



**Biomass surveys of cockles in
Whangarei Harbour, 2002**

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**Final Research Report for
Ministry of Fisheries Research Project COC2001/01
Objectives 3**

National Institute of Water and Atmospheric Research

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Final Research Report

Title: Biomass surveys of cockles in Whangarei Harbour, 2002

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1. **Date:** 28 January, 2003

2. **Contractor:** National Institute of Water & Atmospheric Research Ltd

3. **Project Title:** Stock assessment of cockles in Whangarei Harbour, including Snake Bank

4. **Project Code:** COC2001/01 (Objective 3)

5. **Project Leader:** Martin Cryer

6. **Duration of Project:**

Start date: 1 October, 2001

Expected completion date: 30 September, 2002

7. **Executive Summary:**

A stratified random survey of cockles on Snake Bank in March 2002 (Objective 1 of this project) produced an estimate of recruited biomass (30 mm or greater shell length) of 466 t with a *c.v.* of 19%. Surveys in other parts of the harbour conducted in July–August, 2002, produced a comparable estimate of 881 t with a *c.v.* of 33%, concentrated almost entirely on MacDonald Bank and Marsden Bay. Cockles in other areas sampled (McLeod Bay, Tamaterau, and Wellington Reach) were sparse and of small average size. Based on the most recent surveys, Snake Bank contains about one-third of the biomass of cockles in Whangarei Harbour.

8. **Objectives:**

Only Objective 3 is pertinent to this report. Objectives 1 & 2 were reported earlier (Cryer et al. 2002).

3. To estimate the size structure and absolute biomass of cockles in other areas within Whangarei Harbour during the 2001/2002 fishing year. The target coefficient of variation (*c.v.*) of the estimate of absolute recruited biomass is 20%.

9. Methods:

Previous work has shown that there are substantive populations of cockles on Snake Bank (e.g., Cryer et al. 2002) and MacDonald Bank (e.g., Morrison & Parkinson 2001). Snake Bank was sampled in early 2002 (Cryer et al. op. cit.) but MacDonald Bank was not, so meeting Objective 3 required us to identify other suitable areas, and sample these plus MacDonald Bank. Areas of likely cockle habitat other than Snake and MacDonald Banks were identified by examination of marine charts and maps (as a guide to suitable habitat) and through consultation with local NIWA staff, local fishers, and local officers of the Northland Regional Council. Documentation of some previous surveys commissioned by NRC was also available for scrutiny. We stratified the likely areas geographically into eight strata (Figure 1).

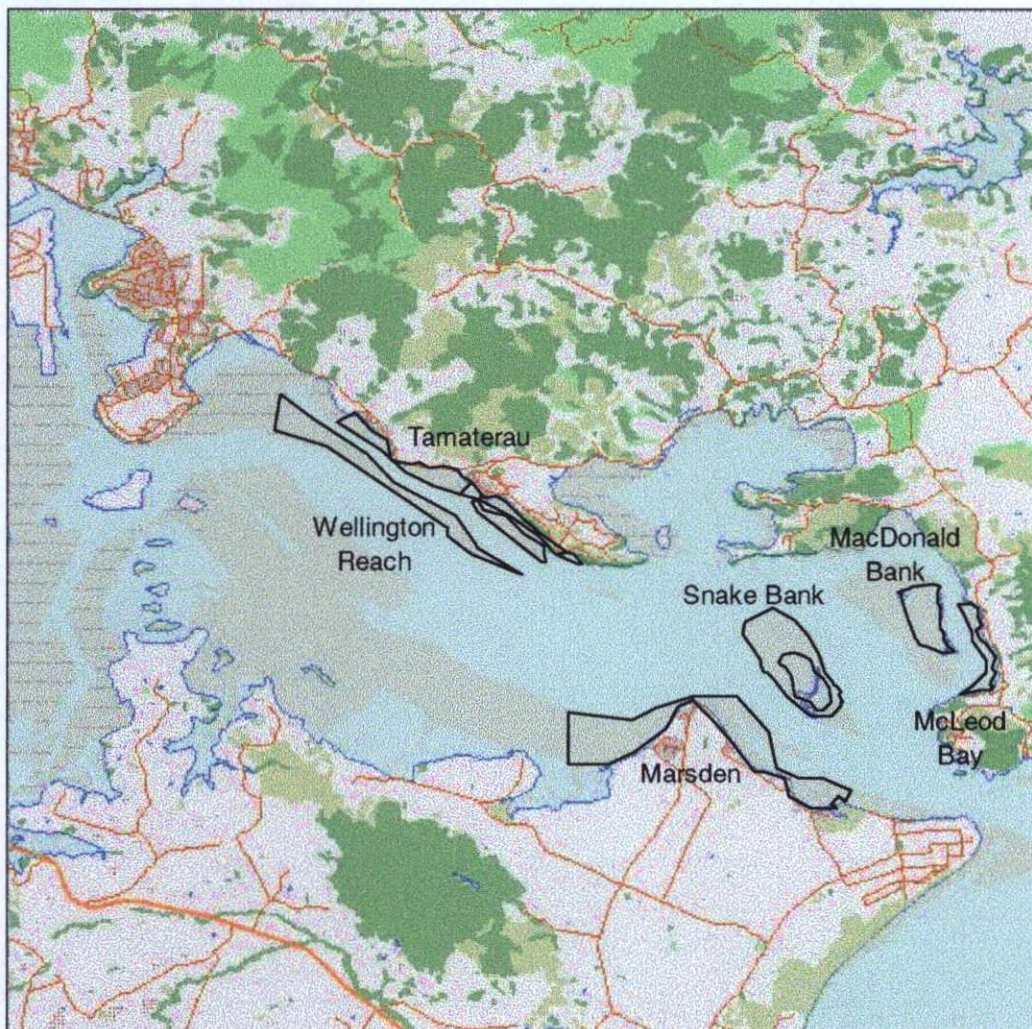


Figure 1: Beaches and banks within Whangarei Harbour that were sampled for cockles in July 2002. Strata are delineated by solid lines.

Stations were allocated to strata on the basis of historical information (MacDonald Bank stratum) or size (all other strata). For MacDonald Bank, we predicted that about 30 stations in the two strata described by Morrison & Parkinson (2001) would generate an estimate of recruited biomass with adequate precision for inclusion in a harbour-wide estimate of recruited biomass. The balance of our sampling effort (and, consequently, sampling sites) was divided among the other strata in proportion to their relative size (area), subject to a

minimum allocation of five sites per stratum (Table 1). We randomised the location of sites within strata using purpose-built software, because the program usually used for this purpose (RAND_STN for PCs) generates site locations with inadequate precision for such small strata.

Table 1: Design of survey of likely cockle habitat in Whangarei Harbour (excluding and including Snake Bank) based on an initial allocation for MacDonald Bank and allocation in proportion to surface area for other strata (subject to a minimum allocation of five sites). Locations of strata are shown in Figure 1.

Stratum	Area (km ²)	Sites in 2002	Sites km ⁻²
MacDonald Bank (new)	0.563	24	42.6
Marsden East (Marsden Bay)	1.214	16	13.2
Marsden West	1.128	15	13.3
McLeods Bay	0.284	5	17.6
Tamaterau	0.685	9	13.1
Wellington Reach	1.100	14	12.7
Wellington Offshore	0.210	5	23.8
Total (excl. Snake Bank)	5.184	88	19.0
Snake Bank (high density)	0.419	36	85.9
Snake Bank (low density)	1.118	17	15.2
Total (incl. Snake Bank)	6.721	141	21.0

During our first survey in July, we discovered that there were substantial discrepancies between the most up-to-date marine chart of the harbour and the various banks and beaches we intended to sample. In particular, many of our proposed sites were in deep channels, or habitat completely unsuited to cockles. The discrepancy was greatest for MacDonald Bank, so we described a single new stratum by walking the tide-line at dead low tide and periodically recording position (using a high-precision, but non-differential, hand-held GPS).

The revised and simplified stratification was used again in 2002 (Table 1). Overall, 88 randomly-located sites in seven strata were visited in turn, using a high-precision (but non-differential) hand-held GPS. At each site, a square quadrat of 0.5 x 0.5 m (0.25 m²) was thrown haphazardly onto the substrate. All sediment beneath the quadrat was excavated to the anaerobic layer (generally to a depth of about 100 mm, but sometimes considerably deeper) by hand, including any animals directly under the south- and west-facing sides (this takes account of any possible “edge effect”). Cockles were extracted from the sediment using a metal sieve of 5 mm square aperture agitated in water. All cockles were measured to the next whole millimetre down, and the aggregate weight of cockles in each of three size classes (< 30 mm, 30–34 mm, ≥ 35 mm) determined by direct weighing. Standing biomass per unit area was estimated by scaling to a square metre of sediment.

The overall mean biomass of cockles (for a given size range) was estimated using the weighted average of the stratum estimates of mean biomass, weights being proportional to the relative area of each stratum:

$$\bar{x}_y = \sum_{i=1}^n W_i \bar{x}_i \quad (1)$$

where \bar{x}_y is the overall mean biomass, W_i is the relative area and \bar{x}_i the mean biomass in stratum i . The variance for this mean was estimated using:

$$s_y^2 = \sum_{i=1}^n W_i^2 s_i^2 / n_i \quad (2)$$

where s_y^2 is the variance of the estimated mean biomass, s_i^2 is the sampling variance in stratum i , and n_i is the number of samples taken in stratum i . (Snedecor & Cochran 1989). No finite correction term was applied because the sampling fraction was negligible (less than 0.1% of the total area).

Station length frequency distributions were estimated by scaling the recorded length frequency distributions to a square metre of sediment. Stratum length frequency distributions were estimated as the average station length frequency distribution for that stratum scaled by the stratum area (in square metres). The population length frequency was estimated by adding the stratum length frequency distributions.

10. Results:

The distribution of recruited biomass among strata, the total biomass, and the estimated precision of these estimates were all sensitive to changes in the assumed size at recruitment. If only very large cockles (those 35 mm or more shell length) are included in the estimate, more than half of the recruited biomass is in Marsden Bay (Marsden East), and the c.v. is very broad. As the size at recruitment (to the potentially fished population) decreases, the biomass is spread among progressively more strata, and the dominance of Marsden Bay decreases. At an assumed size at recruitment of 30 mm (as for Snake Bank), the total recruited biomass in areas other than Snake Bank was estimated to be 881 t (c.v. = 33%), spread roughly 60:40 between MacDonald Bank and Marsden Bay. At an assumed size at recruitment of 20 mm (similar to the size at biological maturity), the total recruited biomass in areas other than Snake Bank was estimated to be 3243 t (c.v. = 15%); about three-quarters was on MacDonald Bank.

Table 2: Sensitivity of distribution among strata, total biomass, and survey precision to changes in the assumed size at recruitment of cockles.

Sizes (mm)	Biomass estimates (t)							C.V.	
	New McDonald	Marsden East	Marsden West	McLeods Bay	Tamaterau	Wgtn. Reach	Wgtn. Offshore		Total
≥ 35	61	72	0	0	0	0	0	132	0.398
≥ 30	548	333	0	0	0	0	0	881	0.329
≥ 25	1 434	521	9	20	3	3	0	1 989	0.207
≥ 20	2 400	614	148	72	8	3	0	3 243	0.148
Total	2 548	677	205	100	13	3	0	3 545	0.139

From these estimates, it can be inferred that large cockles were rare other than on MacDonald Bank and in Marsden Bay. Our estimates of length frequency distribution are consistent with this inference (Figure 2) and we recorded cockles of 30 mm or larger only in these two strata. There were, however, other marked differences among the strata. In Marsden Bay, the length frequency distribution was relatively flat, but tending to bimodal with peaks at roughly 17

and 30 mm. Elsewhere, the length frequency distributions were more markedly peaked, with a modal length class of about 24 mm on MacDonald Bank and about 21 mm elsewhere.

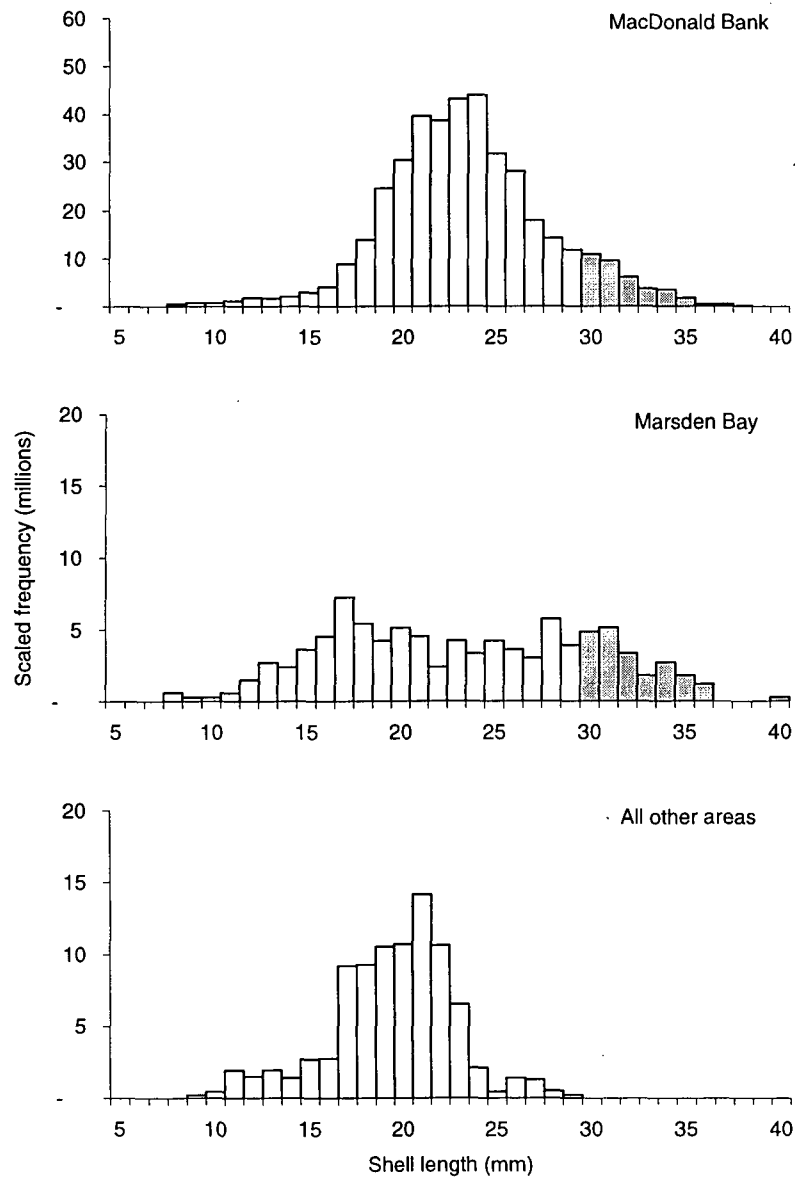


Figure 2: Length frequency distributions, scaled to estimated population size, of cockles on MacDonald Bank, in Marsden Bay (Marsden East Stratum), and all other areas combined in July 2002. Size classes 30 mm or greater shell length are shaded to highlight sizes traditionally considered to be of interest to recreational and commercial pickers.

For comparison, the March 2002 survey of 53 stations on Snake Bank produced an estimated recruited biomass (30 mm or more shell length) of 466 t with a *c.v.* of 18.9% (Cryer et al. 2002). Restricting the estimate of recruited biomass to cockles longer than 35 mm produced a biomass estimate of 44 t with a *c.v.* of 29%, longer than 20 mm a biomass estimate of 1574 t with a *c.v.* of 14%, and total biomass was estimated to be 1618 t with a *c.v.* of 14%.

Thus, Snake Bank contains 25% of the biomass of very large cockles (35 mm or larger), 35% of the traditionally accepted recruited biomass (30 mm or larger), 33% of the biologically mature cockles (20 mm or larger), and 31% of the total cockle biomass in Whangarei Harbour.

References Cited

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- Morrison, M.; Parkinson, D.M. (2001). Stock assessment of cockles on Snake and MacDonald Banks, Whangarei Harbour, 2000. *New Zealand Fisheries Assessment Report 2001/19*. 16 p.
- Snedecor, G.W.; Cochran, W.C. (1989). *Statistical Methods*. 8th ed. Iowa State University Press, Ames, Iowa, USA.

11. Conclusions:

1. A stratified random survey of cockles in parts of Whangarei Harbour other than Snake Bank in July-August, 2002, was used to estimate a recruited biomass (cockles 30 mm or more shell length) of 881 t with a c.v. of almost 33%.
2. The recruited biomass estimate for areas other than Snake Bank and its precision are sensitive to the assumed size at recruitment; at 35 mm or larger, the estimate is 132 t \pm 40% whereas at 20 mm or larger the estimate is 3243 t \pm 15%.
3. At an assumed size at recruitment to the potentially fished population of 30 mm, Snake Bank contains 35% of the recruited biomass of cockles in Whangarei Harbour. This proportion is not very sensitive to the assumed size at recruitment.
4. The estimated length frequency distribution of cockles varied considerably among areas in the harbour, but only on MacDonald Bank and in Marsden Bay were there cockles of 30 mm or larger. There were few cockles longer than 35 mm except in Marsden Bay.

12. Publications:

The only other publications for this project are a Final Research Report for Objectives 1 & 2, and a presentation to the Shellfish Fisheries Assessment Working Group.

13. Data Storage:

Length and weight data from surveys are held on a secure, backed-up server at NIWA, Auckland and will be transferred to the Empress database, *beach* before completion of the project.