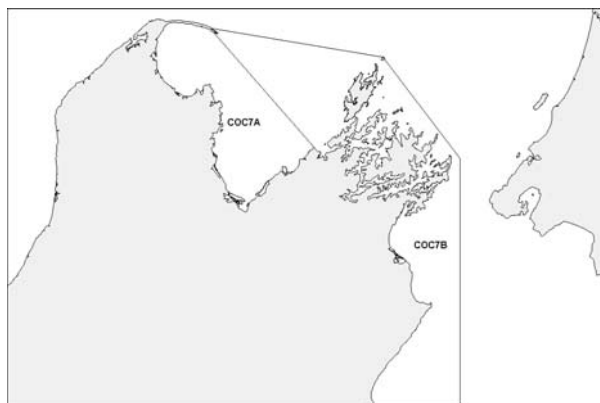


## COCKLES (COC 7A/7B) Nelson/Marlborough

(*Austrovenus stutchburyi*)



### 1. FISHERY SUMMARY

COC 7A was introduced to the Quota Management System in October 2002 with a TAC of 1510 t; comprising a customary allowance of 25 t, a recreational allowance of 85 t, an allowance for other fishing related mortality of 10 t, and a TACC of 1390 t.

COC 7B was introduced to the Quota Management System in October 2002 with a TAC of 10 t; comprising a customary allowance of 5 t, a recreational allowance of 5 t.

#### (a) Commercial fisheries

Commercial harvesting at Pakawau Beach in Golden Bay began in 1984, but with significant landings taken only since 1986. Harvesting at Pakawau Beach has occurred every year since 1984. Cockles have also been taken commercially from Tapu Bay-Riwaka (in Tasman Bay) since 1992–93, and Ferry Point (in Golden Bay) since 1998–99. Catch statistics (Table 1) are derived from company records and QMS returns. All commercial landings have been taken by mechanical harvester.

**Table 1: Reported landings (t) of cockles from all commercially harvested areas in COC 7A/7B. Landings from 1983–84 to 1991–92 are based on company records.**

Fishing Year	Total Landings	Catch Limit
1983–84	2	225
1984–85	38	225
1985–86	174	225
1986–87	230	225
1987–88	224	225
1988–89	265	300
1989–90	368	300
1990–91	535	300
1991–92	298	300
1992–93	300	336
1993–94	440	336
1994–95	326	336
1995–96	329	336
1996–97	325	336
1997–98	513	949
1998–99	552	1130
1999–00	752	1130
2000–01	731	1134
2001–02	556	1134
2002–03	569	1390
2003–04	553	1390
2004–05	428	1390
2005–06	460	1390

At Pakawau Beach, the fishery operated up to October 1988 under a special permit constraining annual landings to 225 t. From 1988–89 to 1997–98, the fishery operated under a commercial permit allowing an annual catch of 300 t. In 1997–98, the fishery was re-assessed and a catch limit of 913 t was set based on a CAY harvest strategy. This level of harvest was changed to 760 t from the 1998–99 fishing year and then 764 t for the 2000–01 fishing year. The harvest is taken from an area of about 500 ha.

The Ferry Point fishery, initiated in 1998–99, has an annual allowable catch of 334 t based on an MCY harvest strategy. The harvested area is about 400 ha. The Tapu Bay-Riwaka fishery, which was developed in 1990–91, has operated under a commercial permit limiting catches to 36 t annually. This fishery has been only lightly harvested owing largely to water quality issues, and the area from which catches have been taken is probably less than 100 ha.

COC 7A (Tasman and Golden Bays) and COC 7B (Marlborough) were introduced into the QMS on 1 October 2002, with COC 7A effective from 1 October 2003. For COC 7A a TAC was set at 1510 t; comprising a customary allowance of 25 t, a recreational allowance of 85 t, and a TACC of 1390 t. For COC 7B a TAC was set at 10 t; comprising a customary allowance of 5 t, a recreational allowance of 5 t and a TCC of 0 t.

#### (b) Recreational fisheries

Cockles are taken by recreational fishers, generally using hand digging. The catch limit is currently 150 cockles per person per day. Relatively large cockles (i.e., shell length > 30 mm) are generally preferred.

Estimates of the amateur cockle harvest from QMA 7 are available (Table 2) from a telephone and diary survey in 1992–93 (Tierney et al., 1997) and from national diary surveys in 1996 (Bradford, 1998) and 2000 (Boyd & Reilly, 2004). Harvest weights were estimated assuming a mean weight of 25 g per cockle. The 1992–93 and 1996 estimates are very uncertain and probably under-estimate actual recreational catch. The 2000 survey is considered to be a more reliable estimate of recreational harvest.

**Table 2: Estimated numbers of cockles harvested by recreational fishers in QMA 7, and the corresponding harvest tonnage. Data from both surveys were not sufficiently reliable to allow estimates of CVs.**

Year	<u>QMA 7 harvest</u>	
	(number)	(t)
1992–93	166 000	4
1996	325 000	8
2000	499 000	12.5

#### (c) Maori customary fisheries

Cockles are an important Maori traditional food, but no quantitative information on the level of customary take in COC 7A/7B is available. However, Kaitiaki are now in place in many areas and estimates of customary harvest can be expected in the near future.

#### (d) Illegal catch

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

#### (e) Other sources of mortality

The extent of any other sources of mortality is unknown. Incidences of unexplained large-scale die-off in localised areas have been noted (e.g., at Pakawau Beach in 1999). Mortality of unrecruited cockles during the mechanical harvesting process was found to be very low (Bull, 1984), and disturbance and mortality of other invertebrates in the harvested areas is slight (Wilson et al., 1988). Cockles (particularly those smaller than 25 mm, which are not taken by the mechanical harvester) are vulnerable to predation by birds and may be important in the diet of some species (Wilson et al., 1988).

## 2. BIOLOGY

All references to “shell length” in this report refer to the maximum linear dimension of the shell (in an anterior-posterior axis). General cockle biology has been summarised earlier in this Plenary report. Some aspects of biology with particular relevance to COC 7A/7B follow.

Estimates of growth and mortality have been made for cockles from Pakawau Beach (Osborne 1992, 1999), and are summarised in Table 3. The 1992 investigation used a Walford plot of tag recapture data (Bull, 1984), and measured growth after about 18 months on translocated cockles, to produce the growth parameters. A MIX analysis of the scaled length-frequency distribution from the 1992 survey enabled calculation of the proportional reduction of the 4+ and 5+ age classes to produce estimates of instantaneous natural mortality,  $M$  (after removal of estimated fishing mortality,  $F$ ).

The 1999 investigation used a MIX analysis of length-frequency data from two strata in comparable surveys in 1997, 1998 and 1999 to estimate mean lengths (and proportion in the population) of the first 8 year classes. Von Bertalanffy parameters were estimated for each survey. Mean natural mortality rates were estimated (for age classes 4–7) between 1997 and 1998, and 1998 and 1999.

It was acknowledged that none of the MIX analyses converged, but the results presented were the best available fits (Osborne, 1992, 1999). However, all four analyses produced very similar von Bertalanffy parameters. There is a trend of a reducing  $L_{\infty}$  and increasing  $K$  over the period 1992–1999, which might be expected as a result of fishing.

**Table 3: Estimates of biological parameters.**

Population & years	Estimate			Source
<b>1. Natural mortality (M)</b>				
Pakawau Beach (1992)	0.45 for 4+; 0.30 for 5+			Osborne (1992, 1999)
Pakawau Beach (1998)	0.40			Osborne (1999)
Pakawau Beach (1999)	0.52			Osborne (1999)
<b>2. Weight = a (shell length)<sup>b</sup> (weight in g, shell length in mm)</b>				
Pakawau Beach (1992)	a = 0.000017	b = 3.78		Osborne (1992)
Ferry Point (1996)	a = 0.000205	b = 3.153		Forrest & Asher (1997)
Tapu Bay-Riwaka (1991)	a = 0.000150	b = 3.249		Stark & Asher (1991)
<b>3. von Bertalanffy growth parameters</b>				
	<b>K</b>	<b>t<sub>0</sub></b>	<b>L<sub>∞</sub></b>	
Pakawau Beach (1984–92)	0.36	0.30	49.0	Osborne (1992)
Pakawau Beach (1997)	0.38	0.68	48.3	Osborne (1999)
Pakawau Beach (1998)	0.40	0.68	47.4	Osborne (1999)
Pakawau Beach (1999)	0.41	0.66	47.0	Osborne (1999)

## 3. STOCKS AND AREAS

Little is known of the stock boundaries of cockles. The planktonic larval phase of this shellfish has a duration of about 3 weeks, so dispersal of larvae to and from a particular site could be considerable. Cockles are known to be abundant and widely distributed throughout Golden and Tasman Bays, and although nothing is known about larval dispersion patterns, cockles in these areas are likely to comprise a single stock. However, in the absence of any detailed information on stocks, the three currently fished sites in COC 7A/7B are all managed separately.

It should be noted that COC 7A/7B includes all the waters in QMA 7 (i.e., from Awarua Point on the West Coast, around the northern South Island to the Clarence River mouth).

## 4. STOCK ASSESSMENT

This report summarizes estimates of absolute biomass and yields for exploited and unexploited cockle populations in Tasman and Golden Bays. Stock assessments have been conducted using absolute biomass surveys, yield-per-recruit analyses, Methods 1 and 2 for estimating MCY, and Method 1 for estimating CAY (Annala et al., 2001).

Recruited cockles are considered to be those with a shell length of 35 mm or greater. This is the minimum size of cockles generally retained by the mechanical harvesters used in the COC 7A/7B fishery. Where possible, estimates of yields from surveys are based on recruited biomass not occurring in areas of eel grass (*Zostera*), as the disturbance of these *Zostera* beds by mechanical harvesters has detrimental effects on intertidal ecology.

(a) **Estimates of fishery parameters and abundance**

Biomass estimates from surveys are available for the three commercially fished areas and three other sites.

On Pakawau Beach, the surveys done in 1992 and 1997–2001 used a stratified random approach (Table 4). An additional southern stratum was added to the survey area in 1997, accounting for the greater survey area relative to 1992. The surveys in 1988 and 1984 covered smaller areas still. There is no apparent decline in biomass per unit area throughout the entire series of surveys. The six comparable surveys show total and recruited biomass to have fluctuated, but with no consistent trend. Because harvesting is not permitted in areas of *Zostera*, additional estimates of recruited biomass available to harvesters are presented (Table 4).

Estimates of biomass are available for Tapu Bay-Riwaka in 1991 using a fixed transect approach (Stark & Asher, 1991) and Ferry Point in 1996 using a stratified random approach (Forrest & Asher, 1997). Both these surveys were conducted about two years prior to the commencement of commercial harvesting in those areas. The cockle resource on three other beaches in Golden Bay was assessed using stratified random surveys in 1993 (Osborne & Seager, 1994). Results from all these surveys are listed in Table 5.

**Table 4: Estimates of biomass (t) with 95% confidence intervals (CI) where available, and mean density (kg/m<sup>2</sup>) for cockles on Pakawau Beach. Values are given for the total and recruited ( $\geq 35$  mm) biomass. Available biomass is recruited biomass not occurring in areas of *Zostera*. *n* = number of samples in the survey. Lines of data in italics represent results from the 1997–1999 surveys, but using only those strata surveyed in 1992.**

Date	Area (ha)	<i>n</i>	Total biomass			Recruited biomass			Available biomass	
			t	CI	kg/m <sup>2</sup>	t	CI	kg/m <sup>2</sup>	t	CI
1984	326	–	4604	1562	1.41	–	–	–	–	–
1988	510	–	5640	–	1.11	–	–	–	–	–
Nov 1992	588	313	6784	929	1.15	5521	852	0.94	3407	–
May 1997	588	257	8979	528	1.53	–	–	–	–	–
Jun 1998	588	265	7970	1326	1.36	–	–	–	–	–
Apr 1999	588	262	8196	1339	1.39	–	–	–	–	–
May 1997	642	264	9279	550	1.45	7796	515	1.21	5888	643
Jun 1998	642	272	8269	1360	1.29	6915	1224	1.08	3604	842
Apr 1999	642	269	8666	1425	1.35	7183	1324	1.12	3645	869
Mar 2000	642	–	7878	1302	1.23	–	–	–	–	–
Mar 2001#	642	231	10 252	1629	1.60	9117	1519	1.42	3613	764
Feb 2004	642	312	10 185	1238	1.59	9421	1195	1.47	6191	945

# Recruited and available biomass were calculated in 2001 using a recruited size of  $\geq 30$  mm shell length.

**Table 5: Estimates of biomass (t) with 95% confidence intervals (CI) where available, and mean density (kg/m<sup>2</sup>) for cockles at various sites in Golden and Tasman Bays. Where possible, values are given for the total and recruited ( $\geq 35$  mm) populations. *n* = number of samples in the survey.**

Site	Date	Area (ha)	<i>n</i>	Total biomass			Recruited biomass		
				t	CI	kg/m <sup>2</sup>	t	CI	kg/m <sup>2</sup>
Tapu Bay-Riwaka	Mar 1991	306	321	~3 900	–	1.28	–	–	–
Tapu Bay	Feb 2004	122.7	144	1 423	269	1.16	1076	235.6	0.88
Riwaka (excl. Tapu Bay)*	Mar 1991	–	–	–	–	–	1880	450	–
Ferry Point	Dec 1996	436	552	2 617	190	5.99	#2442	191	5.60
Ferry Point	Feb 2004	40	126	646	99.8	1.63	443	79	1.12
Collingwood Beach	Mar 1993	176	70	334	148	0.19	292	139	0.17
Takaka Beach	Mar 1993	338	107	1 850	671	0.55	796	395	0.24
Rangihaeata Beach	Mar 1993	197	75	473	345	0.24	438	320	0.22

\* Recalculated by Breen (1996) from data in Stark & Asher (1991).

# Recruited biomass includes cockles  $\geq 30$  mm shell length.

Surveys reporting on cockle abundance have also been produced for Motupipi, Golden Bay, in June 1995 (transect survey, 50 ha, 30 samples, mean density of 87 cockles per m<sup>2</sup>, no sizes or weights recorded), and at various sites in the Marlborough Sounds in August 1986 (diver survey below mean low water only, 9 sites, main densities in Kenepuru and inner Pelorus Sounds).

**(b) Biomass estimates**

Absolute virgin biomasses,  $B_0$ , are assumed to be equal to estimated biomass of cockles  $\geq 35$  mm shell length from surveys conducted before, or in the early stages of, any commercial fishing. These are listed above in Tables 4 and 5. Absolute current biomass can be estimated similarly from current surveys.

The biomass that will support the maximum sustainable yield ( $B_{MSY}$ ) is not known for any of the areas fished in COC 7A/7B.

**(c) Estimation of Maximum Constant Yield (MCY)**

Estimates of MCY have been made for populations of cockles in various areas, and at various times, using the equation  $MCY = 0.25 * F_{ref} * B_0$  (Method 1), where  $F_{ref}$  is either  $F_{0.1}$  or  $F_{max}$ . This method applies to new fisheries, or to those with only very low past levels of exploitation. The value of  $F_{ref}$  is dependent on  $M$ , so owing to the uncertainty of  $M$  a range of MCY estimates have been given for each stock (Table 6). For all estimates in Table 6,  $B_0$  was taken as recruited biomass available for fishing (i.e., not in *Zostera* beds) in the survey area.

Estimates of MCY for Pakawau Beach have also been produced from  $MCY = 0.5 * F_{ref} * B_{av}$  (Method 2), using  $F_{max}$ , and with  $B_{av}$  being 3582 t (the average of the available recruited biomass from the five comparable surveys in 1997–2001). For a range of  $M$  values, MCY is as follows:

M	0.2	0.3	0.4
MCY	1182	2418	4658

**Table 6: Estimates of MCY (t, using  $0.25 * F_{ref} * B_0$ ) for various cockle stocks in Tasman and Golden Bays, assuming a range of values for  $M$ .**

Site	Date	$F_{ref}$	$M$			
			0.2	0.3	0.4	0.5
Pakawau Beach	1992	$F_{0.1}$	230	324	434	554
Pakawau Beach	1997	$F_{0.1}$	397	559	751	957
Ferry Point	1996	$F_{0.1}$	127	170	223	284
Ferry Point	1996	$F_{max}$	264	453	789	1493
Riwaka	1991	$F_{0.1}$	167	224	286	–
Collingwood Beach	1993	$F_{0.1}$	20	28	37	48
Takaka Beach	1993	$F_{0.1}$	53	74	100	127
Rangihaeata Beach	1993	$F_{0.1}$	23	32	43	55

The level of risk by harvesting the populations at the estimated MCY levels cannot be determined for any of the surveyed areas. However, yield estimates are substantially higher when based on  $F_{max}$  rather than  $F_{0.1}$ , so risk would be greater at MCYs based on  $F_{max}$ .

**(d) Estimation of Current Annual Yield (CAY)**

Estimates of CAY have been made in the past for cockle stocks at Pakawau Beach, Ferry Point and Riwaka, using  $CAY = F_{ref}/(F_{ref} + M) * (1 - e^{-(F_{ref} + M)}) * B_{beg}$  (Method 1), where beginning of season biomass ( $B_{beg}$ ) is current recruited biomass available to the fishery, and  $F_{ref}$  is either  $F_{0.1}$  or  $F_{max}$ . However, estimates of current biomass that would allow updated calculations are available only for Pakawau Beach. The most recent estimates of CAY available for all stocks are listed in Table 7.

**Table 7: Estimates of CAY (t) for various cockle stocks in Tasman and Golden Bays, assuming a range of values for M.**

Site	Date	F <sub>ref</sub>	M			
			0.2	0.3	0.4	0.5
Pakawau Beach	2001	F <sub>0.1</sub>	778	996	1 210	1 396
Pakawau Beach #	2001	F <sub>0.1</sub>	1 964	2 514	3 053	3 522
Pakawau Beach	2001	F <sub>max</sub>	1 599	2 388	2 975	–
Ferry Point	1996	F <sub>0.1</sub>	407	501	600	696
Ferry Point	1996	F <sub>max</sub>	748	1050	1 369	1 650
Riwaka	1993	F <sub>0.1</sub>	507	615	708	

# Calculations using total recruited biomass, rather than available recruited biomass.

### (e) Other yield estimates and stock assessment results

F<sub>0.1</sub> and F<sub>max</sub> were estimated from a yield per recruit (YPR) analysis using the age and length-weight parameters for Pakawau Beach cockles from Osborne (1992), and assuming size at recruitment to the fishery of either 30 or 35 mm shell length. A range of M values was used to produce the estimates in Table 8.

**Table 8: Estimates of F<sub>0.1</sub> and F<sub>max</sub> using a range of M values and two minimum harvest sizes (MHS).**

F <sub>ref</sub>	MHS (mm)	M			
		0.2	0.3	0.4	0.5
F <sub>0.1</sub>	35	0.27	0.38	0.51	0.65
F <sub>0.1</sub>	30	0.26	0.34	0.45	0.57
F <sub>max</sub>	35	0.66	1.35	2.60	–
F <sub>max</sub>	30	0.53	0.91	1.59	3.01

### (f) Other factors

The areas of Golden Bay and Tasman Bay currently commercially fished for cockles are very small with respect to the total resource. Recruitment overfishing is unlikely owing to the extent of the resource protected from the fishery in *Zostera* beds, in sub-tidal areas, and in the protected areas adjacent to Farewell Spit and in other areas of Golden Bay. Cockle larvae are planktonic for about 3 weeks, so areas like Golden Bay and Tasman Bay probably constitute single larval pools. Consequently, fisheries in relatively small areas (like Pakawau Beach) are likely to have little effect on recruitment. It is noted, however, that recruitment of juvenile cockles can be reduced by the removal of a large proportion of adult cockles from the area (i.e., successful settlement occurs only in areas containing a population of adult cockles).

It is also likely that growth and mortality of cockles are density-dependent. A reduction in density due to fishing could enhance the growth and survival of remaining cockles.

Because cockles begin to spawn at a shell length of about 18 mm, and the larval pools in Tasman and Golden Bays are probably massive and derive from a wide area (most of which is closed to commercial fishing), there is a low risk of recruitment overfishing at any of the exploited sites.

## 5. STATUS OF THE STOCKS

Estimates of reference biomass and reference fishing mortality rates are available, and there are estimates of current biomass for each area.

At Pakawau Beach, the biomass of cockles does not appear to have declined since the start of the commercial fishery in 1983, and has probably increased owing to exceptional recruitment in 2000. At Ferry Point, the size and abundance of cockles has declined markedly since 1996. A CAY strategy and more frequent surveys may allow this stock to rebuild or at least indicate a long-term average biomass for the area. At Riwaka-Tapu Bay, size and abundance has also declined. A MCY strategy is possible for this stock without on-going surveys, or a CAY strategy with more frequent surveys, which would give better information on the long-term average biomass for the area.

Because of the uncertainty over the relationship between  $B_{\text{current}}$  and  $B_{\text{MSY}}$ , it is not known if recent catches and current catch limits will allow the COC 7A stock to move towards a size that will support the MSY.

Yield estimates, TACCs and reported landings, for the 2005/06 fishing year, are summarised in Table 9.

**Table 9: Summary of yields (t) and reported landings for the most recent fishing year.**

Area	MCY	CAY	2005–2006 TACC	2004–2005 Reported landings	2005–2006 Reported landings
Pakawau Beach	230–957	778–3522	-	-	-
Ferry Point	127–1493	-	-	-	-
Riwaka – Tapu Bay	167–286	-	-	-	-
<b>Fishstock</b>					
COC 7A			1390	428	460

## 6. FOR FURTHER INFORMATION

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