Regional Estuary Monitoring Programme

June 2009
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Environment Waikato
REGIONAL COUNCIL

Acknowledgements

This report summarises the work presented in Felsing and Singleton (2008), and also shows results from Graeme (2005 and 2006).

Throughout the years, many people have assisted with fieldwork on this programme, and I would like to particularly thank Malene Felsing, Vernon Pickett, Bevan Jenkins, Bronwen Gibberd, Erin Petuha, Dan Borman, Glen Cooper, Hannah Jones, Mark Williams, Nick Carter, Nicola Foran, Paul Smith, Rebecca Ireland, Stephanie Turner, and many more. Thank you to Dr Wilma Blom (Auckland Museum) for the processing of Raglan samples. Thanks also go to Lisa Tomlinson, Hannah Jones and Shari Gallop, for help with sorting sediment samples. All the photos of benthic animals were taken by Dr Barry O'Brian (Waikato University).

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summary

1. Summary

In April 2001 Environment Waikato started a long term monitoring programme in the Firth of Thames and Raglan (Whaingaroa) Harbour, looking at estuary health. The programme monitors sediment-dwelling ('benthic') animal communities that live between the low and high tide marks, and sediment characteristics (like the amount of mud, shell and minute algae present).

Estuaries are one of the most sensitive coastal areas, and are at risk from human activities. They are important areas for people culturally, commercially and recreationally, and are highly productive ecosystems that provide important habitats for many fish, shellfish and bird species. Estuaries receive and accumulate sediment, nutrients and contaminants from the surrounding catchment. What happens on land can directly and indirectly affect the health of an estuary. Monitoring will allow early detection of any negative environmental changes, and as such provide a trigger for assessing land management practices.

Five sites are monitored quarterly in the Firth of Thames and Raglan Harbour. Marine worms and shellfish are the most common benthic animals found. Differences in animal communities found between the two estuaries are mainly caused by differences in sediment characteristics (mainly the amount of shell material and proportion of mud in the sediments). Overall, the sediments monitored in the Firth of Thames are sandy with low mud content, and the amount of mud in Raglan Harbour is 2-4 times greater than that found in the Firth of Thames.

In both estuaries, the proportion of mud in the sediment increased between 2001 and 2006. (with a greater rate of increase in Raglan Harbour) - this is a concern. Fewer animals were found at the muddiest sites in Raglan Harbour than at the more sandy sites, which suggests that the mud has a negative effect. However, even though the sediment mud content increased between 2001 and 2006, there is no evidence of declining trends of sensitive animals – at the muddy sites, the number of animals present was low even at the start of the monitoring.

The increase in sediment mud levels could either be caused by activities in the catchment, or it could be part of natural fluctuations. Continued monitoring is needed to determine if the increase in mud is caused by human activities, and if it is having an effect on the benthic animals over time. It is likely that if mud levels continue to increase it is only a matter of time before this will start to impact the benthic animal communities, and the fish and birds that eat them.

Overall the monitoring shows the Firth of Thames and Raglan Harbour are relatively healthy. It is important that monitoring continues in the long term so that any changes in the animal communities resulting from catchment activities can be detected. This will allow better management of these important ecosystems.

2. Introduction

Sand/mudflats in the zone between low and high tide (termed 'intertidal') occupy large areas of estuaries in the Waikato region. For example, 30-50 per cent of eastern Coromandel's estuarine area is sand/mudflats.

Estuaries are important areas for people culturally, commercially and recreationally. They support diverse and abundant animal communities, providing important habitats for many fish, shellfish and bird species. Estuaries are one of the most sensitive coastal areas, and are at risk from human activities. They are major receiving and accumulation areas for sediment, nutrient and water from the land, so can be affected by catchment activities.

Sediment-dwelling ('benthic') animals (such as shellfish, crustacean and marine worm species) have been widely used as indicators of estuary health in environmental monitoring programmes. Benthic organisms respond predictably to many kinds of natural and human-induced stresses. Changes in the number of species and/or the number of individual animals (the benthic 'community') may point to impacts from local-scale pressures like pollution, and broad-scale pressures like increased sediment from land use and catchment activities.

This is why we monitor benthic communities as an indicator of estuary health, and an early warning of negative environmental changes. The monitoring will allow us to detect any adverse environmental changes early, and will act as a trigger for assessing land management practices.

In April 2001 the Regional Estuary Monitoring Programme (REMP) was initiated by Environment Waikato. REMP uses intertidal benthic animal communities and sediment characteristics (like the amount of mud, shell and minute algae present) as indicators of the health of the region's estuaries. It is a long term monitoring programme focusing on two estuaries - the Firth of Thames and Raglan (Whaingaroa) Harbour.

3

objectives

3. Objectives

- To monitor the long term changes in sediment-dwelling animal communities and sediment characteristics, which may result from changes in land use, catchment management practices, point source pollution (i.e. its source can be pinpointed) and/or estuary development.

- Information provided by the Regional Estuary Monitoring Programme will ultimately provide relevant information useful for setting policy and supporting the sustainable management of estuaries in the Waikato region.

4. Locations

4.1 Firth of Thames

The Firth of Thames (Figures 1-5) is a large compound estuary and a 'drowned valley'. It is the primary receiving environment for the ~3,600 km2 Hauraki Catchment, and is New Zealand's largest shallow marine embayment. At its southern end several rivers (in particular the Waihou and Piako rivers) drain into the estuary and at its northern end it opens into the Hauraki Gulf. The Firth of Thames is a site of cultural significance to Hauraki iwi.

Figure 01. Satellite picture of the Firth of Thames and surrounding catchment.

Figure 02. Thames township and Kauaeranga River entering the Firth of Thames.

Figure 03. Southern Firth of Thames at high tide. The mangrove stands (the dark vegetation) extend hundreds of metres onto the intertidal mudflats.

Figure 04. Waihou and Piako rivers entering the southern Firth of Thames.

The south-western intertidal zone of the Firth of Thames is recognised as an internationally important wetland under the Ramsar Convention (one of five sites within New Zealand). The Firth of Thames Ramsar site includes around 7,800 hectares of shallow estuarine waters, intertidal mudflats, mangrove and saltmarsh, and graded shell beach ridges.

It is ranked as one of New Zealand's three most important areas for shorebirds. The Miranda Wildlife Refuge and nearby wetlands, which make up a significant portion of the Ramsar site, are a seasonal home to thousands of wading birds and shorebirds. From spring onwards, large numbers of migrant birds, particularly godwits and knots, begin arriving to feed. Many of these birds will have spent several weeks travelling south from breeding grounds as far away as Siberia and Alaska. In autumn these birds fly north again.

The refuge is also an important site for local species, such as the pied oystercatcher. Three threatened species (the New Zealand dotterel, the variable oystercatcher and the black-backed gull), unique to New Zealand, breed at the Ramsar site.

Figure 05. Miranda Wildlife Refuge and surrounding wetlands (Ramsar site).

The Firth of Thames is also an important habitat for a range of common inshore fish species, many of them of cultural, recreational and commercial value. These include snapper, jack mackerel, red gurnard, and sand and yellowbelly flounders. The Firth is also an important nursery for juvenile snapper, spotted dogfish, and hammerhead shark.

The results from a vegetation survey of the southern Firth of Thames (Graeme, 2006) is shown in Figure 6. This shows that:

- there are no seagrass beds in the inner Firth;
- there are lots of weeds in the Firth – including large patches of the estuarine weed spartina (as well as many small patches) and small concentrated patches of saltwater paspalum between the Waihou and Kauaeranga rivers. These weeds grow in the open estuary and trap sediment, increasing the infilling rate of the Firth;
- the dominant estuarine vegetation in the Firth of Thames is mangroves, covering approximately 1374 ha – this makes it New Zealand's largest mangrove forest.

The Firth of Thames is under increasing pressure from human activities, including marine farming, intensifying farming practices and increasing urban development within the surrounding catchment.

Figure 06. Vegetation map of the southern Firth of Thames.

4.2 Raglan Harbour

Raglan (Whaingaroa) Harbour (Figures 7-9) is a tidal lagoon and drowned river valley, with intertidal sand/mudflats making up about 70 per cent of its area. The catchment area for Raglan Harbour is 525 km2.

Raglan Harbour is an important habitat for resident, rare and threatened, and international migratory bird species. It is also an important area for commercial and recreational fisheries and recreational activities. The critically endangered Maui's Dolphin has been spotted in Raglan Harbour, although it is not known how much this species use the Harbour. The Harbour is also a culturally significant site for Tainui iwi.

Figure 07. South-western Raglan Harbour and surrounding catchment. Photograph: A. Senior.

The clearance of native vegetation over the last century in the Raglan catchment, combined with steep terrain and unstable rock, has led to significant sedimentation input into the harbour. The Whaingaroa Harbour Care group was formed to improve the quality of the water entering the harbour by replanting coastal and stream margins. More than 750, 000 native trees have been planted since 1995.

The results from a vegetation survey of Raglan Harbour (Graeme, 2005) is shown in Figure 10. This shows that:

- small patches of seagrass occur, mainly near the town centre (about 14 ha in total);
- scattered young mangroves are found in the south-west, with larger trees in the north-west of the harbour (about 27 ha in total);
- there are some estuarine weeds, with saltwater paspalum common around the harbour edge (not being controlled), and five known small sites of spartina (controlled by DoC);
- overall there is significantly less estuarine vegetation in Raglan Harbour than in the Firth of Thames (particularly mangroves).

Similar to the Firth of Thames, Raglan Harbour is under increasing pressure from human activities both around the harbour margin and further into the surrounding catchment.

Figure 08. Characteristic intertidal sand/mudflat in Raglan Harbour.

Figure 09. Characteristic intertidal sand/mudflat in Raglan Harbour.

Figure 10. Vegetation map of Raglan Harbour.

5

methods

5. Methods

Five permanent sites in the southern Firth of Thames and five sites in Raglan (Whaingaroa) Harbour are monitored (Figure 11). Sites are considered to be characteristic of the intertidal sand/mudflats found in each estuary.

Figure 11. Location of permanent monitoring sites in the southern Firth of Thames and Raglan Harbour.

Monitoring is done in January, April, July and October (Figures 12-14) of each year. On each occasion 12 core samples (13 cm in diameter and 15 cm deep) are taken from random positions within a 100 m x 100 m monitoring plot.

In the field, benthic animals (such as marine worms, crabs and shellfish) are separated from the sediment cores by sieving with a mesh sieve (Figure 15). Samples are preserved in alcohol that is diluted with tap water, and stained with a pink dye (called Rose Bengal) that colour the animals, so that they are easier to pick out.

Twenty six indicator species are identified – these are typical intertidal sand/mudflat benthic animals (Figure 16). All non-indicator species are classified into broad groups of animals.

Figure 12. Sampling of sand/mudflats in the Firth of Thames.

Figure 13. Sampling of sand/mudflats in the Firth of Thames.

Figure 14. Wadding through the mud in Miranda.

Figure 15. Sieving samples collected in the Firth of Thames, at the Piako River boat ramp.

Figure 16. Microscopic view of a typical benthic sample (stained with Rose Bengal).

6. Results

Marine worms (figures 18, 20, 21 and 23) and bivalves (shellfish, Figure 17) were the two most common groups of animals found at all sampling sites (figures 19 and 22). Overall, bivalves (in particular cockles), and more noticeably marine snails (figures 24 and 25), were more abundant in Raglan Harbour than in the Firth of Thames. Pipi bivalves, however, were found in much greater numbers in the Firth of Thames. Crustaceans (like crabs and amphipods) were consistently found at all sampling sites, though in lower numbers than other animal groups.

In the Firth of Thames higher numbers of animals were found at the Gun Club, and in Raglan Harbour there were more animals at Te Puna Point, and by Whatitirinui Island. Overall the abundance of animals was higher in the Firth of Thames (in particular at the Gun Club, Te Puna Point and Kuranui Bay) than in Raglan Harbour.

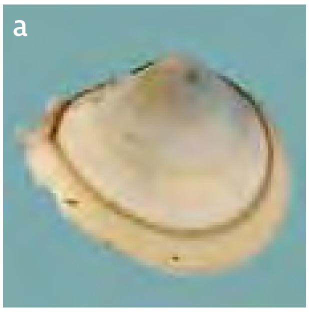

Figure 17. Bivalves (shellfish).

a) Wedge shell (*Macomona lilliana*)
b) Nut shell (*Nucula hartvigiana*).

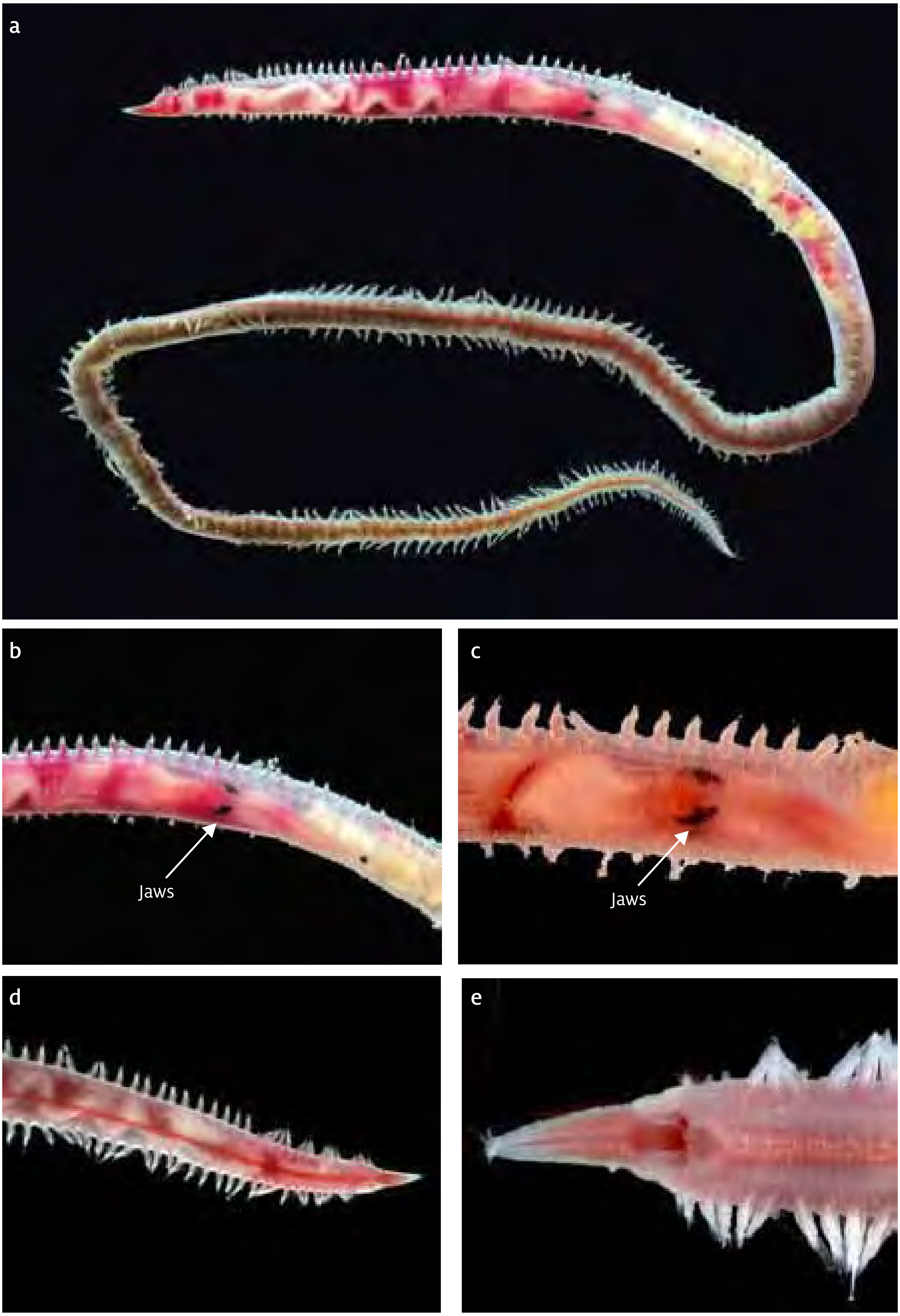

Figure 18. Marine worm: blood worm (Glycerid species).

a) Whole worm;
b) & c) Jaws of worm - used to capture food;
d) Head region (view from underneath, below);
e) Head region (view from above).

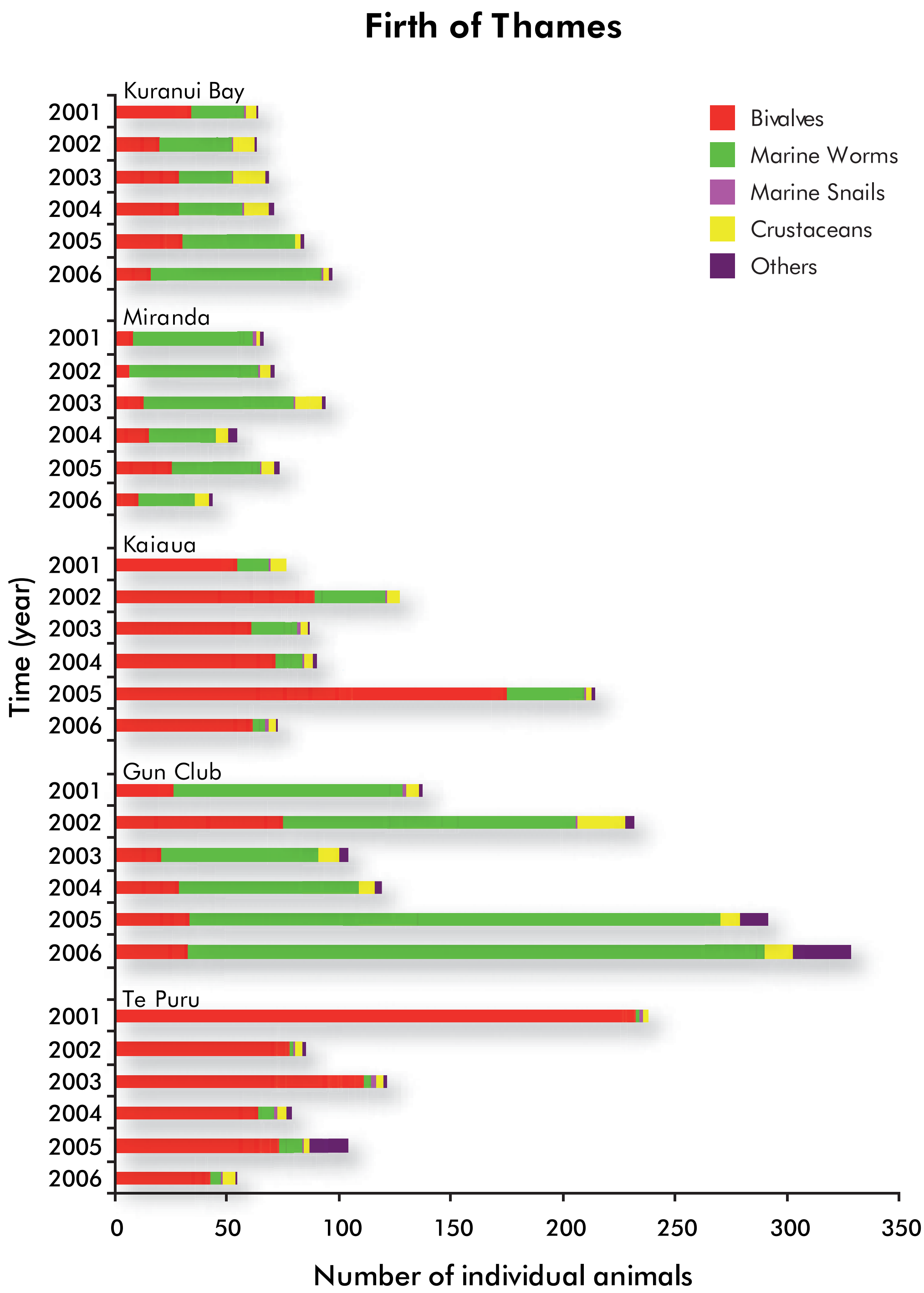

Figure 19. Average number of different types of animals per sample – southern Firth of Thames monitoring sites

Figure 20. Marine worm: ragworm (Nereid species).

Figure 21. Marine worm: ragworm (Nereid species) - head.

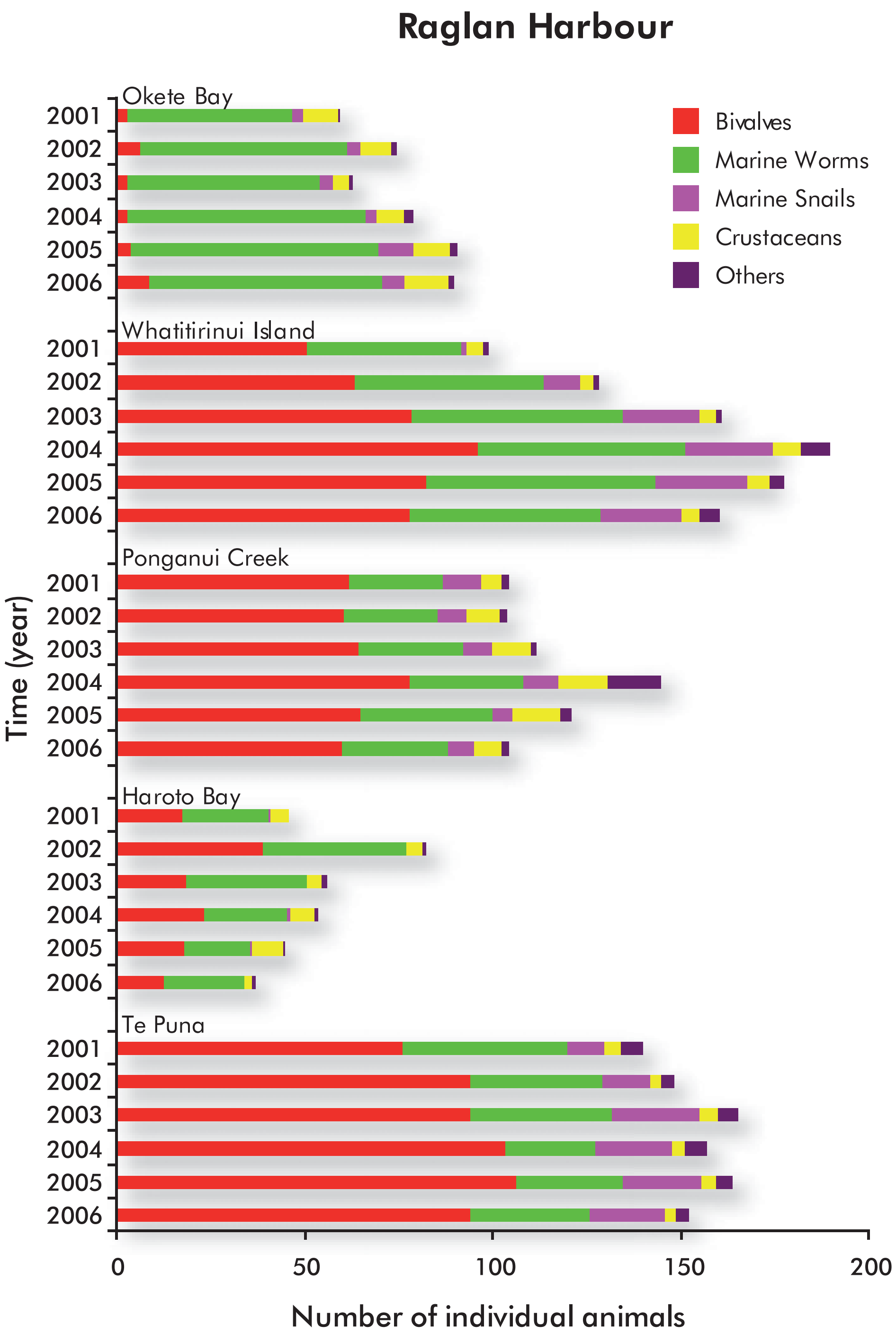

Figure 22. Average number of different types of animals per sample - Raglan Harbour monitoring sites.

Figure 23. Marine worms.

a) Ragworm (Nereid species, view from underneath);
b) Spionid species, view from underneath; and c) Spionid species, body view from above.

Figure 24. Marine snail: *Cominella adspera*

Figure 25. Marine snail: *Cominella glandiformis*.

Figures 26 and 27 show the sediment variables which were found to be most closely linked to abundance and diversity of animals in Raglan Harbour and the Firth of Thames.

In the Firth of Thames the highest abundance of animals (Figure 19) occurred at the Thames Gun Club, which had the greatest amount of shell material (Figure 26a) and overall the highest chlorophyll-a content (sediment microscopic algae, Figure 26b).

In Raglan Harbour the lowest abundance of animals (Figure 22) and species diversity occurred at the sites with the greatest amount of mud, such as Haroto Bay (Figure 27c), and at sites with less coarse sand, for example Okete Bay (Figure 27b). Sites with medium levels of shell and medium to high levels of coarse sand had a high abundance of animals, like Te Puna and Whatitirinui Island (Figure 27a and b).

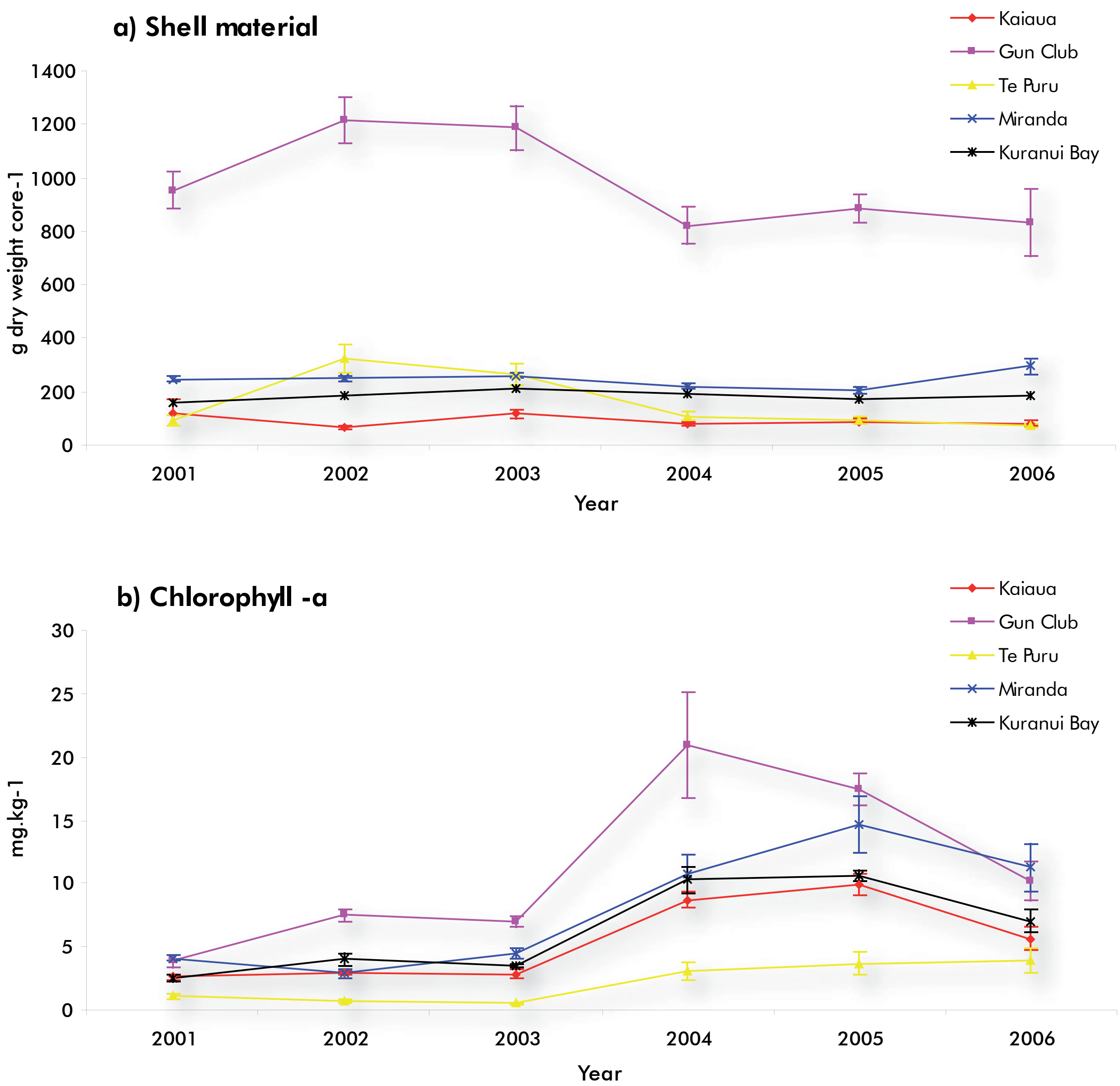

Figure 26. Average (± standard error) a) shell material dry weight within the sediment and b) chlorophyll-a concentration - Firth of Thames monitoring sites.

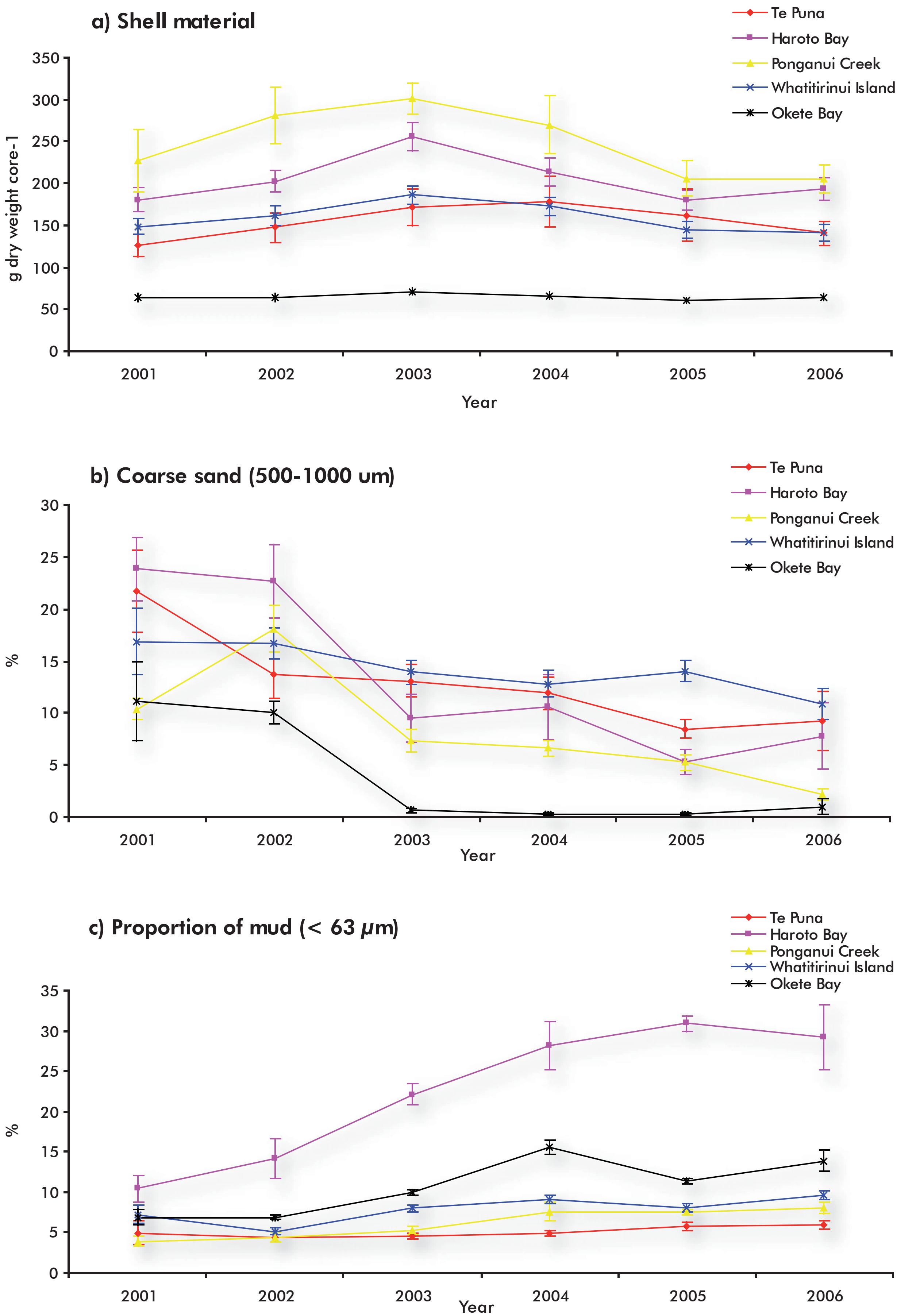

Figure 27. Average (± standard error) a) shell material dry weight within the sediment; b) coarse sand (500 - 1000um) and c) proportion of mud (< 63 μm) - Raglan Harbour monitoring sites.

Figure 28. Marine benthic animals.

a) Marine worm (Spionid species);
b) Marine worm (Paraonid species);
c) Marine worm (Sabellid species);
d) Ribbon worm (Nemertea species);
e) Sea cucumber (Holothurian species) and
f) Crustacean (Isopod species).

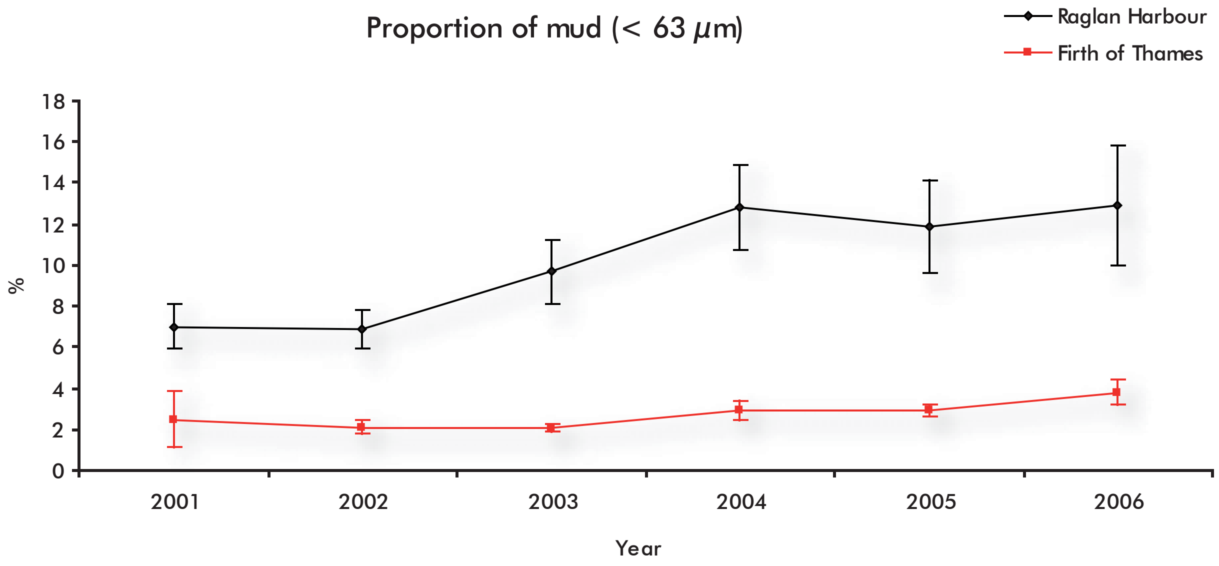

Figure 29. Comparison of the average (± standard error) proportion of mud in the Firth of Thames and Raglan Harbour (averaged over the five sample sites in each estuary).

The sediments of the monitoring sites in the Firth of Thames are mainly sandy with low mud content, as are those at three sites in Raglan Harbour (Whatitirinui Island; Te Puna Point and Ponganui Creek). However, at Okete Bay and Haroto Bay in Raglan Harbour, the sediments have changed from sandy to muddy over the monitoring period. On average, the sediment samples from Raglan Harbour contained two to four times as much mud as those from the Firth of Thames (Figure 29). In both estuaries there was an increase in mud (with a greater rate in Raglan Harbour, particularly at Haroto Bay and Okete Bay) from 2001 to 2006.

7. Conclusions

Overall, the results from REMP sampling indicates that the Firth of Thames and Raglan (Whaingaroa) Harbour are relatively healthy, with mostly high values of animal abundance, biomass and diversity of animals at the sampling sites. However, ongoing long term monitoring is needed to allow detection of any trends or changes in intertidal benthic animal communities and sediment characteristics.

The animal communities found differ between estuaries, and between sampling sites within estuaries. This is a normal feature for the Firth of Thames and Raglan estuarine ecosystems, and is mainly caused by differences in sediment characteristics, primarily the amount of shell, mud, coarse sand and microscopic algae (chlorophyll-a) in the sediments.

Overall, the sediments sampled in the Firth of Thames are sandy with low mud content, and those in Raglan contain more mud. The sediment mud content increased from 2001 to 2006 at all sites, particularly at two sites in Raglan Harbour which changed from being sandy to becoming muddy (Haroto Bay and Okete Bay). At these two muddiest sites, the monitoring showed lower numbers of animals, suggesting that the mud levels are affecting the animal communities.

However, the increase in sediment mud content between 2001 and 2006 does not appear to have led to a decline in sensitive animals at any of the sites monitored; Felsing and Singleton (2008) found no clear declining trend in the abundance of mud-sensitive animals between 2001 and 2006. This could be because the increase in sediment mud has not yet reached levels where animals are affected. It is also possible that sediment mud levels fluctuate naturally, that the animals are used to such changes, and that by co-incidence the monitoring from 2001 to 2006 happened to show an increase in sediment mud which will disappear again naturally over time.

The increase in sediment mud levels at the sites monitored in the two estuaries is of concern. Continued monitoring is needed to determine whether the increase in sediment mud content is part of a natural cycle or a trend caused by catchment activities; and to determine it is affecting the benthic animals that form the bottom of the food web. If the current trend in increasing mud content in the Firth of Thames and Raglan Harbour continues, long term monitoring will detect any adverse effects on the intertidal benthic animal communities which may have knock-on effects for fish and bird populations.

8. References

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ISBN 978-0-9582940-2-7 (Print)
ISBN 978-0-9582940-3-4 (Online)

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S1668 - 0709