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Changes in Abundance of Seagrass (*Zostera marina*) in Southern Tauranga Harbour

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Cover Photo: Swan grazing damage to sea grass beds at Otumoetai, August 1994

Executive Summary

This report presents the results of mapping and assessing changes in abundance of seagrass in southern Tauranga Harbour between 1959 and 1996. Seagrass beds have high ecological values and contribute to the harbour ecosystem in terms of:

- stabilising the sea bed and preventing erosion,
- provide food and shelter for a range of small animals,
- increase productivity
- increased habitat complexity and hence species diversity.

Seagrass beds are particularly sensitive to human induced impacts that result in a decrease in the levels of light reaching the seabed. The main impact is caused by increased suspended sediment and nutrients from land runoff and stormwater.

Overall the loss of seagrass beds between 1959 and 1996 has been assessed at 54% for the whole of southern Tauranga Harbour. Seagrass beds in the shallow subtidal and sub-estuary areas with larger catchments have suffered the most. The areas near the harbour entrance with little land runoff have shown the smallest decline in seagrass abundance.

The magnitude of loss represents a serious impact on harbour ecology and may be even worse if substantial losses have occurred before 1959. With more recent improvements to reducing land runoff of sediments and nutrients it is possible that the decline may be slowing or stopped altogether. The assessments of abundance will provide a baseline against which future changes can be checked along with the effectiveness of land and coastal plan policies.

Contents

Chapter 1: Introduction

1.1 Scope

This report present the results of digitally mapping seagrass beds in southern Tauranga Harbour based on aerial photography from 1959 and 1996. The main aim of this exercise was to allow an assessment of any change in abundance over time and provide a suitable base line for any future assessments.

It also addresses Environment B·O·P's responsibilities under the Resource Management Act (1991) in relation to the sustainable management principals set out in Part II (section 5) and directives to monitor the state of the environment as set out in Part IV (section 35; 1 and 2a, section 30; 1a). MfE have also proposed that the extent and condition of seagrass beds is monitored as one of the national environmental performance indicators for the marine environment. Changes in seagrass abundance will also provide data that can be used to monitor the effectiveness of the coastal plan and land plans, particularly in the long-term, and provide a more holistic understanding of terrestrial and other influences when reviewing these plans.

1.2 Background

1.2.1 Seagrass

Seagrasses are not true grasses but unlike most marine plants they are true flowering plants with stems, leaves, roots, and flowers. The species of seagrass in New Zealand are *Zostera spp.* and commonly referred to as eelgrass. These species commonly occur worldwide in temperate zones. Seagrass beds are found mostly in estuaries and shallow coastal waters with sandy or muddy bottoms. Seagrass plants produce pollen to fertilise flowers and produce seeds in the same manner as terrestrial plants. Plants have extensive horizontal underground stems (rhizomes) and strong roots that anchor the plants to the soft bottom. The roots absorb nutrients but do not take up water.

Erect branches and leaves grow off the buried stem. The leaves have a thin skin that allows efficient nutrient and gas uptake from the water. The continual outward growth of seagrass beds is often not due to new individual plants but horizontal stems continually growing.

Ecological importance

Seagrass is a highly important component of intertidal and shallow subtidal (generally 1-2 m depth) zones within most New Zealand estuaries. Seagrass forms a very productive habitat which enhances overall biological productivity and diversity. The beds stabilise the sand and mud in which they grow, and provide food, shelter, breeding grounds and nursery areas for many marine organisms including commercial fish stocks.

Erosion control – seagrass stabilises the seabed with their roots, horizontal stems and leaves. This prevents the movement of sediments making a more permanent and productive habitat that other organisms can use.

Food - some fish and other organisms can feed directly on seagrass. Decaying seagrass leaves also provide a bountiful food supply for small animals, such as bacteria, worms and crabs, which in turn are eaten by fish. Seagrass produces small amounts of nutrient required by other coastal plants and animals.

Shelter – small animals and plants shelter in the seagrass leaves, receiving protection from predators, and from too much sunlight, or temporary changes in salinity and temperature. Fast water movement is also reduced in seagrass beds, creating a well-protected environment for small organisms. The beds also increase the habitat complexity providing a range of additional microhabitats. The leaves provide a stable substrate upon which epiphytic algae can grow and increase overall productivity of these ecosystems.

Nursery – as a nursery for juvenile fish and crabs, seagrass beds enhance the survival and recruitment rates into commercial fisheries which are worth hundreds of millions of dollars.

Impacts on seagrass

Natural processes, such as storms can damage seagrass beds. However, because seagrass beds are usually found in shallow coastal waters close to human habitation, they are particularly vulnerable to the impact of human activities. Often the mechanisms by which seagrass beds are damaged are complex and may involve a number of factors.

Eutrophication – increased nutrient levels from sewage outfalls and land runoff encourage the excessive growth of microscopic algae suspended in the water above the plants, or the overgrowth of epiphytic algae on the seagrass leaves. If enough algae grows, the sunlight needed for photosynthesis cannot penetrate to the seagrass, eventually causing the plants to die. Sea lettuce when abundant acts in a similar manner by accumulating on the beds and smothering them.

Clarity reduction – decreased water clarity from suspended sediments sourced from land runoff and storm water have a similar impact to that of eutrophication. Reduced light transmittance in muddier waters will reduce seagrass growth rates and the water depth to which they can grow. Sediments settling directly on to leaves of seagrass plants will also reduce growth, or cause death of the plants if settlement occurs over longer periods.

Reclamation – several areas of seagrass in Tauranga Harbour have been lost through the reclamation of the seabed.

Dredging – dredging of shipping channels, ports and canal estates can kill seagrass. Dredging not only physically removes seagrass plants, but creates muddied water that reduces the amount of sunlight penetrating to the seagrass. Therefore photosynthesis cannot take place and the plants cannot grow. Increased water depth in dredged channels may also prevent re-colonisation because of decreased light penetration and increased sedimentation.

Oil – oil spills can directly poison seagrass plants by coating the leaves.

Physical disturbance – seagrass beds are slow growing and sensitive to any physical disturbance. Motor vehicles crossing seagrass beds, boat anchors and small towed dredges are all capable of physically damaging and killing seagrass. In the northern area of Bluegum Bay, Tauranga Harbour, the area disturbed when a pipeline was put in over 20 years ago is still evident.

Introduced organisms – introduced species such as the black swan are present in large numbers on Tauranga Harbour. Swans graze the seagrass by totally removing the plants and open up patches that may be a meter across.

Chapter 2: Methods

2.1 Introduction

To assess cover of seagrass beds in Tauranga Harbour a manual onscreen digital mapping approach was used based on aerial photography. Although complete aerial photography of Tauranga Harbour is available as early as 1943 the quality is low with extensive cloud cover. The 1959 aerial photography was deemed to be the most suitable complete aerial survey that would enable mapping of the entire harbour. A manual mapping approach was used as the 1959 photography is in black and white making the use of automated classification techniques difficult to apply with out extensive editing and checking of output. This simple approach also meant that scanned aerial photography from 1996 could be saved as a grey scale format reducing overall file storage requirements. It also resulted in a more consistent result for the 1959 and 1996 maps.

2.2 Scale and Resolution

1959 aerial photography was available as black and white 1:17,000 scale prints. Prints were scanned to provide a minimum resolution of 2-metre pixel size when the electronic files were viewed on screen. 1996 aerial colour photography was available as 1:15,000 scale prints. The resolution of the scanned prints was the same as the 1959 images.

2.3 Image Registration

I/RAS C software was used to register rectify and mosaic the scanned photography. This method will not achieve ortho-rectification (systematic) removal of camera lens distortion in the photos. The areas being mapped were obviously flat so distortion due to varying terrain elevation was not a problem. Positional accuracy from rectification of photos depends on the degree of overlap between photos and the number of quality registration points.

Generally each photo was registered with between 12-15 known points. Most points were derived from DCDB data with some from image to image and known geographical points. It was often necessary to use the margin area of individual photos to reduce glare from the water surface. This increases distortion in the image from the camera lens. Overall however, the final product has a positional accuracy of ± 10m for 90% of the imagery.

2.4 Mapping

Areas of seagrass were digitally mapped onscreen using Mapinfo version 4.5 and stored as individual data layers for each of the 1959, 1996 surveys. Individual seagrass beds were mapped as polygons with an accuracy of around ± 5m for defining the margins of these areas. Most small isolated seagrass beds down to a size of around 5m diameter were captured.

Because many areas of seagrass are very patchy a ranked system of coverage was used. This allowed faster mapping by enclosing these areas as single polygons and assigning them to one of the density rankings. Three density rankings were used as follows;

100%: polygons with this ranking had 90-100% coverage,

75%: polygons with 60-90% coverage,

50%: polygons with 40-60% coverage.

Chapter 3: Results

3.1 Changes in Seagrass Abundance

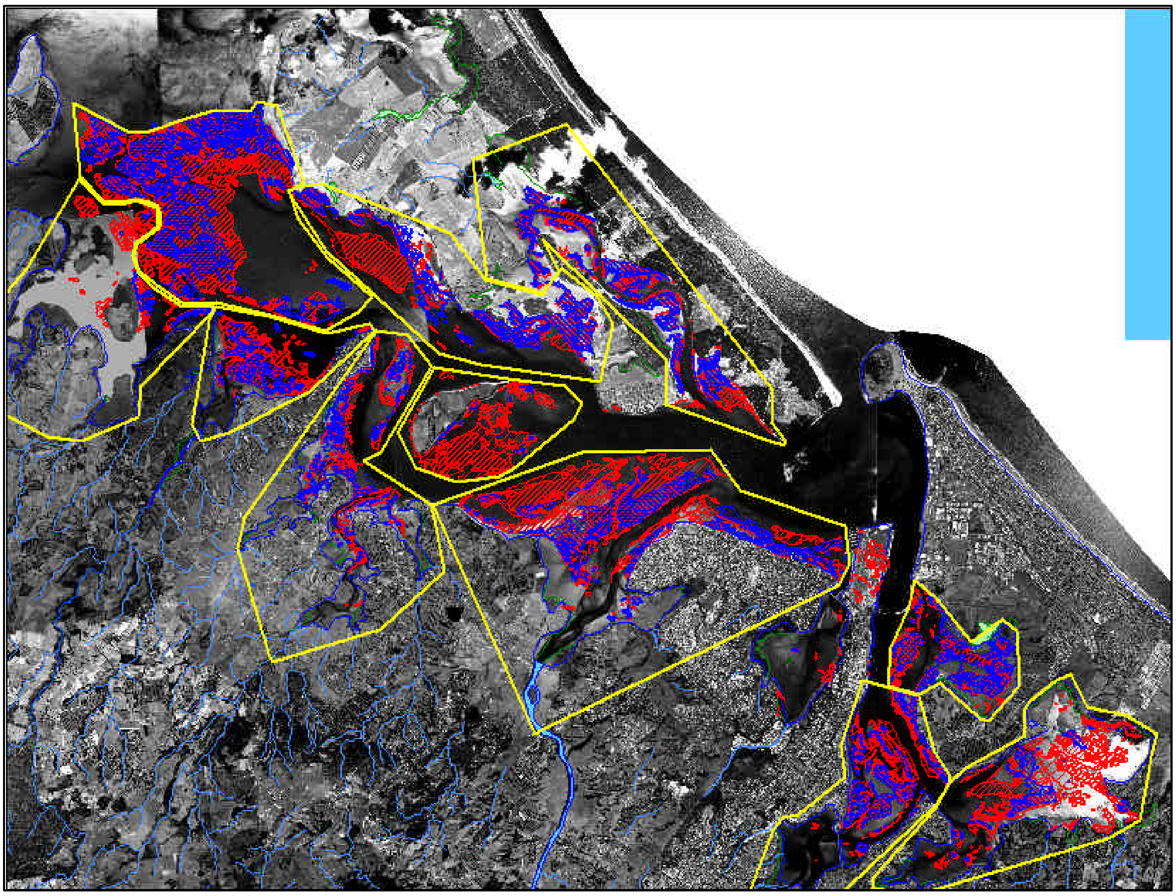
Results for the change in abundance of seagrass in southern Tauranga Harbour between 1959 and 1996 is summarised in Table 3.1 below. For the whole of the southern harbour the area of seagrass beds has reduced from 2,391 hectares in 1959 down to 1,083 hectares in 1996. This is a reduction of 54.7% from the 1959 baseline and represents a very significant and serious loss.

Table 1: Seagrass cover in southern Tauranga Harbour

	Area (Ha)		% reduction
	1959	1996	
Southern Tauranga Harbour	2391.6	1083.9	54.7
Welcome Bay	200.6	43.2	78.5
Town Reach	109.2	65.7	39.8
Waipu Bay	99.9	79.0	20.9
Wairoa Estuary	436.9	173.8	60.2
Mangawai Bay	103.5	49.7	52.0
Waipapa Estuary	108.4	45.3	58.2
Wainui Estuary	67.7	11.0	83.8
Mid upper Harbour	723.7	366.1	49.4
Motuhoa Island	124.6	1.7	98.6
Matakana	231.1	133.6	42.2
Hunters Creek	162.0	113.6	29.9

Table 3.1 also contains a break down into smaller more localised and geographically distinct areas. These areas are shown in Figure 3.1. Each individual area is then shown in Figure 3.2. The density of red and blue shading used in the figures to represent areas of seagrass also corresponds to the three density rankings used (most dense shading = 100% cover).

Figure 3.1 Southern Tauranga Harbour showing the sub-areas summarised in Table 3.1.

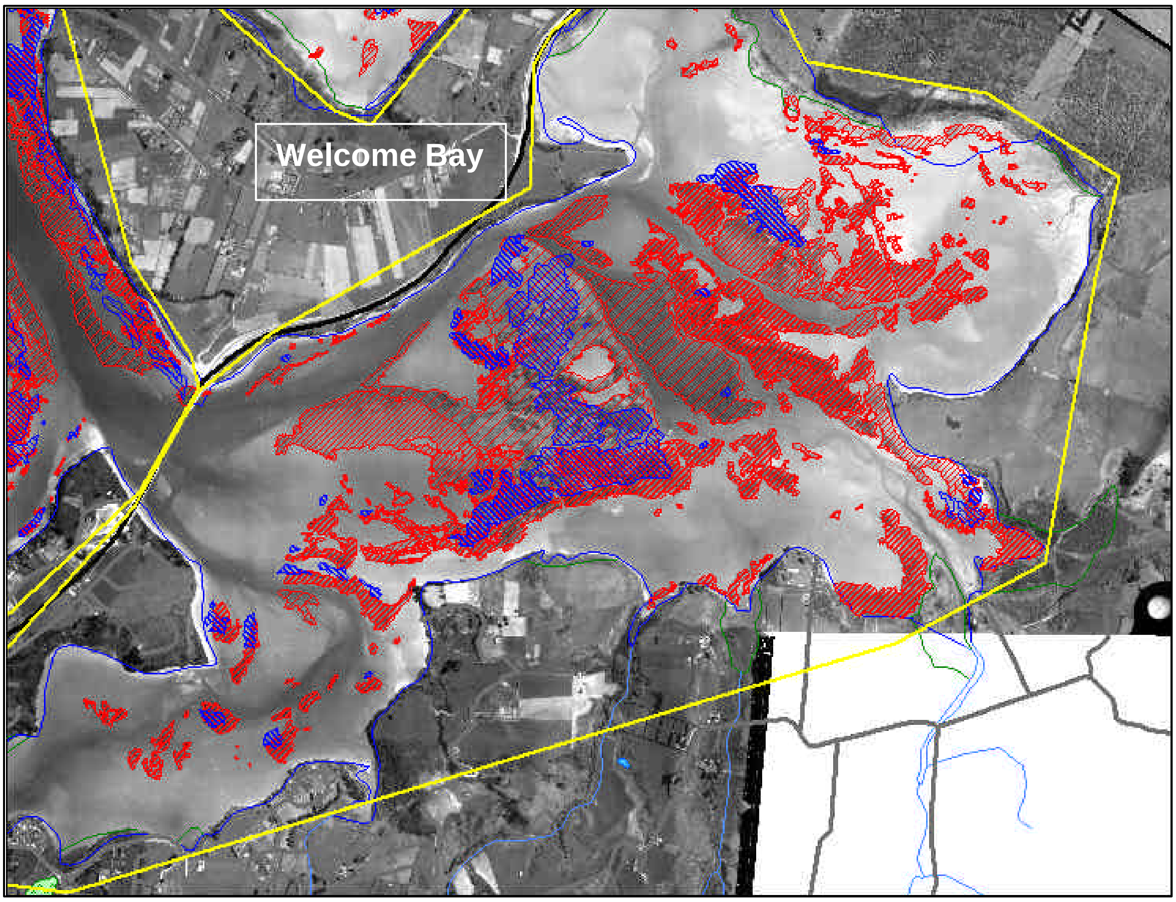


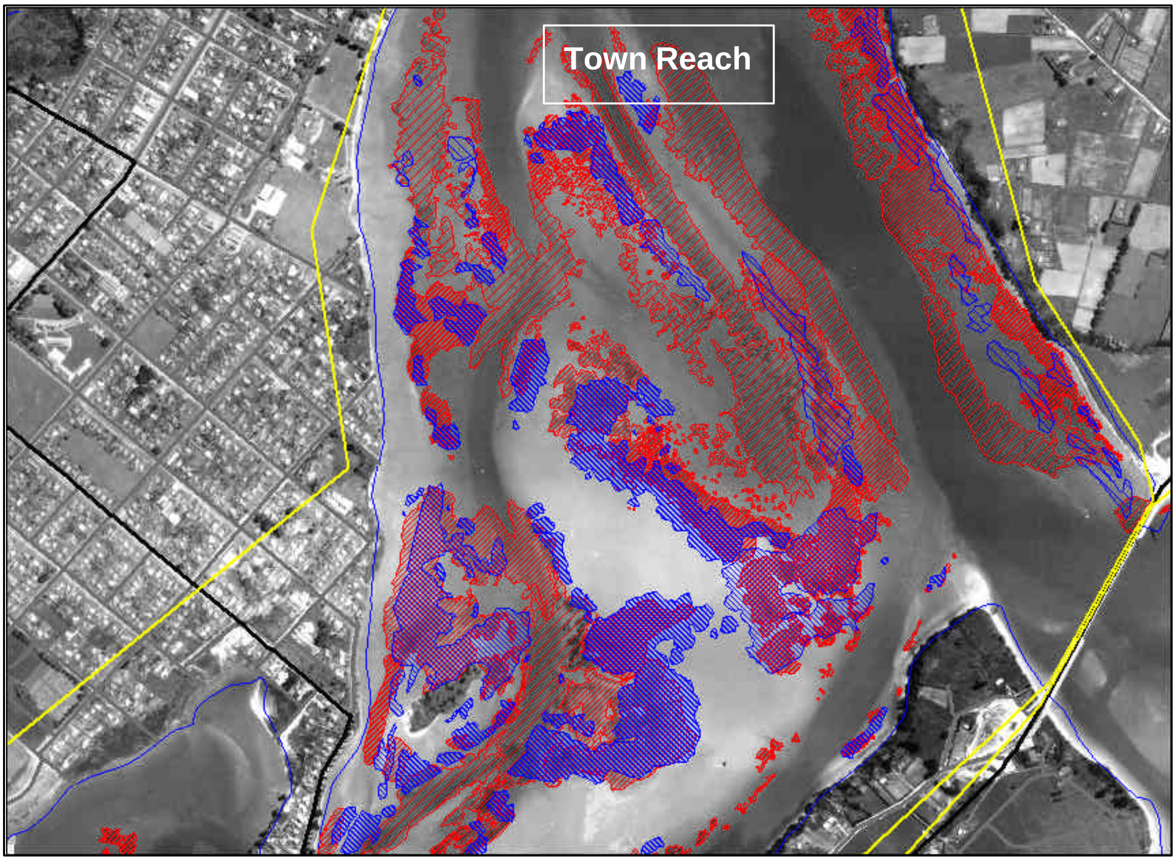
The greatest loss of seagrass between 1959 and 1996 on a sub-regional basis occurred in the Motuhoa Island area. The majority of seagrass beds in this area in 1959 were in the shallow subtidal zone and it is this type of habitat that appears to have suffered most.

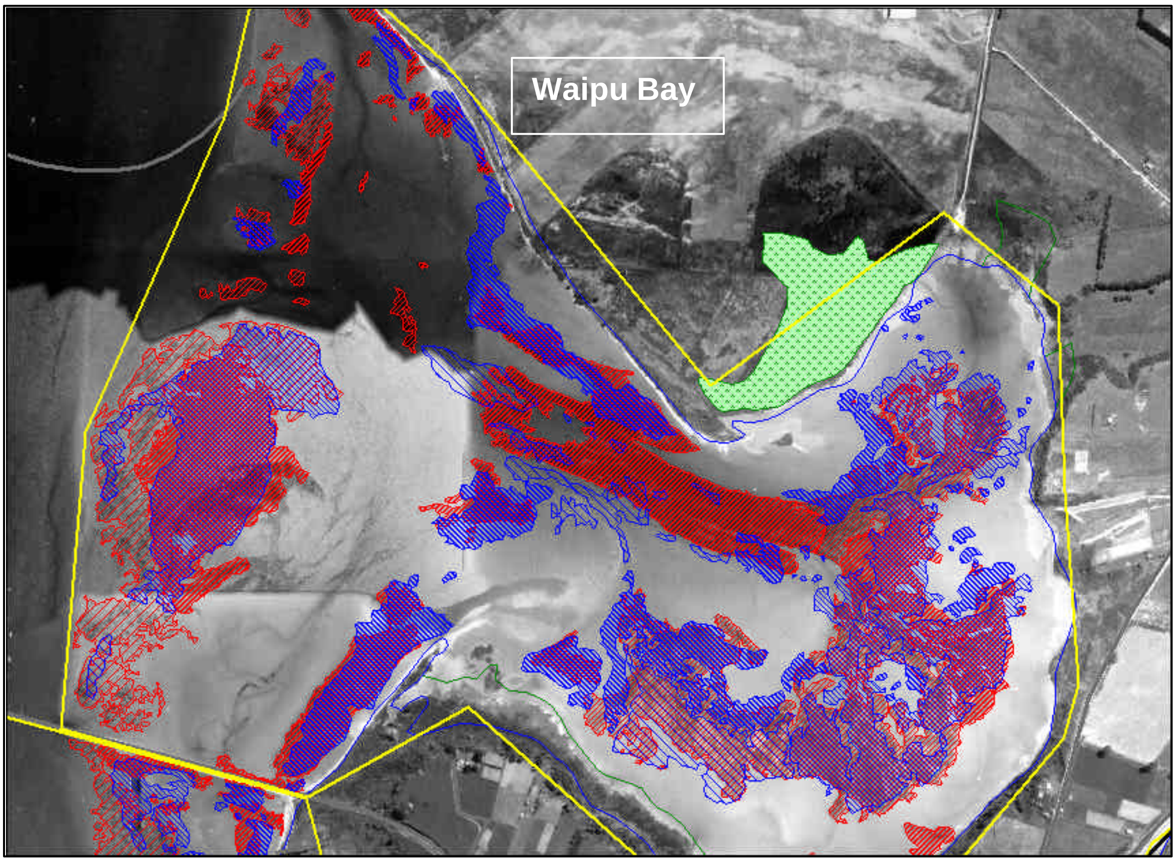
Other areas to suffer very high loss of seagrass were the Welcome Bay and Wainui Estuary areas. Both these areas had predominantly intertidal seagrass beds.

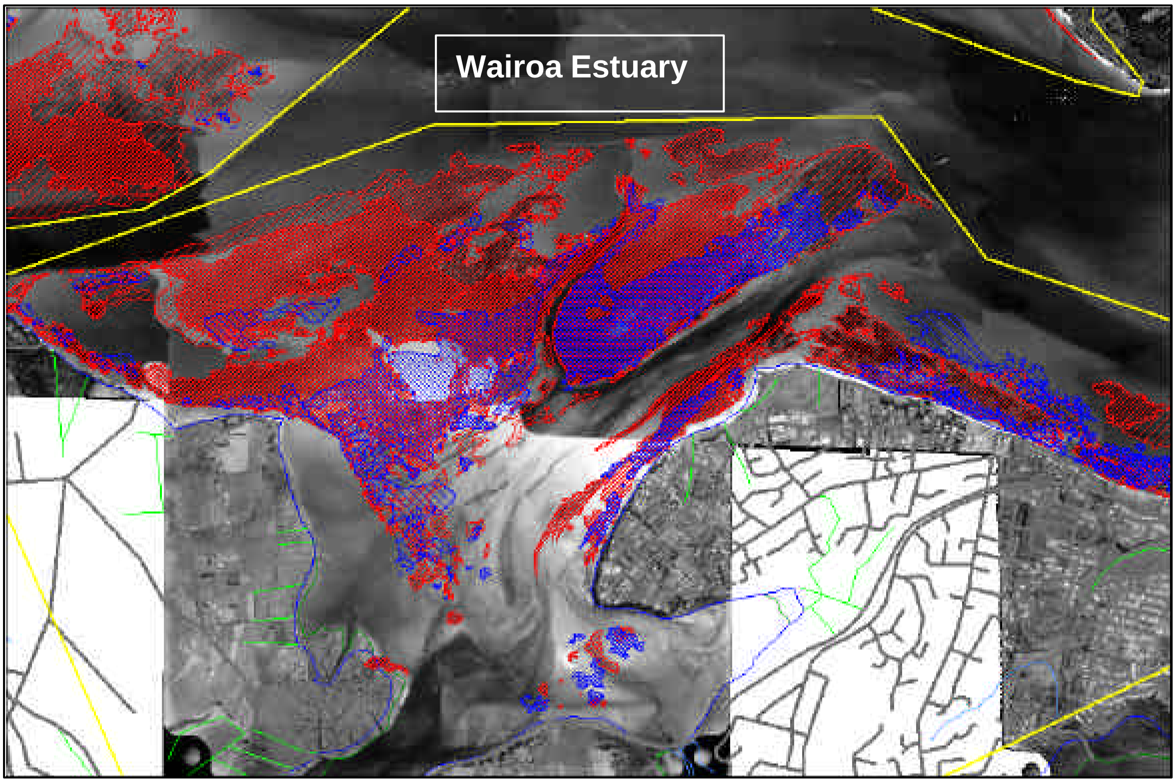
Areas of lowest seagrass loss between 1959 and 1996 included the Waipu Bay and Hunters Creek areas. Both these areas are near the harbour entrance and have very little land runoff.

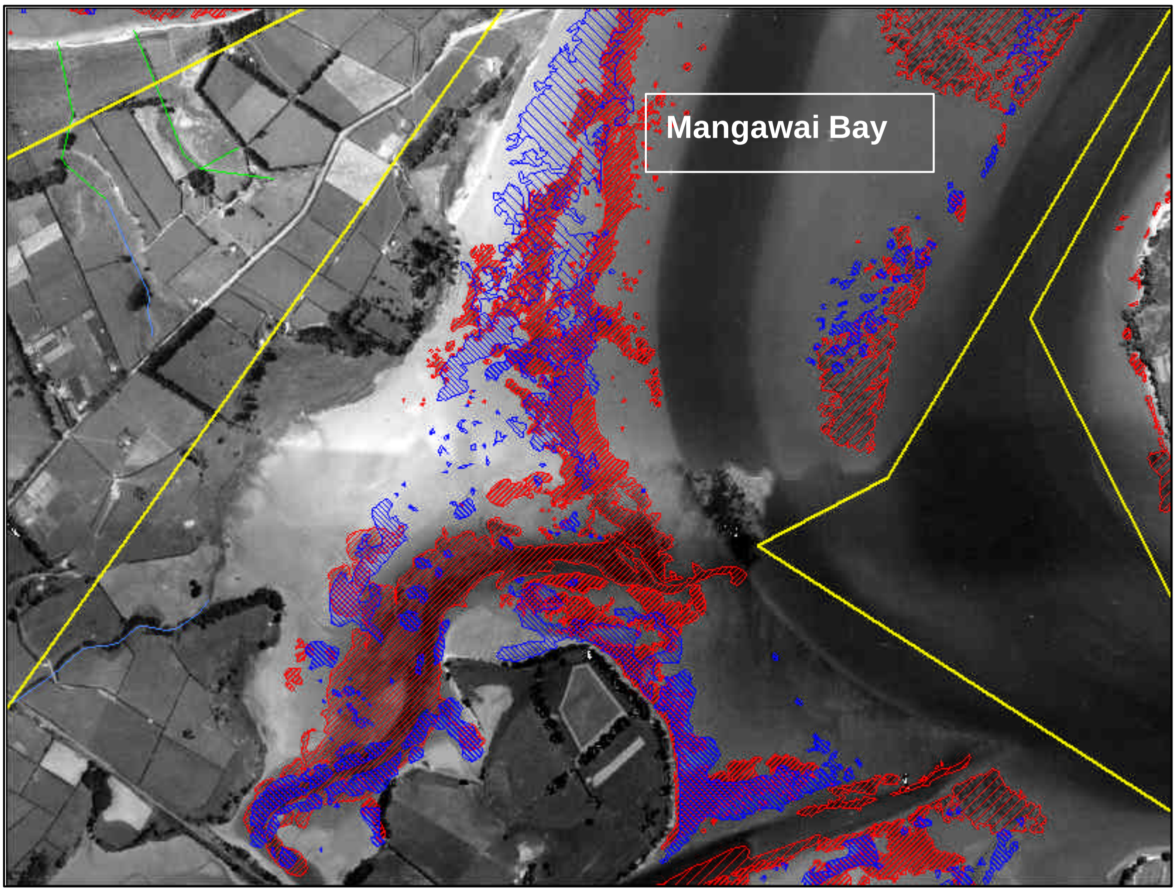
Figure 3.2 Sub-regions showing the areas of seagrass in 1959 (red) and 1996 (blue)

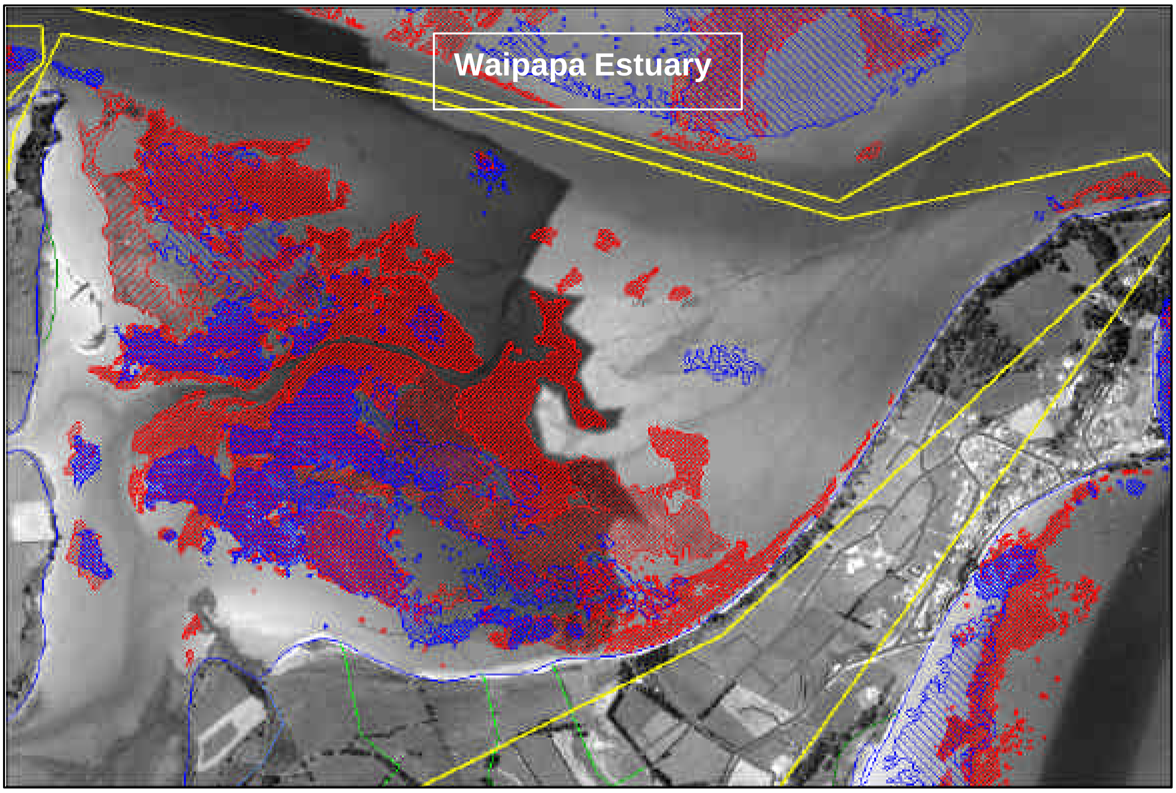


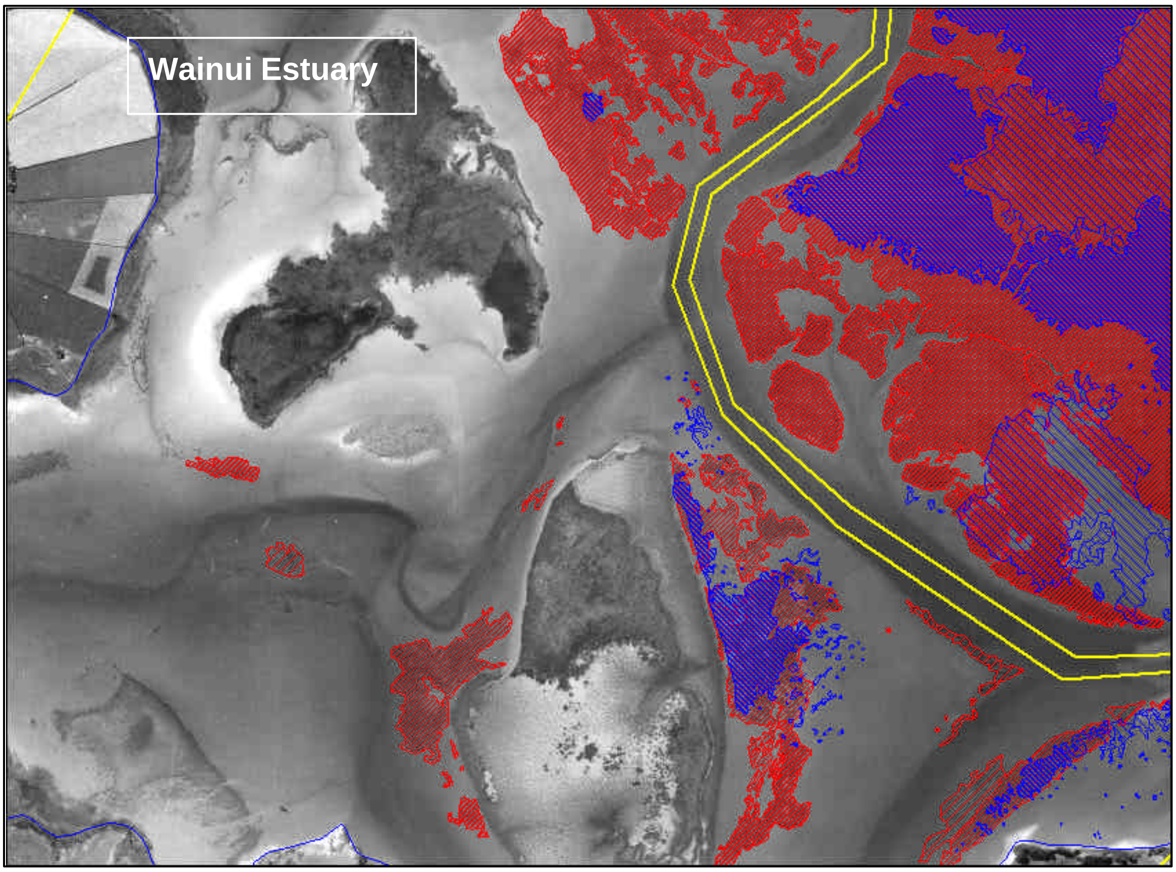


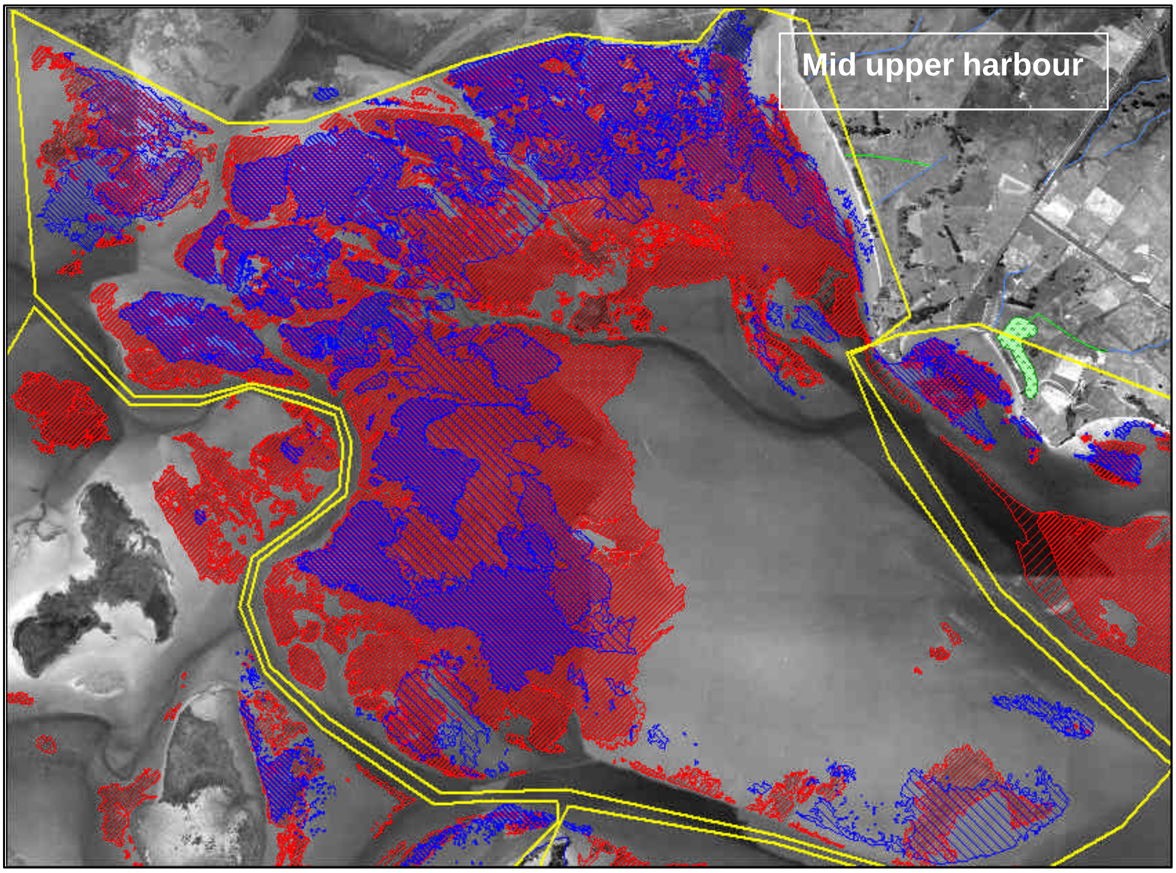

Waipu Bay

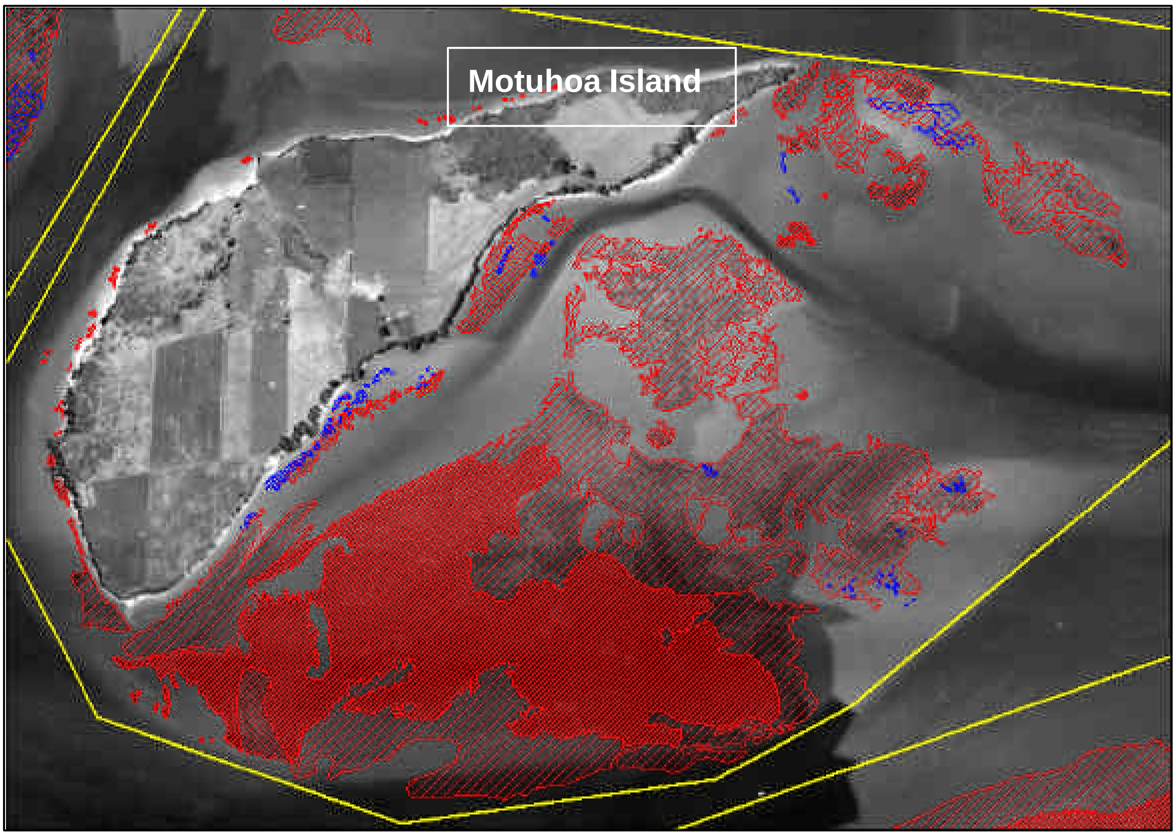

Wairoa Estuary

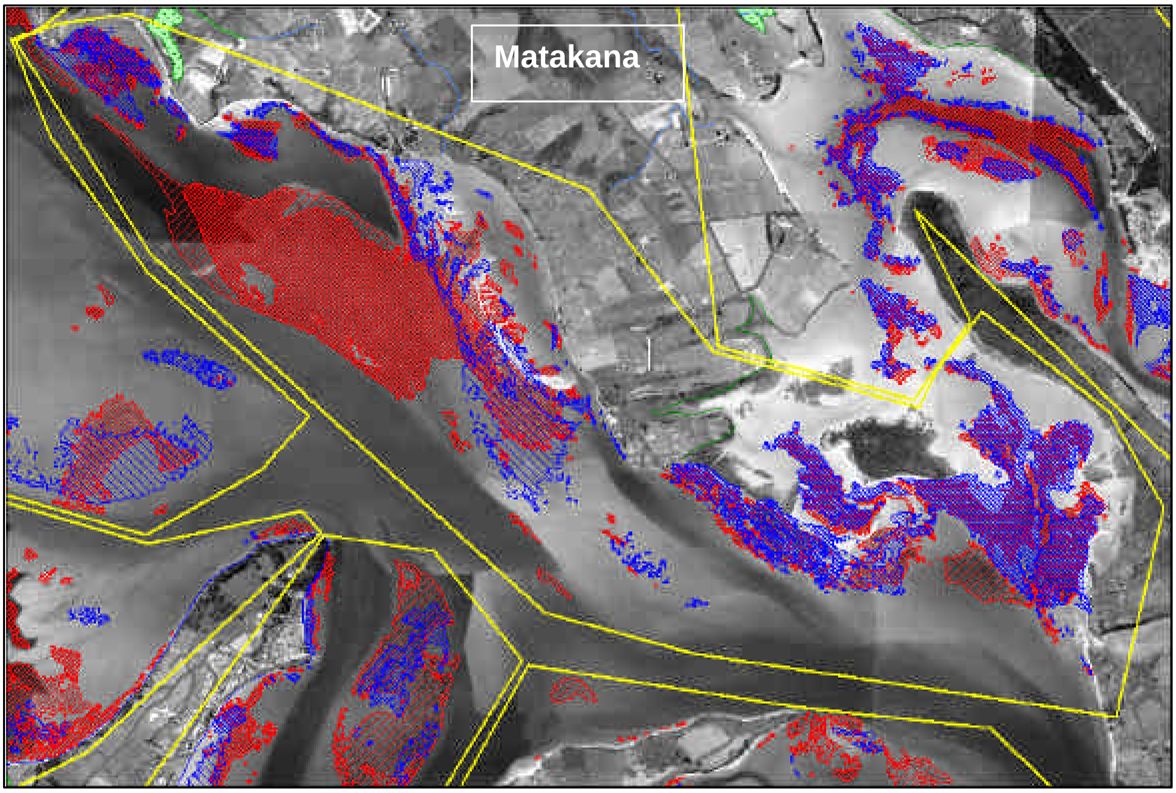

Mangawai Bay

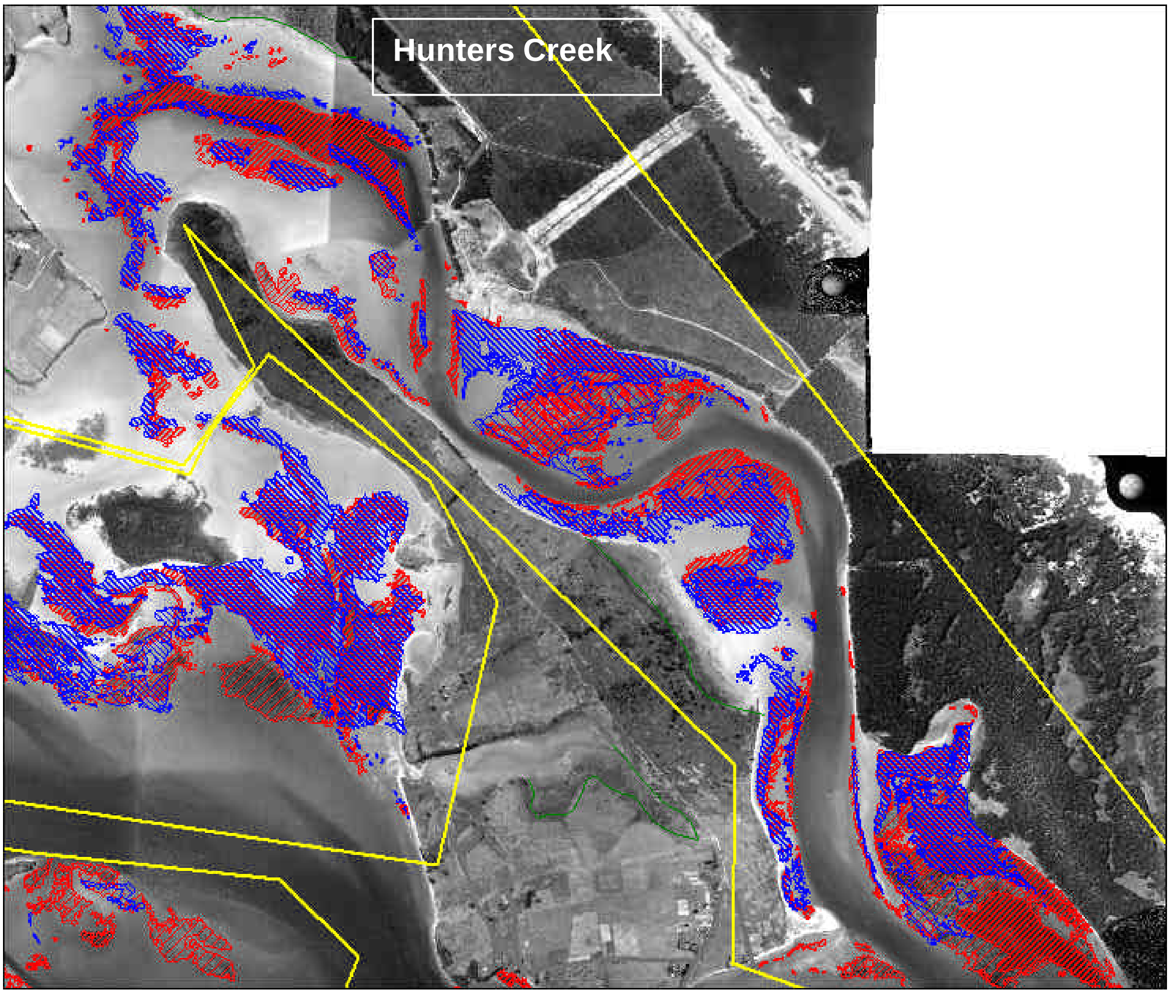

Waipapa Estuary


Wainui Estuary


Mid upper harbour


Motuhoa Island


Matakana


Hunters Creek

Chapter 4: Discussion

In terms of the ecological values of seagrass beds the degree of loss assessed in this mapping exercise represents a very serious impact on the ecology of Tauranga Harbour. This decline does however, mirror the same scenario experienced by many countries overseas including our nearest neighbour Australia. Numerous bays and estuaries on both the western and eastern side of Australia have suffered losses in the order of 50% or more (Walker & McComb 1992). Within New Zealand extensive loss of seagrass has been noted in the Auckland area and the Avon-Heathcote Estuary. In the Avon-Heathcote Estuary, seagrass declined from 1920 until it had almost disappeared in 1952 (Knox & Kilner 1973).

The primary cause of seagrass decline worldwide is related to human-induced impacts. Principally decreased light reaching seagrass for photosnythesis and growth is the major impact. The decrease may result from increased turbidity from particulates in the water, or from the deposition of silt or the growth of epiphytes on leaf surfaces or stems. Eutrophication of coastal waters can lead to reduced light penetration through the water from enhanced plankton growth as well as the direct stimulation of epiphytic algal growth.

In Tauranga Harbour there are a number of factors that have probably contributed to the decline of seagrass. Land run-off and stormwater will have increased turbidity of some harbour areas markedly over time. Extreme one-off siltation events such as Ruahihi Canal collapse may also have contributed. Generally once large areas of seagrass are lost turbidity may increase making it difficult for re-establishment of the plants to occur. Eutrophication of the southern harbour may have also contributed. Tauranga sewage was discharged to the harbour until 1994. The likely impact of these factors is evident in that the least affected areas in the harbour appear to be the shallow beds near the harbour entrance in catchments with very negligible land runoff.

Although the average loss of seagrass in the southern harbour is 54% this is only for the period 1959 –1996. There is likely to be have been considerable loss before this time, particularly in the sub-estuaries on the western side of the harbour. It is also possible that the decline in seagrass beds may be slowing as environmental practices improve. The removal of point nutrient sources to the harbour and improvement in abating land runoff and its associated nutrients and suspended sediments has progressed markedly in recent years. The work presented in this report provides a baseline against which future changes in seagrass abundance can be assessed in the southern harbour. The mapping work and assessment of changes in abundance needs to be extended to the northern harbour. This will also allow a better interpretation of the factors involved in abundance variation over time.

References

Knox, G.A., Kilner, A.R. 1973: The ecology of the Avon-Heathcote Estuary. Unpublished report to Christchurch Drainage Board.

Walker, D.I., McComb, A.J. 1992: Seagrass degradation in Australian coastal waters. Marine Pollution Bulletin, Vol. 25, pp 191-195.