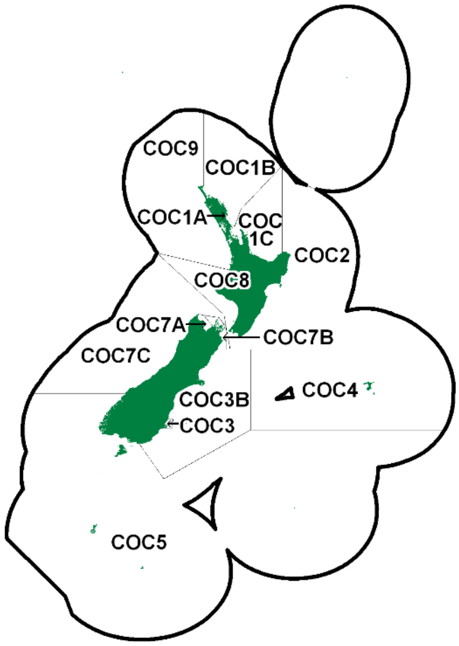
COCKLES (COC)

(*Austrovenus stutchburyi*)
Tuangi



1. INTRODUCTION

Cockles are important shellfish both commercially and for non-commercial fishers. For assessment purposes, individual reports on the largest commercial fisheries have been produced separately:

1. Snake Bank, Whangarei Harbour, in COC 1A.
2. Papanui Inlet, Waitati Inlet, and Otago Harbour, Otago Peninsula in COC 3.
3. Tasman Bay and Golden Bay in COC 7A.

Since 1992, Fisheries New Zealand or its predecessors has commissioned biomass surveys for cockles and pipi in the northern North Island on beaches where there is known recreational and customary fishing pressure. The objective of the surveys is to determine the distribution, abundance, and size frequency of cockles and pipi on selected beaches in the Auckland Fisheries Management Areas (FMA 1 and FMA 2).

Over the years, a total of 35 beaches have been monitored. On average, 12 beaches are sampled each year. The last survey was conducted in 2020 (see Berkenbusch & Neubauer 2020). All the 2019–20 survey sites contained cockle populations, and data from the field sampling were sufficient to provide cockle population estimates with relatively low uncertainty, i.e., with a CV of less than 20%. Seven of the sites had relatively high population densities, where estimates exceeded 500 individuals per square metre, with five sites with particularly high density estimates (1716 per m^2 in Raglan harbour in Waikato, 1656 per m^2 in Bowentown beach in Bay of Plenty, 1299 per m^2 in Pataua harbour in Northland, 1221 per m^2 in Tairua harbour in Coromandel, and 1084 per m^2 in Whitianga harbour in Coromandel). In contrast, the lowest density estimate was Grahams beach in Auckland, where cockles occurred at an estimated 43 per m^2.

The tools employed to manage these fisheries include daily bag limits and seasonal, temporary, and permanent closures. Size limits are also an option, but these are not currently in use. Customary management tools such as 186A closures, taiāpure, and mātaitai may also be implemented at the request of tangata whenua.

The fishing pressure within greater Auckland and the depletion of some shellfish beds have led to the introduction of a range of the above measures at finer spatial scales. Temporary closures to shellfish harvesting under s186A of the Act have been implemented at the request of tangata whenua in the following locations: Marsden Bank and Mair Bank, Maunganui Bay, Te Mata and Waipatukahu Beaches and Umupuia Beach. Closures gazetted under s11 sustainability measures are in place for Ngunguru estuary, Whangateau harbour, and Cockle Bay. There are also permanent shellfish closures at Cheltenham, Eastern Beach, and Karekare.

1.1 Commercial fisheries

Information on cockles that applies to all stocks is included below rather than being repeated in the individual reports for each of the large commercial fisheries.

Cockles were introduced into the QMS on 1 October 2002. The fishing year runs from 1 October until September 30 and catches are measured in greenweight for all stocks. There is no minimum legal size for cockles in any stock. Cockles are managed under Schedule 6 of the Fisheries Act for all stocks listed in Table 1, which allows cockles to be returned to where they were taken as soon as practicable after the cockle is taken, as long as the cockle is likely to survive.

The landings, by stock, of these cockle fisheries are dominated by catch from COC 3 (Figure 1). Landings from COC 3 have been relatively stable since 2002–03; by contrast landings from COC 1A and COC 7A have generally declined during that time. However, it should be noted that since 2009, COC 3 has had access to additional substantial stocks within Otago Harbour.

Table 1: TACC, Recreational, customary, and other sources of mortality allowances, and TAC (t) for all cockle stocks.

Code	Description	TACC	Recreational allowance	Customary allowance	Other sources of mortality	TAC
COC 1A	Whangarei Harbour	346	25	25	4	400
COC 1B	East Northland	0	22	22	2	46
COC 1C	Hauraki Gulf and Bay of Plenty	5	32	32	3	72
COC 2	Central	0	2	2	1	5
COC 3	Otago	1 470	10	10	10	1 500
COC 3B	Part South East Coast	1	27	27	3	58
COC 4	South East (Chatham Rise)	0	1	1	1	3
COC 5	Southland and Sub-Antarctic	2	2	2	1	7
COC 7A	Nelson Bays	1 390	85	25	10	1 510
COC 7B	Marlborough	0	5	5	0	10
COC 7C	Part Challenger	0	3	3	1	7
COC 8	Central (Egmont)	0	1	1	1	3
COC 9	Auckland (West)	0	6	6	1	13

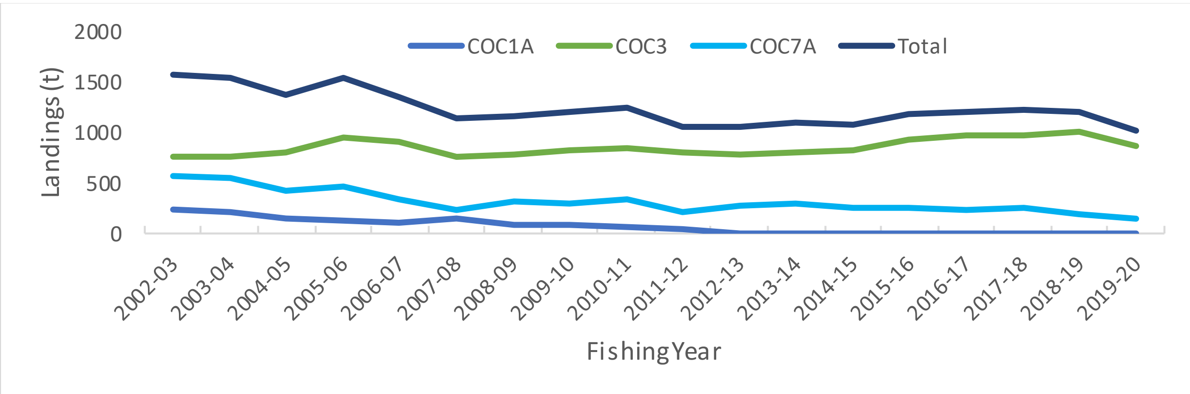


Figure 1: Commercial landings and the sum total (black line) of the three main commercial COC stocks during 2002–03 to 2019–20. Note that this figure does not show data prior to entry into the QMS.

New Zealand operates a mandatory shellfish quality assurance programme for all bivalve shellfish commercial growing or harvesting areas for human consumption. Shellfish caught outside this programme can only be sold for bait. This programme is based on international best practice and managed by Food Safety New Zealand in cooperation with the District Health Board Public Health

Units and the shellfish industry[1] and is summarised below. Before any area can be used to grow or harvest bivalve shellfish, public health officials survey the water catchment area to identify any potential pollution issues and take samples of the water and shellfish over at least a 12-month period, so all seasonal influences are explored. This information is evaluated and, if suitable, the area is classified and listed by Food Safety New Zealand for harvest. There is then a requirement for regular monitoring of the water and shellfish flesh to verify levels of microbiological and chemical contaminants. Management measures stemming from this testing include closure after rainfall, to deal with microbiological contamination from runoff. Natural marine biotoxins can also cause health risks, therefore testing for these also occur at regular intervals. If toxins are detected above the permissible level the harvest areas are closed until the levels fall below the permissible level. Products are also traceable so that the source and time of harvest can always be identified in case of contamination.

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.

Estimates of recreational harvest of cockles at the FMA level are available. Early estimates of the amateur cockle harvest are available from telephone-diary survey in 1992–93 (Teirney et al 1997), 1996 (Bradford 1998), and 2000 (Boyd & Reilly 2002). Harvest weights were estimated assuming a mean weight of 25 g per cockle (for cockles over 30 mm).

The harvest estimates provided by telephone-diary surveys between 1993 and 2001 are no longer considered reliable for various reasons. A Recreational Technical Working Group concluded that these harvest estimates should be used only with the following qualifications: a) they may be very inaccurate; b) the 1996 and earlier surveys contain a methodological error; and c) the 2000 and 2001 estimates are implausibly high for many important fisheries. In response to these problems and the cost and scale challenges associated with onsite methods, a National Panel Survey was conducted for the first time throughout the 2011–12 fishing year (Wynne-Jones et al 2014). The panel survey used face-to-face interviews of a random sample of 30 390 New Zealand households to recruit a panel of fishers and non-fishers for a full year. The panel members were contacted regularly about their fishing activities and harvest information collected in standardised phone interviews. A repeat of the National Panel Survey was conducted over the 2017–18 October fishing year (Wynne-Jones et al 2019). Results are given in Table 2.

Details for COC 1A, COC 3 and COC 7A can be found in the respective Working Group reports.

Table 2: Estimated numbers of cockles harvested by recreational fishers in each FMA for the 2017–18 fishing year, and the corresponding harvest weight based on an assumed mean weight of 25 g.

Stock	Harvest (number of cockles)	CV	Harvest (kg)
COC 1A	-	-	-
COC 1B	17 221	0.69	430.53
COC 1C	164 297	0.52	4 107.42
COC 2	1 492	0.80	37.30
COC 3, 3B	94 885	0.40	2 372.12
COC 3	8 475	0.67	211.86
COC 5	6 761	1.00	169.03
COC 7A	23 176	0.41	579.41
COC 7B	1 601	0.59	40.03
COC 7C	-	-	-
COC 8	-	-	-
COC 9	22 337	0.77	558.44

1.3 Customary non-commercial fisheries

In common with many other intertidal shellfish, cockles are very important to Māori as a traditional food. Limited quantitative information on the level of customary take is available from Fisheries New Zealand (Table 3). These numbers are an underestimate of customary harvest, as only the catch in

[1] For full details of this programme, refer to the Animal Products (Regulated Control Scheme-Bivalve Molluscan Shellfish) Regulations 2006 and the Animal Products (Specifications for Bivalve Molluscan Shellfish) Notice 2006 (both referred to as the BMSRCS), at: https://www.mpi.govt.nz/food-business/food-monitoring-surveillance/seafood-monitoring-programmes/

numbers and kilograms are reported in the table below. Details are provided in the respective Working Group reports.

Table 3: Fisheries New Zealand records of customary harvest of cockles (reported as weight (kg) and numbers), since 2000–01. – no data.

		Weight (kg)		Numbers	
Stock	**Fishing year**	**Approved**	**Harvested**	**Approved**	**Harvested**
COC 1B	2008–09	120	120	450	450
	2009–10	440	440	–	–
	2010–11	340	340	–	–
	2011–12	400	400	–	–
	2012–13	280	280	–	–
COC 1C	2005–06	65	45	2 000	0
	2006–07	3 680	3 680	–	–
	2007–08	465	260	–	–
	2008–09	260	120	–	–
	2009–10	20	20	–	–
	2014–15	25	25	–	–
COC 2	2009–10	–	–	1 200	980
COC 3	2000–01	–	–	400	400
	2001–02	–	–	37	37
	2002–03	–	–	1 200	1 200
	2006–07	100	100	9 100	7 680
	2007–08	–	–	500	500
	2008–09	–	–	24 496	23 865
	2009–10	–	–	4 750	4 750
	2010–11	–	–	19 500	19 500
	2011–12	30	28	10 600	10 600
	2013–14	–	–	2 300	2 100
	2015–16	80	80	9 610	9 510
	2016–17	–	–	5 500	5 240
	2017–18	–	–	4 950	4 800
	2019–20	–	–	3 140	3 140
COC 3B	2006–07	–	–	156	156
	2007–08	–	–	5 000	5 000
	2008–09	–	–	1 250	750
	2011–12	–	–	500	340
	2015–16	–	–	500	100
	2017–18	–	–	2 250	1 433
	2018–19	–	–	1 500	1 356
	2019–20	–	–	2 450	1 640
COC 7C	2006–07	120	120	–	–
COC 9	2009–10	20	20	–	–
	2012–13	145	145	–	–
	2013–14	270	270	–	–
	2014–15	250	250	–	–

1.4 Illegal catch
No quantitative information on the level of illegal catch is available.

1.5 Other sources of mortality
No quantitative information is available on the magnitude of other sources of mortality. Harvesting implements, such as brooms, rakes, "hand-sorters", bedsprings and "quickfeeds" may cause some incidental mortality, particularly of small cockles, but this proposition has not been scientifically investigated. High-grading is often practiced with smaller sized clams being returned to the beds, potentially causing stress and related mortality, however no research has substantiated this.

2. BIOLOGY

The cockle, *Austrovenus stutchburyi*, formerly known as *Chione stutchburyi*, is a shallow-burrowing suspension feeder of the family Veneridae. It is found in soft mud to fine sand on protected beaches and enclosed shores around the North and South Islands, Stewart Island, the Chatham Islands, and the Auckland Islands (Morton & Miller 1973, Spencer et al 2002). Suspension feeders such as *A. stutchburyi* tend to be more abundant in sediments with a larger grain size. Cockles have been shown to be most abundant in sediments of below 12 percent mud in two separate studies (Thrush et al 2003, Anderson 2008). They are also common in eelgrass (e.g., *Zostera* sp.), which often co-occurs with sand flats.

Cockles are found from the lowest high-water neap tide mark to the lowest part of the shore. Larcombe (1971) suggested that the upper limit is found where submergence is only 3.5 hours per day. *A. stutchburyi* is often a dominant species and densities as high as 4500 per m^2 have been reported in some areas. In Pauatahanui Inlet the cockle biomass was estimated at 80% (5000 t) of the total intertidal biomass in 1976 (Richardson et al 1979). Calculations based on laboratory measurements of filtration rates suggested that cockles over 35 mm shell length were capable of filtering 1.1×10^6 m^3 of water or enough to filter all the water in Papanui Inlet every two tidal cycles (Pawson 2004).

Sexes are separate and the sex ratio is usually close to 1:1. Size at maturity has been estimated at about 18 mm shell length (Larcombe 1971). Spawning extends over spring and summer, and fertilisation is followed by a planktonic larval stage lasting about three weeks. Significant depression of larval settlement has been recorded for areas of otherwise suitable substrate from which all live cockles have been removed. This suggests the presence of some conditioning factor.

Work on Snake Bank also showed moderate differences among years in the level of recruitment of juveniles to the population. The variability of recruitment was estimated as $\sigma_R = 0.41$ using all available data (1983–1996) but as $\sigma_R = 0.31$ using data only from those years since the fishery has been considered to be fully developed (1991–96). Given the variability of most shellfish populations and the shortness of the time series, this is probably an underestimate of the real variability of recruitment in the Snake Bank population.

Small cockles grow faster than large cockles, but overall, maximum growth occurs on the first of January, and a period of no growth occurs at the beginning of July (Tuck & Williams 2012). Growth is slower in the higher tidal ranges and in high density beds. Significant increases in growth rates have been observed for individuals remaining in areas that have been 'thinned out' by simulated harvesting. Tagging work at Pakawau beach also highlighted the variability in growth that can occur within a beach (Osborne 2010).

Growth parameters and length weight relationships are listed in Table 4 (Stewart 2008, Williams et al 2009, Osborne 2010). However, considerable variability in growth has been seen in all three QMAs over time. At Snake bank (1A) growth to 30 mm has been estimated as taking between 2 and 5 years in separate studies (Martin 1984, Cryer 1997). Additional tagging work on Snake Bank from 2001 to 2010 showed that on average, cockles reach maturity (18 mm; Larcombe 1971) in their second year of growth, and recruit to harvestable size (about 28 mm SL) in about 3 to 4 years, although these results showed great variability in growth rate (tabulated in table 8, Tuck & Williams 2012). At Pakawau beach (7A) K has varied between 0.36 and 0.41 and L_∞ between 47 and 49mm (Osborne 1992, 1999). The work of Breen et al (1999) in Papanui and Waitati Inlets, Purakanui and Otago Harbour showed no significant growth after one year and modes in the length frequency distributions did not shift when measured over four sampling periods within a year. They concluded that it was unlikely that average growth is really as slow as the results indicated, but there may be high inter-annual variability in growth.

Quite extensive movements of juveniles have been documented, but individuals over 25 mm shell length remain largely sessile, moving only in response to disturbance.

Given that cockles recruit to the spawning biomass at about 18 mm shell length, but do not recruit to commercial or non-commercial fisheries until closer to 30 mm shell length, there is some protection for the stock against overfishing, especially as the Snake Bank and Papanui and Waitati Inlet stocks are probably not isolated as far as recruitment of juveniles is concerned. However, this generality should be treated with some caution, given that some population of adults seems to be required to stimulate settlement of spat.

Natural mortality arises from a number of sources. Birds are a major predator of cockles (up to about 23 mm shell length). Other predators include crabs and whelks. Cockles are also killed after being smothered by sediments shifted during storms or strong tides. A mass mortality that killed an estimated 56–63% of all cockles and 80–84% of cockles over 30 mm in shell length (Fisheries New Zealand unpublished data) has been reported from sites within the Whangateau harbour (north of Auckland). This mortality was attributed to a potential weakening of cockles due to heat stress then mortality from a coccidian parasite and a mycobacterium. Sediments, both suspended and deposited, both impact upon cockle fitness or survival, with terrestrial sediments having greater effects than marine sediments (Gibbs & Hewitt 2004). Increasing suspended sediment concentrations have induced increased physiological stress, decreased reproductive status and decreased juvenile growth rates (Nicholls et al 2003, Gibbs & Hewitt 2004). Sediment deposition has also been shown to negatively impact upon densities of cockles (Lohrer et al 2004). The sum of these effects is seen in the distribution of cockles, which decline in abundance across a number of sites with increasing mud content in the sediments, either above zero or 11% mud content, depending upon the study (Thrush et al 2003, Anderson 2008).

Experimental work on Snake Bank led to estimates of absolute mortality of 17–30% per annum, instantaneous natural mortality (*M*) of 0.19–0.35, with a midpoint of $M = 0.28$. The estimated mortality rates for cockles of over 30 mm shell length were slightly greater at 19–37% per annum, (*M* of 0.21–0.46 with a midpoint of 0.33). This higher estimate was caused by relatively high mortality rates for cockles of over 35 mm shell length and, as these are now uncommon in the population, $M = 0.30$ (range 0.20–0.40) has been assumed for yield calculations across all three stocks (Table 4). Tagging (both notch and individual numbered tags) has been ongoing on Mair Bank from 2001 to 2009 and the last recoveries occurred in 2010 (Tuck & Williams 2012). Annualised mortality estimates (*M)* (averaged over 3, 6 and 9 month recoveries) were 0.356 and 0.465 from studies in 2008 and 2009.

Table 4: Biological parameters used for cockle assessments for different stocks. SL = shell length, within area 7A, P = Pakawau, FP = Ferry Point, TBR = Tapu Bay/Riwaka.

	1A	**3**	**7A**
1. Natural mortality (*M*)	0.3	0.3	0.3
2. Weight (grams)	= *a*(shell length)^b	= *a*(shell length)^b +	= *a*(shell length)^b
a	0.00014	0.7211	P = 0.000018, FP = 0.0002, TBR = 0.00015
b	3.29	11.55	P = 3.78, FP = 3.153, TBR = 3.249
3. von Bertalanffy growth parameters			Not used instead growth = *a*(Ln(age in years))+*b*
K	0.26	0.326	a = 11.452
L_∞ (mm)	35	40.95	b = 16.425
SL at recruitment to the fishery (mm)	28	28	30

3. STOCKS AND AREAS

Little is known of the stock boundaries of cockles. Given the planktonic larval phase, many populations may receive spat fall from other nearby populations and may, in turn, provide spat for these other areas. In the absence of more detailed knowledge, each commercial fishery area is managed as a discrete population.

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