1996

NIWA

Taihoro Nukurangi

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

A report prepared for

Guardians of Pauatahanui Inlet, Pauatahanui

The Guardians of Pauatahanui Inlet Incorporated acknowledge the financial assistance received from the Whitby Community Development Consortium.

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

Ken Grange, Russell Cole and Nadine Parker

National Institute of Water & Atmospheric Research
P.O. Box 893
Nelson

A Report prepared for

Guardians of Pauatahanui Inlet
C/- Post Office
PAUATAHANUI

1996/NEL60416

Table of Contents

List of Tables

List of Figures

1. Introduction

This survey was requested by Guardians of Pauatahanui Inlet, to ascertain whether the distribution, densities, and sizes of cockles (*Austrovenus stutchburyi*) throughout Pauatahanui Inlet had changed since previous surveys.

A previous survey was undertaken in 1976 by New Zealand Oceanographic Institute, as part of the Pauatahanui Environmental Programme. The results of that survey were published by Richardson *et al.* (1979). A subsequent survey was undertaken by NIWA in 1992 (Grange, 1993), with the aim of ascertaining whether there had been a change in the distribution, abundance, or population size structure since the 1976 survey. That survey showed there had been a significant decrease (> 50% decline) in numbers of cockles since 1976. The most pronounced decreases were around the south-east shores of the inlet. The results also showed that there were very few recruits (defined as individuals ≤10 mm) recorded, although reasons for these results were unclear.

This present survey, undertaken in November 1995, represents a resampling of the same sites as in 1992, with the aim of further documenting any changes or trends in the population.

2. Methods

The methodology adopted by Grange (1993) was repeated in 1995. Briefly, 30 transects were sampled at sites which included all beaches throughout the inlet (*see* Grange, 1993; Fig. 1). The same 4 tidal heights were used as in Grange (1993): high tide (HT), upper mid tide (UMT), lower mid tide (LMT), and low tide (LT). At each tidal height at each transect, 3 replicate 0.1m^2 quadrats were randomly placed, dug out to a depth of 10cm, and all cockles counted and measured to the nearest 1mm. Thus 360 samples were collected from 120 sites.

Mean densities for each site and tidal height were used to estimate the total population within the inlet, and comparisons were then made with the 1976 and 1992 surveys.

Similarly, cockle size measurements from each of the 3 replicate quadrats at each site were combined to produce an estimate of population size structure, histograms of which were compared for the various sites and tidal heights. Densities of recruits (≤10mm shell length) as in Larcombe (1971) and Richardson *et al.* (1979) were also analysed to determine whether there were changes in the patterns of recruitment.

3. Results

Mean densities at each site ranged from 0 to >140 per $0.1m^2$ (Fig. 1), with the highest densities down one transect in Browns Bay. Consistently high numbers of cockles were found at Mana and Motukaraka, while Duck Creek, Ration Point, and Cambourne had low densities. Densities at Browns Bay varied greatly among sites, with extremely high numbers occurring at site 4, and low densities at site 6. The most conspicuous trend in the data was the consistent increase in density from uppershore to lowershore sites (A to D) (Fig. 2).

There was a clear trend for a decrease in the density of cockles through time (Table 1), with present mean density being slightly more than one-third of the 1976 estimate. The maximum number of cockles recorded in any one quadrat was higher in 1995 than in 1992, but still lower than in 1976.

Table 1. Densities of cockles *Austrovenus stutchburyi* at Pauatahanui Inlet in 3 years.

	1976	1992	1995
Max. / quadrat	280	168	191
Total counted	15633[1]	7976[2]	6484[2]
Mean / quadrat	52.3	22.2	18.0
99% CL on mean	43.8-60.8	18.7-25.7	14.6-21.4
Total population estimate[3]	438-608 million	187-257 million	146-214 million

[1] Based on 299 quadrats. [2] Based on 360 quadrats. [3] Intertidal population estimated from intertidal area of $1km^2$.

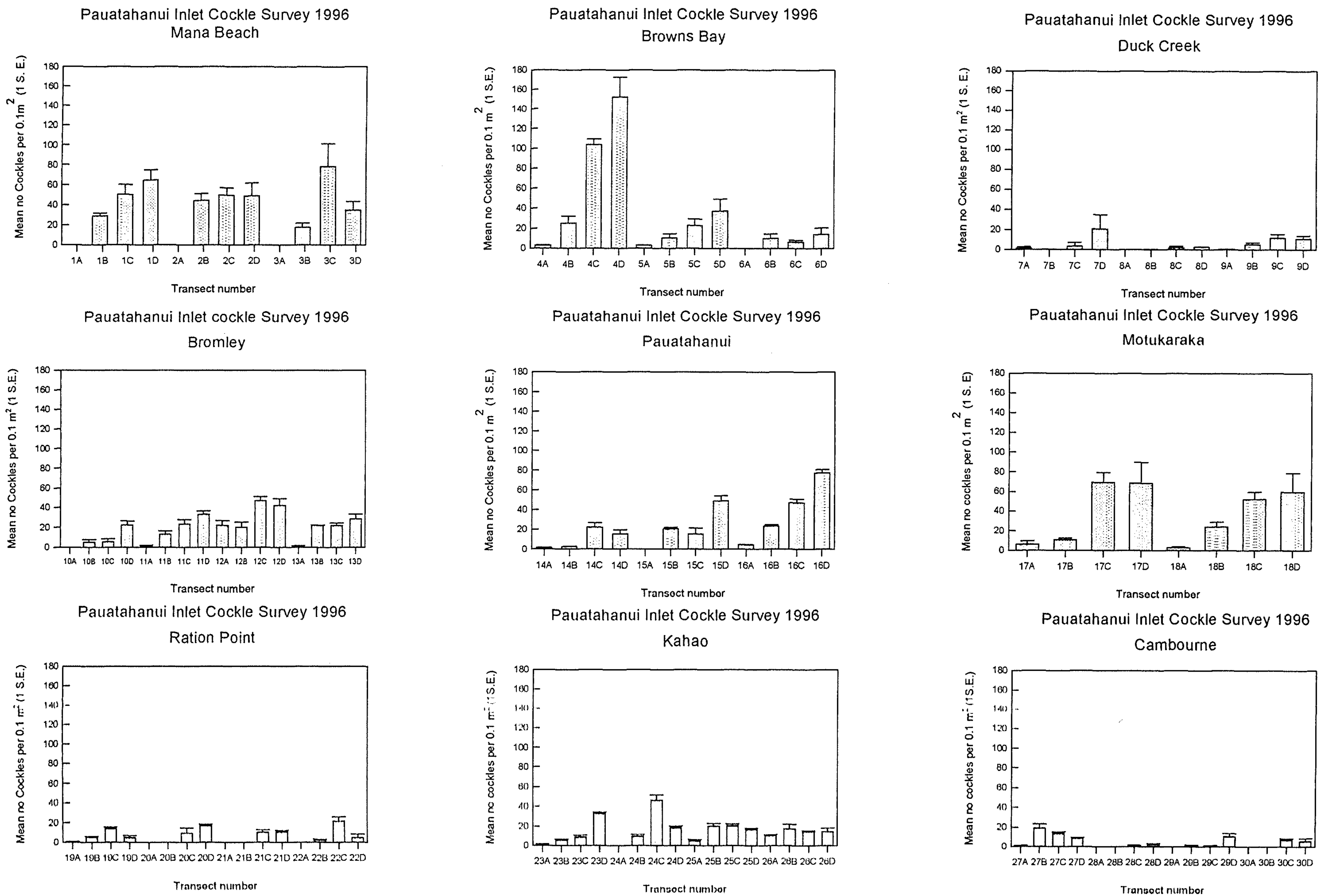

Figure 1. Mean densities of cockles at each locality, November 1995.

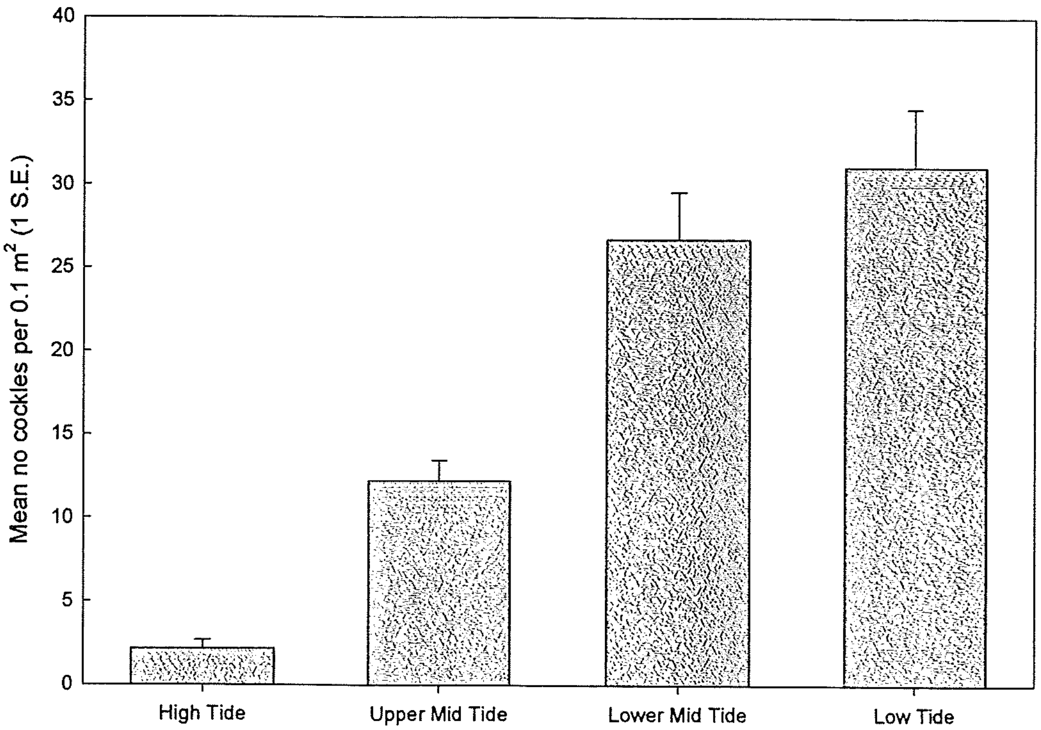

Figure 2. Distribution of cockles at each tidal height, all localities combined, November 1995.

The decrease in the total estimated population from 1976 to 1992 appears to have continued at a similar rate through to 1995 (Fig. 3).

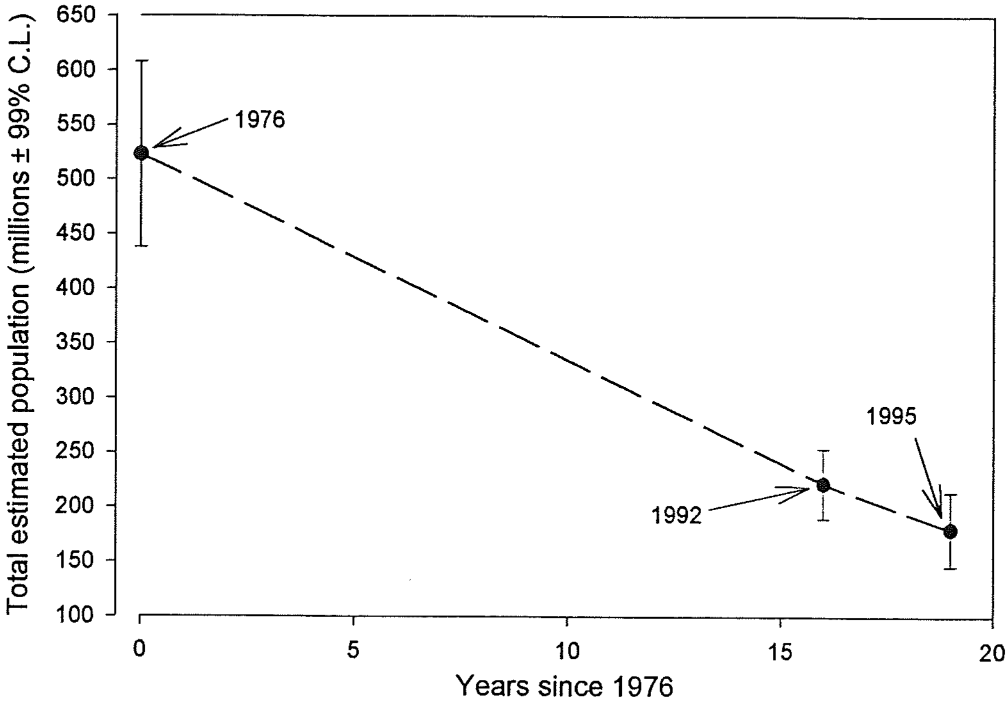

Figure 3. Decline in total cockle population 1976 to 1995, Pauatahanui Inlet

Densities were highly variable both within localities and between localities (Table 2). Variance component analysis of the 1995 data suggested greater variation among sites within localities, rather than between localities, or between replicate samples within localities (Table 2). All variances increased down the shore, parallelling the trend in the densities.

Table 2. Variance component analysis of 1995 data. Table entries are the estimates of the variance associated with the error source, with their standard errors in brackets.

	Error source		
Shore height	Localities	Sites	Replicates
HT	0.0 (0.0)	18.0 (5.1)	3.6 (0.7)
UMT	58.6 (40.9)	61.0 (21.9)	29.1 (5.3)
LMT	281.6 (218.0)	375.7 (130.0)	116.9 (21.35)
LT	325.7 (282.6)	607.3 (211.8)	216.6 (39.5)

Comparing total numbers at each site for the 3 surveys (Fig. 4), it is clear that there has been a pronounced decrease at the eastern and south-eastern shores of Pauatahanui Inlet; sites 7 to 20 have consistent decreases from 1976 to 1995. Only sites 16 and 18 (Pauatahanui/Motukaraka) had resurgences in total numbers from 1992 to 1995 within that group of sites. The largest decrease was from 1978 to 1992 for most sites, but it should be remembered that this represents a much longer time-frame than between the two most recent surveys (Fig. 3), and sites 9 - 17 show the most profound declines. At 23 of the 30 sites, the total number counted in 1995 was less than in 1993.

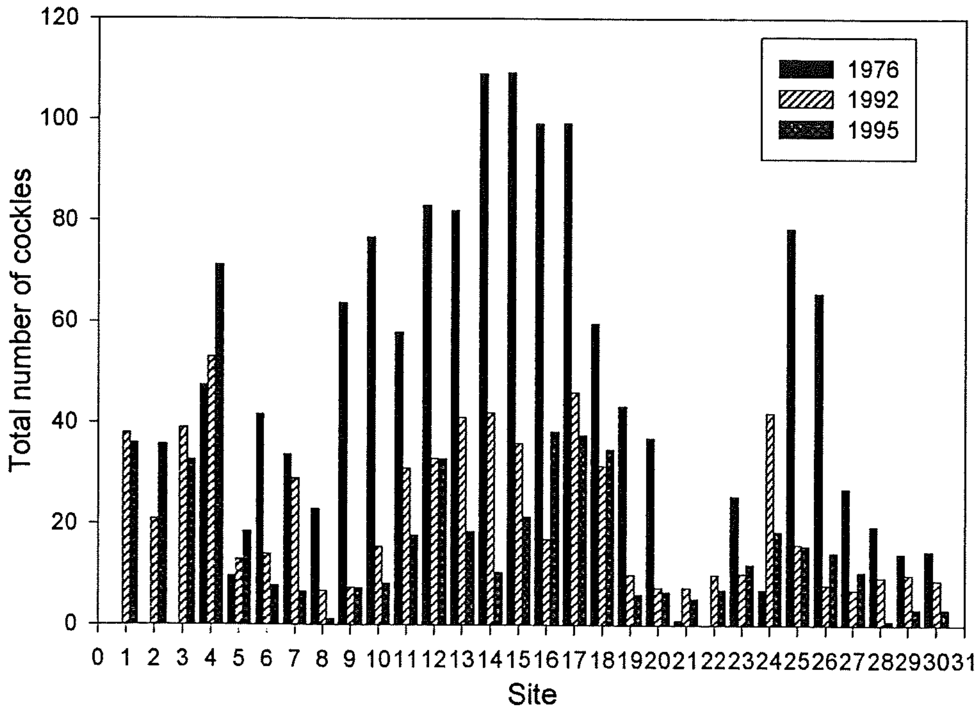

Figure 4. Total numbers of cockles at each site over the 3 sampling years, Pauatahanui Inlet.

Sites 25 to 30, along the northern shore of the Inlet, also displayed a consistent trend for a reduction in cockle abundances, with sites 25 and 26, at the Kahao locality having particularly large declines (Fig. 4). Densities at Cambourne remained low throughout the sampling period, but there were consistent decreases through time for sites 28 - 30.

Changes at Mana (Sites 1-3), which was not sampled in the initial survey, were small and inconsistent (Fig. 4). The other isolated locality, Browns Bay, was the only one at which sites consistently increased in abundance through time.

Sizes at high tide sites were not well estimated, due to the low sample sizes. Generally, populations were unimodal, with modes between 15 and 30 mm (Fig. 5). Juveniles were found only at Bromley and Kahao, which were also the 2 sites with the highest sample sizes. Largest individuals were found at Duck Creek.

Upper mid tide sites provided better sample sizes for estimating population size structure, though few cockles occurred at Duck Creek (Fig. 6). The smallest modes (15 - 20 mm size class) occurred at the Pauatahanui, Motukaraka, and Ration Point localities. Modes in the 20 - 25 mm size classes occurred at all other localities. Individuals greater than 30 mm were not abundant, and occurred at Mana, Duck Creek, Ration Point, and Kahao localities. Recruits (< 10 mm shell length) occurred at Bromley, Pauatahanui, Kahao, and Cambourne, with Pauatahanui having the greatest representation of small individuals.

At the lower mid tidal level, the Pauatahanui sites had a mode in the 15 - 20 mm size class, the Cambourne sites had a mode in the 25 - 30 mm size class, and all other localities had modes in the 20 - 25 mm size class (Fig. 7). Only Duck Creek lacked juveniles altogether, and Motukaraka had the greatest representation of juveniles. The largest cockles (up to 55 mm) occurred at Cambourne. Pauatahanui had a narrow range of sizes present, with the population being dominated by the 15 - 20 mm size class.

At the low tide level, Mana, Duck Creek, Ration Point, and Cambourne all had size modes in the 25 - 30 mm size class, while all other sites had modes in the 20 - 25 mm size class (Fig. 8). Bromley had the smallest maximum size, while Motukaraka had the greatest representation of small individuals. All sites had a broad range of sites present, but Pauatahanui again had a narrower range than the others. The largest cockles occurred at Cambourne, which also lacked recruits.

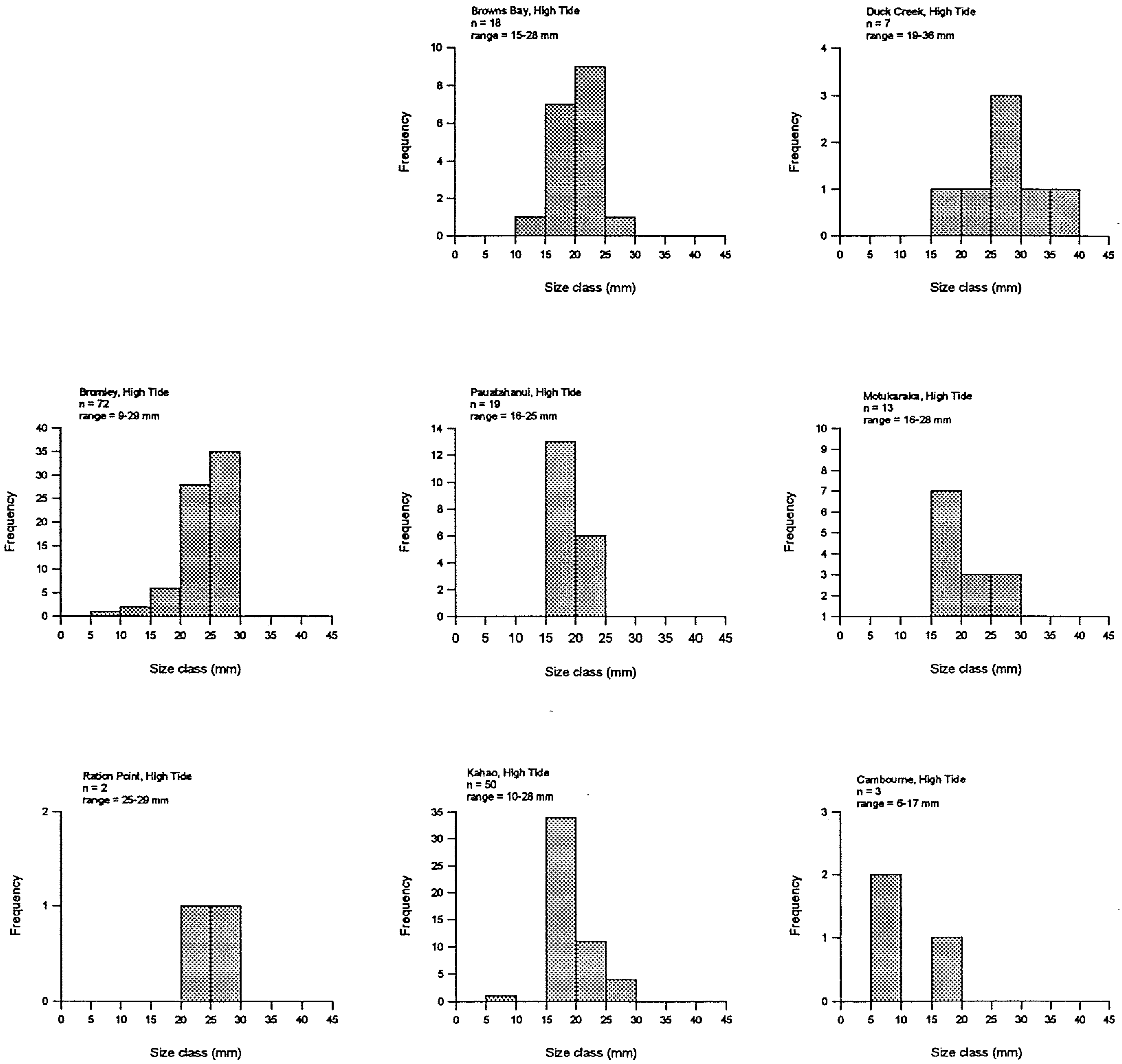

Figure 5. Size frequencies of cockles from high tide sites, Pauatahanui Inlet, November 1995.

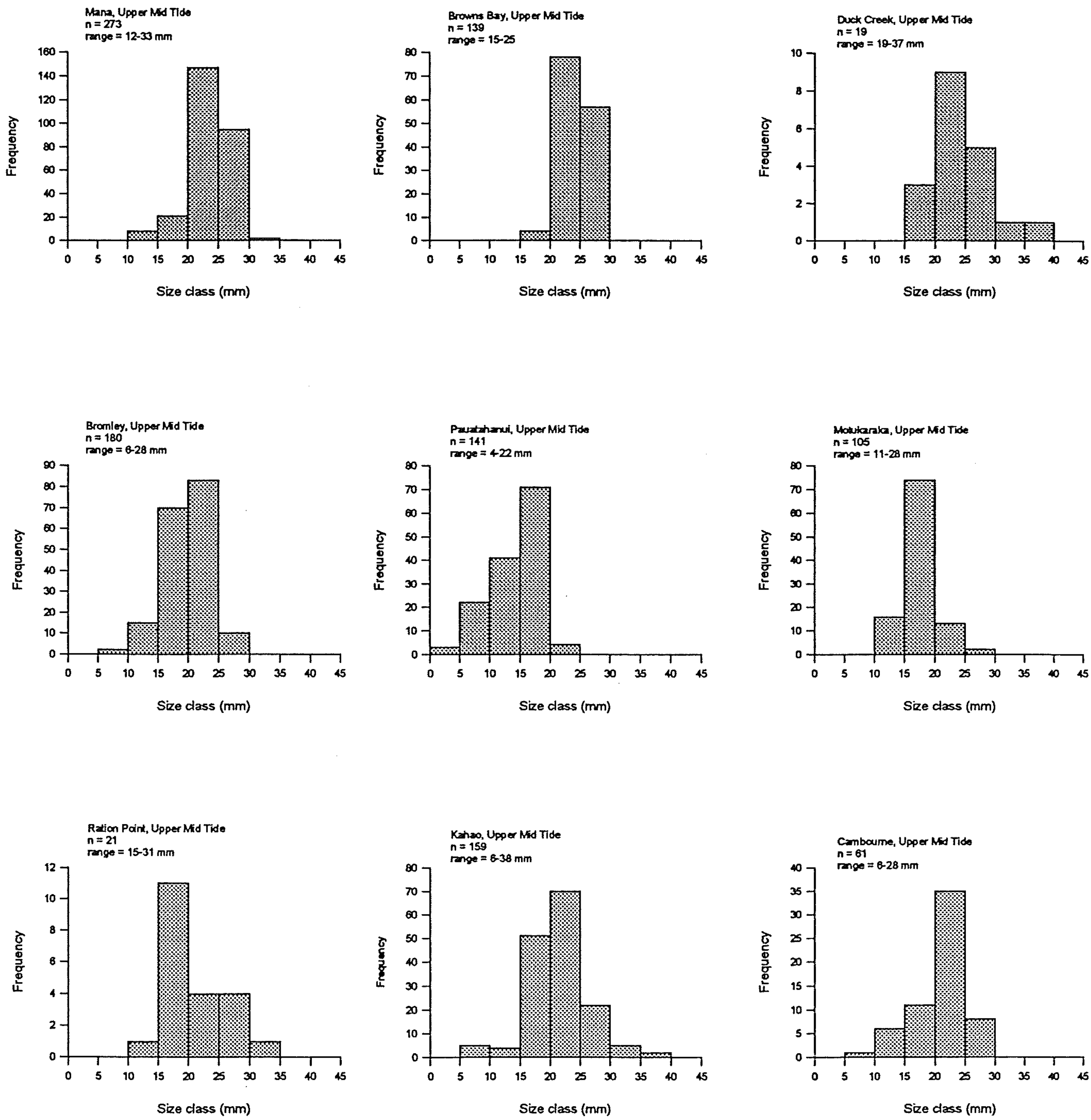

Figure 6. Size frequencies of cockles from upper mid-tide sites, Pauatahanui Inlet, November 1995.

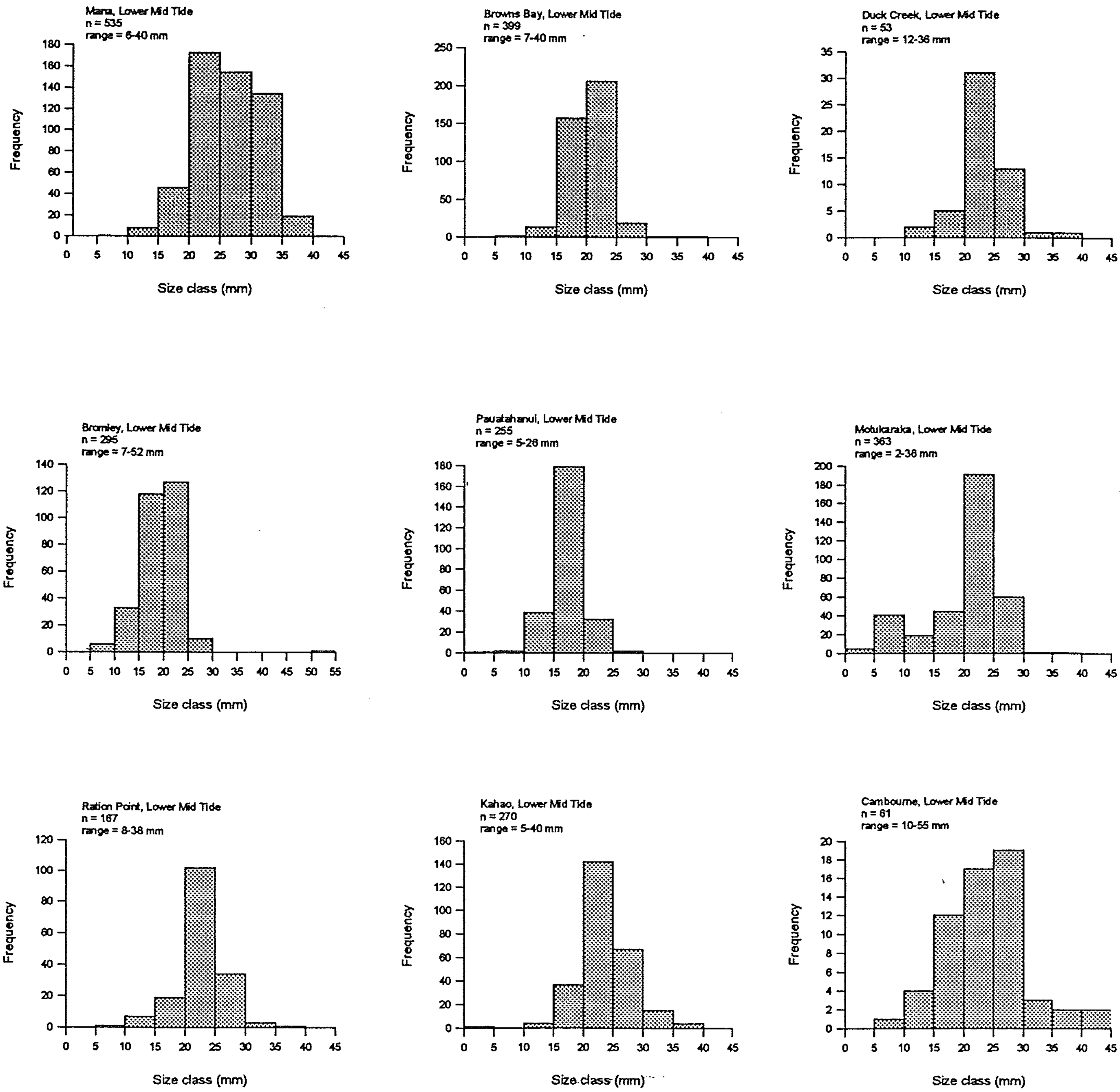

Figure 7. Size frequencies of cockles from lower mid-tide sites, Pauatahanui Inlet, November 1995.

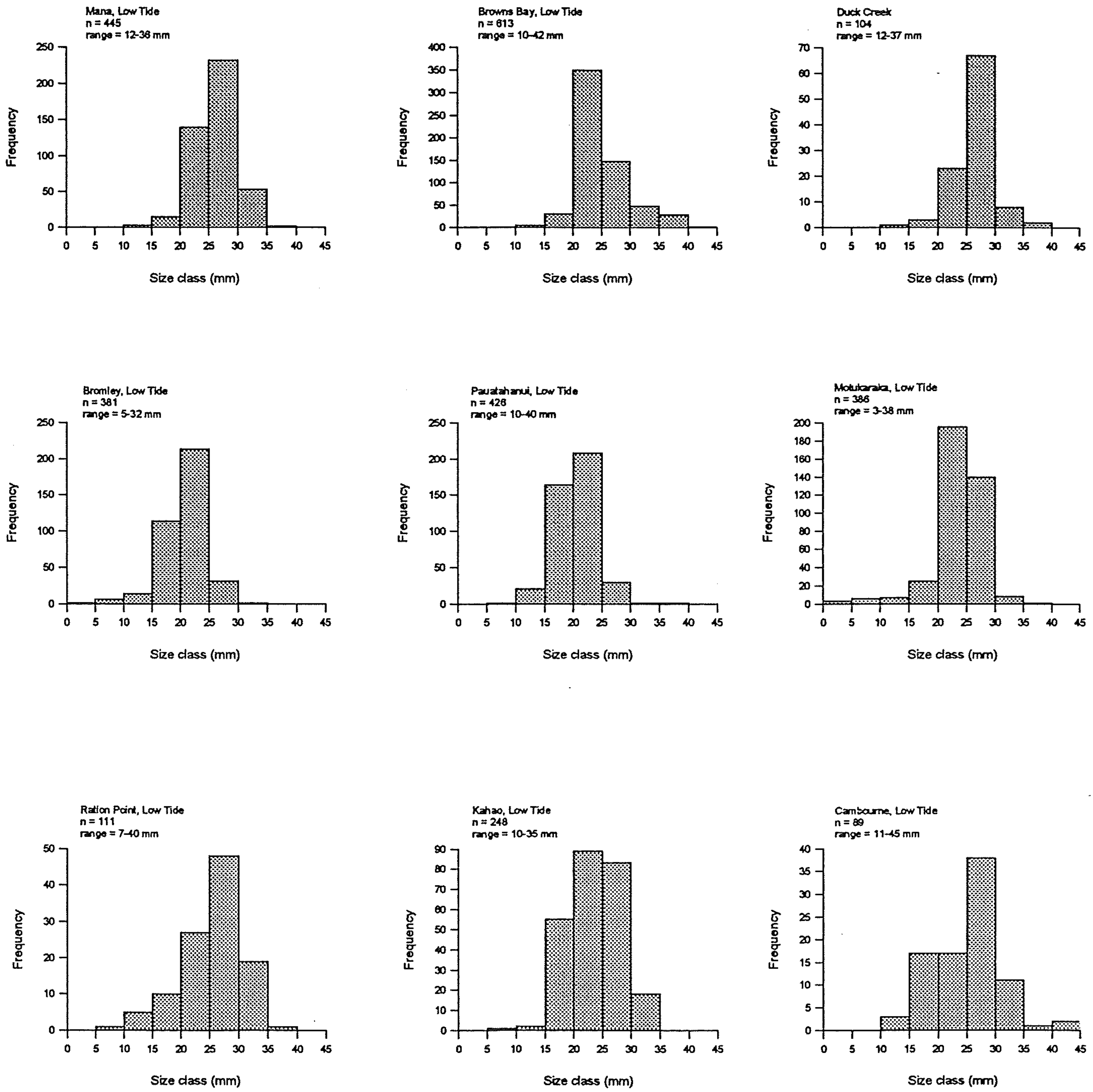

Figure 8. Size frequencies of cockles from low tide sites, Pauatahanui Inlet, November 1995.

At high tide, small sample sizes produced imprecise estimates of mean sizes (Fig. 9). Otherwise, there was a consistent trend across all tidal heights for larger mean sizes at Mana, Duck Creek, Ration Point, Kahao, and Cambourne, and smaller mean sizes at the eastern sites (Pauatahanui, Bromley, Motukaraka). There were no clear trends in size across the shore, though low-shore sites often had larger individuals than the midshore (Table 3). High shore samples frequently (Table 3: Duck Creek, Bromley, Pauatahanui, Motukaraka, Ration Point) had larger mean sizes than those lower on the shore, particularly in the midshore region. Those comparisons are rendered difficult however by the small sample sizes for upper shore sites (Fig. 5).

Table 3. Mean sizes of cockles for each shore height at each site. Frequency histograms of the data and sample sizes are presented in Figs. 5 - 8.

Site	Tidal level			
	High	**Upper Mid**	**Lower Mid**	**Low**
Mana	-	24.7	27.0	26.7
Browns Bay	21.1	20.3	21.1	25.8
Duck Creek	27.4	24.4	24.0	27.0
Bromley	24.3	20.4	19.9	21.2
Pauatahanui	19.7	14.8	18.1	21.1
Motukaraka	21.2	18.0	20.9	24.2
Ration Point	27.0	21.7	23.4	26.1
Kahao	20.4	22.2	24.9	24.6
Cambourne	10.0	21.3	25.5	26.4

A comparison of the numbers of juveniles recorded at each locality between 1993 and 1995 is shown in Fig 10. There were no clear overall trends. Four sites recorded fewer juveniles in 1995 compared with 1993 (Mana, Browns Bay, Ration Point, and Cambourne), while 3 sites recorded more (Bromley, Pauatahanui, and Motukaraka). Samples at Pauatahanui and Motukaraka showed large increases, from a total of 16 juveniles at Pauatahanui in 1993 to 29 in 1995, and from 10 to 55 at Motukaraka. These large increases caused more juveniles overall to be collected in 1995 compared with 1993 (118 to 83).

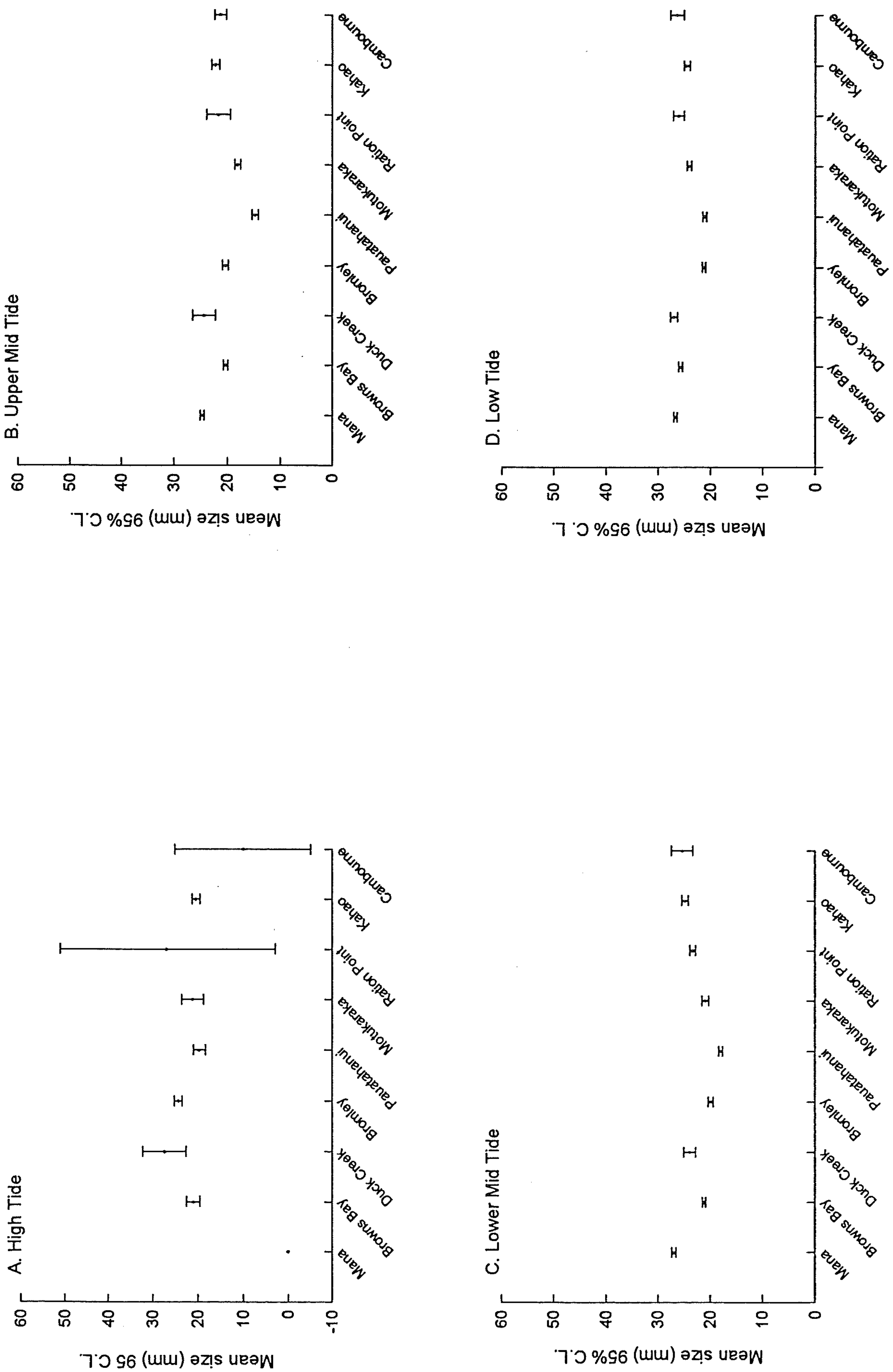

Figure 9. Mean sizes of cockles at each site and tidal height, November 1995.

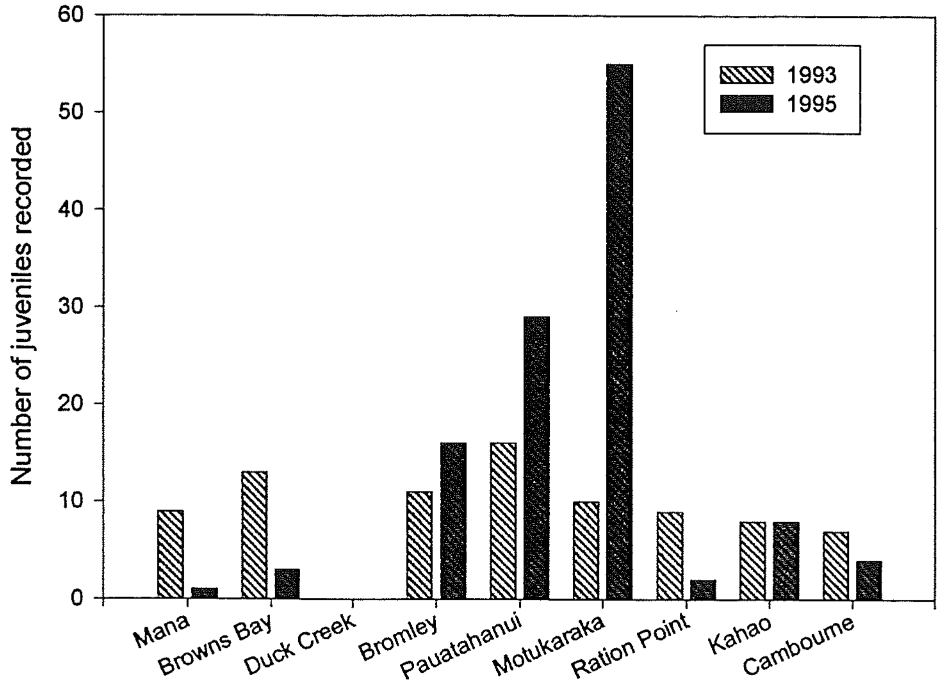

Figure 10. A comparison of the total numbers of juvenile cockles collected at each locality, Pauatahanui Inlet, between 1993 and 1995.

4. Discussion

The methods used in the 1995 survey are directly comparable with those used in the 1993 survey, and the comparison can therefore be made with more confidence than the prior one (1978 vs 1993 - Grange 1993). The evidence indicates that declines are continuing.

The 1995 estimate of total abundance is lower than the prior estimate (Grange, 1993). The estimate is about 20% lower than the 1992 survey, whereas the 1992 survey estimated a 50% decrease over the 1978 abundance. The rate of change is greater in more recent years; a 20% decrease over 3 years is a greater decline than 50% over 14 years. However, the greater overall numbers of juveniles recorded in this present survey may mean that this trend could reverse over the next few years, if settlement continues.

At Whangateau Harbour near Leigh (Cole, unpubl.), and at Otago Harbour (Dobbinson et al., 1989) there is a pattern of increasing sizes across the shore, which was not apparent in the present study. Dobbinson et al. (1989) also found increased growth rates in cockles transplanted to lower shore levels, and suggested that this was due to the increased time available for feeding, or to the depletion of phytoplankton by dense populations of cockles as the incoming tide rose up the shore (see also Peterson & Black, 1991).

The most consistent areas of decrease from 1992 to 1995 were in the Bromley and Pauatahanui areas, and of sites 10 to 15, only site 12 did not show a conspicuous decrease. Though densities were already low at site 8 and at the Cambourne locality, the proportional declines there were large. Cockle populations in most of the harbour are continuing to decline. This could result from increased mortality via natural mortality agents, or human influences. Grange (1980, 1993) suggested that populations in the Browns Bay area were recovering from silt input from the Whitby subdivision; for 2 of those sites (4, 5) that trend has continued.

Recruitment to the populations continues to be low, but it is uncertain whether this is natural or a consequence of human modifications to the environment. It may be that recruitment to these sites is naturally low, and there is a consistent trickle recruitment each year which maintains the population. Larcombe (1971) suggested late summer - autumn spawning from gonad samples of adults in the Whangateau Harbour, where Parr (1993) also caught venerid larvae from October through to June. The low densities of juveniles could occur because those involved in the survey were searching mainly for larger cockles. Individual growth rates (obtainable by tagging) could allow the population size structure data to be interpreted more clearly. The lack of distinct cohorts in the populations suggests slow growth and/or low recruitment.

The use of settlement traps (e.g. Parr, 1993) could provide information regarding the role of settlement or recruitment processes to be addressed. Low natural settlement/recruitment, in combination with a declining adult population, could lead to populations vanishing from beaches; densities are already low.

High sediment loads via runoff from nearby land could have negative effects on either adults or juveniles, though observations on the Coromandel Peninsula (D. Morrisey, NIWA Ecosystems, Hamilton) suggest that adults can survive inundation, and Dobbie (1996) found that adult cockles were able to resurface readily through 10 cm of sand. Modification of recruitment habitat via sediment addition is another possible agent of change. Correlations of densities with sediment parameters could be useful in addressing this.

5. References

Dobbie, N.J. 1996. The benthic fauna of Pine Harbour Marina. Unpubl. MSc thesis, University of Waikato.

Dobbinson, S.J., Barker, M.F., Jillett, J.B. 1989. Experimental shore level transplantation of the New Zealand cockle *Chione stutchburyi*. Journal of Shellfish Research 8: 197-212.

Grange, K. R. 1993. Distribution, abundance, and population structure of cockles (*Austrovenus stutchburyi*) in Pauatahanui Inlet. Unpubl. report to Guardians of the Inlet. NIWA Oceanographic Report 1993/11

Grange. K.R. 1980. Intertidal biology. pp. 108-114, in Healy, W. B. (ed.), "Pauatahanui Inlet - an environmental study". DSIR Information Series 141, 198pp.

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

Parr, S.W. 1993. Bivalve larvae in the Whangateau Harbour. MSc thesis, University of Auckland.

Peterson, C.H., Black, R. 1991. Preliminary evidence for progressive sestonic food depletion in incoming tide over a broad tidal sandflat. Estuarine, Coastal and Shelf Science 32: 405-413.

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, 10pp.