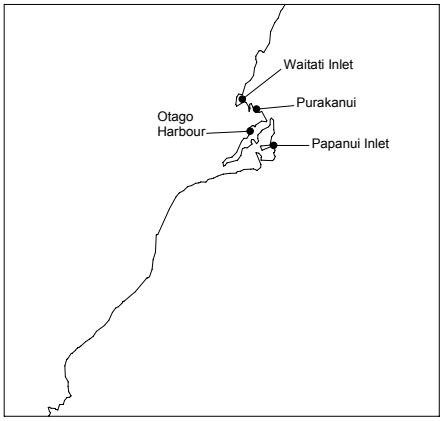
COCKLES (COC 3A) Otago Peninsula

(*Austrovenus stutchburyi*)
Tuangi



1. FISHERY SUMMARY

1.1 Commercial fisheries

Cockles are fished commercially only in Papanui and Waitati Inlets, but they are also present in other places around the Otago Peninsula. Commercial landings from Papanui and Waitati Inlets are shown in Table 1. A limit of 104 t was in effect for Papanui and Waitati Inlets combined from 1986–87 through 1991–92. From 1992–93 to 1998–99, the catch limits were 90 t for Papanui Inlet and 252 t for Waitati Inlet. In April 2000, the catch limits were increased to 427 t for Papanui Inlet and 746 t for Waitati Inlet.

Table 1: Reported landings (t) of cockles from Papanui and Waitati Inlets, Otago, combined (FMA 3), from 1986–87 to 2007-08 based on Licensed Fish Receiver Returns (LFRR). Catch split provided by Southern Clams Ltd (Stewart 2005).

Year	Papanui (t)	Waitati (t)	Total (t)
1986–87	14		14
1987–88	8		8
1988–89	5		5
1989–90	25		25
1990–91	90	16	106
1991–92	90	14	104
1992–93	90	92	182
1993–94	90	109	199
1994–95	90	252	342
1995–96	90	252	342
1996–97	90	252	342
1997–98	90	252	342
1998–99	90	293	383
1999–00	118	434	552
2000–01	90	606	696
2001–02	49	591	640
2002–03	52	717	767
2003–04	73	689	762
2004–05	91	709	800
2005–06	68	870	943
2006–07	0*	907	907
2007–08+	–	–	760

*No catches were taken from Papanui Inlet in 2006–07 because of water quality problems.
+Catch split unavailable in 2007-08

Commercial fishing in Papanui and Waitati Inlets began in 1983. There has been no size limit. In 1992, 35 mm shell length was the minimum size for commercial cockles. However, commercial fishers currently target ≥28 mm cockles, therefore 28 mm is used as the effective minimum size in

yield calculations. CPUE data are available for this fishery. COC 3A was introduced to the Quota Management System in October 2002 with a TAC of 1500 t; comprising a customary allowance of 10 t, a recreational allowance of 10 t, an allowance for other fishing related mortality of 10 t, and a TACC of 1470 t.

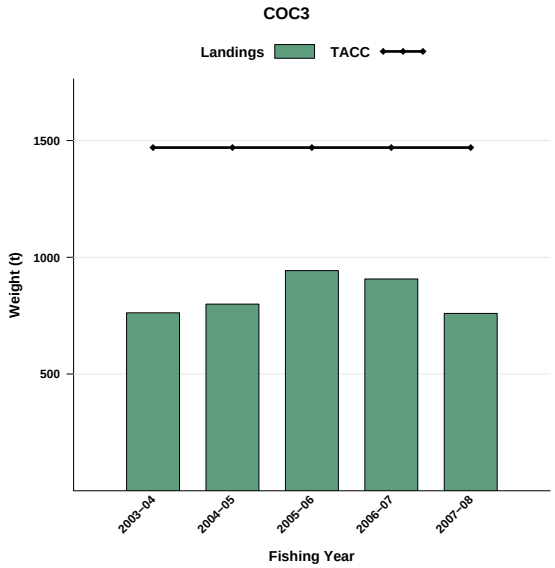


Figure 1: Historical landings and TACC for COC3 (Otago). Note that this figure does not show data prior to entry into the QMS.

1.2 Recreational fisheries

Cockles are taken by recreational fishers in many areas of New Zealand. The recreational fishery is harvested entirely by hand digging. Relatively large cockles are preferred, but ≥30 mm cockles are taken.

Amateur harvest levels in FMA 3 were estimated by telephone and diary surveys in 1993–94 (Teirney *et al*. 1997), 1996 (Bradford 1998) and 2000 (Boyd & Reilly 2004), Table 2. COC 3A is a smaller area within FMA 3. Harvest weights are estimated using an assumed mean weight of 25 g (for cockles >30 mm). The estimates for 1993–94 and 1996 are considerably less than the 2000 estimate and are considered to substantially underestimate the recreational harvest. The 2000 estimate is considered to be a more reliable estimate of absolute harvest.

Table 2: Estimated numbers of cockles harvested by recreational fishers in FMA 3, and the corresponding harvest tonnage. Figures were extracted from a telephone and diary survey in 1993–94, and the national recreational diary surveys in 1996 and 2000.

Fishstock	Survey	Harvest (N)	% CV	Harvest (t)
	1993–94			
FMA 3	South	106 000	51	2.7
	1996			
FMA 3		144 000	–	3.6
	2000			
FMA3		1 476 000	45	36.9

1.3 Customary non-commercial fisheries

Many intertidal bivalves, including cockles, are very important to Maori as traditional food, particularly to Huirapa and Otakou Maori in the Otago area. Tangata tiaki issue customary harvest permits for cockles in Otago. The number of cockles harvested under customary permits is given in Table 3.

Table 3: Number of cockles harvest under customary fishing permits.

Year	Number of cockles
1998	750
1999	0
2000	1 109
2001	1 090
2002	0
2003	2 750
2004	4 390
2005	5 699

1.4 Illegal catch

No quantitative information is available on the magnitude of illegal catch but it is thought to be insignificant.

1.5 Other sources of mortality

No quantitative information is available on the magnitude of other sources of mortality. It has been suggested that some harvesting implements, such as brooms, rakes, "hand-sorters", bedsprings and "quick-feeds" cause some incidental mortality, particularly of small cockles, but this proposition has not been scientifically investigated. The incidental mortality from mechanical digging is thought to be relatively small. High-grading of cockles is also practised, with smaller sized cockles being returned to the beds. The mortality from this activity is unknown, but is likely to be low.

2. STOCKS AND AREAS

Little is known of the stock boundaries of cockles. No specific studies of stock structure in cockles are available. Recent assessments have considered the commercially fished areas to be "discrete populations".

Cockles have larvae that spend about three weeks in the plankton. As in similar marine invertebrates that are essentially sessile after settlement, the planktonic phase may function as a dispersal mechanism. Populations such as those surveyed near Dunedin may receive spat from other nearby populations and may, in turn, provide spat for other areas.

3. STOCK ASSESSMENT

Stock assessments for Papanui Inlet and Waitati Inlet have been conducted using absolute biomass surveys, yield-per-recruit analyses, and Method 1 for estimating CAY (Annala *et al*. 2002). Breen *et al*. (1999) also estimated biomasses and yields for Otago Harbour and Purakanui.

3.1 Estimates of fishery parameters and abundance

A project to estimate growth and mortality in Papanui and Waitati Inlets, Purakanui and Otago Harbour (Bed 1) was undertaken in the late 1990s. Notched clams did not exhibit significant growth when recovered after one year, and modes in the length frequency distributions did not shift when measured over four sampling periods within a year (Breen *et al*. 1999).

In 2004 yield-per-recruit modelling was conducted for Papanui and Waitati inlets separately (Stewart 2005). For this the parameters $L\infty$ = 40.296 mm, K = 0.311/yr, t_0 = 0.0 mm, M = 0.30-^{yr}, size at recruitment = 30 mm, a = 0.00023172, b = 3.1375, as used by Wing *et al.* (2002), were used again. For both inlets, $F_{0.1}$ was estimated for M = 0.1, 0.2 and 0.3/yr respectively.

3.2 Biomass estimates

Biomass surveys have been undertaken periodically in COC 3 since 1984. A major difference in methods used to extract biomass values for different size classes exists between previous surveys. Wildish (1984) and Stewart *et al*. (1992) separated cockles by sieving into three size classes. Breen *et al*. (1999) measured random samples of cockles from each inlet to calculate length-weight relationships. The first method only allows estimation of biomass from predetermined size classes. By

calculating size structure of populations using length to weight data a more flexible approach is allowed where data can be matched to current commercial needs as well as to future survey results. The 1998 survey used random samples from each inlet to calculate length to weight relationships (Breen *et al*. 1999). This method was once again used in the 2002 survey (Wing *et al*. 2002). In the 2004 and 2007 surveys random samples from each shellfish bed were weighed and their longest axis measured (Stewart 2005, 2008). These data were then used to generate length to weight relationships.

In Table 4, estimates of biomass from previous surveys are compared with the 2007 survey (Stewart 2008). In Waitati inlet the biomass of juveniles (334 t) in 2007 is higher than in 2004 but remains well below the 1210 t figure from the 1992 survey. The 2007 biomass of adults (19–34 mm) was higher than in 2004 but less than the 1998 figure. The biomass of larger-sized adults (i.e., the ≥30) was lower than in 2004, as was the estimate for the ≥35 mm size class.

Table 4: Current (±95% CI) and previous biomass estimates from Papanui Inlet and Waitati Inlet*.

Papanui Inlet

Size Class	1984	1992	1998	2002	2004 Total inlet	2004 Commercial area
>2 to 18mm (juveniles)	65	139	33	17 ± 1.7	36 ± 2.2	13 ± 1.3
19 to 34mm (adults)	3 705	3 721	3 435	1 970 ± 192	2 415 ± 151	825 ± 88
≥35mm	2 370	1 706	2 231	2 579 ± 252	2 301 ± 273	1 847 ± 208
≥30mm			3 990.2	3 860 ± 365	3 677 ± 367	2 420 ± 271
Total (t)	6 140	5 567	5 699	4 565 ± 424	4 752 ± 425	2 685 ± 298

*Wildish 1984; Stewart *et al*. 1992; Breen *et al*. 1999; Wing *et al*. 2002; Stewart, 2005. Area of current commercial beds, Papanui Inlet = 815,811 m^2.

Waitati Inlet*.

Size Class	1984	1992	1998	2002	2004 Total Inlet	2004 Commercial area	2007 Total Inlet	2007 Commercial area
>2 to 18mm (juveniles)	619	1 210	304	153 ± 20	257 ± 14	77 ± 4	335 ± 26	102 ± 7.5
19 to 34mm (adults)	7 614	5 198	8 519	6 653 ± 652	7 272 ± 403	2 735 ± 129	7 673 ± 591	1 284 ± 95
≥35mm	3 844	4 620	4 381	4 298 ± 298	4 535 ± 508	3 872 ± 384	3 941 ± 462	
≥30mm			7 235	7 183 ± 463	7 993 ± 720	5 612 ± 681	7 107 ± 548	4 726 ± 352
Total (t)	12 080	11 027	13 204	11 103 ± 848	12 064 ± 925	6 685 ± 517	11 948 ± 921	6 112 ± 456

*Area of current commercial beds, Waitati Inlet = 943,986 m^2

3.3 Estimates of Maximum Constant Yield (MCY)

No estimates of MCY were made because current biomass was available for Waitati Inlet to estimate CAY.

3.4 Estimates of Current Annual Yield (CAY)

For Waitati Inlet, CAY was estimated (Table 6) using Method 1 ($CAY = (F_{0.1}/Z)\ (1-\exp(-Z))B_{BEG}$) and the 2007 biomass estimates. CAY was estimated for both the entire inlet area and a subset area where the commercial fishery has been operating for the past several years.

Table 6: CAY estimates for COC 3 cockles ≥28 mm shell length.

Waitati whole inlet
B_{BEG} = 8378

M	$F_{0.1}$	CAY
0.2	0.2899	1 920
0.3	0.3863	2 342
0.4	0.5537	2 990

Waitati current commercial area
B_{BEG} = 5261

M	$F_{0.1}$	CAY
0.2	0.2899	1 205.84
0.3	0.3863	1 470.53
0.4	0.5537	1 877.60

3.5 Other factors

Commercial, customary and recreational fishers target different sized cockles. Biomass and yield estimates will differ for different sizes of recruitment to the fishery. Maori and recreational fishers prefer larger cockles (>45 mm shell length and greater) whereas commercial fishers currently prefer cockles of around 28–34 mm. Estimates of yields have been estimated for size of recruitment at ≥28 mm; however, these estimates do not consider multiple fisheries preferring different sized cockles. Depending on the management approach taken in the future in COC 3, the appropriateness of the current methods to estimate yield may need to be reviewed.

The yield estimates use information from yield-per-recruit analyses that assume constant recruitment, and constant growth and mortality rates. Yield estimates will be improved when growth, mortality and recruitment variation are better known.

As cockles become sexually mature at around 18 mm, using a size of recruitment of 30 mm should provide some protection against egg overfishing under most circumstances. Certainly the increase in the biomass of small cockles (>2 to 18mm) seen in both inlets in 2004 suggests that the very poor recruitment observed by Wing *et al*. (2002) may have been due to natural variability, and supports the conjecture that significant recruitment might occur only sporadically in the Otago fishery, as suggested by John Jillett (pers. comm.) and Breen *et al*. (1999). The possibility that fishing has an effect on recruitment remains an unknown.

In other cockle fisheries it has been shown that recruitment of juvenile cockles can be reduced by the removal of a large proportion of adult cockles from a given area of substrate. This would suggest that there is some optimal level of adult biomass to facilitate recruitment, although its value is not known. To date it has not been determined whether the cockles being targeted by commercial harvesting in the Otago fishery comprise the bulk of the spawning stock or if disturbance of the cockle beds is influencing settlement.

The distribution of very small size classes (2 to 10mm) across the various beds is variable. The fact that very small shellfish are notably absent, or present in only low numbers, on Beds E and G in Waitati Inlet, suggests that commercially fished beds may have low numbers of recruits. This is, however, by no means consistent, with other commercial beds (e.g., Bed B) having reasonably high numbers of recruits that are comparable with non-commercially harvested beds. A comparison of the size/frequency histograms with fishing history for each bed would be a worthwhile exercise and may reveal more. The fact that the relationship between spawning stock and recruitment in this fishery is poorly understood remains a concern.

The possibility that fishing has an effect on recruitment does, however, remain an unknown. To date it has not been determined whether the cockles being targeted by commercial harvesting comprise the bulk of the spawning stock or if disturbance of the cockle beds is influencing settlement.

The very slight decrease in biomass recorded in the current survey suggests that the current level of harvest is sustainable. What is not known is if the decrease in biomass is the beginning of a long-term trend or simply the result of natural variability.

The impacts of the illegal catch, the Maori traditional catch and incidental handling mortality are unknown, although illegal catch is thought to be insignificant. The impacts of the recreational fishery are probably minor compared with those from the commercial fishery.

4. STATUS OF THE STOCKS

The last stock assessment for Papanui Inlet and Waitati was in 2007. In Waitati Inlet for 2007 the biomass of juvenile cockles (>2–18 mm) has increased from 2002 and 2004 levels but remains well below figures for 1992. The biomass of adult (19–34 mm) cockles has also increased over 2002 and 2004 levels but is lower than that recorded in 1998. The biomass of large adult (≥35 mm) cockles is the lowest since 1992, and the biomass of cockles ≥30 mm is the lowest since 1998.

No size limit has been set for COC 3. However, commercial fishers currently target cockles between 28-34 mm, and >38 mm. In Waitati Inlet, the estimates of CAY for this size category are above current catch levels and recent reported landings. Furthermore, CAY estimates for the area of the inlet where commercial fishing currently occurs are also above current catch levels and recent reported landings. Catch levels higher than recent reported landings would be required to move the stocks in the inlets towards a size that will support the maximum sustainable yield.

Cockles recruit to the spawning stocks in the Otago area at a length of about 18 mm shell length. The harvested beds may receive spat from other areas. For these reasons, and because of the low harvesting levels, the risk of recruitment overfishing is probably low.

Yields and reported landings, for the 2007–08 fishing year, are summarized in Table 7.

Table 7: Summary of yields and reported landings (t) for the most recent fishing year.

Area	MCY	CAY	2007-08 Reported landings
Whole of Papanui Inlet			–
Whole of Waitati Inlet		1920 - 2990	–
COC3A Total landings			760

5. FOR FURTHER INFORMATION

Annala JH., Sullivan KJ. 1996. Report from the mid-year Fishery Assessment Plenary, November 1996: stock assessments and yield estimates. Ministry of Fisheries.

Annala JH., Sullivan KJ., O'Brien CJ., Smith NWMcL., and Grayling SM. 2003. Report from the Fishery Assessment Plenary, May 2003: stock assessments and yield estimates. Ministry of Fisheries.

Bradford E. 1998. Harvest estimates from the 1996 national recreational fishing surveys. New Zealand Fisheries Assessment Research Document 1998/16. 27p.

Breen P A., Carbines GC., and Kendrick TH. 1999. Stock assessment of cockles in Papanui and Waitati Inlets, Otago Harbour, and Purakanui, Otago. Final Report for the Ministry of Fisheries research project COC9701 dated July 1999.

Cameron T. 1997. Aspects of growth and condition in *Austrovenus stutchburyi* (Finlay 19270 (Bivalvia: Veneridae) at Waitati Inlet: Influence of shore height and distance from mouth. Unpublished MSc thesis, University of Otago, Dunedin, New Zealand.

Cranfield HJ., Micheal KP., and Francis RICC. 1996). Growth rates of five species of subtidal clam on a beach in the South Island, New Zealand. Marine and Freshwater Research 47: 773-784.

Francis RICC. (1984). An adaptive strategy for stratified random trawl surveys. New Zealand Journal of Marine and Freshwater Research 18: 59-71.

Hilborn R. and Walters CJ. 1992. Quantitative Fisheries Stock Assessment: Choice, dynamics and uncertainty. Chapman and Hall, London.

Irwin CR. 1999. The effects of harvesting on the reproductive and population biology of the New Zealand Littleneck Clam (*Austrovenus stutchburyi*) in Waitati Inlet. Unpublished Msc thesis, University of Otago, Dunedin, New Zealand.

McKinnon J. 1996. Studies of the age, growth and shell increment patterns in the New Zealand cockle (*Austrovenus stutchburyi*). Unpublished Msc thesis, University of Otago, Dunedin, New Zealand.

Manly BFJ., Akroyd JM., and Walshe KAR. 2002. Two-phase stratified random surveys on multiple populations at multiple locations. New Zealand Journal of Marine and Freshwater Research 36: 581-591.

Morton J., Miller M. 1973. The New Zealand Sea Shore. Collins, Auckland. 653p.

Stewart B., Keogh J., Fletcher D., and Mladenov P. 1992. Biomass survey of the New Zealand littleneck clam (*Chione stutchburyi*) in Papanui and Waitati Inlets, Otago during 1991/1992. Marine Science and Aquaculture research Centre, University of Otago, Dunedin, New Zealand. 37p.

Stewart B. 2004. Warrington treated Sewage Discharge: Waitati Inlet Ecological Survey, 2004. Prepared for DCC. 21p.

Stewart B. 2006. Stock assessment of Cockles (*Austrovenus stutchburyi*) in Papanui and Waitati Inlets, Otago, 2004. Final Research Report for the Ministry of Fisheries Research Project COC2004/02. 54p.

Stewart B. 2008. Stock assessment of clams (*Austrovenus stutchburyi*) in Waitati Inlet, Otago, 2007. Final Research Report for Southern Clams Ltd. 24p.

Sukhatme PV. 1954. Sampling theory of surveys: with applications. New Delhi : Indian Society of Agricultural Statistics. 49p.

Teirney LD., Kilner AR., Millar RE., Bradford E., and Bell J.D. 1997. Estimation of recreational catch from 1991–92 to 1993–94 New Zealand Fisheries Assessment Research Document 1997/15. 43p.

Wildish K. 1984a. The cockle resource in the Otago region: 1. An initial study of the New Zealand cockle (*Chione stutchburyi*) resource in Papanui and Waitati Inlets. Report to the Ministry of Agriculture and Fisheries.

Wildish K. 1984b. The cockle resource in the Otago region: further analysis of results from the survey of *Chione stutchburyi* (the New Zealand cockle) populations at Papanui and Waitati Inlets. Report to the Ministry of Agriculture and Fisheries.

Wing S., Irwin C., Granger G. 2002. Biomass survey and yield estimates for the New Zealand littleneck clam *Austrovenus stutchburyi* in Papanui and Waitati Inlets, Otago. Final Report for the Ministry of Fisheries Research Project COC2001/02. 52p.

Zar JH. 1996. Biostatistical Analysis. Third Edition. Prentice Hall International Inc.