore estimated nitrogen (the major driver of eutrophication) loadings are low. However, sediment inputs are naturally elevated because of the predominantly soft rock, grassland catchment. Given these characteristics, the estuary is categorised as being susceptible to any increase in the intensity of landuse in the catchment. Landuse monitoring is therefore recommended as a means of identifying potential threats to the values of this estuary.

Estuary Type	River mouth lagoon
Estuary area (ha)	1.7
Catchment area (km²)	46.6
Catchment landuse	50% sheep and beef (reverting to bush), 50% forest/scrub
Area dairying (ha)	None
Nitrogen loading	3.6 kg/ha/yr Source: NIWA Sparrow Model
Catchment rock type	50% hard rock, 50% soft rock
Saltmarsh area (ha)	0
Mean Salinity (@HW)	Estimate <1ppt - 10 ppt depending on mouth closure
Mean depth (m)	Estimate 1m at high water
Tidal flats	None

ISSUES

Very remote.
Mouth closed in summer.
Natural cycle of low to high water quality.
Threat of algal blooms each summer if nutrient load increases.

VALUES

Human use very low due to remoteness.
Habitat values low, but biodiversity may be high due to remoteness.

RECOMMENDED MONITORING

Objective: Monitor major stressor leading to degradation of estuary.

Design:

Monitor landuse in rivermouth lagoon estuary catchment.
If landuse intensifies significantly introduce management actions.
5 yearly intervals.

	Sedimentation	Eutrophication	Disease Risk	Contaminants	Habitat Loss	Invaders	Shellfish Issues
Existing Condition Rating	Moderate	Moderate	Low	Low	Low	Low	Low
Susceptibility Rating	Moderate	Moderate	Low	Low	Low	Low	Low

ESTUARIES

Oterei Estuary

Oterei River just upstream of estuary

Sampling at Oterei Estuary Mouth

Beach to north of Oterei Estuary Mouth

OVERALL VULNERABILITY RATING

LOW

OTEREI ESTUARY

(5km north of Awhea)

The Oterei estuary is a small "river mouth lagoon " estuary whose mouth blocks or becomes restricted most summers. As a consequence, it is poorly flushed at times and can be expected to experience nutrient enrichment issues (low oxygen levels, anoxic sediments, and blooms of macroalgae and phytoplankton) depending on the length of time that the mouth is restricted. The estuary is narrow and shallow (mean depth <1m) with a thin band of sedge (three square, *Schoenoplectus pungens*) and rushes (*Juncus kraussi*). Salinities vary depending on the extent of tidal inflow, but generally are more freshwater than saline. Saline intrusion is expected to extend between 200m and 500m upstream. On 13 Dec 2006, the estuary was open but the mouth constricted by a sand/gravel bar. Salinity was <1ppt at high water 300m upstream of the mouth and 26 ppt near the mouth. The water was relatively clear, the bed consisted of clean sand and silts, and there was no evidence of nutrient enrichment issues such as macroalgal blooms or anoxic sediments. Beyond the thin sedge band the estuary margins were dominated by grazed pasture.

Current landuse is not intensive and therefore estimated nitrogen (the major driver of eutrophication) loadings are low. However, sediment inputs are naturally elevated because of the predominantly soft rock, grassland catchment. Given these characteristics, the estuary is categorised as being susceptible to any increase in the intensity of landuse in the catchment. Landuse monitoring is therefore recommended as a means of identifying potential threats to the values of this estuary.

Estuary Type	River mouth lagoon
Estuary area (ha)	3.7
Catchment area (km²)	65
Catchment landuse	80 % Sheep and beef ; 20% scrub/forest
Area dairying (ha)	Zero
Nitrogen loading	Moderate; 3.5 kg/ha/yr Source: NIWA Sparrow Model
Catchment rock type	Mix soft and hard rock (predominantly hard)
Saltmarsh area (ha)	0.5
Mean Salinity (@HW)	Estimate <1-10 ppt depending on mouth closure
Mean depth (m)	<1 m at high water
Tidal flats	Some gravel sand flats

ISSUES

Mouth closed in summer.
Natural cycle of low to high water quality.
Threat of algal blooms each summer if nutrient load increases.
Disease risk to bathers if catchment pathogen load increases.

VALUES

Low -moderate fishing, swimming, birdlife, walking.

RECOMMENDED MONITORING

Objective: Monitor major stressor leading to degradation of estuary.
Design:
Monitor landuse in river mouth lagoon estuary catchment.
If landuse intensifies significantly introduce management actions.
5 yearly intervals.

OTEREI ESTUARY	Sedimentation	Eutrophication	Disease Risk	Contaminants	Habitat Loss	Invaders	Shellfish Issues
Existing Condition Rating	Moderate	Moderate	Low	Low	Low	Low	Low
Susceptibility Rating	Moderate	Moderate	Low	Low	Low	Low	Low

ESTUARIES

Awhea Estuary at Tora

Awhea Estuary looking upstream

Lower Awhea Estuary

Awhea Estuary narrow margin of salt marsh

OVERALL VULNERABILITY RATING

LOW

AWHEA ESTUARY (TORA)

The Awhea estuary is a small and very river dominated "river mouth lagoon " estuary whose mouth blocks or becomes restricted most summers. As a consequence, it is poorly flushed at times and may experience nutrient enrichment issues (low oxygen levels, anoxic sediments, and blooms of macroalgae and phytoplankton) some summers. The estuary is narrow and shallow (mean depth <1m) with a thin band of marsh clubrush (*Bolboschoenus fluviatilis*) around the margins. Salinities vary depending on the extent of tidal inflow, but generally are more freshwater than saline.

On 13 Dec 2006, the estuary was open but the mouth constricted by a sand/gravel bar. Salinity was <1ppt at high water 300m upstream of the mouth and 1.1 ppt near the mouth. The water was turbid, the bed consisted of clean sand and silts, and there was no evidence of nutrient enrichment issues such as macroalgal blooms or anoxic sediments. Beyond the thin sedge band the estuary margins were dominated by grazed pasture. Catchment landcover is predominantly scrubland and grassland which is used for extensive grazing of sheep and cattle. Catchment rock type is predominantly soft sedimentary rock and overall the catchment has a moderate to severe susceptibility to erosion.

Current landuse is not intensive and therefore estimated nitrogen (the major driver of eutrophication) loadings are low. However, sediment inputs are naturally elevated because of the predominantly soft rock, grassland catchment. Given these characteristics, the estuary is categorised as being susceptible to any increase in the intensity of landuse in the catchment. Landuse monitoring is therefore recommended as a means of identifying potential threats to the values of this estuary.

Estuary Type	River mouth lagoon
Estuary area (ha)	2.7
Catchment area (km²)	152
Catchment landuse	90 % Sheep and beef; 10% scrub/forest
Area dairying (ha)	1800
Nitrogen loading	Moderate; 4.5 kg/ha/yr Source: NIWA Sparrow Model
Catchment rock type	Soft rock mainly
Saltmarsh area (ha)	0.7
Mean Salinity (@HW)	1-10 ppt depending on mouth closure
Mean depth (m)	<1 m at high water
Tidal flats	Some gravel sand flats

ISSUES

Mouth closed in summer.
Natural cycle of low to high water quality.
Threat of algal blooms each summer if nutrient load increases.
Disease risk to bathers if catchment pathogen load increases.

VALUES

Low use for fishing, swimming, birdlife, walking.

RECOMMENDED MONITORING

Objective: Monitor major stressor leading to degradation of estuary.
Design:
Monitor landuse in river mouth lagoon estuary catchment.
If landuse intensifies significantly introduce management actions.
5 yearly intervals.

AWHEA ESTUARY	Sedimentation	Eutrophication	Disease Risk	Contaminants	Habitat Loss	Invaders	Shellfish Issues
Existing Condition Rating	Moderate	Moderate	Low	Low	Low	Low	Low
Susceptibility Rating	Moderate	Moderate	Low	Low	Low	Low	Low

ESTUARIES

Opouawe Estuary near White Rock

Upper reaches of Opouawe Estuary

OVERALL VULNERABILITY RATING

LOW

OPOUAWE ESTUARY (NEAR WHITE ROCK)

The Opouawe estuary is a relatively broad and very river dominated "river mouth lagoon " estuary whose mouth blocks or becomes restricted most summers. The estuary lagoon floods a large area behind and parallell to the beach. As a consequence, it is poorly flushed at times and may experience moderate nutrient enrichment issues (green algae on gravels near margins) some summers. The estuary is narrow and shallow (mean depth <1m) and when the mouth blocks the river floods the gravel flats bordering the lagoon. There is no salt marsh vegetation on estuary margins, instead it borders directly onto grazed grassland or duneland. Salinities vary depending on the extent of tidal inflow, but generally are more freshwater than saline. On 13 Dec 2006, the estuary was open but the mouth constricted by a sand/gravel bar. Salinity was <1ppt at high water 50m upstream of the mouth. The water was turbid, the bed consisted of clean sand and gravels, and there was no evidence of nutrient enrichment issues such as macroalgal blooms or anoxic sediments. Catchment landcover is predominantly scrub and forest but has some areas of grassland which is used for extensive grazing of sheep and cattle. Catchment rock type is a mix of hard and soft sedimentary rock.

Because landcover is predominantly scrub and forest and landuse is less intensive, the estimated nitrogen (the major driver of eutrophication), sediment and pathogen loadings are low. Given these catchment characteristics, the existing condition of the estuary is relatively good, despite its high susceptibility to water quality degradation. However, any increase in the intensity of landuse in the catchment is likely to lead to estuary deterioration, especially during the summer months. Landuse monitoring is therefore recommended as a means of identifying potential threats to the values of this estuary.

Estuary Type	River mouth lagoon
Estuary area (ha)	46
Catchment area (km²)	105
Catchment landuse	30 % Sheep and beef; 70% scrub/forest
Area dairying (ha)	None
Nitrogen loading	Moderate; 4.7 kg/ha/yr Source: NIWA Sparrow Model
Catchment rock type	Mix hard and soft rock
Saltmarsh area (ha)	0
Mean Salinity (@HW)	<1-10 ppt depending on mouth closure
Mean depth (m)	<1 m at high water
Tidal flats	Some gravel sand flats

ISSUES

Mouth closes particularly in summer.
Natural cycle of moderate to high water quality.
Threat of algal blooms each summer if nutrient load increases.
Disease risk to bathers if catchment pathogen load increases.

VALUES

Low use for fishing, swimming, birdlife, walking.

RECOMMENDED MONITORING

Objective: Monitor major stressor leading to degradation of estuary.
Design:
Monitor landuse in river mouth lagoon estuary catchment.
If landuse intensifies significantly introduce management actions.
5 yearly intervals.

OPOUAWE ESTUARY	Sedimentation	Eutrophication	Disease Risk	Contaminants	Habitat Loss	Invaders	Shellfish Issues
Existing Condition Rating	Moderate	Moderate	Low	Low	Low	Low	Low
Susceptibility Rating	Moderate	Moderate	Low	Low	Low	Low	Low

SECTION 8 CAPE PALLISER TO WHATARANGI

BEACHES AND ROCKY SHORES

Spinifex duneland

Ngawi

Cape Palliser lighthouse

Seawall

OVERALL VULNERABILITY RATING

MODERATE

This 22km long section of the coast is very exposed and bathed by relatively clear, clean waters (except at the western Whatarangi end where shoreline and catchment consists of soft rock and is more erosion-prone). Below high water, the shores are narrow, steep gravel, cobble beaches or boulder and rock fields with artificial seawalls present in many areas (particularly at Whatarangi along the base of the eroding cliffs). Above high water, a broad uplifted flat coastal plain of mixed alluvial and marine gravels is backed by a series of raised platforms and steep weathered hillsides. The coastal platform is relatively narrow on this section of coast and is primarily mixed grassland and scrubland, flanked by steep grassland hillsides. The coastline from Te Kawakawa (Black) Rocks to Whatarangi sees the coastal platform widen, with steep gravel beaches flanked by spinifex dominated dunes and grassland. At Te Humenga Point the spinifex-dominated duneland is relatively wide and is considered a national priority for conservation (Partridge 1992) based primarily on the lack of weeds and the absence of marram grass, although small patches of marram were recorded during this survey.

A number of streams and rivers discharge to this section of the coast (e.g. Whawanui, Mangatoetoe, Otakaha and Paraki streams). All drain hard rock-type catchments and consequently they tend to have low sediment loadings and exit the coast across broad shingle and cobble fans. Nutrient and pathogen loadings are expected to be low. The river mouths experience various levels of mouth constriction depending on swell size, direction and river flows and occasionally have narrow and shallow freshwater dominated lagoons present at the mouth.

The foreshore between Cape Palliser to Kupe's sail is identified by GWRC as an area of important conservation value and on this section of coast, large rocky outcrops dominate with boulder and gravel fields at the top of the beaches. A seal colony is present at the Cape. Five kilometers north of Cape Palliser is Ngawi, a small fishing / holiday town. Ngawi's main claim to fame is that it has more bulldozers per head of population than anywhere else. These line the foreshore and are used to launch and retrieve the many local fishing boats. Ngawi is also a popular holiday area and there are several popular surf breaks.

Erosion is particularly severe around Whatarangi where both the road and houses are threatened and large sections of the coast have seawalls along the base of the eroding cliffs and dunes to protect the foreshore. Human use of the area is high and public access along the coastal road is good. Farming is the dominant land use, with walking, surfing, diving, holidaying, scientific interest and inshore fishing all popular.

The major ecological risks to this section of the coast are habitat loss from erosion, marram grass invasion of the Te Humenga duneland, and the influence of climate change (e.g. increase in temperature) on high biodiversity rocky reef areas.

ISSUES

- Marram grass invasion of duneland at Te Humenga.
- Impact of climate change on high biodiversity rocky shores.
- Coastal erosion.

VALUES

High use for fishing, swimming, surfing, birdlife, diving, scientific/geology, landform appreciation, walking.

RECOMMENDED MONITORING

Beaches. None.

Dunes. Measure change in area of duneland and change in position of seaward margin. Repeat broadscale mapping of duneland at 5-10 yearly intervals.

Rocky Shores. Monitor high biodiversity rocky shore and reef areas
e.g. Hard greywacke substrate near Cape Palliser.

CAPE PALLISER TO WHATARANGI	Disease Risk	Algal Blooms	Habitat Loss	Contamination	Clarity Isues	Invaders	Shellfish Issues
Existing Condition Rating	Low	Low	Low	Low	Low	Moderate	Low
Susceptibility Rating	Low	Low	Low	Low	Low	Moderate	Low

SECTION 9 PALLISER BAY (WHANGAIMOANA TO OCEAN BEACH 19KM)

BEACHES AND ROCKY SHORES

Ocean Beach

Wharekauhau Stream

OVERALL VULNERABILITY RATING

LOW
MODERATE

The shoreline of the broad embayment of Palliser Bay is basically a long stretch of steep, gravel and cobble beach (16km) dominated at either end by soft mudstone cliffs (20 to 40 m high and up to 100m in the east) with Lake Onoke and the Onoke Spit in the centre of the Bay. The water within the bay is often turbid. The steep gravel beach itself is generally has a broad (100-200m wide) backshore, sometimes with a thin strip of marram and spinifex dominated duneland at its inland margin. The duneland generally borders onto grassland used for extensive sheep and cattle grazing. Several small streams cut through the cliffs at either end of Palliser Bay, while the larger Ruamahanga River discharges through Lake Onoke at Lake Ferry. The steep reflective beach results in steep dumping waves.

On the eastern side of Lake Ferry is the 8.5 km long Whangaimoana Beach backed by uplifted mudstone cliffs of raised alluvial terraces. The beach is narrow and the sea impacts directly on the base of the cliffs at high tide. Significant erosion is evident and the cliffs are unvegetated. Approximately 3km from the Huripi Stream mouth the beach begins to widen and a narrow band of duneland begins. The cliffs, protected from direct sea erosion by the widening beach gain a cover of grass and flax.

Where the cliffs are broken for a small area around the Whangaimoana River, a few baches are present and surfcasting and beachgoing are popular. The river itself is small and forms a narrow (2-3m wide) and shallow (average depth <0.5m) backshore lagoon running parallel to the gravel beach for approximatey 800m. The lagoon has no significant vegetation around it, and has no obvious estuarine characteristics. The duneland (a mix of marram grass, spinifex and various herbs and grasses) continues to widen between the Whangaimoana River to where the Ruamahanga River discharges from Lake Onoke at Lake Ferry.

ISSUES

Marram grass invasion of duneland. Coastal erosion.

VALUES

High use for fishing, swimming, surfing, birdlife, diving, scientific/geology, landform appreciation, walking.

RECOMMENDED MONITORING

Beaches. None.

Dunes. Measure change in area of duneland and change in position of seaward margin. Repeat broadscale mapping of duneland at 5-10 yearly intervals.

Rocky Shores. None.

Immediately west of Lake Ferry is the 3 km long Onoke Spit (a coastal dune system of high value) and the bordering Lake Onoke. **Onoke Spit dune is home to pingao,spinifex and mat plant communities of** *Raoulia australis* and *Pimelea arenaria*. **Gravels** dominate the spit and the the dune, which is largely unaffected by grazing, and has not been completely overtaken by the introduced marram grass. It therefore remains an area of high botanical value. It is also habitat for the threatened katipo spider and a valued breeding site for Caspian terns, banded dotterels, white fronted terns and black-backed gulls. Signicificant pressures on the spit include disturbance from motor bikes and four-wheel-drive vehicles, as well as dogs.

To the west of the spit the beach is again flanked by steep mudstone cliffs of raised alluvial terraces with the cliff faces mostly covered in native scrub or grassland. The beach is broad (100-200m wide) and comprises mixed gravel, sand and cobble, with gravel and cobble fans dominating the stream mouths to the west. The beach is bordered by a narrow margin of mixed duneland species dominated by marram grass at the top of the beach. Inland of this is a relatively wide band of grassland between the beach and the base of the cliffs where a few scattered baches/cribs are present. Occasional shallow coastal wetlands are present within the duneland. **The western end of Ocean Beach is cut by several waterways including** Corner Creek, Wharekauhau Stream, and Wharepapa River. These cut steeply through the flanking cliffs and have eroded large gravel, cobble and boulder fans that spread across the beach. The streams flow steeply across these fans to the sea, carving a variable path under different flow conditions. The streams have no estuarine values.

PALLISER BAY	Disease Risk	Algal Blooms	Habitat Loss	Contamination	Clarity Issues	Invaders	Shellfish Issues
Existing Condition Rating	Low	Low	Low	Low	Low	Moderate	Low
Susceptibility Rating	Low	Low	Low	Low	Low	Moderate	Low

LAKE ONOKE

Lake Onoke (photo GWRC)

OVERALL VULNERABILITY RATING

MODERATE

HIGH

The Lower Wairarapa Valley Development Scheme, which incudes Lake Onoke, is one of New Zealand's largest and most ambitious flood protection projects. Barrage control gates enable levels of Lake Onoke to be raised quickly to either overcome impending blockage of the outlet or to aid in the formation of a new opening. This also means that the lake can be kept at a low level, ready to accept any flows from the Oporua Floodway. Such flows are the result of the overflow of flood discharges from the Ruamahanga River at various points further upstream.

Lake Onoke (Ferry), centred in Palliser Bay in the southern Wairarapa, is a large (~650 ha), brackish intermittently open/closed "coastal lake" estuary fed by the Ruamahanga River. It is separated from the sea by Onoke Spit (see previous section) and the lake drains to the sea through a gap at the eastern end. Historically for long periods the lake was tidal, but in southerly conditions with a low river flow, the exit to the sea became blocked until the shingle spit naturally breached with rising lake levels. More recently, to reduce the danger of flooding on nearby farmland, extensive flood control structures have been established combined with artificial opening of the lake outlet if it is closed.

Lake Onoke, together with Lake Wairarapa and their associated wetlands, comprise the largest wetland system in the lower North Island. The area is of national and international importance for indigenous fish, plant and animal communities and is important to Maori as an area for gathering food such as eel, fish, waterfowl, and plant material, including flax and raupo. The lake is listed by GWRC as an area of significant conservation value. The western shore of the lake is the least modified with large areas of rushland and saltmarsh ribbonwood present. The northern boundary of the lake has been drained and embankments surround much of the lake margin, including the lower section of the Ruamahanga River. Much of the open lake water is devoid of aquatic vegetation, perhaps because of its high turbidity (Ogle et al. 1990). The area is popular for holidaying, fishing (surfcasting, whitebaiting), birdwatching, and botanising. Commercial eel and flounder fishing also occur in the lake.

Monitoring data for the lower Ruamahanga River (Scarsbrook 2006) indicates loadings to Lake Onoke of nutrient, pathogen and suspended solids are elevated. Despite the obvious significance of the lake and its susceptibility, very little seems to be known about the key ecological attributes that would define its existing state. Given the high values and susceptibility of such coastal lakes to eutrophication, sedimentation and increased disease risk, it is recommended that long term monitoring be undertaken once an initial synoptic study and risk analysis has been carried out.

Estuary Type	Shallow, "coastal lake" estuary
Estuary area (ha)	650
Catchment area (km^2)	3470
Catchment landuse	Mixed, sheep, beef, with extensive areas of dairying
Area dairying (ha)	Significant
Nitrogen loading	6 kg/ha/yr Source: NIWA Sparrow Model (expect higher)
Catchment rock type	Soft rock
Saltmarsh area (ha)	Approximately 60ha
Mean Salinity (@HW)	Unknown
Mean depth (m)	Unknown
Tidal flats	Some appear at low lake levels.

ISSUES

High turbidity.
Susceptibility to nutrient enrichment and algal blooms.
Susceptibility to sedimentation and waterborne pathogens.
Salt marsh and aquatic biodiversity valued but little studied.

VALUES

High value for fishing, boating, swimming, biodiversity, birdwatching.

RECOMMENDED MONITORING

Step 1. Undertake synoptic study and risk analysis to identify appropriate monitoring and management options.

Step 2. Long term monitoring likely to include:
Fine scale water quality and sediment quality component targeting nutrient loadings, plant and algal assemblages and sediment mapping.
Broad scale intertidal and subtidal habitat mapping and risk assessment every 5 yrs.

LAKE ONOKE ESTUARY	Sedimentation	Eutrophication	Disease Risk	Contaminants	Habitat Loss	Invaders	Shellfish Issues
Existing Condition Rating	Moderate	Moderate	Moderate	Low	Moderate	Low	Low
Susceptibility Rating	High	High	High	Low	Moderate	Low	Low

SECTION 10 OCEAN BEACH TO BARING HEAD

BEACHES AND ROCKY SHORES

Rocky outcrops Turikirae Head

Turikirae Head (photo DOC)

OVERALL VULNERABILITY RATING

LOW

Human use of the beach and rocky shores in this section of the coast is generally low, although the area between Turakirae Head and Baring Head is a popular destination for a "drive". Landscape appreciation and scientific interest in the ecology and geology of the area is high. Public access to the scenic reserve is good, although vehicle access along the coast is restricted.

The coastline between Ocean Beach and Baring Head (19km long) is very exposed and bathed by relatively clear waters. The shore is a variable mix of beaches and headlands, beach substrate transitioning from gravels at Ocean Beach, through cobbles and finally to boulders and rock fields at Turakirae Head, beyond which the shoreline changes again as the the small drowned valleys of the Orongorongo and Wainuiomata Rivers discharge through wide gravel beaches with the river mouths almost closed by gravel bars. These form "river mouth lagoon" estuaries with characteristics as discussed previously. Inland of the beaches a narrow coastal plain (predominantly native scrub and grassland pasture interspersed with a diverse mix of wetlands, herbfields and dunelands) is bounded by the towering greywacke hillsides of the Rimutaka Range, dominated by native scrub and occasional forest remnants. Many small steep streams flow down from these hills, cross the coastal plain and discharge or seep directly to the coast. The streams have no estuarine features and are generally characterised by large gravel and cobble fans.

A particularly interesting section of the coastline occurs a few kilometres east of the Orongorongo River mouth at Turikirae Head. The Turakirae Head Scientific Reserve provides valuable habitat for a variety of plants and wildlife, most notably seals, and preserves a well-defined sequence of earthquake-raised beaches. Within the reserve a series of raised beach ridges extend ~1km inland, each supporting a distinctive grouping of native vegetation consisting of a mixture of salt tolerant herbs, tussock and reed associations, dune associations and coastal forest. The lowest platform and ridge are characterised by a boulderfield with sparse growth of halophytic herbs and shrubs *(Plagianthus divaricatus).* The contrasting vegetation between the droughty beach ridges and the boggy platforms is very marked. The next ridge up is dominated by a dense divaricating shrubland (*Coprosma propinqua-Muehlenbeckia complexa-Hymenathera crassifolia*). The next two platforms show the rapid development of peat mires with the growth of tussockland, reedland (*Leptocarpus similis* and *Typha orientalis*), and herbfield. The older platforms and ridges carry grass shrubland on old peat mires with remnants of coastal forest (*Corynocarpus laevigatus*) at the base of the hills. *Coprosma-Cassinia* grass shrubland grows on the unstable, stoney alluvial soils and is strongly influenced by grazing and burning. A nationally-threatened plant, the shrubby tororaro, *Muehlenbeckia astonii*, occurs within the reserve, with a new population established in 1998 as part of a programme to avert the extinction of the species. Fire, both pre-European and more recent, has been the principal environmental factor influencing the present vegetation pattern. The vegetation is still subject to grazing by sheep, cattle, possum, and rabbits.

In order to facilitate better decision-making regarding the valued plant associations at Turikirae Head, it is recommended that this be mapped at a broad scale every 5-10 yrs.

ISSUES

Marram grass invasion of duneland. Impact of grazing on Turikirae Head vegetation.

VALUES

Low use for fishing, birdlife, wildlife, diving, scientific/geology, landform appreciation, walking.

RECOMMENDED MONITORING

Beaches. None.

Dunes. Measure change in area of duneland and change in position of seaward margin. Repeat broadscale mapping of duneland at 5-10 yearly intervals.

Rocky Shores/Coastal platform. Measure change in area of plant associations at Turikirae Head. Repeat broadscale mapping of duneland at 5-10 yearly intervals.

OCEAN BEACH TO BARING HEAD	Disease Risk	Algal Blooms	Habitat Loss	Contamination	Clarity Issues	Invaders	Shellfish Issues
Existing Condition Rating	Low	Low	Low	Low	Low	Moderate	Low
Susceptibility Rating	Low	Low	Low	Low	Low	Moderate	Low

ESTUARIES

Orongorongo Estuary near Baring Head

OVERALL VULNERABILITY RATING

LOW

ORONGORONGO RIVER ESTUARY

Located midway between Baring Head and Turakirae Head, the Orongorongo River estuary is a small river mouth lagoon located at the top of the beach where the braided Orongorongo River cuts its way directly to the sea through the wide gravel and cobble beach. The river mouth lagoon is narrow and shallow (mean depth <1m), freshwater dominated (salinity <1ppt), with minimal tidal influence. The river is almost always open to the sea, but regularly experiences constriction as high seas push gravel across the mouth.

There is little vegetation around the lagoon, with the margins dominated by beach gravels and large piles of driftwood, and very small areas of grassland, marram grass and gorse.

Water is abstracted in the headwaters for the Wainuiomata Water Treatment Plant and this has an effect on flow in the Orongorongo River, which can contribute to it dropping below the current minimum flow.

During low flow periods when the estuary mouth is restricted, it is likely that the estuary would experience enhanced algal growth and build-up of fine organic rich sediments. However such conditions, if they occurred, would be short-lived and any algae and sediments would be flushed to the sea as soon as flows were large enough to open the mouth again.

Because conditions are harsh and habitat diversity is low in these very short, shallow, low salinity estuaries, they naturally exhibit low biodiversity. Given these ecological characteristics, and their low use by humans, this estuary is considered a low priority for any estuary monitoring. However, in order to ensure conditions do not deteriorate, landuse monitoring is recommended in order to provide information on the key stressor affecting estuary condition.

Estuary Type	River mouth lagoon
Estuary area (ha)	0.6
Catchment area (km²)	49
Catchment landuse	Forest/scrub, minor grassland
Area dairying (ha)	0
Nitrogen loading	Low - Moderate; 7 kg/ha/yr Source: NIWA Sparrow Model
Catchment rock type	Hard rock mainly
Saltmarsh area (ha)	0
Mean Salinity (@HW)	<5 ppt depending on mouth closure
Mean depth (m)	<0.5 m at high water
Tidal flats	Fills behind beach

ISSUES

Mouth restrictions.
Water abstraction.
Natural cycle of low to high water quality as degree of mouth restriction varies.
Particularly sensitive to nutrient inputs.

VALUES

Low use for fishing, paddling, birdlife, walking.

RECOMMENDED MONITORING

Objective: Monitor major stressor leading to degradation of estuary.

Design:
Monitor landuse in river mouth lagoon estuary catchment.
If landuse intensifies significantly introduce management actions.
5 yearly intervals.

ORONGORONGO ESTUARY	Sedimentation	Eutrophication	Disease Risk	Contaminants	Habitat Loss	Invaders	Shellfish Issues
Existing Condition Rating	Low	Low	Low	Low	Low	Low	Low
Susceptibility Rating	Low	Low	Low	Low	Low	Low	Low

ESTUARIES

Wainuiomata Estuary near Baring Head

OVERALL VULNERABILITY RATING

LOW

WAINUIOMATA RIVER ESTUARY

The Wainuiomata "river mouth lagoon" is situated 20km south of Wainuiomata township. The Wainuiomata River flows predominantly through farmland in the lower reaches before it leaves the confines of the valley floor and meanders parallel to the shore for approximately 800m before cutting through a wide gravel and cobble beach to discharge to the sea. The lagoon itself is relatively shallow and, like the Orongorongo, is **almost always open, but regularly experiences** constriction as high seas push gravel across the mouth **or during low** river flows. Very little estuarine vegetation occurs around the lagoon margins, which is generally limited to a narrow band of duneland and grassland near the top of the beach. Unlike the estuaries further north, the estuary bed is dominated by sands and gravel (a reflection of its hard rock catchment). There is very little tidal influence. During low flow periods when the estuary mouth is restricted, it is likely that the estuary would experience enhanced algal growth and build-up of fine organic rich sediments. During high flows, the estuary would be flushed clean again.

The Wainuiomata River is part of the GWRC "*Streams Alive*" programme as 43% of its catchment is in native or exotic forest, around 54% of the catchment is protected by covenants or in Department of Conservation ownership, and the wide variety of stream habitats in the catchment provide home for a wide variety of native fish. It is also a regionally significant trophy brown trout fishery and the river mouth is reported to have good inanga (whitebait) spawning habitat. Water is abstracted upstream (for Wainuiomata Water Treatment Plant) and this is having a major effect on river flow, consistently causing it to drop below the current minimum flow (Harkness 2002).

Because conditions are harsh and habitat diversity is relatively low in this small, shallow, low salinity estuary, it is not expected to exhibit high biodiversity. Given these ecological characteristics, and its low use by humans, this estuary is considered a low priority for any estuary monitoring. However, in order to ensure conditions do not deteriorate, landuse monitoring is recommended in order to provide information on the key stressor affecting estuary condition.

Estuary Type	River mouth lagoon
Estuary area (ha)	6.7
Catchment area (km²)	57
Catchment landuse	Forest/scrub, minor grassland, grazing
Area dairying (ha)	0
Nitrogen loading	Moderate; 9.6 kg/ha/yr Source: NIWA Sparrow Model
Catchment rock type	Hard rock
Saltmarsh area (ha)	0
Mean Salinity (@HW)	<5 ppt depending on mouth closure
Mean depth (m)	<0.5 m at high water
Tidal flats	Fills behind beach

ISSUES

Water abstraction.
Whitebait spawning.
Mouth restrictions.
Natural cycle of low to high water quality as degree of mouth restriction varies.
Particularly sensitive to nutrient inputs.

VALUES

Low - moderate use for **fishing, swim**-ming, birdlife, walking, whitebaiting.

RECOMMENDED MONITORING

Objective: Monitor major stressor leading to degradation of estuary.

Design:
Monitor landuse in rivermouth lagoon estuary catchment.
If landuse intensifies significantly introduce management actions.
5 yearly intervals.

WAINUIOMATA ESTUARY	Sedimentation	Eutrophication	Disease Risk	Contaminants	Habitat Loss	Invaders	Shellfish Issues
Existing Condition Rating	Low	Low	Low	Low	Low	Low	Low
Susceptibility Rating	Moderate	Moderate	Low	Low	Low	Low	Low

SECTION 11 CONCLUSIONS

The Wairarapa Coastal Habitat study, which involved field assessment by Wriggle Coastal Management ecologists of 217km of the Wairarapa coast in December 2006, identified an exposed and rugged coastline with a wide range of coastal shoreline habitats including: estuaries, beaches, dunes, rocky shores, with a predominantly grassy hinterland. For each of these broad habitats, the study has provided three main outputs: habitat maps, vulnerability assessments and monitoring priorities which are summarised as follows:

ESTUARIES	**(i) Habitat Mapping** The Wairarapa coast includes a total of 14 moderate sized estuaries which have rivers draining into them. These include 12 river mouth lagoon estuaries, 1 coastal lake and one tidal river. It also includes a further 60-70 very small estuaries (predominantly river mouth lagoons) which have streams draining to them. The survey of the main river estuaries and selected representative stream estuaries showed that they generally exhibited low habitat diversity, with salt marsh and tidal flats virtually absent, and lagoon size varying throughout the year (depending on the extent of mouth blockage). Because of the exposure to high seas, the majority of the estuaries regularly block at the mouth (particularly in summer), which results in water and sediment quality degradation till high flows open the mouth and flush the lagoon clean. **(ii) Vulnerability Assessment:** Vulnerability assessments of the main river estuaries and selected representative stream estuaries indicated mainly low or low-moderate vulnerability to ecological damage from the major stressors (i.e. climate change, intensification of agriculture, aquaculture, fisheries, port development etc.), except for Lake Onoke (a shallow coastal lagoon) which rated a moderate to high vulnerability, and Whareama Estuary which had a moderate rating. **(iii) Monitoring Recommendations** • Monitor landuse in all estuary catchments at 5 yearly intervals. • Monitor and manage long term condition of high biodiversity coastal lakes (Lake Onoke) with high susceptibility to ecological change. • Monitor long term condition of representative Wairarapa estuaries with highest biodiversity and risk to ecology (e.g. Whareama Estuary).
BEACHES	**(i) Habitat Mapping** The Wairarapa coastline includes 107 km of beach habitat spread along much of its length with many of these beaches also having rocky outcrops, particularly in the northern section where platform reefs were common. A wide range of beach types were mapped including: primarily broad, flat, sandy beaches with white sand and wide surf zones to the north (bathed by cloudy waters) which progressively change towards the south to moderately steep beaches, with dark coarser grained sand and ultimately to very steep, gravel beaches (lacking a surf zone) and having clear waters. Biodiversity is greatest in the less harsh environment of the dissipative and intermediate type beaches to the north. **(ii) Vulnerability Assessment:** Vulnerability assessments of the beaches indicated low or low-moderate vulnerability to ecological damage from the major stressors (i.e. climate change, intensification of agriculture, aquaculture, fisheries, port development etc.). Sea level rise and subsequent removal or inland migration of beaches is foreseen as the major threat. **(iii) Monitoring Recommendations** Monitor trends in biodiversity of beaches with highest biodiversity, (e.g. between Castlepoint and Whakataki River mouth).

SECTION 11 CONCLUSIONS

DUNES	**(i) Habitat Mapping** The Wairarapa broad scale mapping showed duneland was spread along a large section of the Wairarapa coastline (104 km of the 217 km long coastline was dunes). In many sections it was present only as a very thin margin. Most of the dunes were dominated by the introduced and invasive marram grass and grazed by stock. Only in the Cape Palliser area were there significant areas of duneland where native duneland species were dominant. Biodiversity is expected to be greatest in the native dominated dunes where a more diverse range of habitats are present. **(ii) Vulnerability Assessment:** Vulnerability assessments of the dune habitat indicated mainly low or low-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. Major stressors on dune habitat include invasion of marram grass and sea level rise and subsequent removal or inland migration of dunes through erosion. **(iii) Monitoring Recommendations** Monitor long term trends in dune area, dominant vegetation and invasive weeds.
ROCKY SHORES	**(i) Habitat Mapping** The Wairarapa broad scale mapping showed rocky shores were spread along a large section of the Wairarapa coastline (121 km of the 217 km long coastline was rocky shore). In the northern sections they tended to be dominated by soft sedimentary rock platform reefs and turbid water and to the south, hard boulder and rockfield shores and mainly clear waters (except for Palliser Bay where soft sedimentary rock and turbid waters were common). Biodiversity of rocky shores appeared high with each rock type inhabited by its own diverse assemblage of plant and animal species. **(ii) Vulnerability Assessment:** Vulnerability assessments of the rocky shore habitat indicated mainly low or low-moderate vulnerability. Apart from harvesting pressures, the most significant stressor that may influence future rocky shore ecology was considered to be climate change. **(iii) Monitoring Recommendations** Monitor long term trends in biodiversity of high biodiversity rocky shores.
MARGIN (200M)	**(i) Habitat Mapping** The Wairarapa broad scale mapping showed that grassland (used for the extensive grazing of sheep and cattle) dominated the immediate coastal hinterland (i.e. the area 200m inland of dune, beach and rocky shore margins). Of the 217 km of Wairarapa coastline, 75% was dominated by grassland, 17% by scrub and forest, 3.5% by residential (including rural residential), 1.7 % by cliffs, and 1.5% by old duneland. **(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), and residential property development on old dunelands. **(iii) Monitoring Recommendations** Monitor landuse of coastal margin land at 5 yearly intervals.

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APPENDIX 1 WAIRARAPA ESTUARY DETAILS

APPENDIX 1 WAIRARAPA ESTUARY CHARACTERISTICS

December 2006	Mataikona	Okau	Whakataki	Ngakauau	Humpies	Otahome
Type	River mouth lagoon	River mouth lagoon	River mouth lagoon	River mouth lagoon	River mouth lagoon	River mouth lagoon
Frequency of mouth closure	low	high	high	high	high	high
Mean depth (m)	1	<0.5m	0.5m	0.3m	0.3m	0.5m
Depth of central basin (m)	<3	<1	1	<1	<1	<1
Estuary Area (ha)	12.3	0.6	5	2.5	0.3	1.5
Catchment Area (km2)	190	12.6	40.3	15.7	4.2	7.3
Salt Marsh Area (ha)	0	0.12	0.33	0.5	0.03	0.85
Length of salinity intrusion (km)	0.75	0.25	0.5	<0.5	<0.6	<0.7
Rock Type	Soft sed	Soft sed	Soft sed	Soft sed	Soft sed	Soft sed
Dominant Landuse	Sheep/beef	Sheep	Sheep/beef	Sheep (forest)	Sheep (forest)	Sheep (forest)
Dairying (ha)	0	0	0	0	0	0
N Loading (t/yr) - NIWA data	85	5.2	12.7	6.9	2.5	4.1
Mean Salinity @HW	<1-5	<1-10	<1-10	<1-10	<1-10	<1-10
Presence of fringe areas	Low	Low	Low	Low	Low	Low
Macroalgal Abundance	Low	Mod	Mod	High	High	High
Macroalgal Frequency	Periodic	Periodic	Periodic	Periodic	Periodic	Periodic
Phyto blooms spatial cover	Low	Low	Low	Low	Low	Low
Phyto blooms surface conc.	Very low	Very low	Very low	Very low	Very low	Very low
Phyto blooms frequency	Never	Never	Never	Never	Never	Never
DO depletion surf conc	No problem	No problem	No problem	Biol stress	Biol stress	Biol stress
DO depletion spatial cover	Very low	Very low	Very low	Low	Low	Low
DO depletion frequency	Never	Never	Never	Episodic	Episodic	Episodic
Seagrass loss trend	Low	Low	Low	Low	Low	Low
Seagrass magnitude loss	Low	Low	Low	Low	Low	Low
HABs frequency	Never	Never	Never	Never	Never	Never
Anoxic sediments frequency	Never	Never	Never	Periodic	Periodic	Periodic

APPENDIX 1 WAIRARAPA ESTUARY CHARACTERISTICS (CONTINUED)

December 2006	Whareama	Motuwaireka	Patanui	Kaiwhata	Pahaoa	Rerewhak-aaitu
Type	Tidal river	River mouth lagoon	River mouth lagoon	River mouth lagoon	River mouth lagoon	River mouth lagoon
Frequency of mouth closure	never	high	ND	ND	annual	high
Mean depth (m)	1-2m	<1m	ND	ND	<1	ND
Depth of central basin (m)	2	<2	ND	ND	ND	ND
Estuary Area (ha)	113	6	5.4	5	35	1.7
Catchment Area (km2)	251	33.2	35.7	101	272	46.4
Salt Marsh Area (ha)	5.5	1.1	4.1	low	4	0
Length of salinity intrusion (km)	13	<0.5	ND	ND	2	ND
Rock Type	Soft sed	Soft sed	Soft sed	Soft sed	Soft & hard sed	Soft & hard sed
Dominant Landuse	Sheep (beef forest scrub)	Sheep (beef forest scrub)	Sheep/beef (forest)	Forest/scrub (sheep/beef)	Sheep/Forest (beef)	Forest scrub (sheep/beef)
Dairying (ha)	0	0	0	0	0	0
N Loading (t/yr) - NIWA data	240	19.9	18.8	38.7	264.7	16.8
Mean Salinity @HW	5-15ppt	<1-10	<1-10	<1-10	<1-10	<1-10
Presence of fringe areas	Low	Low	Low	Low	Low	Low
Macroalgal Abun-dance	Low	Mod	ND	ND	Low	ND
Macroalgal Frequency	Episodic	Periodic	ND	ND	Episodic	Episodic
Phyto blooms spatial cover	Low	Low	ND	ND	Low	Low
Phyto blooms surface conc.	Very low	Very low	ND	ND	Very low	Very low
Phyto blooms fre-quency	Never	Never	ND	ND	Never	Never
DO depletion surf conc	No problem	No problem	No problem	Biol stress	Biol stress	Biol stress
DO depletion spatial cover	Very low	Very low	Very low	Low	Low	Low
DO depletion fre-quency	Never	Never	Never	Episodic	Episodic	Episodic
Seagrass loss trend	Low	Low	Low	Low	Low	Low
Seagrass magnitude loss	Low	Low	Low	Low	Low	Low
HABs frequency	Never	Never	Never	Never	Never	Never
Anoxic sediments frequency	Never	Never	Never	Periodic	Periodic	Periodic

APPENDIX 1 WAIRARAPA ESTUARY CHARACTERISTICS

December 2006	Oterei	Awhea	Opouawe	L. Onoke	Orongorongo	Wainuiou-mata
Type	River Mouth Lagoon	River Mouth Lagoon	River Mouth Lagoon	Coastal Lake	River Mouth Lagoon	River Mouth Lagoon
Frequency of mouth closure	high	high	high	manually opened	ND	regular
Mean depth (m)	<1m	<1m	<1	ND	<0.5	<0.5
Depth of central basin (m)	<3	<3	<3	ND	<1	<1
Estuary Area (ha)	3.7	2.7	46.4	650	0.6	6.7
Catchment Area (km2)	65	152	105	3470	49.3	57
Salt Marsh Area (ha)	0.5	0.7	0	60	0	0
Length of salinity intrusion (km)	0.3	0.2	<0.1	ND	<0.1	<0.1
Rock Type	Soft & hard sed	Soft sed	Soft & hard sed	Soft sed	Hard sed	Hard sed
Dominant Landuse	Sheep/beef (scrub/forest)	Sheep/beef (scrub/forest)	Scrub (sheep/ beef)	Sheep/beef	Scrub/forest	Scrub/forest
Dairying (ha)	0	0	0	Lots	0	0
N Loading (t/yr) - NIWA data	22.3	68.1	47	2179	35	55
Mean Salinity @HW	<1-10	<1-10	<1-10	?	<1-10	<1-10
Presence of fringe areas	Low	Low	Low	Low	Low	Low
Macroalgal Abun-dance	Low	Low	Low	ND	Low	Low
Macroalgal Frequency	Never	Never	Never	ND	Never	Never
Phyto blooms spatial cover	Low	Low	Low	ND	Low	Low
Phyto blooms surface conc.	Very low	Very low	Very low	ND	Very low	Very low
Phyto blooms fre-quency	Never	Never	Never	ND	Never	Never
DO depletion surf conc	No problem	No problem	No problem	ND	No problem	No problem
DO depletion spatial cover	Very low	Very low	Very low	ND	Very low	Very low
DO depletion fre-quency	Never	Never	Never	ND	Never	Never
Seagrass loss trend	Low	Low	Low	ND	Low	Low
Seagrass magnitude loss	Low	Low	Low	ND	Low	Low
HABs frequency	Never	Never	Never	ND	Never	Never
Anoxic sediments frequency	Never	Never	Never	ND	Never	Never

APPENDIX 2 BEACH , DUNE, ROCKY SHORE AND ESTUARY RISK ANALYSES

(1) METHODOLOGY FOR VULNERABILITY ASSESSMENT

The aim of the ecological vulnerability assessment is to represent the reactions of the natural coastline and estuary ecosystems to the effects of stressors (often human activities) in the catchment area. The approach used is an adaptation of an existing UNESCO methodology (UNESCO 2000). These reactions are expressed directly according to:

- the sensitivity of the receiving environment,
- human uses and
- the upstream catchment area risk factors (stressors).

By taking into account the sensitivity of various environments in coastal Wairarapa and the risks to which they are subjected, we are able to highlight so-called ecologically "vulnerable" zones. The vulnerability assessment process involves the following:

- Descriptive assessments of the coastal environment, both natural and anthropogenic.
- Sensitivity and risk matrices are then compiled via interpretation of the above parameters to give overall vulnerability.

1. Ecological Sensitivity	The notion of ecosystem sensitivity is complex and involves a wide range of factors. It can be defined as the ability to resist a stress factor; this stress factor being defined as a situation which forces the system to mobiiize its resources and use an increased amount of energy to maintain its integrity. The ability to resist a stress factor involves three aspects : • **Ecosystem Richness.** The ecosystem's natural riches or specific diversity. It can be supposed that the more an ecosystem is rich and diversified, the greater the losses will be in the event of an aggression. This ecosystem richness of the Wairarapa habitats was assessed based on expert opinion and observations during the field visits to each habitat. It is divided into 4 subcategories; birds, vegetation, fish and other biota. • **Ecosystem Susceptibility.** This is an estimate of the physical susceptibility of the ecosystem to degradation. For example, is it an estuary where the mouth closes regularly and is poorly flushed and is therefore susceptible to water and sediment quality degradation. • **Ecosystem Existing Condition.** This is a measure or estimate of the existing condition of the estuary as assessed by scores for relevant condition indicators (e.g. signs of eutrophication, sedimentation, habitat loss). The existing condition of the Wairarapa coastline was primarily assessed based on expert opinion during the field visits to each site.
2. Human Uses	The human use rating is based primarily on the number of persons involved: • Low: less than 10 per year • Medium: 10 to 50 per year (< 30 per day in summer) • High: Greater than 30 per day (maybe just in summer) but less than 200 per day • Very High: > 200 per day
3. Stressors	The stressors are activities (often in the catchment) that affect the ecological condition of coastal habitat (e.g. terrestrial runoff, grazing in dunes, 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.
Vulnerability	The overall "vulnerability" rating is assessed by combining the results from 1, 2 and 3.

Examples of Vulnerability Assessments (common to the Wairarapa)

- Coastal lagoon estuaries that are mostly blocked at the mouth (i.e. poorly flushed), experience eutrophication symptoms during blockage, have high natural ecological richness and human use are classified as vulnerable.
- Estuaries that experience regular periods of mouth closure (i.e. poorly flushed) but are have long periods when it is open; experience eutrophication symptoms during blockage but these disappear once high flows open mouth, have high natural ecological richness and human use are classified as moderately vulnerable.
- Beaches that are exposed to coastal erosion and development of seawalls, have high ecological richness and human use are classified as vulnerable.
- Dunelands that are invaded by aggressive dune vegetation (e.g. marram grass) that hinders their ability to nourish the foreshore during erosion events, and have high, or potentially high, ecological richness and human use are classified as vulnerable.
- Rocky shores that are exposed to sea level rise and temperature change through climate change, and have high ecological richness and human use are classified as vulnerable.

BEACH, DUNE & ROCKY SHORE VULNERABILITY	OWAHANGA TO CASTLEPOINT BEACH																													
	TYPE: DISSIPATIVE																													
VULNERABILITY SCORE = LOW - MODERATE	**USES AND VALUES**					**PRESENCE OF STRESSORS**																			**ECOLOGICAL SENSITIVITY**					
VERY HIGH = BLACK HIGH = 1 DARK GREY MEDIUM = 2 MEDIUM GREY LOW = 3 WHITE	**Bathing**	**Shellfish collection**	**Natural character**	**Boating**	**Cultural/spiritual**	**Terrestrial runoff**	**Coastal outfall**	**Stormwater outfall**	**River plume**	**Oil spills**	**Grazing/forestry dunes**	**Erosion/Cont. Structures**	**Offshore dredging**	**Spills non-oil**	**Commercial Fishing**	**Seafood collection**	**Algal blooms (from sea)**	**Marine farms**	**Invasive weeds/pests**	**Climate change**	**Extreme storm surf**	**Vehicles beaches/dunes**	**Property development**	**Mining**	**Existing Condition**	**Susceptibility**	**Ecological richness birds**	**Ecological richness vegetation**	**Ecological richness biota**	**Ecological richness Fish**
MONITORING INDICATORS (if recommended then shaded)	**RISK OF INDICATOR AFFECTING USE**					**RISK OF STRESSOR AFFECTING INDICATOR**																			**INDICATOR SENSITIVITY**					
Disease risk - faecal indicators																														
Turbidity																														
Nutrients in water																														
Chlorophyll																														
Macroalgal blooms in water																														
Toxic algae																														
Sea temperature																														
Nutrients sediment																														
Sulphide sediments																														
Smell																														
Heavy metals																														
SVOCs																														
Area/condition of protective dune vegetation																														
Change in beach area																														
Change in dune area																														
Change in frequency of major coastal storms																														
Sea level rise																														
Change in area of unique habitat																														
Shellfish stock assessment																														
Fish stock assessment																														
Benthic invertebrates																														
Oil spill monitoring																														
Invasive species																														

BEACH, DUNE & ROCKY SHORE VULNERABILITY	CASTLEPOINT BEACH																														
	TYPE: DISSIPATIVE																														
VULNERABILITY SCORE = LOW-MODERATE	USES AND VALUES					PRESENCE OF STRESSORS																					ECOLOGICAL SENSITIVITY					
VERY HIGH = BLACK HIGH = 1 DARK GREY MEDIUM = 2 MEDIUM GREY LOW = 3 WHITE	Bathing	Shellfish collection	Natural character	Boating	Cultural/spiritual	Terrestrial runoff	Coastal outfall	Stormwater outfall	River plume	Oil spills	Grazing/forestry dunes	Erosion/Cont. Structures	Offshore dredging	Spills non-oil	Commercial Fishing	Seafood collection	Algal blooms (from sea)	Marine farms	Invasive weeds/pests	Climate change	Extreme storm surf	Vehicles beaches/dunes	Property development	Mining	Existing Condition	Susceptibility	Ecological richness birds	Ecological richness vegetation	Ecological richness biota	Ecological richness Fish
MONITORING INDICATORS (if recommended then shaded)	RISK OF INDICATOR AFFECTING USE					RISK OF STRESSOR AFFECTING INDICATOR																			INDICATOR SENSITIVITY					
Disease risk - faecal indicators																															
Turbidity																															
Nutrients in water																															
Chlorophyll																															
Macroalgal blooms in water																															
Toxic algae																															
Sea temperature																															
Nutrients sediment																															
Sulphide sediments																															
Smell																															
Heavy metals																															
SVOCs																															
Area/condition of protective dune vegetation																															
Change in beach area																															
Change in dune area																															
Change in frequency of major coastal storms																															
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Change in area of unique habitat																															
Shellfish stock assessment																															
Fish stock assessment																															
Benthic invertebrates																															
Oil spill monitoring																															
Invasive species																															

BEACH, DUNE & ROCKY SHORE VULNERABILITY	**CASTLEPOINT BEACH to WHAREAMA**																												
VULNERABILITY SCORE = LOW	**USES AND VALUES**					**PRESENCE OF STRESSORS**																				**ECOLOGICAL SENSITIVITY**					
VERY HIGH = BLACK HIGH = 1 DARK GREY MEDIUM = 2 MEDIUM GREY LOW = 3 WHITE	**Bathing**	**Shellfish collection**	**Natural character**	**Boating**	**Cultural/spiritual**	**Terrestrial runoff**	**Coastal outfall**	**Stormwater outfall**	**River plume**	**Oil spills**	**Grazing/forestry dunes**	**Erosion/Cont. Structures**	**Offshore dredging**	**Spills non-oil**	**Commercial Fishing**	**Seafood collection**	**Algal blooms (from sea)**	**Marine farms**	**Invasive weeds/pests**	**Climate change**	**Extreme storm surf**	**Vehicles beaches/dunes**	**Property development**	**Mining**	**Existing Condition**	**Susceptibility**	**Ecological richness birds**	**Ecological richness vegetation**	**Ecological richness biota**	**Ecological richness Fish**
MONITORING INDICATORS (if recommended then shaded)	**RISK OF INDICATOR AFFECTING USE**					**RISK OF STRESSOR AFFECTING INDICATOR**																			**INDICATOR SENSITIVITY**					
Disease risk - faecal indicators																													
Turbidity																													
Nutrients in water																													
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Change in area of unique habitat																													
Shellfish stock assessment																													
Fish stock assessment																													
Benthic invertebrates																													
Oil spill monitoring																													
Invasive species																													

BEACH, DUNE & ROCKY SHORE VULNERABILITY	WHAREAMA TO FLAT POINT																													
VULNERABILITY SCORE = LOW-MODERATE	**USES AND VALUES**					**PRESENCE OF STRESSORS**																				**ECOLOGICAL SENSITIVITY**					
VERY HIGH = BLACK HIGH = 1 DARK GREY MEDIUM = 2 MEDIUM GREY LOW = 3 WHITE	**Bathing**	**Shellfish collection**	**Natural character**	**Boating**	**Cultural/spiritual**	**Terrestrial runoff**	**Coastal outfall**	**Stormwater outfall**	**River plume**	**Oil spills**	**Grazing/forestry dunes**	**Erosion/Cont. Structures**	**Offshore dredging**	**Spills non-oil**	**Commercial Fishing**	**Seafood collection**	**Algal blooms (from sea)**	**Marine farms**	**Invasive weeds/pests**	**Climate change**	**Extreme storm surf**	**Vehicles beaches/dunes**	**Property development**	**Mining**	**Existing Condition**	**Susceptibility**	**Ecological richness birds**	**Ecological richness vegetation**	**Ecological richness biota**	**Ecological richness Fish**
MONITORING INDICATORS (if recommended then shaded)	**RISK OF INDICATOR AFFECTING USE**					**RISK OF STRESSOR AFFECTING INDICATOR**																			**INDICATOR SENSITIVITY**					
Disease risk - faecal indicators																														
Turbidity																														
Nutrients in water																														
Chlorophyll																														
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Sea level rise																														
Change in area of unique habitat																														
Shellfish stock assessment																														
Fish stock assessment																														
Benthic invertebrates																														
Oil spill monitoring																														
Invasive species																														

BEACH, DUNE & ROCKY SHORE VULNERABILITY	FLAT POINT TO PAHAOA ESTUARY																													
	TYPE: INTERMEDIATE																													
VULNERABILITY SCORE = LOW	USES AND VALUES					PRESENCE OF STRESSORS																				ECOLOGICAL SENSITIVITY					
VERY HIGH = BLACK HIGH = 1 DARK GREY MEDIUM = 2 MEDIUM GREY LOW = 3 WHITE	Bathing	Shellfish collection	Natural character	Boating	Cultural/spiritual	Terrestrial runoff	Coastal outfall	Stormwater outfall	River plume	Oil spills	Grazing/forestry dunes	Erosion/Cont. Structures	Offshore dredging	Spills non-oil	Commercial Fishing	Seafood collection	Algal blooms (from sea)	Marine farms	Invasive weeds/pests	Climate change	Extreme storm surf	Vehicles beaches/dunes	Property development	Mining	Existing Condition	Susceptibility	Ecological richness birds	Ecological richness vegetation	Ecological richness biota	Ecological richness Fish
MONITORING INDICATORS (if recommended then shaded)	RISK OF INDICATOR AFFECTING USE					RISK OF STRESSOR AFFECTING INDICATOR																			INDICATOR SENSITIVITY					
Disease risk - faecal indicators																														
Turbidity																														
Nutrients in water																														
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Shellfish stock assessment																														
Fish stock assessment																														
Benthic invertebrates																														
Oil spill monitoring																														
Invasive species																														

BEACH, DUNE & ROCKY SHORE VULNERABILITY	PAHAOA ESTUARY to CAPE PALLISER																													
VULNERABILITY SCORE = LOW	USES AND VALUES					PRESENCE OF STRESSORS																					ECOLOGICAL SENSITIVITY					
VERY HIGH = BLACK HIGH = 1 DARK GREY MEDIUM = 2 MEDIUM GREY LOW = 3 WHITE	Bathing	Shellfish collection	Natural character	Boating	Cultural/spiritual	Terrestrial runoff	Coastal outfall	Stormwater outfall	River plume	Oil spills	Grazing/forestry dunes	Erosion/Cont. Structures	Offshore dredging	Spills non-oil	Commercial Fishing	Seafood collection	Algal blooms (from sea)	Marine farms	Invasive weeds/pests	Climate change	Extreme storm surf	Vehicles beaches/dunes	Property development	Mining	Existing Condition	Susceptibility	Ecological richness birds	Ecological richness vegetation	Ecological richness biota	Ecological richness Fish
MONITORING INDICATORS (if recommended then shaded)	RISK OF INDICATOR AFFECTING USE					RISK OF STRESSOR AFFECTING INDICATOR																			INDICATOR SENSITIVITY					
Disease risk - faecal indicators																														
Turbidity																														
Nutrients in water																														
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Sea temperature																														
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Sulphide sediments																														
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SVOCs																														
Area/condition of protective dune vegetation																														
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Change in area of unique habitat																														
Shellfish stock assessment																														
Fish stock assessment																														
Benthic invertebrates																														
Oil spill monitoring																														
Invasive species																														

BEACH, DUNE & ROCKY SHORE VULNERABILITY	CAPE PALLISER to WHATARANGI																											
	TYPE: REFLECTIVE																											
VULNERABILITY SCORE = MODERATE	USES AND VALUES					PRESENCE OF STRESSORS																				ECOLOGICAL SENSITIVITY					
VERY HIGH = BLACK HIGH = 1 DARK GREY MEDIUM = 2 MEDIUM GREY LOW = 3 WHITE	Bathing	Shellfish collection	Natural character	Boating	Cultural/spiritual	Terrestrial runoff	Coastal outfall	Stormwater outfall	River plume	Oil spills	Grazing/forestry dunes	Erosion/Cont. Structures	Offshore dredging	Spills non-oil	Commercial Fishing	Seafood collection	Algal blooms (from sea)	Marine farms	Invasive weeds/pests	Climate change	Extreme storm surf	Vehicles beaches/dunes	Property development	Mining	Existing Condition	Susceptibility	Ecological richness birds	Ecological richness vegetation	Ecological richness biota	Ecological richness Fish
MONITORING INDICATORS (if recommended then shaded)	RISK OF INDICATOR AFFECTING USE					RISK OF STRESSOR AFFECTING INDICATOR																			INDICATOR SENSITIVITY					
Disease risk - faecal indicators																													
Turbidity																													
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Shellfish stock assessment																													
Fish stock assessment																													
Benthic invertebrates																													
Oil spill monitoring																													
Invasive species																													

BEACH, DUNE & ROCKY SHORE VULNERABILITY	PALLISER BAY																	TYPE: REFLECTIVE														
VULNERABILITY SCORE = LOW-MODERATE	**USES AND VALUES**					**PRESENCE OF STRESSORS**																					**ECOLOGICAL SENSITIVITY**					
VERY HIGH = BLACK HIGH = 1 DARK GREY MEDIUM = 2 MEDIUM GREY LOW = 3 WHITE	**Bathing**	**Shellfish collection**	**Natural character**	**Boating**	**Cultural/spiritual**	**Terrestrial runoff**	**Coastal outfall**	**Stormwater outfall**	**River plume**	**Oil spills**	**Grazing/forestry dunes**	**Erosion/Cont. Structures**	**Offshore dredging**	**Spills non-oil**	**Commercial Fishing**	**Seafood collection**	**Algal blooms (from sea)**	**Marine farms**	**Invasive weeds/pests**	**Climate change**	**Extreme storm surf**	**Vehicles beaches/dunes**	**Property development**	**Mining**	**Existing Condition**	**Susceptibility**	**Ecological richness birds**	**Ecological richness vegetation**	**Ecological richness biota**	**Ecological richness Fish**
MONITORING INDICATORS (if recommended then shaded)	**RISK OF INDICATOR AFFECTING USE**					**RISK OF STRESSOR AFFECTING INDICATOR**																			**INDICATOR SENSITIVITY**					
Disease risk - faecal indicators																																
Turbidity																																
Nutrients in water																																
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Macroalgal blooms in water																																
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Sulphide sediments																																
Smell																																
Heavy metals																																
SVOCs																																
Area/condition of protective dune vegetation																																
Change in beach area																																
Change in dune area																																
Change in frequency of major coastal storms																																
Sea level rise																																
Change in area of unique habitat																																
Shellfish stock assessment																																
Fish stock assessment																																
Benthic invertebrates																																
Oil spill monitoring																																
Invasive species																																

BEACH, DUNE & ROCKY SHORE VULNERABILITY	OCEAN BEACH TO BARING HEAD																													
	TYPE: REFLECTIVE																													
VULNERABILITY SCORE = LOW	USES AND VALUES					PRESENCE OF STRESSORS																				ECOLOGICAL SENSITIVITY					
VERY HIGH = BLACK HIGH = 1 DARK GREY MEDIUM = 2 MEDIUM GREY LOW = 3 WHITE	Bathing	Shellfish collection	Natural character	Boating	Cultural/spiritual	Terrestrial runoff	Coastal outfall	Stormwater outfall	River plume	Oil spills	Grazing/forestry dunes	Erosion/Cont. Structures	Offshore dredging	Spills non-oil	Commercial Fishing	Seafood collection	Algal blooms (from sea)	Marine farms	Invasive weeds/pests	Climate change	Extreme storm surf	Vehicles beaches/dunes	Property development	Mining	Existing Condition	Susceptibility	Ecological richness birds	Ecological richness vegetation	Ecological richness biota	Ecological richness Fish
MONITORING INDICATORS (if recommended then shaded)	RISK OF INDICATOR AFFECTING USE					RISK OF STRESSOR AFFECTING INDICATOR																			INDICATOR SENSITIVITY					
Disease risk - faecal indicators																														
Turbidity																														
Nutrients in water																														
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Macroalgal blooms in water																														
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Sea temperature																														
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Sulphide sediments																														
Smell																														
Heavy metals																														
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Area/condition of protective dune vegetation																														
Change in beach area																														
Change in dune area																														
Change in frequency of major coastal storms																														
Sea level rise																														
Change in area of unique habitat																														
Shellfish stock assessment																														
Fish stock assessment																														
Benthic invertebrates																														
Oil spill monitoring																														
Invasive species																														

Estuary Risk Analysis		MATAIKONA ESTUARY																													
		TYPE: RIVER MOUTH LAGOON																													
Overall Vulnerability Score = Low		HUMAN USES					PRESENCE OF STRESSORS																			ECOLOGICAL SENSITIVITY					
VERY HIGH = BLACK HIGH = 1 DARK GREY MEDIUM = 2 MEDIUM GREY LOW = 3 WHITE		Bathing	Shellfish collection	Natural character/aesthetic	Boating	Cultural/spiritual	Terrestrial runoff	Coastal outfall	Stormwater outfall	Oil spills	Grazing	Freshwater abstraction	Reclamation	Spills non-oil	Erosion control structures	Seafood collection	Algal blooms (from sea)	Marine farms	Invasive weeds/pests	Climate change	Mouth closing/constriction	Vehicle access	Margin property development	Structures	Existing Condition	Susceptibility	Ecological richness birds	Ecological richness vegetation	Ecological richness biota	Ecological richness Fish
MONITORING INDICATORS If recommended then shaded		RISK OF INDICATOR AFFECTING USE					RISK OF STRESSOR AFFECTING INDICATOR																			INDICATOR SENSITIVITY					
Eutrophication	Dissolved Oxygen																														
	Clarity																														
	Nutrients sediment																														
	Nutrients in water																														
	Chlorophyll																														
	Macroalgal growth																														
	Sulphide sediments																														
	Org C sediments																														
	Smell																														
Flow	Salinity																														
	River flows																														
Temperature	Temperature																														
Sea level	Sea level																														
Sedimentation	Muddiness																														
	Sedimentation rate																														
	Clarity																														
Disease Risk	Faecal Indicators																														
Toxicants	Heavy Metals																														
	SVOCs																														
	Toxic algae																														
Habitat Loss	Saltmarsh																														
	Seagrass																														
	Margin buffer																														
Biota Abundance	Shellfish																														
	Fish																														
Biodiversity	Benthic invertebrates																														
	Invasive species																														

Estuary Risk Analysis		OKAU AND WHAKATAKI ESTUARIES																													
		TYPE: RIVER MOUTH LAGOONS																													
Overall Vulnerability Score = Low		**HUMAN USES**					**PRESENCE OF STRESSORS**																			**ECOLOGICAL SENSITIVITY**					
VERY HIGH = BLACK HIGH = 1 DARK GREY MEDIUM = 2 MEDIUM GREY LOW = 3 WHITE		**Bathing**	**Shellfish collection**	**Natural character/aesthetic**	**Boating**	**Cultural/spiritual**	**Terrestrial runoff**	**Coastal outfall**	**Stormwater outfall**	**Oil spills**	**Grazing**	**Freshwater abstraction**	**Reclamation**	**Spills non-oil**	**Erosion control structures**	**Seafood collection**	**Algal blooms (from sea)**	**Marine farms**	**Invasive weeds/pests**	**Climate change**	**Mouth closing/constriction**	**Vehicle access**	**Margin property development**	**Structures**	**Existing Condition**	**Susceptibility**	**Ecological richness birds**	**Ecological richness vegetation**	**Ecological richness biota**	**Ecological richness Fish**
MONITORING INDICATORS If recommended then shaded		**RISK OF INDICATOR AFFECTING USE**					**RISK OF STRESSOR AFFECTING INDICATOR**																		**INDICATOR SENSITIVITY**					
Eutrophication	Dissolved Oxygen																														
	Clarity																														
	Nutrients sediment																														
	Nutrients in water																														
	Chlorophyll																														
	Macroalgal growth																														
	Sulphide sediments																														
	Org C sediments																														
	Smell																														
Flow	Salinity																														
	River flows																														
Temperature	Temperature																														
Sea level	Sea level																														
Sedimentation	Muddiness																														
	Sedimentation rate																														
	Clarity																														
Disease Risk	Faecal Indicators																														
Toxicants	Heavy Metals																														
	SVOCs																														
	Toxic algae																														
Habitat Loss	Saltmarsh																														
	Seagrass																														
	Margin buffer																														
Biota Abundance	Shellfish																														
	Fish																														
Biodiversity	Benthic invertebrates																														
	Invasive species																														

Estuary Risk Analysis		Ngakauau, Humpies, Otahome Estuaries																												
		TYPE: RIVER MOUTH LAGOONS																												
Overall Vulnerability Score = Low		HUMAN USES					PRESENCE OF STRESSORS																			ECOLOGICAL SENSITIVITY					
VERY HIGH = BLACK HIGH = 1 DARK GREY MEDIUM = 2 MEDIUM GREY LOW = 3 WHITE		Bathing	Shellfish collection	Natural character/aesthetic	Boating	Cultural/spiritual	Terrestrial runoff	Coastal outfall	Stormwater outfall	Oil spills	Grazing	Freshwater abstraction	Reclamation	Spills non-oil	Erosion control structures	Seafood collection	Algal blooms (from sea)	Marine farms	Invasive weeds/pests	Climate change	Mouth closing/constriction	Vehicle access	Margin property development	Structures	Existing Condition	Susceptibility	Ecological richness birds	Ecological richness vegetation	Ecological richness biota	Ecological richness Fish
MONITORING INDICATORS If recommended then shaded		RISK OF INDICATOR AFFECTING USE					RISK OF STRESSOR AFFECTING INDICATOR																			INDICATOR SENSITIVITY					
Eutrophication	Dissolved Oxygen																													
	Clarity																													
	Nutrients sediment																													
	Nutrients in water																													
	Chlorophyll																													
	Macroalgal growth																													
	Sulphide sediments																													
	Org C sediments																													
	Smell																													
Flow	Salinity																													
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Sea level	Sea level																													
Sedimentation	Muddiness																													
	Sedimentation rate																													
	Clarity																													
Disease Risk	Faecal Indicators																													
Toxicants	Heavy Metals																													
	SVOCs																													
	Toxic algae																													
Habitat Loss	Saltmarsh																													
	Seagrass																													
	Margin buffer																													
Biota Abundance	Shellfish																													
	Fish																													
Biodiversity	Benthic invertebrates																													
	Invasive species																													

Estuary Risk Analysis		WHAREAMA ESTUARY																												
		TYPE: TIDAL RIVER																												
Overall Vulnerability Score = Moderate		HUMAN USES					PRESENCE OF STRESSORS																			ECOLOGICAL SENSITIVITY					
VERY HIGH = BLACK HIGH = 1 DARK GREY MEDIUM = 2 MEDIUM GREY LOW = 3 WHITE		Bathing	Shellfish collection	Natural character/aesthetic	Boating	Cultural/spiritual	Terrestrial runoff	Coastal outfall	Stormwater outfall	Oil spills	Grazing	Freshwater abstraction	Reclamation	Spills non-oil	Erosion control structures	Seafood collection	Algal blooms (from sea)	Marine farms	Invasive weeds/pests	Climate change	Mouth closing/constriction	Vehicle access	Margin property development	Structures	Existing Condition	Susceptibility	Ecological richness birds	Ecological richness vegetation	Ecological richness biota	Ecological richness Fish
MONITORING INDICATORS If recommended then shaded		RISK OF INDICATOR AFFECTING USE					RISK OF STRESSOR AFFECTING INDICATOR																			INDICATOR SENSITIVITY					
Eutrophication	Dissolved Oxygen																													
	Clarity																													
	Nutrients sediment																													
	Nutrients in water																													
	Chlorophyll																													
	Macroalgal growth																													
	Sulphide sediments																													
	Org C sediments																													
	Smell																													
Flow	Salinity																													
	River flows																													
Temperature	Temperature																													
Sea level	Sea level																													
Sedimentation	Muddiness																													
	Sedimentation rate																													
	Clarity																													
Disease Risk	Faecal Indicators																													
Toxicants	Heavy Metals																													
	SVOCs																													
	Toxic algae																													
Habitat Loss	Saltmarsh																													
	Seagrass																													
	Margin buffer																													
Biota Abundance	Shellfish																													
	Fish																													
Biodiversity	Benthic invertebrates																													
	Invasive species																													

Estuary Risk Analysis		MOTUWAIREKA ESTUARY																												
		TYPE: RIVER MOUTH LAGOON																												
Overall Vulnerability Score = Low-Moderate		**HUMAN USES**					**PRESENCE OF STRESSORS**																			**ECOLOGICAL SENSITIVITY**					
VERY HIGH = BLACK HIGH = 1 DARK GREY MEDIUM = 2 MEDIUM GREY LOW = 3 WHITE		**Bathing**	**Shellfish collection**	**Natural character/aesthetic**	**Boating**	**Cultural/spiritual**	**Terrestrial runoff**	**Coastal outfall**	**Stormwater outfall**	**Oil spills**	**Grazing**	**Freshwater abstraction**	**Reclamation**	**Spills non-oil**	**Erosion control structures**	**Seafood collection**	**Algal blooms (from sea)**	**Marine farms**	**Invasive weeds/pests**	**Climate change**	**Mouth closing/constriction**	**Vehicle access**	**Margin property development**	**Structures**	**Existing Condition**	**Susceptibility**	**Ecological richness birds**	**Ecological richness vegetation**	**Ecological richness biota**	**Ecological richness Fish**
MONITORING INDICATORS If recommended then shaded		**RISK OF INDICATOR AFFECTING USE**					**RISK OF STRESSOR AFFECTING INDICATOR**																		**INDICATOR SENSITIVITY**					
Eutrophication	Dissolved Oxygen																													
	Clarity																													
	Nutrients sediment																													
	Nutrients in water																													
	Chlorophyll																													
	Macroalgal growth																													
	Sulphide sediments																													
	Org C sediments																													
	Smell																													
Flow	Salinity																													
	River flows																													
Temperature	Temperature																													
Sea level	Sea level																													
Sedimentation	Muddiness																													
	Sedimentation rate																													
	Clarity																													
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Toxicants	Heavy Metals																													
	SVOCs																													
	Toxic algae																													
Habitat Loss	Saltmarsh																													
	Seagrass																													
	Margin buffer																													
Biota Abundance	Shellfish																													
	Fish																													
Biodiversity	Benthic invertebrates																													
	Invasive species																													

Estuary Risk Analysis		PATANUI & KAIWHATA ESTUARIES																												
		TYPE: RIVER MOUTH LAGOON																												
Overall Vulnerability Score = Low		**HUMAN USES**					**PRESENCE OF STRESSORS**																			**ECOLOGICAL SENSITIVITY**					
VERY HIGH = BLACK HIGH = 1 DARK GREY MEDIUM = 2 MEDIUM GREY LOW = 3 WHITE		**Bathing**	**Shellfish collection**	**Natural character/aesthetic**	**Boating**	**Cultural/spiritual**	**Terrestrial runoff**	**Coastal outfall**	**Stormwater outfall**	**Oil spills**	**Grazing**	**Freshwater abstraction**	**Reclamation**	**Spills non-oil**	**Erosion control structures**	**Seafood collection**	**Algal blooms (from sea)**	**Marine farms**	**Invasive weeds/pests**	**Climate change**	**Mouth closing/constriction**	**Vehicle access**	**Margin property development**	**Structures**	**Existing Condition**	**Susceptibility**	**Ecological richness birds**	**Ecological richness vegetation**	**Ecological richness biota**	**Ecological richness Fish**
MONITORING INDICATORS If recommended then shaded		**RISK OF INDICATOR AFFECTING USE**					**RISK OF STRESSOR AFFECTING INDICATOR**																		**INDICATOR SENSITIVITY**					
Eutrophication	Dissolved Oxygen																													
	Clarity																													
	Nutrients sediment																													
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	Chlorophyll																													
	Macroalgal growth																													
	Sulphide sediments																													
	Org C sediments																													
	Smell																													
Flow	Salinity																													
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Temperature	Temperature																													
Sea level	Sea level																													
Sedimentation	Muddiness																													
	Sedimentation rate																													
	Clarity																													
Disease Risk	Faecal Indicators																													
Toxicants	Heavy Metals																													
	SVOCs																													
	Toxic algae																													
Habitat Loss	Saltmarsh																													
	Seagrass																													
	Margin buffer																													
Biota Abundance	Shellfish																													
	Fish																													
Biodiversity	Benthic invertebrates																													
	Invasive species																													

Estuary Risk Analysis		PAHAOA ESTUARY																		TYPE: RIVER MOUTH LAGOON											
Overall Vulnerability Score = Low		**HUMAN USES**					**PRESENCE OF STRESSORS**																				**ECOLOGICAL SENSITIVITY**					
VERY HIGH = BLACK HIGH = 1 DARK GREY MEDIUM = 2 MEDIUM GREY LOW = 3 WHITE		Bathing	Shellfish collection	Natural character/aesthetic	Boating	Cultural/spiritual	Terrestrial runoff	Coastal outfall	Stormwater outfall	Oil spills	Grazing	Freshwater abstraction	Reclamation	Spills non-oil	Erosion control structures	Seafood collection	Algal blooms (from sea)	Marine farms	Invasive weeds/pests	Climate change	Mouth closing/constriction	Vehicle access	Margin property development	Structures	Existing Condition	Susceptibility	Ecological richness birds	Ecological richness vegetation	Ecological richness biota	Ecological richness Fish
MONITORING INDICATORS If recommended then shaded		**RISK OF INDICATOR AFFECTING USE**					**RISK OF STRESSOR AFFECTING INDICATOR**																			**INDICATOR SENSITIVITY**					
Eutrophication	Dissolved Oxygen																														
	Clarity																														
	Nutrients sediment																														
	Nutrients in water																														
	Chlorophyll																														
	Macroalgal growth																														
	Sulphide sediments																														
	Org C sediments																														
	Smell																														
Flow	Salinity																														
	River flows																														
Temperature	Temperature																														
Sea level	Sea level																														
Sedimentation	Muddiness																														
	Sedimentation rate																														
	Clarity																														
Disease Risk	Faecal Indicators																														
Toxicants	Heavy Metals																														
	SVOCs																														
	Toxic algae																														
Habitat Loss	Saltmarsh																														
	Seagrass																														
	Margin buffer																														
Biota Abundance	Shellfish																														
	Fish																														
Biodiversity	Benthic invertebrates																														
	Invasive species																														

Estuary Risk Analysis		REREWHAKAAITU ESTUARY																			TYPE: RIVER MOUTH LAGOON											
Overall Vulnerability Score = Low		**HUMAN USES**					**PRESENCE OF STRESSORS**																				**ECOLOGICAL SENSITIVITY**					
VERY HIGH = BLACK HIGH = 1 DARK GREY MEDIUM = 2 MEDIUM GREY LOW = 3 WHITE		Bathing	Shellfish collection	Natural character/aesthetic	Boating	Cultural/spiritual	Terrestrial runoff	Coastal outfall	Stormwater outfall	Oil spills	Grazing	Freshwater abstraction	Reclamation	Spills non-oil	Erosion control structures	Seafood collection	Algal blooms (from sea)	Marine farms	Invasive weeds/pests	Climate change	Mouth closing/constriction	Vehicle access	Margin property development	Structures	Existing Condition	Susceptibility	Ecological richness birds	Ecological richness vegetation	Ecological richness biota	Ecological richness Fish
MONITORING INDICATORS If recommended then shaded		**RISK OF INDICATOR AFFECTING USE**					**RISK OF STRESSOR AFFECTING INDICATOR**																		**INDICATOR SENSITIVITY**					
Eutrophication	Dissolved Oxygen																															
	Clarity																															
	Nutrients sediment																															
	Nutrients in water																															
	Chlorophyll																															
	Macroalgal growth																															
	Sulphide sediments																															
	Org C sediments																															
	Smell																															
Flow	Salinity																															
	River flows																															
Temperature	Temperature																															
Sea level	Sea level																															
Sedimentation	Muddiness																															
	Sedimentation rate																															
	Clarity																															
Disease Risk	Faecal Indicators																															
Toxicants	Heavy Metals																															
	SVOCs																															
	Toxic algae																															
Habitat Loss	Saltmarsh																															
	Seagrass																															
	Margin buffer																															
Biota Abundance	Shellfish																															
	Fish																															
Biodiversity	Benthic invertebrates																															
	Invasive species																															

Estuary Risk Analysis		OTEREI ESTUARY																												
Overall Vulnerability Score = Low		**HUMAN USES**					**PRESENCE OF STRESSORS**																			**ECOLOGICAL SENSITIVITY**					
VERY HIGH = BLACK HIGH = 1 DARK GREY MEDIUM = 2 MEDIUM GREY LOW = 3 WHITE		**Bathing**	**Shellfish collection**	**Natural character/aesthetic**	**Boating**	**Cultural/spiritual**	**Terrestrial runoff**	**Coastal outfall**	**Stormwater outfall**	**Oil spills**	**Grazing**	**Freshwater abstraction**	**Reclamation**	**Spills non-oil**	**Erosion control structures**	**Seafood collection**	**Algal blooms (from sea)**	**Marine farms**	**Invasive weeds/pests**	**Climate change**	**Mouth closing/constriction**	**Vehicle access**	**Margin property development**	**Structures**	**Existing Condition**	**Susceptibility**	**Ecological richness birds**	**Ecological richness vegetation**	**Ecological richness biota**	**Ecological richness Fish**
MONITORING INDICATORS If recommended then shaded		**RISK OF INDICATOR AFFECTING USE**					**RISK OF STRESSOR AFFECTING INDICATOR**																			**INDICATOR SENSITIVITY**					
Eutrophication	Dissolved Oxygen																													
	Clarity																													
	Nutrients sediment																													
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	Chlorophyll																													
	Macroalgal growth																													
	Sulphide sediments																													
	Org C sediments																													
	Smell																													
Flow	Salinity																													
	River flows																													
Temperature	Temperature																													
Sea level	Sea level																													
Sedimentation	Muddiness																													
	Sedimentation rate																													
	Clarity																													
Disease Risk	Faecal Indicators																													
Toxicants	Heavy Metals																													
	SVOCs																													
	Toxic algae																													
Habitat Loss	Saltmarsh																													
	Seagrass																													
	Margin buffer																													
Biota Abundance	Shellfish																													
	Fish																													
Biodiversity	Benthic invertebrates																													
	Invasive species																													

Estuary Risk Analysis		AWHEA ESTUARY																													
Overall Vulnerability Score = Low		**HUMAN USES**					**PRESENCE OF STRESSORS**																				**ECOLOGICAL SENSITIVITY**					
VERY HIGH = BLACK HIGH = 1 DARK GREY MEDIUM = 2 MEDIUM GREY LOW = 3 WHITE		Bathing	Shellfish collection	Natural character/aesthetic	Boating	Cultural/spiritual	Terrestrial runoff	Coastal outfall	Stormwater outfall	Oil spills	Grazing	Freshwater abstraction	Reclamation	Spills non-oil	Erosion control structures	Seafood collection	Algal blooms (from sea)	Marine farms	Invasive weeds/pests	Climate change	Mouth closing/constriction	Vehicle access	Margin property development	Structures	Existing Condition	Susceptibility	Ecological richness birds	Ecological richness vegetation	Ecological richness biota	Ecological richness Fish
MONITORING INDICATORS If recommended then shaded		**RISK OF INDICATOR AFFECTING USE**					**RISK OF STRESSOR AFFECTING INDICATOR**																		**INDICATOR SENSITIVITY**					
Eutrophication	Dissolved Oxygen																														
	Clarity																														
	Nutrients sediment																														
	Nutrients in water																														
	Chlorophyll																														
	Macroalgal growth																														
	Sulphide sediments																														
	Org C sediments																														
	Smell																														
Flow	Salinity																														
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	Sedimentation rate																														
	Clarity																														
Disease Risk	Faecal Indicators																														
Toxicants	Heavy Metals																														
	SVOCs																														
	Toxic algae																														
Habitat Loss	Saltmarsh																														
	Seagrass																														
	Margin buffer																														
Biota Abundance	Shellfish																														
	Fish																														
Biodiversity	Benthic invertebrates																														
	Invasive species																														

Estuary Risk Analysis		OPOUAWE ESTUARY																					TYPE: RIVER MOUTH LAGOON						
Overall Vulnerability Score = Low		**HUMAN USES**					**PRESENCE OF STRESSORS**																	**ECOLOGICAL SENSITIVITY**					
VERY HIGH = BLACK HIGH = 1 DARK GREY MEDIUM = 2 MEDIUM GREY LOW = 3 WHITE		**Bathing**	**Shellfish collection**	**Natural character/aesthetic**	**Boating**	**Cultural/spiritual**	**Terrestrial runoff**	**Coastal outfall**	**Stormwater outfall**	**Oil spills**	**Grazing**	**Freshwater abstraction**	**Reclamation**	**Spills non-oil**	**Erosion control structures**	**Seafood collection**	**Algal blooms (from sea)**	**Marine farms**	**Invasive weeds/pests**	**Climate change**	**Mouth closing/constriction**	**Vehicle access**	**Margin property development**	**Structures**	**Existing Condition**	**Susceptibility**	**Ecological richness birds**	**Ecological richness vegetation**	**Ecological richness biota**	**Ecological richness Fish**
MONITORING INDICATORS If recommended then shaded		**RISK OF INDICATOR AFFECTING USE**					**RISK OF STRESSOR AFFECTING INDICATOR**																	**INDICATOR SENSITIVITY**					
Eutrophication	Dissolved Oxygen																												
	Clarity																												
	Nutrients sediment																												
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Flow	Salinity																												
	River flows																												
Temperature	Temperature																												
Sea level	Sea level																												
Sedimentation	Muddiness																												
	Sedimentation rate																												
	Clarity																												
Disease Risk	Faecal Indicators																												
Toxicants	Heavy Metals																												
	SVOCs																												
	Toxic algae																												
Habitat Loss	Saltmarsh																												
	Seagrass																												
	Margin buffer																												
Biota Abundance	Shellfish																												
	Fish																												
Biodiversity	Benthic invertebrates																												
	Invasive species																												

Estuary Risk Analysis

LAKE ONOKE

TYPE: COASTAL LAKE

Overall Vulnerability Score = Moderate-High

		HUMAN USES					PRESENCE OF STRESSORS																		ECOLOGICAL SENSITIVITY					
VERY HIGH = BLACK HIGH = 1 DARK GREY MEDIUM = 2 MEDIUM GREY LOW = 3 WHITE		Bathing	Shellfish collection	Natural character/aesthetic	Boating	Cultural/spiritual	Terrestrial runoff	Coastal outfall	Stormwater outfall	Oil spills	Grazing	Freshwater abstraction	Reclamation	Spills non-oil	Erosion control structures	Seafood collection	Algal blooms (from sea)	Marine farms	Invasive weeds/pests	Climate change	Mouth closing/constriction	Vehicle access	Margin property development	Structures	Existing Condition	Susceptibility	Ecological richness birds	Ecological richness vegetation	Ecological richness biota	Ecological richness Fish
MONITORING INDICATORS If recommended then shaded		**RISK OF INDICATOR AFFECTING USE**					**RISK OF STRESSOR AFFECTING INDICATOR**																		**INDICATOR SENSITIVITY**					
Eutrophication	Dissolved Oxygen																													
	Clarity																													
	Nutrients sediment																													
	Nutrients in water																													
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	Toxic algae																													
Habitat Loss	Saltmarsh																													
	Seagrass																													
	Margin buffer																													
Biota Abundance	Shellfish																													
	Fish																													
Biodiversity	Benthic invertebrates																													
	Invasive species																													

Estuary Risk Analysis		ORONGORONGO ESTUARY																		TYPE: RIVER MOUTH LAGOON											
Overall Vulnerability Score = Low		**HUMAN USES**					**PRESENCE OF STRESSORS**																				**ECOLOGICAL SENSITIVITY**					
VERY HIGH = BLACK HIGH = 1 DARK GREY MEDIUM = 2 MEDIUM GREY LOW = 3 WHITE		Bathing	Shellfish collection	Natural character/aesthetic	Boating	Cultural/spiritual	Terrestrial runoff	Coastal outfall	Stormwater outfall	Oil spills	Grazing	Freshwater abstraction	Reclamation	Spills non-oil	Erosion control structures	Seafood collection	Algal blooms (from sea)	Marine farms	Invasive weeds/pests	Climate change	Mouth closing/constriction	Vehicle access	Margin property development	Structures	Existing Condition	Susceptibility	Ecological richness birds	Ecological richness vegetation	Ecological richness biota	Ecological richness Fish		
MONITORING INDICATORS If recommended then shaded		**RISK OF INDICATOR AFFECTING USE**					**RISK OF STRESSOR AFFECTING INDICATOR**																			**INDICATOR SENSITIVITY**					
Eutrophication	Dissolved Oxygen																														
	Clarity																														
	Nutrients sediment																														
	Nutrients in water																														
	Chlorophyll																														
	Macroalgal growth																														
	Sulphide sediments																														
	Org C sediments																														
	Smell																														
Flow	Salinity																														
	River flows																														
Temperature	Temperature																														
Sea level	Sea level																														
Sedimentation	Muddiness																														
	Sedimentation rate																														
	Clarity																														
Disease Risk	Faecal Indicators																														
Toxicants	Heavy Metals																														
	SVOCs																														
	Toxic algae																														
Habitat Loss	Saltmarsh																														
	Seagrass																														
	Margin buffer																														
Biota Abundance	Shellfish																														
	Fish																														
Biodiversity	Benthic invertebrates																														
	Invasive species																														

Estuary Vulnerability		WAINUIOMATA ESTUARY														TYPE: RIVER MOUTH LAGOON															
Overall Vulnerability Score = Low		**HUMAN USES**					**PRESENCE OF STRESSORS**																			**ECOLOGICAL SENSITIVITY**					
VERY HIGH = BLACK HIGH = 1 DARK GREY MEDIUM = 2 MEDIUM GREY LOW = 3 WHITE		Bathing	Shellfish collection	Natural character/aesthetic	Boating	Cultural/spiritual	Terrestrial runoff	Coastal outfall	Stormwater outfall	Oil spills	Grazing	Freshwater abstraction	Reclamation	Spills non-oil	Erosion control structures	Seafood collection	Algal blooms (from sea)	Marine farms	Invasive weeds/pests	Climate change	Mouth closing/constriction	Vehicle access	Margin property development	Structures	Existing Condition	Susceptibility	Ecological richness birds	Ecological richness vegetation	Ecological richness biota	Ecological richness Fish
MONITORING INDICATORS If recommended then shaded		**RISK OF INDICATOR AFFECTING USE**					**RISK OF STRESSOR AFFECTING INDICATOR**																			**INDICATOR SENSITIVITY**					
Eutrophication	Dissolved Oxygen																														
	Clarity																														
	Nutrients sediment																														
	Nutrients in water																														
	Chlorophyll																														
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