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Mahurangi Estuary Ecological Monitoring Programme

Report on Data Collected from July 1994 to January 2007

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Mahurangi Estuary Ecological Monitoring Programme - report on data collected from July 1994 to January 2007

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1 Executive Summary

Sediment characteristics and populations and communities of the monitored macrofaunal taxa have not changed markedly at the intertidal or subtidal sites over the past two years of monitoring. The intertidal communities at Hamilton Landing, Te Kapa Inlet and Cowans Bay have continued to become more similar to each other, as have those of Jamieson Bay and Mid Harbour. The subtidal communities of Sites A and C are also currently very similar.

A total of 33 intertidal populations are currently showing trends in abundance; approximately half of these are increasing trends and half are decreasing trends. All sites have populations that are exhibiting ecologically signficant trends; most occur at Hamilton Landing and Te Kapa Inlet, and the least at Mid Harbour. Seven subtidal populations are exhibiting trends in abundance. Six of these are increases in abundance of taxa known to prefer medium amounts of mud.

Of most concern is that four species considered sensitive to increased suspended sediment concentrations are exhibiting declines in abundance at the intertidal sites (Table 10). Two ecologically important bivalve species, *Macomona liliana* and *Austrovenus stutchburyi*, and the polychaete *Scoloplos cylindrifer* continue to decline in abundance at the muddiest site, Hamilton Landing. *Macomona* is also declining at Jamieson Bay. Decreasing trends were detected for *Austrovenus* and the nut shell, *Nucula hartvi*giana, at Te Kapa Inlet. These declines are likely to be correlated with the continued expansion of the muddy portion of the Te Kapa Inlet site noted over the monitored period.

The decreases noted in the *Macomona* populations at Mid Harbour and Te Kapa Inlet in previous years are no longer apparent with two more years of data due to significant recuitment events. Mid Harbour contains reasonable numbers of spawning sized individuals, indicating that this increase may continue in future years as these resident adults continue to reproduce. Abundances of spawning sized individuals are low at Te Kapa Inlet however, and recruitment at this site relies on transport of juveniles from elsewhere in the harbour.

Very few of the intertidal populations exhibit highly predictable cyclic abundance patterns, where peaks in abundance occur in the same monitoring month every year.

Numbers and sizes of *Atrina zealandica* are similar at both of the subtidal sites. Numbers are low and the sizes of *Atrina* have not increased much over the past two years, probably reflecting the fact that the growth of these populations is slowing as the individuals age and reach their maximum size..

An additional intertidal monitoring site was established at Dyers Creek in October 2005. The Dyers Creek subcatchment is one of the priority subcatchments being targeted for remedial work under the Mahurangi Action Plan. Monitoring at this site was implemented in response to this, in order that any changes over time in its ecology may be able to be linked to these changes in catchment management. Comments on trends and patterns in abundance of the monitored populations and community at this site will be made in future reports.

This monitoring programme has continued to provide very useful information on trends and cycles in monitored taxa populations and sediment characteristics that can be used to guide and monitor the effectiveness of catchment management within Mahurangi Estuary. With two more years of data our previous recommendations concerning the need to investigate and implement improved sediment controls still apply, as we are still detecting declines in abundance of taxa known to be sensitive to increased sediment loading. Recent evidence of recruitment of juvenile bivalve populations is encouraging, and highlights the potential for the recovery of some areas of the harbour should sediment control measures be effective.

2 Introduction

In July 1994 a long-term ecological monitoring programme of Mahurangi Estuary's intertidal and subtidal benthic communities was started. The monitoring programme was designed to:

- provide stocktaking of resources under stewardship;
- provide information on the ecology of the intertidal and subtidal benthic communities for the Mahurangi Estuary Management Plan (Mahurangi Action Plan, MAP);
- assess the overall condition of Mahurangi Estuary in terms of its benthic communities; and
- provide a basis on which to document any ecological changes that may occur as a result of catchment and estuary development.

Specific sites and populations (Appendix 1) for this long-term monitoring programme were identified from a survey conducted in 1993, and recommended in a previous report to ARC Environment (Cummings et al. 1994).

This monitoring programme has now been running for 12.5 years. In this report, we comment on the temporal variation in abundance of some monitored macrofaunal populations at the intertidal and subtidal sites, and on the temporal variation in abundance and size of the horse mussel, *Atrina zelandica*, at the subtidal sites. On the basis of trend and community analyses of the monitored taxa, we describe the current ecological status of the harbour and make recommendations for the future of this monitoring programme.

3 Methods

3.1 Intertidal Sites

In July 2004, five permanent intertidal sites were established in locations predetermined from an initial survey of the estuary conducted in April 1993 (Cummings et al. 1994; Figure 1). Four of the five sites cover areas of 9000 m^2 and are situated at about mid-tide level. The fifth intertidal site (Jamieson Bay) is constrained by the size of the bay and occupies a slightly smaller area (7200 m^2). This latter site also covers a greater tidal range than the other sites due to the steep gradient of the beach.

In October 2005, an additonal permanent intertidal site was established at Dyers Creek. The site was chosen and established by the ARC, in the approximate vicinity of the site initially surveyed by NIWA in 1993 (Cummings et al. 1994).

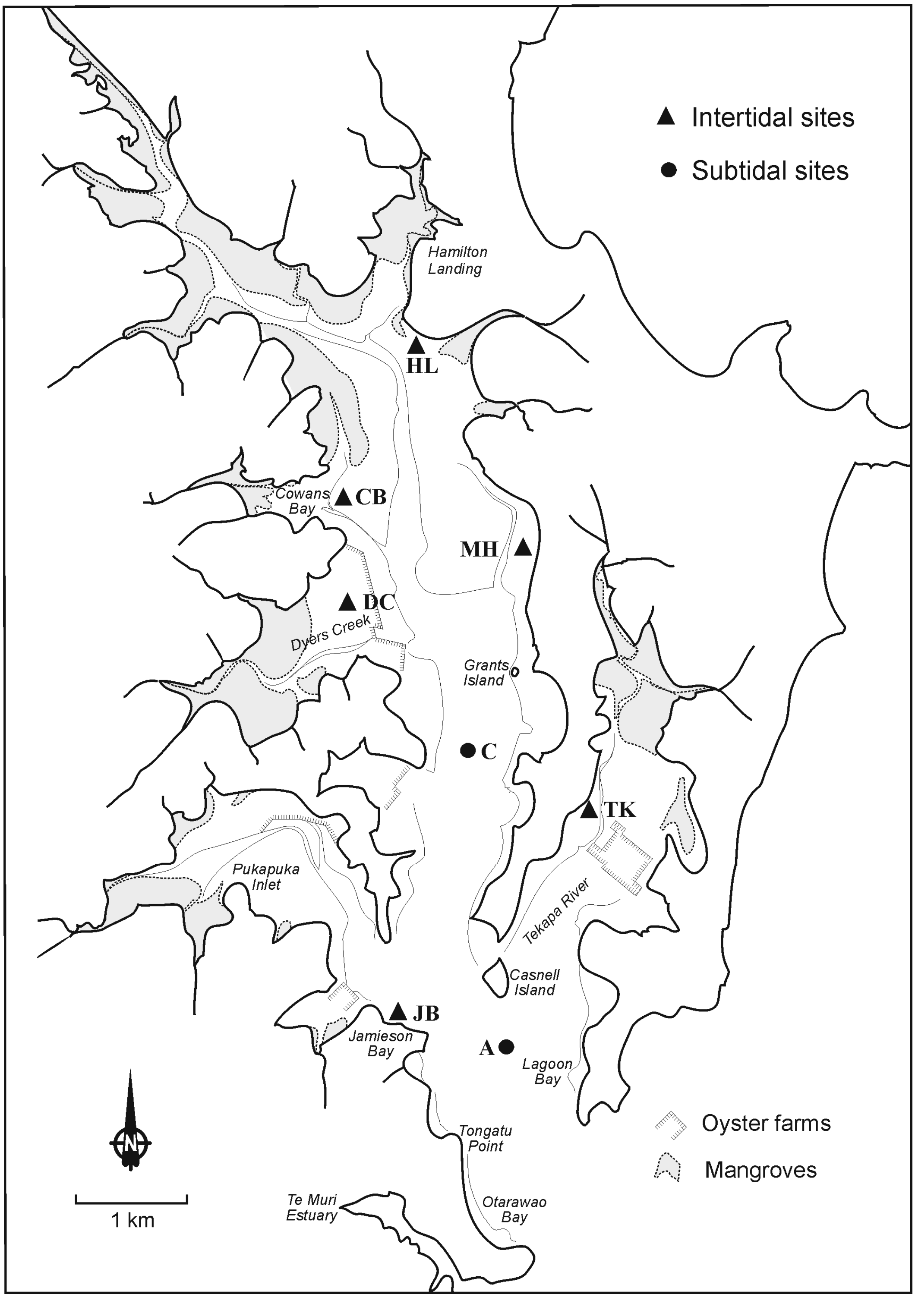
All six intertidal sites are sampled at three-monthly intervals.

3.1.1 Macrofauna

On each sampling occasion, core samples (13 cm diameter, 15 cm deep) are collected at 12 predetermined locations at each site. To provide adequate dispersion over the site, each site is 'divided' into 12 equal blocks and one core sample taken from a random location within each block. To reduce the influence of previous sampling activity and spatial autocorrelation (Hewitt et al. 1994; Pridmore et al. 1990; Thrush et al. 1988, 1994), samples are not positioned within a 5 m radius of each other or of any samples collected in the previous 12 months. Core samples are sieved (500 µm mesh) and the residues stained with rose bengal and preserved in 70% isopropyl alcohol in seawater. Samples are then sorted, identified to the lowest possible/practical taxonomic level, counted and stored in 50% isopropyl alcohol. Following the recommendations of an earlier report (Cummings et al. 1997), the monitored bivalve species are now measured on each sampling date, to enable determination of the number of individuals in different size classes (i.e., $\leq$4 mm, $\geq$4-8 mm, $\geq$8 – 16 mm, $\geq$16 mm). Measurements are made using either electronic callipers, or a camera lucida and digitising pad.

Figure 1.

Map of Mahurangi Harbour, showing locations of the intertidal and subtidal monitoring sites. Intertidal site abbreviations are as follows: CB = Cowans Bay; DC = Dyers Creek; HL = Hamilton Landing; JB = Jamieson Bay; MH = Mid harbour; TK = Te Kapa Inlet.



3.1.2 Sediment characteristics

Sediment samples for grain size analysis were collected from each site in April of each year up to April 2000. Since July 2000, sediment samples have been collected on each sampling occasion (following the recommendations made by Hewitt 2000). Surface sediment (0 - 2 cm) is collected adjacent to every second macrofauna core sample at each site and bulked for subsequent analysis. Prior to analysis, the samples are homogenised and a subsample taken. They are then digested in 6% hydrogen peroxide until all organic matter is removed, and sampled by wet sieving and pipette analysis (Gatehouse 1971). The April 1996 samples were analysed using a Mastersizer Laser Analyser (see Cummings et al. 1999). The results of the grain size analyses are presented as percentage composition of gravel/shell hash (>2000 mm), coarse sand (500 – 2000 mm), medium sand (250 – 500 mm), fine sand (62.5 – 500 mm), silt (3.9 – 62.5 mm) and clay (<3.9 mm).

Also beginning in July 2000, the organic content and chlorophyll *a* content of the sediments at each site have been assessed on each sampling occasion (as recommended by Hewitt 2000). To determine the organic content, 1 teaspoon of the homogenised sediment sample collected for grain size analysis is dried to constant weight at 60°C, and combusted for 5.5 h at 400°C. Six small sediment cores (2 cm diameter, 2 cm deep) are collected at each site to assess sediment chlorophyll *a* content. These sediment cores are collected adjacent to every second macrofaunal core sample, pooled and stored frozen and in the dark. The samples are freeze dried prior to analysis. Chlorophyll *a* is extracted by boiling this freeze dried sediment in 90% ethanol, and the extract processed using a spectrophotometer. An acidification step is used to separate degradation products from chlorophyll *a* (Sartory 1982).

At Te Kapa Inlet, most of the site is 'muddy', but a portion of it is relatively sandy. Therefore, sediment samples for the above analyses are collected from the two different areas of this site. These are referred to as 'Te Kapa Inlet mud' and 'Te Kapa Inlet sand', respectively.

3.2 Subtidal Sites

Three permanent subtidal sites were established in locations predetermined from the initial survey of the estuary (Cummings et al. 1994). Following the recommendations made in our 2001 report (Cummings et al. 2001), the number of subtidal sites routinely monitored was reduced, with Sites A and C continuing to be monitored. Both of these sites are situated adjacent to the main estuary channel, in approximately 6 - 10 m of water (Figure 1). A major reason for subtidal sampling in Mahurangi Estuary is to monitor the horse mussels (*Atrina zelandica*).

Due to the difficulties of working subtidally in Mahurangi (e.g., poor visibility, strong tidal currents), each site is relocated at the surface via visual line-of-sight bearings and a weight with a line attached is then dropped to the estuary floor. Thus, a haphazardly chosen 50 m^2 area is sampled within our approximately 300 m^2 site on each sampling occasion. All sampling is carried out by SCUBA divers.

Transects (20 - 50 m long) of the horse mussels and their associated fauna have been videotaped at each site on each sampling occasion. The video footage is taken from a target height of 40 cm above the seafloor, resulting in a transect width of approximately 50 cm. Information gained from the video supplements the quadrat data and provides a visual archive of the communities associated with the horse mussel beds.

Subtidal sites were sampled at six-monthly intervals, beginning in October 1994. Due to recommendations made in Cummings et al. (2001), since July 2001 subtidal sites A and C have been sampled every 3 months.

3.2.1 Macrofauna

On each sampling occasion, 12 core samples (10 cm diameter, 16 cm deep) are collected randomly within a 10 m radius of the weight dropped to the estuary floor. Samples are then processed as described for those from the intertidal sites (see above).

3.2.2 Sediment characteristics

As at the intertidal sites, surface sediment for grain size analysis has been collected from each site in April of each year up to April 2000, and on every sampling occasion thereafter. In addition, beginning in July 2000, sediments at each site are now also assessed for organic and chlorophyll *a* content. Collection and analyses of these sediments are as described for the intertidal sites (see above).

3.2.3 *Atrina zelandica*

Estimates of size and density of the *Atrina* are made at each subtidal site. Ten quadrats (0.25 m^2) are haphazardly placed on the estuary floor and the number of *Atrina* contained in each quadrat is recorded. The size (maximum shell width) of five randomly selected live *Atrina* within each quadrat is also measured. During the October 1994 sampling, mean numbers of *Atrina* in the quadrats were derived from 8 and 15 quadrats at Sites A and C, respectively. Also during October 1994 sizes of *Atrina* were compiled from measurements of individuals along transects at Site A and adjacent to quadrats at Site C. A total of 32 and 21 *Atrina* were measured at Sites A and C, respectively, on this date.

On the April 1995 sampling occasion we noted that the majority of *Atrina* individuals at one of the sites were dead. Therefore, on every subsequent sampling occasion the number of live and dead *Atrina* within each quadrat has been recorded, and only live individuals are measured. The number of live individuals on the previous sampling occasions was estimated from the video footage.

3.3 Analyses of macrofaunal abundance

3.3.1 Biological interpretation of patterns

Plots of total abundance for each monitored population over the monitored period were visually examined to identify repeatable cyclic patterns that indicate seasonal or inter-annual variation in recruitment. We also consider the density of each species at each site in light of our knowledge of the natural history of each species, to ensure that our statistical analyses are interpreted in a biologically meaningful fashion.

3.3.2 Trend analysis

To formally identify any suggested trends in the abundance of the monitored taxa at both the intertidal and subtidal sites, trend analyses were conducted. Autocorrelation in each time series was investigated using chi-square probabilities (SAS/ETS). Where autocorrelation was indicated, increasing or decreasing trends were investigated by adjusting parameters and significance levels (AUTOREG procedure, SAS/ETS). Otherwise ordinary least squares regression was carried out. Only linear trends were investigated as investigation of residual variability suggested no other responses. Analyses were carried out on both the original time series and the baseline population (i.e., when peak abundances occurred in a repeatable, cyclic pattern, they were removed, and the remaining 'basal' population analysed). Doing both analyses enables identification of trends that are due to changes in recruitment which may not (yet) be affecting basal abundances, and thus aids biological interpretation.

3.3.3 Community analysis

To make an overall assessment of stability of sites over time, we constructed multivariate ordination plots using monitored taxa only. The intertidal and subtidal sites were analysed separately using correspondence analysis (CANOCO; ter Braak, 1986).

4 Results and Discussion

4.1 Intertidal sites

4.1.1 Sediment characteristics

The sediment grain size composition of the five original intertidal sites continues to contain a higher proportion of fine sand and lower amount of medium sand compared with the first two years of monitoring (Figure 2, Appendix 2). The Dyers Creek site sediments are also comprised predominantly of fine sand (79.48-90.25%), with some silt and clay (3.62-12.79 and 1.65-4.87%, respectively) (Figure 2, Appendix 2).

The organic and chlorophyll *a* content of the sediments at each site from July 2000 to January 2007 are provided in Appendix 3. The organic content is lowest at Dyers Creek (range 0.76-1.34% since monitoring began at this site in October 2005), and highest at Hamilton Landing (range 1.58-6.65%). While there is no predictable pattern in organic content over time that is consistent across all sites, there are similarities between Cowans Bay, Jamieson Bay and Te Kapa Inlet (Figure 3).

Chlorophyll *a* content of the sediments continues to be highest at Cowans Bay (10.66-23.08 $\mu g\ g^{-1}$ sediment) and lowest at Jamieson Bay (1.76 - 6.76 $\mu g\ g^{-1}$ sediment). Dyers Creek chlorophyll levels are intermediate between these sites (5.16-8.10 $\mu g\ g^{-1}$ sediment). There is no easily discernable temporal pattern in sediment chlorophyll *a* levels across the sites (Appendix 3). However, it is interesting to note that four of the sites have exhibited their highest ever chlorophyll *a* levels in July (i.e., Hamilton Landing, Jamieson Bay and Te Kapa Inlet (muddy region) in July 2001, Mid Harbour in July 2002; Appendix 3).

Figure 2.

Changes in the proportions of mud (i.e., silt/clay; <63 µm), fine sand (62.5 – 250 µm), medium sand (250 –500 µm) and coarse sediment (>500 µm) content at each of the intertidal sites over the monitored period. Detailed sediment grain size data, on which these graphs are based, is presented in Appendix 2.

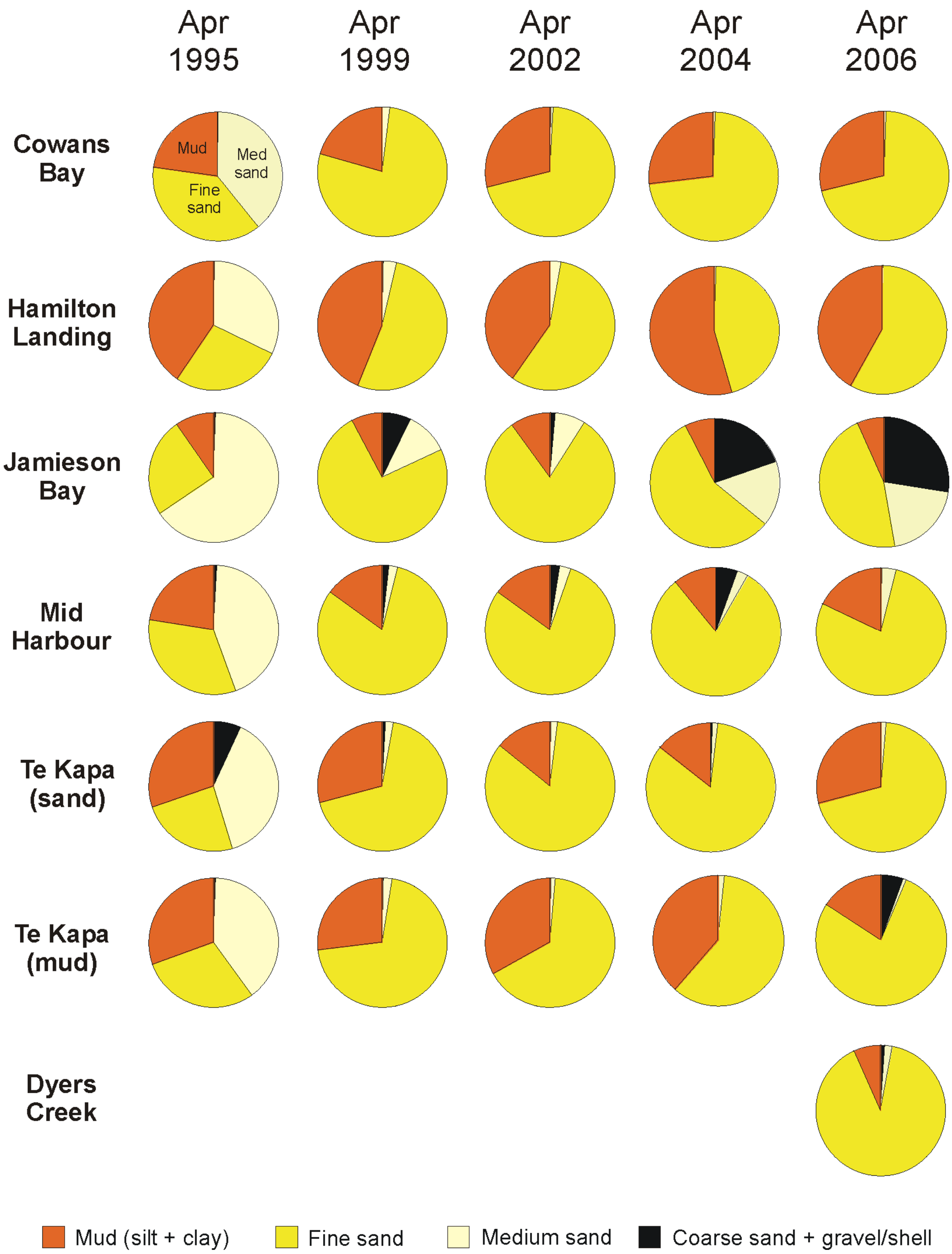
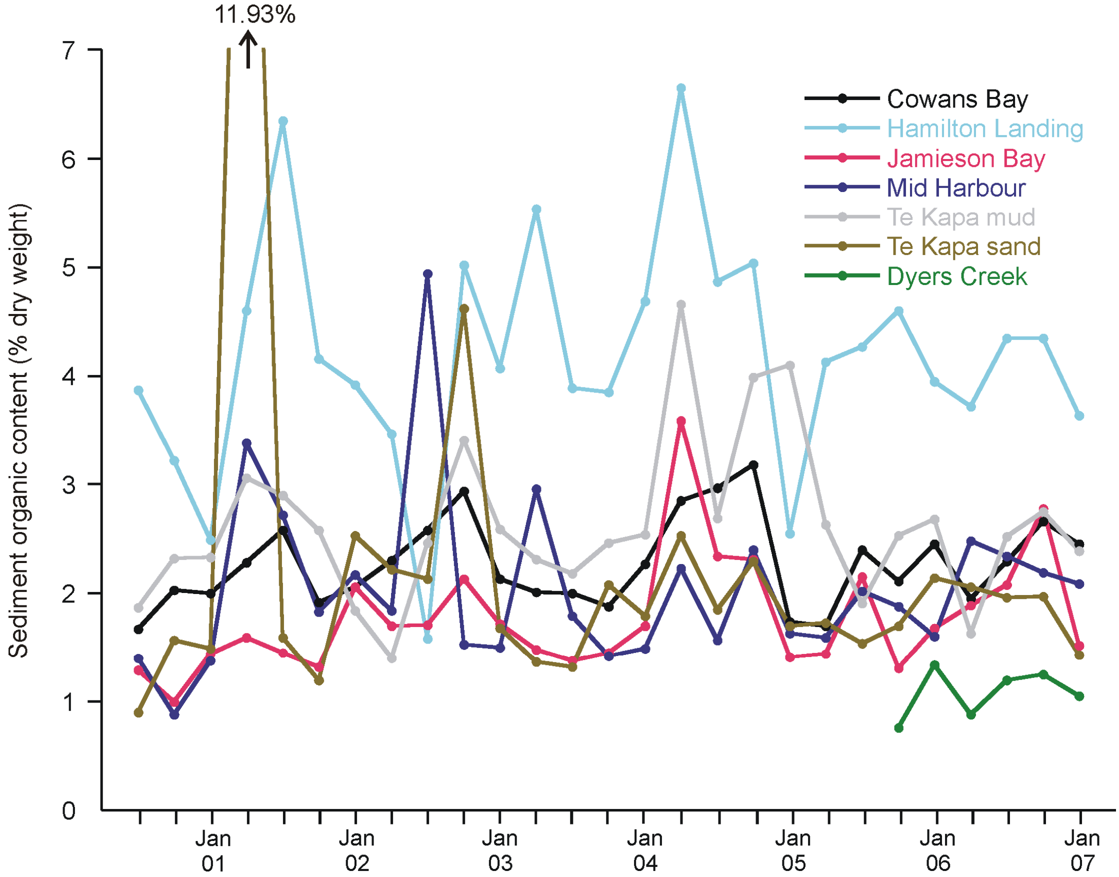


Figure 3.

Sediment organic content at the intertidal sites on each sampling occasion since July 2000.



4.1.2 Macrofauna - comments on the abundance of common taxa

Throughout this report 'total' abundances (i.e., total numbers of individuals collected in 12 samples) of the monitored taxa are discussed. The abundances of all the intertidal monitored taxa collected at each site on each sampling date since the last report (i.e., from April 2005 to January 2007) are given in Appendix 4[1].

The following are site-by-site descriptions of the monitored macrofauna. For each site, we discuss the three most abundant taxa, populations exhibiting visually identifiable cycles in abundance, and populations for which statistically identifiable trends in abundance have been detected by trend analysis. A table summarising the trend analysis results is given at the end of this section (Table 6).

[1] *Prionospio aucklandica* referred to in this report follows taxonomic change to *Aquilaspio aucklandica*.

4.1.2.1 Cowans Bay

The polychaete *Cossura* sp. has dominated this site on all but one occasion since monitoring began in July 1994 (Table 1), with 135 to 738 individuals found on each sampling date. The decline in abundance of *Arthritica bifurca* noted in our last report has not continued, and this small bivalve has featured amongst the dominant taxa on six of the eight most recent sampling dates. Polydorid polychaetes were the third most abundant monitored taxa in April 2005; they had not previously featured amongst the dominant taxa at this site (Table 1), and have not since. The polychaete *Heteromastus filiformis*, the amphipod *Torridoharpinia hurleyi*, and the nut shell *Nucula hartvigiana* (Figure 4) were also common over the past two years at Cowans Bay (Table 1).

Table 1.

The three dominant taxa collected at Cowans Bay from July 1994 to January 2007. The most abundant taxa are on the left hand side of the table.

Jul 94	*Cossura* sp.	*Heteromastus filiformis*	*Arthritica bifurca*
Oct 94	*Cossura* sp.	*Heteromastus filiformis*	*Arthritica bifurca*
Jan 95	*Cossura* sp.	*Arthritica bifurca*	*Heteromastus filiformis*
Apr 95	*Cossura* sp.	*Arthritica bifurca*	*Nucula hartvigiana*
Jul 95	*Cossura* sp.	*Arthritica bifurca*	*Heteromastus filiformis*
Oct 95	*Cossura* sp.	*Arthritica bifurca*	*Heteromastus filiformis*
Jan 96	*Cossura* sp.	*Arthritica bifurca*	*Heteromastus filiformis*
Apr 96	*Cossura* sp.	*Heteromastus filiformis*	*Arthritica bifurca*
Jul 96	*Cossura* sp.	*Heteromastus filiformis*	*Arthritica bifurca*
Oct 96	*Cossura* sp.	*Heteromastus filiformis*	*Arthritica bifurca*
Jan 97	*Cossura* sp.	*Arthritica bifurca*	*Heteromastus filiformis*
Apr 97	*Cossura* sp.	*Heteromastus filiformis*	*Arthritica bifurca*
Jul 97	*Cossura* sp.	*Torridoharpinia hurleyi*	*Arthritica bifurca*
Oct 97	*Cossura* sp.	*Heteromastus filiformis*	*Arthritica bifurca*
Jan 98	*Cossura* sp.	*Heteromastus filiformis*	*Arthritica bifurca*
Apr 98	*Cossura* sp.	*Heteromastus filiformis*	*Arthritica bifurca*
Jul 98	*Cossura* sp.	*Heteromastus filiformis*	*Arthritica bifurca*
Oct 98	*Cossura* sp.	*Arthritica bifurca*	*Heteromastus filiformis*
Jan 99	*Cossura* sp.	*Arthritica bifurca*	*Heteromastus filiformis*
Apr 99	*Cossura* sp.	*Arthritica bifurca*	*Heteromastus filiformis*
Jul 99	*Cossura* sp.	*Heteromastus filiformis*	*Arthritica bifurca*
Oct 99	*Cossura* sp.	*Heteromastus filiformis*	*Arthritica bifurca*
Jan 00	*Cossura* sp.	*Arthritica bifurca*	*Heteromastus filiformis*
Apr 00	*Cossura* sp.	*Heteromastus filiformis*	*Arthritica bifurca*
Jul 00	*Cossura* sp.	*Heteromastus filiformis*	*Arthritica bifurca*
Oct 00	*Cossura* sp.	*Heteromastus filiformis*	*Arthritica bifurca*
Jan 01	*Cossura* sp.	*Arthritica bifurca*	*Torridoharpinia hurleyi*
Apr 01	*Cossura* sp.	*Heteromastus filiformis*	*Arthritica bifurca*
Jul 01	*Cossura* sp.	*Arthritica bifurca*	*Heteromastus filiformis*
Oct 01	*Cossura* sp.	*Arthritica bifurca*	*Heteromastus filiformis*
Jan 02	*Cossura* sp.	*Arthritica bifurca*	*Heteromastus filiformis*
Apr 02	*Cossura* sp.	*Heteromastus filiformis*	*Arthritica bifurca*
Jul 02	*Cossura* sp.	*Heteromastus filiformis*	*Arthritica bifurca*
Oct 02	*Cossura* sp.	*Heteromastus filiformis*	*Arthritica bifurca*
Jan 03	*Cossura* sp.	*Heteromastus filiformis*	*Arthritica bifurca*
Apr 03	*Cossura* sp.	*Heteromastus filiformis*	*Arthritica bifurca*
Jul 03	*Cossura* sp.	*Heteromastus filiformis*	*Torridoharpinia hurleyi*
Oct 03	*Cossura* sp.	*Heteromastus filiformis*	*Macomona liliana*
Jan 04	*Cossura* sp.	*Heteromastus filiformis*	*Nucula hartvigiana*
Apr 04	*Cossura* sp.	*Heteromastus filiformis*	*Torridoharpinia hurleyi*
Jul 04	*Cossura* sp.	*Heteromastus filiformis*	*Torridoharpinia hurleyi*
Oct 04	*Cossura* sp.	*Heteromastus filiformis*	*Torridoharpinia hurleyi*

Jul 94	*Cossura* sp.	*Heteromastus filiformis*	*Arthritica bifurca*
Jan 05	*Torridoharpinia hurleyi*	*Cossura* sp.	*Nucula hartvigiana*
Apr 05	*Cossura* sp.	*Heteromastus filiformis*	Polydorids
Jul 05	*Cossura* sp.	*Heteromastus filiformis*	*Arthritica bifurca*
Oct 05	*Cossura* sp.	*Heteromastus filiformis*	*Nucula hartvigiana*
Jan 06	*Cossura* sp.	*Nucula hartvigiana*	*Arthritica bifurca*
Apr 06	*Cossura* sp.	*Arthritica bifurca*	*Heteromastus filiformis*
Jul 06	*Cossura* sp.	*Arthritica bifurca*	*Nucula hartvigiana*
Oct 06	*Cossura* sp.	*Arthritica bifurca*	*Torridoharpinia hurleyi*
Jan 07	*Cossura* sp.	*Torridoharpinia hurleyi*	*Arthritica bifurca*

Populations showing cyclic abundance patterns

Nucula hartvigiana exhibits peaks in abundance in January of most years, except for 2002 and 2003 when peaks occurred in October (Figure 4). Similarly, the mud crab *Macrophthalmus hirtipes* is most abundant in January or October (Figure 5). *Heteromastus filiformis* numbers generally peak in July or October, with smaller peaks noted in October 2006.

The apparent cyclic pattern in abundance noted for *Cossura* sp. in our last report is no longer apparent with two more years of data

Figure 4.
Total number of *Nucula hartvigiana* collected on each sampling occasion at Cowans Bay. Peaks in abundance occur annually, most often in January months, and an increasing trend in basal abundance of this bivalve was also detected.

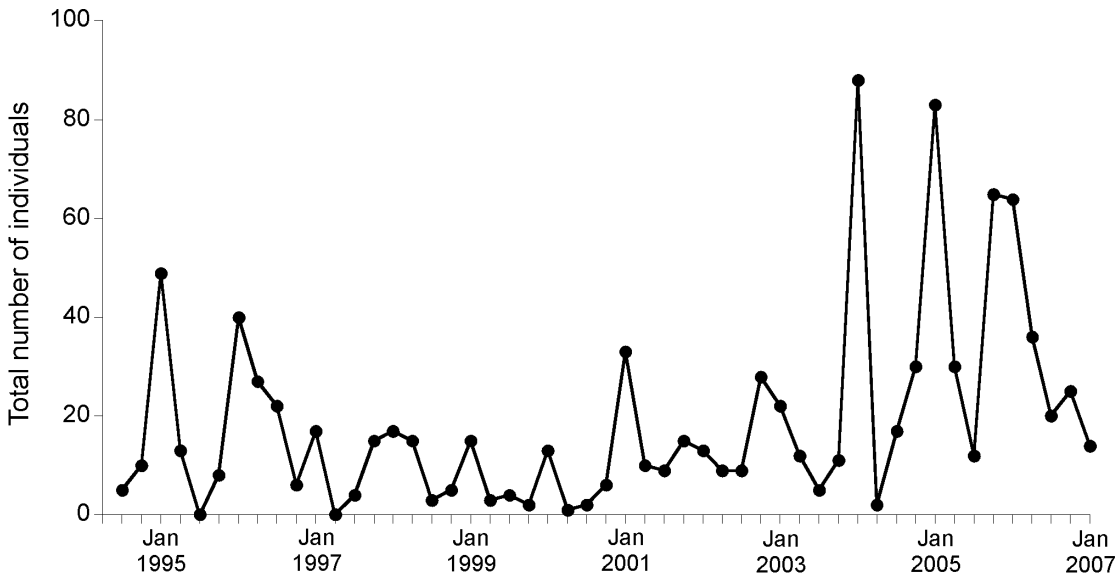
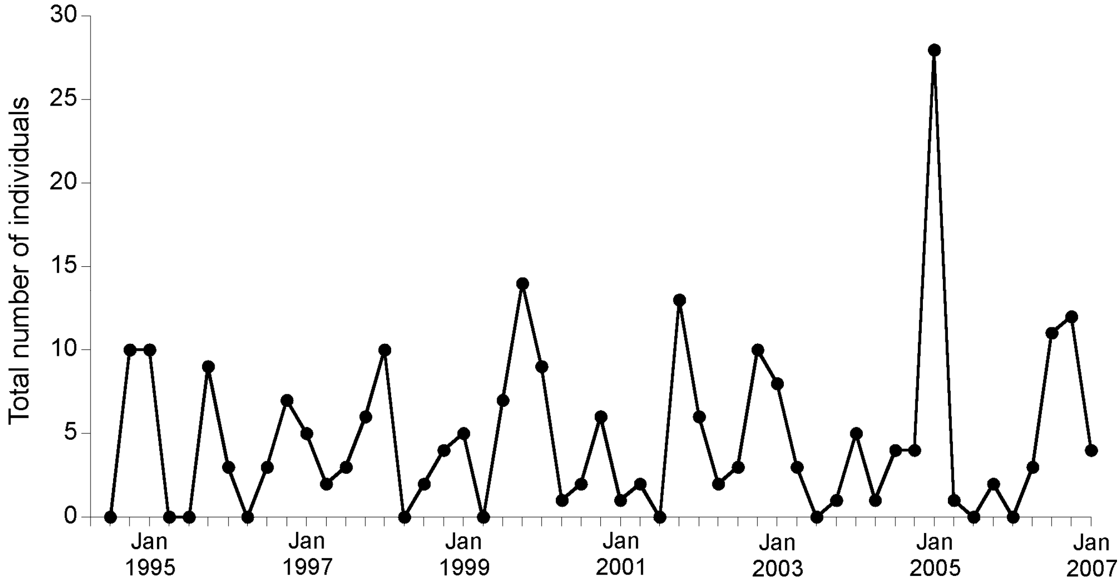


Figure 5.
Total number of *Macrophthalmus hirtipes* collected on each sampling occasion at Cowans Bay. Peaks in abundance of this crab occur annually, most often in January or October months.



Populations showing trends in abundance

Four new trends in abundance were detected at Cowans Bay: the polychaetes *Cossura* sp. and *Prioniospio aucklandica* and nemerteans, all of which exhibit decreasing trends, and an increase in abundance of the bivalve *Nucula hartvigiana* (Table 6). *Cossura* is found in very high numbers at this site, and there has been a slight decline in its peak abundances over the monitored period. However, these numbers have increased in recent months (195-405 individuals were found over the past two years) and it is likely this trend is just a reflection of fluctuations in abundance of this polychaete. The magnitude of the trend detected for *Prionospio* is very small (see Table 6); this polychaete has never been very abundant at this site (2-3 individuals on most occasions). A small decreasing trend was also detected for nemerteans, due to the smaller peak in abundance in recent years. This species has been found in low numbers at this site in recent years (<10 individuals).

An increase in baseline abundances of *Nucula hartvigiana* was detected, reflecting higher numbers of this bivalve since October 2000 (Figure 4); there was no trend in overall abundance (Table 6). While a statistically significant increasing trend in abundance was detected for *Paracalliope novizelandiae*, it was of very low magnitude (Table 6). This amphipod has been found on only two occasions at Cowans Bay over the past two years (when only 1 individual was collected on each date), and we do not place much emphasis on this trend.

The decline in polydorid polychaete abundances detected in past reports is now no longer apparent (Figure 6A). Abundances of this taxa over the past two years have been amongst the highest recorded over the monitored period. The unusually high numbers of *Torridoharpinia hurleyi* found in January 2005 (i.e., 312 individuals) have not persisted (Figure 7). Consequently, and as expected, the increasing trend in numbers of this amphipod detected in our 2005 report is no longer apparent (Table 6).

Figure 6.
Total number of polydorids collected on each sampling occasion at the intertidal sites. Peaks in abundance of this polychaete occur annually at Hamilton Landing and Jamiesons Bay, and approximately every two years at Te Kapa Inlet. Decreasing trends in abundance were detected at all sites except Cowans Bay.

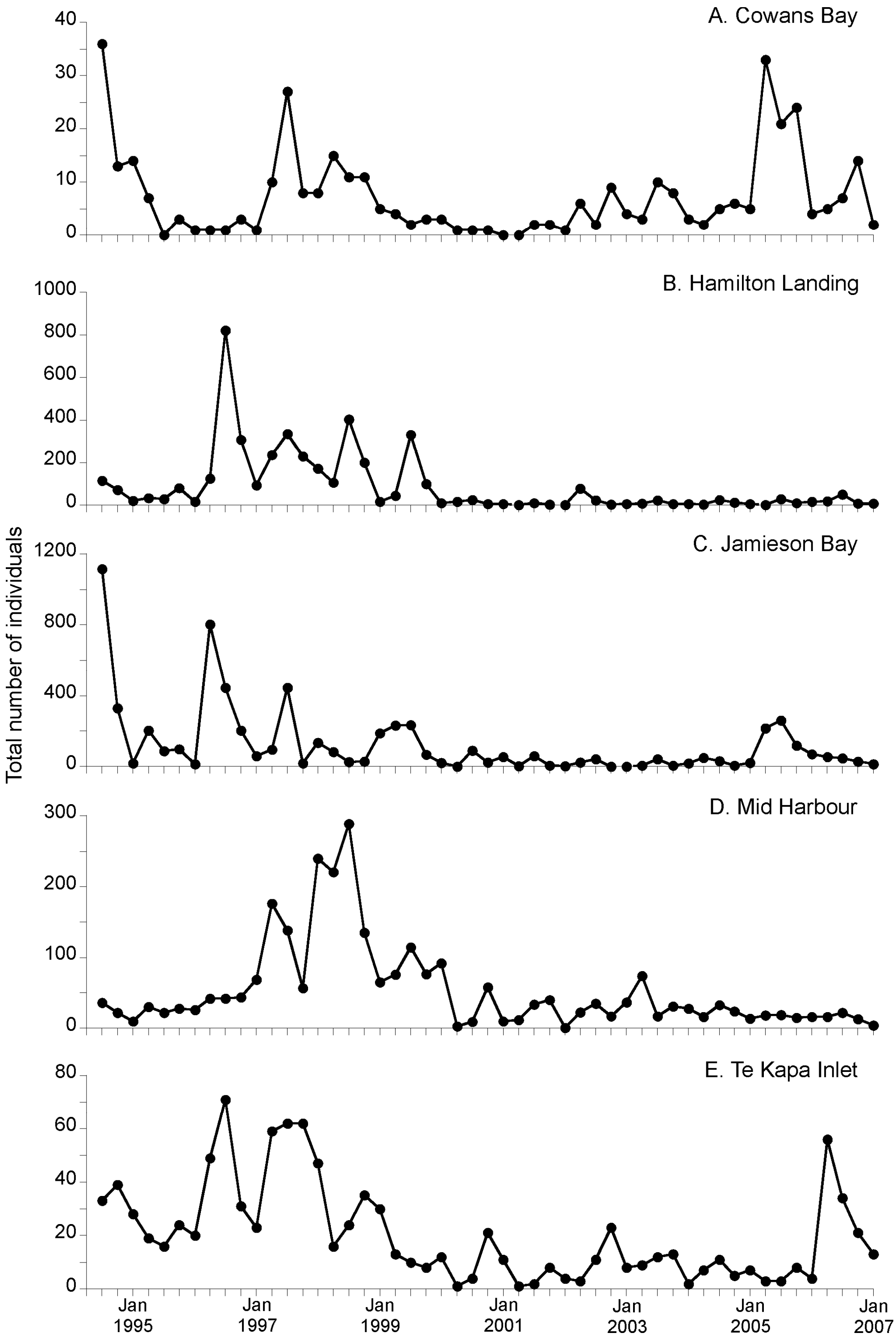
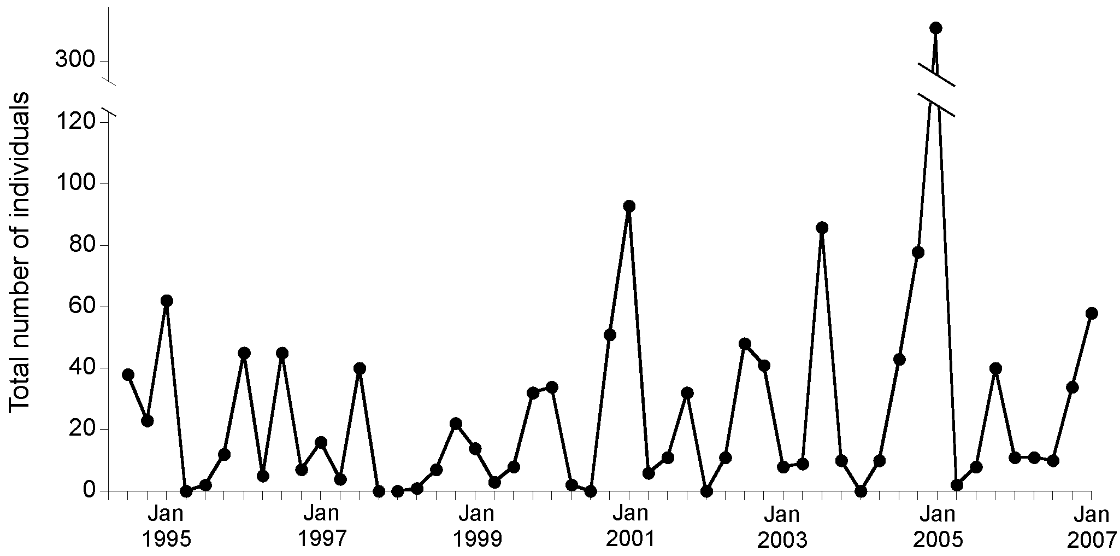


Figure 7.
Total number of *Torridoharpinia hurleyi* amphipods collected on each sampling occasion at Cowans Bay. The increasing trend in abundance detected for this taxa in our 2005 report is no longer apparent.



4.1.2.2 Hamilton Landing

Cossura sp.and *Heteromastus filiformis* are still the first and second most abundant of the monitored species at Hamilton Landing, and both continue to increase in abundance as the monitoring programme continues. *Cossura* recorded its highest ever numbers at this site in April 2006 (1234 individuals). In the past two years *Aridicea* sp., polydorids, oligochaetes and *Arthritica bifurca* have featured as the third most abundant monitored taxa at this site.

Populations showing cyclic abundance patterns

The small bivalve *Arthritica bifurca* exhibits a greater than annual cycle in its abundance, with peaks in January or October. (Figure 8).

Polydorid polychaetes have exhibited peaks in abundance in January most years, except for 1995 and 2002 when these occurred in October and April, respectively. Numbers of polydorids have been considerably lower in the last half of the monitored period (i.e., since October 1999), but remain steady (Figure 6B).

The crab *Macrophthalmus hirtipes* and the polychaete *Heteromastus filiformis* exhibit peaks in abundance every year, and most often in October (Figures 9 and 10).

Figure 8.

Total number of *Arthritica bifurca* collected on each sampling occasion at Hamilton Landing. Peaks in abundance of this bivalve occur on a greater than annual cycle, in January or October months.

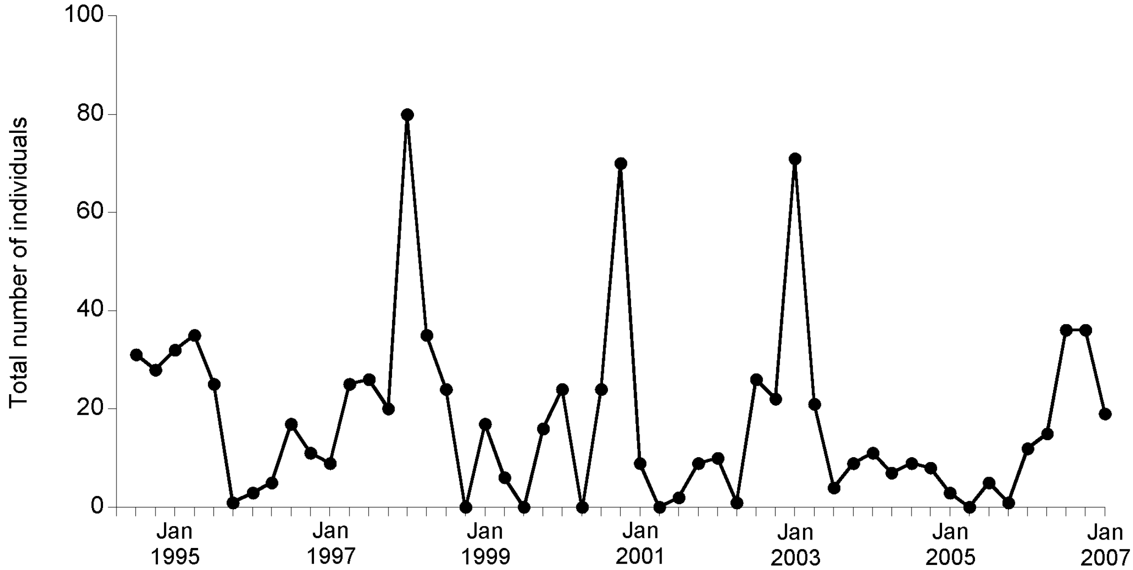


Figure 9.

Total number of *Macrophthalmus hirtipes* collected on each sampling occasion at Hamilton Landing. Peaks in abundance of this crab occur annually, most often in October months.

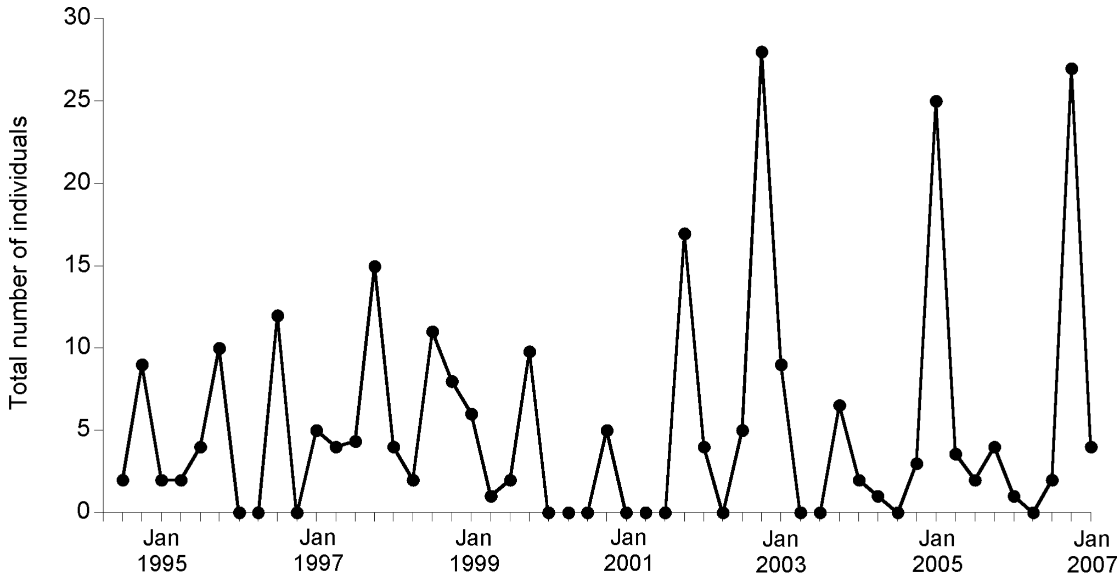


Table 2.

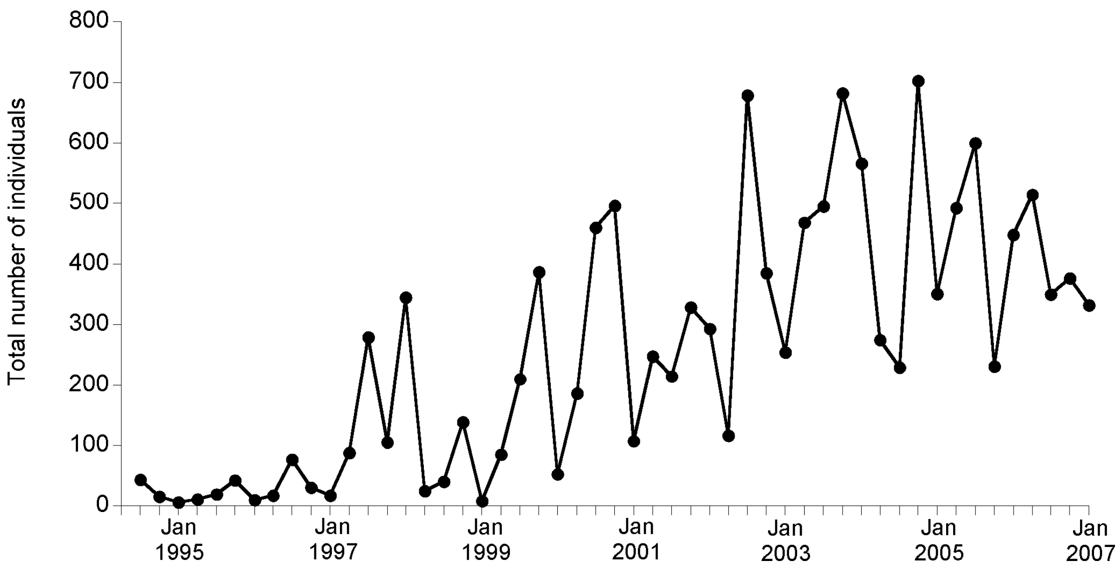
The three dominant taxa collected at Hamilton Landing from July 1994 to January 2007. The most abundant taxa are on the left hand side of the table. When more than one taxa has the same rank they are represented as (for example) '*Arthritica bifurca*/*Cossura* sp.'

Jul 94	*Austrovenus stutchburyi*	Polydorids	*Cossura* sp.
Oct 94	*Austrovenus stutchburyi*	Polydorids	*Cossura* sp.
Jan 95	*Austrovenus stutchburyi*	*Nucula hartvigiana*	*Arthritica bifurca/Cossura* sp.
Apr 95	*Austrovenus stutchburyi*	*Cossura* sp.	*Arthritica bifurca*
Jul 95	*Austrovenus stutchburyi*	*Cossura* sp.	*Polydorids*
Oct 95	*Austrovenus stutchburyi*	Polydorids	*Heteromastus filiformis*
Jan 96	*Austrovenus stutchburyi*	Polydorids	*Heteromastus filiformis*
Apr 96	Polydorids	*Austrovenus stutchburyi*	*Heteromastus filiformis*
Jul 96	Polydorids	*Heteromastus filiformis*	*Cossura* sp.
Oct 96	Polydorids	*Heteromastus filiformis*	*Austrovenus stutchburyi*
Jan 97	Polydorids	*Austrovenus stutchburyi*	*Cossura* sp.
Apr 97	Polydorids	*Cossura* sp.	*Heteromastus filiformis*
Jul 97	Polydorids	*Heteromastus filiformis*	*Cossura* sp.
Oct 97	Polydorids	*Heteromastus filiformis*	*Cossura* sp.
Jan 98	*Heteromastus filiformis*	Polydorids	*Cossura* sp.
Apr 98	*Austrovenus stutchburyi*	Polydorids	*Cossura* sp.
Jul 98	Polydorids	*Austrovenus stutchburyi*	*Cossura* sp.
Oct 98	Polydorids	*Heteromastus filiformis*	*Cossura* sp.
Jan 99	*Austrovenus stutchburyi / Cossura* sp.	*Arthritica bifurca /* Polydorids	
Apr 99	*Heteromastus filiformis*	*Cossura* sp.	*Austrovenus stutchburyi*
Jul 99	Polydorids	*Heteromastus filiformis*	*Cossura* sp.
Oct 99	*Heteromastus filiformis*	Polydorids	*Cossura* sp.
Jan 00	*Austrovenus stutchburyi*	*Heteromastus filiformis*	*Cossura* sp.
Apr 00	*Heteromastus filiformis*	*Cossura* sp.	*Torridoharpinia hurleyi*
Jul 00	*Heteromastus filiformis*	*Cossura* sp.	Oligochaetes
Oct 00	*Heteromastus filiformis*	*Cossura* sp.	*Arthritica bifurca*
Jan 01	*Cossura* sp.	*Heteromastus filiformis*	Nemerteans
Apr 01	*Cossura* sp.	*Heteromastus filiformis*	*Prionospio aucklandica*
Jul 01	*Cossura* sp.	*Heteromastus filiformis*	Polydorids
Oct 01	*Cossura* sp.	*Heteromastus filiformis*	Nemerteans
Jan 02	*Cossura* sp.	*Heteromastus filiformis*	*Prionospio aucklandica*
Apr 02	*Cossura* sp.	*Heteromastus filiformis*	Polydorids
Jul 02	*Heteromastus filiformis*	*Cossura* sp.	*Arthritica bifurca*
Oct 02	*Cossura* sp.	*Heteromastus filiformis*	*Macrophthalmus hirtipes*
Jan 03	*Cossura* sp.	*Heteromastus filiformis*	*Arthritica bifurca*
Apr 03	*Cossura* sp.	*Heteromastus filiformis*	*Arthritica bifurca*
Jul 03	*Cossura* sp.	*Heteromastus filiformis*	*Aricidea* sp.
Oct 03	*Heteromastus filiformis*	*Cossura* sp.	*Prionospio aucklandica*
Jan 04	*Cossura* sp.	*Heteromastus filiformis*	*Aricidea* sp.
Apr 04	*Cossura* sp.	*Heteromastus filiformis*	*Prionospio aucklandica*

Jul 04	*Cossura* sp.	*Heteromastus filiformis*	*Arthritica bifurca*
Oct 04	*Cossura* sp.	*Heteromastus filiformis*	*Aricidea* sp.
Jan 05	*Cossura* sp.	*Heteromastus filiformis*	*Aricidea* sp.
Apr 05	*Cossura* sp.	*Heteromastus filiformis*	Oligochaetes
Jul 05	*Cossura* sp.	*Heteromastus filiformis*	Polydorids
Oct 05	*Cossura* sp.	*Heteromastus filiformis*	*Aricidea* sp.
Jan 06	*Cossura* sp.	*Heteromastus filiformis*	*Aricidea* sp.
Apr 06	*Cossura* sp.	*Heteromastus filiformis*	*Aricidea* sp.
Jul 06	*Cossura* sp.	*Heteromastus filiformis*	Polydorids
Oct 06	*Cossura* sp.	*Heteromastus filiformis*	*Arthritica bifurca*
Jan 07	*Cossura* sp.	*Heteromastus filiformis*	*Aricidea* sp.

Figure 10.

Total number of *Heteromastus filiformis* collected on each sampling occasion at Hamilton Landing. Peaks in abundance of this polychaete occur annually, most often in October months. An increasing trend in overall and basal abundances was also detected.



Populations showing trends in abundance

Trends in abundance over the monitoring period were detected for 10 of the monitored populations at Hamilton Landing; all of these were also noted in our last report (Table 6). Five populations exhibit increases in abundance, and five exhibit decreases.

Cossura sp. and *Heteromastus filiformis* (Figure 10) both exhibit strong increasing trends, and for the latter this is also apparent in basal abundances (see Table 6). Abundances of *Heteromastus* in the past two years have been lower than previously, and may indicate a tailing off of this increase (Figure 10). Smaller increases in abundance were detected for *Aricidea* sp., *Prionospio aucklandic*a and nemerteans (Table 6).

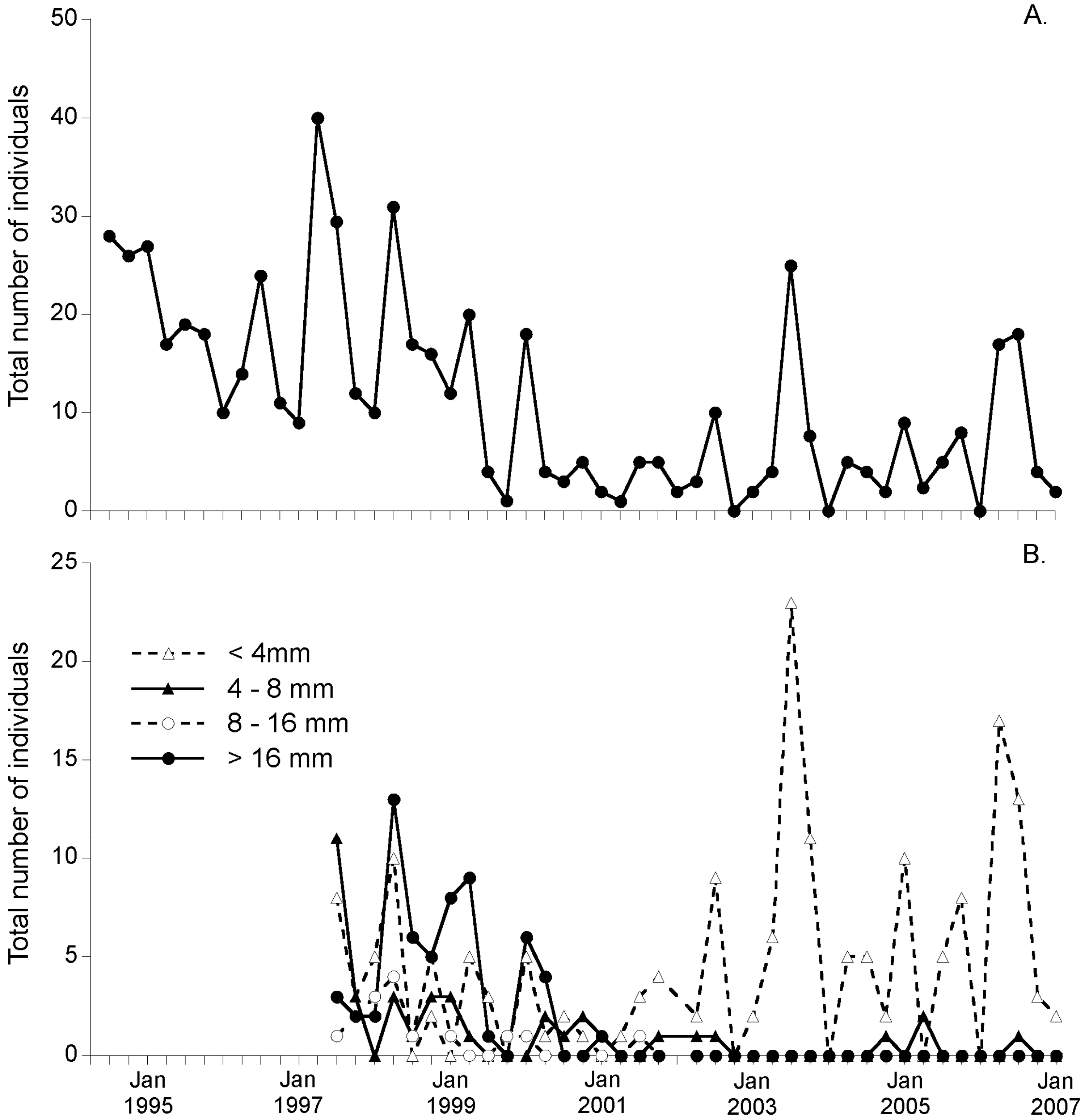
Overall and baseline abundances of polydorids have declined over the monitored period (Table 6). As noted above, its numbers have been relatively low, but steady, at this site since October 1999 (Figure 6B).

The bivalves *Austrovenus stutchburyi* and *Macomona liliana* continue to exhibit declines in abundance at Hamilton Landing. Since January 2001, between 0 and 2 individual *Austrovenus* have been found at this site. *Macomona* abundance peaks were up around its previous high values in July 2003 (25 individuals), and relatively high abundances occurred in April and July 2006 (17 and 18 individuals, respectively). Numbers of *Macomona* now appear to be steady at a new baseline abundance of 0-9 individuals (Figure 11A). The *Macomona* population at Hamilton Landing is now largely comprised of very small (<4 mm) individuals; no large, spawning sized individuals have been collected since January 2001 (Figure 11B). This indicates that juvenile *Macomona* are being supplied to this site from elsewhere in the harbour and few are surviving to adulthood.

Decreasing trends were detected for *Scoloplos cylindrifer* and *Perinereis nuntia*; these polychaetes have been scarce or absent at Hamilton Landing since July 1999.

Figure 11.

A. The total number of *Macomona liliana* collected on each sampling occasion at Hamilton Landing. A decreasing trend in overall abundance was detected for this bivalve.
B. The total number of individuals in each size class, from July 1997 onwards.



4.1.2.3 Jamieson Bay

Nucula hartvigiana was the first or second most abundant species at Jamieson Bay between April 2005 and January 2007 (Table 3), when 36-366 individuals were found. Polydorids were amongst the three dominant monitored species on five of the eight most recent sampling dates (14-260 individuals). *Heteromastus filiformis* (15-85 individuals) and *Macomona liliana* (7-84 individuals) were the second or third most abundant taxa on four and three occasions, respectively. The amphipods *Paracalliope novizelandiae* (0-30 individuals) and *Torridoharpinia hurleyi* (1-27 individuals), the polychaete *Aonides oxycephala* (8-27 individuals), and oligochaetes have all featured in the dominant taxa list once over the past two years (Table 3). All of these taxa have featured amongst the dominant taxa list at this site over the course of the monitoring programme (Table 3).

Table 3.

The three dominant taxa collected at Jamieson Bay from July 1994 to January 2007. The most abundant taxa is on the left hand side of the table. When more than one taxa has the same rank they are represented as (for example) *'Arthritica bifurca* / *Cossura* sp.).

Jul 94	Polydorids	*Nucula hartvigiana*	*Macomona liliana*
Oct 94	Polydorids	*Nucula hartvigiana*	*Heteromastus filiformis*
Jan 95	*Nucula hartvigiana*	*Macomona liliana*	*Cossura* sp.
Apr 95	*Nucula hartvigiana*	Polydorids	*Torridoharpinia hurleyi*
Jul 95	*Nucula hartvigiana*	Polydorids	*Macomona liliana*
Oct 95	Polydorids	*Nucula hartvigiana*	*Heteromastus filiformis*
Jan 96	*Nucula hartvigiana*	*Aonides oxycephala*	*Heteromastus filiformis*
Apr 96	Polydorids	*Nucula hartvigiana*	*Aonides oxycephala*
Jul 96	Polydorids	*Nucula hartvigiana*	*Macomona liliana*
Oct 96	Polydorids	*Nucula hartvigiana*	*Heteromastus filiformis*
Jan 97	*Nucula hartvigiana*	Polydorids	*Cossura* sp. / *Heteromastus filiformis*
Apr 97	*Nucula hartvigiana*	Polydorids	*Aonides oxycephala*
Jul 97	Polydorids	*Nucula hartvigiana*	*Torridoharpinia hurleyi*
Oct 97	*Aonides oxycephala*	*Nucula hartvigiana*	*Heteromastus filiformis*
Jan 98	*Nucula hartvigiana*	Polydorids	*Heteromastus filiformis*
Apr 98	Polydorids	*Nucula hartvigiana*	*Heteromastus filiformis*
Jul 98	*Aonides oxycephala*	*Nucula hartvigiana*	*Heteromastus filiformis*
Oct 98	*Nucula hartvigiana*	Polydorids	*Heteromastus filiformis*
Jan 99	Polydorids	*Nucula hartvigiana*	*Macomona liliana*
Apr 99	Polydorids	*Nucula hartvigiana*	*Macomona liliana*
Jul 99	Polydorids	*Heteromastus filiformis*	*Nucula hartvigiana*
Oct 99	Polydorids	*Heteromastus filiformis*	*Aonides oxycephala*
Jan 00	*Nucula hartvigiana*	Nemerteans	Polydorids
Apr 00	*Nucula hartvigiana*	*Aonides oxycephala*	*Scoloplos cylindrifer*
Jul 00	Polydorids	*Aonides oxycephala*	*Heteromastus filiformis*
Oct 00	*Nucula hartvigiana*	*Aonides oxycephala*	Polydorids
Jan 01	*Nucula hartvigiana*	Polydorids	*Aonides oxycephala*
Apr 01	*Nucula hartvigiana*	*Aonides oxycephala*	*Paracalliope novizealandiae*
Jul 01	*Nucula hartvigiana*	Polydorids	*Aonides oxycephala*
Oct 01	*Nucula hartvigiana*	*Aricidea* sp.	*Macomona liliana*
Jan 02	*Nucula hartvigiana*	*Cossura* sp.	*Macomona liliana*
Apr 02	*Nucula hartvigiana*	*Paracalliope novizealandiae*	*Cossura* sp.
Jul 02	*Nucula hartvigiana*	*Heteromastus filiformis*	Polydorids
Oct 02	*Nucula hartvigiana*	*Aricidea* sp.	*Heteromastus filiformis*
Jan 03	*Nucula hartvigiana*	*Cossura* sp.	*Paracalliope novizealandiae*
Apr 03	*Nucula hartvigiana*	*Aonides oxycephala*	*Aricidea* sp.
Jul 03	*Nucula hartvigiana*	*Heteromastus filiformis*	Oligochaete
Oct 03	*Nucula hartvigiana*	*Aonides oxycephala*	*Heteromastus filiformis*
Jan 04	*Nucula hartvigiana*	*Heteromastus filiformis*	*Aonides oxycephala*
Apr 04	*Nucula hartvigiana*	Polydorids	*Aonides oxycephala*

Jul 04	*Nucula hartvigiana*	Oligochaete	*Aonides oxycephala*
Oct 04	*Nucula hartvigiana*	*Aricidea* sp.	*Heteromastus filiformis*
Jan 05	*Nucula hartvigiana*	*Torridoharpinia hurleyi*	*Paracalliope novizealandiae*
Apr 05	Polydorids	*Nucula hartvigiana*	*Heteromastus filiformis*
Jul 05	Polydorids	*Nucula hartvigiana*	*Heteromastus filiformis*
Oct 05	Polydorids	*Nucula hartvigiana*	*Paracalliope novizealandiae*
Jan 06	*Nucula hartvigiana*	*Aonides oxycephala*	Polydorids
Apr 06	*Nucula hartvigiana*	*Heteromastus filiformis*	*Macomona liliana*
Jul 06	*Nucula hartvigiana*	*Heteromastus filiformis*	Oligochaete
Oct 06	*Nucula hartvigiana*	*Macomona liliana*	Polydorids
Jan 07	*Nucula hartvigiana*	*Torridoharpinia hurleyi*	*Macomona liliana*

Populations showing cyclic abundance patterns

Three populations exhibit annual cyclic abundance patterns at Jamieson Bay: polydorids, *Aricidea* sp. and *Nucula hartvigiana*. Polydorids have highest numbers in July or April each year, although there was no abundance peak for this polychaete between April of 1998 and 1999 (Figure 6C). *Aricidea* peak abundances occur in either July or October months, while *Nucula* consistently exhibits its highest numbers in January or April.

The cyclic abundance patterns noted for *Heteromastus filiformis*, *Macomona liliana* and *Austrovenus stutchburyi* in our 2005 report are no longer apparent with the addition of two more years of data.

Populations showing trends in abundance

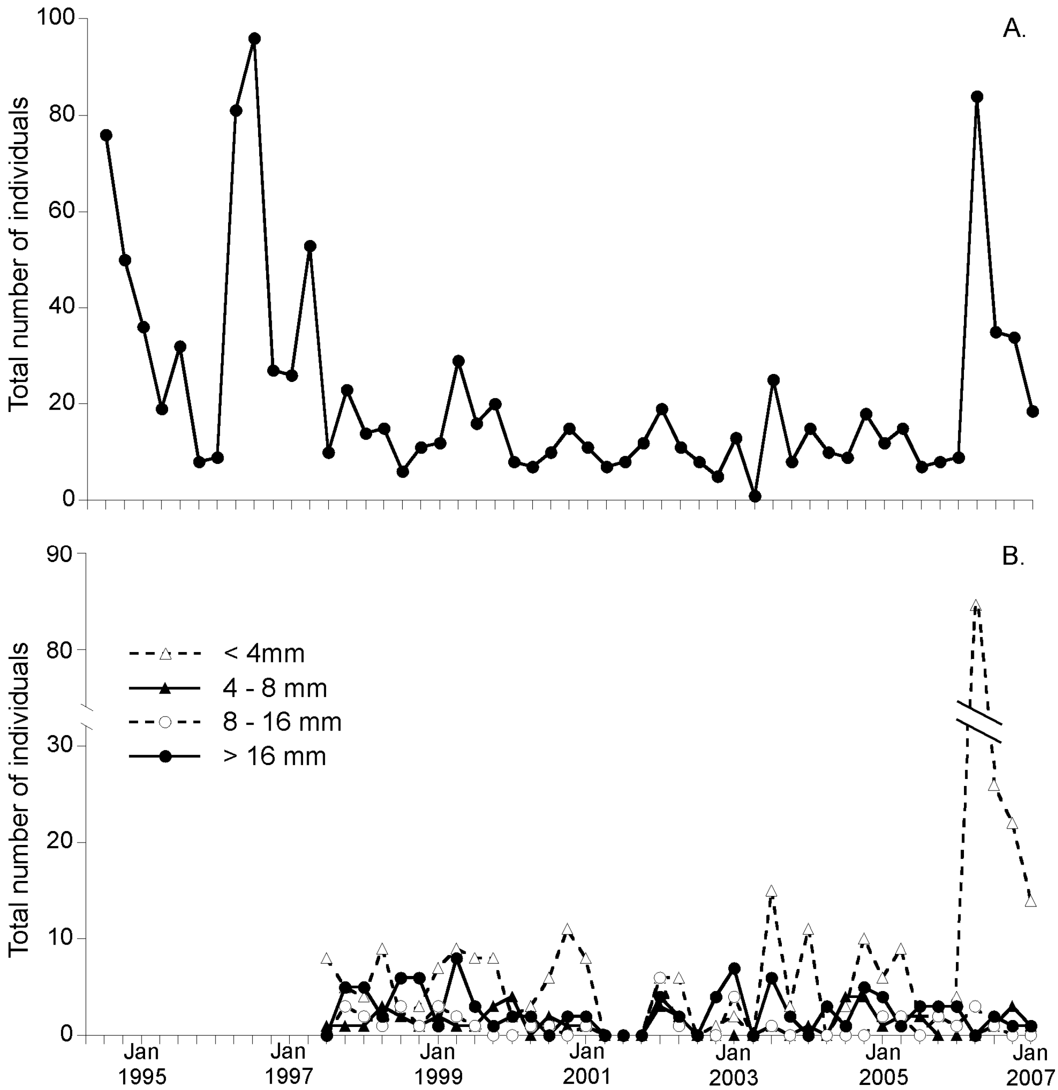
Statistically significant trends in abundance were detected for five populations at Jamieson Bay (Table 6). Declines in abundance were apparent for *Macomona liliana*, *Torridoharpinia hurleyi* and polydorids. *Macomona* was abundant at this site for the first three years of monitoring, after which abundances declined to around 10 individuals on average. While Fig. 12A suggests that this decline has been reversed (with a large peak in abundance in April 2006, this was comprised almost entirely of <4 mm individuals (Figure 12B). The decline in *Torridoharpinia* was also noted in our last report, although the magnitude of this trend is less now due to the relatively high numbers of this amphipod found in January 2004 (31 individuals). Polydorids exhibit a decreasing trend in both overal and basal abundances (Figure 6C).

Small increases in abundance of two populations were detected: *Arthritica bifurca* and *Aricidea* sp. (Table 6). *Arthritica* has exhibited large fluctuations in abundance in the last half of the monitoring programme, ranging from 0-25 individuals since April 2000 (compared to 0-9 prior to that time). *Aricidea* numbers have fluctuated considerably throughout the monitoring programme (ranging from 0-46 individuals), and the trend detected for this polychaete is not of concern.

The trends noted in our last report for *Owenia fusiformis* (a decrease) and *Paracalliope novizelandiae* (an increase) are no longer apparent with two more years of data (Table 6).

Figure 12.

A. Total number of *Macomona liliana* collected on each sampling occasion at Jamieson Bay. A decreasing trend in overall abundance of this bivalve was detected. B. The total number of individuals in each size class, from July 1997 onwards.



4.1.2.4 Mid Harbour

Nucula hartvigiana continues to dominate Mid Harbour (Table 4), with between 320 and 498 individuals collected on the last eight monitoring dates. As has been the case for the last 6 years, *Arthritica bifurca* (34-110 individuals), *Cossura* sp. (24-55 individuals) and *Heteromastus filiformis* (19-56 individuals) were the second or third most abundant of the monitored taxa (Table 4) on the last eight monitoring dates.

Populations showing cyclic abundance patterns

Heteromastus filiformis and *Macrophthalmus hirtipes* (Figure 13) exhibit peaks in abundance every year at Mid Harbour, in July or October months. *Nucula hartvigiana* numbers are highest in January or October each year (except for 2003 and 2004, when peak abundances occurrred in April). *Cossura* sp. exhibits peaks annually, in July, October or April months.

Arthritica bifurca has exhibited peaks in its abundance every few years over the monitored period, but the timing of these is not predictable.

Figure 13.

Total number of *Macrophthalmus hirtipes* collected on each sampling occasion at Mid Harbour. Peaks in abundance of this crab occur annually, most often in July or October months.

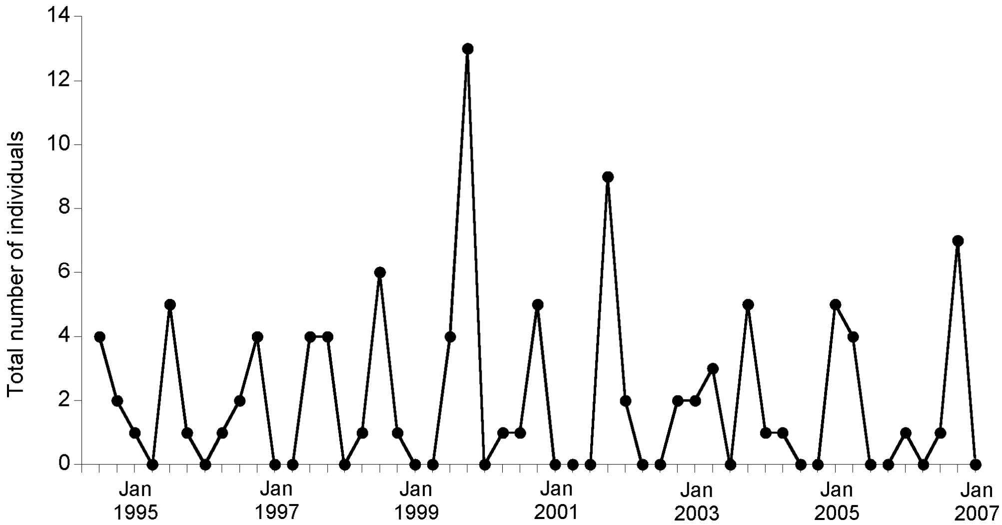


Table 4.

The three dominant taxa collected at Mid Harbour from July 1994 to January 2007. The most abundant taxa is on the left hand side of the table.

Jul 94	*Heteromastus filiformis*	*Cossura* sp.	*Nucula hartvigiana*
Oct 94	*Nucula hartvigiana*	*Cossura* sp.	*Macomona liliana*
Jan 95	*Nucula hartvigiana*	*Cossura* sp.	*Arthritica bifurca*
Apr 95	*Nucula hartvigiana*	*Cossura* sp.	Polydorids
Jul 95	*Nucula hartvigiana*	*Cossura* sp.	*Macomona liliana*
Oct 95	*Nucula hartvigiana*	*Cossura* sp.	*Arthritica bifurca*
Jan 96	*Nucula hartvigiana*	*Cossura* sp.	Polydorids
Apr 96	*Nucula hartvigiana*	*Polydorids*	*Cossura* sp.
Jul 96	*Nucula hartvigiana*	*Polydorids*	*Cossura* sp.
Oct 96	*Nucula hartvigiana*	*Polydorids*	*Cossura* sp.
Jan 97	*Nucula hartvigiana*	*Polydorids*	*Cossura* sp.
Apr 97	*Nucula hartvigiana*	*Polydorids*	*Cossura* sp.
Jul 97	*Nucula hartvigiana*	*Polydorids*	*Cossura* sp.
Oct 97	*Nucula hartvigiana*	*Polydorids*	*Cossura* sp.
Jan 98	*Nucula hartvigiana*	*Polydorids*	*Cossura* sp.
Apr 98	*Nucula hartvigiana*	*Polydorids*	*Cossura* sp.
Jul 98	*Nucula hartvigiana*	*Polydorids*	*Austrovenus stutchburyi*
Oct 98	*Nucula hartvigiana*	*Polydorids*	*Cossura* sp.
Jan 99	*Nucula hartvigiana*	*Polydorids*	*Cossura* sp.
Apr99	*Nucula hartvigiana*	*Polydorids*	*Heteromastus filiformis*
Jul 99	*Nucula hartvigiana*	*Polydorids*	*Cossura* sp.
Oct 99	*Nucula hartvigiana*	*Polydorids*	*Heteromastus filiformis*
Jan 00	*Nucula hartvigiana*	*Polydorids*	*Arthritica bifurca*
Apr 00	*Nucula hartvigiana*	*Arthritica bifurca*	*Cossura* sp.
Jul 00	*Nucula hartvigiana*	*Cossura* sp.	*Heteromastus filiformis*
Oct 00	*Nucula hartvigiana*	Polydorids	*Arthritica bifurca*
Jan 01	*Nucula hartvigiana*	*Arthritica bifurca*	*Cossura* sp.
Apr 01	*Heteromastus filiformis*	*Prionospio aucklandica*	*Aricidea* sp. */ Nemerteans*
Jul 01	*Heteromastus filiformis*	*Aricidea* sp.	*Arthritica bifurca*
Oct 01	*Nucula hartvigiana*	*Arthritica bifurca*	*Heteromastus filiformis*
Jan 02	*Nucula hartvigiana*	*Heteromastus filiformis*	*Arthritica bifurca*
Apr 02	*Nucula hartvigiana*	*Arthritica bifurca*	*Heteromastus filiformis*
Jul 02	*Nucula hartvigiana*	*Arthritica bifurca*	*Heteromastus filiformis*
Oct 02	*Nucula hartvigiana*	*Cossura* sp.	*Heteromastus filiformis*
Jan 03	*Nucula hartvigiana*	*Cossura* sp.	*Arthritica bifurca*
Apr 03	*Nucula hartvigiana*	Polydorids	*Cossura* sp.
Jul 03	*Nucula hartvigiana*	*Cossura* sp.	*Heteromastus filiformis*
Oct 03	*Nucula hartvigiana*	*Heteromastus filiformis*	Polydorids
Jan 04	*Nucula hartvigiana*	*Cossura* sp.	*Arthritica bifurca*
Apr 04	*Nucula hartvigiana*	*Cossura* sp.	*Heteromastus filiformis*
Jul 04	*Nucula hartvigiana*	*Arthritica bifurca*	*Cossura* sp.

Oct 04	*Nucula hartvigiana*	*Arthritica bifurca*	*Heteromastus filiformis*
Jan 05	*Nucula hartvigiana*	*Cossura* sp.	*Macomona liliana*
Apr 05	*Nucula hartvigiana*	*Cossura* sp.	*Heteromastus filiformis*
Jul 05	*Nucula hartvigiana*	*Heteromastus filiformis*	*Cossura* sp.
Oct 05	*Nucula hartvigiana*	*Arthritica bifurca*	*Cossura* sp.
Jan 06	*Nucula hartvigiana*	*Arthritica bifurca*	*Cossura* sp.
Apr 06	*Nucula hartvigiana*	*Heteromastus filiformis*	*Arthritica bifurca*
Jul 06	*Nucula hartvigiana*	*Arthritica bifurca*	*Cossura* sp.
Oct 06	*Nucula hartvigiana*	*Arthritica bifurca*	*Heteromastus filiformis*
Jan 07	*Nucula hartvigiana*	*Arthritica bifurca*	*Cossura* sp.

Populations showing trends in abundance

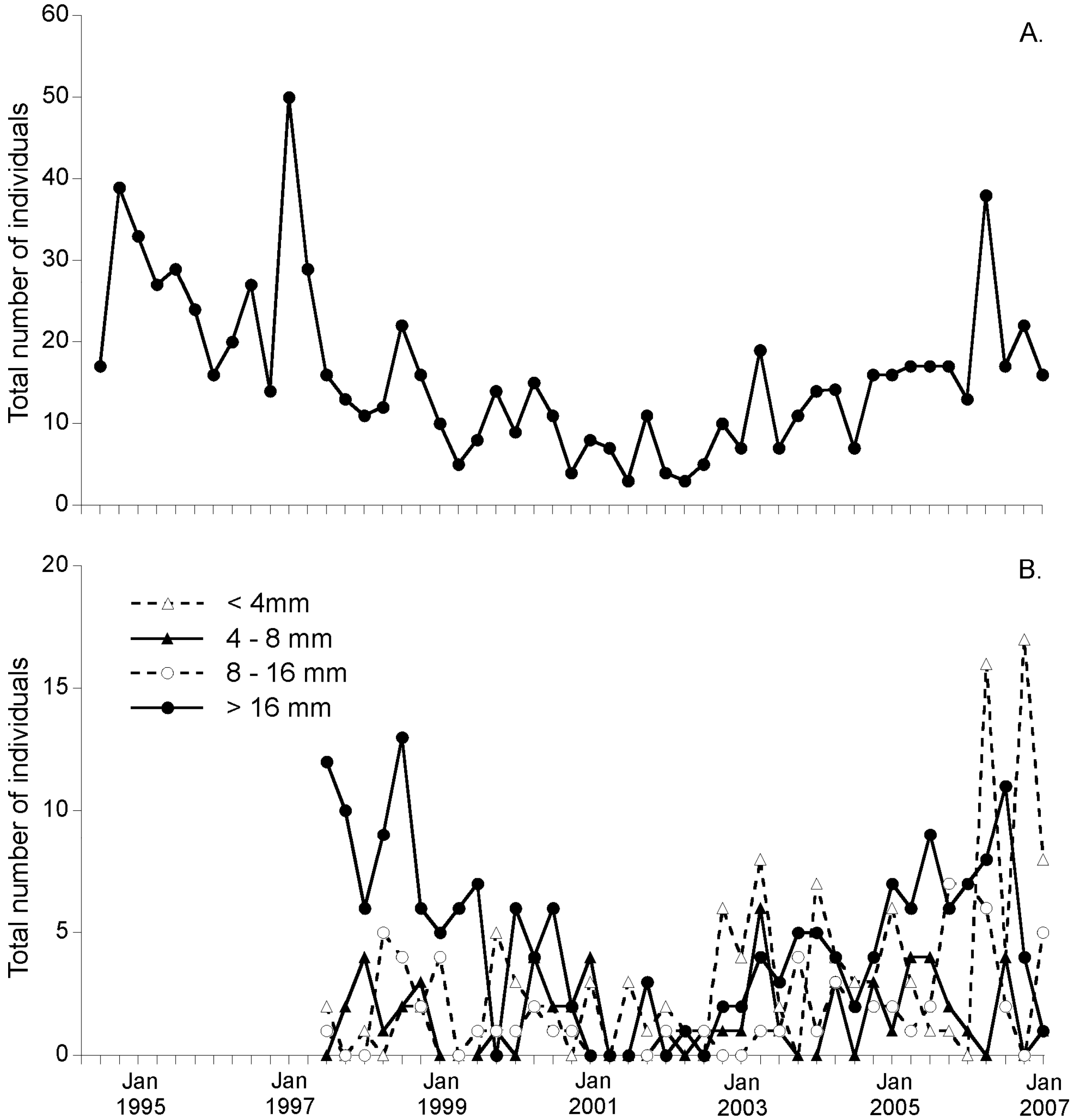
Three populations exhibit trends in abundance at Mid Harbour: *Arthritica bifurca* and *Paracalliope novizelandiae* (increases) and *Notoacmea helmsi* (a decrease). An increase of *Arthritica bifurca* was also noted in our 2003 report (Table 6).

The magnitudes of the trends noted for *Paracalliope novizelandiae* and *Notoacmea helmsi* were both very small (Table 6). Considering the sporadic occurrences and low abundances of these species at this site, we do not consider these trends to be ecologically important.

The decreasing trend noted for *Macomona liliana* in our last report is no longer detectable. This bivalve exhibited a decline in numbers in the middle of the monitoring programme. Peak abundances are now similar to those noted prior to this decline, and baseline abundances have increased (Figure 14A). The population is now comprised of individuals of a range of sizes and, encouragingly, there have been two recruitment peaks in the past two years (indicated by high numbers of <4 mm individuals; Figure 14B).

The increasing trend noted for *Aricidea* sp. in our last report is no longer apparent with two more years of data (Table 6).

Figure 14.
A. Total number of *Macomona liliana* collected on each sampling occasion at Mid Harbour. The decreasing trend in abundance of this bivalve noted in previous years is no longer apparent. B. The total number of individuals in each size class, from July 1997 onwards.



4.1.2.5 Te Kapa Inlet

The Te Kapa Inlet monitored community has been dominated by three taxa over the last two years of monitoring (Table 5). *Cossura* sp., the most abundant species, has continually been found in very high numbers (304-536 individuals) since the last report. *Heteromastus filiformis* was the second most abundant taxa over this same time period, with 117-339 individuals collected. *Aricidea* sp. (55-129 individuals) was the third most abundant taxa on all but the most recent sampling date (January 2007), when *Nucula hartvigiana* (12-64 individuals) was more common. All four of these taxa have featured amongst the most domininat at this site over the course of the monitoring programme..

Populations showing cyclic abundance patterns

Only three of the eight populations that exhibited cyclic patterns in abundance at Te Kapa Inlet in 2005 still do so (i.e., *Aricidea* sp., *Heteromastus filiformis* and polydorids). The cyclic patterns noted for *Scoloplos cylindrifer*, *Macomona liliana*, *Austrovenus stutchburyi*, *Arthritica bifurca* and oligochaetes in our last report are no longer apparent with the addition of two more years of data.

Aricidea sp. and *Heteromastus filiformis* exhibit peaks in abundance each year, but the timing of these peaks is not predictable. Polydorids show a greater than annual cycle in abundance; peaks have occurred every two years since April 1998, and generally in July or October months (although the most recent occurred in April, Figure 6E).

Populations showing trends in abundance

Trends in abundance were detected for ten populations at Te Kapa Inlet: five are increasing trends and five are decreasing.

There has been a large increase in numbers of *Cossura* sp. at this site, particularly in the last half of the monitored period (abundances ranged from 1-367 prior to July 2000, and 143-810 since this time). *Heteromastus filiformis* has continued to increase since monitoring began. Small increases in abundances of nemerteans and *Scoloplos cylindrifer* were also detected. An increasing trend has been detected for nemerteans on every occasion that trend analysis has been conducted (Table 6). However, the magnitude of this trend is now smaller and numbers are more similar to those collected in the first year of monitoring, perhaps reflecting a longer term cycle in the abundance of this taxa (Figure 15). A new trend was detected for *Arthritica bifurca*; the increase in abundance of this small bivalve is likely to be due to the relatively high numbers found on two recent sampling dates and may be disproved with collection of more data.

Table 5.

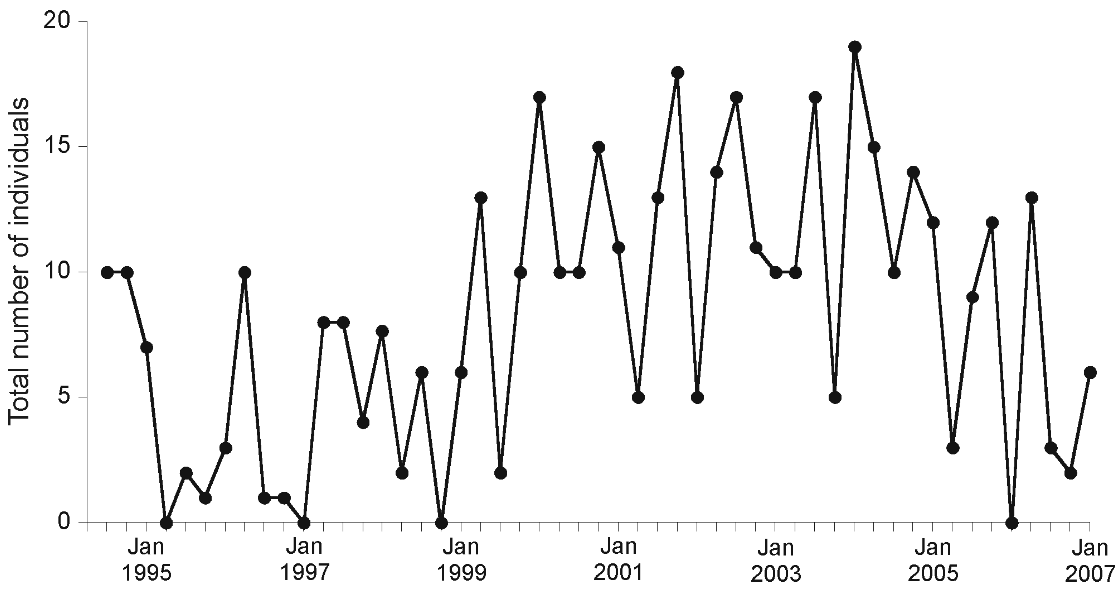
The three dominant taxa collected at Te Kapa Inlet from July 1994 to January 2007. The most abundant taxa is on the left hand side of the table.

Jul 94	*Austrovenus stutchburyi*	*Heteromastus filiformis*	*Aricidea* sp.
Oct 94	*Austrovenus stutchburyi*	*Heteromastus filiformis*	*Nucula hartvigiana*
Jan 95	*Heteromastus filiformis*	*Cossura* sp.	*Nucula hartvigiana*
Apr 95	*Austrovenus stutchburyi*	*Nucula hartvigiana*	*Cossura* sp.
Jul 95	*Austrovenus stutchburyi*	*Nucula hartvigiana*	*Heteromastus filiformis*
Oct 95	*Nucula hartvigiana*	*Heteromastus filiformis*	*Austrovenus stutchburyi*
Jan 96	*Heteromastus filiformis*	*Austrovenus stutchburyi*	*Nucula hartvigiana*
Apr 96	*Heteromastus filiformis*	*Nucula hartvigiana*	*Cossura* sp.
Jul 96	*Heteromastus filiformis*	*Cossura* sp.	*Aricidea* sp.
Oct 96	*Heteromastus filiformis*	*Cossura* sp.	*Aricidea* sp.
Jan 97	*Austrovenus stutchburyi*	*Prionospio aucklandica*	*Heteromastus filiformis*
Apr 97	*Heteromastus filiformis*	*Prionospio aucklandica*	*Aricidea* sp.
Jul 97	*Prionospio aucklandica*	*Aricidea* sp.	*Austrovenus stutchburyi*
Oct 97	*Heteromastus filiformis*	*Aricidea* sp.	*Cossura* sp.
Jan 98	*Aricidea* sp.	*Prionospio aucklandica*	*Cossura* sp.
Apr 98	*Cossura* sp.	*Heteromastus filiformis*	*Prionospio aucklandica*
Jul 98	*Heteromastus filiformis*	*Aricidea* sp.	*Prionospio aucklandica*
Oct 98	*Aricidea* sp.	*Heteromastus filiformis*	*Cossura* sp.
Jan 99	*Austrovenus stutchburyi*	*Cossura* sp.	*Nucula hartvigiana*
Apr99	*Cossura* sp.	*Austrovenus stutchburyi*	*Prionospio aucklandica*
Jul 99	*Cossura* sp.	*Heteromastus filiformis*	*Aricidea* sp.
Oct 99	*Cossura* sp.	*Nucula hartvigiana*	*Austrovenus stutchburyi*
Jan 00	*Cossura* sp.	*Prionospio aucklandica*	*Heteromastus filiformis*
Apr 00	*Cossura* sp.	*Prionospio aucklandica*	*Austrovenus stutchburyi*
Jul 00	*Cossura* sp.	*Heteromastus filiformis*	*Austrovenus stutchburyi*
Oct 00	*Cossura* sp.	*Heteromastus filiformis*	*Prionospio aucklandica*
Jan 01	*Cossura* sp.	*Nucula hartvigiana*	*Austrovenus stutchburyi*
Apr 01	*Cossura* sp.	*Heteromastus filiformis*	*Nucula hartvigiana*
Jul 01	*Cossura* sp.	*Heteromastus filiformis*	*Nucula hartvigiana*
Oct 01	*Cossura* sp.	*Heteromastus filiformis*	*Aricidea* sp.
Jan 02	*Cossura* sp.	*Heteromastus filiformis*	*Nucula hartvigiana*
Apr 02	*Cossura* sp.	*Heteromastus filiformis*	*Aricidea* sp.
Jul 02	*Cossura* sp.	*Heteromastus filiformis*	*Aricidea* sp.
Oct 02	*Cossura* sp.	*Heteromastus filiformis*	*Aricidea* sp.
Jan 03	*Cossura* sp.	*Heteromastus filiformis*	*Nucula hartvigiana*
Apr 03	*Cossura* sp.	*Heteromastus filiformis*	*Aricidea* sp.
Jul 03	*Cossura* sp.	*Aricidea* sp.	*Heteromastus filiformis*
Oct 03	*Cossura* sp.	*Heteromastus filiformis*	*Austrovenus stutchburyi*
Jan 04	*Cossura* sp.	*Heteromastus filiformis*	*Austrovenus stutchburyi*
Apr 04	*Cossura* sp.	*Heteromastus filiformis*	*Nucula hartvigiana*
Jul 04	*Cossura* sp.	*Heteromastus filiformis*	*Aricidea* sp.
Oct 04	*Cossura* sp.	*Heteromastus filiformis*	*Austrovenus stutchburyi*

Jan 05	*Cossura* sp.	*Heteromastus filiformis*	*Nucula hartvigiana*
Apr 05	*Cossura* sp.	*Heteromastus filiformis*	*Aricidea* sp.
Jul 05	*Cossura* sp.	*Heteromastus filiformis*	*Aricidea* sp.
Oct 05	*Cossura* sp.	*Heteromastus filiformis*	*Aricidea* sp.
Jan 06	*Cossura* sp.	*Heteromastus filiformis*	*Aricidea* sp.
Apr 06	*Cossura* sp.	*Heteromastus filiformis*	*Aricidea* sp.
Jul 06	*Cossura* sp.	*Heteromastus filiformis*	*Aricidea* sp.
Oct 06	*Cossura* sp.	*Heteromastus filiformis*	*Aricidea* sp.
Jan 07	*Cossura* sp.	*Heteromastus filiformis*	*Nucula hartvigiana*

Figure15.

Total number of nemerteans collected on each sampling occasion at Te Kapa Inlet. An increasing trend in abundance has been detected for this species.



A decline in abundance of *Austrovenus stutchburyi* was again detected at this site (Table 6), and lowest ever numbers of this bivalve were recorded on the most recent sampling occasion (i.e., 7 individuals; Figure 16A). Abundances of all size classes of *Austrovenus stutchburyi* have fluctuated over the monitoring period (Figure 16B).

Numbers of *Prionospio aucklandica* have also continued to decline at this site. A significant peak in abundance of polydorids was noted in recent months (Figure 6E), and this is reflected in the smaller magnitude of the decreasing trend noted for this taxa in this years analysis, compared to previously (Table 6).

Declines in abundance of *Nucula hartvigiana* and *Notoacmea helmsi* were also detected. In the case of *Notoacmea helmsi*, however, this trend is driven by high numbers of this limpet on the first sampling occasion (39 individuals) and this trend is unlikely to be ecologically significant.

The decreasing trends in abundance noted for *Macomona liliana* and *Torridoharpinia hurleyi* in our previous report are no longer apparent. For *Macomona liliana* this is encouraging, as it is largely due to a big peak in abundance of this bivalve (80 individuals) in April 2006 (Figure 17A). Examination of the size classes of individuals collected on this date reveals this peak was due to large numbers of <4 mm sized individuals. In fact, the population was comprised mostly of this size class on each of the four recent samping dates (Figure 17B). This is the first influx of small bivalves of this magnitude to occur at Te Kapa Inlet since measurements began in July 1997. However, no increase in large-sized animals has yet been observed.

Figure 16.

A. Total number of *Austrovenus stutchburyi* collected on each sampling occasion at Te Kapa Inlet. A decreasing trend in overall abundance of this bivalve was detected. B. The total number of individuals in each size class, from July 1997 onwards.

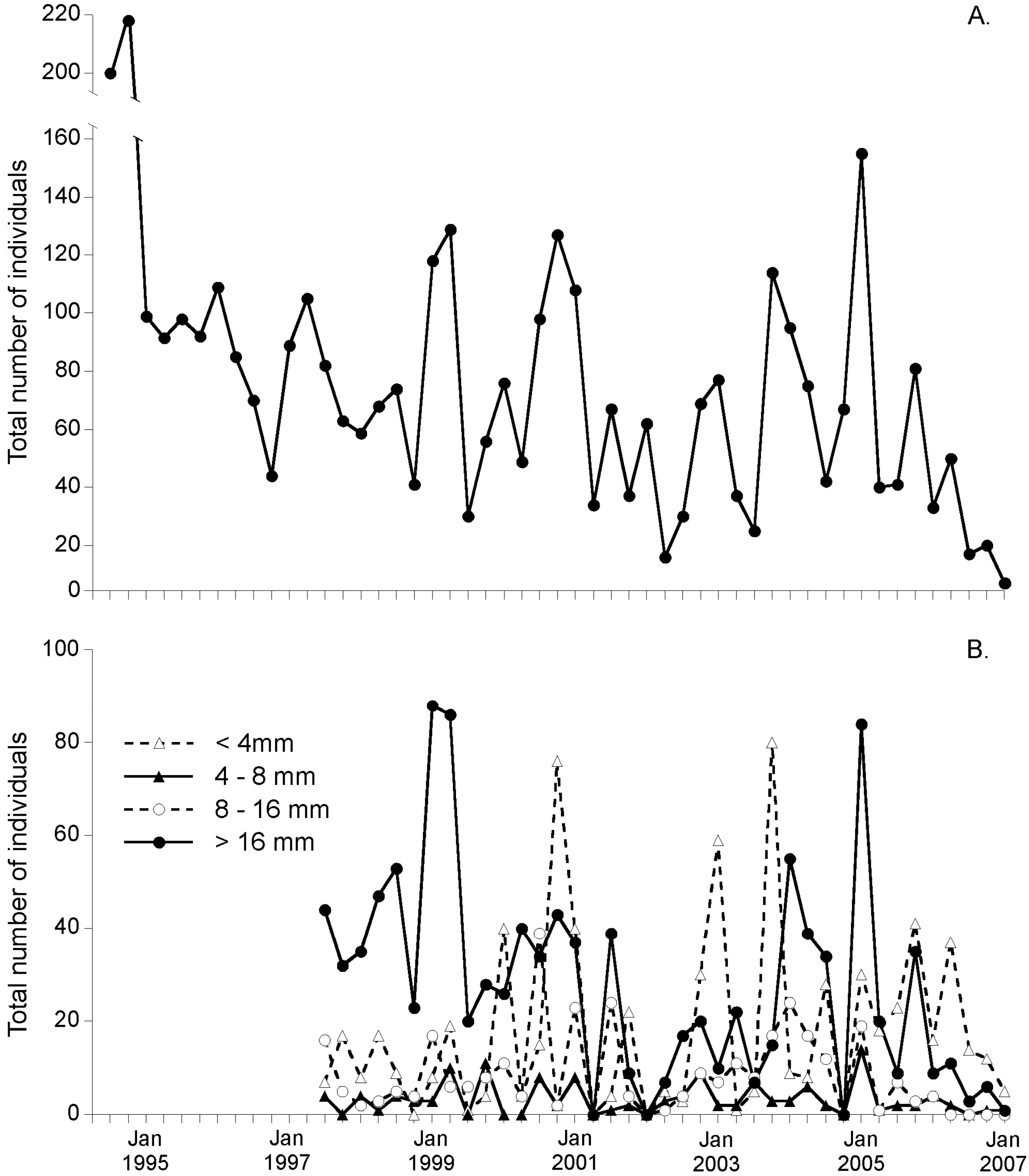


Figure 17.

A. Total number of *Macomona liliana* collected on each sampling occasion at Te Kapa Inlet. The decreasing trend in overall abundance of this bivalve detected in previous years is no longer apparent. B. The total number of individuals in each size class, from July 1997 onwards.

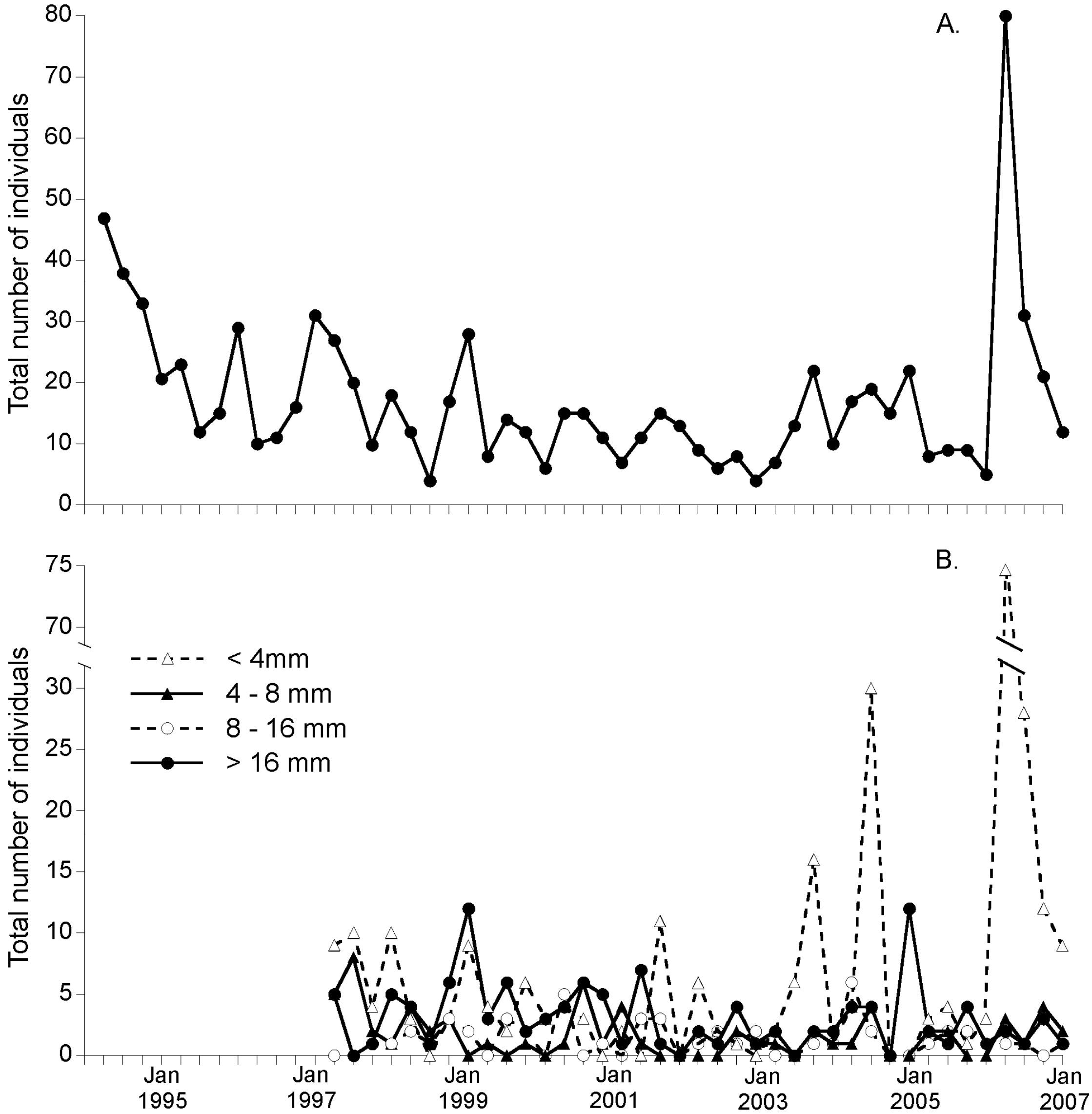


Table 6.
Trends in abundance of intertidal taxa at each site detected using regression analysis. Populations with significant trends in 2005 and/or 2007 are included. Negative numbers indicate a decrease in abundance, while positive numbers indicate an increase. Analysis of each taxa was conducted firstly on all data, and then, if a repeatable cyclic abundance pattern was apparent, on baseline data with peak abundances removed. Baseline trends are shown in parentheses. * indicates statistically significant trends that are considered unlikely to be ecologically significant due to low and/or sporadic occurrences of these taxa.

Monitored Taxa	2007	2005	2003	2001
Cowans Bay				
Cossura sp.	-4.07	No trend	No trend	No trend
Nemerteans	0.08	No trend	No trend	No trend
Nucula hartvigiana	(0.41)	No trend	No trend	No trend
*Paracalliope novizealandiae**	0.02	0.05	No trend	No trend
Polydorids	No trend	-0.18	-0.30	-0.42
Prionospio aucklandica	-0.04 (-0.04)	No trend	No trend	No trend
Torridoharpinia hurleyi	No trend	1.23	No trend	No trend
Hamilton Landing				
Aricidea sp.	0.66	0.86	No trend	No trend
Austrovenus stutchburyi	-2.33	-2.82	-3.67 (-3.46)	-4.71 (-5.48)
Cossura sp.	19.73	22.09	17.60	7.97
Heteromastus filiformis	10.36 (10.16)	12.37	11.20 (6.67)	11.26
Macomona liliana	-0.39	-0.51	-0.71	-0.77
Nemerteans	0.18	0.30	0.288	No trend
Nucula hartvigiana	No trend	-0.35	-0.44	No trend
*Perinereis nuntia**	-0.06	No trend	-0.10	No trend
Polydorids	-4.16 (-2.68)	-5.05	No trend	No trend
Prionospio aucklandica	0.28	0.52	0.35	0.28
*Scoloplos cylindrifer**	-0.25	-0.30	No trend	No trend
Jamieson Bay				
Arthritica bifurca	0.17	0.16	No trend	No trend
Aricidea sp.*	0.28 (0.32)	(0.36)	0.41 (0.54)	No trend
Paracalliope novizelandiae	No trend	0.34	0.59	No trend
Polydorids	-6.37 (-2.16)	-9.11 (-3.62)	-11.89 (-4.48)	-14.51
Macomona liliana	-0.48	-0.89	-1.24	-1.63
Owenia fusiformis	No trend	-0.05	-0.11	-0.14
Torridoharpinia hurleyi	-0.41 (-0.42)	-0.58	-0.97	-1.41
Mid Harbour				
Arthritica bifurca	0.83	No trend	1.01	No trend
Aricidea sp.	No trend	0.27	0.52	No trend
Aonides oxycephala	No trend	-0.01	-0.01	-0.02
Macomona liliana	No trend	-0.48	-0.79	-0.92 (-1.03)
*Notoacmea helmsi**	-0.01	No trend	No trend	No trend
*Paracalliope novizelandiae**	0.08	No trend	No trend	No trend

Te Kapa Inlet				
Arthritica bifurca	0.40	No trend	No trend	No trend
Austrovenus stutchburyi	-1.57	No trend	-2.21	-2.07
Cossura sp.	9.76	14.90	13.64	7.77
Heteromastus filiformis	2.00	(4.58)	No trend	No trend
*Notoacmea helmsi**	-0.14	No trend	No trend	-0.47
Nucula hartvigiana	-0.84	No trend	No trend	-2.01
Nemerteans*	0.12	0.263	0.29	0.28
Polydorids	-0.57	-0.91 (-1.09)	-1.08 (-1.10)	No trend
Prionospio aucklandica	-1.18	-1.17	No trend	No trend
*Scoloplos cylindrifer**	0.05	No trend	No trend	No trend
Macomona liliana	No trend	-0.36	-0.66 (-0.88)	-0.78 (-0.64)
Torridoharpinia hurleyi	No trend	0.27	No trend	No trend

4.1.2.6 Dyers Creek

Dyers Creek is situated on the western side of Mahurangi Estuary, immediately south of Cowans Bay (Figure 1). The Dyers Creek subcatchment is one of the priority subcatchments being targeted for remedial work under the Mahurangi Action Plan (MAP). ARC initiated the MAP, in partnership with Rodney District Council and the local community, with the objective of reducing erosion and sedimentation. It includes an environmental education programme for schools, community groups and other interested members of the public. The focus has been fencing and riparian planting to reduce input of sediments into the estuary. The MAP recognised that monitoring of sites in the receiving estuary below targeted subcatchments would be useful to assess the effectiveness of these remedial actions. This monitoring may detect changes over time in the local ecology that might then be able to be linked to changes in catchment management. For this reason, a long term monitoring site was established in Dyers Creek in October 2005.

Remedial work began in the Dyers Creek subcatchment in 2006. The amount of riparian fencing in this subcatchment had been increased by 10.83% in April 2006 (MAP newsletter, April 2006), and riparian planting grants for 5000 plants have recently been been awarded to residents (Megan Stewart, ARC, pers comm.).

Dyers Creek in 1993

Dyers Creek was one of 20 intertidal sites visited as part of the April 1993 survey of Mahurangi Harbour, which was conducted to identify potential sites for this long term monitoring programme (Cummings et al. 1994). Although this early survey sampling consisted of only 5 samples, collected 5 m apart, and on only one occasion, it will provide baseline information against which to determine whether the present community at this site is radically different today. The site sampled at that time (36º 28.00'S, 174º 42.90'E) was noted as being "firm mud with small mangroves" with a higher shore area comprised of rockier substrate, and was characterised as 'a muddy site dominated by bivalves'. *Austrovenus stutchburyi*, *Prionospio aucklandica*, *Heteromastus filiformis* and *Nucula hartvigiana*, dominated the macrobenthic community at the site, and *Macomona liliana*, *Notoacmea helmsi*, *Perinereis nuntia* and cirratulids were also common (Table 7). All of these species, except cirratulids, are routinely counted as part of this monitoring programme.

Dyers Creek was one of the five intertidal areas originally recommended for establishment of a long term monitoring site as a result of the initial survey (Cummings et al. 1994). However, due to the close proximity of the oyster farms which surround this intertidal flat, and the concern that these might modify the site in some way, an alternative long term site was established in Cowans Bay (Cummings et al. 1994).

Table 7.

Taxa found in the initial survey of Dyers Creek in April 1993. Numbers are based on individuals found in 10 cm diameter cores. 'Corrected average' denotes abundances adjusted to a 13 cm diam.core, the size used in the current monitoring programme; 'Adjusted total' = 1993 abundances adjusted to the total number of individuals in twelve 13 cm diam. cores (to allow direct comparison to the numbers discussed throughout this report).

TAXA	Total	Corrected average	Median	Range	Adjusted total
Austrovenus stutchburyi	103	20.6	17	9	417.6
Prionospio aucklandica	59	11.8	9	6	238.8
Heteromastus filiformis	35	7	7	3	141.6
Nucula hartvigiana	26	5.2	5	1	105.6
Notoacmea sp.	13	2.6	1	0	52.8
Macomona liliana	11	2.2	2	1	44.4
Perinereis nuntia	9	1.8	1	1	36
Cirratulidae	5	1	1	2	20.4
Exogonidae 1	3	0.6	0	1	12
Torridoharpinia hurleyi	3	0.6	1	1	12
Aonides oxycephala	2	0.4	0	0	8.4
Aricidea sp.	2	0.4	0	1	8.4
Capitella sp.	2	0.4	0	0	8.4
Glycera americana	2	0.4	0	1	8.4
Hemigrapsus crenulatus	2	0.4	0	1	8.4
Magelona ?dakini	2	0.4	0	1	8.4
Oligochaete	2	0.4	0	1	8.4
Polydorid	2	0.4	0	1	8.4
Anemone	1	0.2	0	0	3.6
Arthritica bifurca	1	0.2	0	0	3.6
Helice crassa	1	0.2	0	0	3.6
Nemertean	1	0.2	0	0	3.6
Scolecolepides benhami	1	0.2	0	0	3.6

Dyers Creek October 2005-January 2007

Site description

In October 2005 a 100 × 90 m site was chosen and established by ARC. The site is comprised of muddy sand (firm underfoot) with a silty surface layer.

When established in October 2005, the site had a covering of dead shells, and contained two obvious patches of seagrass (Plate 1); the largest of which was approximately 5 × 10 m. Other patches of seagrass were noted a few hundred metres to the north of the monitoring site. The size, shape and condition of the seagrass patches has fluctuated since October 2005. For example, in July 2006 the patches appeared brown, less dense and smaller (N. Hancock, pers. obs.), but their condition had improved by the next sampling occasion (October 2006). Such changes over time are not unexpected for seagrass, and are in part a reflection of changes in light conditions and nutrient availablity with season.

Mangrove seedlings have also been noted at the site on several occasions, and in April 2007 some had become established as small plants (approx. 15 cm high; N. Hancock, pers obs.)

Occurrence of monitored taxa

Dyers Creek today is dominated by the bivalves *Nucula hartvigiana* (358-467 individuals) and *Austrovenus stutchburyi* (117-293 individuals). These were the first and second most abundant, respectively, of the monitored taxa collected from October 2005 to January 2007 (Table 8). *Heteromastus filiformis* was also common (53-119 individuals), and *Macomona liliana* has appeared amongst three dominant taxa on one occasion (57 individuals) *Macomona* is found consistently at this site, in low numbers (31-87 individuals).

Prionospio aucklandica, Notoacmea helmsi, *Perinereis nuntia,* all common at this site in April 1993, were found in varying abundances over the past two years (Appendix 4). *Notoacmea helmsi* was moderately abundant (total of 15-55 individuals per core), numbers of *Prionospio aucklandica* were low (1-16 inds) and *Perinereis nuntia* was rare (found only on two occasions, at a maximum of 4 individuals). *Aricidea* sp., *Arthritica bifurca* and polydorids were routinely found at this site (abundances ranged from 11-34, 11-43 and 6-43 individuals, respectively). *Scoloplos cylindrifer*, *Paracalliope novizelandiae*, *Torridoharpinia hurleyi* all reach moderate abundances on some occasions, but their numbers fluctuate (Appendix 4).

Plate 1.

Dyers Creek monitoring site in October 2005. The site is comprised of muddy sand with a covering of shells (top photo), and contained two obvious patches of seagrass (bottom photo).

Table 8.
The three dominant taxa collected at Dyers Creek from October 2005 to January 2007. The most abundant taxa is on the left hand side of the table.

Oct 05	*Nucula hartvigiana*	*Austrovenus stutchburyi*	*Macomona liliana*
Jan 06	*Nucula hartvigiana*	*Austrovenus stutchburyi*	*Heteromastus filiformis*
Apr 06	*Nucula hartvigiana*	*Austrovenus stutchburyi*	*Heteromastus filiformis*
Jul 06	*Nucula hartvigiana*	*Austrovenus stutchburyi*	*Heteromastus filiformis*
Oct 06	*Nucula hartvigiana*	*Austrovenus stutchburyi*	*Heteromastus filiformis*
Jan 07	*Nucula hartvigiana*	*Austrovenus stutchburyi*	*Heteromastus filiformis*

Populations showing cyclic patterns or trends in abundance

More data are required from Dyers Creek before any trends or patterns in abundance of any of the monitored taxa can be elucidated.

4.1.3 Intertidal sites - general patterns

4.1.3.1 Harbour-wide patterns in intertidal macrofaunal populations

Populations showing cyclic abundance patterns

Only seven taxa exhibit cyclic abundance patterns (Table 9). Very few of these taxa exhibit highly predictable patterns, where peaks in abundance occur in the same monitoring month every year. Interestingly though, the taxa that do are found at the muddiest of the intertidal sites, Cowans Bay (i.e., *Nucula hartvigiana*) and Hamilton Landing (i.e., *Heteromastus filiformis, Macrophthalmus hirtipes* and polydorids). This could be an indication that these sites are more stable.

Table 9.
Summary of monitored taxa currently exhibiting cyclic abundance patterns at the Mahurangi intertidal monitoring sites. * peaks occur annually but month of occurrence varies; > indicates a greater than annual abundance cycle. CB = Cowans Bay, HL = Hamilton Landing, JB = Jamieson Bay, MH = Mid Harbour, TK = Te Kapa Inlet.

Taxa currently showing cyclic abundance pattern	CB	HL	JB	MH	TK
Aricidea sp.			Jul/Oct		*
Arthritica bifurca	.	Jan/Oct (>)	.	*	.
Cossura sp.	.	.	.	Jul/Oct/Apr	.
Heteromastus filiformis	Jul/Oct	Oct	.	Jul/Oct	*
Macrophthalmus hirtipes	Jan/Oct	Oct	.	Jul/Oct	.
Nucula hartvigiana	Jan	.	Jan/Apr	Jan/Oct	.
Polydorids	.	Jan	Jul/Apr	.	Jul/Oct (>)

Populations showing trends in abundance

A total of 33 populations are currently showing trends in abundance; 17 of these are increasing trends and 16 are decreasing trends. All sites have populations that are exhibiting trends; most occur at Hamilton Landing and Te Kapa Inlet (10 populations each), and the least at Mid Harbour (3 populations). Considerably more trends were detected in this year's analysis compared with those noted in our 2005 report, (26 populations, Cummings et al. 2005). However, only 24 of these trends detected as significant in this year's analysis are considered to be ecologically significant (see Table 10).

Four species considered sensitive to increased suspended sediment concentrations are exhibiting declines in abundance in Mahurangi Estuary (Table 10). Three of the important bivalve taxa, *Macomona liliana*, *Austrovenus stutchbury* and *Nucula hartvigiana* are declining at two sites each. The decline in abundance previously noted for *Macomona* at Hamilton Landing and Jamieson Bay is still apparent (Table 6). Despite this, there is some encouraging news with respect to trends in abundances of *Macomona* populations. With two more years of data ,the decreases noted for this bivalve at Mid Harbour and Te Kapa Inlet in previous years are no longer apparent. In both cases this is in part due to a high peak in abundance of small (<4 mm) individuals in April 2006 (Figures 14 & 17). A peak in abundance of small individuals was also observed on this date at Jamesons Bay (Figure 12). These increased numbers are supported by higher numbers of larger, spawning sized individuals at Mid Harbour (Figure 14), indicating that this increase may continue in future years as these resident adults continue to reproduce. This may not persist at Te Kapa Inlet or Jamieson Bay, however, where abundances of spawning sized individuals are low (Figures 12B & 17B). This suggests that the influx of small individuals to these sites may be largely due to transport of juveniles from elsewhere in the harbour.

Austrovenus stutchburyi is exhibiting declines in abundance at Hamilton Landing and Te Kapa Inlet. In our last report we noted the disappearance of a decreasing trend at Te Kapa Inlet. In recent months, however, numbers of *Austrovenus* have been the lowest ever recorded at this site, and this trend is again apparent (Table 6). *Nucula hartvigiana* is also declining in abundance at Te Kapa Inlet, as well as at Cowans Bay. In our early monitoring reports we noted that the Te Kapa Inlet site was unusual in that the half closest to the inlet entrance had sandy substrate while the upper inlet half was muddy (Cummings et al. 1995). This muddy area has gradually expanded, and in 2003 we noted that it covered approximately $^4/_5$ of the sampling area (Cummings et al. 2003). There is now only a small portion of the north-western corner of this site which is sandy (N. Hancock, pers obs), and generally only one of the 12 replicate cores is taken from this area of the site. This change is highly correlated with the decline in abundance of *Austrovenus* at this site. However, we do note that a considerable amount of planting grants have been awarded to residents of the Te Kapa Inlet catchment as part of the MAP (i.e., 32,000 plants; Megan Stewart, ARC, pers comm.), which may have positive implications in reducing sediment inputs to this monitoring site in future.

Scoloplos cylindrifer has declined markedly at Hamilton Landing over the monitored period. This polychaete is considered sensitive to increased suspended sediment concentrations. Prior to October 1999 between 0 and 54 individual *Scoloplos* were collected on any one sampling date, but it has since been found at this site in very low numbers (1-2 individuals) and on few occasions.

We noted in our last report that polydorid polychaetes were exhibiting decreasing trends in abundance at all of the intertidal sites except Mid Harbour. These polychaetes are still declining in abundance at three of these sites, but there is no longer a decreasing trend at Cowans Bay. These switching patterns support the idea that these polychaetes exhibit greater than annual cyclic abundance patterns (on the order of 5 to 7 years), as noted for the polydorid *Boccardia syrtis* in Manukau Harbour (Funnell et al. 2003, Cummings et al. 2005). For example, the increase in abundance at Te Kapa in recent months (Figure 6E) may be the beginning of a period of peak abundance; this will be confirmed with the collection of more data.

A number of trends were detected for species that show intermediate responses to increased suspended sediment concentrations (i.e., they prefer sediment containing some mud but not in high percentages). *Cossura* sp. and *Aricidea* sp., both polychaete species that thrive in muddy, organically enriched sediments, are exhibiting increases in abundance at Te Kapa Inlet (both taxa) and Hamilton Landing (*Cossura* only). These trends at Te Kapa Inlet are likely a reflection of the continued growth of the muddy area at this site. *Cossura* sp. is exhibiting a decline in abundance at Cowans Bay. Nemerteans (Hamilton Landing/Cowans Bay), the small bivalve *Arthritica bifurca* (Jamieson Bay/Mid Harbour/Te Kapa Inlet) and the polychaete *Heteromastus filiformis* (Te Kapa Inlet/Hamilton Landing), all exhibit increases in abundance at two intertidal sites (Table 10). The polychaete *Prionospio aucklandica* is increasing at two sites (Te Kapa Inlet and Cowans Bay) and decreasing at the muddiest site (Hamilton Landing).

Several of the monitored populations exhibiting trends in abundance appear to show an increase or decrease in numbers part way through the monitored period. In many cases these 'shifts' occurred around the same time, i.e., late 1999/early 2000 (e.g., see Figures 6C, 6D, 6E, 11A, & 15). While this could be a lagged response to the increase in muddiness of the sediments that occurred in 1997, it could also be part of larger than annual cyclic abundance patterns that are also suggested for some of these taxa (see above). We recommend a more detailed assessment of this suggested pattern in our next report, once more data have been collected.

Table 10.

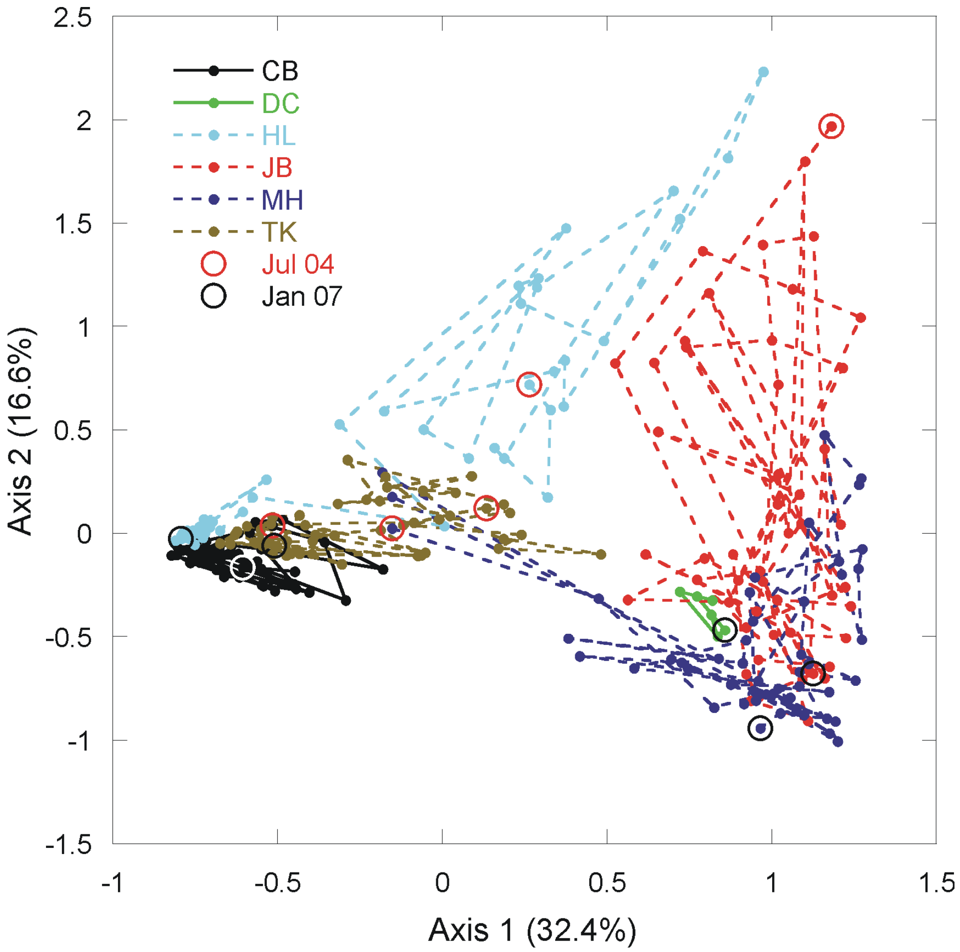
Summary of monitored taxa showing trends in abundance at the Mahurangi monitoring sites, and their sediment preferences (Sed Pref). Sediment preferences are derived from Tables 5 and 6 in Gibbs & Hewitt (2004) and from Norkko et al. (2001). S = Sand preference, I = prefers some mud but not in high percentages, ? = unknown preference. dec = decreasing trend, inc = increasing trend. JB = Jamieson Bay, MH = Mid Harbour, TK = Te Kapa Inlet, CB = Cowans Bay, HL = Hamilton Landing.

Sed pref	Taxa currently showing trends	JB (least muddy)	MH	TK	CB	HL (most muddy)
S	*Austrovenus stutchburyi*	.	.	dec	.	dec
S	*Macomona liliana*	dec	.	.	.	dec
S	*Nucula hartvigiana*	.	.	dec	dec	.
S	*Scoloplos cylindrifer*	.	.		.	dec
I	*Prionospio aucklandica*	.	.	dec	dec	inc
I	*Aricidea* sp.		.	.	.	inc
I	*Arthritica bifurca*	inc	inc	inc	.	.
I	*Cossura* sp.	.	.	inc	dec	inc
I	*Heteromastus filiformis*	.	.	inc	.	inc
I	Nemerteans	.	.		inc	inc
I	Polydorids	dec	.	dec	.	dec
?	*Torridoharpinia hurleyi*	dec				

4.1.3.2 Intertidal macrofaunal community composition

Figure 18 shows the relative composition of the monitored-taxa communities at each site, and the temporal change in these communities over the sampling period. The Cowans Bay community has remained very stable since monitoring began, and continues to exhibit very little temporal variation in community composition relative to the other intertidal sites. The Hamilton Landing, Te Kapa Inlet and Cowans Bay sites have become more similar in recent years, and are now situated much more closely in ordination space (e.g., see January 2007 symbols). The monitored communities at Jamieson Bay, Mid Harbour and Dyers Creek are similar to each other and, as noted for the other intertidal sites, the communities at Jamieson Bay and Mid Harbour are now more similar than when monitoring began.

Figure 18.
Correspondence analysis ordination plot, showing the temporal variation in the monitored community composition at each intertidal site over the monitored period. For each site, the positions of the community on the first (July 1994) and the most recent (January 2007) sampling occasions are highlighted. To enable identification, a white symbol is used to denote the most recent sampling date for Cowans Bay. The percentage values associated with each axis indicate the % variance explained. CB = Cowans Bay, DC = Dyers Creek, HL = Hamilton Landing, JB = Jamieson Bay, MH = Mid Harbour, TK = Te Kapa Inlet.

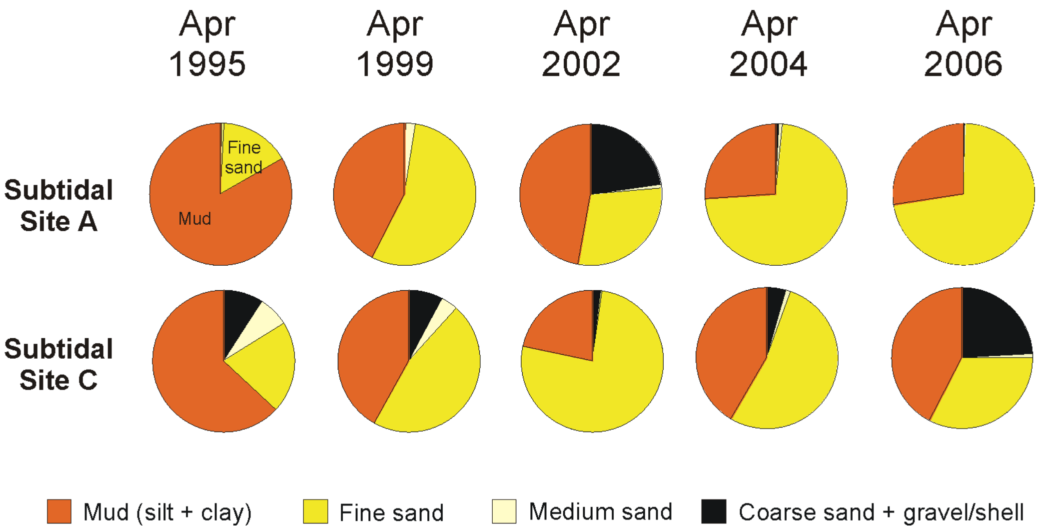


4.2 Subtidal sites

4.2.1 Sediment characteristics

The sediment grain size composition at both of the subtidal sites has been very consistent over the past two years of monitoring (Appendix 5). There is little medium sand at either of the sites, and around twice as much fine sand at Site A than at Site C (i.e., 66-76% cf. 27-34% over the past two years). Site C sediments have a higher silt and clay (i.e., mud) content, and more gravel/shell hash than those at Site A (see Figure 19, Appendix 5).

Figure 19.
Changes in the proportions of the mud (i.e., silt + clay; <63 µm), fine sand (62.5 – 250 µm), medium sand (250 –500 µm) and coarse fractions (>500 µm) of the sediment at each of the subtidal sites over the monitored period. Detailed sediment grain size data, on which these graphs are based, is presented in Appendix 5.

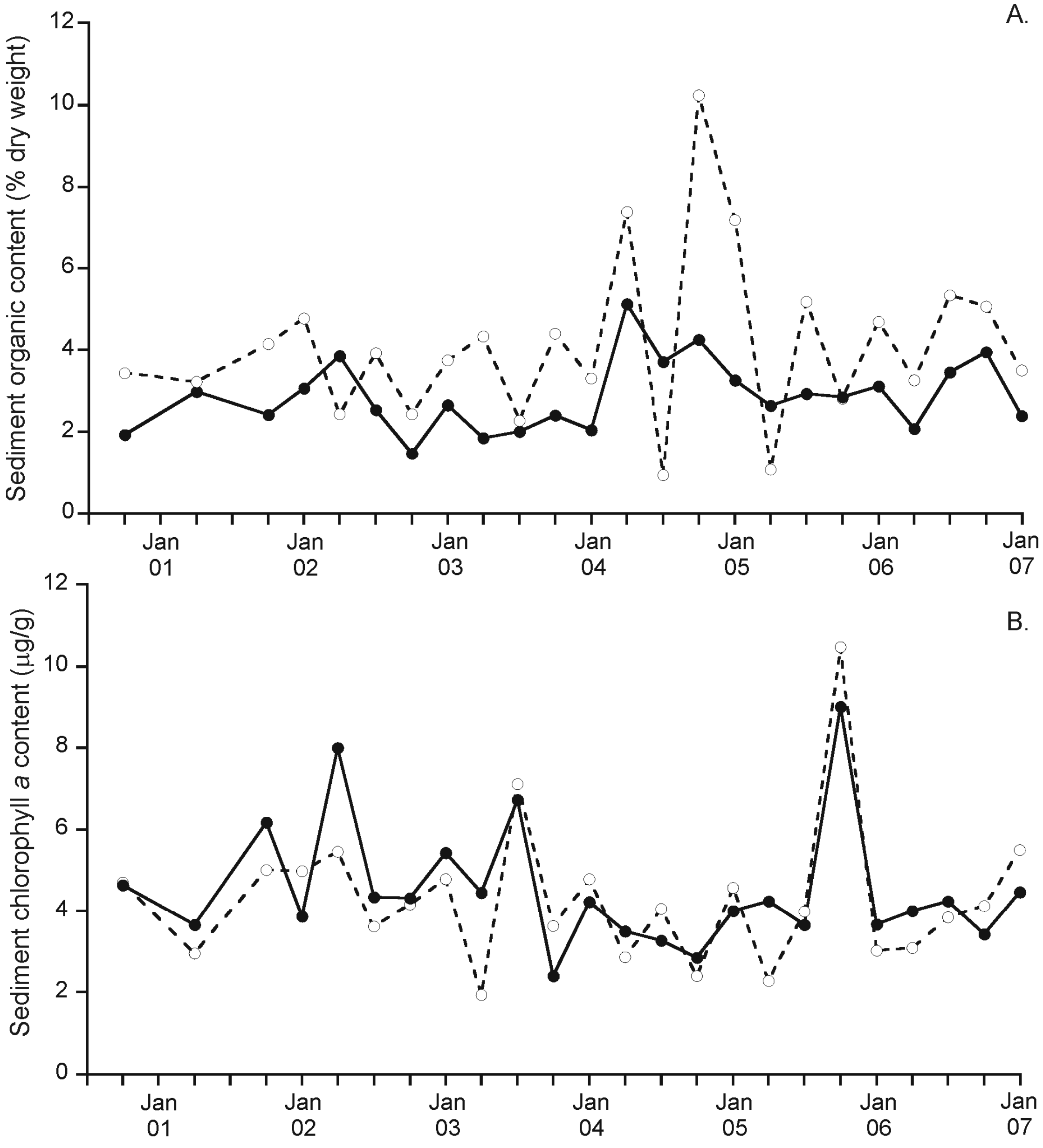


Organic content of the sediments is low and similar at both subtidal sites, although levels tend to be slightly higher at Site C on most occasions (Figure 20A; Appendix 6). In our last report we noted that the sediment organic content had generally been higher at both sites between January 2004 and January 2005 than on previous sampling dates. While this remains true for Site C, with more data this is no longer the case at Site A (Figure 20A).

Sediment chlorophyll *a* levels are also very similar at each site, and follow similar temporal fluctuations (Figure 20B; Appendix 6). Despite this, there is no predictable relationship between high and low chlorophyll *a* levels and sampling month (season). In the past two years, both sites have exhibited their highest ever chlorophyll *a* levels (in October 2005) since these samples began to be collected (Figure 20B).

Figure 20.

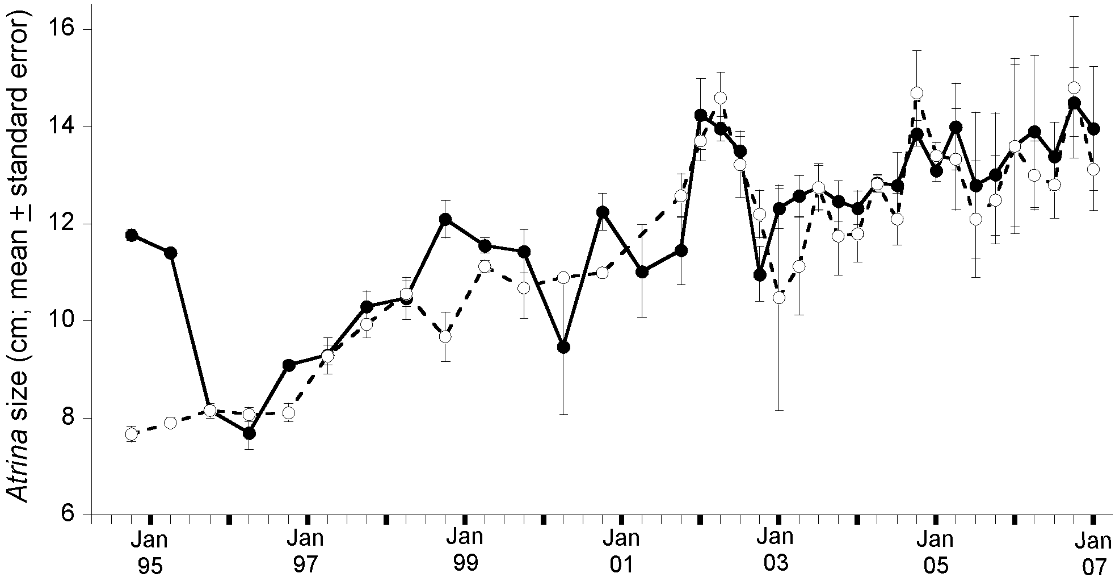
A. Sediment organic content, and B. sediment chlorophyll a content, at the subtidal sites. Site A = black symbols, Site C = white symbols.



4.2.2 *Atrina zelandica*

Numbers and sizes of *Atrina* are similar at both of the subtidal sites. Numbers have remained consistently low since our last report, with 0-2 live individuals on average found in each 0.25 m^2 quadrat. As noted in previous reports, patches are comprised of live and dead individuals, and the proportions of each in any one quadrat are similar at the two sites. The sizes of *Atrina* over the past two years have been similar at the two sites, and are similar to the sizes noted in our last report; this probably reflects the fact that the growth of these populations is slowing as the individuals age and reach their maximum size (Figure 21). We have not noted beds of smaller individuals in the vicinity of the areas targeted for monitoring, indicating there has been no recent recruitment to these sites.

Figure 21.
The mean size of live *Atrina zelandica* recorded in a 0.25 m^2 quadrat at the two subtidal sites on each sampling occasion. Site A = black symbols, Site C = white symbols.



4.2.3 Macrofauna - comments on the abundance of common taxa

The abundances of subtidal monitored taxa collected at each site on each sampling date since the last report (i.e., from April 2005 to January 2007) are given in Appendix 7.

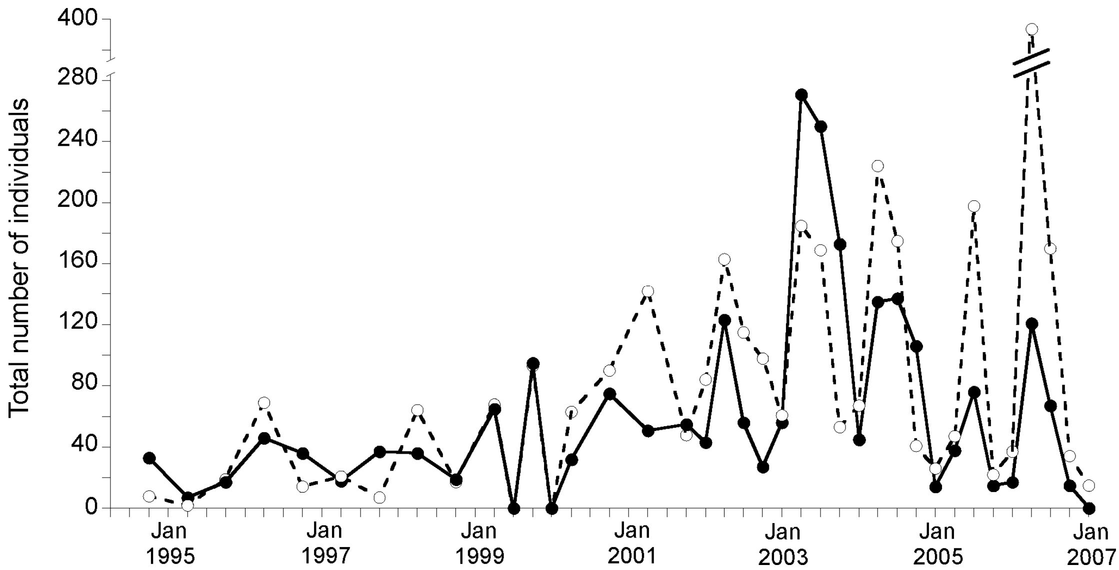
The following are site-by-site descriptions of the monitored macrofauna. For each site, we discuss the three most abundant taxa, populations exhibiting visually identifiable cycles in abundance, and populations for which statistically identifiable trends in abundance have been detected by trend analysis (Table 13).

4.2.3.1 Site A

Seven taxa have comprised the dominant three at Site A over the past two years of monitoring: the bivalves *Theora lubrica* (0-121 individuals) and *Arthritica bifurca* (2-16 individuals) the polychaetes *Aricidea* sp. (0-17 individuals), cirratulids (4-17 individuals) and polydorids (4-79 individuals), and the amphipods *Torridoharpinia hurleyi* (5-56 individuals) and corophidae-complex (0-12 individuals) (Table 11). In previous reports *Theora lubrica* has been the dominant taxa found at subtidal Site A. However, over the last two years , whilst it has been amongst the top three ranked taxa on all but one occasion, it has only been the most dominant on two dates. This reflects smaller sized peaks in abundance of this bivalve noted on recent sampling dates (Figure 22).

Figure 22.

The total number of *Theora lubrica* collected on each sampling occasion at the subtidal sites. Site A = black symbols, Site C = white symbols.



Populations showing cyclic abundance patterns

Three populations exhibit greater than annual abundance cycles at Site A. The polychaete *Armandia maculata* has large peaks in April, and smaller ones in October months. *Torridoharpinia hurleyi* also shows peak abundances in April or October months. Both of these patterns were also noted in our 2005 report. *Theora lubrica* generally exhibits peak abundances in April (Figure 22). Oligochaetes exhibit a greater than annual cyclic abundance pattern; its numbers have peaked in October of 1996 and 2000, and in April of 2002, 2004 and 2006.

Table 11.

The three dominant taxa collected at subtidal Site A from October 1994 to January 2007. The most abundant taxa are on the left hand side of the table. When more than one taxa has the same rank they are represented as (for example) *'Arthritica bifurca / Cossura* sp.'.

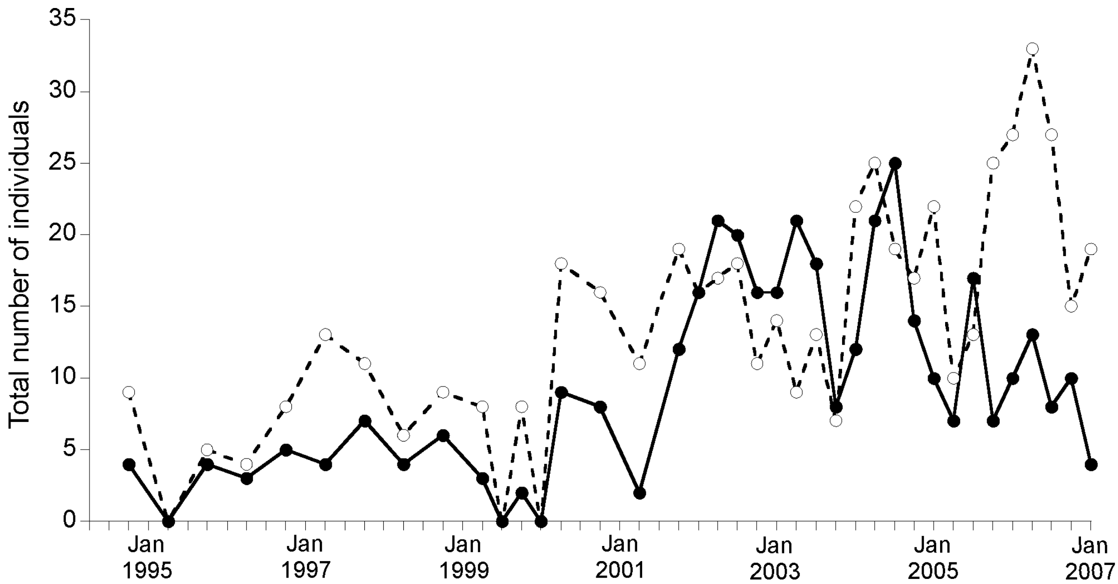
Oct 94	*Prionospio* sp.	*Theora lubrica*	*Torridoharpinia hurleyi*
Apr 95	*Torridoharpinia hurleyi / Nucula hartvigiana*		*Theora lubrica*
Oct 95	*Theora lubrica*	*Arthritica bifurca*	Cirratulids
Apr 96	*Theora lubrica*	*Torridoharpinia hurleyi*	*Nucula hartvigiana*
Oct 96	*Theora lubrica*	Oligochaetes	*Torridoharpinia hurleyi*
Apr 97	*Theora lubrica*	*Torridoharpinia hurleyi*	*Prionospio* sp.
Oct 97	*Theora lubrica*	Cirratulids / *Prionospio* sp.	
Apr 98	Polydorids	*Torridoharpinia hurleyi*	*Theora lubrica*
Oct 98	*Theora lubrica*	Cirratulids	Oligochaetes / *Prionospio* sp.
Apr 99	*Theora lubrica*	*Arthritica bifurca*	Oligochaetes
Oct 99	*Theora lubrica*	Oligochaetes	*Arthritica bifurca* / Polydorids
Apr 00	*Theora lubrica*	Cirratulids / *Torridoharpinia hurleyi*	
Oct 00	*Theora lubrica*	*Torridoharpinia hurleyi*	Cirratulids
Apr 01	*Theora lubrica*	*Torridoharpinia hurleyi*	*Prionospio* sp.
Oct 01	*Theora lubrica*	Cirratulids	*Torridoharpinia hurleyi*
Jan 02	*Theora lubrica*	Cirratulids	*Torridoharpinia hurleyi*
Apr 02	*Theora lubrica*	Cirratulids	Polydorids
Jul 02	*Theora lubrica*	Cirratulids	*Prionospio* sp.
Oct 02	*Theora lubrica*	*Prionospio* sp.	Cirratulids
Jan 03	*Theora lubrica*	*Aricidea* sp.	*Arthritica bifurca*
Apr 03	*Theora lubrica*	*Arthritica bifurca / Torridoharpinia hurleyi*	
Jul 03	*Theora lubrica*	*Aricidea* sp.	Polydorids
Oct 03	*Theora lubrica*	*Arthritica bifurca*	Cirratulids
Jan 04	*Theora lubrica*	Polydorids	*Aricidea* sp.
Apr 04	*Theora lubrica*	Cirratulids	*Arthritica bifurca*
Jul 04	*Theora lubrica*	*Arthritica bifurca*	Cirratulids
Oct 04	*Theora lubrica*	*Torridoharpinia hurleyi*	*Arthritica bifurca*
Jan 05	*Theora lubrica*	Polydorids	*Aricidea* sp.
Apr 05	*Polydorids*	*Theora lubrica*	*Torridoharpinia hurleyi*
Jul 05	*Polydorids*	*Theora lubrica*	Cirratulids
Oct 05	*Aricidea* sp.	*Theora lubrica*	Polydorids
Jan 06	*Torridoharpinia hurleyi*	Polydorids	*Theora lubrica*
Apr 06	*Theora lubrica*	*Arthritica bifurca*	Cirratulids / *Torridoharpinia hurleyi*
Jul 06	*Theora lubrica*	*Aricidea* sp.	*Arthritica bifurca* / Cirratulids
Oct 06	*Nucula hartvigiana*	*Aricidea* sp.	*Theora lubrica*
Jan 07	*Torridoharpinia hurleyi*	*Arthritica bifurca*	Corophidae-complex

Populations showing trends in abundance

Three populations, cirratulids (Figure 23), *Arthritica bifurca* and *Aricidea* sp., exhibit trends in abundance at subtidal Site A, and all of these are increases. These trends were also noted in our last report (Table 13). The magnitude of the increasing trend for cirratulid polychaetes has declined since our last report (Table 13), and may turn out to be a longer cyclic abundance pattern (Figure 23). The increase in abundance of *Theora lubrica* noted in 2005 is now no longer apparent: this trend was being driven by higher than normal peak abundances and, as noted above, these have been smaller in recent years (Figure 22). This bivalve was not found on the most recent sampling date (Figure 22).

Figure 23.

The total number of cirratulids collected on each sampling occasion at the subtidal sites. Site A = black symbols, Site C = white symbols.



4.2.3.2 Site C

Theora lubrica was the first or second most abundant monitored taxa at Site C over the last two years, when 22-385 individuals were found. Oligochaetes and cirratulids were also common (14-56 and 10-33 individuals, respectively); both were the top ranked taxa on one occasion each, and amongst the second and third most abundant on several occasions (Table 12). Polydorid polychaetes (1-78 individuals), *Arthritica bifurca* (1-21 individuals) and *Torridoharphina hurleyi* (2-43 individuals) were the second or third most common taxa on one occasion each. These species have all featured amongst the dominant taxa at this site over the monitored period (Table 12).

Populations showing cyclic abundance patterns

Theora lubrica exhibits an annual cyclic abundance pattern at Site C, with peaks occurring in April of each year, except for 1999 (October) and 2005 (July) (Figure 22).

Two new patterns are now apparent, both of them greater than annual abundance cycles. Cirratulid peak abundances occur in April (Figure 23). Corophidae-complex amphipods have exhibited peaks in abundance roughly every two years (i.e., in October 1995, April 1998, October 2000, January 2003 and January 2005; Figure 24).

Figure 24.
The total number of corophidae-complex amphipods collected on each sampling occasion at subtidal Site C.

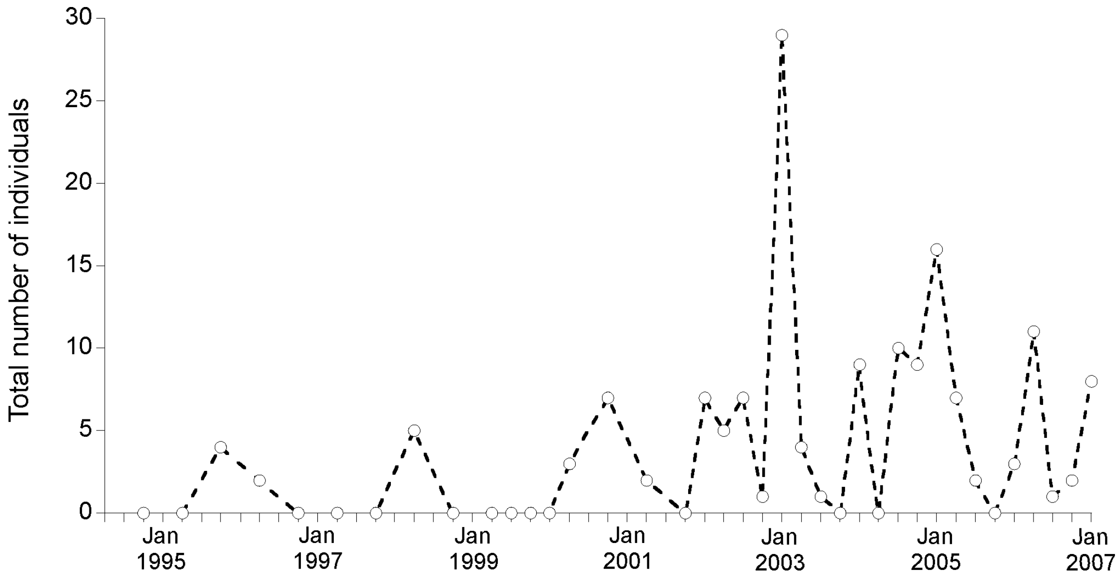


Table 12.

The three dominant taxa collected at subtidal Site C from October 1994 to January 2007. The most abundant taxa is on the left hand side of the table. When more than one taxa has the same rank they are represented as (for example) '*Arthritica bifurca* / *Cossura* sp.'

Oct 94	*Arthritica bifurca*	*Prionospio* sp.	*Torridoharpinia hurleyi*
Apr 95	*Nucula hartvigiana*	*Arthritica bifurca*	Polydorids
Oct 95	*Arthritica bifurca*	*Theora lubrica*	Polydorids
Apr 96	*Theora lubrica*	*Arthritica bifurca*	Oligochaetes
Oct 96	*Theora lubrica*	Tanaid B	*Arthritica bifurca*
Apr 97	Oligochaetes	*Arthritica bifurca*	*Theora lubrica*
Oct 97	Oligochaetes	*Arthritica bifurca*	*Prionospio* sp.
Apr 98	Oligochaetes	*Arthritica bifurca*	*Theora lubrica*
Oct 98	Oligochaetes	*Arthritica bifurca*	*Theora lubrica*
Apr 99	*Theora lubrica*	Oligochaetes	*Arthritica bifurca*
Oct 99	Oligochaetes	*Theora lubrica*	*Torridoharpinia hurleyi*
Apr 00	*Theora lubrica*	Oligochaetes	Cirratulids
Oct 00	Oligochaetes	*Theora lubrica*	*Torridoharpinia hurleyi*
Apr 01	*Theora lubrica*	*Arthritica bifurca*	Oligochaetes
Oct 01	Oligochaetes	*Theora lubrica*	*Torridoharpinia hurleyi*
Jan 02	*Theora lubrica*	Oligochaetes	Polydorids / Cirratulids
Apr 02	*Theora lubrica*	Oligochaetes	*Arthritica bifurca* / Cirratulids
Jul 02	*Theora lubrica*	Oligochaetes	Cirratulids
Oct 02	*Theora lubrica*	Oligochaetes	*Torridoharpinia hurleyi*
Jan 03	*Theora lubrica*	*Nucula hartvigiana*	*Arthritica bifurca*
Apr 03	*Theora lubrica*	*Prionospio* sp.	Cirratulids / *Torridoharpinia hurleyi*
Jul 03	*Theora lubrica*	Oligochaetes	*Aricidea* sp.
Oct 03	*Theora lubrica*	Cirratulids	Oligochaetes
Jan 04	Oligochaetes	*Theora lubrica*	Cirratulids
Apr 04	*Theora lubrica*	Oligochaetes	Cirratulids
Jul 04	*Theora lubrica*	Cirratulids	*Arthritica bifurca / Torridoharpinia hurleyi*
Oct 04	*Torridoharpinia hurleyi*	*Theora lubrica*	Oligochaetes
Jan 05	Oligochaetes	*Theora lubrica*	*Torridoharpinia hurleyi*
Apr 05	*Theora lubrica*	Oligochaetes	*Torridoharpinia hurleyi*
Jul 05	*Theora lubrica*	Polydorids	Oligochaetes
Oct 05	Cirratulids	*Theora lubrica*	Oligochaetes
Jan 06	*Theora lubrica*	Oligochaetes	Cirratulids
Apr 06	*Theora lubrica*	Cirratulids	Oligochaetes
Jul 06	*Theora lubrica*	Oligochaetes	Cirratulids
Oct 06	Oligochaetes	*Theora lubrica*	*Arthritica bifurca*
Jan 07	Torridoharpinia hurleyi	Cirratulids	Oligochaetes

Populations showing trends in abundance

Four populations are exhibiting trends in abundance at Site C, and all of these were also detected in our 2005 analysis (Table 13). *Arthritica bifurca* is now less common at this site, its numbers have declined from 9-101 individuals in the first four years of monitoring to 0-40 since that time. *Theora lubrica* is still increasing, but this increase is in its peak abundances only; basal abundances of this bivalve remain steady (Figure 22). Cirratulid polychaetes and corophidae-complex amphipods also continue to increase (Figures 23 & 24).

Table 13.

Magnitudes of trends in abundance of subtidal taxa at each site detected using regression analysis. Negative numbers indicate a decrease in abundance, while positive numbers indicate an increase.

Monitored taxa	2007	2005	2003	2001
Site A				
Arthritica bifurca	0.29	0.40	No trend	No trend
Aricidea sp.	0.34	0.36 (0.18)	0.34	0.14
Cirratulids	0.21	0.44	0.46	No trend
Theora lubrica	No trend	2.88	1.34	2.00
Site C				
Arthritica bifurca	-0.75	-0.97	No trend	No trend
Cirratulids	0.38	0.36	0.36	No trend
Corophidae-complex	0.14	0.23	0.29	No trend
Theora lubrica	2.67	2.96 (1.32)	3.18	3.13

Subtidal sites - general patterns

4.2.3.3 Harbour-wide patterns in subtidal macrofaunal populations

Populations showing cyclic abundance patterns

Six of the monitored taxa populations exhibit cyclic patterns in abundance at the subtidal sites (Table 14).

Table 14.

Summary of monitored taxa currently exhibiting cyclic abundance patterns at the Mahurangi subtidal monitoring sites. > indicates a greater than annual abundance cycle.

Taxa currently showing cyclic abundance pattern	Site A	Site C
Armandia maculata	Apr/Oct	
Cirratulids	.	Apr (>)
Corophidae-complex	.	Oct/Apr/Jan (>)
Oligochaetes	Apr/Oct (>)	.
Theora lubrica	Apr	Apr
Torridoharpinia hurleyi	Apr/Oct	.

Populations showing trends in abundance

A total of seven subtidal populations and five different taxa are exhibiting trends in abundance at the Mahurangi Harbour subtidal sites (Table 15). Two taxa show trends at both sites: the bivalve *Arthritica bifurca* is increasing at Site A and decreasing at Site C, and cirratulid polychaetes are increasing in abundance at both sites. *Aricidea* sp. is increasing in abundance at Site A only, and both *Theora lubrica* and corophidae-complex amphipods are increasing at Site C. All of these taxa except corophidae-complex amphipods (for which there is no information) are known to prefer some mud content in the sediment but not high proportions (Gibbs & Hewitt 2004).

Table 15.

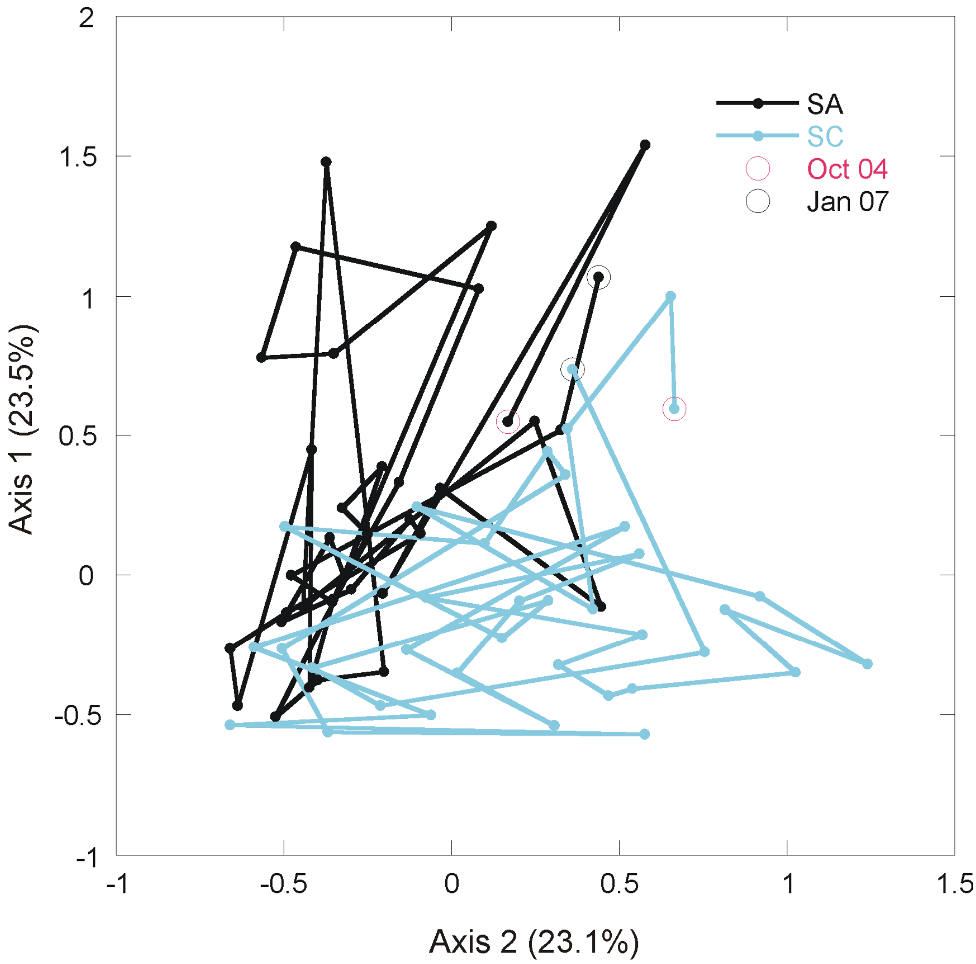
Summary of monitored taxa showing trends in abundance at the Mahurangi subtidal monitoring sites. dec = decreasing trend, inc = increasing trend.

Taxa currently showing trends	Site A	Site C
Aricidea sp.	inc	.
Arthritica bifurca	inc	dec
Cirratulids	inc	inc
Corophidae-complex	.	inc
Theora lubrica	.	inc

4.2.3.4 Subtidal macrofaunal community composition

As noted in our last report, while the monitored communities at Sites A and C have exhibited considerable fluctuations over the monitored period, they are currently very similar both to one another, and to the communities observed at the start of the monitoring programme (Figure 25).

Figure 25.
Correspondence analysis ordination plot, showing the temporal variation in the monitored community composition at the subtidal sites over the monitored period. For each site, the positions of the community on the first (July 1994) and the most recent (January 2007) sampling occasions are highlighted. The percentage values associated with each axis indicate the % variance explained.



5 Summary & conclusions

Sediment characteristics and populations and communities of the monitored macrofaunal taxa have not changed markedly at the intertidal or subtidal sites over the past two years of monitoring. The monitored macrofaunal communities at Hamilton Landing, Te Kapa Inlet and Cowans Bay have continued to become more similar to each other, as have those of Jamieson Bay and Mid Harbour (Figure 18). The communities at subtidal Sites A and C are also currently very similar (Figure 25).

A total of 33 intertidal populations are currently showing trends in abundance; approximately half of these are increasing trends and half are decreasing trends. All sites have populations that are exhibiting ecologically significant trends; most occur at Hamilton Landing and Te Kapa Inlet (9 and 7 populations each, respectively), and the least at Mid Harbour (1 population). Several of the monitored populations exhibiting trends in abundance appear to show an increase or decrease in numbers part way through the monitored period (i.e., late 1999/early 2000) which may be a lagged response to the increases in muddiness of the sediments that occurred throughout the estuary in 1997.

Of most concern is that four taxa considered sensitive to increased suspended sediment concentrations are exhibiting declines in abundance at the intertidal sites (Table 10). Two ecologically important bivalve species, *Macomona liliana* and *Austrovenus stutchburyi*, and the polychaete *Scoloplos cylindrifer* continue to decline in abundance at the muddiest site, Hamilton Landing. *Macomona* is also declining at Jamieson Bay. Decreasing trends were detected for *Austrovenus* and the nut shell, *Nucula hartvigiana*, at Te Kapa Inlet. These declines are likely to be correlated with the continued expansion of the muddy portion of the Te Kapa Inlet site noted over the monitored period.

Despite this, there is some encouraging news with respect to trends in abundances of *Macomona* populations. The decreases noted at Mid Harbour and Te Kapa Inlet in previous years are no longer apparent with two more years of data, due in part to a high peak in abundance of small (<4 mm) individuals in April 2006 (Figures 14 & 17). Mid Harbour contains reasonable numbers of spawning sized individuals (Figure 14), indicating that his increase may continue in future years as these resident adults continue to reproduce. Abundances of spawning sized individuals are low at Te Kapa Inlet however (Figure 17), and recruitment at this site relies on transport of juveniles from elsewhere in the harbour.

Very few of the intertidal populations exhibit highly predictable cyclic abundance patterns, where peaks in abundance occur in the same monitoring month every year (Table 9). Interestingly, the taxa that do are found at the muddiest of the intertidal sites, Cowans Bay and Hamilton Landing, perhaps reflecting that these sites are relatively stable in terms of sedimentary conditions and populations (e.g., Figure 18).

Numbers and sizes of the horse mussel *Atrina zealandica* are similar at both of the subtidal sites. Numbers are low, with 0-2 live individuals on average found in a 0.25 m^2 quadrat on any one sampling date. The sizes of *Atrina* have not increased much over the past two years. This probably reflects the fact that the growth of these populations is slowing as the individuals age and reach their maximum size (Figure 21).

Seven subtidal populations are exhibiting trends in abundance, and all but one of these are increasing (Table 15). All of these taxa except corophidae-complex amphipods (for which there is no information) are known to prefer some mud but not high percentages (Gibbs & Hewitt 2004). Two taxa show trends at both sites: cirratulid polychaetes (increasing at both sites) and the bivalve *Arthritica bifurca* (increasing at Site A, decreasing at Site C). Six of the monitored populations exhibit cyclic patterns in abundance at the subtidal sites (Table 14).

The Dyers Creek and Te Kapa Inlet subcatchments are both being targeted for remedial work under the Mahurangi Action Plan. An additional intertidal monitoring site was established Dyers Creek in October 2005 in response to this, in order that any changes over time in its ecology may be able to be linked to these changes in catchment management. The site is comprised of muddy sand (firm underfoot) with a silty surface layer, and has a monitored community similar to that of Jamieson Bay and Mid Harbour (Figure 18). The dominant taxa include the bivalves *Nucula hartvigiana*, *Austrovenus stutchburyi* and *Macomona liliana* and the polychaete *Heteromastus filiformis*. Comments on trends and patterns in abundance of the monitored populations and community at Dyers Creek will be made in future reports, following collection of more data.

Fluctuations in abundance of invertebrate populations is to be expected, and we must document and understand this natural variability to enable identification of 'unusual' increases or a decreases that may be due to some environmental stressor (e.g., sedimentation). Similarly, this baseline information is also needed to be able to document recovery of impacted populations. In addition, populations that are under stress tend to exhibit more variablity in their abundance, so we might not expect to see a simple linear response in all populations. Some of the taxa monitored in Mahurangi Estuary are also monitored in the long term ecological monitoring programmes in Manukau and Waitemata Harbours; interpretations of trends and patterns in abundance of Mahurangi populations is done with knowledge of information on populations from Manukau in particular, where there is no sedimentation issue.

This monitoring programme has continued to provide very useful information on trends and cycles in monitored taxa populations and sediment characteristics that can be used to guide and monitor the effectiveness of catchment management within Mahurangi Estuary. With two more years of data our previous recommendations concerning the need to investigate and implement improved sediment controls still apply, as we are still detecting declines in abundance of taxa known to be sensitive to increased sediment loading. Recent evidence of recruitment of juvenile bivalves to some of the intertidal populations is encouraging, as this highlights the potential for the recovery of some areas of the harbour should these control measures be effective.

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8 Appendices

8.1 Appendix 1

The taxa monitored at the intertidal and subtidal sites.

Intertidal	**Subtidal**
Aricidea sp.	*Aricidea* sp.
Arthritica bifurca	*Armandia maculata*
Austrovenus stutchburyi	*Arthritica bifurca*
Cossura sp.	Cirratulids
Heteromastus filiformis	Corophidae-complex
Macomona liliana	*Nucula hartvigiana*
Macrophthalmus hirtipes	Oligochaetes
Nemerteans	Polydorids
Notoacmea sp.	*Prionospio* sp.
Nucula hartvigiana	*Tawera spissa*
Oligochaetes	*Theora lubrica*
Owenia fusiformis	*Torridoharpinia hurleyi*
Paracalliope novizealandiae	
Perinereis nuntia	
Polydorids	
Scoloplos cylindrifer	
Torridoharpinia hurleyi	

8.2 Appendix 2

Results of grain size analysis for the intertidal sites. CB = Cowans Bay, DC = Dyers Creek, HL = Hamilton Landing, JB = Jamieson Bay, MH = Mid Harbour, TK = Te Kapa Inlet.

% sediment composition	Year	Month	CB	HL	JB	MH	TK (sand)	TK (mud)	DC
Gravel/	1995	Apr	0.07	0.04	0.37	0.64	3.50	0.24	
Shell hash	1996	Apr	0.00	0.00	0.00	0.00	0.00	0.00	
	1997	Apr	0.02	0.00	21.42	6.56	10.14	0.00	
	1998	Apr	0.02	1.16	16.08	1.78	1.94	0.01	
	1999	Apr	0.03	0.00	5.04	1.50	0.83	0.12	
	2000	Apr	0.02	0.18	8.61	0.67	0.43	0.00	
		Jul	0.07	0.00	18.96	0.00	3.72	0.00	
		Oct	0.05	0.00	7.98	0.10	1.79	0.00	
	2001	Jan	0.43	0.04	0.65	0.19	1.60	0.00	
		Apr	0.00	0.00	8.5	0.33	0.00	0.04	
		Jul	0.00	0.00	0.13	0.46	0.06	0.00	
		Oct	0.00	0.00	3.27	0.43	0.68	0.00	
	2002	Jan	0.00	0.00	1.79	0.02	1.58	0.00	
		Apr	0.02	0.00	0.17	2.38	0.32	0.25	
		Jul	1.63	7.34	0.26	0.35	0.00	0.00	
		Oct	0.00	0.06	0.02	4.02	31.18	0.16	
	2003	Jan	0.00	0.01	0.51	0.07	0.76	0.40	
		Apr	0.02	0.00	0.19	1.80	0.46	0.29	
		Jul	0.00	0.00	2.88	0.19	0.09	0.07	
		Oct	0.00	0.00	19.72	0.16	0.50	0.03	
	2004	Jan	0.00	0.00	17.17	0.43	3.93	0.00	
		Apr	0.00	0.00	12.01	4.99	0.35	0.00	
		Jul	0.00	0.00	5.34	0.51	0.34	1.95	
		Oct	0.02	0.02	8.03	0.56	0.65	0.00	
	2005	Jan	0.00	0.00	2.83	0.97	2.70	0.00	
		Apr	0.00	0.00	3.04	0.79	0.00	0.00	
		Jul	0.00	0.00	5.70	0.97	1.04	0.00	
		Oct	0.00	0.00	7.14	0.11	21.57	0.00	1.83
	2006	Jan	0.00	0.00	9.30	0.50	0.55	0.00	0.28
		Apr	0.00	0.00	17.44	0.09	0.00	5.12	0.25
		Jul	0.00	0.39	2.64	0.10	5.38	0.00	0.78
		Oct	0.00	0.00	22.54	0.00	0.62	0.00	1.51
	2007	Jan	0.00	0.00	8.72	0.68	4.36	0.62	1.46
Coarse sand	1995	Apr	0.08	0.17	0.27	0.20	3.58	0.22	
	1996	Apr	0.54	1.47	21.11	6.17	5.99	1.73	
	1997	Apr	0.06	0.34	6.02	1.43	0.18	0.03	
	1998	Apr	0.06	0.93	11.36	0.34	0.62	0.15	
	1999	Apr	0.05	0.21	2.06	0.17	0.08	0.07	
	2000	Apr	0.07	0.32	14.01	0.33	0.24	0.14	
		Jul	0.07	0.23	9.33	0.13	0.29	0.10	
		Oct	0.06	0.08	4.37	0.62	0.23	0.16	
	2001	Jan	0.14	0.17	0.65	0.34	0.07	0.09	
		Apr	0.06	0.06	18.88	0.05	0.35	0.21	

		Jul	0.51	0.15	0.30	0.54	0.09	0.34	
		Oct	0.00	0.00	2.80	0.05	0.07	0.00	
	2002	Jan	0.02	0.00	7.48	0.00	0.14	0.00	
		Apr	0.14	0.10	1.32	0.18	0.09	0.07	
		Jul	4.70	3.06	0.14	0.96	0.09	0.04	
		Oct	0.06	0.06	0.11	7.86	0.13	0.16	
	2003	Jan	0.06	0.12	0.49	0.12	0.49	0.17	
		Apr	0.13	0.09	1.50	0.13	0.17	0.08	
		Jul	0.07	0.26	2.27	0.20	0.31	0.07	
		Oct	0.02	0.12	10.22	0.05	0.09	0.09	
	2004	Jan	0.00	0.00	12.67	0.26	1.09	0.15	
		Apr	0.00	0.12	7.69	0.54	0.19	0.08	
		Jul	0.00	0.02	10.69	0.24	0.41	0.05	
		Oct	0.06	0.22	7.54	0.19	0.37	0.14	
	2005	Jan	0.00	0.07	7.74	0.00	0.37	0.14	
		Apr	0.07	0.00	11.18	0.31	0.53	0.48	
		Jul	0.08	0.10	5.78	0.07	0.06	0.04	
		Oct	0.10	0.21	16.07	0.33	0.16	0.08	0.24
	2006	Jan	0.04	0.08	11.48	0.25	0.19	0.08	0.28
		Apr	0.07	0.11	10.14	0.32	0.11	0.30	0.25
		Jul	0.04	0.07	4.78	0.12	0.31	0.06	0.14
		Oct	0.00	0.12	5.83	0.19	0.04	0.00	0.12
	2007	Jan	0.04	0.04	12.73	0.21	0.10	0.01	0.15
Medium sand	1995	Apr	38.94	30.74	64.93	43.64	38.15	39.60	
	1996	Apr	18.37	15.71	32.19	39.50	26.03	13.42	
	1997	Apr	8.71	1.08	15.78	5.63	2.19	3.56	
	1998	Apr	0.78	5.18	22.67	6.29	2.48	0.50	
	1999	Apr	1.84	3.43	11.08	2.26	1.82	2.43	
	2000	Apr	0.52	4.81	46.93	4.19	1.10	1.72	
		Jul	0.60	1.08	11.94	4.80	2.24	0.33	
		Oct	0.90	0.74	33.67	8.10	2.83	1.66	
	2001	Jan	0.83	4.52	6.08	5.64	2.05	1.73	
		Apr	0.72	0.70	39.23	2.08	0.48	1.50	
		Jul	0.67	0.81	5.01	7.4	1.83	1.38	
		Oct	0.57	0.13	10.89	5.04	2.17	0.88	
	2002	Jan	0.43	0.61	19.77	15.08	1.65	1.28	
		Apr	0.66	2.70	7.28	2.75	1.42	1.10	
		July	15.14	1.85	3.16	0.90	0.20	0.61	
		Oct	0.52	0.34	3.11	19.76	1.53	1.69	
	2003	Jan	0.95	0.26	3.44	2.75	1.66	1.34	
		Apr	0.65	2.41	8.30	2.08	0.94	1.29	
		Jul	0.44	0.53	26.98	2.25	2.93	1.45	
		Oct	0.49	0.25	18.79	3.91	1.17	0.77	
	2004	Jan	0.69	0.23	20.72	4.51	1.67	1.78	
		Apr	0.56	0.35	16.03	2.72	1.32	1.57	
		Jul	0.38	0.30	24.34	7.73	1.67	1.10	
		Oct	0.61	0.37	15.02	3.27	1.66	1.41	
	2005	Jan	0.92	0.23	18.71	3.43	1.63	1.73	
		Apr	0.40	0.86	33.90	4.03	1.60	1.29	
		Jul	0.93	0.38	15.21	3.43	1.51	1.52	
		Oct	0.70	0.47	30.88	3.65	1.72	1.61	1.65
	2006	Jan	0.59	0.32	22.64	3.69	0.60	0.90	2.08
		Apr	0.40	0.27	19.59	3.38	1.32	1.06	2.07
		Jul	0.54	0.24	13.44	3.12	1.53	1.49	2.16

		Oct	0.70	0.24	13.25	3.67	1.26	1.41	1.97
	2007	Jan	0.67	0.34	21.34	3.82	1.22	1.24	1.25
Fine sand	1995	Apr	38.04	26.50	24.65	33.05	24.41	29.34	
	1996	Apr	28.40	19.08	19.11	26.16	16.90	19.79	
	1997	Apr	75.34	33.23	52.17	72.05	73.46	67.23	
	1998	Apr	79.76	52.91	47.18	80.72	75.12	58.41	
	1999	Apr	77.54	52.55	74.14	81.09	68.21	70.32	
	2000	Apr	66.19	60.20	29.26	79.84	79.29	63.18	
		Jul	70.18	42.73	56.13	74.69	87.48	54.48	
		Oct	71.24	51.56	50.38	86.93	75.16	60.85	
	2001	Jan	72.19	62.16	84.19	85.25	85.81	62.42	
		Apr	77.79	56.02	31.69	62.62	53.70	62.77	
		July	71.76	50.02	87.15	60.77	79.95	60.87	
		Oct	80.53	44.40	71.37	83.77	82.89	61.61	
	2002	Jan	81.51	57.74	63.83	74.17	79.31	65.13	
		Apr	69.70	55.98	80.65	78.88	83.52	64.96	
		Jul	70.72	58.54	73.40	76.53	45.41	63.87	
		Oct	70.99	49.23	83.39	61.47	56.65	65.82	
	2003	Jan	79.42	55.57	84.20	86.93	79.10	76.72	
		Apr	69.19	49.97	92.01	59.49	77.47	76.09	
		Jul	71.03	47.82	58.73	74.61	82.82	64.66	
		Oct	71.70	48.10	45.71	87.08	77.57	57.06	
	2004	Jan	67.38	43.87	42.37	86.83	82.64	63.57	
		Apr	72.59	45.03	56.77	80.87	83.56	59.64	
		Jul	68.43	50.00	54.36	84.43	89.73	58.56	
		Oct	68.08	54.08	62.39	86.23	88.12	63.54	
	2005	Jan	71.24	57.91	62.94	88.30	86.59	60.75	
		Apr	70.70	55.64	46.57	82.99	85.16	60.63	
		Jul	71.32	48.36	64.64	82.74	87.18	62.11	
		Oct	70.78	57.06	42.74	87.60	67.63	62.70	88.03
	2006	Jan	67.69	51.57	50.78	86.95	79.99	58.34	89.15
		Apr	70.70	57.74	46.08	78.40	69.60	77.61	90.25
		Jul	71.78	51.92	69.24	81.99	76.93	62.65	89.10
		Oct	69.95	51.85	47.61	81.14	84.42	64.19	89.37
	2007	Jan	71.11	59.35	51.26	83.41	82.07	63.86	79.48
Silt	1995	Apr	17.42	34.03	6.44	18.37	27.38	23.63	
	1996	Apr	38.08	46.32	19.30	19.69	33.01	48.03	
	1997	Apr	11.12	39.04	4.09	7.78	7.27	21.66	
	1998	Apr	12.74	29.06	2.38	6.71	12.75	29.93	
	1999	Apr	8.24	27.77	7.56	8.73	17.98	19.41	
	2000	Apr	24.61	20.37	0.30	9.94	12.50	27.58	
		Jul	29.01	54.62	3.79	17.36	4.27	34.20	
		Oct	22.02	41.08	3.06	3.88	16.76	19.14	
	2001	Jan	22.22	28.10	8.00	7.10	7.93	29.95	
		Apr	18.98	40.19	0.04	31.70	36.64	29.83	
		Jul	26.93	47.46	7.36	30.22	17.02	35.93	
		Oct	7.84	48.63	11.09	3.31	11.83	32.13	
	2002	Jan	17.60	35.24	6.75	8.09	14.72	29.48	
		Apr	22.81	37.26	7.05	10.28	12.78	29.32	
		Jul	5.68	17.34	20.52	14.17	30.34	26.90	
		Oct	23.51	38.81	9.88	4.14	7.88	25.73	
	2003	Jan	15.15	35.03	8.66	6.75	7.20	12.82	
		Apr	23.21	27.12	20.00	19.50	26.00	26.15	

		Jul	22.25	45.58	7.53	15.59	9.23	32.11	
		Oct	23.60	47.52	2.78	5.28	11.00	32.54	
	2004	Jan	22.54	54.95	6.70	4.16	4.57	26.93	
		Apr	15.66	33.74	3.70	3.11	9.72	31.33	
		Jul	23.17	44.03	3.36	3.86	4.58	36.34	
		Oct	24.99	33.05	4.82	5.85	4.60	28.56	
	2005	Jan	18.56	31.90	3.59	3.13	6.66	23.01	
		Apr	23.39	29.00	4.25	6.99	6.35	29.43	
		Jul	19.60	33.36	4.34	7.10	6.50	26.86	
		Oct	22.96	22.14	1.06	0.00	6.69	22.66	5.25
	2006	Jan	24.70	38.42	3.12	5.33	9.72	31.56	5.18
		Apr	23.39	33.00	4.70	13.50	21.65	10.97	3.62
		Jul	20.17	33.06	6.85	9.77	9.90	27.60	5.85
		Oct	21.86	32.49	3.32	9.29	8.19	24.36	5.37
	2007	Jan	22.66	31.68	3.78	6.16	8.01	27.30	12.79
Clay	1995	Apr	5.45	4.96	3.34	4.10	2.98	6.98	
	1996	Apr	14.61	17.42	8.29	8.48	18.07	17.03	
	1997	Apr	4.75	26.33	0.51	6.54	6.76	7.52	
	1998	Apr	6.64	10.77	0.32	4.18	7.09	11.00	
	1999	Apr	12.31	16.05	0.14	6.25	11.09	7.65	
	2000	Apr	8.60	14.12	0.90	5.03	6.43	7.37	
		Jul	0.08	1.34	0.11	3.01	2.00	10.89	
		Oct	5.74	6.54	0.53	0.37	3.22	18.19	
	2001	Jan	4.19	5.02	0.45	1.47	2.55	5.82	
		Apr	2.45	3.04	1.67	3.23	8.83	5.65	
		Jul	0.13	1.55	0.05	0.62	1.06	1.49	
		Oct	11.05	6.83	0.58	7.40	2.35	5.38	
	2002	Jan	0.44	6.41	0.37	2.64	2.61	4.11	
		Apr	6.68	3.95	3.53	5.53	1.88	4.31	
		Jul	2.13	11.87	2.52	7.09	23.95	8.59	
		Oct	4.92	11.50	3.49	2.76	2.63	6.43	
	2003	Jan	4.43	9.01	2.64	3.38	10.79	8.55	
		Apr	6.79	2.88	10.00	10.50	4.00	3.85	
		Jul	6.21	5.82	1.61	7.16	4.62	1.63	
		Oct	4.19	4.00	2.78	3.52	9.68	9.52	
	2004	Jan	9.39	0.95	0.37	3.81	6.09	7.57	
		Apr	11.19	20.77	3.74	7.77	4.86	7.37	
		Jul	8.02	5.64	1.92	3.22	3.27	1.98	
		Oct	6.25	12.24	2.19	3.90	4.60	6.35	
	2005	Jan	9.28	9.90	4.19	4.17	2.05	14.38	
		Apr	5.44	14.50	1.06	4.89	6.35	8.17	
		Jul	8.07	17.79	4.34	5.68	3.71	9.48	
		Oct	5.47	20.13	2.12	8.32	2.23	12.95	3.00
	2006	Jan	6.97	9.61	2.68	3.28	7.95	9.12	3.19
		Apr	5.44	8.88	2.06	4.32	7.42	4.94	3.01
		Jul	7.47	14.33	3.05	4.89	5.94	8.20	1.95
		Oct	7.51	15.29	7.46	5.71	5.46	10.03	1.65
	2007	Jan	5.51	8.58	2.16	5.72	4.24	6.97	4.87

8.3 Appendix 3

A. Organic content (% dry weight), and B. Chlorophyll a content (µg g-1 sediment) of sediments at the intertidal sites on each sampling occasion since July 2000. * = highest recorded value at a particular site.

A. Organic content

	Cowans Bay	Hamilton Landing	Jamieson Bay	Mid Harbour	Te Kapa mud	Te Kapa sand	Dyers Creek
Jul00	1.67	3.87	1.29	1.40	1.87	0.90	
Oct00	2.03	3.22	1.00	0.88	2.32	1.57	
Jan01	2.00	2.49	1.44	1.38	2.33	1.49	
Apr01	2.28	4.60	1.59	3.38	3.06	11.93*	
Jul01	2.58	6.35	1.45	2.72	2.90	1.59	
Oct01	1.92	4.16	1.32	1.83	2.58	1.20	
Jan02	2.06	3.92	2.06	2.17	1.84	2.53	
Apr02	2.30	3.47	1.70	1.84	1.40	2.22	
Jul02	2.58	1.58	1.71	4.94*	2.46	2.13	
Oct02	2.94	5.02	2.13	1.53	3.41	4.62	
Jan03	2.13	4.07	1.72	1.50	2.59	1.68	
Apr03	2.01	5.54	1.48	2.96	2.31	1.37	
Jul03	2.00	3.89	1.38	1.79	2.18	1.32	
Oct03	1.88	3.85	1.45	1.42	2.46	2.08	
Jan04	2.27	4.69	1.70	1.49	2.54	1.79	
Apr04	2.85	6.65*	3.59*	2.23	4.66*	2.53	
Jul04	2.97	4.87	2.34	1.57	2.69	1.85	
Oct04	3.18*	5.04	2.31	2.40	3.99	2.29	
Jan05	1.74	2.55	1.41	1.63	4.10	1.70	
Apr05	1.70	4.13	1.44	1.59	2.63	1.73	
Jul05	2.40	4.27	2.15	2.02	1.91	1.54	
Oct05	2.11	4.60	1.31	1.88	2.53	1.70	0.76
Jan06	2.45	3.95	1.68	1.60	2.68	2.14	1.34*
Apr06	1.95	3.72	1.89	2.48	1.63	2.06	0.88
Jul06	2.29	4.35	2.08	2.34	2.52	1.96	1.20
Oct06	2.66	4.35	2.78	2.19	2.75	1.97	1.25
Jan07	2.45	3.64	1.52	2.09	2.39	1.43	1.05

B. Chlorophyll *a*

	Cowans Bay	Hamilton Landing	Jamieson Bay	Mid Harbour	Te Kapa mud	Te Kapa sand	Dyers Creek
Jul00	17.81	12.14	4.59	10.03	14.74	6.35	
Oct00	23.08*	11.32	3.97	7.33	8.40	15.39	
Jan01	12.40	10.04	3.44	6.54	5.94	9.62	
Apr01	15.54	12.63	1.76	10.38	13.11	ns	
Jul01	21.21	16.74*	6.76*	10.46	17.41*	9.99	
Oct01	14.01	8.32	3.65	6.55	12.63	5.22	
Jan02	12.23	8.21	2.75	4.53	9.15	5.23	
Apr02	18.07	13.13	6.15	9.76	14.32	6.30	

	Cowans Bay	Hamilton Landing	Jamieson Bay	Mid Harbour	Te Kapa mud	Te Kapa sand	Dyers Creek
Jul02	15.52	6.41	4.58	10.99*	14.16	6.14	
Oct02	14.02	7.27	3.14	8.59	9.91	6.48	
Jan03	12.63	10.07	5.04	9.02	11.38	7.32	
Apr03	12.72	5.93	3.66	7.05	9.11	7.60	
Jul03	13.08	6.19	3.50	3.09	9.65	6.76	
Oct03	14.04	7.70	5.50	8.98	9.06	5.50	
Jan04	10.66	10.78	3.09	8.49	6.07	17.43*	
Apr04	16.65	12.35	2.86	10.67	5.96	9.85	
Jul04	15.13	10.86	3.38	7.05	7.22	14.10	
Oct04	11.02	7.62	3.23	2.53	4.03	7.62	
Jan05	12.28	8.48	4.61	10.93	6.90	9.05	
Apr05	10.80	6.62	3.74	9.13	11.03	7.30	
Jul05	13.57	12.82	4.76	7.43	6.82	13.89	
Oct05	10.82	10.94	2.71	8.42	6.46	9.66	8.10*
Jan06	11.05	9.87	3.09	7.33	6.06	9.23	7.36
Apr06	13.98	9.50	4.13	8.36	5.73	3.20	7.23
Jul06	13.76	6.44	3.38	8.71	8.48	4.76	5.22
Oct06	13.53	8.60	3.21	6.65	10.77	4.93	5.16
Jan07	15.24	10.78	3.10	7.80	11.46	5.39	6.99

8.4 Appendix 4

Summary of temporal results2 at the intertidal sites from April 2005 (Time = 44) to January 2007 (Time = 51). CB = Cowans Bay, DC = Dyers Creek, HL = Hamilton Landing, JB = Jamieson Bay, MH = Mid Harbour, TK = Te Kapa Inlet.

Taxa	Site	Time	Total[3]	Median	Range[4]	Mean
Aonides oxycephala	CB	44	0	0	0	0
Aonides oxycephala	CB	45	2	0	1	0.17
Aonides oxycephala	CB	46	0	0	0	0
Aonides oxycephala	CB	47	0	0	0	0
Aonides oxycephala	CB	48	0	0	0	0
Aonides oxycephala	CB	49	0	0	0	0
Aonides oxycephala	CB	50	0	0	0	0
Aonides oxycephala	CB	51	0	0	0	0
Aonides oxycephala	DC	46	0	0	0	0
Aonides oxycephala	DC	47	0	0	0	0
Aonides oxycephala	DC	48	1	0	1	0.08
Aonides oxycephala	DC	49	0	0	0	0
Aonides oxycephala	DC	50	3	0	3	0.25
Aonides oxycephala	DC	51	1	0	1	0.08
Aonides oxycephala	HL	44	0	0	0	0
Aonides oxycephala	HL	45	0	0	0	0
Aonides oxycephala	HL	46	0	0	0	0
Aonides oxycephala	HL	47	0	0	0	0
Aonides oxycephala	HL	48	0	0	0	0
Aonides oxycephala	HL	49	0	0	0	0
Aonides oxycephala	HL	50	0	0	0	0
Aonides oxycephala	HL	51	0	0	0	0
Aonides oxycephala	JB	44	8	0	3	0.67
Aonides oxycephala	JB	45	27	1	19	2.25
Aonides oxycephala	JB	46	15	0	10	1.25
Aonides oxycephala	JB	47	70	0	27	5.83
Aonides oxycephala	JB	48	9	0	5	0.75
Aonides oxycephala	JB	49	21	0	12	1.75
Aonides oxycephala	JB	50	19	0	8	1.55
Aonides oxycephala	JB	51	16	0	6	1.36
Aonides oxycephala	MH	44	0	0	0	0
Aonides oxycephala	MH	45	0	0	0	0
Aonides oxycephala	MH	46	0	0	0	0
Aonides oxycephala	MH	47	0	0	0	0
Aonides oxycephala	MH	48	0	0	0	0
Aonides oxycephala	MH	49	1	0	1	0.08
Aonides oxycephala	MH	50	0	0	0	0
Aonides oxycephala	MH	51	1	0	1	0.08
Aonides oxycephala	TK	44	0	0	0	0
Aonides oxycephala	TK	45	0	0	0	0
Aonides oxycephala	TK	46	0	0	0	0
Aonides oxycephala	TK	47	0	0	0	0
Aonides oxycephala	TK	48	0	0	0	0
Aonides oxycephala	TK	49	0	0	0	0
Aonides oxycephala	TK	50	1	0	1	0.08
Aonides oxycephala	TK	51	0	0	0	0
Aricidea sp.	CB	44	1	0	1	0.08
Aricidea sp.	CB	45	1	0	1	0.08
Aricidea sp.	CB	46	8	1	3	0.67
Aricidea sp.	CB	47	1	0	1	0.08
Aricidea sp.	CB	48	7	1	2	0.58

[2] Data is only given if the taxa occurred at a site during this time period.
[3] Total number of individuals collected in 12 samples. Calculated by mean abundance*12.
[4] Range = between the 5th and 95th percentile.

Aricidea sp.	CB	49	3	0	2	0.25
Aricidea sp.	CB	50	0	0	0	0
Aricidea sp.	CB	51	1	0	1	0.08
Aricidea sp.	DC	46	21	2	3	1.75
Aricidea sp.	DC	47	12	1	3	1.00
Aricidea sp.	DC	48	32	2	7	2.67
Aricidea sp.	DC	49	14	1	4	1.17
Aricidea sp.	DC	50	34	2	10	2.83
Aricidea sp.	DC	51	11	1	2	0.92
Aricidea sp.	HL	44	43	4	8	3.6
Aricidea sp.	HL	45	25	2	4	2.08
Aricidea sp.	HL	46	33	3	8	2.75
Aricidea sp.	HL	47	17	1	4	1.42
Aricidea sp.	HL	48	24	1	7	2.00
Aricidea sp.	HL	49	28	2	9	2.33
Aricidea sp.	HL	50	21	1	8	1.75
Aricidea sp.	HL	51	50	4	7	4.17
Aricidea sp.	JB	44	2	0	1	0.17
Aricidea sp.	JB	45	19	2	4	1.58
Aricidea sp.	JB	46	21	2	8	1.75
Aricidea sp.	JB	47	13	0	8	1.08
Aricidea sp.	JB	48	8	0	3	0.67
Aricidea sp.	JB	49	39	1	19	3.25
Aricidea sp.	JB	50	11	0	3	0.91
Aricidea sp.	JB	51	14	0	4	1.18
Aricidea sp.	MH	44	2	0	1	0.17
Aricidea sp.	MH	45	5	0	3	0.42
Aricidea sp.	MH	46	4	0	1	0.33
Aricidea sp.	MH	47	0	0	0	0
Aricidea sp.	MH	48	8	1	2	0.67
Aricidea sp.	MH	49	5	0	3	0.42
Aricidea sp.	MH	50	9	1	3	0.75
Aricidea sp.	MH	51	4	0	2	0.33
Aricidea sp.	TK	44	55	3	17	4.58
Aricidea sp.	TK	45	93	5	29	7.75
Aricidea sp.	TK	46	129	10	26	10.75
Aricidea sp.	TK	47	38	2	11	3.17
Aricidea sp.	TK	48	121	7	31	10.08
Aricidea sp.	TK	49	86	4	30	7.17
Aricidea sp.	TK	50	70	5	13	5.83
Aricidea sp.	TK	51	62	4	16	5.17
Arthritica bifurca	CB	44	15	0	9	1.25
Arthritica bifurca	CB	45	24	1	7	2.00
Arthritica bifurca	CB	46	8	0	4	0.67
Arthritica bifurca	CB	47	44	3	15	3.67
Arthritica bifurca	CB	48	74	4	24	6.17
Arthritica bifurca	CB	49	44	3	12	3.67
Arthritica bifurca	CB	50	115	9	18	9.58
Arthritica bifurca	CB	51	29	1	13	2.42
Arthritica bifurca	DC	46	26	1	10	2.17
Arthritica bifurca	DC	47	23	1	8	1.92
Arthritica bifurca	DC	48	43	2	11	3.58
Arthritica bifurca	DC	49	11	1	3	0.92
Arthritica bifurca	DC	50	33	2	13	2.75
Arthritica bifurca	DC	51	36	1	13	3.00
Arthritica bifurca	HL	44	0	0	0	0
Arthritica bifurca	HL	45	5	0	2	0.42
Arthritica bifurca	HL	46	1	0	1	0.08
Arthritica bifurca	HL	47	12	0	7	1.00
Arthritica bifurca	HL	48	15	0	7	1.25
Arthritica bifurca	HL	49	36	2	13	3.00
Arthritica bifurca	HL	50	36	3	7	3.00
Arthritica bifurca	HL	51	19	1	8	1.58
Arthritica bifurca	JB	44	4	0	2	0.33

Arthritica bifurca	JB	45	5	0	3	0.42
Arthritica bifurca	JB	46	0	0	0	0
Arthritica bifurca	JB	47	0	0	0	0
Arthritica bifurca	JB	48	25	1	16	2.08
Arthritica bifurca	JB	49	20	1	5	1.67
Arthritica bifurca	JB	50	15	1	7	1.27
Arthritica bifurca	JB	51	3	0	1	0.27
Arthritica bifurca	MH	44	17	0	9	1.42
Arthritica bifurca	MH	45	12	0	6	1.00
Arthritica bifurca	MH	46	37	2	10	3.08
Arthritica bifurca	MH	47	49	3	21	4.08
Arthritica bifurca	MH	48	50	4	11	4.17
Arthritica bifurca	MH	49	34	2	12	2.83
Arthritica bifurca	MH	50	70	4	16	5.83
Arthritica bifurca	MH	51	110	5	43	9.17
Arthritica bifurca	TK	44	16	0	8	1.33
Arthritica bifurca	TK	45	24	1	10	2.00
Arthritica bifurca	TK	46	2	0	1	0.17
Arthritica bifurca	TK	47	36	1	17	3.00
Arthritica bifurca	TK	48	66	4	19	5.5
Arthritica bifurca	TK	49	26	2	5	2.17
Arthritica bifurca	TK	50	58	6	14	4.83
Arthritica bifurca	TK	51	27	2	9	2.25
Austrovenus stutchburyi	CB	44	3	0	3	0.25
Austrovenus stutchburyi	CB	45	0	0	0	0
Austrovenus stutchburyi	CB	46	3	0	2	0.25
Austrovenus stutchburyi	CB	47	0	0	0	0
Austrovenus stutchburyi	CB	48	1	0	1	0.08
Austrovenus stutchburyi	CB	49	1	0	1	0.08
Austrovenus stutchburyi	CB	50	0	0	0	0
Austrovenus stutchburyi	CB	51	0	0	0	0
Austrovenus stutchburyi	DC	46	293	23	25	24.42
Austrovenus stutchburyi	DC	47	181	16	19	15.08
Austrovenus stutchburyi	DC	48	282	21	33	23.5
Austrovenus stutchburyi	DC	49	149	12	36	12.42
Austrovenus stutchburyi	DC	50	166	15	13	13.83
Austrovenus stutchburyi	DC	51	117	9	19	9.75
Austrovenus stutchburyi	HL	44	0	0	0	0
Austrovenus stutchburyi	HL	45	1	0	1	0.08
Austrovenus stutchburyi	HL	46	6	0	3	0.50
Austrovenus stutchburyi	HL	47	0	0	0	0
Austrovenus stutchburyi	HL	48	0	0	0	0
Austrovenus stutchburyi	HL	49	1	0	1	0.08
Austrovenus stutchburyi	HL	50	3	0	1	0.25
Austrovenus stutchburyi	HL	51	1	0	1	0.08
Austrovenus stutchburyi	JB	44	3	0	2	0.25
Austrovenus stutchburyi	JB	45	2	0	1	0.17
Austrovenus stutchburyi	JB	46	3	0	2	0.25
Austrovenus stutchburyi	JB	47	5	0	1	0.42
Austrovenus stutchburyi	JB	48	10	0	4	0.83
Austrovenus stutchburyi	JB	49	1	0	1	0.08
Austrovenus stutchburyi	JB	50	2	0	1	0.18
Austrovenus stutchburyi	JB	51	0	0	0	0
Austrovenus stutchburyi	MH	44	0	0	0	0
Austrovenus stutchburyi	MH	45	0	0	0	0
Austrovenus stutchburyi	MH	46	0	0	0	0
Austrovenus stutchburyi	MH	47	0	0	0	0
Austrovenus stutchburyi	MH	48	0	0	0	0
Austrovenus stutchburyi	MH	49	0	0	0	0
Austrovenus stutchburyi	MH	50	0	0	0	0
Austrovenus stutchburyi	MH	51	0	0	0	0
Austrovenus stutchburyi	TK	44	40	2	24	3.33
Austrovenus stutchburyi	TK	45	41	1	28	3.42
Austrovenus stutchburyi	TK	46	81	3	33	6.75

Austrovenus stutchburyi	TK	47	33	1	19	2.75
Austrovenus stutchburyi	TK	48	50	2	22	4.17
Austrovenus stutchburyi	TK	49	17	1	8	1.42
Austrovenus stutchburyi	TK	50	20	0	9	1.67
Austrovenus stutchburyi	TK	51	7	0	4	0.58
Cossura sp.	CB	44	264	21	28	22.00
Cossura sp.	CB	45	203	16	22	16.92
Cossura sp.	CB	46	257	21	18	21.42
Cossura sp.	CB	47	194	16	22	16.17
Cossura sp.	CB	48	405	30	39	33.75
Cossura sp.	CB	49	249	19	29	20.75
Cossura sp.	CB	50	260	20	23	21.67
Cossura sp.	CB	51	240	21	23	20.00
Cossura sp.	DC	46	0	0	0	0
Cossura sp.	DC	47	0	0	0	0
Cossura sp.	DC	48	1	0	1	0.08
Cossura sp.	DC	49	0	0	0	0
Cossura sp.	DC	50	0	0	0	0
Cossura sp.	DC	51	0	0	0	0
Cossura sp.	HL	44	839	67	90	69.90
Cossura sp.	HL	45	670	52	76	55.83
Cossura sp.	HL	46	597	49	65	49.75
Cossura sp.	HL	47	719	56	100	59.92
Cossura sp.	HL	48	1234	106	59	102.83
Cossura sp.	HL	49	983	66	125	81.92
Cossura sp.	HL	50	736	62	64	61.33
Cossura sp.	HL	51	822	69	71	68.50
Cossura sp.	JB	44	2	0	2	0.17
Cossura sp.	JB	45	4	0	3	0.33
Cossura sp.	JB	46	21	1	9	1.75
Cossura sp.	JB	47	20	0	14	1.67
Cossura sp.	JB	48	8	0	8	0.67
Cossura sp.	JB	49	34	2	15	2.83
Cossura sp.	JB	50	4	0	3	0.36
Cossura sp.	JB	51	12	0	6	1.00
Cossura sp.	MH	44	55	2	30	4.58
Cossura sp.	MH	45	40	3	6	3.33
Cossura sp.	MH	46	27	2	8	2.25
Cossura sp.	MH	47	30	3	7	2.5
Cossura sp.	MH	48	16	1	4	1.33
Cossura sp.	MH	49	24	2	5	2.00
Cossura sp.	MH	50	18	1	7	1.50
Cossura sp.	MH	51	37	2	11	3.08
Cossura sp.	TK	44	536	50	115	44.67
Cossura sp.	TK	45	442	36	66	36.83
Cossura sp.	TK	46	380	34	66	31.67
Cossura sp.	TK	47	304	22	58	25.33
Cossura sp.	TK	48	580	51	151	48.33
Cossura sp.	TK	49	402	29	107	33.5
Cossura sp.	TK	50	416	27	94	34.67
Cossura sp.	TK	51	428	41	67	35.67
Heteromastus filiformis	CB	44	96	9	15	8.00
Heteromastus filiformis	CB	45	114	10	17	9.50
Heteromastus filiformis	CB	46	136	10	26	11.33
Heteromastus filiformis	CB	47	30	2	10	2.50
Heteromastus filiformis	CB	48	71	5	15	5.92
Heteromastus filiformis	CB	49	19	1	3	1.58
Heteromastus filiformis	CB	50	27	2	6	2.25
Heteromastus filiformis	CB	51	17	1	4	1.42
Heteromastus filiformis	DC	46	42	2	11	3.50
Heteromastus filiformis	DC	47	53	4	15	4.42
Heteromastus filiformis	DC	48	119	10	13	9.92
Heteromastus filiformis	DC	49	95	7	10	7.92
Heteromastus filiformis	DC	50	109	9	19	9.08

Heteromastus filiformis	DC	51	61	5	11	5.08
Heteromastus filiformis	HL	44	493	42	43	41.10
Heteromastus filiformis	HL	45	600	49	77	50.00
Heteromastus filiformis	HL	46	232	17	41	19.33
Heteromastus filiformis	HL	47	448	39	67	37.33
Heteromastus filiformis	HL	48	515	37	42	42.92
Heteromastus filiformis	HL	49	350	28	46	29.17
Heteromastus filiformis	HL	50	377	28	43	31.42
Heteromastus filiformis	HL	51	333	27	37	27.75
Heteromastus filiformis	JB	44	19	1	7	1.58
Heteromastus filiformis	JB	45	79	6	23	6.58
Heteromastus filiformis	JB	46	28	0	15	2.33
Heteromastus filiformis	JB	47	45	3	14	3.75
Heteromastus filiformis	JB	48	85	6	17	7.08
Heteromastus filiformis	JB	49	71	3	21	5.92
Heteromastus filiformis	JB	50	28	0	10	2.36
Heteromastus filiformis	JB	51	15	1	6	1.27
Heteromastus filiformis	MH	44	19	1	4	1.58
Heteromastus filiformis	MH	45	56	5	14	4.67
Heteromastus filiformis	MH	46	12	1	3	1.00
Heteromastus filiformis	MH	47	0	0	0	0
Heteromastus filiformis	MH	48	53	6	8	4.42
Heteromastus filiformis	MH	49	18	1	5	1.50
Heteromastus filiformis	MH	50	31	2	8	2.58
Heteromastus filiformis	MH	51	14	1	4	1.17
Heteromastus filiformis	TK	44	117	11	22	9.75
Heteromastus filiformis	TK	45	205	18	25	17.08
Heteromastus filiformis	TK	46	211	17	29	17.58
Heteromastus filiformis	TK	47	95	6	17	7.92
Heteromastus filiformis	TK	48	339	26	32	28.25
Heteromastus filiformis	TK	49	255	18	49	21.25
Heteromastus filiformis	TK	50	273	20	39	22.75
Heteromastus filiformis	TK	51	238	16	37	19.83
Macomona liliana	CB	44	7	1	2	0.58
Macomona liliana	CB	45	0	0	0	0
Macomona liliana	CB	46	7	0	2	0.58
Macomona liliana	CB	47	6	0	2	0.50
Macomona liliana	CB	48	36	3	9	3.00
Macomona liliana	CB	49	4	0	2	0.33
Macomona liliana	CB	50	13	1	3	1.08
Macomona liliana	CB	51	1	0	1	0.08
Macomona liliana	DC	46	57	5	6	4.75
Macomona liliana	DC	47	52	5	4	4.33
Macomona liliana	DC	48	89	7	6	7.42
Macomona liliana	DC	49	31	2	4	2.58
Macomona liliana	DC	50	79	6	10	6.58
Macomona liliana	DC	51	55	5	9	4.58
Macomona liliana	HL	44	2	0	1	0.2
Macomona liliana	HL	45	5	0	2	0.42
Macomona liliana	HL	46	8	0	3	0.67
Macomona liliana	HL	47	0	0	0	0
Macomona liliana	HL	48	17	1	3	1.42
Macomona liliana	HL	49	18	1	6	1.50
Macomona liliana	HL	50	4	0	2	0.33
Macomona liliana	HL	51	2	0	2	0.17
Macomona liliana	JB	44	15	1	5	1.25
Macomona liliana	JB	45	7	1	2	0.58
Macomona liliana	JB	46	8	0	3	0.67
Macomona liliana	JB	47	9	1	2	0.75
Macomona liliana	JB	48	84	5	19	7.00
Macomona liliana	JB	49	35	2	9	2.92
Macomona liliana	JB	50	34	4	6	2.82
Macomona liliana	JB	51	19	1	5	1.55
Macomona liliana	MH	44	17	2	3	1.42

Macomona liliana	MH	45	17	1	3	1.42
Macomona liliana	MH	46	17	1	3	1.42
Macomona liliana	MH	47	13	1	3	1.08
Macomona liliana	MH	48	38	3	7	3.17
Macomona liliana	MH	49	17	1	5	1.42
Macomona liliana	MH	50	22	2	5	1.83
Macomona liliana	MH	51	16	1	3	1.33
Macomona liliana	TK	44	8	0	4	0.67
Macomona liliana	TK	45	9	0	4	0.75
Macomona liliana	TK	46	9	0	7	0.75
Macomona liliana	TK	47	5	0	2	0.42
Macomona liliana	TK	48	80	6	8	6.67
Macomona liliana	TK	49	31	3	6	2.58
Macomona liliana	TK	50	21	2	5	1.75
Macomona liliana	TK	51	12	1	4	1.00
Macrophthalmus hirtipes	CB	44	1	0	1	0.08
Macrophthalmus hirtipes	CB	45	0	0	0	0
Macrophthalmus hirtipes	CB	46	2	0	1	0.17
Macrophthalmus hirtipes	CB	47	0	0	0	0
Macrophthalmus hirtipes	CB	48	3	0	2	0.25
Macrophthalmus hirtipes	CB	49	11	1	3	0.92
Macrophthalmus hirtipes	CB	50	12	1	2	1.00
Macrophthalmus hirtipes	CB	51	4	0	2	0.33
Macrophthalmus hirtipes	DC	46	1	0	1	0.08
Macrophthalmus hirtipes	DC	47	3	0	2	0.25
Macrophthalmus hirtipes	DC	48	0	0	0	0
Macrophthalmus hirtipes	DC	49	3	0	1	0.25
Macrophthalmus hirtipes	DC	50	6	0	2	0.5
Macrophthalmus hirtipes	DC	51	4	0	2	0.33
Macrophthalmus hirtipes	HL	44	4	0	1	0.30
Macrophthalmus hirtipes	HL	45	2	0	1	0.17
Macrophthalmus hirtipes	HL	46	4	0	2	0.33
Macrophthalmus hirtipes	HL	47	1	0	1	0.08
Macrophthalmus hirtipes	HL	48	0	0	0	0
Macrophthalmus hirtipes	HL	49	2	0	1	0.17
Macrophthalmus hirtipes	HL	50	27	3	4	2.25
Macrophthalmus hirtipes	HL	51	4	0	2	0.33
Macrophthalmus hirtipes	JB	44	0	0	0	0
Macrophthalmus hirtipes	JB	45	0	0	0	0
Macrophthalmus hirtipes	JB	46	1	0	1	0.08
Macrophthalmus hirtipes	JB	47	1	0	1	0.08
Macrophthalmus hirtipes	JB	48	0	0	0	0
Macrophthalmus hirtipes	JB	49	1	0	1	0.08
Macrophthalmus hirtipes	JB	50	4	0	3	0.36
Macrophthalmus hirtipes	JB	51	0	0	0	0
Macrophthalmus hirtipes	MH	44	4	0	2	0.33
Macrophthalmus hirtipes	MH	45	0	0	0	0
Macrophthalmus hirtipes	MH	46	0	0	0	0
Macrophthalmus hirtipes	MH	47	1	0	1	0.08
Macrophthalmus hirtipes	MH	48	0	0	0	0
Macrophthalmus hirtipes	MH	49	1	0	1	0.08
Macrophthalmus hirtipes	MH	50	7	0	2	0.58
Macrophthalmus hirtipes	MH	51	0	0	0	0
Macrophthalmus hirtipes	TK	44	0	0	0	0
Macrophthalmus hirtipes	TK	45	4	0	1	0.33
Macrophthalmus hirtipes	TK	46	1	0	1	0.08
Macrophthalmus hirtipes	TK	47	2	0	1	0.17
Macrophthalmus hirtipes	TK	48	0	0	0	0
Macrophthalmus hirtipes	TK	49	2	0	1	0.17
Macrophthalmus hirtipes	TK	50	5	0	1	0.42
Macrophthalmus hirtipes	TK	51	0	0	0	0
Notoacmea helmsi	CB	44	0	0	0	0
Notoacmea helmsi	CB	45	0	0	0	0
Notoacmea helmsi	CB	46	0	0	0	0

Notoacmea helmsi	CB	47	0	0	0	0
Notoacmea helmsi	CB	48	0	0	0	0
Notoacmea helmsi	CB	49	0	0	0	0
Notoacmea helmsi	CB	50	0	0	0	0
Notoacmea helmsi	CB	51	0	0	0	0
Notoacmea helmsi	DC	46	55	5	8	4.58
Notoacmea helmsi	DC	47	16	1	4	1.33
Notoacmea helmsi	DC	48	15	1	3	1.25
Notoacmea helmsi	DC	49	18	0	9	1.50
Notoacmea helmsi	DC	50	54	4	9	4.50
Notoacmea helmsi	DC	51	38	2	5	3.17
Notoacmea helmsi	HL	44	0	0	0	0
Notoacmea helmsi	HL	45	0	0	0	0
Notoacmea helmsi	HL	46	0	0	0	0
Notoacmea helmsi	HL	47	0	0	0	0
Notoacmea helmsi	HL	48	0	0	0	0
Notoacmea helmsi	HL	49	0	0	0	0
Notoacmea helmsi	HL	50	0	0	0	0
Notoacmea helmsi	HL	51	0	0	0	0
Notoacmea helmsi	JB	44	8	0	4	0.67
Notoacmea helmsi	JB	45	0	0	0	0
Notoacmea helmsi	JB	46	1	0	1	0.08
Notoacmea helmsi	JB	47	6	0	4	0.50
Notoacmea helmsi	JB	48	6	0	2	0.50
Notoacmea helmsi	JB	49	9	0	4	0.75
Notoacmea helmsi	JB	50	0	0	0	0
Notoacmea helmsi	JB	51	0	0	0	0
Notoacmea helmsi	MH	44	0	0	0	0
Notoacmea helmsi	MH	45	0	0	0	0
Notoacmea helmsi	MH	46	0	0	0	0
Notoacmea helmsi	MH	47	0	0	0	0
Notoacmea helmsi	MH	48	0	0	0	0
Notoacmea helmsi	MH	49	0	0	0	0
Notoacmea helmsi	MH	50	0	0	0	0
Notoacmea helmsi	MH	51	0	0	0	0
Notoacmea helmsi	TK	44	1	0	1	0.08
Notoacmea helmsi	TK	45	0	0	0	0
Notoacmea helmsi	TK	46	7	0	7	0.58
Notoacmea helmsi	TK	47	0	0	0	0
Notoacmea helmsi	TK	48	0	0	0	0
Notoacmea helmsi	TK	49	4	0	4	0.33
Notoacmea helmsi	TK	50	2	0	2	0.17
Notoacmea helmsi	TK	51	0	0	0	0
Nemerteans	CB	44	5	0	3	0.42
Nemerteans	CB	45	6	0	3	0.50
Nemerteans	CB	46	5	0	1	0.42
Nemerteans	CB	47	3	0	1	0.25
Nemerteans	CB	48	3	0	2	0.25
Nemerteans	CB	49	0	0	0	0
Nemerteans	CB	50	1	0	1	0.08
Nemerteans	CB	51	1	0	1	0.08
Nemerteans	DC	46	2	0	1	0.17
Nemerteans	DC	47	5	0	2	0.42
Nemerteans	DC	48	4	0	1	0.33
Nemerteans	DC	49	8	1	3	0.67
Nemerteans	DC	50	3	0	1	0.25
Nemerteans	DC	51	4	0	2	0.33
Nemerteans	HL	44	12	1	3	1.00
Nemerteans	HL	45	15	1	4	1.25
Nemerteans	HL	46	8	0	3	0.67
Nemerteans	HL	47	1	0	1	0.08
Nemerteans	HL	48	15	1	3	1.25
Nemerteans	HL	49	11	1	4	0.92
Nemerteans	HL	50	3	0	1	0.25

Nemerteans	HL	51	5	0	2	0.42
Nemerteans	JB	44	2	0	1	0.17
Nemerteans	JB	45	8	0	4	0.67
Nemerteans	JB	46	17	0	11	1.42
Nemerteans	JB	47	3	0	2	0.25
Nemerteans	JB	48	4	0	2	0.33
Nemerteans	JB	49	5	0	2	0.42
Nemerteans	JB	50	2	0	2	0.18
Nemerteans	JB	51	0	0	0	0
Nemerteans	MH	44	1	0	1	0.08
Nemerteans	MH	45	2	0	2	0.17
Nemerteans	MH	46	5	0	2	0.45
Nemerteans	MH	47	1	0	1	0.08
Nemerteans	MH	48	6	0	2	0.5
Nemerteans	MH	49	7	1	2	0.58
Nemerteans	MH	50	3	0	2	0.25
Nemerteans	MH	51	0	0	0	0
Nemerteans	TK	44	3	0	1	0.25
Nemerteans	TK	45	9	0	5	0.75
Nemerteans	TK	46	12	1	4	1.00
Nemerteans	TK	47	0	0	0	0
Nemerteans	TK	48	13	1	3	1.08
Nemerteans	TK	49	3	0	1	0.25
Nemerteans	TK	50	2	0	1	0.17
Nemerteans	TK	51	6	0	2	0.50
Nucula hartvigiana	CB	44	30	3	5	2.5
Nucula hartvigiana	CB	45	12	0	4	1.00
Nucula hartvigiana	CB	46	65	5	10	5.42
Nucula hartvigiana	CB	47	64	4	12	5.33
Nucula hartvigiana	CB	48	36	3	7	3.00
Nucula hartvigiana	CB	49	20	2	4	1.67
Nucula hartvigiana	CB	50	25	2	5	2.08
Nucula hartvigiana	CB	51	14	1	3	1.17
Nucula hartvigiana	DC	46	400	26	72	33.33
Nucula hartvigiana	DC	47	358	25	64	29.83
Nucula hartvigiana	DC	48	467	38	55	38.92
Nucula hartvigiana	DC	49	369	28	55	30.75
Nucula hartvigiana	DC	50	411	32	54	34.25
Nucula hartvigiana	DC	51	397	34	54	33.08
Nucula hartvigiana	HL	44	0	0	0	0
Nucula hartvigiana	HL	45	0	0	0	0
Nucula hartvigiana	HL	46	4	0	2	0.33
Nucula hartvigiana	HL	47	3	0	1	0.25
Nucula hartvigiana	HL	48	1	0	1	0.08
Nucula hartvigiana	HL	49	1	0	1	0.08
Nucula hartvigiana	HL	50	3	0	2	0.25
Nucula hartvigiana	HL	51	0	0	0	0.00
Nucula hartvigiana	JB	44	186	15	49	15.5
Nucula hartvigiana	JB	45	162	12	37	13.5
Nucula hartvigiana	JB	46	36	3	15	3.00
Nucula hartvigiana	JB	47	144	5	68	12.00
Nucula hartvigiana	JB	48	366	28	53	30.5
Nucula hartvigiana	JB	49	175	15	29	14.58
Nucula hartvigiana	JB	50	250	17	53	20.82
Nucula hartvigiana	JB	51	276	25	62	23.000
Nucula hartvigiana	MH	44	320	29	21	26.67
Nucula hartvigiana	MH	45	381	32	21	31.75
Nucula hartvigiana	MH	46	382	32	33	31.83
Nucula hartvigiana	MH	47	460	37	30	38.33
Nucula hartvigiana	MH	48	438	29	69	36.50
Nucula hartvigiana	MH	49	486	39	42	40.50
Nucula hartvigiana	MH	50	434	38	48	36.17
Nucula hartvigiana	MH	51	498	41	48	41.50
Nucula hartvigiana	TK	44	16	1	6	1.33

Nucula hartvigiana	TK	45	12	1	5	1.00
Nucula hartvigiana	TK	46	15	0	11	1.25
Nucula hartvigiana	TK	47	37	3	7	3.08
Nucula hartvigiana	TK	48	45	1	30	3.75
Nucula hartvigiana	TK	49	23	1	15	1.92
Nucula hartvigiana	TK	50	23	1	10	1.92
Nucula hartvigiana	TK	51	64	4	17	5.33
Oligochaetes	CB	44	0	0	0	0
Oligochaetes	CB	45	0	0	0	0
Oligochaetes	CB	46	0	0	0	0
Oligochaetes	CB	47	1	0	1	0.08
Oligochaetes	CB	48	0	0	0	0
Oligochaetes	CB	49	0	0	0	0
Oligochaetes	CB	50	0	0	0	0
Oligochaetes	CB	51	0	0	0	0
Oligochaetes	DC	46	3	0	3	0.25
Oligochaetes	DC	47	0	0	0	0
Oligochaetes	DC	48	1	0	1	0.08
Oligochaetes	DC	49	0	0	0	0
Oligochaetes	DC	50	4	0	3	0.33
Oligochaetes	DC	51	2	0	2	0.17
Oligochaetes	HL	44	54	3	13	4.50
Oligochaetes	HL	45	2	0	2	0.17
Oligochaetes	HL	46	0	0	0	0
Oligochaetes	HL	47	6	0	2	0.50
Oligochaetes	HL	48	2	0	1	0.17
Oligochaetes	HL	49	10	0	4	0.83
Oligochaetes	HL	50	1	0	1	0.08
Oligochaetes	HL	51	3	0	2	0.25
Oligochaetes	JB	44	7	0	3	0.58
Oligochaetes	JB	45	2	0	2	0.17
Oligochaetes	JB	46	25	0	12	2.08
Oligochaetes	JB	47	0	0	0	0
Oligochaetes	JB	48	0	0	0	0
Oligochaetes	JB	49	52	1	28	4.33
Oligochaetes	JB	50	2	0	2	0.18
Oligochaetes	JB	51	2	0	1	0.18
Oligochaetes	MH	44	0	0	0	0
Oligochaetes	MH	45	0	0	0	0
Oligochaetes	MH	46	0	0	0	0
Oligochaetes	MH	47	0	0	0	0
Oligochaetes	MH	48	0	0	0	0
Oligochaetes	MH	49	0	0	0	0
Oligochaetes	MH	50	1	0	1	0.08
Oligochaetes	MH	51	1	0	1	0.08
Oligochaetes	TK	44	0	0	0	0
Oligochaetes	TK	45	0	0	0	0
Oligochaetes	TK	46	2	0	1	0.17
Oligochaetes	TK	47	1	0	1	0.08
Oligochaetes	TK	48	0	0	0	0
Oligochaetes	TK	49	0	0	0	0
Oligochaetes	TK	50	0	0	0	0
Oligochaetes	TK	51	4	0	2	0.33
Owenia fusiformis	CB	44	0	0	0	0
Owenia fusiformis	CB	45	0	0	0	0
Owenia fusiformis	CB	46	0	0	0	0
Owenia fusiformis	CB	47	0	0	0	0
Owenia fusiformis	CB	48	0	0	0	0
Owenia fusiformis	CB	49	0	0	0	0
Owenia fusiformis	CB	50	0	0	0	0
Owenia fusiformis	CB	51	0	0	0	0
Owenia fusiformis	DC	46	0	0	0	0
Owenia fusiformis	DC	47	0	0	0	0
Owenia fusiformis	DC	48	0	0	0	0

Owenia fusiformis	DC	49	0	0	0	0
Owenia fusiformis	DC	50	0	0	0	0
Owenia fusiformis	DC	51	0	0	0	0
Owenia fusiformis	HL	44	0	0	0	0
Owenia fusiformis	HL	45	0	0	0	0
Owenia fusiformis	HL	46	0	0	0	0
Owenia fusiformis	HL	47	0	0	0	0
Owenia fusiformis	HL	48	0	0	0	0
Owenia fusiformis	HL	49	0	0	0	0
Owenia fusiformis	HL	50	0	0	0	0
Owenia fusiformis	HL	51	0	0	0	0
Owenia fusiformis	JB	44	0	0	0	0
Owenia fusiformis	JB	45	4	0	2	0.33
Owenia fusiformis	JB	46	0	0	0	0
Owenia fusiformis	JB	47	3	0	2	0.25
Owenia fusiformis	JB	48	0	0	0	0
Owenia fusiformis	JB	49	1	0	1	0.08
Owenia fusiformis	JB	50	3	0	1	0.27
Owenia fusiformis	JB	51	2	0	1	0.18
Owenia fusiformis	MH	44	0	0	0	0
Owenia fusiformis	MH	45	0	0	0	0
Owenia fusiformis	MH	46	0	0	0	0
Owenia fusiformis	MH	47	0	0	0	0
Owenia fusiformis	MH	48	0	0	0	0
Owenia fusiformis	MH	49	0	0	0	0
Owenia fusiformis	MH	50	0	0	0	0
Owenia fusiformis	MH	51	0	0	0	0
Owenia fusiformis	TK	44	0	0	0	0
Owenia fusiformis	TK	45	0	0	0	0
Owenia fusiformis	TK	46	0	0	0	0
Owenia fusiformis	TK	47	0	0	0	0
Owenia fusiformis	TK	48	0	0	0	0
Owenia fusiformis	TK	49	0	0	0	0
Owenia fusiformis	TK	50	0	0	0	0
Owenia fusiformis	TK	51	0	0	0	0
Paracalliope novizelandiae	CB	44	0	0	0	0
Paracalliope novizelandiae	CB	45	0	0	0	0
Paracalliope novizelandiae	CB	46	1	0	1	0.08
Paracalliope novizelandiae	CB	47	1	0	1	0.08
Paracalliope novizelandiae	CB	48	0	0	0	0
Paracalliope novizelandiae	CB	49	0	0	0	0
Paracalliope novizelandiae	CB	50	0	0	0	0
Paracalliope novizelandiae	CB	51	0	0	0	0
Paracalliope novizelandiae	DC	46	19	2	5	1.58
Paracalliope novizelandiae	DC	47	0	0	0	0
Paracalliope novizelandiae	DC	48	7	0	2	0.58
Paracalliope novizelandiae	DC	49	9	1	2	0.75
Paracalliope novizelandiae	DC	50	0	0	0	0
Paracalliope novizelandiae	DC	51	2	0	2	0.17
Paracalliope novizelandiae	HL	44	0	0	0	0
Paracalliope novizelandiae	HL	45	2	0	2	0.17
Paracalliope novizelandiae	HL	46	19	1	6	1.58
Paracalliope novizelandiae	HL	47	0	0	0	0
Paracalliope novizelandiae	HL	48	1	0	1	0.08
Paracalliope novizelandiae	HL	49	0	0	0	0
Paracalliope novizelandiae	HL	50	0	0	0	0
Paracalliope novizelandiae	HL	51	1	0	1	0.08
Paracalliope novizelandiae	JB	44	0	0	0	0
Paracalliope novizelandiae	JB	45	9	0	6	0.75
Paracalliope novizelandiae	JB	46	30	1	25	2.50
Paracalliope novizelandiae	JB	47	5	0	2	0.42
Paracalliope novizelandiae	JB	48	15	1	8	1.25
Paracalliope novizelandiae	JB	49	0	0	0	0
Paracalliope novizelandiae	JB	50	0	0	0	0

Paracalliope novizelandiae	JB	51	11	0	6	0.91
Paracalliope novizelandiae	MH	44	0	0	0	0
Paracalliope novizelandiae	MH	45	3	0	2	0.25
Paracalliope novizelandiae	MH	46	3	0	1	0.25
Paracalliope novizelandiae	MH	47	0	0	0	0
Paracalliope novizelandiae	MH	48	30	2	7	2.50
Paracalliope novizelandiae	MH	49	0	0	0	0
Paracalliope novizelandiae	MH	50	0	0	0	0
Paracalliope novizelandiae	MH	51	0	0	0	0
Paracalliope novizelandiae	TK	44	0	0	0	0
Paracalliope novizelandiae	TK	45	1	0	1	0.08
Paracalliope novizelandiae	TK	46	0	0	0	0
Paracalliope novizelandiae	TK	47	0	0	0	0
Paracalliope novizelandiae	TK	48	0	0	0	0
Paracalliope novizelandiae	TK	49	0	0	0	0
Paracalliope novizelandiae	TK	50	0	0	0	0
Paracalliope novizelandiae	TK	51	3	0	1	0.25
Perinereis nuntia	CB	44	0	0	0	0
Perinereis nuntia	CB	45	0	0	0	0
Perinereis nuntia	CB	46	0	0	0	0
Perinereis nuntia	CB	47	0	0	0	0
Perinereis nuntia	CB	48	0	0	0	0
Perinereis nuntia	CB	49	0	0	0	0
Perinereis nuntia	CB	50	0	0	0	0
Perinereis nuntia	CB	51	0	0	0	0
Perinereis nuntia	DC	46	3	0	2	0.25
Perinereis nuntia	DC	47	0	0	0	0
Perinereis nuntia	DC	48	4	0	3	0.33
Perinereis nuntia	DC	49	0	0	0	0
Perinereis nuntia	DC	50	0	0	0	0
Perinereis nuntia	DC	51	0	0	0	0
Perinereis nuntia	HL	44	0	0	0	0
Perinereis nuntia	HL	45	0	0	0	0
Perinereis nuntia	HL	46	0	0	0	0
Perinereis nuntia	HL	47	1	0	1	0.08
Perinereis nuntia	HL	48	0	0	0	0
Perinereis nuntia	HL	49	0	0	0	0
Perinereis nuntia	HL	50	1	0	1	0.08
Perinereis nuntia	HL	51	0	0	0	0
Perinereis nuntia	JB	44	3	0	3	0.25
Perinereis nuntia	JB	45	1	0	1	0.08
Perinereis nuntia	JB	46	2	0	2	0.17
Perinereis nuntia	JB	47	0	0	0	0
Perinereis nuntia	JB	48	5	0	5	0.42
Perinereis nuntia	JB	49	3	0	2	0.25
Perinereis nuntia	JB	50	3	0	2	0.27
Perinereis nuntia	JB	51	7	0	2	0.55
Perinereis nuntia	MH	44	0	0	0	0
Perinereis nuntia	MH	45	0	0	0	0
Perinereis nuntia	MH	46	0	0	0	0
Perinereis nuntia	MH	47	0	0	0	0
Perinereis nuntia	MH	48	0	0	0	0
Perinereis nuntia	MH	49	0	0	0	0
Perinereis nuntia	MH	50	1	0	1	0.08
Perinereis nuntia	MH	51	0	0	0	0
Perinereis nuntia	TK	44	8	0	7	0.67
Perinereis nuntia	TK	45	0	0	0	0
Perinereis nuntia	TK	46	1	0	1	0.08
Perinereis nuntia	TK	47	4	0	1	0.33
Perinereis nuntia	TK	48	0	0	0	0
Perinereis nuntia	TK	49	0	0	0	0
Perinereis nuntia	TK	50	0	0	0	0
Perinereis nuntia	TK	51	0	0	0	0
Polydorids	CB	44	33	1	16	2.75

Polydorids	CB	45	21	1	7	1.75
Polydorids	CB	46	24	2	4	2.00
Polydorids	CB	47	4	0	2	0.33
Polydorids	CB	48	5	0	1	0.42
Polydorids	CB	49	7	0	3	0.58
Polydorids	CB	50	14	1	5	1.17
Polydorids	CB	51	2	0	1	0.17
Polydorids	DC	46	11	1	3	0.92
Polydorids	DC	47	6	0	2	0.50
Polydorids	DC	48	33	2	14	2.75
Polydorids	DC	49	43	2	12	3.58
Polydorids	DC	50	39	3	7	3.25
Polydorids	DC	51	28	2	6	2.33
Polydorids	HL	44	0	0	0	0
Polydorids	HL	45	28	2	5	2.33
Polydorids	HL	46	9	1	2	0.75
Polydorids	HL	47	15	1	4	1.25
Polydorids	HL	48	19	1	5	1.58
Polydorids	HL	49	50	3	17	4.17
Polydorids	HL	50	7	1	2	0.58
Polydorids	HL	51	7	0	2	0.58
Polydorids	JB	44	216	8	61	18.00
Polydorids	JB	45	260	17	54	21.67
Polydorids	JB	46	118	7	37	9.83
Polydorids	JB	47	70	3	15	5.83
Polydorids	JB	48	56	1	29	4.67
Polydorids	JB	49	48	1	16	4.00
Polydorids	JB	50	31	1	9	2.55
Polydorids	JB	51	14	0	7	1.18
Polydorids	MH	44	18	1	5	1.50
Polydorids	MH	45	19	1	6	1.58
Polydorids	MH	46	15	1	6	1.25
Polydorids	MH	47	16	1	5	1.33
Polydorids	MH	48	16	1	5	1.33
Polydorids	MH	49	22	2	6	1.83
Polydorids	MH	50	13	1	4	1.08
Polydorids	MH	51	4	0	2	0.33
Polydorids	TK	44	3	0	2	0.25
Polydorids	TK	45	3	0	2	0.25
Polydorids	TK	46	8	1	3	0.67
Polydorids	TK	47	4	0	1	0.33
Polydorids	TK	48	56	2	14	4.67
Polydorids	TK	49	34	1	11	2.83
Polydorids	TK	50	21	1	10	1.75
Polydorids	TK	51	13	0	9	1.08
Prionospio aucklandica	CB	44	0	0	0	0
Prionospio aucklandica	CB	45	1	0	1	0.08
Prionospio aucklandica	CB	46	0	0	0	0
Prionospio aucklandica	CB	47	0	0	0	0
Prionospio aucklandica	CB	48	0	0	0	0
Prionospio aucklandica	CB	49	0	0	0	0
Prionospio aucklandica	CB	50	0	0	0	0
Prionospio aucklandica	CB	51	0	0	0	0
Prionospio aucklandica	DC	46	4	0	2	0.33
Prionospio aucklandica	DC	47	6	0	2	0.50
Prionospio aucklandica	DC	48	16	1	5	1.33
Prionospio aucklandica	DC	49	8	0	3	0.67
Prionospio aucklandica	DC	50	1	0	1	0.08
Prionospio aucklandica	DC	51	22	1	11	1.83
Prionospio aucklandica	HL	44	13	1	3	1.10
Prionospio aucklandica	HL	45	6	0	2	0.5
Prionospio aucklandica	HL	46	4	0	1	0.33
Prionospio aucklandica	HL	47	12	1	5	1.00
Prionospio aucklandica	HL	48	13	1	3	1.08

Prionospio aucklandica	HL	49	6	1	1	0.5
Prionospio aucklandica	HL	50	5	0	1	0.42
Prionospio aucklandica	HL	51	15	1	3	1.25
Prionospio aucklandica	JB	44	1	0	1	0.08
Prionospio aucklandica	JB	45	0	0	0	0
Prionospio aucklandica	JB	46	0	0	0	0
Prionospio aucklandica	JB	47	0	0	0	0
Prionospio aucklandica	JB	48	1	0	1	0.08
Prionospio aucklandica	JB	49	0	0	0	0
Prionospio aucklandica	JB	50	0	0	0	0
Prionospio aucklandica	JB	51	1	0	1	0.09
Prionospio aucklandica	MH	44	1	0	1	0.08
Prionospio aucklandica	MH	45	0	0	0	0
Prionospio aucklandica	MH	46	0	0	0	0
Prionospio aucklandica	MH	47	0	0	0	0
Prionospio aucklandica	MH	48	3	0	1	0.25
Prionospio aucklandica	MH	49	1	0	1	0.08
Prionospio aucklandica	MH	50	0	0	0	0
Prionospio aucklandica	MH	51	2	0	2	0.17
Prionospio aucklandica	TK	44	10	1	5	0.83
Prionospio aucklandica	TK	45	5	0	2	0.42
Prionospio aucklandica	TK	46	16	1	6	1.33
Prionospio aucklandica	TK	47	2	0	1	0.17
Prionospio aucklandica	TK	48	64	3	17	5.33
Prionospio aucklandica	TK	49	14	1	6	1.17
Prionospio aucklandica	TK	50	13	1	4	1.08
Prionospio aucklandica	TK	51	37	4	8	3.08
Scoloplos cylindrifer	CB	44	0	0	0	0
Scoloplos cylindrifer	CB	45	0	0	0	0
Scoloplos cylindrifer	CB	46	2	0	1	0.17
Scoloplos cylindrifer	CB	47	0	0	0	0
Scoloplos cylindrifer	CB	48	0	0	0	0
Scoloplos cylindrifer	CB	49	0	0	0	0
Scoloplos cylindrifer	CB	50	0	0	0	0
Scoloplos cylindrifer	CB	51	0	0	0	0
Scoloplos cylindrifer	DC	46	6	0	2	0.50
Scoloplos cylindrifer	DC	47	1	0	1	0.08
Scoloplos cylindrifer	DC	48	23	1	10	1.92
Scoloplos cylindrifer	DC	49	12	1	4	1
Scoloplos cylindrifer	DC	50	25	1	11	2.08
Scoloplos cylindrifer	DC	51	5	0	3	0.42
Scoloplos cylindrifer	HL	44	0	0	0	0
Scoloplos cylindrifer	HL	45	1	0	1	0.08
Scoloplos cylindrifer	HL	46	0	0	0	0
Scoloplos cylindrifer	HL	47	0	0	0	0
Scoloplos cylindrifer	HL	48	0	0	0	0
Scoloplos cylindrifer	HL	49	0	0	0	0
Scoloplos cylindrifer	HL	50	0	0	0	0
Scoloplos cylindrifer	HL	51	0	0	0	0
Scoloplos cylindrifer	JB	44	2	0	1	0.17
Scoloplos cylindrifer	JB	45	1	0	1	0.08
Scoloplos cylindrifer	JB	46	3	0	2	0.25
Scoloplos cylindrifer	JB	47	3	0	2	0.25
Scoloplos cylindrifer	JB	48	9	0	8	0.75
Scoloplos cylindrifer	JB	49	0	0	0	0
Scoloplos cylindrifer	JB	50	0	0	0	0
Scoloplos cylindrifer	JB	51	2	0	2	0.18
Scoloplos cylindrifer	MH	44	0	0	0	0
Scoloplos cylindrifer	MH	45	0	0	0	0
Scoloplos cylindrifer	MH	46	1	0	1	0.08
Scoloplos cylindrifer	MH	47	0	0	0	0
Scoloplos cylindrifer	MH	48	2	0	1	0.17
Scoloplos cylindrifer	MH	49	0	0	0	0
Scoloplos cylindrifer	MH	50	1	0	1	0.08

Scoloplos cylindrifer	MH	51	0	0	0	0
Scoloplos cylindrifer	TK	44	0	0	0	0
Scoloplos cylindrifer	TK	45	4	0	4	0.33
Scoloplos cylindrifer	TK	46	0	0	0	0
Scoloplos cylindrifer	TK	47	1	0	1	0.08
Scoloplos cylindrifer	TK	48	8	0	5	0.67
Scoloplos cylindrifer	TK	49	4	0	4	0.33
Scoloplos cylindrifer	TK	50	5	0	3	0.42
Scoloplos cylindrifer	TK	51	0	0	0	0
Torridoharpinia hurleyi	CB	44	2	0	1	0.17
Torridoharpinia hurleyi	CB	45	8	0	4	0.67
Torridoharpinia hurleyi	CB	46	40	2	9	3.33
Torridoharpinia hurleyi	CB	47	11	0	4	0.92
Torridoharpinia hurleyi	CB	48	11	1	4	0.92
Torridoharpinia hurleyi	CB	49	10	1	2	0.83
Torridoharpinia hurleyi	CB	50	34	2	7	2.83
Torridoharpinia hurleyi	CB	51	58	3	16	4.83
Torridoharpinia hurleyi	DC	46	1	0	1	0.08
Torridoharpinia hurleyi	DC	47	0	0	0	0
Torridoharpinia hurleyi	DC	48	13	1	3	1.08
Torridoharpinia hurleyi	DC	49	4	0	2	0.33
Torridoharpinia hurleyi	DC	50	6	0	2	0.50
Torridoharpinia hurleyi	DC	51	13	0	5	1.08
Torridoharpinia hurleyi	HL	44	7	0	3	0.60
Torridoharpinia hurleyi	HL	45	2	0	1	0.17
Torridoharpinia hurleyi	HL	46	6	1	1	0.50
Torridoharpinia hurleyi	HL	47	0	0	0	0
Torridoharpinia hurleyi	HL	48	1	0	1	0.08
Torridoharpinia hurleyi	HL	49	1	0	1	0.08
Torridoharpinia hurleyi	HL	50	4	0	2	0.33
Torridoharpinia hurleyi	HL	51	4	0	1	0.33
Torridoharpinia hurleyi	JB	44	1	0	1	0.08
Torridoharpinia hurleyi	JB	45	2	0	1	0.17
Torridoharpinia hurleyi	JB	46	5	0	1	0.42
Torridoharpinia hurleyi	JB	47	1	0	1	0.08
Torridoharpinia hurleyi	JB	48	10	1	2	0.83
Torridoharpinia hurleyi	JB	49	3	0	2	0.25
Torridoharpinia hurleyi	JB	50	21	2	5	1.73
Torridoharpinia hurleyi	JB	51	27	1	11	2.27
Torridoharpinia hurleyi	MH	44	6	1	1	0.50
Torridoharpinia hurleyi	MH	45	5	0	4	0.42
Torridoharpinia hurleyi	MH	46	11	1	3	0.92
Torridoharpinia hurleyi	MH	47	6	0	2	0.50
Torridoharpinia hurleyi	MH	48	16	1	4	1.33
Torridoharpinia hurleyi	MH	49	5	0	3	0.42
Torridoharpinia hurleyi	MH	50	1	0	1	0.08
Torridoharpinia hurleyi	MH	51	29	2	7	2.42
Torridoharpinia hurleyi	TK	44	3	0	2	0.25
Torridoharpinia hurleyi	TK	45	8	0	3	0.67
Torridoharpinia hurleyi	TK	46	34	1	10	2.83
Torridoharpinia hurleyi	TK	47	0	0	0	0
Torridoharpinia hurleyi	TK	48	2	0	1	0.17
Torridoharpinia hurleyi	TK	49	6	0	3	0.50
Torridoharpinia hurleyi	TK	50	9	0	5	0.75
Torridoharpinia hurleyi	TK	51	17	0	8	1.42

8.4 Appendix 5

Results of grain size analysis for the subtidal sites.

% Sediment composition	Year	Month	Site A	Site C
Gravel/shell hash	1995	Apr	0.17	7.10
	1996	Apr	0.00	0.00
	1997	Apr	0.20	3.01
	1998	Apr	0.08	5.22
	1999	Apr	0.05	5.23
	2000	Apr	0.74	14.77
		Oct	0.25	21.47
	2001	Apr	3.88	5.35
		Oct	0.07	1.56
	2002	Jan	0.08	1.47
		Apr	19.08	1.32
		Jul	0.00	0.35
		Oct	1.70	0.27
	2003	Jan	0.68	13.63
		Apr	20.12	1.58
		Jul	0.41	0.01
		Oct	0.00	0.00
	2004	Jan	0.09	11.17
		Apr	0.41	3.46
		Jul	0.80	5.16
		Oct	0.00	2.09
	2005	Jan	2.03	4.74
		Apr	10.76	9.14
		Jul	0.73	3.73
		Oct	0.96	0.15
	2006	Jan	0.36	20.49
		Apr	0.07	20.44
		Jul	0.00	3.39
		Oct	0.27	9.97
	2007	Jan	0.00	10.78
Coarse sand	1995	Apr	0.17	2.10
	1996	Apr	0.04	0.05
	1997	Apr	0.48	1.65
	1998	Apr	0.17	4.57
	1999	Apr	0.12	2.53
	2000	Apr	0.47	5.29
		Oct	0.48	4.26
	2001	Apr	0.76	2.70
		Oct	0.11	0.67
	2002	Jan	0.27	1.43
		Apr	3.57	0.53
		Jul	0.15	0.11
		Oct	1.05	0.92
	2003	Jan	0.99	2.95
		Apr	3.76	0.64

		Jul	0.45	0.13
		Oct	0.26	0.04
	2004	Jan	0.37	1.76
		Apr	0.52	0.90
		Jul	0.21	1.87
		Oct	0.44	1.69
	2005	Jan	0.00	2.42
		Apr	5.72	3.39
		Jul	0.34	0.64
		Oct	0.75	0.79
	2006	Jan	0.42	3.04
		Apr	0.26	3.59
		Jul	0.05	1.47
		Oct	0.32	1.21
	2007	Jan	0.34	1.49
Medium sand	1995	Apr	0.51	6.98
	1996	Apr	13.07	12.01
	1997	Apr	0.79	1.20
	1998	Apr	23.31	1.47
	1999	Apr	2.35	3.84
	2000	Apr	1.29	1.53
		Oct	1.04	1.22
	2001	Apr	0.65	1.19
		Oct	0.25	0.57
	2002	Jan	0.49	0.23
		Apr	0.96	0.51
		Jul	1.95	1.21
		Oct	0.63	1.00
	2003	Jan	0.64	1.11
		Apr	0.01	0.62
		Jul	0.79	0.20
		Oct	0.41	0.61
	2004	Jan	0.39	0.57
		Apr	0.64	1.25
		Jul	0.28	0.80
		Oct	0.73	0.81
	2005	Jan	0.68	0.29
		Apr	5.45	1.12
		Jul	0.56	0.90
		Oct	0.75	1.39
	2006	Jan	0.35	0.89
		Apr	0.29	1.07
		Jul	0.16	0.35
		Oct	0.76	0.54
	2007	Jan	0.48	0.64
Fine sand	1995	Apr	15.83	20.87
	1996	Apr	25.58	25.67
	1997	Apr	74.86	49.10
	1998	Apr	54.79	35.58
	1999	Apr	54.89	46.46
	2000	Apr	73.83	31.02
		Oct	71.15	28.51
	2001	Apr	71.34	46.34

		Oct	44.40	39.82
	2002	Jan	78.85	53.98
		Apr	29.04	76.10
		Jul	75.38	56.23
		Oct	77.04	44.27
	2003	Jan	76.85	41.51
		Apr	30.62	91.30
		Jul	73.89	71.53
		Oct	86.30	38.66
	2004	Jan	72.83	32.71
		Apr	72.27	52.60
		Jul	69.68	37.27
		Oct	69.26	34.18
	2005	Jan	75.60	39.01
		Apr	42.61	38.84
		Jul	71.62	29.54
		Oct	71.57	26.54
	2006	Jan	72.87	27.54
		Apr	71.76	32.34
		Jul	67.74	33.77
		Oct	66.23	33.82
	2007	Jan	76.03	32.84
Silt	1995	Apr	73.72	55.41
	1996	Apr	41.96	40.91
	1997	Apr	18.13	42.85
	1998	Apr	16.13	46.06
	1999	Apr	29.39	39.47
	2000	Apr	15.37	30.09
		Oct	23.11	37.01
	2001	Apr	20.18	36.55
		Oct	21.31	45.77
	2002	Jan	17.85	35.53
		Apr	14.95	16.15
		Jul	15.76	32.51
		Oct	10.60	34.23
	2003	Jan	12.65	16.32
		Apr	9.47	22.50
		Jul	17.46	18.46
		Oct	12.34	41.61
	2004	Jan	17.69	35.58
		Apr	13.08	23.89
		Jul	27.24	52.63
		Oct	19.71	43.74
	2005	Jan	19.72	49.71
		Apr	17.73	34.27
		Jul	16.72	42.51
		Oct	12.30	47.43
	2006	Jan	18.83	36.21
		Apr	20.72	30.61
		Jul	23.23	42.71
		Oct	20.53	34.39
	2007	Jan	17.02	32.91

Clay	1995	Apr	9.61	7.48
	1996	Apr	19.35	21.36
	1997	Apr	5.53	2.19
	1998	Apr	5.52	7.11
	1999	Apr	13.20	2.46
	2000	Apr	8.30	17.30
		Oct	3.97	7.52
	2001	Apr	3.19	7.86
		Oct	3.98	11.59
	2002	Jan	2.46	7.37
		Apr	32.40	5.38
		Jul	6.75	9.59
		Oct	8.97	15.32
	2003	Jan	8.18	24.47
		Apr	20.53	7.50
		Jul	6.99	9.67
		Oct	0.69	19.07
	2004	Jan	8.62	18.20
		Apr	13.08	17.91
		Jul	1.79	2.27
		Oct	9.85	17.50
	2005	Jan	1.97	3.82
		Apr	17.73	13.24
		Jul	10.03	22.67
		Oct	12.30	23.71
	2006	Jan	7.17	11.84
		Apr	6.91	11.95
		Jul	8.81	18.31
		Oct	11.88	20.06
	2007	Jan	6.13	21.34

8.5 Appendix 6

A. Organic content (% dry weight), and B. Chlorophyll a content (µg g-1 sediment) of sediments at the subtidal sites from October 2000. * highest value recorded at each site.

A. Organic content

Sampling date	Site A	Site C
Oct00	1.93	3.43
Apr01	2.99	3.23
Oct01	2.42	4.15
Jan02	3.07	4.77
Apr02	3.86	2.44
Jul02	2.53	3.93
Oct02	1.46	2.44
Jan03	2.66	3.76
Apr03	1.85	4.33
July03	2.01	2.27
Oct03	2.40	4.41
Jan04	2.05	3.30
Apr04	5.13*	7.39
Jul04	3.72	0.93
Oct04	4.26	10.24*
Jan05	3.27	7.19
Apr05	2.64	1.07
July05	2.93	5.18
Oct05	2.86	2.81
Jan06	3.12	4.69
Apr06	2.08	3.26
Jul06	3.46	5.35
Oct06	3.95	5.06
Jan07	2.39	3.51
range	1.46 - 5.13	0.93 - 10.24

B. Chlorophyll *a*

Sampling date	Site A	Site C
Oct00	4.64	4.71
Apr01	3.66	2.97
Oct01	6.17	5.01
Jan02	3.87	4.99
Apr02	8.00	5.46
Jul02	4.35	3.62
Oct02	4.32	4.17
Jan03	5.44	4.78
Apr03	4.45	1.94
July03	6.73	7.11

Oct03	2.41	3.64
Jan04	4.23	4.79
Apr04	3.51	2.87
Jul04	3.28	4.06
Oct04	2.86	2.41
Jan05	4.00	4.57
Apr05	4.24	2.28
July05	3.66	3.99
Oct05	9.01*	10.48*
Jan06	3.68	3.02
Apr06	4.01	3.09
Jul06	4.24	3.84
Oct06	3.44	4.13
Jan07	4.47	5.50
range	2.41 - 9.01	1.94 - 10.48

8.6 Appendix 7

Summary of the temporal results[5] at the subtidal sites from April 2005 (Time = 44) to January 2007 (Time = 51). SA = Site A, SC = Site C.

Taxa	Site	Time	Total[6]	Median	Range[7]	Mean
Aricidea sp.	SA	44	13	1	2	1.09
Aricidea sp.	SA	45	14	1	4	1.17
Aricidea sp.	SA	46	16	1	4	1.33
Aricidea sp.	SA	47	0	0	0	0.00
Aricidea sp.	SA	48	11	1	3	0.92
Aricidea sp.	SA	49	17	2	3	1.42
Aricidea sp.	SA	50	17	1	4	1.42
Aricidea sp.	SA	51	9	1	4	0.75
Aricidea sp.	SC	44	1	0	1	0.08
Aricidea sp.	SC	45	1	0	1	0.08
Aricidea sp.	SC	46	2	0	1	0.17
Aricidea sp.	SC	47	9	0	5	0.75
Aricidea sp.	SC	48	7	0	3	0.58
Aricidea sp.	SC	49	7	0	2	0.58
Aricidea sp.	SC	50	2	0	1	0.17
Aricidea sp.	SC	51	5	0	3	0.42
Armandia maculata	SA	44	3	0	2	0.27
Armandia maculata	SA	45	2	0	2	0.17
Armandia maculata	SA	46	0	0	0	0.00
Armandia maculata	SA	47	0	0	0	0.00
Armandia maculata	SA	48	0	0	0	0.00
Armandia maculata	SA	49	0	0	0	0.00
Armandia maculata	SA	50	0	0	0	0.00
Armandia maculata	SA	51	0	0	0	0.00
Armandia maculata	SC	44	8	0	2	0.67
Armandia maculata	SC	45	1	0	1	0.08
Armandia maculata	SC	46	0	0	0	0.00
Armandia maculata	SC	47	0	0	0	0.00
Armandia maculata	SC	48	1	0	1	0.08
Armandia maculata	SC	49	0	0	0	0.00
Armandia maculata	SC	50	0	0	0	0.00
Armandia maculata	SC	51	0	0	0	0.00
Arthritica bifurca	SA	44	5	0	3	0.45
Arthritica bifurca	SA	45	11	0	3	0.92
Arthritica bifurca	SA	46	2	0	2	0.17
Arthritica bifurca	SA	47	10	0	3	0.83
Arthritica bifurca	SA	48	16	1	6	1.33
Arthritica bifurca	SA	49	8	0	7	0.67
Arthritica bifurca	SA	50	13	1	3	1.08
Arthritica bifurca	SA	51	15	1	8	1.25
Arthritica bifurca	SC	44	1	0	1	0.08
Arthritica bifurca	SC	45	7	0	2	0.58
Arthritica bifurca	SC	46	2	0	1	0.17
Arthritica bifurca	SC	47	14	0	9	1.17
Arthritica bifurca	SC	48	21	1	13	1.75
Arthritica bifurca	SC	49	13	1	3	1.08
Arthritica bifurca	SC	50	21	0	15	1.75
Arthritica bifurca	SC	51	7	0	3	0.58

[5] Data are only given if the taxa occur at a site during this time period.
[6] Total number of individuals collected in 12 samples. Calculated by mean abundance*12.
[7] Range = between the 5th and 95th percentile.

Cirratulids	SA	44	7	0	4	0.55
Cirratulids	SA	45	17	1	4	1.42
Cirratulids	SA	46	7	0	2	0.58
Cirratulids	SA	47	10	1	2	0.83
Cirratulids	SA	48	13	1	3	1.08
Cirratulids	SA	49	8	0	3	0.67
Cirratulids	SA	50	10	1	3	0.83
Cirratulids	SA	51	4	0	2	0.33
Cirratulids	SC	44	10	1	4	0.83
Cirratulids	SC	45	13	0	3	1.08
Cirratulids	SC	46	25	2	4	2.08
Cirratulids	SC	47	27	2	7	2.25
Cirratulids	SC	48	33	3	7	2.75
Cirratulids	SC	49	27	2	5	2.25
Cirratulids	SC	50	15	1	3	1.25
Cirratulids	SC	51	19	1	5	1.58
Corophidae-complex	SA	44	1	0	1	0.09
Corophidae-complex	SA	45	0	0	0	0.00
Corophidae-complex	SA	46	0	0	0	0.00
Corophidae-complex	SA	47	0	0	0	0.00
Corophidae-complex	SA	48	1	0	1	0.08
Corophidae-complex	SA	49	3	0	1	0.25
Corophidae-complex	SA	50	1	0	1	0.08
Corophidae-complex	SA	51	10	1	3	0.83
Corophidae-complex	SC	44	7	0	4	0.58
Corophidae-complex	SC	45	2	0	1	0.17
Corophidae-complex	SC	46	0	0	0	0.00
Corophidae-complex	SC	47	3	0	3	0.25
Corophidae-complex	SC	48	11	1	3	0.92
Corophidae-complex	SC	49	1	0	1	0.08
Corophidae-complex	SC	50	2	0	1	0.17
Corophidae-complex	SC	51	8	0	4	0.67
Nucula hartvigiana	SA	44	2	0	2	0.18
Nucula hartvigiana	SA	45	2	0	1	0.17
Nucula hartvigiana	SA	46	1	0	1	0.08
Nucula hartvigiana	SA	47	1	0	1	0.08
Nucula hartvigiana	SA	48	0	0	0	0.00
Nucula hartvigiana	SA	49	0	0	0	0.00
Nucula hartvigiana	SA	50	28	2	5	2.33
Nucula hartvigiana	SA	51	0	0	0	0.00
Nucula hartvigiana	SC	44	3	0	1	0.25
Nucula hartvigiana	SC	45	6	0	2	0.50
Nucula hartvigiana	SC	46	3	0	2	0.25
Nucula hartvigiana	SC	47	3	0	1	0.25
Nucula hartvigiana	SC	48	6	0	2	0.50
Nucula hartvigiana	SC	49	0	0	0	0.00
Nucula hartvigiana	SC	50	15	1	5	1.25
Nucula hartvigiana	SC	51	1	0	1	0.08
Oligochaetes	SA	44	2	0	1	0.18
Oligochaetes	SA	45	1	0	1	0.08
Oligochaetes	SA	46	1	0	1	0.08
Oligochaetes	SA	47	1	0	1	0.08
Oligochaetes	SA	48	8	0	2	0.67
Oligochaetes	SA	49	0	0	0	0.00
Oligochaetes	SA	50	3	0	1	0.25
Oligochaetes	SA	51	0	0	0	0.00
Oligochaetes	SC	44	21	2	6	1.75
Oligochaetes	SC	45	26	2	7	2.17
Oligochaetes	SC	46	14	0	4	1.17
Oligochaetes	SC	47	28	2	10	2.33
Oligochaetes	SC	48	32	1	10	2.67
Oligochaetes	SC	49	41	3	8	3.42
Oligochaetes	SC	50	56	5	9	4.67
Oligochaetes	SC	51	16	0	9	1.33

Polydorids	SA	44	72	5	15	6.00
Polydorids	SA	45	79	6	16	6.58
Polydorids	SA	46	13	1	3	1.08
Polydorids	SA	47	21	0	17	1.75
Polydorids	SA	48	9	1	2	0.75
Polydorids	SA	49	6	0	2	0.50
Polydorids	SA	50	6	0	4	0.50
Polydorids	SA	51	4	0	3	0.33
Polydorids	SC	44	7	0	2	0.58
Polydorids	SC	45	78	4	45	6.50
Polydorids	SC	46	1	0	1	0.08
Polydorids	SC	47	2	0	2	0.17
Polydorids	SC	48	8	1	2	0.67
Polydorids	SC	49	1	0	1	0.08
Polydorids	SC	50	1	0	1	0.08
Polydorids	SC	51	8	0	6	0.67
Prionospio sp.	SA	44	8	0	3	0.64
Prionospio sp.	SA	45	10	1	3	0.83
Prionospio sp.	SA	46	1	0	1	0.08
Prionospio sp.	SA	47	2	0	1	0.17
Prionospio sp.	SA	48	8	0	3	0.67
Prionospio sp.	SA	49	4	0	3	0.33
Prionospio sp.	SA	50	1	0	1	0.08
Prionospio sp.	SA	51	4	0	1	0.33
Prionospio sp.	SC	44	5	0	2	0.42
Prionospio sp.	SC	45	10	1	3	0.83
Prionospio sp.	SC	46	3	0	1	0.25
Prionospio sp.	SC	47	2	0	1	0.17
Prionospio sp.	SC	48	8	0	3	0.67
Prionospio sp.	SC	49	3	0	2	0.25
Prionospio sp.	SC	50	6	0	2	0.50
Prionospio sp.	SC	51	7	0	3	0.58
Tawera spissa	SA	44	0	0	0	0.00
Tawera spissa	SA	45	2	0	1	0.17
Tawera spissa	SA	46	1	0	1	0.08
Tawera spissa	SA	47	0	0	0	0.00
Tawera spissa	SA	48	0	0	0	0.00
Tawera spissa	SA	49	0	0	0	0.00
Tawera spissa	SA	50	0	0	0	0.00
Tawera spissa	SA	51	3	0	1	0.25
Tawera spissa	SC	44	1	0	1	0.08
Tawera spissa	SC	45	0	0	0	0.00
Tawera spissa	SC	46	0	0	0	0.00
Tawera spissa	SC	47	0	0	0	0.00
Tawera spissa	SC	48	2	0	2	0.17
Tawera spissa	SC	49	0	0	0	0.00
Tawera spissa	SC	50	0	0	0	0.00
Tawera spissa	SC	51	4	0	1	0.33
Theora lubrica	SA	44	38	3	7	3.18
Theora lubrica	SA	45	76	6	13	6.33
Theora lubrica	SA	46	15	1	6	1.25
Theora lubrica	SA	47	17	1	4	1.42
Theora lubrica	SA	48	121	5	36	10.08
Theora lubrica	SA	49	67	5	14	5.58
Theora lubrica	SA	50	15	1	7	1.25
Theora lubrica	SA	51	0	0	0	0.00
Theora lubrica	SC	44	47	4	8	3.92
Theora lubrica	SC	45	198	14	47	16.50
Theora lubrica	SC	46	22	2	4	1.83
Theora lubrica	SC	47	37	3	8	3.08
Theora lubrica	SC	48	385	27	71	32.08
Theora lubrica	SC	49	170	13	18	14.17
Theora lubrica	SC	50	34	3	6	2.83
Theora lubrica	SC	51	15	1	4	1.25

Torridoharpinia hurleyi	SA	44	22	2	5	1.82
Torridoharpinia hurleyi	SA	45	4	0	2	0.33
Torridoharpinia hurleyi	SA	46	10	0	4	0.83
Torridoharpinia hurleyi	SA	47	56	4	12	4.67
Torridoharpinia hurleyi	SA	48	13	1	4	1.08
Torridoharpinia hurleyi	SA	49	5	0	2	0.42
Torridoharpinia hurleyi	SA	50	7	0	5	0.58
Torridoharpinia hurleyi	SA	51	23	1	5	1.92
Torridoharpinia hurleyi	SC	44	16	1	6	1.33
Torridoharpinia hurleyi	SC	45	4	0	2	0.33
Torridoharpinia hurleyi	SC	46	2	0	1	0.17
Torridoharpinia hurleyi	SC	47	11	1	3	0.92
Torridoharpinia hurleyi	SC	48	20	2	4	1.67
Torridoharpinia hurleyi	SC	49	4	0	2	0.33
Torridoharpinia hurleyi	SC	50	4	0	1	0.33
Torridoharpinia hurleyi	SC	51	43	3	11	3.58