Taihoro Nukurangi

User Survey of Shellfish Harvesting in the Auckland Metropolitan Area

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7. Executive Summary:

The recreational intertidal shellfish harvest was estimated and harvest patterns were characterised at three beaches within the Auckland metropolitan area. Sampling was initiated at Cornwallis Beach and Mill Bay as originally intended. Sampling was not conducted at two other beaches specified by the Ministry of Fisheries: Howick Beach, and Wenderholm's data from the previous year's intertidal shellfish abundance surveys indicated that shellfish densities were low at these beaches. After detailed consultation with the Ministry of Fisheries, surveying was initiated at Okoromai Bay and Beachlands. Initial results from the Beachlands indicated that negligible shellfish harvesting was taking place and sampling was therefore terminated at the end of the summer season. After consultation with the Ministry of Fisheries, a survey was initiated at Duder's Beach, Umupuia in July 1998. Surveying at Umupuia was terminated after six months when it was discovered that the interviewer had been falsifying his data. Levels of shellfish harvesting at Umupuia are therefore not assessed. Shellfish harvest estimates and harvest patterns are therefore given for Cornwallis beach, Mill Bay and Okoromai Bay.

Estimates of the annual harvest of cockles (*Austrovenus stutchburyi*), pipi (*Paphies australis*), Pacific oysters (*Crassostrea gigas*) and scallops (*Pecten novaezelandiae*), in weight and numbers taken, are given for Cornwallis Beach and Mill Bay and for cockles at Okoromai Bay. The annual estimates of cockle harvest for all three beaches were similar to estimates of CAY calculated as part of an associated survey of intertidal resources. The current levels of cockle harvesting at the beaches studied are therefore thought to be sustainable. After this survey was completed, the daily bag limit for the Auckland Metropolitan area has been reduced from 150 cockles per person to 50. Harvest levels of pipi and scallops at Cornwallis Beach and Mill Bay are also thought to be sustainable. It is not currently possible to assess the sustainability of the other main species picked at Cornwallis Beach and Mill Bay Pacific oysters.

Estimates of harvest are also given by season and day type. Seasonal harvests patterns were species specific with the greatest harvests generally occurring in the summer and lowest harvests in the winter. Annual estimates of weekday and weekday harvests are similar for most species at Cornwallis Beach and Mill Bay although harvesting is more concentrated during the weekend due to the fewer days available. Cockle harvesting at Okoromai Bay appears to occur predominantly at the weekend. The selectivity of cockle pickers was also calculated for Cornwallis Beach, Mill Bay and Okoromai Bay.

8. Introduction

There is widespread public concern in Auckland that overfishing by amateurs has caused declines in the abundance of many intertidal shellfish. Previous work (Drey & Hartill 1993) has shown that most pickers take predominantly soft-shore bivalves such as pipi and cockles, although a variety of other species such as Pacific oysters and crabs are taken. The numbers of shellfish taken occasionally exceed amateur bag limits. This study was carried out on behalf of the Ministry of Fisheries to meet the following objective:

"To estimate the annual harvest of pipi, cockle, and tuatua and characterise the overall pattern of harvest from 1 December 1997 to 30 November 1998 at the following four beaches within the Auckland metropolitan area: Cornwallis Beach, Mill Bay, Howick Beach, and Wenderholm."

Sampling was initiated at Cornwallis Beach and Mill Bay as specified in the objective. Sampling was not conducted at two other beaches specified by the Ministry of Fisheries: Howick Beach, and Wenderholm's data from the previous year's intertidal shellfish abundance surveys indicated that shellfish densities were low at these beaches. After detailed consultation with the Ministry of Fisheries, surveying was initiated at Okoromai Bay and Beachlands. Initial results from the Beachlands indicated that negligible shellfish harvesting was taking place and sampling was therefore terminated at the end of the summer season. After consultation with the Ministry of Fisheries, a survey was initiated at Duder's Beach, Umupuia in July 1998. After six months of surveying at Umupuia it was discovered that the interviewer had been falsifying his data and the survey was terminated. Levels of shellfish harvesting at Umupuia are therefore not assessed. Shellfish harvest estimates and harvest patterns are therefore given for Cornwallis beach, Mill Bay and Okoromai Bay. Harvest estimates are compared with estimates of population size and yield estimates given in Morrison *et al.* 1999.

9. Methods and results

9.1 Estimation of annual harvest

The recreational intertidal shellfish harvest was estimated and harvest patterns were characterised at three beaches within the Auckland metropolitan area (Figure 1). Sampling was initiated at Cornwallis Beach and Mill Bay as originally intended in December 1997. Sampling was not conducted at two other beaches specified by the Ministry of Fisheries, Howick Beach, and Wenderholm because data from the previous year's intertidal shellfish abundance surveys indicated that shellfish densities were very low at these beaches. After detailed consultation with the Ministry of Fisheries, surveying was initiated at Beachlands in December 1997 and Okoromai Bay in January 1998. Initial results from the Beachlands indicated that negligible shellfish harvesting was taking place and sampling was therefore terminated at the end of the summer season. Following further consultation with the Ministry of Fisheries, a survey was initiated at Duder's Beach, Umupuia in July 1998. This survey was terminated after six months when it was discovered that the interviewer had falsified data. Data relating to Duder's Beach, Umupuia are therefore not analysed.

Copies of the forms used in the survey are included in Appendix 4.

A stratified random approach was used to estimate the annual harvest and picking patterns of key bivalve species. The year was divided up into four 3-month seasonal strata which were further divided into two day-type strata, weekday and weekend, the latter including public holidays. Within each of these season/day-type strata, eight sample days were randomly allocated, with each day comprising a sampling unit. Because there were 248 weekdays and 117 weekend/public holidays in a year, weekdays were sampled at a lower intensity, approximately 13% as opposed to 27% for weekend/public holidays. Eight days sampling within each of the eight season/day-type strata resulted in a sampling intensity of 17.5% overall, given the 64 days sampled. Beaches were also divided into between 3 to 6 spatial strata, depending on the area of accessible shoreline. The beaches and their spatial strata are shown in Figures 2 to 5.

The harvest C, within each season/day-type/spatial stratum was estimated by combining effort E, defined as the number of hours picked, and catch per unit effort R, defined as the number of shellfish picked per hour.

$$C = E \times R$$

9.2 Effort

As intertidal shellfish harvesting generally takes place during low tide, interviewers sampled only two hours on either side of low tide, although sampling was conducted over a longer period for exceptionally low tides when shellfish harvesting was still possible. All of the interviewers used lived within sight of the beaches surveyed and were therefore able to determine when picking could potentially start. Interviewers also remained on the beach later than two hours after low tide when picking was still taking place. It is still possible however that a small amount of picking may have occurred outside of survey hours. When low tides occurred at both dawn and dusk, sampling was conducted during all daylight hours on either side of both tides except early hours prior to 7am. All daylight hours at least two hours on either side of low tide were therefore sampled on randomly predetermined days within each season/day-type strata (Table 1).

A modification of an aerial-access survey (*sensu* Pollock *et al.* 1994), was used to estimate recreational fishing effort. Instantaneous counts of recreational fishers picking shellfish were made hourly by strategically-placed ground-based observers. Counts of people actually involved in picking shellfish were taken at a pre-determined random time within each 1 hour block on either side of predicted low tide at each site. Picking effort was variable at all beaches studied (Figure 6). Picking effort appears to take place throughout the low tide with most picking occurring within two and a half hours of low tide.

Picking effort was also variable with respect to the height of low tide (Figure 7). As days were selected at random with respect to season and day type, the influence of daily low tide height was not considered in the original design. As most shellfish harvested are readily available at most daily low tidal heights, the influence of tidal height is thought to have little impact on the harvest of most species including those specified in the study's objective. A major exception to this is scallops. Spring low tides are often targeted by scallop pickers to increase the chances of detecting what is usually a subtidal species. The relatively low proportion of spring tides sampled during the year, coupled with the length of the scallop season, may have resulted in poor estimates of scallop picking effort and hence harvest. Caution should therefore be used when using these estimates.

When the picker's harvest was not visible/hidden the interviewer had no option but to estimate that harvest. The estimate was based on the interviewer's observation of that pickers harvesting activity and what was carried off the beach.

Table 1: **Number of hours surveyed and number of pickers interviewed at Cornwallis Beach, Mill Bay, and Okoromai Bay by season and day type**

Beach	Season	Day type	Number of days surveyed	Number of hours surveyed	Number of of pickers interviewed
Cornwallis Beach	Summer	Weekday	8	34	74
		Weekend	8	33	217
	Autumn	Weekday	8	30	12
		Weekend	8	34	85
	Winter	Weekday	8	29	40
		Weekend	8	31	84
	Spring	Weekday	8	31	72
		Weekend	8	30	143
Mill Bay	Summer	Weekday	8	36	57
		Weekend	8	35	204
	Autumn	Weekday	8	30	20
		Weekend	8	38	86
	Winter	Weekday	8	28	13
		Weekend	8	30	51
	Spring	Weekday	8	32	28
		Weekend	8	32	141
Okoromai Bay	Summer	Weekday	8	31	58
		Weekend	8	32	364
	Autumn	Weekday	8	32	1
		Weekend	8	30	66
	Winter	Weekday	8	31	11
		Weekend	8	32	148
	Spring	Weekday	8	32	23
		Weekend	8	32	244

Hourly counts were made for each spatial stratum and mean daily picking effort was estimated for each spatial stratum as follows:

$$\hat{e}_i = \bar{I}_i \times T_i$$

Where $\hat{e}_i$ is the mean daily picking effort, $\bar{I}_i$ is the average of the instantaneous count of harvesters for each day, and T_i is the size of (number of hours in) stratum i. Because hourly counts of picking effort were made from strategic points along the shoreline it was not possible to determine accurately the species catch associated with that effort. The mean daily picking effort was therefore apportioned by species using interview data. As part of the interviews discussed in the next section, pickers were asked what species were picked and how much picking effort was associated with each species picked. Within each season/day-type/spatial stratum the total hours spent picking a species was divided by the total hours spent picking by all species.

$$P_{ij} = \frac{L_{ij}}{\sum_{j=1}^{n} L_{ij}}$$

Where P_{ij} is the proportion of hours spent picking a species j, and L_{ij} is the total effort in season/day-type/spatial stratum i spent picking species j derived from all interviews. This proportion, which was calculated across all days sampled within the stratum, was applied to the random hourly counts of the number of pickers.

The picking effort from a given group of strata, including for the whole period of interest for a given species j was estimated using:

$$\hat{E}_{ij} = \sum_{i=1}^{n} \frac{\hat{e}_i P_{ij}}{\pi_i}$$

Where $\hat{E}_{ij}$ is the estimated total fishing effort for a given species j, and π_i is the probability of the sample days occurring during a season/day-type strata i.

9.3 Catch per unit Effort

Between making counts of pickers, staff interviewed pickers to estimate catch rates for completed trips. Pickers leaving the beach were randomly selected and approached and, with their permission, interviewed to determine the start and finish times of their picking, and details of the harvest. When the number of pickers at a beach was low, it was possible to interview all pickers. This was usually the case. Random subsamples of about 20 of each species picked were measured to the nearest millimeter using vernier calipers, and the aggregate weight of all shellfish of that species was weighed by the interviewer using a spring balance. While it is possible that the presence of the interviewers may have influenced pickers behavior it is not possible to determine the extent of this influence. Interviewers only approached pickers as they left the beach and did not wear a uniform,

On occasion pickers refused to be interviewed for reasons which could not be determined at the time. It was recognised that the harvesting habits of pickers who refused to be interviewed may not be the same as those of pickers who agreed to be interviewed. Before interviews were conducted therefore an estimate of the weight of each species harvested was made by the interviewer. For completed interviews, both estimated and actual weights were recorded while, for refused interviews, only the estimated harvest was available. For each interviewer, a relationship was calculated between estimated and actual weights, and these relationships were used to correct bias associated estimated weights where the actual weight was not measured. It was necessary to use estimated weights for 9% of the interviews. Any bias due to poor estimation of harvest weights is therefore thought to have little influence on shellfish harvest estimates.

During the study it was noted that the weight of a bag limit of scallops was usually twice that expected using the length weight relationship given in Table 2. Spring balances and their interpretation by interviewers were checked and found to give reliable estimates of weight. It was therefore concluded that high estimates of harvest weight were due to retention of water by scallops which were usually weighed soon after harvest. A sample of 50 harvests of scallops were both weighed and counted and measured. The length frequencies of these samples were converted to weights and a relationship was calculated for converting the measured weight of a harvest to that predicted from the length frequency relationship (Figure 8).

predicted weight = 0.8144* measured weight - 0.1375

Water retention by cockles was also investigated but there was no apparent change in sample weights two hours after picking.

Harvest was also estimated in terms of numbers of shellfish taken. The lengths of the 20 randomly selected shellfish were converted using length weight relationships taken from other studies, or when no appropriate relationship was available, one was determined for the purposes of this study (Table 2, Figures 9 & 10).

Table 2: **Parameters used to derive weight from length measurements**

Weight = a (length)^b (weight in g, length in cm)

Species	a	b	Source
Cockle	0.00037	3.026	This FARD
Pacific oyster	0.04477	1.525	This FARD
Pipi	0.00003	3.315	Hooker (1995)
Scallop	0.00042	2.662	Cryer & Parkinson (1999)

The ratio of the total harvest weight to that of the measured subsample was then used to scale up the length frequency distribution of the subsample. When it was not possible to measure a random subsample as part of an interview, the average weight of all other shellfish of that species measured at that beach was used to convert harvest weights to numbers caught.

Harvest weights were converted to numbers for cockles, Pacific oysters, pipi and scallops because these were considered key species given the observed level of harvest (Table 3), or in the case of pipi its specification in the study's objectives.

Table 3: **Number of pickers interviewed, average hours picked and average harvest of species picked at Cornwallis Beach, Mill Bay and Okoromai Bay**

Location	**Species**	**Number of pickers interviewed**	**Average hours of picking effort**	**Average harvest per picker (kg)**
Cornwallis Beach	Cockles	263	1.13	2.17
	Scallops	285	0.84	1.95
	Pacific oysters	125	1.27	2.29
	Green lipped mussels	22	1.28	5.20
	Cats eyes	28	1.20	2.53
	Horse mussels	38	1.21	1.32
	Mixed species	18	1.13	2.33
	Kina	3	1.75	8.27
	Whelk species	25	0.96	0.86
	Crab species	7	0.98	0.28
	Pipi	6	1.11	0.25
Mill Bay	Cockles	371	1.25	3.09
	Pacific oysters	182	1.32	3.14
	Scallops	62	1.27	1.46
	Horse mussels	12	2.30	0.91
	Whelk species	13	1.00	0.65
	Pipi	4	0.88	0.88
	Mixed species	3	0.94	0.50
Okoromai	Cockles	915	1.03	3.37

Mean CPUE (for a given stratum and species) was estimated using on-site interviews from completed trips using identical stratification as for effort. The ratio of mean harvest, in terms of weight and numbers, divided by mean effort, was used as an estimator of the average catch rate of completed trips:

$$\hat{R} = \frac{\sum_{t=1}^{n} c_t / n}{\sum_{t=1}^{n} L_t / n} \text{, or:}$$

$$\hat{R} = \bar{c} \,/\, \bar{L}$$

Where L_t is the length and c_t the harvest from fishing trip t., n trips having been investigated, or $\bar{c}$ and $\bar{L}$ are the calculated mean values.

9.4 Harvest

Harvest was estimated as the product of effort and catch per unit effort (CPUE: in this case mean harvest per hour)

$$\hat{C} = \hat{E} \times \hat{R}$$

Where C is the total harvest (catch), E is the total fishing effort, and R is the average CPUE. Variances were estimated using a non-parametric bootstrapping technique. The original daily picking effort and individual picker catch and effort data were "resampled" (with replacement) and an estimate of harvest was calculated. These bootstraps were calculated 1000 times and their distribution was assumed to be representative of the error structure of the harvest estimate.

Harvest estimates and associated bootstrap variance estimates were calculated for each species for seasonal/day type/spatial strata. When calculating variance estimates for combinations of seasonal, day type and or spatial strata, the individual bootstrap harvest estimates of each stratum were combined and variance was estimated from the distribution of their 1000 combined bootstrap harvest estimates. The frequency distributions of 1000 bootstrap estimates of annual harvest for key species are given in Figures 11 and 12 and appear to be generally although not always normally distributed. When the level of picking effort was low, and hence harvest was low, bootstrap estimates deviated from normality with the left hand limb of the distribution truncated at 0 (see Mill Bay pipi, Figure 11). The means of the bootstrap harvest estimates were usually within 5% of the analytical estimates of harvest (Appendices 1, 2 & 3).

In some instances, no CPUE data were available for a seasonal/day type/area stratum. When this occurred, the CPUE data from the alternative day type were used from the relevant seasonal/area stratum. When CPUE data was not available from the alternative day type, data from neighbouring spatial strata were used from the relevant seasonal/day type strata. Any bias arising from the use CPUE data from a corresponding stratum is unlikely to have much affect on final annual harvest estimates because the harvest estimates of the affected stratum are low due to low levels of picking effort.

Estimates of annual harvest were calculated both in terms of weight taken (Table 4) and numbers picked (Table 5). Harvest estimates were only calculated for key species picked at the beaches studied. At Cornwallis Beach and Mill Bay, estimates of cockle and pipi harvest were calculated because these two species were part of the study's original objective. Harvests of Pacific oysters and scallops were also estimated because these species comprised a large proportion of the total shellfish harvest from these beaches. At Okoromai Bay, only cockle harvest estimates were calculated because this was the only species which was observed (Table 3).

***Table 4*: Estimated weight of key species harvested annually on Cornwallis Beach, Mill Bay, and Okoromai Bay**

Location	Species	Estimated harvest (kg)	Bootstrap mean	Bootstrap c.v.
Cornwallis Beach	Cockles	3 269	3 280	0.13
	Pacific oysters	1 820	1 820	0.16
	Pipi	6	6	0.27
	Scallops	3 518	3 528	0.13
Mill Bay	Cockles	4 983	4 970	0.14
	Pacific oysters	2 851	2 853	0.15
	Pipi	22	23	0.54
	Scallops	385	399	0.17
Okoromai Bay	Cockles	17 192	17 056	0.14

Table 5: **Estimated number of key species harvested annually on Cornwallis Beach, Mill Bay, and Okoromai Bay**

Location	**Species**	**Estimated harvest (N)**	**Bootstrap mean**	**Bootstrap c.v.**
Cornwallis Beach	Cockles	283 721	282 095	0.14
	Pacific oysters	60 022	59 978	0.16
	Pipi	980	977	0.26
	Scallops	30 359	30 468	0.12
Mill Bay	Cockles	497 401	497 984	0.14
	Pacific oysters	102 422	101 179	0.15
	Pipi	3 916	3 899	0.57
	Scallops	3 345	3 448	0.16
Okoromai Bay	Cockles	1 069 625	1 074 226	0.13

Estimates of annual harvest of cockles at Cornwallis Beach, Okoromai Bay are similar to estimates of CAY given in Morrison *et al.* 1999 (Table 6) with the annual harvest at Mill Bay exceeding optimum yield. This is reflected in a comparison of reference fishing mortalities (Table 7). The annual harvest estimate of cockles at Cornwallis Beach differs from that in Table 4 as the definition of Cornwallis Beach used in the intertidal resources survey (research programme AKI9701) corresponds to spatial areas 4, 5 and 6 in this study (*see* Figure 2).

Table 6: **Biomass and estimates of CAY taken from Morrison *et al.* 1999, and estimates of harvest, with 95% confidence intervals for cockle populations at Cornwallis Beach (spatial areas 4, 5, & 6 only), Mill Bay and Okoromai Bay**

Beach	**Biomass (t)***	**CAY ($F_{0.1}$) (t)**	**Estimated harvest (t) ± 95% C.I.**
Cornwallis Beach	14.87	3.1	2.8 ± 0.80
Mill Bay	18.06	3.5	5.0 ± 1.39
Okoromai Bay	70.15	14.9	17.2 ± 4.70

*Biomass estimates based on simplified knife edge selectivity.

Table 7: **A comparison of reference fishing mortality estimates for a given level of natural mortality at Cornwallis Beach (spatial areas 4, 5, & 6 only), Mill Bay and Okoromai Bay. The biomass figure is taken from Morrison *et al.* 1999 and $F_{0.1}$ and F_{max} are calculated using the method given in Morrison *et al.* 1999, M is taken from Cryer 1996 and F_{est} is calculated using the Baranov catch equation**

Beach	**Biomass (t)***	**M**	**$F_{0.1}$**	**F_{max}**	**F_{est}**
Cornwallis Beach	14.87	0.30	0.27	0.39	0.25
Mill Bay	18.06	0.30	0.25	0.36	0.38
Okoromai Bay	70.15	0.30	0.28	0.40	0.33

*Biomass estimates based on simplified knife edge selectivity.

Harvest estimates are also given by season and day type for each species (*see* Appendices 1 and 2). Lower levels of stratification sometimes resulted in bootstrap frequency distributions which departed from normality. The confidence intervals given in the appendices are therefore the bootstrap estimates associated with the 95% percentiles of proportional bootstrap frequencies. As mentioned above, estimates of scallop harvest may not be reliable as the influence of tidal height was not considered in the experimental design.

Harvests of key species were seasonal, with the greatest harvests generally occurring in summer and the lowest in winter (Figure 13). Scallops were picked steadily throughout the season with a small amount harvested at Cornwallis Beach during the closed season. Annual weekend and weekday harvests of key shellfish species were similar at Cornwallis Beach and Mill Bay, although weekend harvesting is more concentrated because of the fewer days available (Figure 14). Cockle harvesting at Okoromai Bay appears to occur predominantly during the weekend. There were clear spatial patterns of harvesting at each beach (Figure 15). Differences between the spatial distribution of species' harvests on each beach reflect the distributions of each population. Pacific oysters were mainly harvested from mudstone rocks found at the western end of Cornwallis Beach at Puponga point and at the eastern end of Mill Bay. The main scallop harvest was in areas 2, 3 and 4 on Cornwallis Beach where the greatest densities of scallops are exposed at low tides.

Length frequency distributions were also calculated for the key species for each season at each beach (Figures 16 to 24). The length frequencies of individual groups of pickers interviewed were weighted according to the estimated number of shellfish taken by each group. These weighted length frequencies were then weighted again to reflect the relative predominance of the day type on which each group's harvesting took place. These length data were then combined and expressed as proportional length frequencies. At Cornwallis Beach and Mill Bay there appear to be marked seasonal differences in the seasonal length frequencies of all species, probably partially because of the low numbers of shellfish measured. These differences are less marked when length frequencies with large sample sizes are compared. Only small pipi were observed in picker's catches with a mean shell length of 39.6 mm at Cornwallis Beach, and 37.8 mm at Mill Bay. At Okoromai Bay, where only cockles are picked, sample sizes are comparatively large and the seasonal length frequency distributions and their means are similar.

9.5 Selectivity

Picker selectivity was calculated for cockle populations at all three beaches using population length frequencies taken from Morrison *et al.* 1999, which were collected during the summer of 1997/98, and summer harvest length frequencies. Length frequency data from Cornwallis Beach were taken only from spatial areas 4, 5 and 6, because these areas corresponded to the definition of Cornwallis beach used in Morrison *et al.* 1999. The selectivity pattern of amateur pickers at each of the sites for each season was assessed using Jacobs' Electivity Index, D (Jacobs 1974) and Richards selection curves.

Jacobs' Electivity Index was originally devised for the assessment of the diet of predators in relation to the availability of certain types of prey, and is therefore completely analogous to the selectivity of pickers for their "prey":

$$D = \frac{(r-p)}{(r+p-2rp)}$$

Where D is the electivity index, r is the fraction of a given size class of cockles in the harvest, and p is the fraction of the same size class in the population at large at that beach in that season. Possible values of the index, D, range from -1 to +1, positive values indicating a proportion taken by fishers (*c.f.* the diet of a predator) higher (and negative values lower) than the proportion of a given species or size class in the environment.

Approximate (probably minimum) confidence intervals were estimated for each value of Jacobs' D using a non-parametric bootstrap technique. Both the population and harvest length frequencies were sampled with replacement and D was calculated for each 1mm length class. These bootstrap estimates of D were calculated 1000 times and the 95% percentiles of each length class's bootstrap distribution were taken as the 95% confidence intervals for that length class.

At Cornwallis Beach, Mill Bay and Okoromai Bay, the Jacobs' indices were significantly positive for all sizes of cockles greater than 29 mm, 25 mm, and 31 mm respectively (Figures 26, 29 and 32). Electivity confidence intervals for Cornwallis Beach and Mill Bay were very broad. The knife edge lengths at recruitment were used in an associated research programme AKI9701. Similar recruitment lengths to those observed at Cornwallis Beach and Mill Bay have been calculated for the Snake Bank commercial cockle fishery, 30 mm in 1992 and 29 mm in 1996.

Picker selectivity was also calculated using a Richards selection curve (Figures 27, 30 and 33) which is a logistic curve specified by two parameters a and b, with a asymmetry parameter, δ.

$$r(l) = \left(\frac{\exp(a + bl}{1 + \exp(a + bl)} \right)^{1/\delta}$$

Approximate confidence intervals were estimated using a non-parametric bootstrap technique similar to that used for the Jacobs' Electivity index. Both the population and harvest length frequencies were sampled with replacement and a Richards selection curve was fitted to the resulting population and harvest length frequencies. These bootstrap estimates were calculated 1000 times and the 95% percentiles of each length class's bootstrap distribution were taken as the 95% confidence intervals for that length class.

10. Management implications

The cockle harvest estimates presented in this report are similar to CAY estimates given in an associated assessment of intertidal shellfish resources at the beaches studied (research programme AKI9701, Morrison *et al.* 1999). The current levels of cockle harvesting at Cornwallis Beach and Okoromai Bay are thought to be sustainable, although the annual harvest of cockles at Mill Bay slightly exceed optimum levels of yield (CAY). Since this survey was completed, the daily bag limit for the Auckland Metropolitan area has been reduced from 150 cockles per person to 50.

Levels of pipi harvesting appear low, probably because the small size of shellfish available. Despite its specification in the objective, no tuatua were observed in pickers' harvests, nor have any been found in previous intertidal resource surveys at the beaches studied (Morrison *et al.* 1999). Tuatua are usually found subtidally on more exposed beaches.

The annual scallop harvest estimates presented in this report may not be reliable because the influence of spring, normal and neap tides was not taken into account in the original experimental design. As this species is accessible only at extreme low tides, and the populations at Cornwallis Beach and Mill Bay are mostly subtidal, observed harvest levels are probably sustainable. It is not possible to assess the sustainability of Pacific oyster harvesting at Cornwallis and Mill Bay because there are no current estimates of biomass for these populations.

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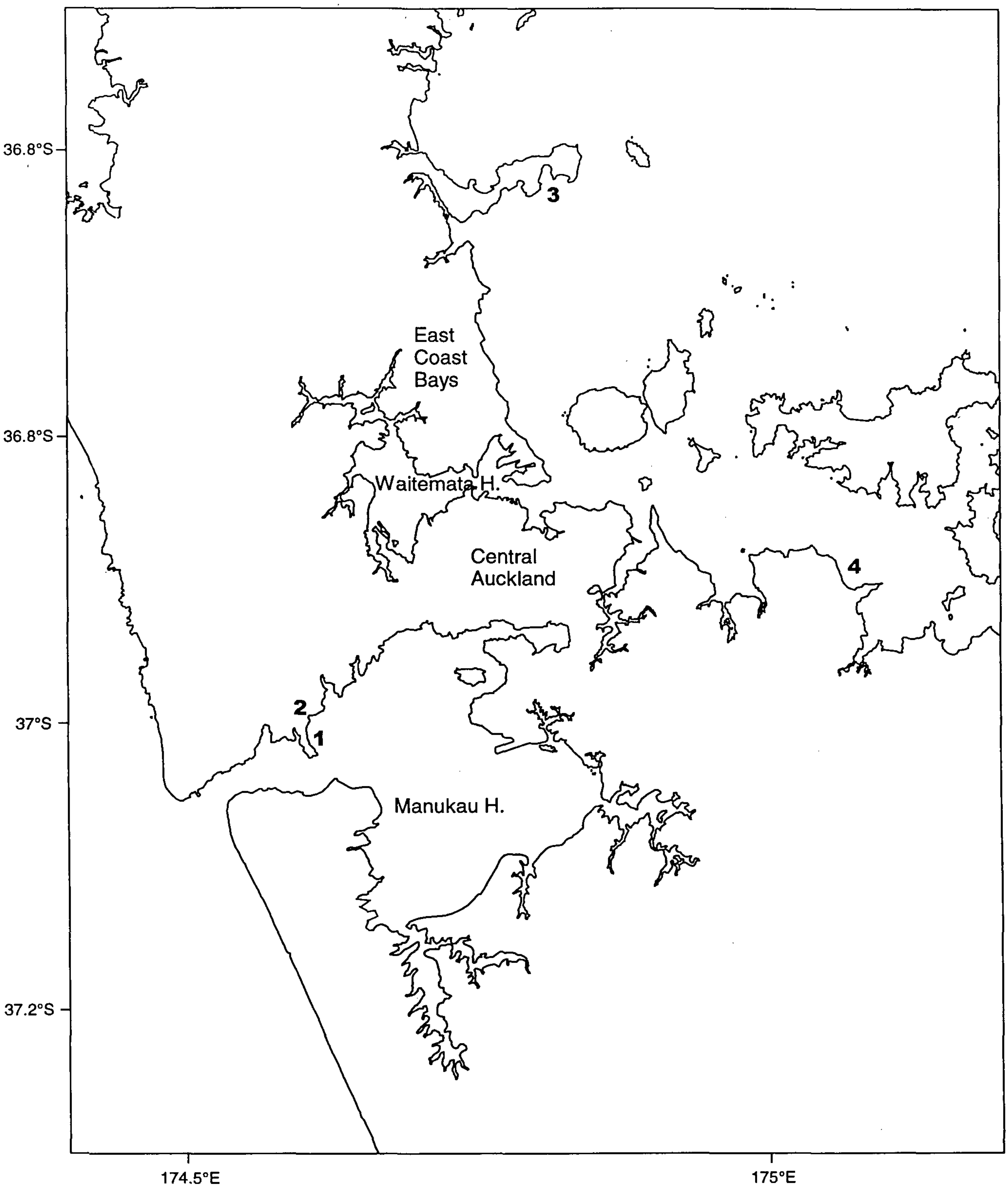

Beaches

1 Cornwallis Beach
2 Mill Bay
3 Okomorai Bay
4 Umupuia

Figure 1: **Beach locations in the greater Auckland metropolitan area.**

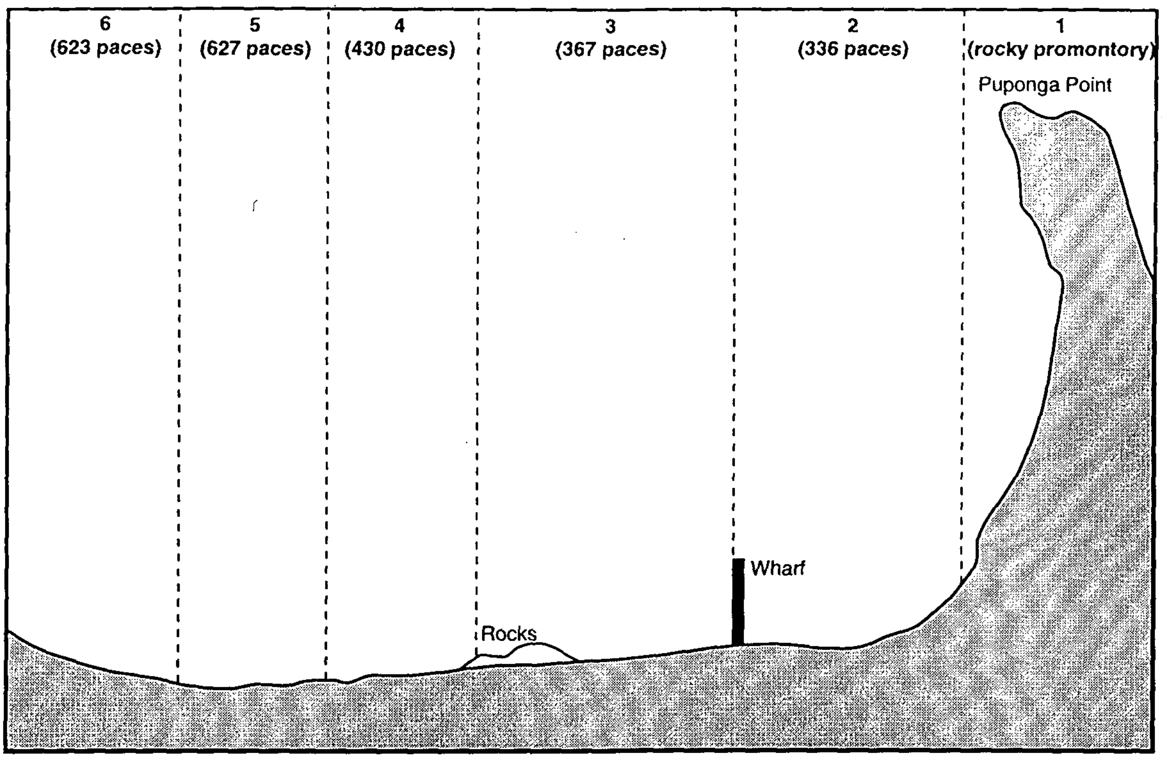

Figure 2: **Cornwalls Beach, dashed lines denote spatial strata.**

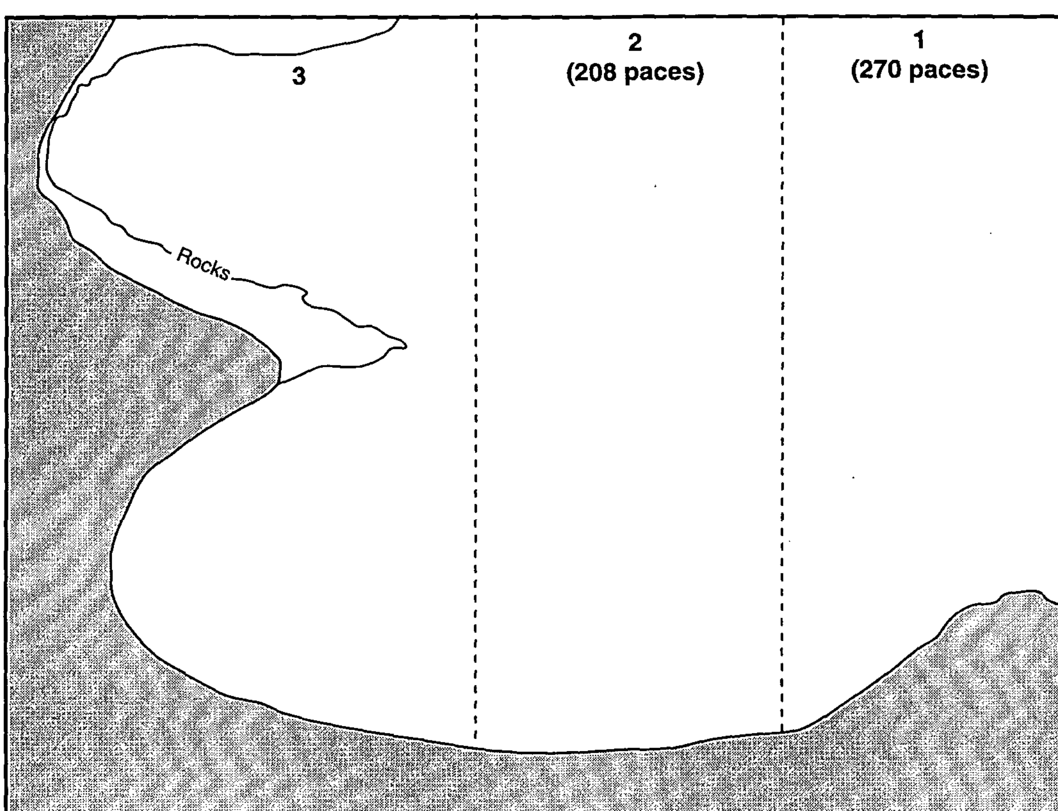

Figure 3: **Mill Bay, dashed lines denote spatial strata.**

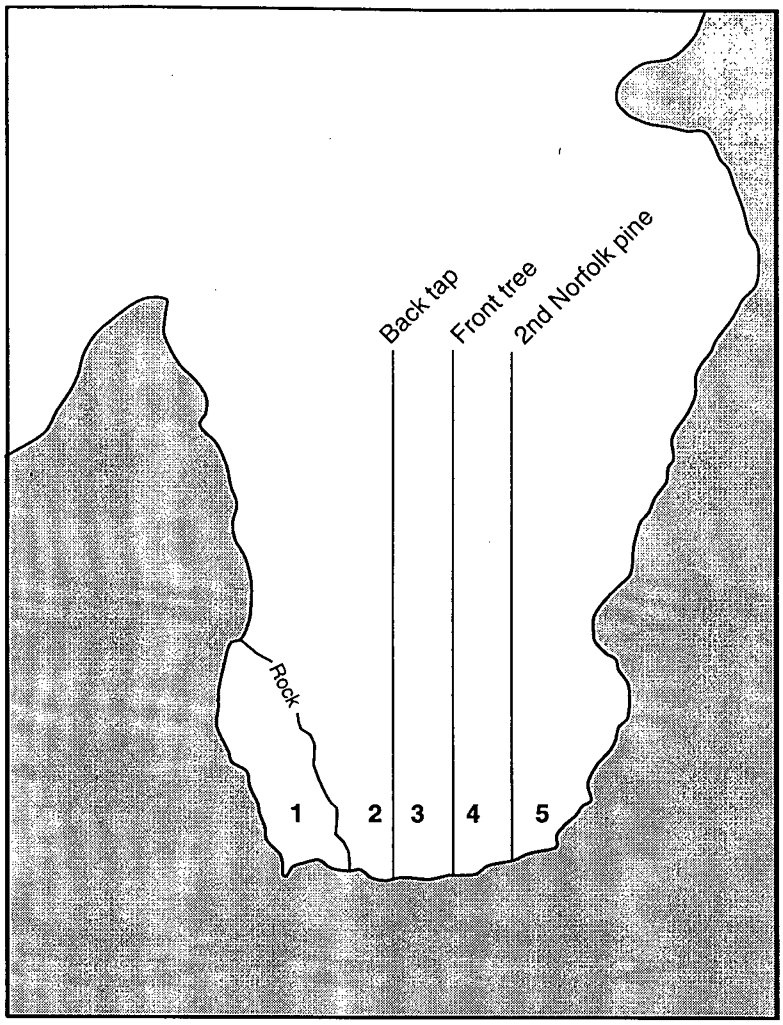

***Figure 4*: Okoromai Bay, dashed lines denote spatial strata**

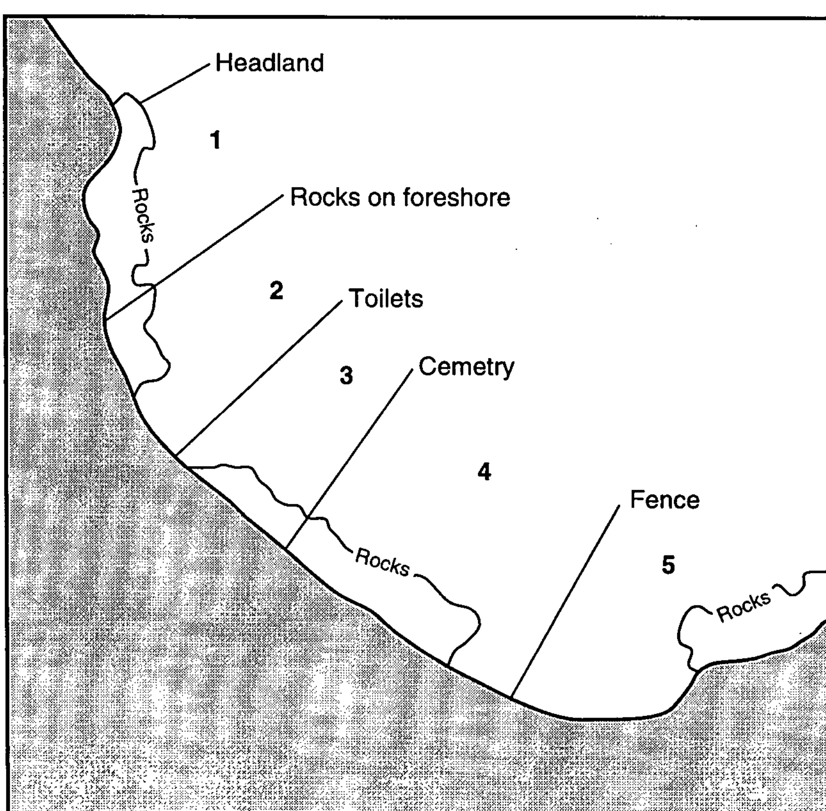

***Figure 5*: Umupuia Beach, dashed lines denote spatial strata**

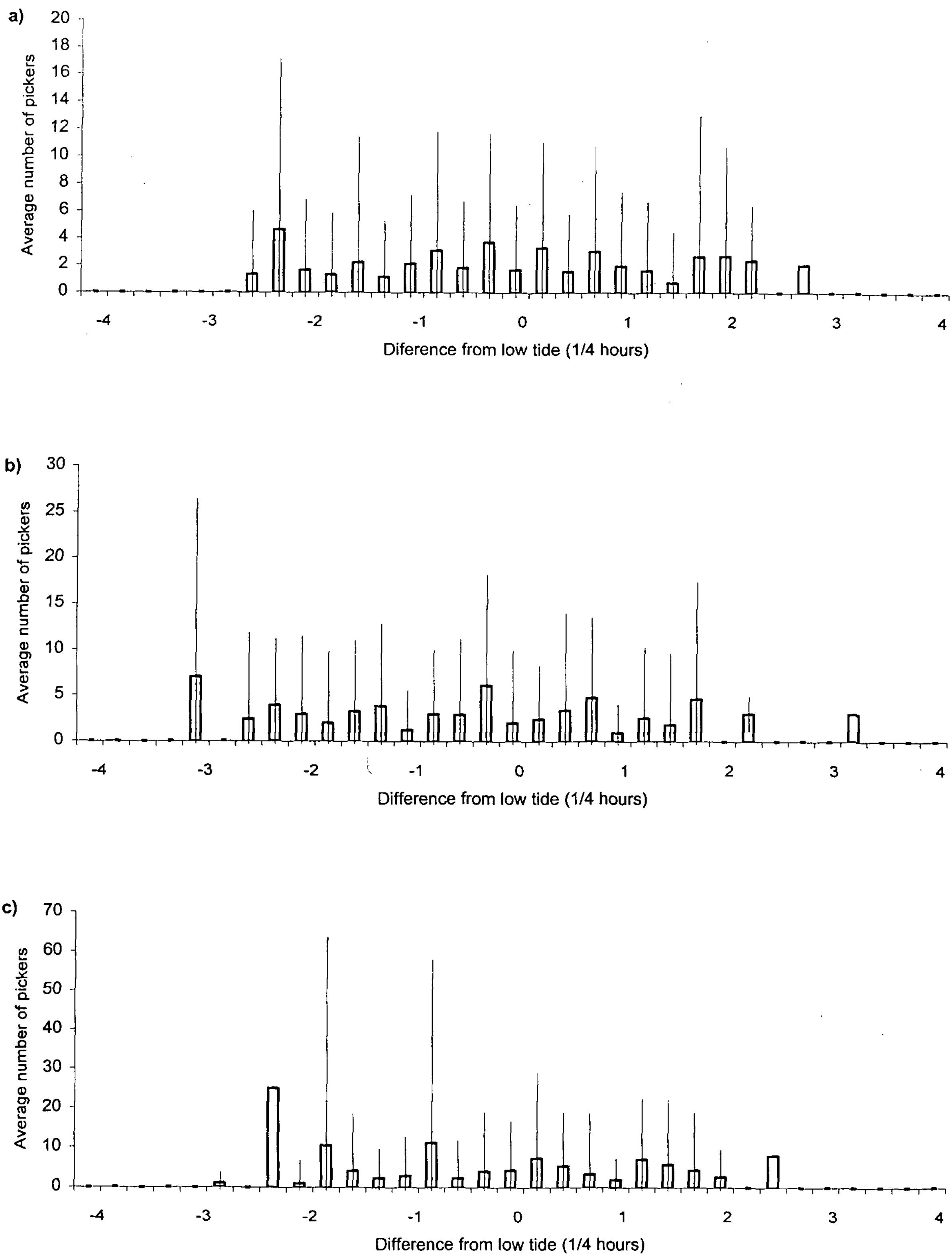

***Figure 6*: Average number of pickers observed at instantaneous hourly counts taken randomly relative to low tide at a) Cornwallis Beach, b) Mill Bay and c) Okoromai Bay. Error bars denote 95% confidence intervals.**

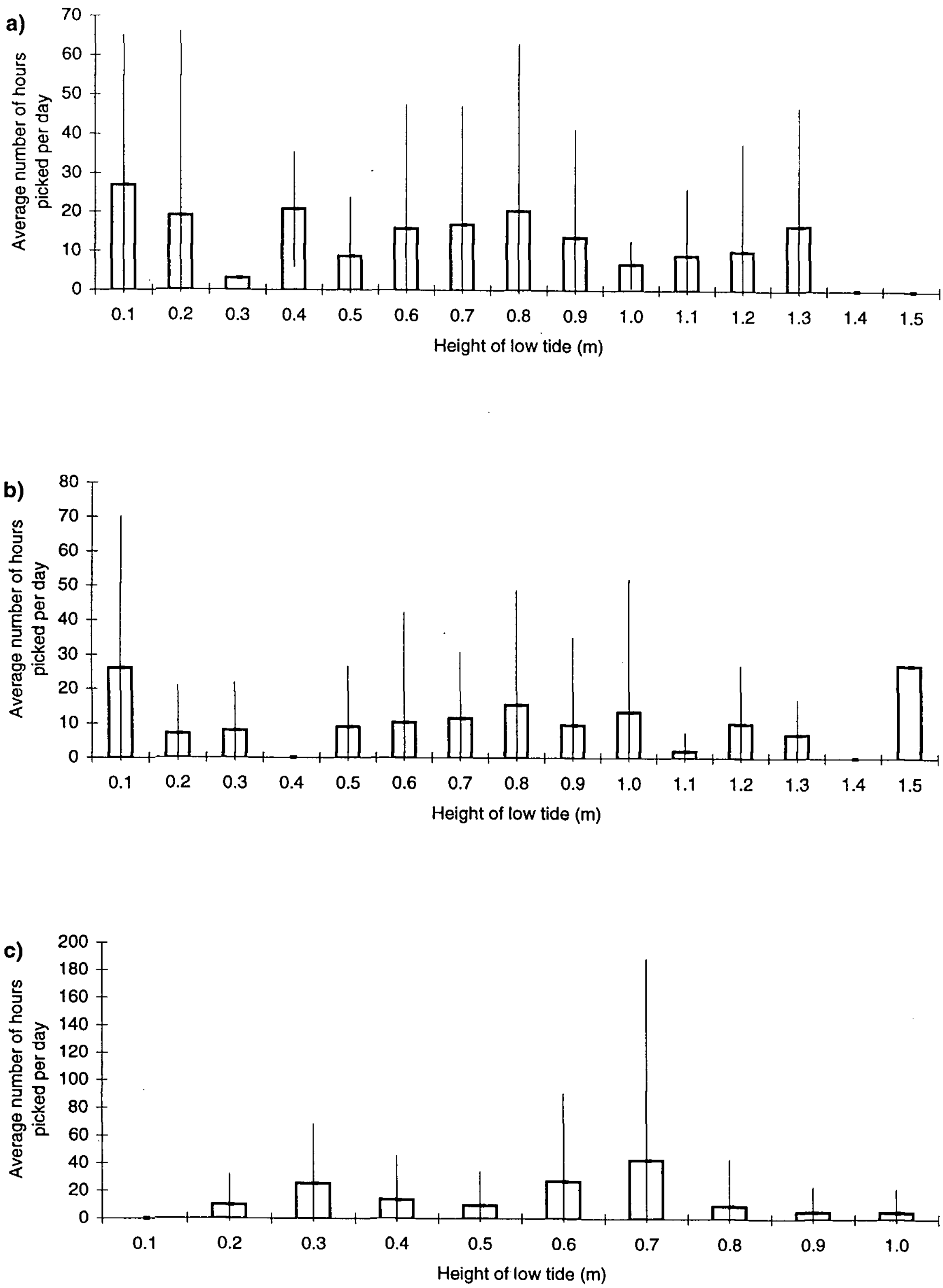

Figure 7 : **Average daily number of hours picked relative to daily low tide height at a) Cornwallis Beach, b) Mill Bay and c) Okoromai Bay. Error bars denote 95% confidence intervals.**

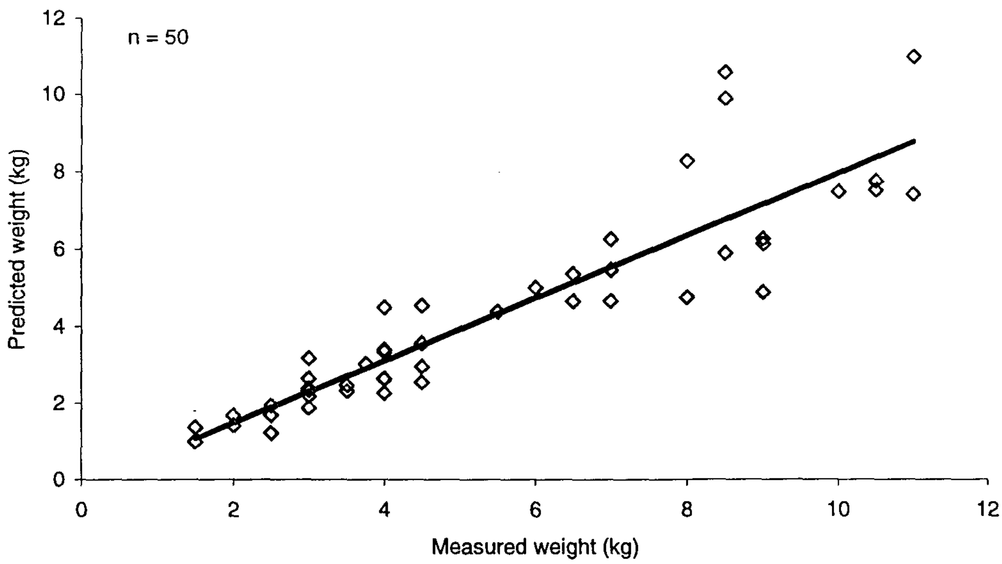

Figure 8 : **Relationship between measured weights of scallop catches and those predicted from the length frequency composition of the catch using a length weight relationship.**

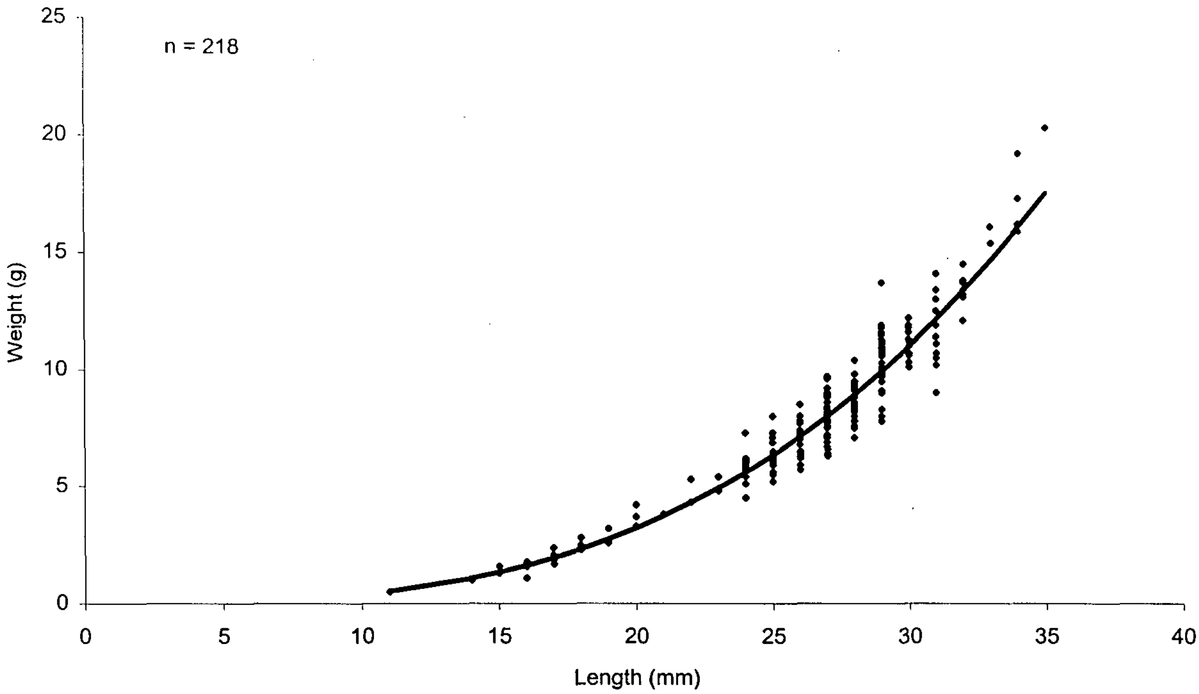

Figure 9: **Length weight relationship of cockles picked from Cornwallis Beach and Mill Bay.**

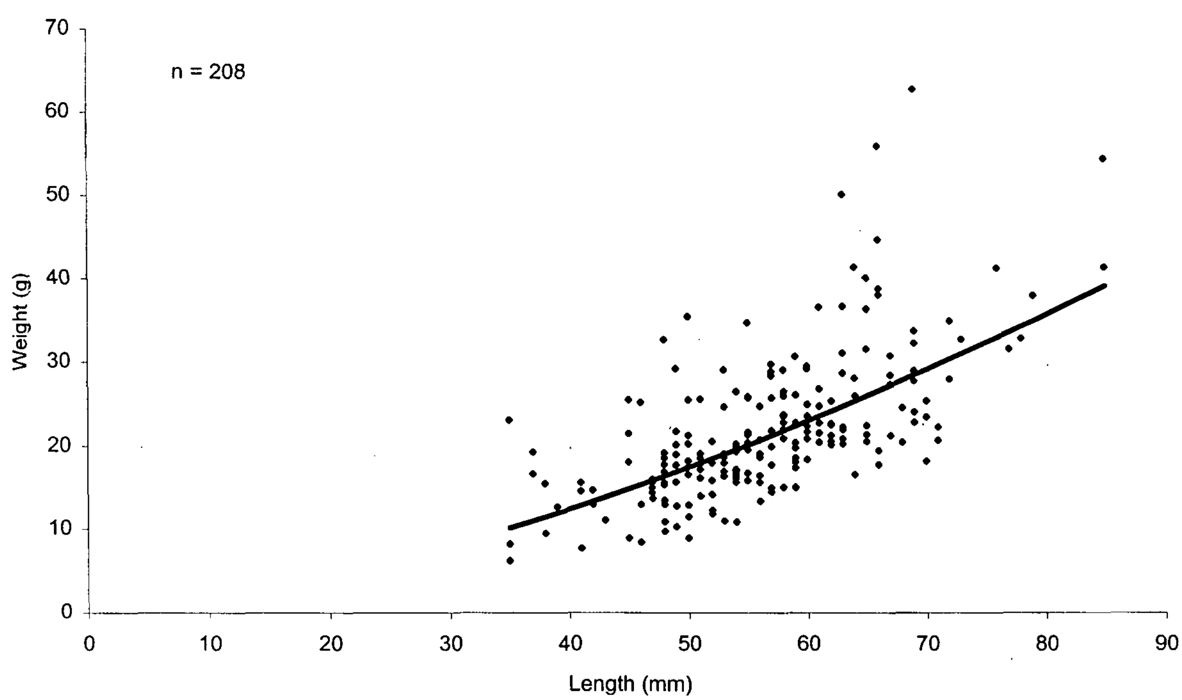

Figure 10: **Length weight relationship of Pacific oysters picked from Mill Bay.**

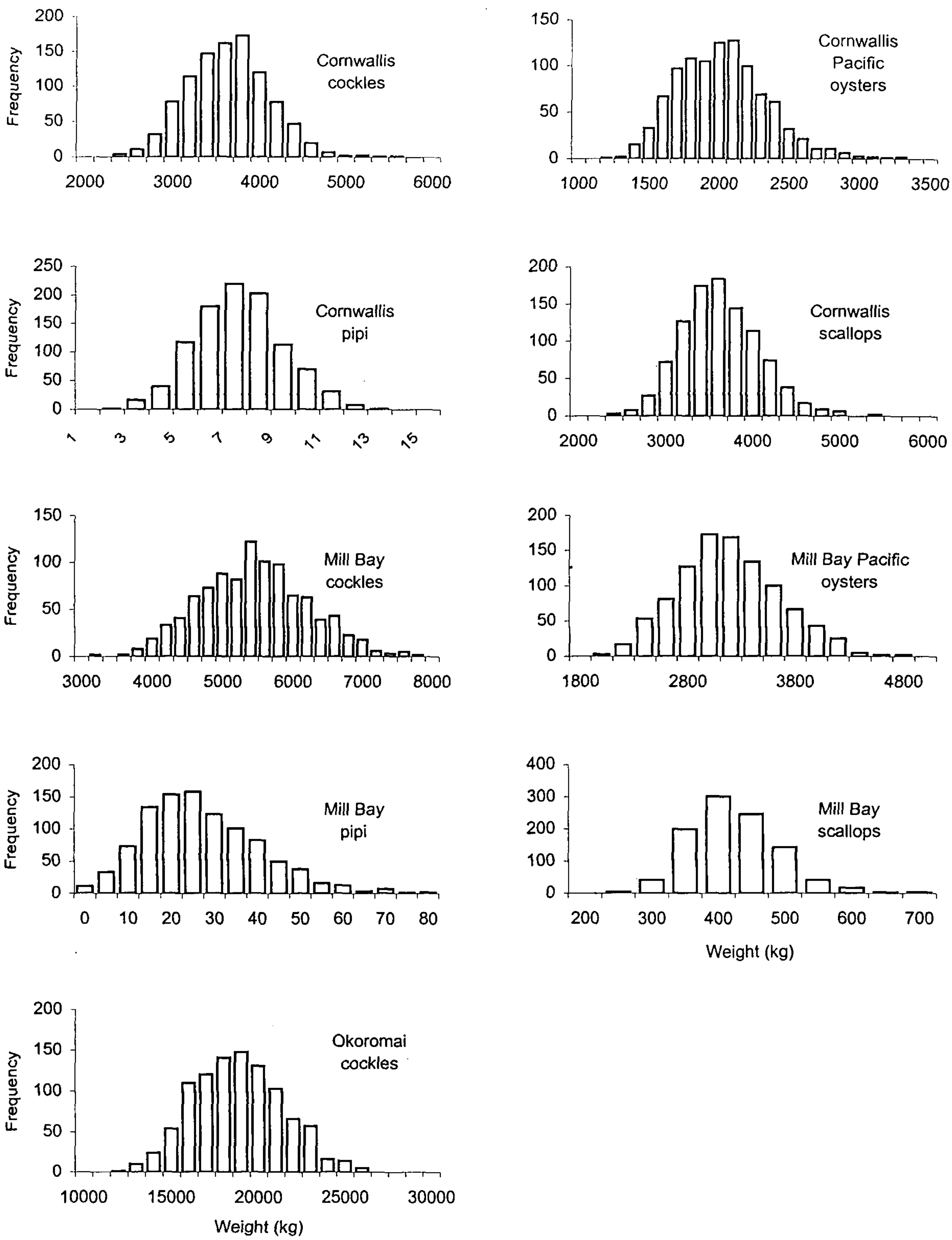

Figure 11 **: Frequency distributions of the 1000 bootstraps used to determine the variance of estimates of the harvest (kg) of the key species picked at Cornwallis Beach, Mill Bay and Okoromai Bay.**

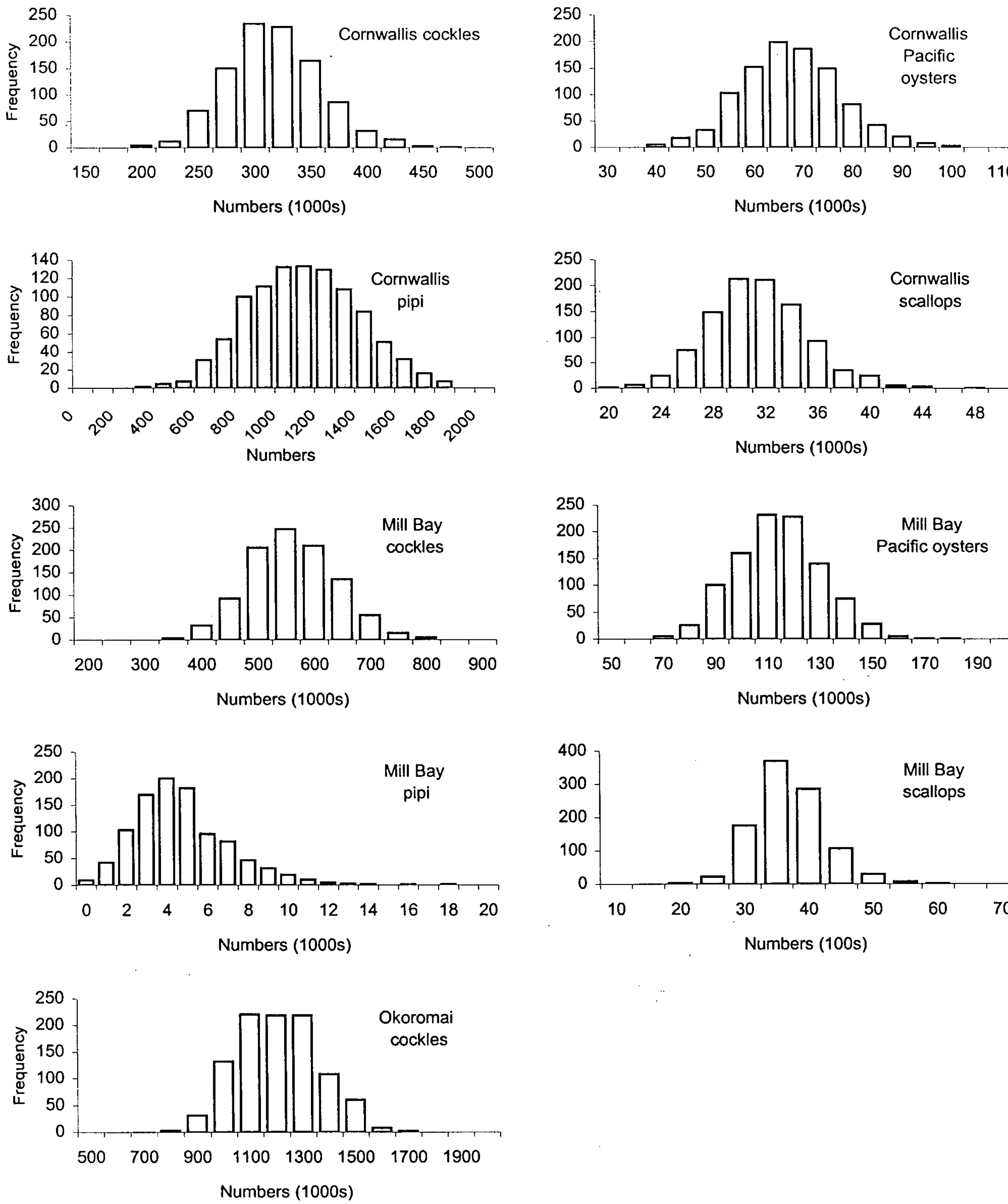

Figure 12: **Frequency distributions of the 1000 bootstraps used to determine the variance of estimates of the harvest (numbers) of the key species picked at Cornwallis Beach, Mill Bay and Okoromai Bay.**

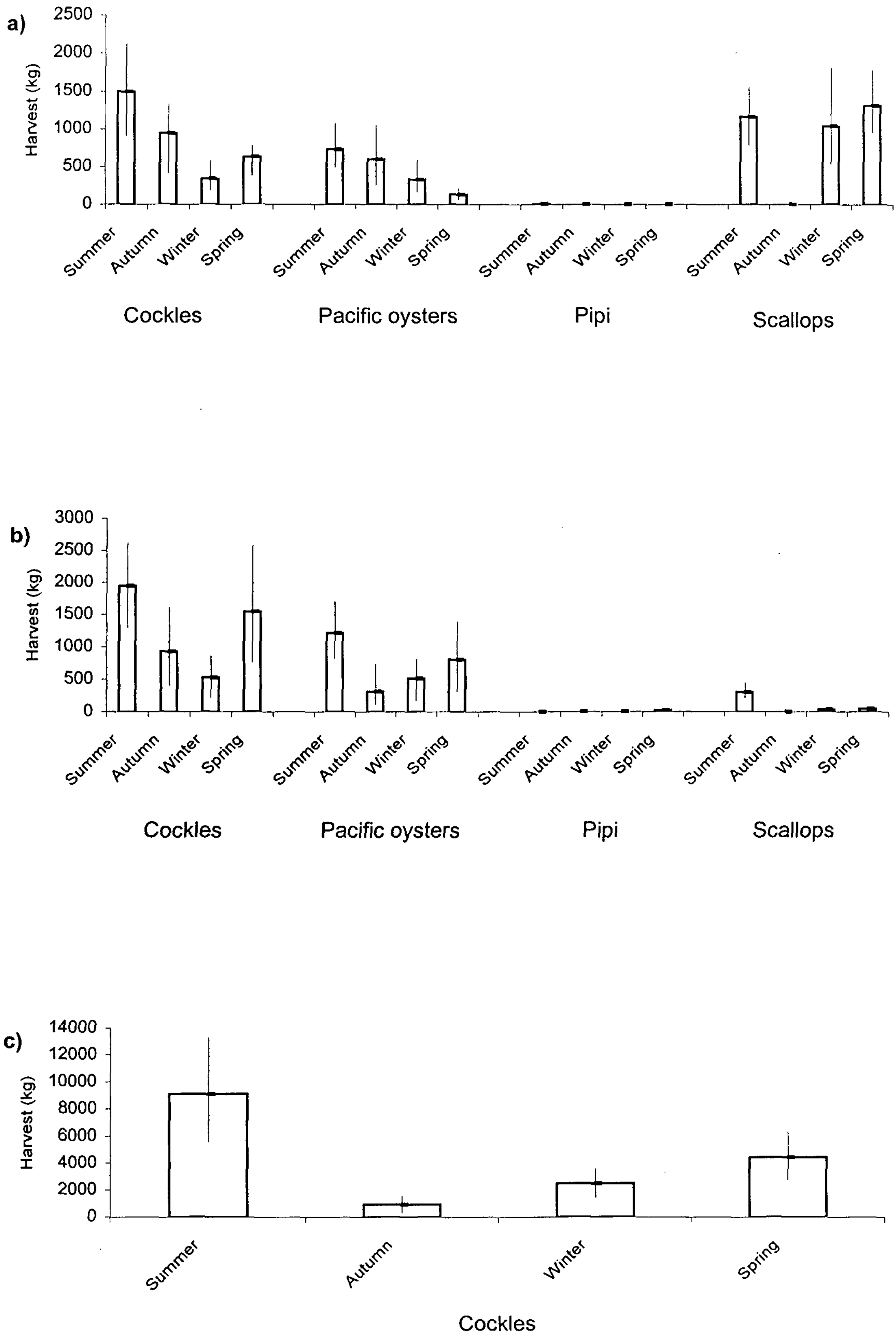

***Figure 13*: Seasonal harvests of key species picked at a) Cornwallis Beach, b) Mill Bay and c) Okoromai Bay. Error bars denote 95% confidence intervals.**

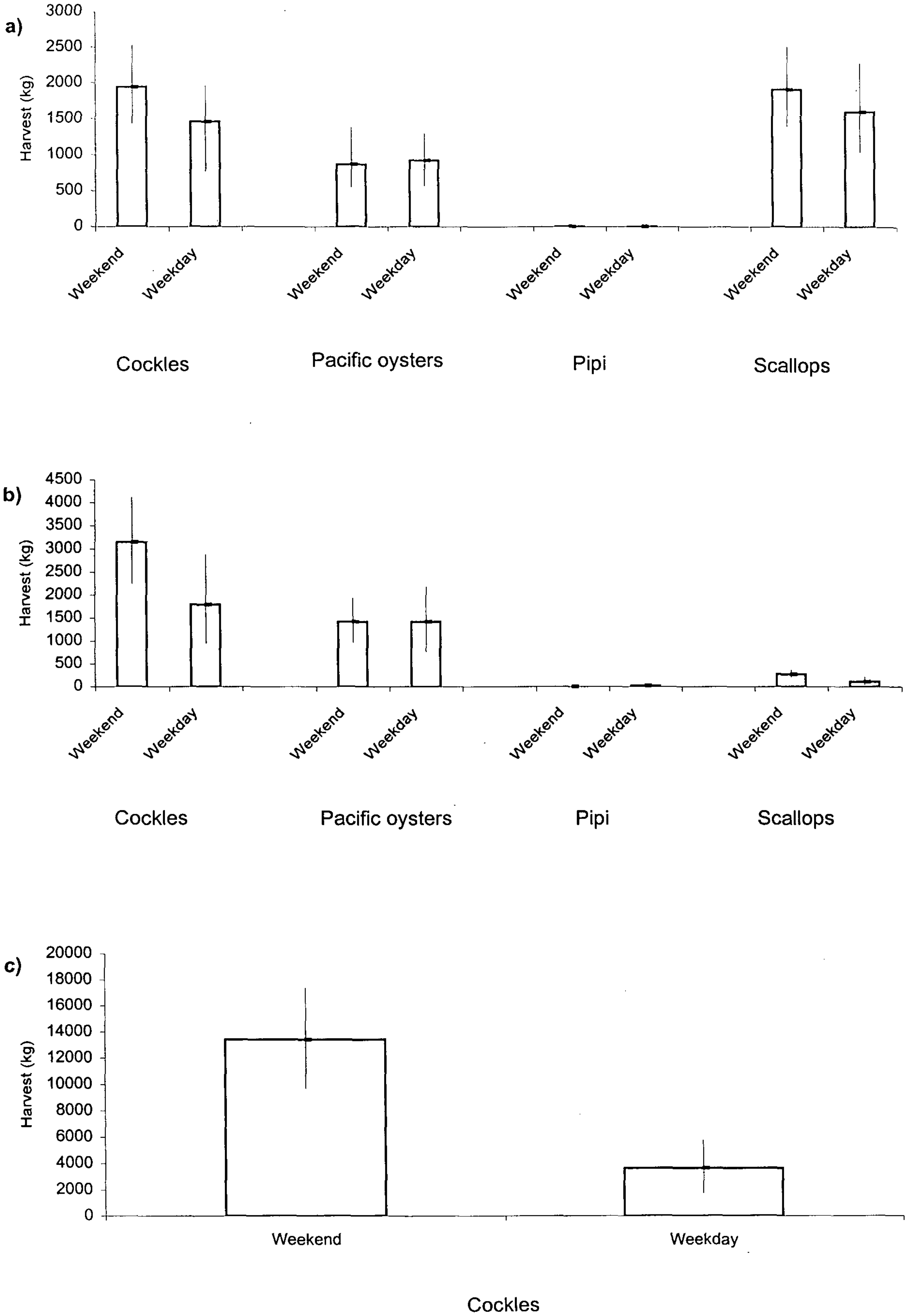

***Figure 14*: Estimated annual harvests of key species picked on weekend days and week days at a) Cornwallis Beach, b) Mill Bay and c) Okoromai Bay. Error bars denote 95% confidence intervals.**

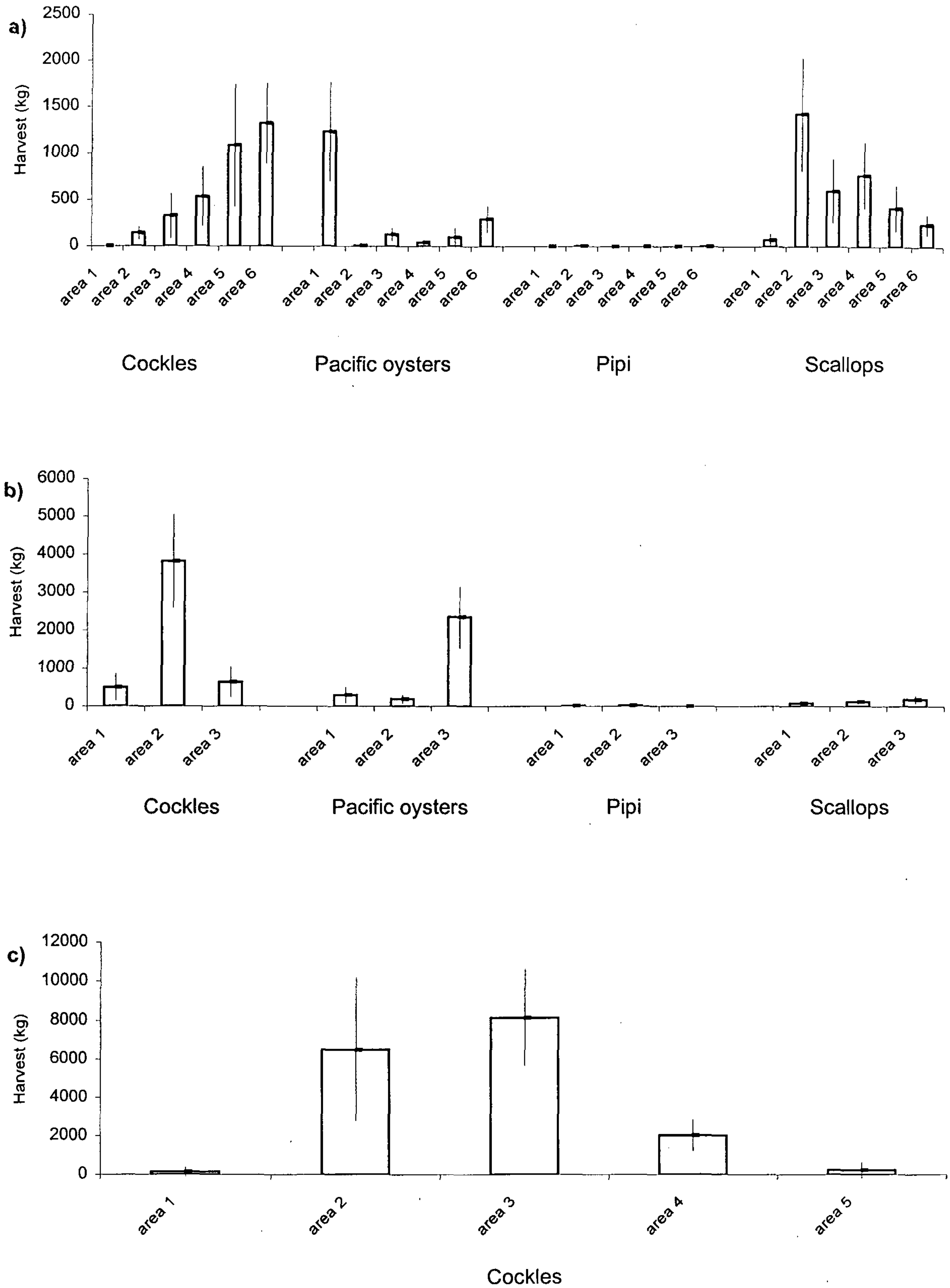

***Figure 15*: Estimated annual harvests of key species picked from each area strata at a) Cornwallis Beach, b) Mill Bay and c) Okoromai Bay. Error bars denote 95% confidence intervals.**

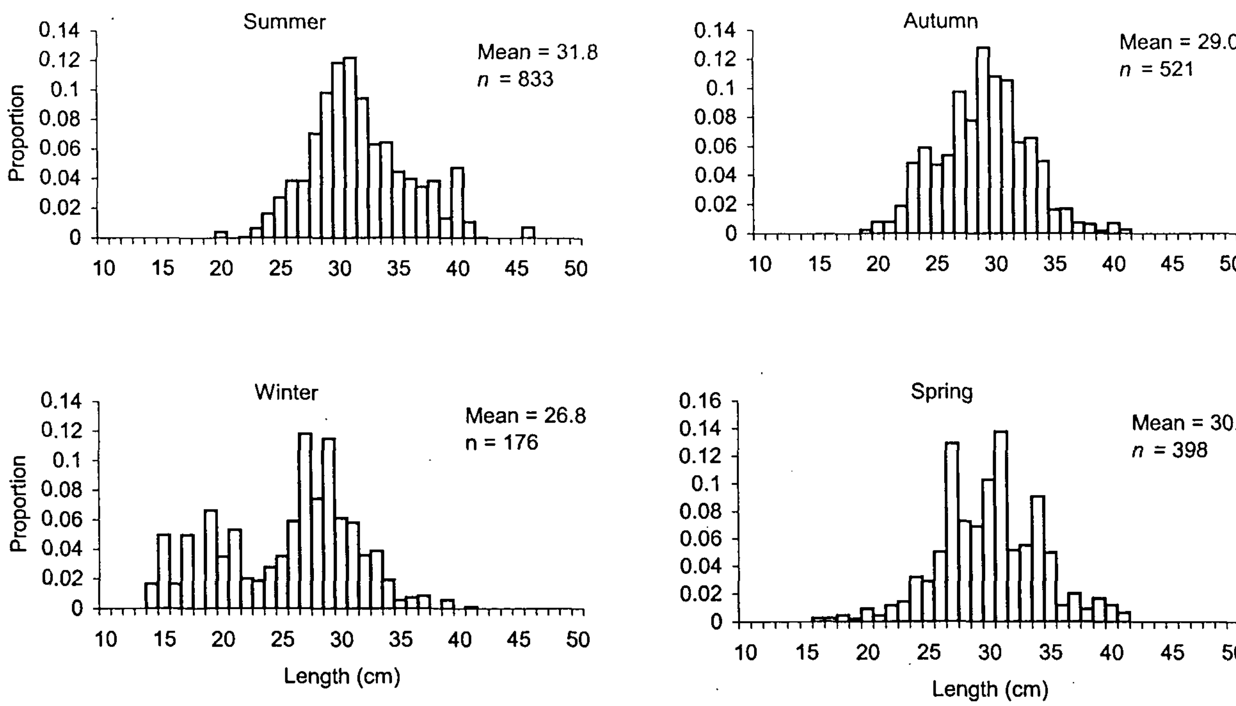

Figure 16: **Length frequencies of cockles harvested by interviewed pickers at Cornwallis Beach. Individual harvests have been weighted by the estimated number of cockles picked by that group.**

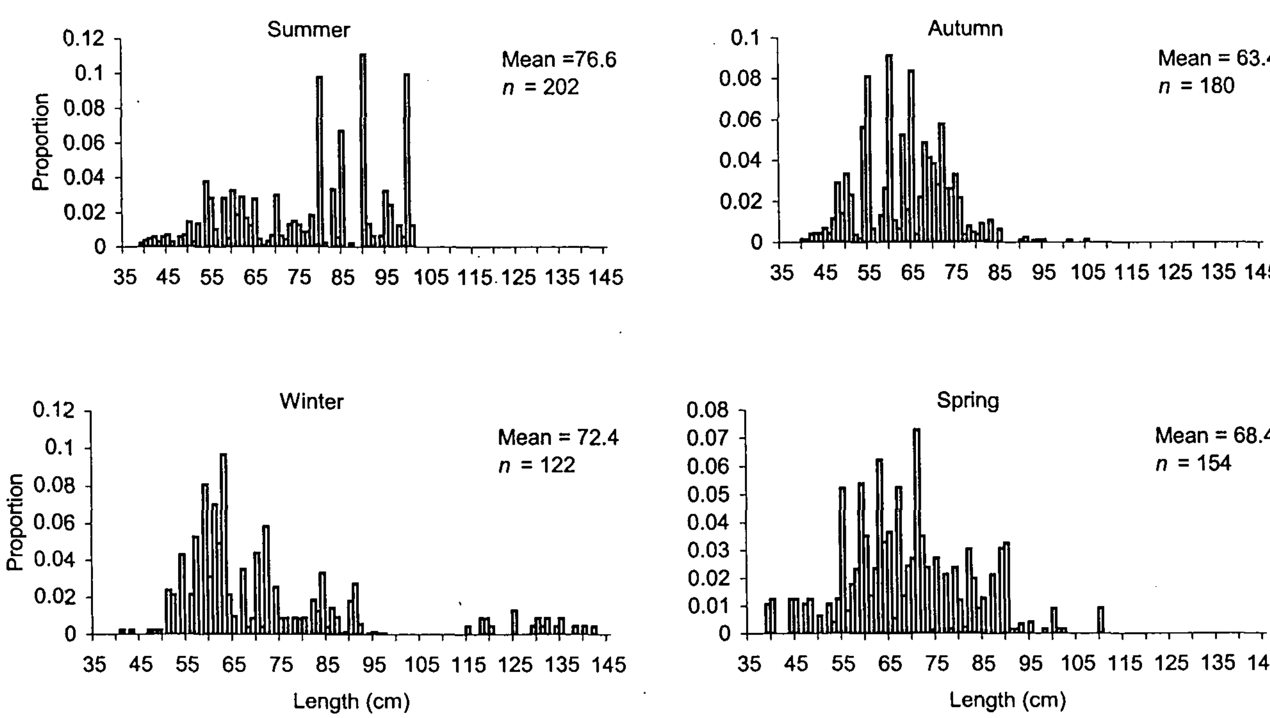

Figure 17: **Length frequencies of Pacific oysters harvested by interviewed pickers at Cornwallis Beach. Individual harvests have been weighted by the estimated number of Pacific oysters picked by that group.**

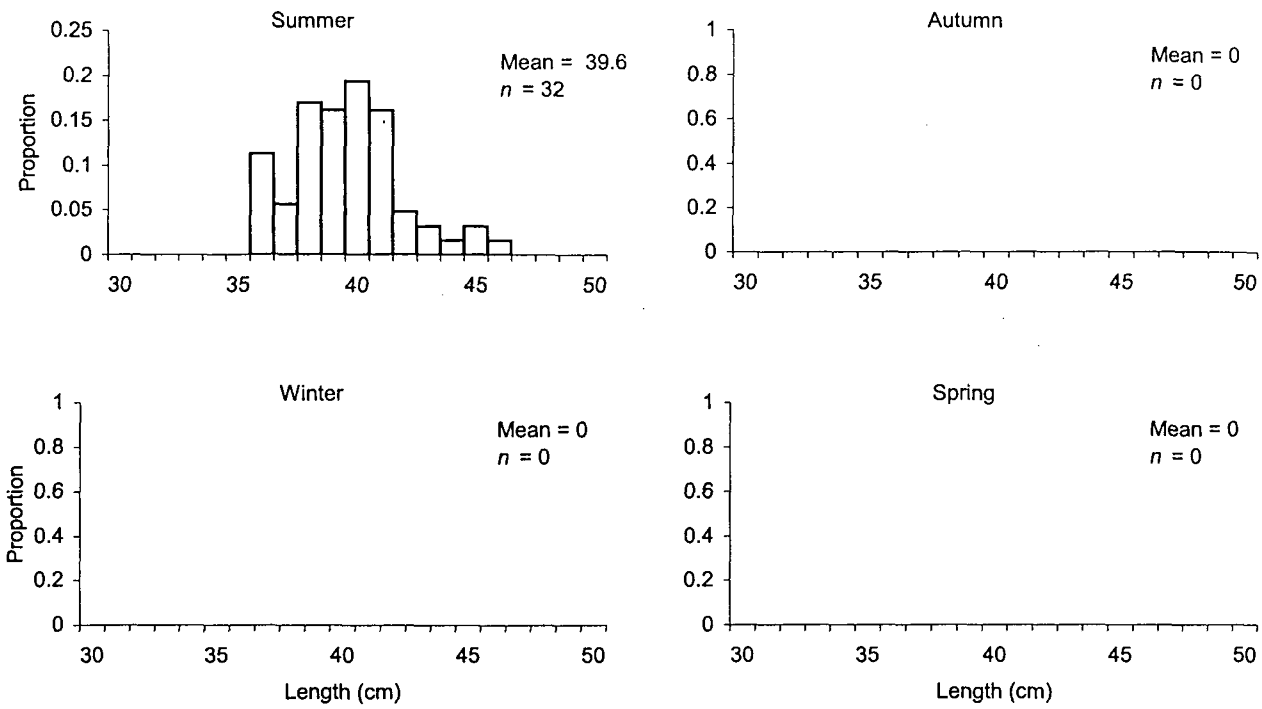

Figure 18: **Length frequencies of pipi harvested by interviewed pickers at Cornwallis Beach. Individual harvests have been weighted by the estimated number of pipi picked by that group.**

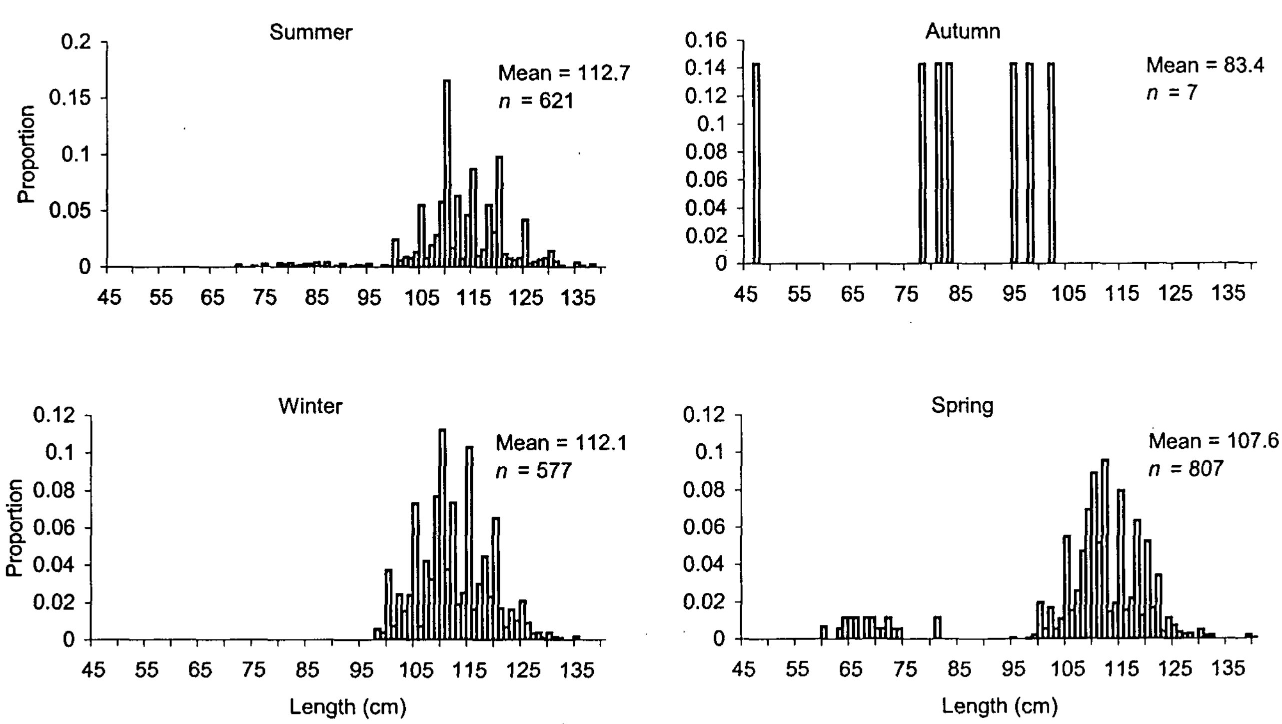

Figure 19: **Length frequencies of scallops harvested by interviewed pickers at Cornwallis Beach. Individual harvests have been weighted by the estimated number of scallops picked by that group.**

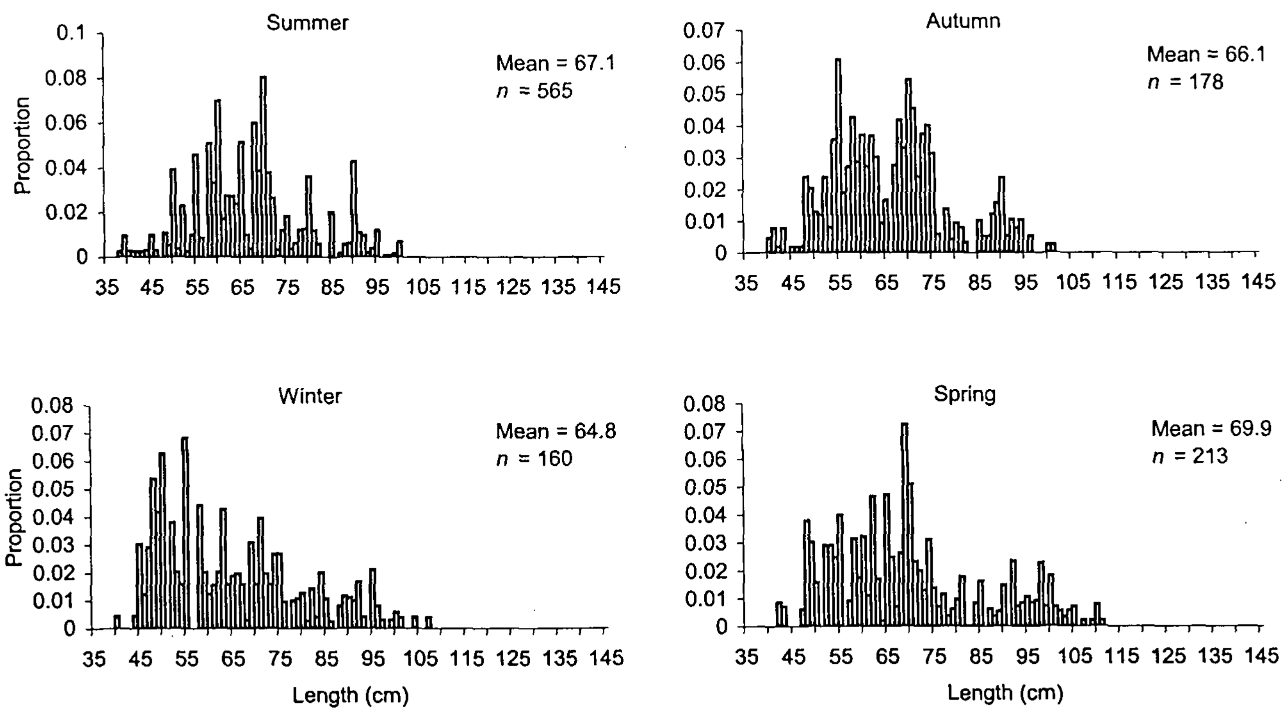

Figure 21: **Length frequencies of Pacific oysters harvested by interviewed pickers at Mill Bay. Individual harvests have been weighted by the estimated number of Pacific oysters picked by that group.**

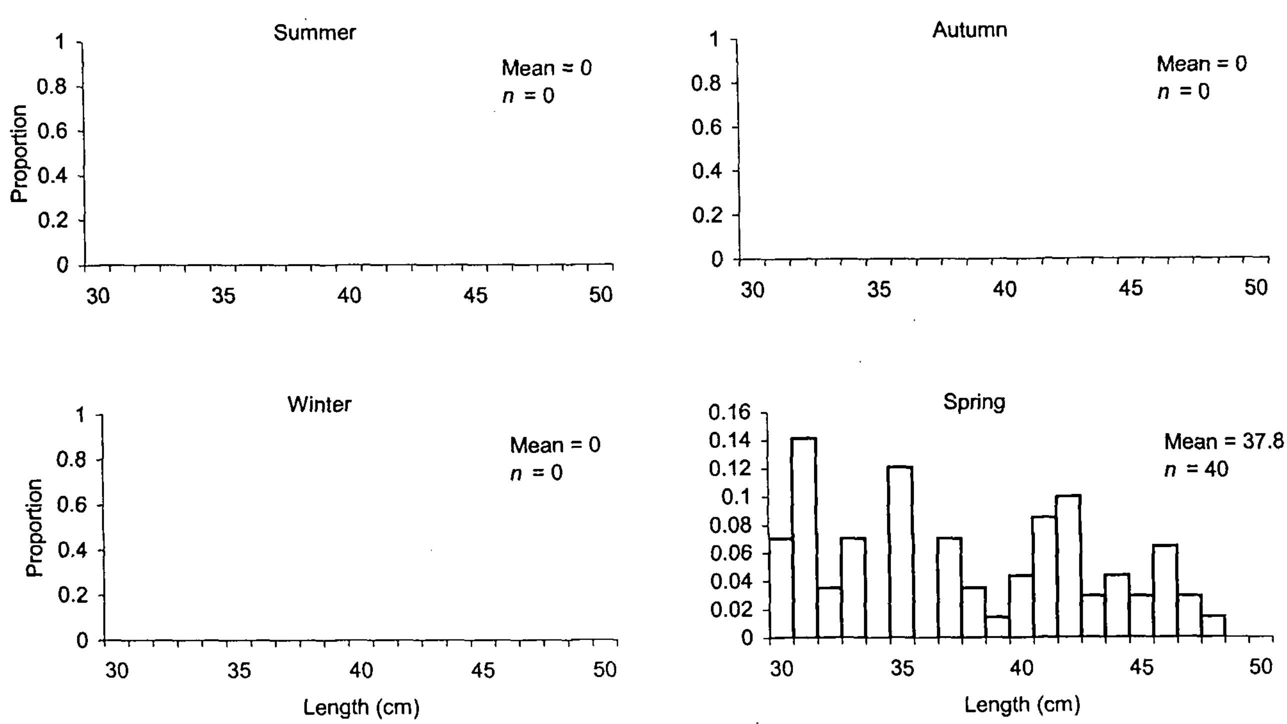

Figure 22: **Length frequencies of pipi harvested by interviewed pickers at Mill Bay. Individual harvests have been weighted by the estimated number of pipi picked by that group.**

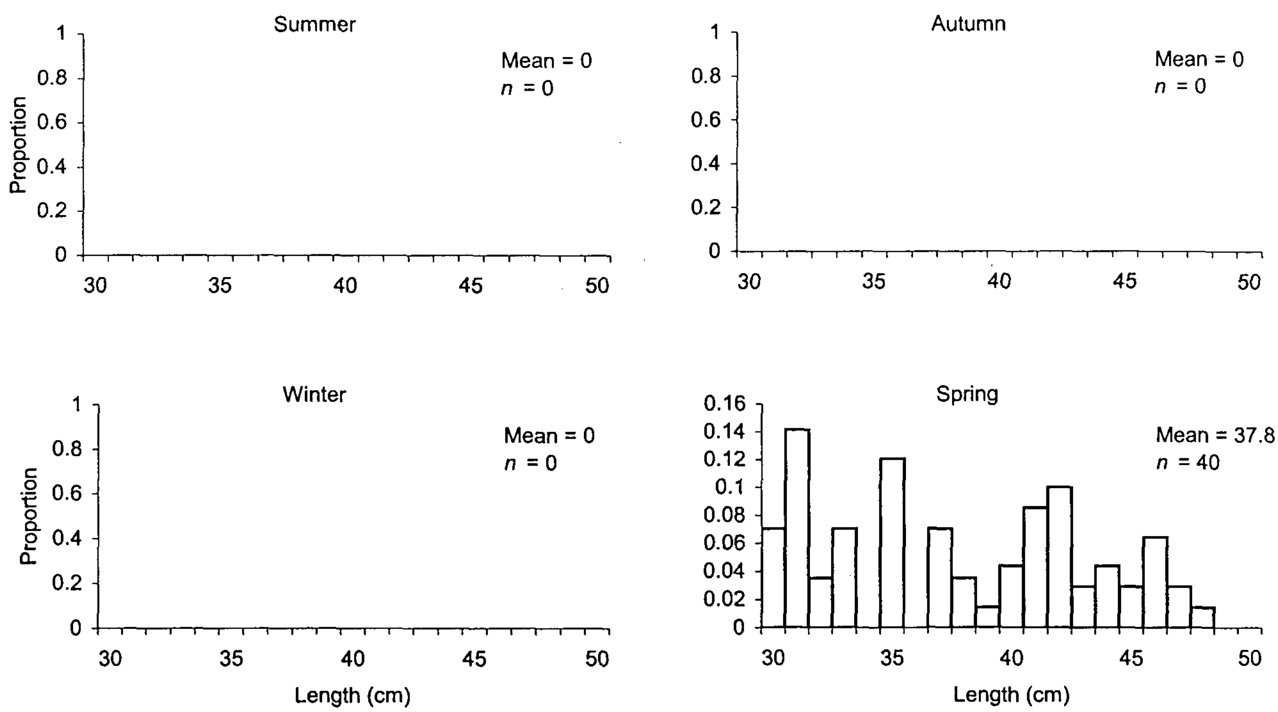

Figure 22: **Length frequencies of pipi harvested by interviewed pickers at Mill Bay. Individual harvests have been weighted by the estimated number of pipi picked by that group.**

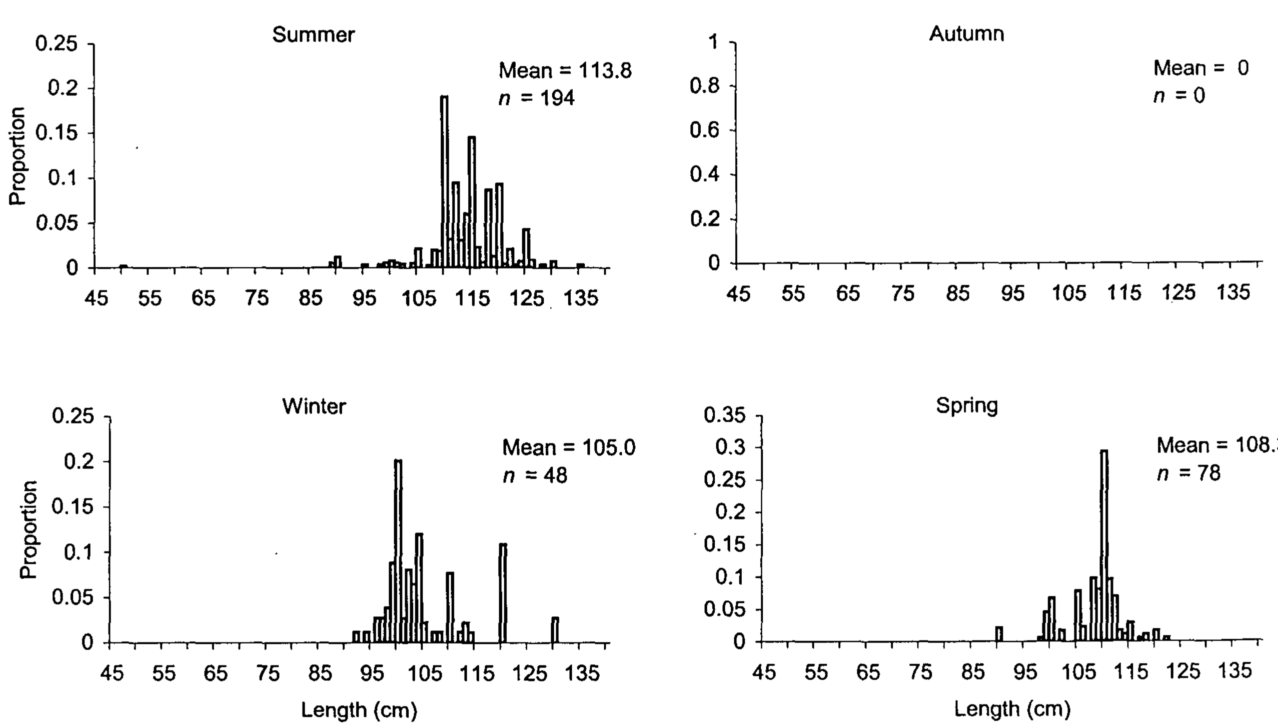

Figure 23: **Length frequencies of scallops harvested by interviewed pickers at Mill Bay. Individual harvests have been weighted by the estimated number of scallops picked by that group.**

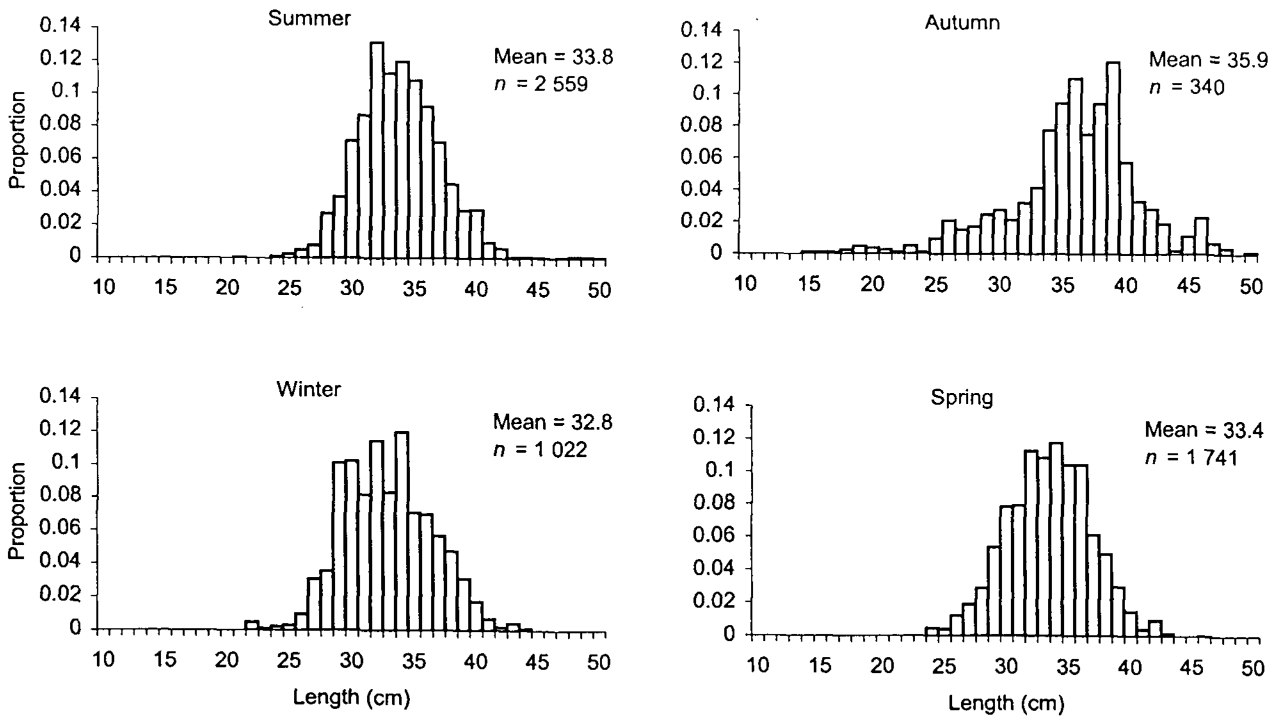

Figure 24: **Length frequencies of cockles harvested by interviewed pickers at Okoromai Bay. Individual harvests have been weighted by the estimated number of cockles picked by that group.**

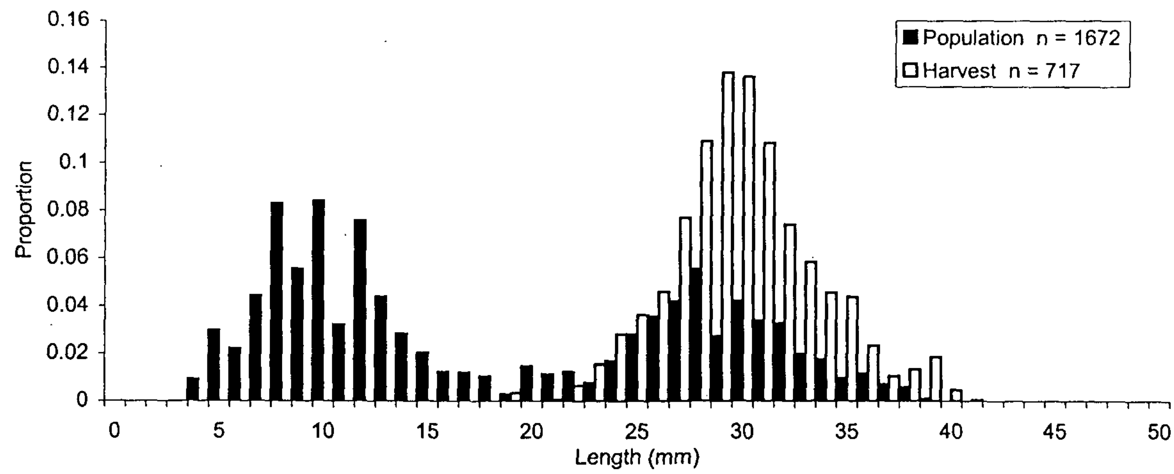

Figure 25 : **Proportional length frequency distributions of the Cornwallis Beach cockle population and cockles harvested from that population by recreational pickers.**

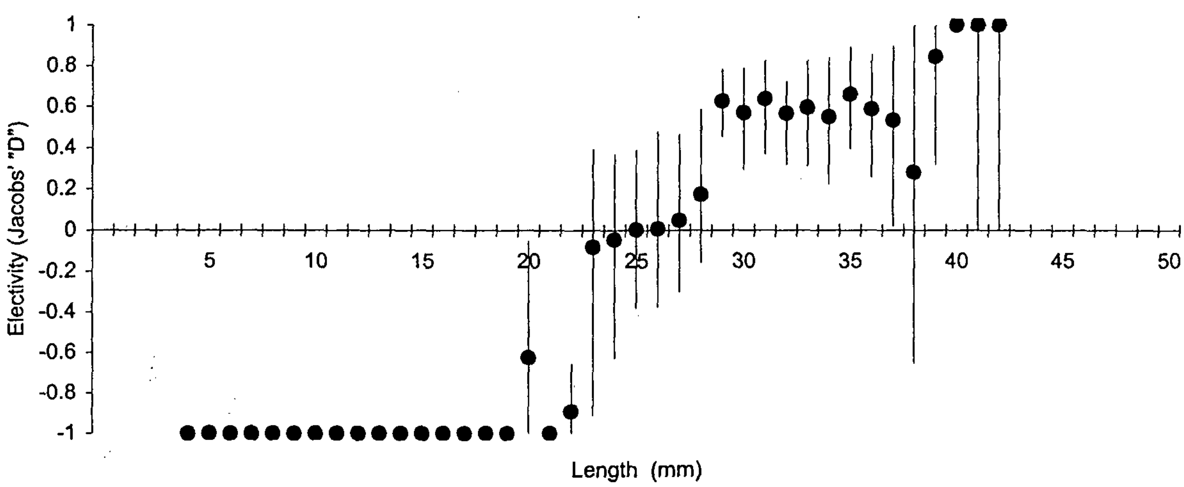

Figure 26 : **Electivity (as Jacobs' "D") of recreational cockle pickers at Cornwallis Beach. Possible values of D range from +1 to -1, positive values indicate length classes which are harvested at a higher proportion than exists in the population and vice versa. Error bars denote approximate 95% confidence intervals calculated using a bootstrap technique.**

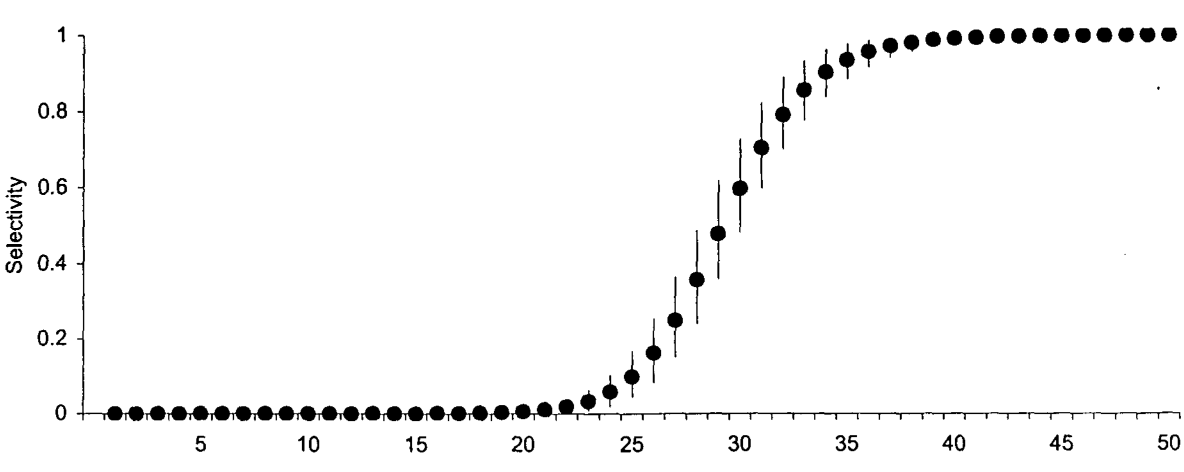

Figure 27 : **Selectivity of recreational cockle pickers at Cornwallis Beach. Error bars denote approximate 95% confidence intervals calculated using a bootstrap technique.**

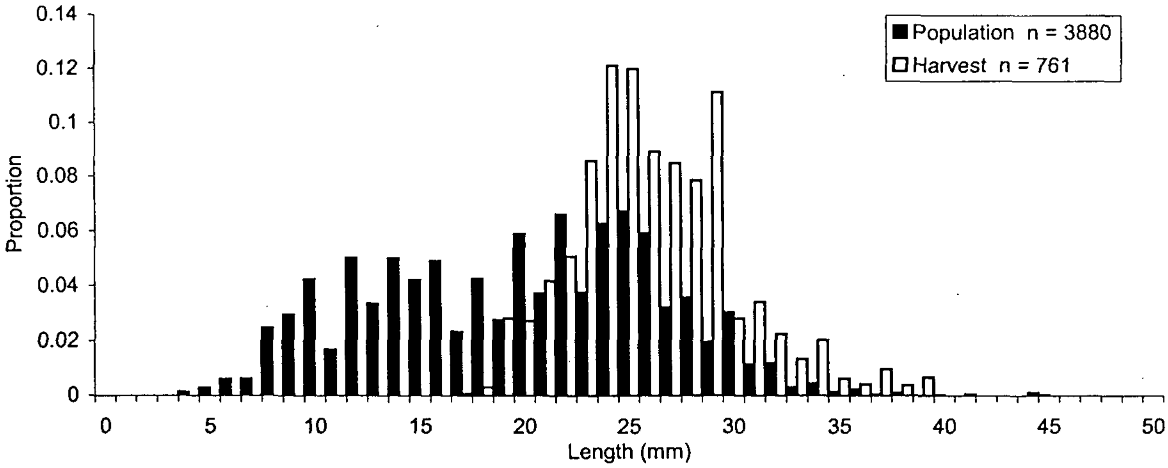

Figure 28 : **Proportional length frequency distributions of the Mill Bay cockle population and cockles harvested from that population by recreational pickers.**

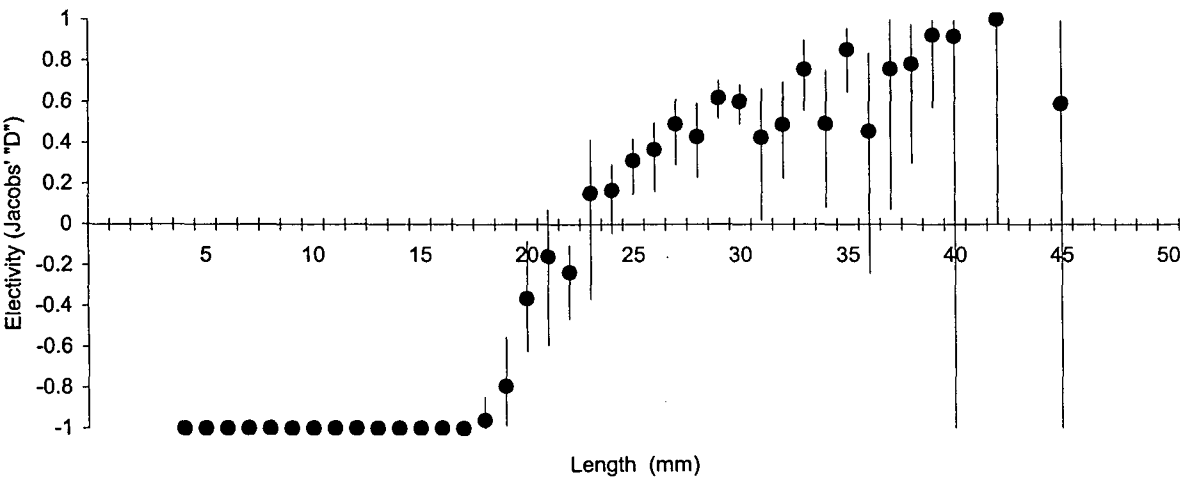

Figure 29 : **Electivity (as Jacobs' "D") of recreational cockle pickers at Mill Bay. Possible values of D range from +1 to -1, positive values indicate length classes which are harvested at a higher proportion than exists in the population and vice versa. Error bars denote approximate 95% confidence intervals calculated using a bootstrap technique.**

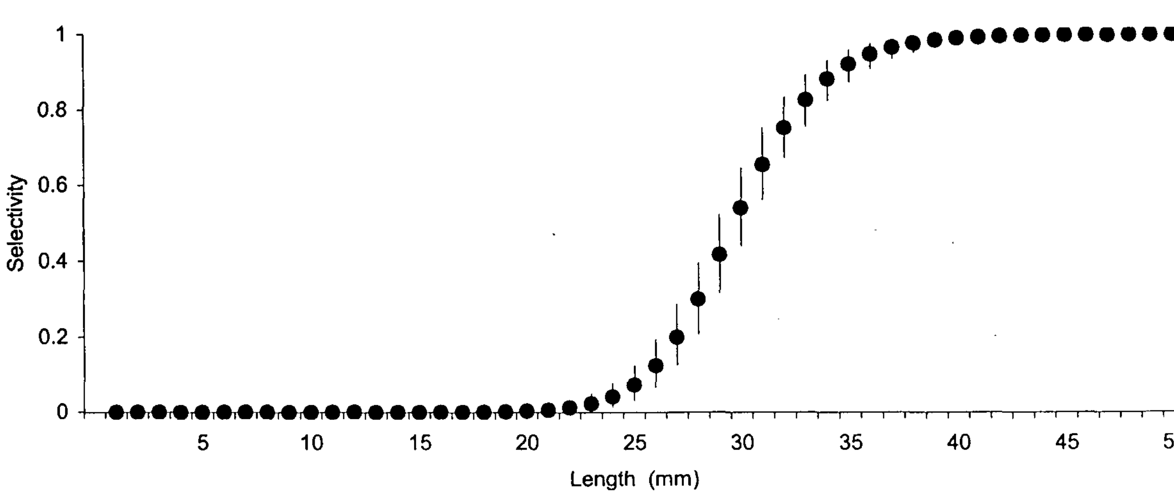

Figure 30 : **Selectivity of recreational cockle pickers at Mill Bay. Error bars denote approximate 95% confidence intervals calculated using a bootstrap technique.**

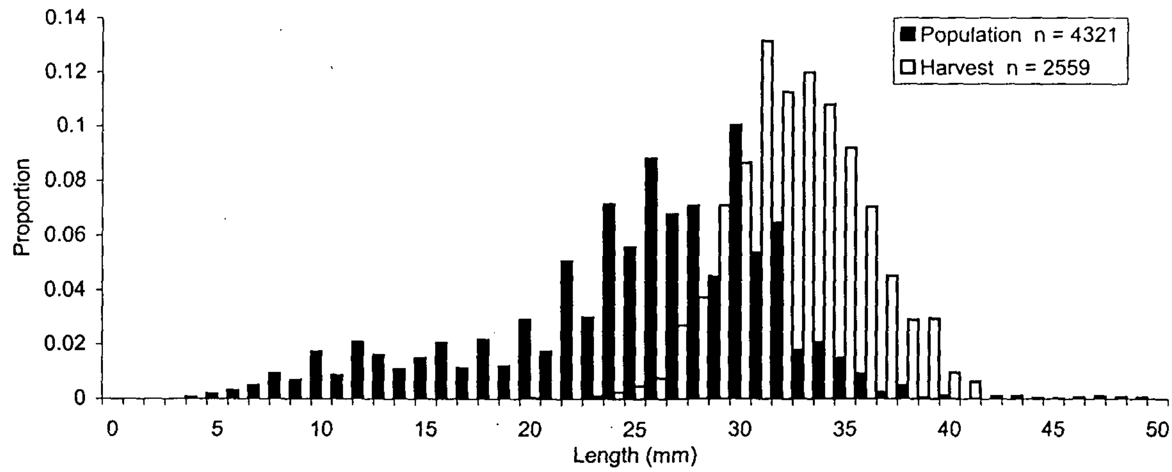

Figure 31 : **Proportional length frequency distributions of the Okoromai Bay cockle population and cockles harvested from that population by recreational pickers.**

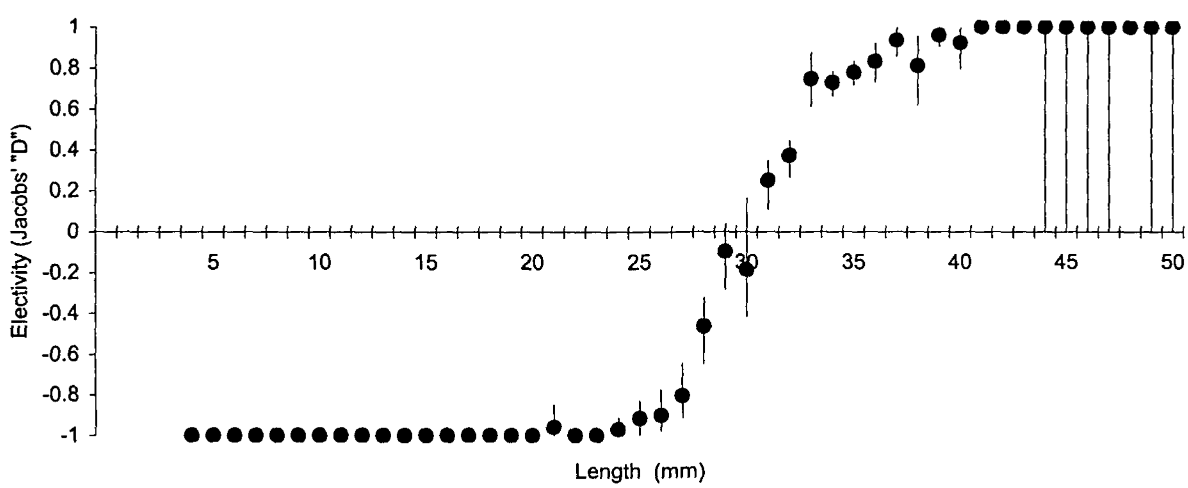

Figure 32 : **Electivity (as Jacobs' "D") of recreational cockle pickers at Okoromai Bay. Possible values of D range from +1 to -1, positive values indicate length classes which are harvested at a higher proportion than exists in the population and vice versa. Error bars denote approximate 95% confidence intervals calculated using a bootstrap technique.**

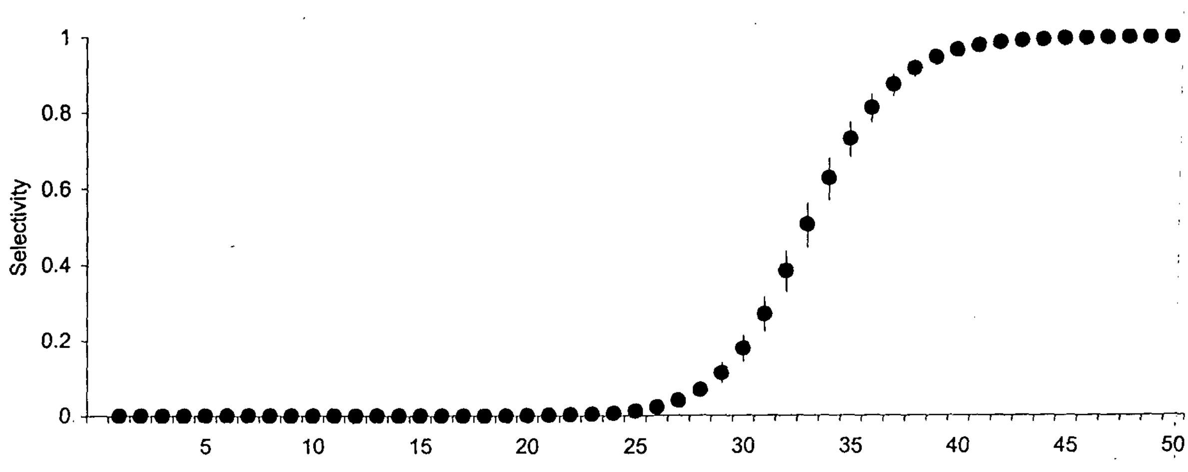

Figure 33 : **Selectivity of recreational cockle pickers at Okoromai Bay. Error bars denote approximate 95% confidence intervals calculated using a bootstrap technique.**

Appendix 1: Estimated weight (kg) of key species harvested at Cornwallis Beach, Mill Bay and Okoromai Bay by season and day type.

Location	Species	Season	Day type	Estimated harvest (kg)	Bootstrap mean	Lower C.I.	Upper C.I.
Cornwallis Beach	Cockles	Summer	Weekend	727	730	471	1 062
			Weekday	764	771	282	1 348
			Total	1 491	1 500	928	2 155
		Autumn	Weekend	708	705	338	1 170
			Weekday	106	105	0	276
			Total	814	810	413	1 339
		Winter	Weekend	223	227	90	411
			Weekday	127	127	26	248
			Total	350	353	180	572
		Spring	Weekend	279	285	172	435
			Weekday	335	331	145	574
			Total	614	616	378	884
		Annual	Weekend	1 936	1 946	1 431	2 550
			Weekday	1 332	1 334	769	1 978
			Total	3 269	3 280	2 513	4 145
Cornwallis Beach	Pacific oysters	Summer	Weekend	432	423	217	721
			Weekday	318	327	162	534
			Total	751	750	493	1 091
		Autumn	Weekend	231	228	48	633
			Weekday	373	367	93	658
			Total	605	595	246	1 053
		Winter	Weekend	131	132	51	239
			Weekday	209	213	50	447
			Total	339	344	162	589
		Spring	Weekend	110	110	53	175
			Weekday	15	21	0	92
			Total	126	131	63	222
		Annual	Weekend	905	892	549	1 398
			Weekday	915	928	564	1 306
			Total	1 820	1 820	1 313	2 488

Appendix 1 continued: Estimated weight (kg) of key species harvested at Cornwallis Beach, Mill Bay and Okoromai Bay by season and day type.

Location	Species	Season	Day type	Estimated harvest (kg)	Bootstrap mean	Lower C.I.	Upper C.I.
Cornwallis Beach	Pipi	Summer	Weekend	4	4	2	7
			Weekday	3	2	0	4
			Total	6	6	3	10
		Autumn	Weekend	0	0	–	–
			Weekday	0	0	–	–
			Total	0	0	–	–
		Winter	Weekend	0	0	–	–
			Weekday	0	0	–	–
			Total	0	0	–	–
		Spring	Weekend	0	0	–	–
			Weekday	0	0	–	–
			Total	0	0	–	–
		Annual	Weekend	4	4	2	7
			Weekday	3	2	0	4
			Total	6	6	3	10
Cornwallis Beach	Scallops	Summer	Weekend	536	533	564	455
			Weekday	628	621	453	492
			Total	1 164	1 155	1 017	947
		Autumn	Weekend	1	1	1	1
			Weekday	0	0	–	–
			Total	1	1	1	1
		Winter	Weekend	524	530	536	802
			Weekday	513	515	532	454
			Total	1 037	1 046	1 068	1 256
		Spring	Weekend	853	861	921	913
			Weekday	463	466	515	488
			Total	1 316	1 327	1 435	1 401
		Annual	Weekend	1 914	1 925	2 021	2 170
			Weekday	1 604	1 603	1 500	1 434
			Total	3 518	3 528	3 521	3 604

Appendix 1 continued: Estimated weight (kg) of key species harvested at Cornwallis Beach, Mill Bay and Okoromai Bay by season and day type.

Location	Species	Season	Day type	Estimated harvest (kg)	Bootstrap mean	Lower C.I.	Upper C.I.
Mill Bay	Cockles	Summer	Weekend	1 270	1 274	789	1 853
			Weekday	703	692	307	1 146
			Total	1 973	1 966	1 314	2 676
		Autumn	Weekend	694	702	232	1 352
			Weekday	235	232	15	521
			Total	929	934	409	1 622
		Winter	Weekend	411	401	135	713
			Weekday	109	108	0	268
			Total	520	509	211	859
		Spring	Weekend	799	798	409	1 225
			Weekday	761	763	90	1 707
			Total	1 560	1 561	763	2 605
		Annual	Weekend	3 174	3 174	2 266	4 143
			Weekday	1 809	1 796	946	2 913
			Total	4 983	4 970	3 674	6 368
Mill Bay	Pacific oysters	Summer	Weekend	864	883	685	849
			Weekday	367	340	197	310
			Total	1 230	1 223	983	1 189
		Autumn	Weekend	111	112	66	104
			Weekday	195	219	78	175
			Total	306	331	184	285
		Winter	Weekend	295	270	134	247
			Weekday	210	203	101	202
			Total	505	473	303	448
		Spring	Weekend	159	162	63	143
			Weekday	651	664	386	614
			Total	810	826	523	776
		Annual	Weekend	1 429	1 427	1 166	1 390
			Weekday	1 422	1 426	761	2 205
			Total	2 852	2 853	2 398	2 784

Appendix 1 continued: Estimated weight (kg) of key species harvested at Cornwallis Beach, Mill Bay and Okoromai Bay by season and day type.

Location	*Species*	*Season*	*Day type*	*Estimated harvest (kg)*	*Bootstrap mean*	*Lower C.I.*	*Upper C.I.*
Mill Bay	Pipi	Summer	Weekend	0	0	–	–
			Weekday	0	0	–	–
			Total	0	0	–	–
		Autumn	Weekend	0	0	–	–
			Weekday	0	0	–	–
			Total	0	0	–	–
		Winter	Weekend	0	0	–	–
			Weekday	0	0	–	–
			Total	0	0	–	–
		Spring	Weekend	0	0	–	–
			Weekday	22	23	2	51
			Total	22	23	2	51
		Annual	Weekend	0	0	–	–
			Weekday	22	23	2	51
			Total	22	23	2	51
Mill Bay	Scallops	Summer	Weekend	200	210	240	202
			Weekday	102	103	88	115
			Total	302	314	328	317
		Autumn	Weekend	0	0	–	–
			Weekday	0	0	–	–
			Total	0	0	–	–
		Winter	Weekend	35	34	26	2
			Weekday	2	2	2	2
			Total	37	36	27	4
		Spring	Weekend	39	41	29	38
			Weekday	7	8	7	3
			Total	46	49	36	41
		Annual	Weekend	274	285	295	243
			Weekday	111	114	96	120
			Total	385	399	391	362

Appendix 1 continued: Estimated weight (kg) of key species harvested at Cornwallis Beach, Mill Bay and Okoromai Bay by season and day type.

Location	Species	Season	Day type	Estimated harvest (kg)	Bootstrap mean	Lower C.I.	Upper C.I.
Okoromai Bay	Cockles	Summer	Weekend	7 287	7 250	4 219	11 193
			Weekday	1 978	1 957	539	4 029
			Total	9 265	9 207	5 682	13 527
		Autumn	Weekend	907	893	278	1 591
			Weekday	42	42	0	125
			Total	948	935	308	1 633
		Winter	Weekend	1 854	1 853	995	2 831
			Weekday	604	597	105	1 254
			Total	2 458	2 450	1 399	3 598
		Spring	Weekend	3 485	3 478	2 188	4 938
			Weekday	1 035	985	190	2 292
			Total	4 520	4 464	2 728	6 457
		Annual	Weekend	13 532	13 475	9 791	17 615
			Weekday	3 659	3 581	1 761	5 875
			Total	17 192	17 056	12 707	21 655

Appendix 2: Estimated number of key species harvested at Cornwallis Beach, Mill Bay and Okoromai Bay by season and day type.

Location	Species	Season	Day type	Estimated no. harvested	Bootstrap mean	Lower C.I.	Upper C.I.
Cornwallis Beach	Cockles	Summer	Weekend	55 954	56 517	37 116	80 379
			Weekday	58 136	57 811	16 598	107 472
			Total	114 090	114 328	69 464	170 013
		Autumn	Weekend	66 481	66 146	29 042	110 833
			Weekday	8 074	6 567	0	16 153
			Total	74 555	72 714	34 345	119 575
		Winter	Weekend	21 606	21 733	9 220	37 994
			Weekday	22 518	22 406	3 832	48 681
			Total	44 124	44 139	20 073	71 911
		Spring	Weekend	19 270	19 507	11 775	29 303
			Weekday	31 682	31 407	12 420	52 844
			Total	50 952	50 914	29 945	74 699
		Annual	Weekend	163 311	163 904	118 868	216 807
			Weekday	120 410	118 191	66 904	175 696
			Total	283 721	282 095	213 896	360 754
Cornwallis Beach	Pacific oysters	Summer	Weekend	13 701	13 651	7 765	21 469
			Weekday	9 529	9 722	4 560	16 972
			Total	23 231	23 374	15 087	33 231
		Autumn	Weekend	9 354	9 457	2 129	23 452
			Weekday	12 379	12 002	3 250	22 747
			Total	21 732	21 459	9 179	37 182
		Winter	Weekend	4 329	4 328	1 709	7 700
			Weekday	6 223	6 418	1 354	13 355
			Total	10 552	10 746	4 858	18 421
		Spring	Weekend	3 828	3 804	1 629	6 461
			Weekday	679	595	0	2 555
			Total	4 507	4 399	2 024	7 347
		Annual	Weekend	31 212	31 241	19 672	46 395
			Weekday	28 810	28 737	16 968	43 504
			Total	60 022	59 978	42 683	79 263

Appendix 2 continued: Estimated number of key species harvested at Cornwallis Beach, Mill Bay and Okoromai Bay by season and day type.

Location	Species	Season	Day type	Estimated no. harvested	Bootstrap mean	Lower C.I.	Upper C.I.
Cornwallis Beach	Pipi	Summer	Weekend	594	591	269	954
			Weekday	386	387	0	739
			Total	980	977	519	1 478
		Autumn	Weekend	0	0	–	–
			Weekday	0	0	–	–
			Total	0	0	–	–
		Winter	Weekend	0	0	–	–
			Weekday	0	0	–	–
			Total	0	0	–	–
		Spring	Weekend	0	0	–	–
			Weekday	0	0	–	–
			Total	0	0	–	–
		Annual	Weekend	594	591	269	954
			Weekday	386	387	0	739
			Total	980	977	519	1 478
Cornwallis Beach	Scallops	Summer	Weekend	4 158	4 132	4 379	3 201
			Weekday	5 363	5 334	6 573	6 381
			Total	9 521	9 466	10 952	9 582
		Autumn	Weekend	27	23	32	5
			Weekday	0	0	–	–
			Total	27	23	32	5
		Winter	Weekend	4 326	4 354	4 400	3 462
			Weekday	4 319	4 333	2 894	4 620
			Total	8 645	8 688	7 294	8 082
		Spring	Weekend	6 938	6 994	5 789	5 277
			Weekday	5 228	5 298	4 383	5 689
			Total	12 166	12 292	10 171	10 966
		Annual	Weekend	15 449	15 503	14 600	11 945
			Weekday	14 910	14 965	13 849	16 690
			Total	30 359	30 468	28 449	28 634

Appendix 2 continued: Estimated number of key species harvested at Cornwallis Beach, Mill Bay and Okoromai Bay by season and day type.

Location	Species	Season	Day type	Estimated no. harvested	Bootstrap mean	Lower C.I.	Upper C.I.
Mill Bay	Cockles	Summer	Weekend	141 946	142 251	79 150	216 782
			Weekday	71 540	71 113	30 570	128 266
			Total	213 486	213 365	137 093	301 097
		Autumn	Weekend	65 973	65 326	21 019	127 780
			Weekday	25 338	25 874	1 388	56 741
			Total	91 311	91 199	37 200	160 960
		Winter	Weekend	41 458	40 066	14 629	73 215
			Weekday	10 435	10 758	0	25 478
			Total	51 893	50 824	22 587	85 575
		Spring	Weekend	67 964	67 675	35 491	104 069
			Weekday	72 747	74 920	13 403	157 008
			Total	140 711	142 596	66 447	230 498
		Annual	Weekend	317 341	315 318	222 599	418 600
			Weekday	180 059	182 666	93 087	290 413
			Total	497 401	497 984	362 880	637 784
Mill Bay	Pacific oysters	Summer	Weekend	29 749	30 292	19 708	42 853
			Weekday	13 778	12 663	4 296	24 292
			Total	43 527	42 955	28 748	59 680
		Autumn	Weekend	3 570	3 512	1 022	6 756
			Weekday	7 616	8 127	480	22 749
			Total	11 185	11 639	3 425	27 173
		Winter	Weekend	11 112	10 341	1 974	22 098
			Weekday	8 266	7 858	0	15 872
			Total	19 378	18 199	7 169	32 572
		Spring	Weekend	4 314	4 372	1 097	9 946
			Weekday	24 017	24 014	5 919	44 625
			Total	28 331	28 386	10 187	48 731
		Annual	Weekend	48 744	48 517	32 546	66 159
			Weekday	53 677	52 662	29 011	77 368
			Total	102 422	101 179	72 815	131 811

Appendix 2 continued: Estimated number of key species harvested at Cornwallis Beach, Mill Bay and Okoromai Bay by season and day type.

Location	Species	Season	Day type	Estimated no. harvested	Bootstrap mean	Lower C.I.	Upper C.I.
Mill Bay	Pipi	Summer	Weekend	0	0	–	–
			Weekday	0	0	–	–
			Total	0	0	–	–
		Autumn	Weekend	0	0	–	–
			Weekday	0	0	–	–
			Total	0	0	–	–
		Winter	Weekend	0	0	–	–
			Weekday	0	0	–	–
			Total	0	0	–	–
		Spring	Weekend	0	0	–	–
			Weekday	3 916	3 899	477	9 057
			Total	3 916	3 899	477	9 057
		Annual	Weekend	0	0	–	–
			Weekday	3 916	3 899	477	9 057
			Total	3 916	3 899	477	9 057
Mill Bay	Scallops	Summer	Weekend	1 593	1 647	1 616	1 620
			Weekday	890	907	740	572
			Total	2 483	2 554	2 355	2 192
		Autumn	Weekend	0	0	–	–
			Weekday	0	0	–	–
			Total	0	0	–	–
		Winter	Weekend	393	398	231	57
			Weekday	37	37	28	48
			Total	431	436	259	104
		Spring	Weekend	358	376	373	282
			Weekday	74	83	108	97
			Total	432	459	482	379
		Annual	Weekend	2 344	2 421	2 220	1 959
			Weekday	1 001	1 027	876	717
			Total	3 345	3 448	3 096	2 676

Appendix 2 continued: Estimated number of key species harvested at Cornwallis Beach, Mill Bay and Okoromai Bay by season and day type.

Location	Species	Season	Day type	Estimated no. harvested	Bootstrap mean	Lower C.I.	Upper C.I.
Okoromai Bay	Cockles	Summer	Weekend	444 368	445 732	266 897	686 374
			Weekday	126 483	128 625	40 360	265 216
			Total	570 851	574 357	350 445	825 913
		Autumn	Weekend	45 808	46 181	16 165	83 465
			Weekday	1 912	1 862	0	5 736
			Total	47 720	48 044	17 594	86 496
		Winter	Weekend	118 170	117 409	63 691	174 352
			Weekday	49 487	49 424	9 950	99 812
			Total	167 657	166 833	96 303	242 037
		Spring	Weekend	218 954	220 372	139 332	306 493
			Weekday	64 443	64 621	13 155	148 920
			Total	283 397	284 992	184 804	406 107
		Annual	Weekend	827 300	829 694	608 146	1 099 336
			Weekday	242 325	244 532	114 760	417 753
			Total	1 069 625	1 074 226	811 788	1 360 850

Appendix 3: Estimated weight (kg) and number of key species harvested at Cornwallis Beach as defined in the intertidal survey (Morrison *et al.* 1999) by season and day

Location	Species	Season	Day type	Estimated harvest (kg)	Bootstrap mean	Lower C.I.	Upper C.I.
Cornwallis Beach	Cockles	Summer	Weekend	645	694	420	1 032
			Weekday	535	592	127	1 195
			Total	1181	1285	727	1 962
		Autumn	Weekend	692	749	342	1 264
			Weekday	106	115	0	301
			Total	798	864	425	1 407
		Winter	Weekend	215	239	86	438
			Weekday	82	87	6	187
			Total	297	326	148	542
		Spring	Weekend	228	251	129	408
			Weekday	335	357	148	619
			Total	564	608	352	901
		Annual	Weekend	1780	1933	1 374	2 580
			Weekday	1059	1151	598	1 814
			Total	2839	3084	2 262	3 973

Location	Species	Season	Day type	Estimated no. harvested	Bootstrap mean	Lower C.I.	Upper C.I.
Cornwallis Beach	Cockles	Summer	Weekend	50 267	54 387	33 432	80 818
			Weekday	47 734	51 209	9 611	103 855
			Total	98 001	105 596	59 201	165 797
		Autumn	Weekend	65 216	70 422	30 270	118 915
			Weekday	8 074	7 159	0	17 607
			Total	73 290	77 580	35 885	129 085
		Winter	Weekend	20 385	22 530	8 798	39 909
			Weekday	8 466	9 047	601	19 087
			Total	28 852	31 577	14 793	51 568
		Spring	Weekend	15 451	16 865	8 924	27 420
			Weekday	31 682	33 887	13 380	57 017
			Total	47 133	50 752	27 563	76 384
		Annual	Weekend	151 319	164 204	115 680	222 182
			Weekday	95 956	101 302	51 924	163 899
			Total	247 275	265 505	197 683	345 071

Appendix 4: Forms used in the survey.

SHELLFISH HARVEST SURVEY FORM
SESSION INFORMATION

Page ....of........

Interview location: ____________________ Interviewer name: ____________________

Interview location code	interview time of day code	Date (d d m m y y)	Session time start (24 hour)	Session time finish (24 hour)	Day type	Interviewer Initials

Day type: 1=Weekend or Public holiday, 2=Weekday

Time of low tide (24 hour)

Environmental data:

Sea conditions
1=Smooth (0.1 - 0.5m)
2=Slight (0.5 - 1.0 m)
3=Moderate (1.0 - 2.5m)
4=Rough (2.5 - 4.0m)

Rain
1=Nil
2=Light continous
3=Light scattered
4=Medium scattered

Overhead conditions
1=Sunny continuous
2=Mainly sunny
3=Mainly cloudy
4=Continuous cloudy

Wind speed
1=Nil
2=Light (1-10 kts)
3=Medium (11-20 kts)
4=Strong (21 + kts)

Wind direction
1=Nil (no wind)
2=Variable
3=North
4=South
5=NorthEast
6=SouthWest
7=East
8=West
9=SouthEast
10=NorthWest

Fisher count data:

Hour	Strata No.	Count	Hour	Strata No.	Count	Hour	Strata No.	Count

Hour	Strata No.	Count	Hour	Strata No.	Count	Hour	Strata No.	Count

Appendix 4 continued: Forms used in the survey.

SHELLFISH HARVEST SURVEY FORM
INTERVIEW INFORMATION

Page ....of........

Interview location code	Time of day code	Date (d d m m y y)

Group No.	No. of Fishers	Strata No.	Time of intercept	Intercept outcome	Target species	Time start (24 hour)	Time finish (24 hour)	Species	Estimated Weight	Agreed Weight

Group No.	Species	Max Length (cm)

Group No.	Species	Max Length (cm)

Group No.	Species	Max Length (cm)