Distribution, Abundance, and Population Structure of Cockles (*Austrovenus stutchburyi*) in Pauatahanui Inlet

Ken R. Grange

NIWA Oceanographic (NZOI)
National Institute of Water and Atmospheric Research Ltd
P.O. Box 14-901, Kilbirnie, Wellington

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CONTENTS

1. INTRODUCTION

This survey was requested by the public, represented by the Guardians of Pauatahanui Inlet, to ascertain whether the numbers, distribution, and size of cockles (*Austrovenus stutchburyi*) throughout Pauatahanui Inlet had changed over recent years.

A previous survey had been undertaken on 30 November 1976 by the New Zealand Oceanographic Institute, as part of the Pauatahanui Environmental Programme. This survey sampled the cockle population at low tide on a single day. The results have been published by Richardson *et al* (1979). This present survey was designed to occur at the same time of year so results on population structure would be comparable. Accordingly, a survey was undertaken at low tide on 21 November 1992, encompassing all major beaches and cockle habitats, but excluding the offshore sand banks.

Richardson *et al* (1979) sampled a total of 515 stations, along 77 transects, covering all expected habitats, including offshore sand banks. Each intertidal transect was sampled at 20 m intervals down the shore from high tide to the water's edge at low tide. Each sample consisted of a single quadrat 0.1 m^2 in area dug to a depth of 7 cm. The entire volume was removed, stored in a cheese cloth bag, and transported to the laboratory where cockles were counted and measured. Labels were lost from 52 stations, and results were not presented from samples at Mana Beach or the offshore sand banks, resulting in 299 stations being reported in Richardson *et al* (1979).

2. METHODS

The 1992 survey was designed slightly differently from the 1976, with replicate quadrats being sampled at each site to allow statistical estimates of the results. All cockles collected during the 1992 survey were returned to the same area after measuring to avoid the need for MAF Fisheries collecting permits.

A total of 30 transects were laid out around the inlet, covering all beaches, as shown in figure 1. Four tidal heights were identified by stakes down each transect on the days prior to 21 November, corresponding to high tide (HT), upper mid tide (UMT), lower mid tide (LMT), and low tide (LT). At each tidal height, 3 randomly placed 0.1 m^2 quadrats were dug out to a depth of 10 cm and all cockles counted and measured to the nearest 1 mm. This gave data from a set of 120 sites, and a total of 360 samples.

The data were subsequently analysed for numbers of cockles in each sample, and mean numbers of cockles at each site and tidal height, which allowed an estimate of the total population within the inlet to be calculated, and a comparison to be made with the 1976 survey.

All measurements of cockles were combined for the 3 replicates at each site and size frequency histograms plotted for each site. This allowed the population structure to be examined throughout the inlet, and the mean size of cockles to be calculated at each tidal height. The size frequency data also allowed the numbers of recruits at each site to be determined. Recruits were defined as those individuals 10 mm or less in length, following Larcombe (1971) and Richardson *et al* (1979).

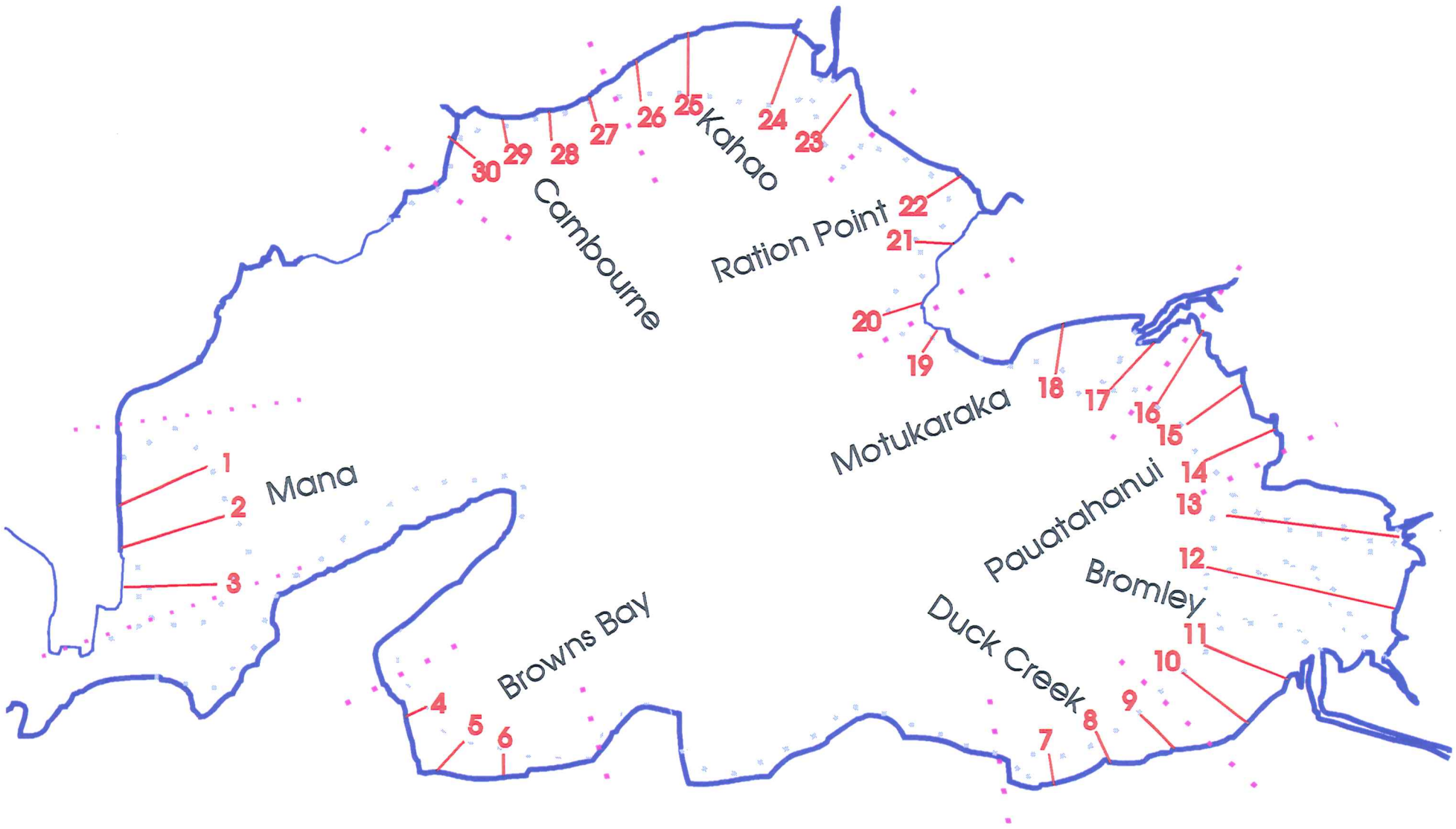


Figure 1. Pauatahanui Inlet cockle sampling sites, November 1992

3. RESULTS

3.1 Abundance

The mean abundances of cockles from each of the 3 replicate samples down each transect at all sites are presented in figure 2. There are no overall clear trends in the plots between transects, but generally there are increases in abundances from high tide (A series) to low tide (D series).

Duck Creek, Ration Point, Kahao, and Cambourne have low abundances (with the exception of one LMT site at Kahao), while numbers of cockles are high at Browns Bay, Bromley, and Pauatahanui beaches. The greatest mean abundance, around 1300 per square metre, occurred at station 17D, a LT site at Motukaraka. Cockles were recorded at every tidal height (although not every sample) on every transect.

Cockles were recorded at all tidal heights, on all beaches. However, when results from all localities are combined, there are greater numbers of cockles at lower mid-tidal and low-tidal levels than further up the beach (Fig. 3). The error bars on figure 3 indicate that high-tidal sites have significantly fewer cockles, approximately 60 per square metre. Lower mid-tidal and low-tidal sites have significantly more cockles than high-tidal or upper mid-tidal, but there is no significant difference between lower mid-tide and low tide. Both tidal levels have around 250-300 cockles per square metre, averaged over the entire inlet.

A comparison of cockle abundances throughout Pauatahanui Inlet between the 1976 and 1992 surveys is presented in table 1.

Table 1. Summary of cockle abundance in Pauatahanui Inlet, 1976 and 1992.

	1976 survey	1992 survey
Max no. per quadrat	280	168
Total no. counted	15,633 (299 quadrats)	7,976 (360 quadrats)
Mean no. per quadrat	52.3	22.2
99% confidence limits of mean	43.8-60.8	18.7-25.7
Total estimated intertidal population*	438-608 million	187-257 million

* Intertidal population based on an estimated intertidal area of 1 km^2.

Table 1 shows that both the maximum and mean numbers of cockles recorded in quadrats decreased between the two surveys. There were far fewer cockles counted in 1992 than in 1976, despite more quadrats being sampled in 1992.

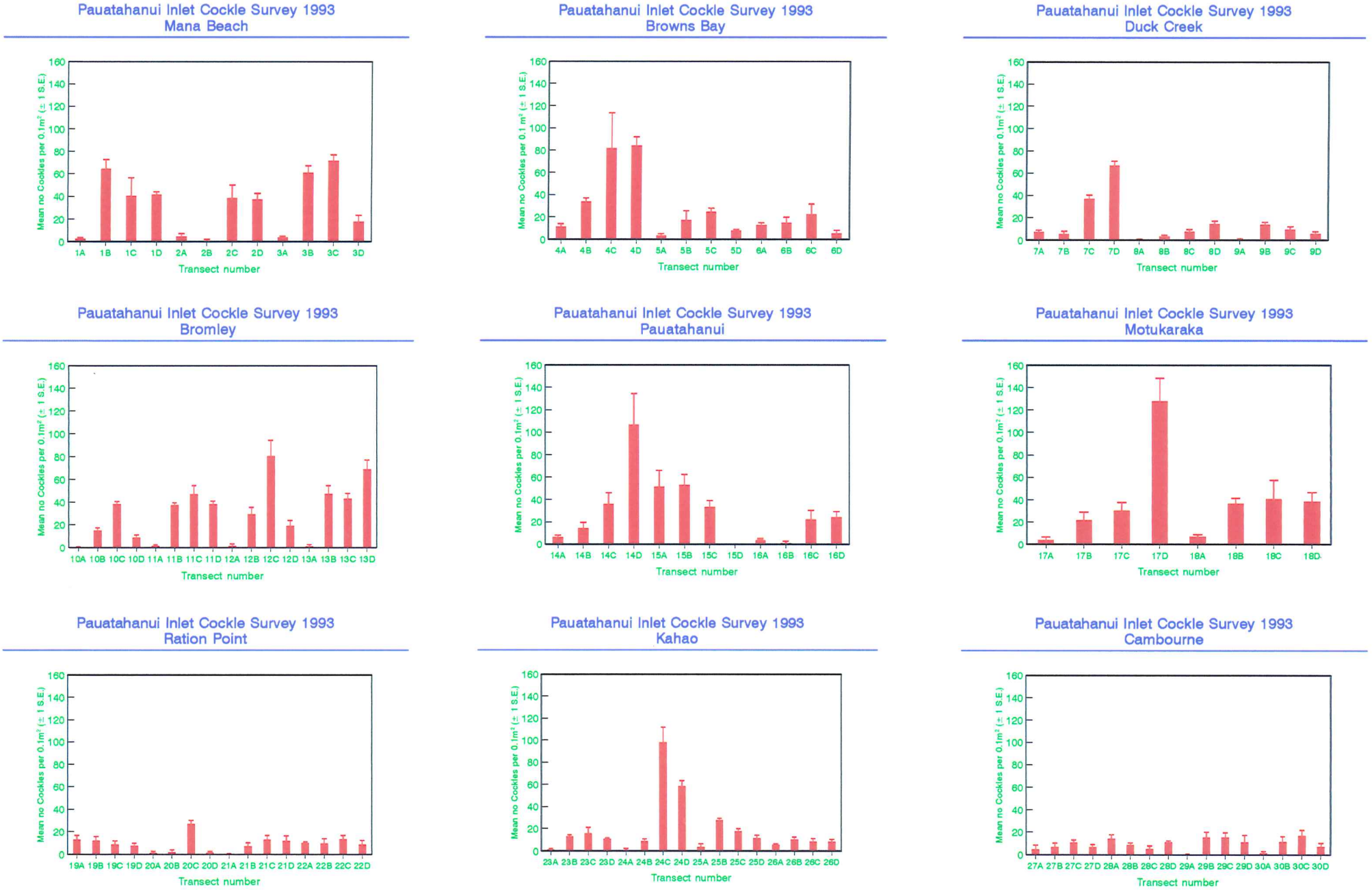


Figure 2. Mean numbers of cockles per quadrat at all transects. A = HT, B = UMT, C = LMT, D = LT.

Pauatahanui Inlet Cockle Survey 1992

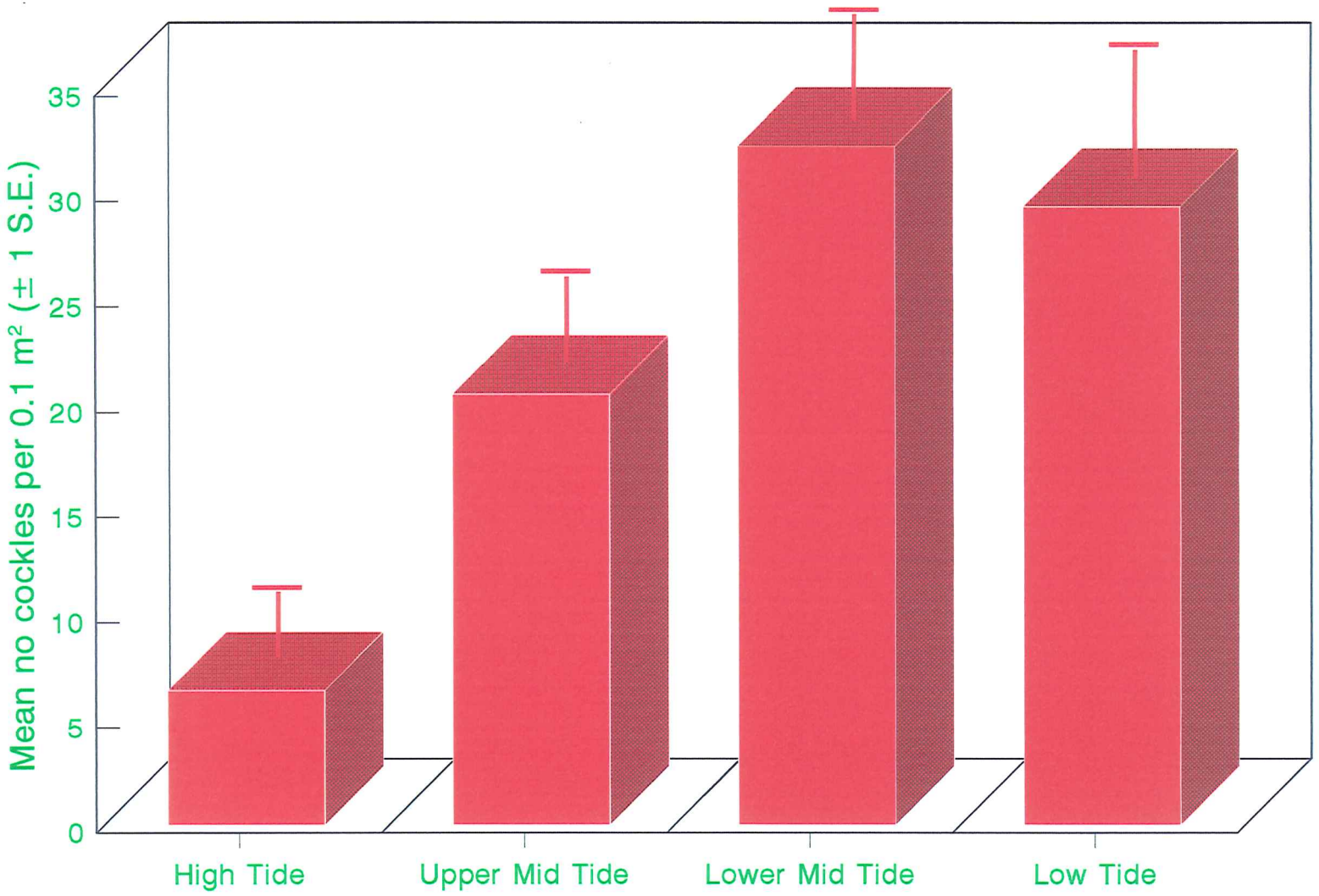


Figure 3. Distribution of cockles at each tidal height, all localities combined.

The total estimated cockle population in the intertidal area of Pauatahanui Inlet can be calculated by multiplying the mean number per 0.1 m^2 quadrat $\pm$ 99% confidence limits by the estimated intertidal area of the inlet, which is approximately 1 km^2 (Healy, 1980). This gives a population of 187-257 million, a decrease of over 50% from that estimated in the 1976 results.

3.2 Distribution within the Inlet.

The distribution of cockles at various localities around the inlet can best be determined if all results from each locality are combined. This is shown in figure 4. The maximum abundances occur near the entrance to the inlet, at Mana Beach and Browns Bay, and at the eastern end at Pauatahanui and Motukaraka beaches. There was an average of 260 cockles collected along each transect, with a maximum of almost 800 at Pauatahanui. In general, Duck Creek, Ration Point, and Cambourne beaches supported fewer cockles than average.

The estimated population of cockles throughout the inlet appears to have decreased since 1976. Whether this decrease is spread over all beaches, or in just a few specific areas can be determined from a comparison of equivalent transects from the 1976 and 1992 surveys. Those transects sampled in 1976 that appeared to be very close to those sampled in 1992 were identified from Richardson *et al* (1979) and the mean numbers compared with those recorded in 1992. The results (Fig 5) show decreases in all but four equivalent transects. Two of these four (transects 4 & 5) are at Browns Bay, one (transect 21) at Ration Point, and the transect with the largest increase (transect 24) at Kahao Beach. The largest decreases in cockle numbers (> 80%) occurred at Duck Creek (transect 9), Motukaraka (transect 16), and Kahao (transects 25 & 26). When results from each beach are combined, the numbers of cockles decreased at all, except Ration Point. The largest decreases for entire beaches occurred at Pauatahanui (72%), Motukaraka (59%) and Bromley (58%).

3.3 Population structure.

The population structure was able to be determined since all cockles collected in the samples (7,976) were measured to the nearest 1 mm before being replaced. For each locality (beach) the data from the 3 replicates at each tidal height were combined. Since the individuals living at lower tidal levels have longer to feed each tidal cycle, they may be larger or grow faster than those further up the beach. It is impractical,

Pauatahanui Inlet Cockle Survey 1992

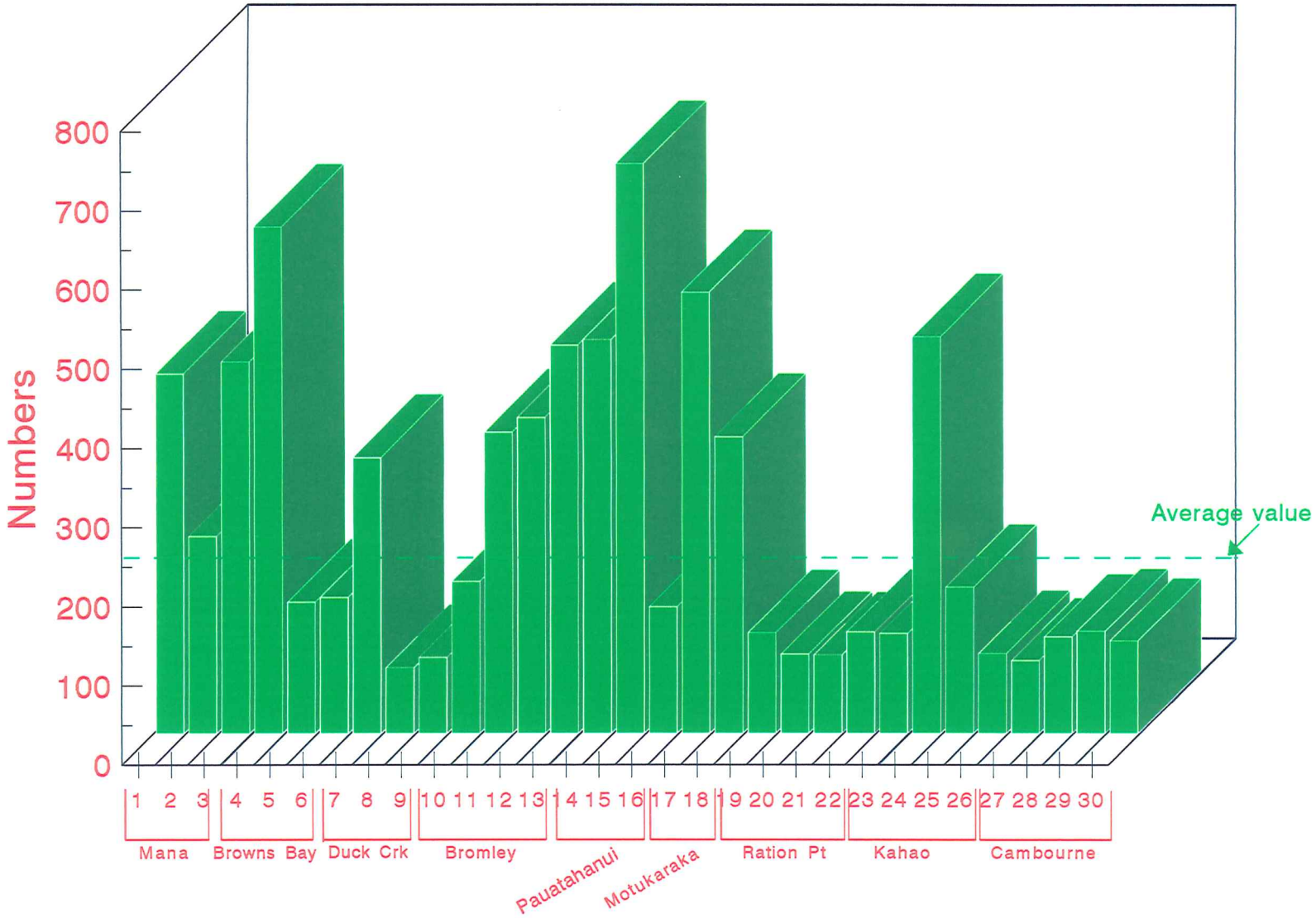


Figure 4. Total numbers of cockles collected on each transect, Nov 1992.

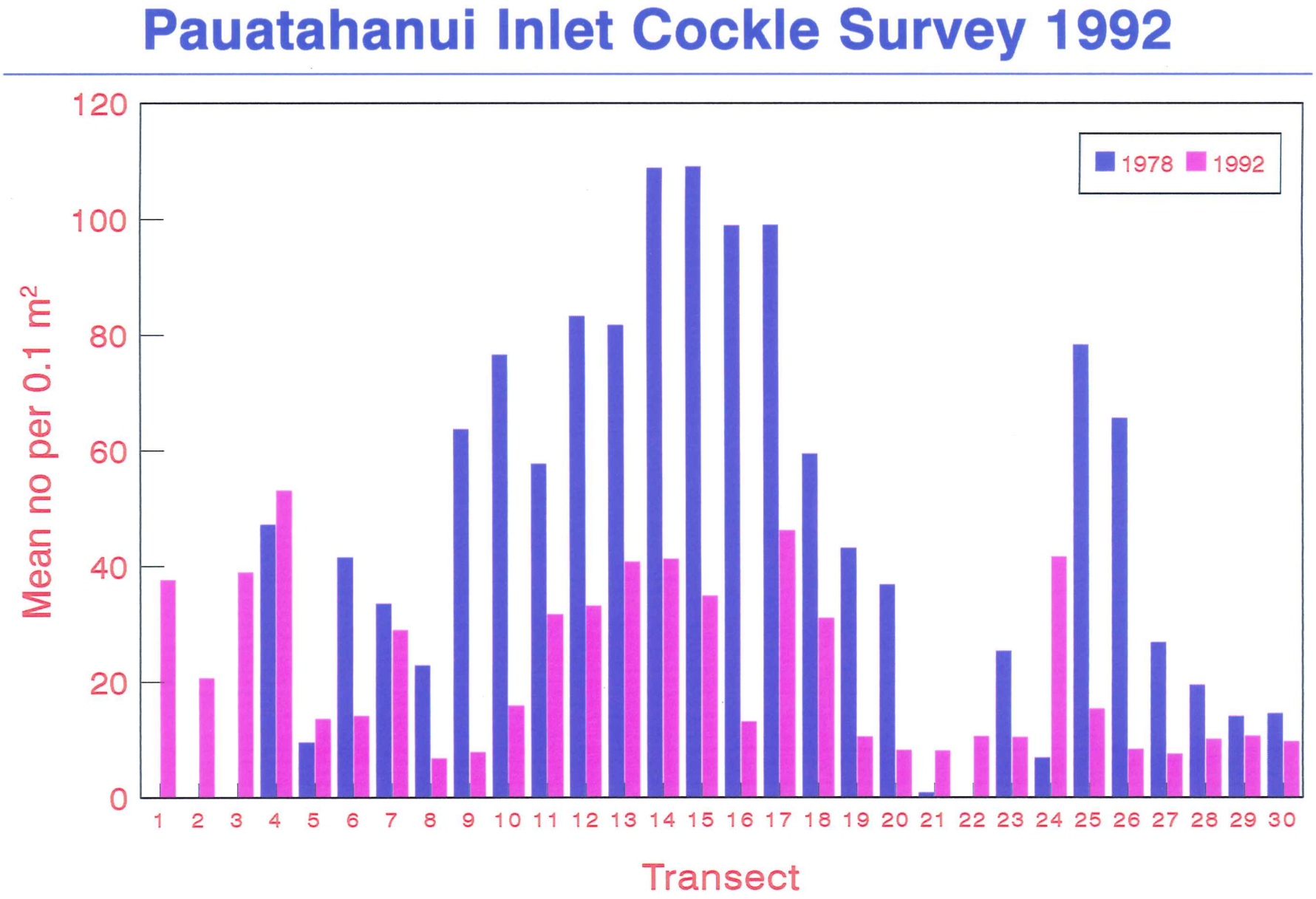


Figure 5. Comparison of mean numbers of cockles from 1978 and 1992 surveys, using equivalent transects only.

therefore, to combine data from different tidal heights, so the results are presented separately for each tidal height.

All measurements were grouped into 5 mm size classes and the numbers of individuals in each plotted as a size frequency histogram. The results are presented in figures 6-9.

High Tide Sites:

The histograms at most sites show a unimodal distribution, i.e. there are no clear separate year classes, except for a few very large individuals at Ration Point and Kahao (Fig 6). The ranges of sizes are very similar at all beaches. Juveniles (those < 10 mm) were found only at Browns Bay, Pauatahanui, and Cambourne.

Upper Mid-tide Sites:

All sites show, once again, unimodal distributions. Juveniles were found at several sites, but only in low numbers.

Lower Mid-tide Sites:

Although all sites had unimodal distributions, the spread of the histograms along the X axis was greater than further up the beaches. This reflects a wider range of sizes among the individuals.

Low Tide Sites:

These histograms are very similar in appearance to those at LMT, although numbers of very large (> 35 mm) individuals are greater. Juveniles were recorded at most sites.

The mean sizes of all cockles collected at each tidal height at each site are presented in figure 10. The plots appear to show that those localities at the eastern end of the inlet, furthest from the open coast (Bromley along to Ration Point) generally have smaller individuals at all tide levels. Individuals at Mana, Browns Bay, Duck Creek, and Cambourne are consistently larger at all tidal heights.

There is a trend for the average size of the population to increase towards low tide, irrespective of locality. This is shown in figure 11, and is consistent with a greater food supply and longer feeding times being available towards low tide.

3.4 Recruitment

The size frequency histograms allow the numbers of juveniles or recruits (those individuals less than one year old) to be calculated for each site. The histograms show that numbers of recruits, those ≤ 10 mm in length,

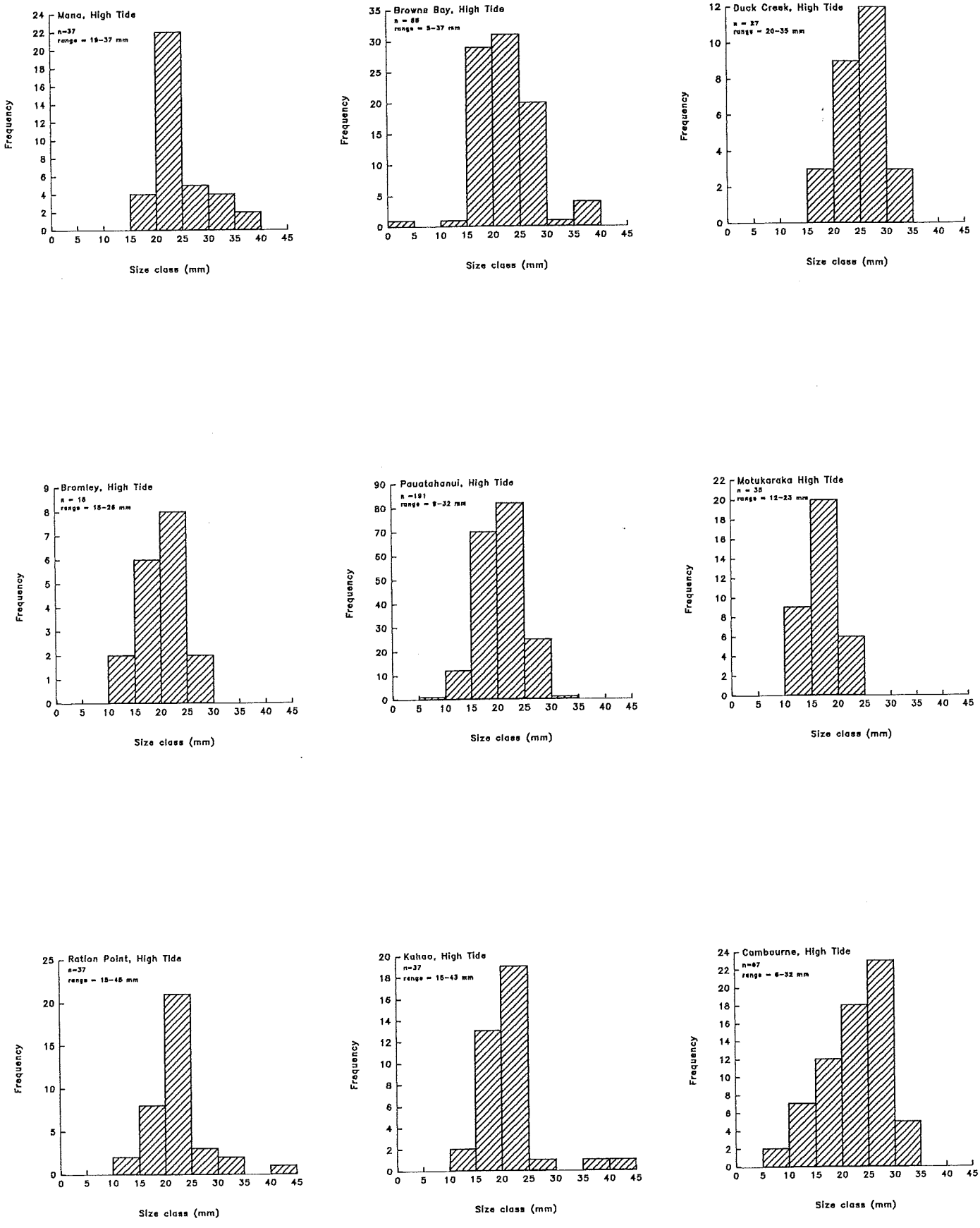


Figure 6. Size frequencies of cockles, high tidal sites, Pauatahanui Inlet, November 1992

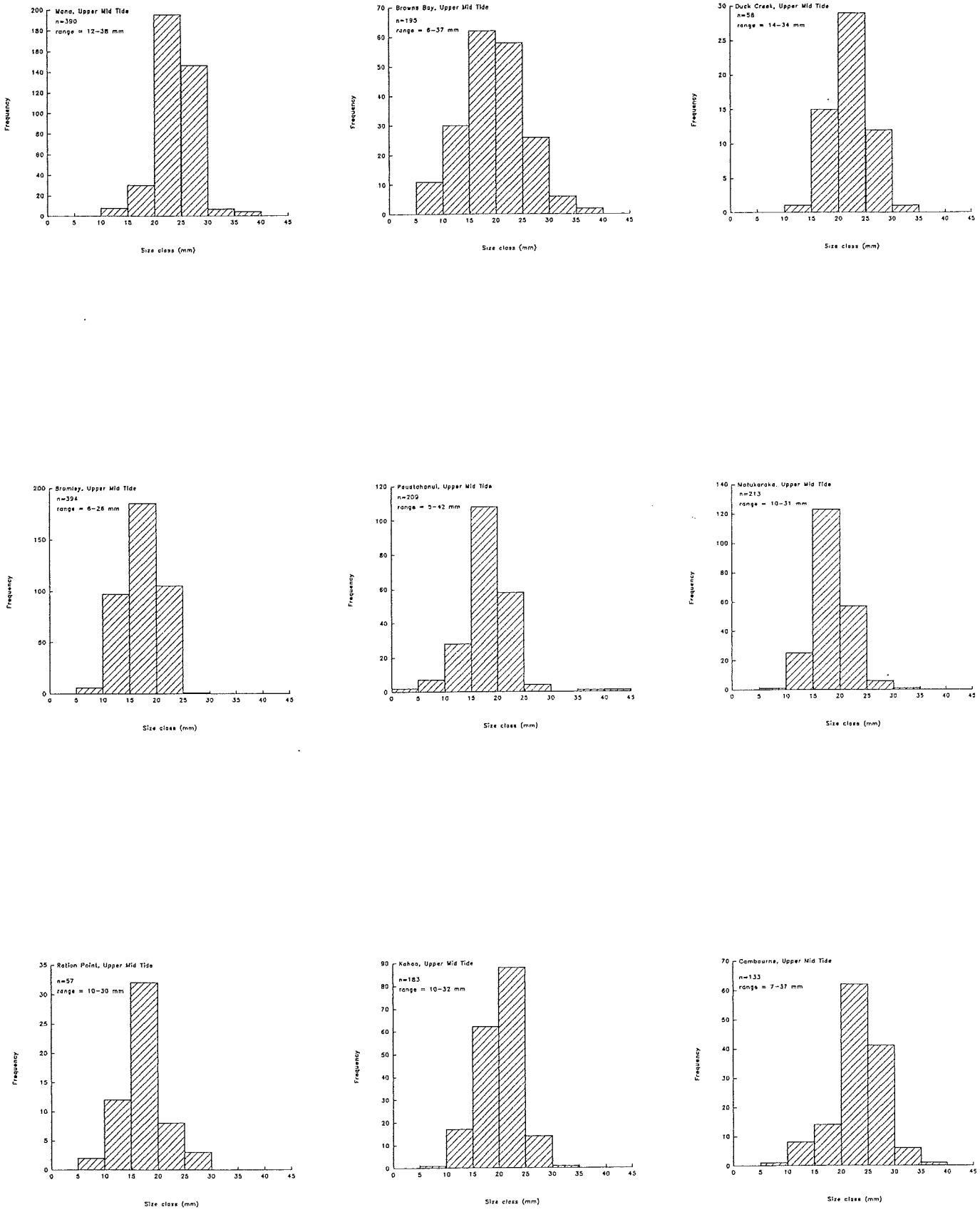


Figure 7. Size frequencies of cockles, upper mid–tidal sites, Pauatahanui Inlet, November 1992.

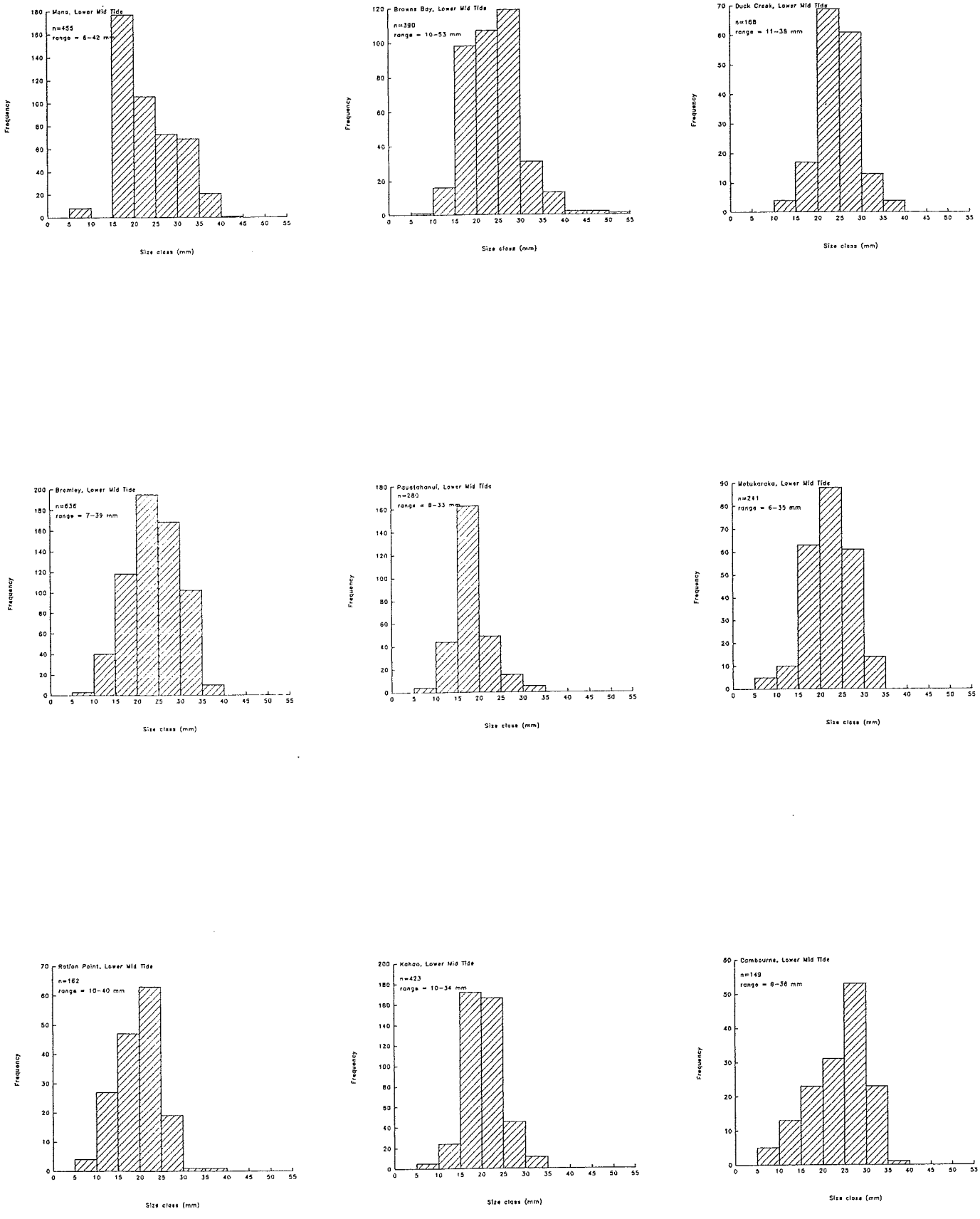


Figure 8. Size frequencies of cockles, lower mid–tidal sites, Pauatahanui Inlet, November 1992.

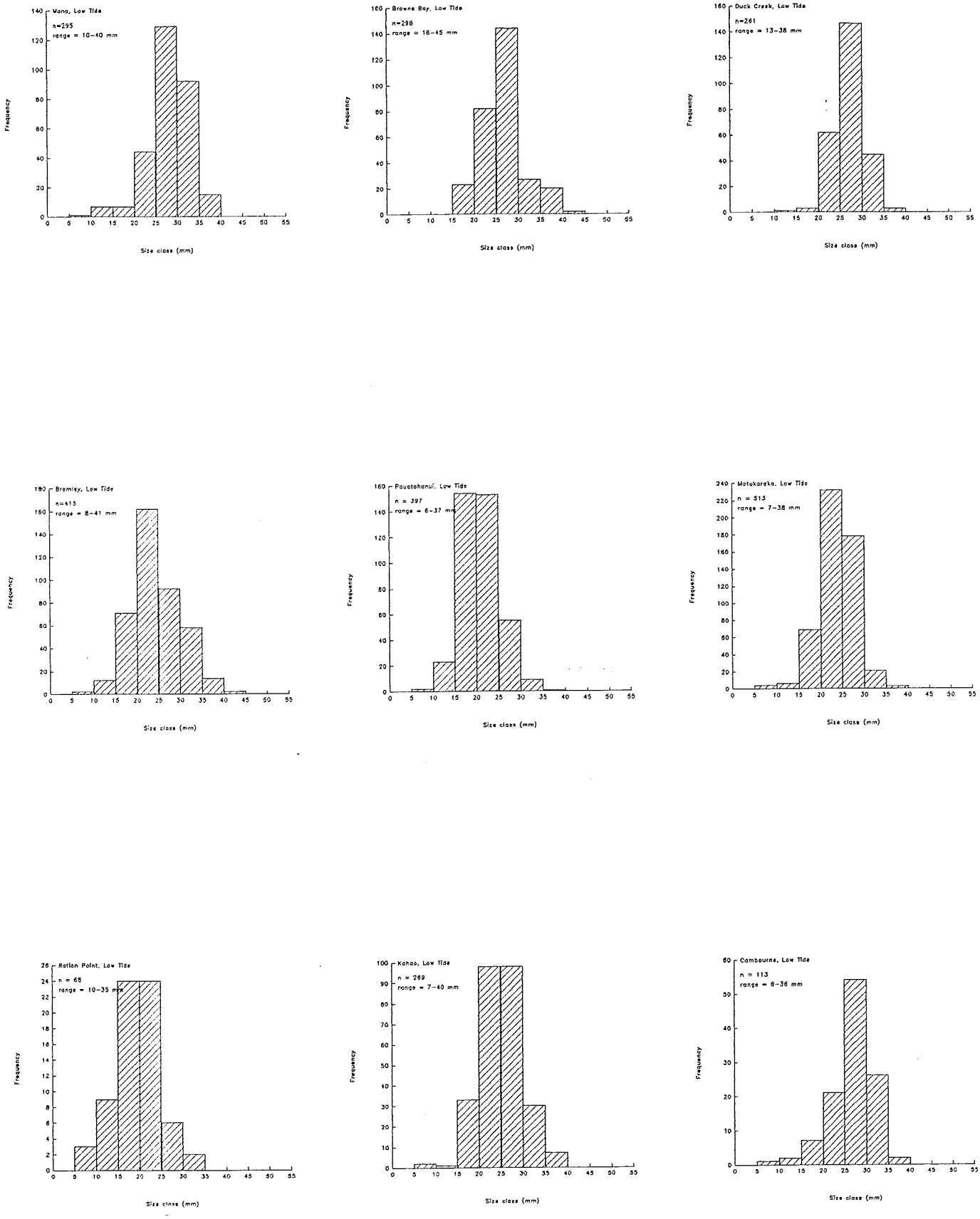
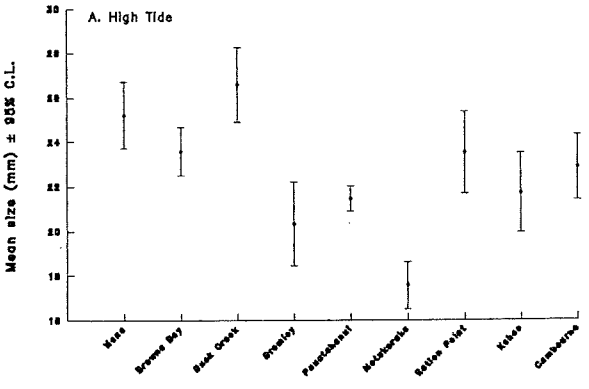
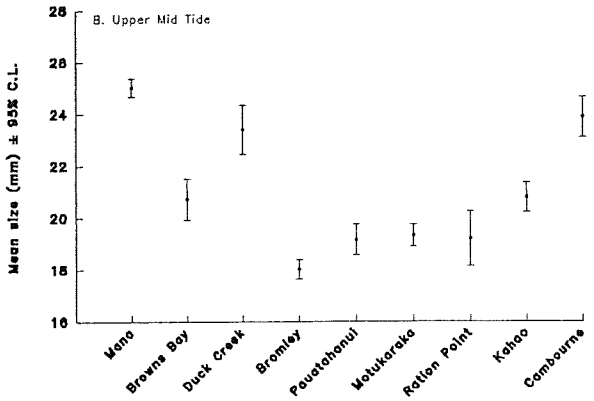
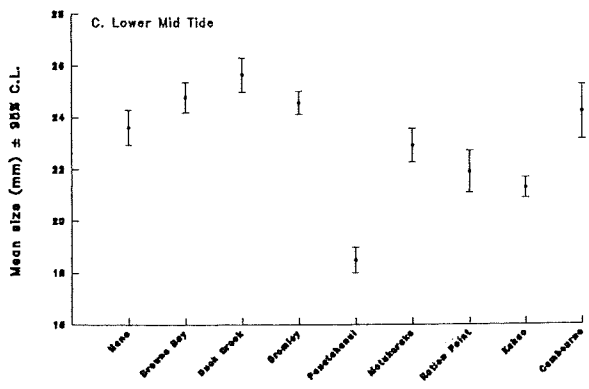


Figure 9. Size frequencies of cockles, low tidal sites, Pauatahanui Inlet, November 1992.







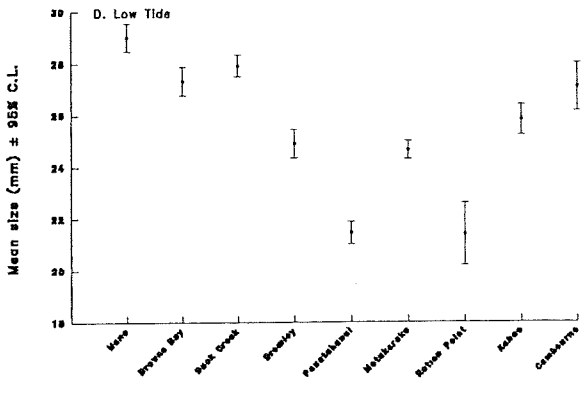


Figure 10. Mean size of cockles at each locality and tidal height. November 1992.

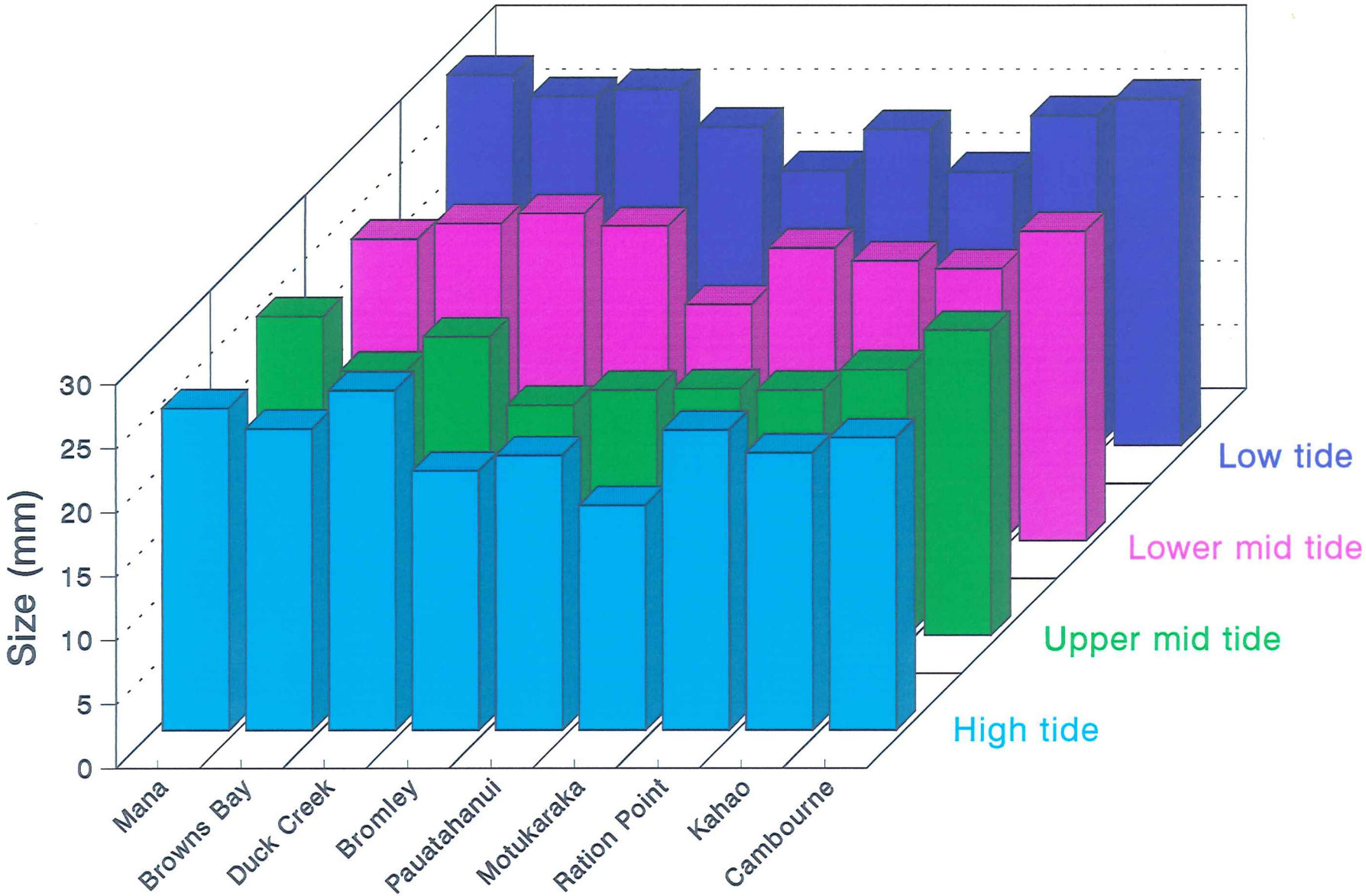
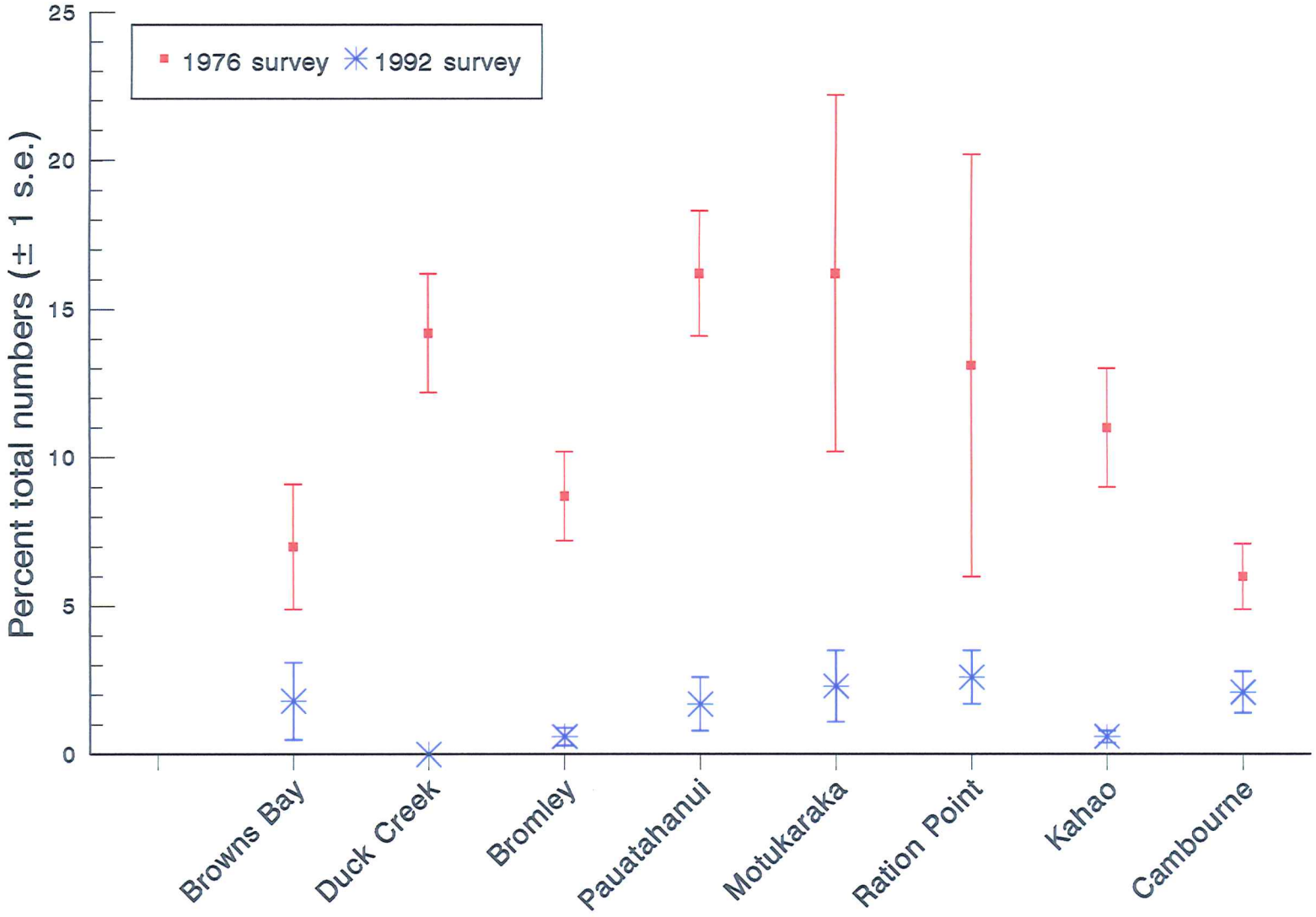


Figure 11. Mean size of cockles at each tidal height and locality, November 1992.

are low at all sites. To ascertain whether this represents a normal pattern, or at least whether it is a similar pattern to that found in 1976, the raw data from Richardson *et al* (1979) was re-analysed to calculate the percentage of recruits in the population at each locality. These results were then compared with those obtained from the present survey. The comparison between the two sampling periods is shown in figure 12.

It is obvious that numbers of recruits at all localities in 1992 are considerably less than in 1976. However, a t-test between each pair of means indicates that although the percentage of recruits is lower in 1992, the decrease is not significant at all localities. There are significant differences, however, at Duck Creek, Bromley, Pauatahanui, Motukaraka, and Kahao. No recruits at all were recorded from Duck Creek in the 1992 survey, yet in 1976 this locality was one of the best recruitment sites, with approximately 15% of the poulation under 10 mm in length. The very low numbers of small individuals at these localities may help explain the large mean size of cockles, as shown in figure 10.



Note: The means at Browns Bay, Ration Point & Cambourne are not significantly different (95% level)

Figure 12. Comparison of the numbers of cockle recruits (<10mm) from 1978 and 1992 data.

4. DISCUSSION

The cockle survey undertaken in November 1992 has provided a data set that may be used to compare several population parameters with those sampled in 1976. The data analysis methods are not equivalent, and the sample positions were not precisely at the same sites. Nevertheless, several trends are apparent, and are statistically significant.

The numbers of cockles recorded throughout the inlet were significantly less in 1992. The mean number collected from each quadrat was less, and the maximum number recorded at any one quadrat or any one site fewer. The estimate of the total population is over 50% less than in 1976. Despite the different sampling methods, this represents a significant decrease.

The decrease in abundance is most pronounced around the south-eastern shore of the inlet, and at Kahao. Reasons for the decrease are not known, as no sediment or nutrient analyses were undertaken as part of this survey. Development of the catchments in both areas has occurred recently, and reports have been received of silt washing on to the beaches. This parallels the situation in 1976, when silt from the Whitby subdivision caused widespread impacts to the marine life in Browns Bay (Grange, 1980). It is interesting to note that in this present survey, Browns Bay has a greater abundance of cockles than in 1976. The numbers of recruits is also not significantly different, indicating that this locality has recovered from the impact.

There are very few recruits throughout the entire inlet, as shown by the 1992 results. Reasons for this are unclear. The summers of 1991 and 1992 have both been colder than average, with El Nino affects. El Nino and cold summers have been implicated as a cause for a lack of successful breeding of cockles in Auckland (Prof M. C. Miller, University of Auckland, *pers. comm.*). Significant decreases in cockle recruitment show a pattern similar to the overall abundance results. Recruitment has been least successful along the south-eastern shore, and at Kahao.

The correlation between decreases in abundance and recruitment are correlated with development of catchments, including topsoil removal for housing. This does not, however, necessarily indicate a cause and effect. More data are required on whether sediments at these localities have changed, or whether other (natural) environmental changes may explain the differences.

5. REFERENCES

Grange, K.R. 1980: Intertidal Biology. Pp 108-114 *in* Healy, W.B. (Co-ord) "Pauatahanui Inlet - an envirnmental study." *DSIR Information Series 141*: 198 p.

Healy, W.B. 1980: Pauatahanui Inlet - an environmental study. *DSIR Information Series 141*: 198 p.

Larcombe, M.F. 1971: The ecology, population dynamics, and energetics of some soft shore molluscs. PhD Thesis, University of Auckland.

Richardson, J.R.; Aldridge, A.E.; Main, W.deL. 1979: Distribution of the New Zealand cockle, *Chione stutchburyi*, at Pauatahanui Inlet. *NZOI Oceanographic Field Report 14*: 10p.