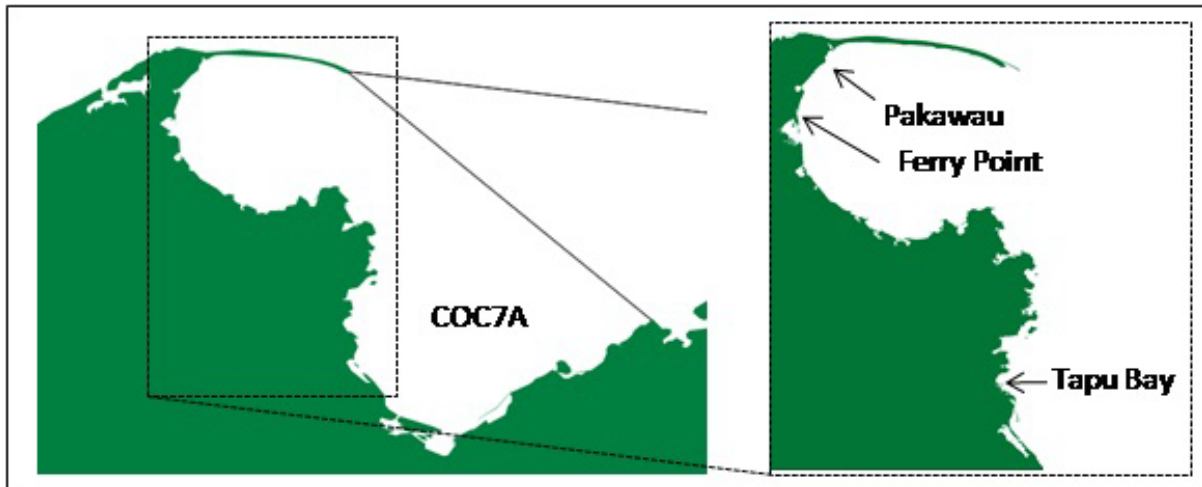


**COCKLES (COC 7A) Tasman and Golden Bays**

*(Austrovenus stutchburyi)*  
Tuangi



**1. FISHERY SUMMARY**

COC 7A was introduced into the Quota Management System in October 2002 with a TAC of 1510 t which comprised 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. These limits have remained unchanged since. The TACC was set higher than historical catch levels on the basis of the development potential of assessed beds.

**1.1 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 the Tapu Bay-Riwaka area (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. Historical landings and TACC for this stock are depicted in Figure 1.

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

Fishing Year	Total Landings	TACC	Fishing Year	Total Landings	TACC
1983–84	2	225	2003–04	553	1 390
1984–85	38	225	2004–05	428	1 390
1985–86	174	225	2005–06	460	1 390
1986–87	230	225	2006–07	337	1 390
1987–88	224	225	2007–08	237	1 390
1988–89	265	300	2008–09	307	1 390
1989–90	368	300	2009–10	301	1 390
1990–91	535	300	2010–11	348	1 390
1991–92	298	300	2011–12	220	1 390
1992–93	300	336	2012–13	269	1 390
1993–94	440	336	2013–14	290	1 390
1994–95	326	336	2014–15	263	1 390
1995–96	329	336	2015–16	263	1 390
1996–97	325	336	2016–17	238	1 390
1997–98	513	949	2017–18	254	1 390
1998–99	552	1 130	2018–19	187	1 390
1999–00	752	1 130	2019–20	146	1 390
2000–01	731	1 134	2020–21	293	1 390
2001–02	556	1 134	2021–22	276	1 390
2002–03	569	1 390			

## COCKLES (COC 7A)

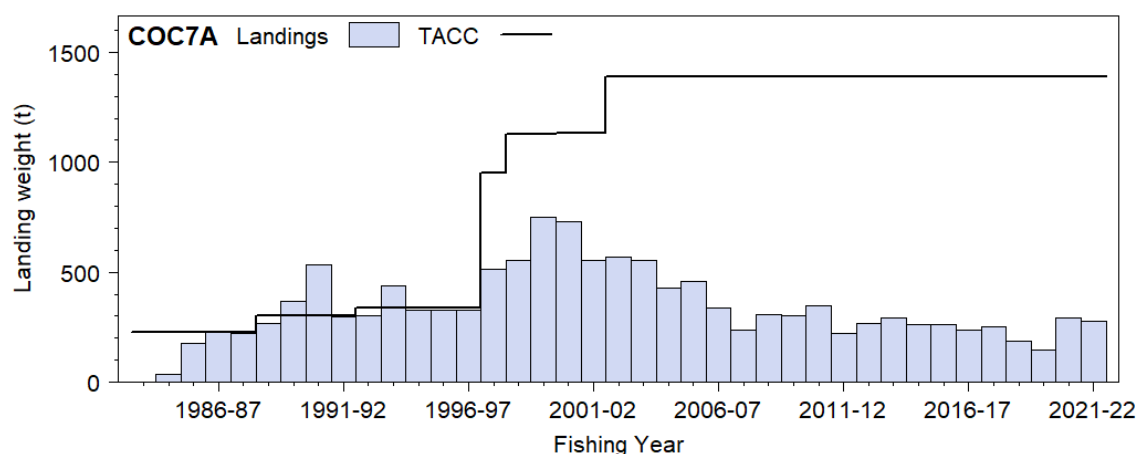


Figure 1: Total reported landings and TACC for COC 7A (Nelson Bays) since 1983–84.

### 1.2 Recreational fisheries

Cockles are taken by recreational fishers, generally by digging by hand. The catch limit is currently 150 cockles per person per day. Relatively large cockles (i.e., shell length over 30 mm) are generally preferred. Specific areas for recreational fishing are set aside from the commercial fishery by regulation and these include the area north of Ferry Point opposite Totara Ave and the area of Tapu Bay itself north of the fishery.

No estimates of recreational harvest of cockles from COC 7A are available. History of the estimates of recreational catch and their reliability is provided in the Introduction – Cockle chapter. Estimated numbers of cockles harvested by recreational fishers in QMA 7 are provided in Table 2.

Table 2: Estimated numbers of cockles harvested by recreational fishers in QMA 7, and the corresponding harvest tonnage based on an assumed mean weight of 25 g. Figures were extracted from telephone-diary surveys in 1993–94, 1996, and 1999–2000, and from the national panel surveys in 2011–12 and 2017–18.

Survey	Numbers	CV	Tonnes	Reference
1993–94	166 000	–	4.0	Teirney et al (1997)
1996	325 000	–	8.0	Bradford (1998)
1999–2000	499 000	–	12.5	Boyd & Reilly (2002)
2011–12	78 751	0.45	2.0	Wynne-Jones et al (2014)
2017–18	23 176	0.41	0.6	Wynne-Jones et al (2019)

### 1.3 Customary non-commercial fisheries

Cockles are an important Māori traditional food. Māori customary fishers can utilise the provisions under both the Fisheries (Amateur Fishing) Regulations 2013 and the Fisheries (South Island Customary Fishing) Regulations 1999. Many tangata whenua harvest cockles under their recreational allowance and these are not included in records of customary catch. There is no customary catch reported in COC 7A.

### 1.4 Illegal catch

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

### 1.5 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 and Ferry Point 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). For further information on other sources of mortality, please refer to the Introduction – Cockle chapter.

## 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 follow.

Estimates of growth and mortality have been made for cockles from Pakawau Beach (Osborne 1992, 1999, 2010), and the two early studies 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.

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

Population & years	Estimate			Source
<u>1. Natural mortality (<math>M</math>)</u>				
Pakawau Beach (1992)	0.45 for 4+; 0.30 for 5+			Osborne (1992, 1999)
Pakawau Beach (1998)	0.4			Osborne (1999)
Pakawau Beach (1999)	0.52			Osborne (1999)
<u>2. Weight = <math>a</math> (shell length)<sup><math>b</math></sup> (weight in g, shell length in mm)</u>				
	$a$	$b$		
Pakawau Beach (1992)	0.000017	3.78		Osborne (1992)
Ferry Point (1996)	0.00020	3.153		Forrest & Asher (1997)
Tapu Bay-Riwaka (1991)	0.000150	3.249		Stark & Asher (1991)
<u>3. von Bertalanffy growth parameters</u>				
	$K$	$t_0$	$L_{\infty}$	
Pakawau Beach (1984–92)	0.36	0.3	49	Osborne (1992)
Pakawau Beach (1997)	0.38	0.68	48.3	Osborne (1999)
Pakawau Beach (1998)	0.4	0.68	47.4	Osborne (1999)
Pakawau Beach (1999)	0.41	0.66	47	Osborne (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. In 2009, growth was modelled by the equation  $y = 11.452\text{Ln}(x) + 16.425$ , where  $y$  is shell width and  $x$  is age in years, this equation is only applicable to individuals 23–55 mm in shell width.

## 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 three 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 Bay and Tasman Bay, and, although nothing is known about larval dispersion patterns, cockles in these areas are likely to comprise a single stock. In the absence of any detailed information on stocks, the three currently fished sites in COC 7A are all managed as one stock.

## 4. STOCK ASSESSMENT

This report summarises estimates of absolute biomass and yields for exploited and unexploited cockle populations in Tasman Bay and Golden Bay. 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* (as documented in the Introductory section of the annual Plenaries).

Recruited cockles are considered to be those with a shell length of 30 mm or greater. This is the minimum size of cockles generally retained by the mechanical harvesters used in the COC 7A fishery. At present, most cockles in the fishery are > 35 mm shell length due to size grading by the fisher at Pakawau Beach who returns undersized cockles to the beach. However, the minimum size harvested has gradually declined as the proportion of smaller cockles in the population has increased and the density of large cockles has decreased. In the past, biomass occurring in areas of eel grass (*Zostera*) was not considered to be vulnerable to fishing because the mechanical harvesters cannot operate in areas of *Zostera*. However, it is now known that in the lower parts of the beach *Zostera* beds are periodically covered and re-exposed by moving waves of sand. When covered, cockles from the *Zostera* beds migrate vertically to the surface of the sand waves and become vulnerable to fishing. Also, since 2009, the location of all harvesting at Pakawau Beach has been precisely mapped, delineating the extent of harvestable areas. Biomass vulnerable to fishing has been redefined to include all that biomass 30 mm or greater shell length occurring within the defined extent of harvestable area.

### 4.1 Estimates of fishery parameters and abundance

None are available.

### 4.2 Biomass estimates

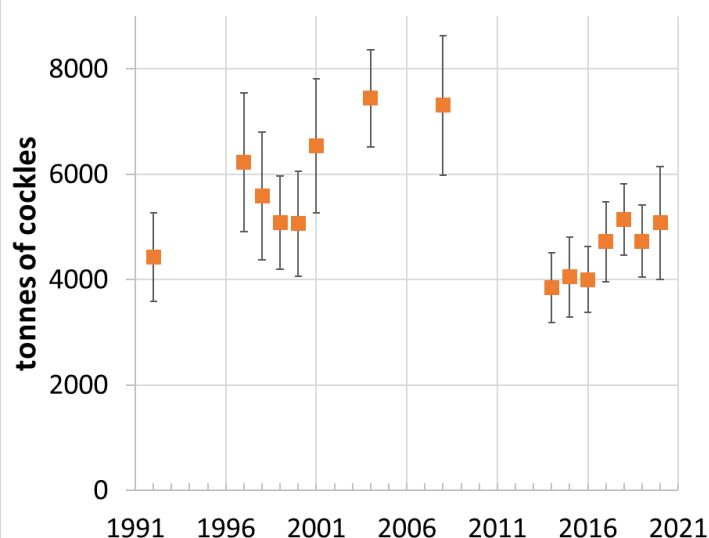
Biomass estimates from surveys are available for the three commercially fished areas and three other sites.

On Pakawau Beach, the surveys done in 1992 and 1997–2004 used a stratified random approach over a wide area of intertidal habitat (Table 4). An additional southern stratum was added to the survey area in 1997 after legal definition of the fishery area, accounting for the greater survey area relative to 1992. The surveys in 1984 and 1988 covered smaller areas still. Since 2008, the survey area has been modified to remove areas observed to be consistently unsuitable habitat for cockles or cockle harvesting (sand banks, soft mud, and *Zostera* areas). From 2014 to 2020, annual biomass surveys were conducted over a similar but slightly varying total area, but individual strata were varied depending on rotational fishing history. The area for which biomass was estimated included all areas known to be historically fished. By 2020, a set of strata were identified as suitable for standardising the time series into the future. Previous surveys were reanalysed with post-stratification (Osborne 2021). The 15 comparable surveys (1992–2020) show recruited biomass increased from 4400 t in 1992 to 7300 t by 2008, declined to 3800 t by 2014 (no intervening surveys), but increased steadily to almost 5100 t by 2020. The lowest value in this time series was recorded in 2014 (Table 4, Figure 2). Reference biomass levels used for *MCY* calculation are given in Table 4. In earlier years,  $B_{AV}$  was taken as the average vulnerable biomass (defined as that which was of minimum harvest size (30 mm) and outside *Zostera* beds). Most recently,  $B_{AV}$  was calculated as the average of post-stratified estimates of recruited biomass from the standard strata making up the area vulnerable to fishing (302 ha).

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). Since then both Riwaka and Ferry Point have been surveyed in 2004 and 2008 using stratified random survey designs. Results from all these surveys are listed in Table 5. The biomass estimates at Riwaka and Ferry Point have generally decreased over time.

**Table 4: Estimates of biomass with 95% confidence intervals where available for Pakawau Beach. Values are total biomass in the original area surveyed, a standardised series of post-stratified estimates from set strata, and reference levels of biomass used for calculating *MCY* ( $B_0$  virgin biomass,  $B_{av}$  average biomass). In 1992 and 2008 one of the six standard strata was not sampled so the area covered is less (the average biomass of the missing strata in other years was 260 tonnes). Prior to 2014 vulnerable biomass (averaged to give  $B_{AV}$ ) was calculated differently (see Osborne 2014, 2021 for details).**

	Total biomass in Original Survey strata				Standardised recruited biomass				Assessed reference levels		
	Area (ha)	tonnes	95% CI	CV	Area (ha)	tonnes	95% CI	CV	$B_0$	$B_{av}$	95% CI
1984	326	4 604	1 562	–	–	–	–	–	–	–	–
1988	510	5 640	–	–	–	–	–	–	–	–	–
1992	588	6 784	929	7.0	280	4 429	840	9.7	3 293	–	–
1997	642	9 331	1 749	9.6	302	6 230	1 319	10.8	–	3 655	134
1998	642	8 269	1 360	8.42	302	5 591	1 211	11.1	–	3 574	176
1999	642	8 666	1 425	8.4	302	5 087	883	8.9	–	3 445	282
2000	642	7 878	1 302	8.4	302	5 061	997	10.1	–	3 184	556
2001	642	10 255	1 629	8.1	302	6 537	1 272	9.9	–	3 172	455
2004	642	10 185	1 243	6.2	302	7 441	918	6.3	–	3 539	817
2008	407	9 212	1 674	9.3	280	7 307	1 328	9.3	–	3 716	788
2014	358	4 431	712	8.2	302	3 844	658	8.7	–	5 686	1 137
2015	196	3 128	563	9.2	302	4 050	758	9.5	–	–	–
2016	303	4 114	918	11.4	302	4 003	622	7.9	–	–	–
2017	381	5 345	997	9.5	302	4 721	757	8.2	–	–	–
2018	294	5 946	855	7.3	302	5 143	680	6.7	–	–	–
2019	294	5 273	784	7.6	302	4 730	689	7.2	–	–	–
2020	302	5 543	1 102	10.1	302	5 076	1 069	10.7	–	5 283	629



**Figure 2: Recruited biomass ( $\geq 30$  mm shell length) over time at Pakawau Beach from a standard set of strata covering 302 ha.**

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  $m^2$ , 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).

**Table 5: Estimates of biomass (t) with 95% confidence intervals (CI) where available, and mean density ( $kg\ m^{-2}$ ) for cockles at various sites in Golden Bay and Tasman Bay. Where possible, values are given for the total and recruited ( $\geq 30$  mm) populations.  $n$  = number of samples in the survey.**

Site	Date	Area (ha)	$n$	Total biomass			Recruited biomass		
				t	CI	$kg\ m^{-2}$	t	CI	$kg\ m^{-2}$
Tapu Bay-Riwaka	Mar-91	306	321	~3 900	–	1.28	–	–	–
Riwaka	Feb-04	122.7	144	1 423	269	1.16	1 076	235.6	0.88
Riwaka	Mar-08	103	82	1475	257	1.44	939	178	0.9
Riwaka (excl. Tapu Bay)*	Mar-91	–	–	–	–	–	1 880	450	–
Ferry Point	Dec-96	40	552	2 617	190	5.99	2 442	191	5.6
Ferry Point	Feb-04	40	126	646	99.8	1.63	443	79	1.12
Ferry Point	Jan-08	28.2	75	662	112	2.35	470	83	1.7
Collingwood Beach	Mar-93	176	70	334	148	0.19	292	139	0.17
Takaka Beach	Mar-93	338	107	1 850	671	0.55	796	395	0.24
Rangihaeata Beach	Mar-93	197	75	473	345	0.24	438	320	0.22

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

## COCKLES (COC 7A)

Absolute virgin biomass,  $B_0$ , is assumed to be equal to estimated biomass of cockles 30 mm or over 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. A preliminary deterministic length-based model suggests  $B_{MSY}$  is considerably lower than current biomass (Osborne 2021).

### 4.3 Yield estimates and projections

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, because of 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  $F_{0.1}$ , and with  $B_{AV}$  being the average of the available recruited biomass from the previous comparable surveys. For a range of  $M$  values, the latest estimates of  $MCY$  are as follows (for mean and upper and lower 95% confidence estimates of  $B_{AV}$ ):

$M$	0.2	0.3	0.4
$MCY$	528 (465, 591)	792 (698, 887)	1057 (931, 1182).

**Table 6: Estimates of  $MCY$  (t, using  $0.25 * F_{REF} * B_0$ ) for various cockle stocks in Tasman Bay and Golden Bay, 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
Pakawau Beach	2001	$F_{MAX}$	1 182	2 418	4 658	–
Pakawau Beach	2004	$F_{0.1}$	482	683	924	–
Pakawau Beach	2008	$F_{0.1}$	340	481	651	–
Pakawau Beach	2014	$F_{0.1}$	665	996	1 312	–
Pakawau Beach	2020	$F_{0.1}$	528	792	1 057	–
Ferry Point	1996	$F_{0.1}$	127	170	223	284
Ferry Point	1996	$F_{MAX}$	264	453	789	1 493
Ferry Point	2004	$F_{0.1}$	122	173	234	–
Ferry Point	2008	$F_{0.1}$	111	157	212	–
Riwaka	1991	$F_{0.1}$	167	224	286	–
Riwaka	2004	$F_{0.1}$	81	115	156	–
Riwaka	2008	$F_{0.1}$	118	167	226	–
Collingwood Beach	1993	$F_{0.1}$	20	28	37	48
Takaka Beach	1993	$F_{0.1}$	53	74	100	127
Rangihacata Beach	1993	$F_{0.1}$	23	32	43	55

The level of risk of 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  $F_{MAX}$  than on  $F_{0.1}$ , so risk would be greater at  $MCY$ s based on  $F_{MAX}$ .

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  $F_{max}$ . The most recent estimates of  $CAY$  available for all stocks are listed in Table 7.

### 4.4 Other yield estimates and stock assessment results

$F_{0.1}$  and  $CAY$  were estimated from a yield per recruit (YPR) analysis using the age and length-weight parameters for Pakawau Beach cockles from Osborne (2010) and assuming size-at-recruitment to the fishery of either 30, 35, or 37 mm shell length. A range of  $M$  values was used to produce the latest estimates in Table 8 (Osborne 2014). Yield per recruit increases with reduction in minimum size at harvest over this size range.

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

Site	Date	$F_{REF}$	$M$			
			0.2	0.3	0.4	0.5
Pakawau Beach	2001	$F_{0.1}$	778	996	1 210	1 396
Pakawau Beach #	2001	$F_{0.1}$	1 964	2 514	3 053	3 522
Pakawau Beach	2004	$F_{0.1}$	1 202	1 555	1 910	
Pakawau Beach	2008	$F_{0.1}$	1 161	1 501	1 845	
Pakawau Beach	2014	$F_{0.1}$	638	844	1 040	
Pakawau Beach	2020	$F_{0.1}$	949	1275	1566	
Ferry Point	1996	$F_{0.1}$	407	501	600	696
Ferry Point	2004	$F_{0.1}$	69	89	109	
Ferry Point	2008	$F_{0.1}$	88	114	140	
Riwaka	1993	$F_{0.1}$	507	615	708	
Riwaka	2004	$F_{0.1}$	138	179	220	
Riwaka	2008	$F_{0.1}$	1 161	1 501	1 845	

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

**Table 8: Latest estimates of  $F_{0.1}$  from a yield per recruit analysis and  $CAY$  at different levels of minimum size at harvest (MSH) and natural mortality ( $M$ ) (Osborne 2014).**

	MSH (mm)	$B_{beg}$	$M$		
			0.20	0.30	0.40
$F_{0.1}$	30		0.23	0.34	0.46
$CAY$		3 363	638	844	1 040
$F_{0.1}$	35		0.28	0.40	0.54
$CAY$		2 409	541	696	838
$F_{0.1}$	37		0.31	0.43	0.56
$CAY$		2 026	489	617	732

The annual exploitation rate ( $u$ ) corresponding to  $F_{0.1}$  values for minimum size at harvest of 30 mm over the plausible range of  $M$  values are as follows:

$M$	0.2	0.3	0.4
$F_{0.1}$	0.23	0.34	0.46
$u$	19%	25%	31%

#### 4.5 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 because of 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 three 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 Bay and Golden Bay 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.

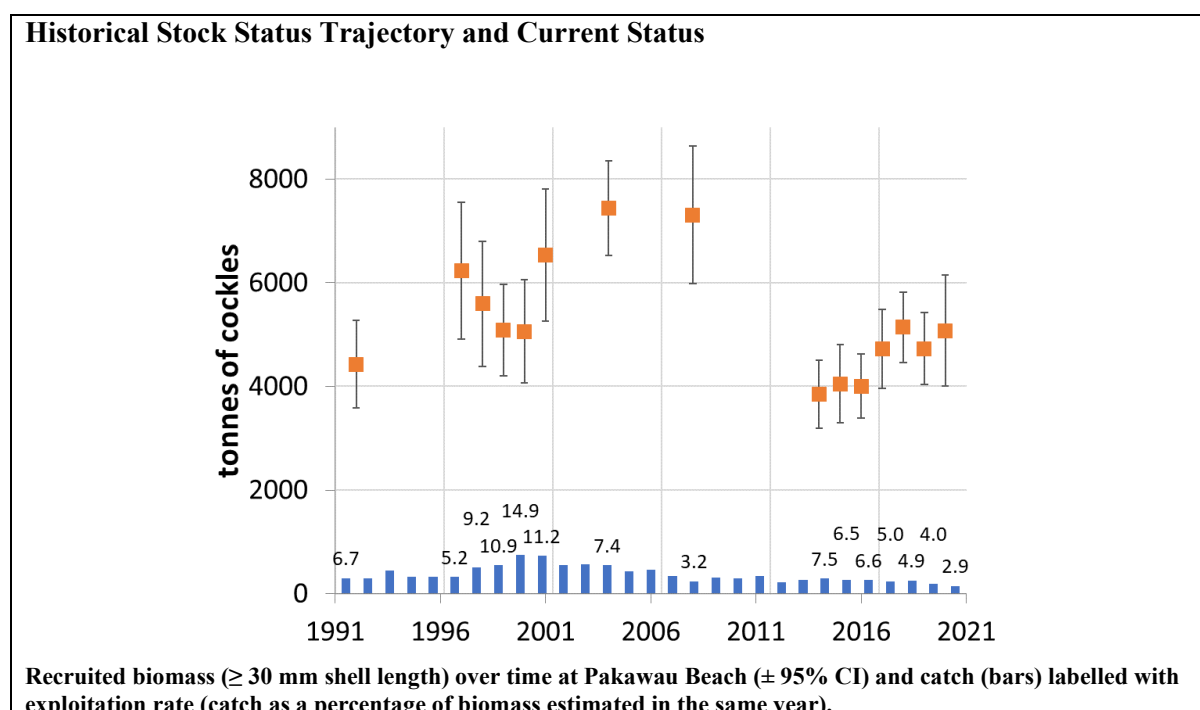
## 5. STATUS OF THE STOCKS

### Stock structure assumptions

Little is known of the stock boundaries of cockles. Given differences in growth and mortality within and between different beds and in the absence of more detailed knowledge regarding larval connectivity, this commercial fishery area is managed as a discrete population.

COC 7A – Tasman Bay and Golden Bay

Stock Status	
Year of Most Recent Assessment	2021
Assessment Runs Presented	Survey biomass estimates for $\geq 30$ mm shell length
Reference Points	Target(s): Not defined, but $B_{MSY}$ assumed Soft Limit: 20% $B_0$ Hard Limit: 10% $B_0$ Overfishing threshold: - Undefined
Status in relation to Target	Likely (> 60%) to be at or above the target (except for local depletion in some bays)
Status in relation to Limits	Unlikely (< 40%) to be below the soft limit and Very Unlikely (< 10%) to be below the hard limit
Status in relation to Overfishing	Overfishing is Very Unlikely (<10%) to be occurring



Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	The recruited biomass estimates of cockles from Pakawau Beach have shown periods of increase and decline since 1992, peaking in 2004, a marked decline after 2008 to a historical low in 2014, and a steady increase again since then. Two other areas open for commercial fishing within COC 7A are not commercially fished.
Recent Trend in Fishing Mortality or Proxy	Landings since 2004–05 are intermediate compared with the history of the fishery and have fluctuated without trend between 146 and 460 t. Exploitation rate over the same period has ranged from 2.9% to 7.5% measured in years where biomass estimates are available. The exploitation rate corresponding to $F_{0.1}$ ranges from 19% to 31% over the range of plausible M values. Therefore, the fishery exploitation rate is relatively low in comparison to $F_{0.1}$ . Exploitation rate (catch / biomass) has declined in recent years and is currently very low (< 3%).
Other Abundance Indices	-
Trends in Other Relevant Indicators or Variables	-



<b>Projections and Prognosis</b>	
Stock Projections or Prognosis	-
Probability of Current Catch or TACC causing Biomass to remain below or to decline below Limits	Fishing at present levels is Very Unlikely (< 10%) to cause declines below the soft or hard limits.
Probability of Current Catch or TACC causing Overfishing	Very Unlikely (< 10%)

<b>Assessment Methodology and Evaluation</b>		
Assessment Type	Level 2 - Partial quantitative stock assessment	
Assessment Method	Absolute biomass estimates from quadrant surveys	
Assessment Dates	Latest assessment: 2021	Next assessment: 2028
Overall assessment quality rank	1 – High Quality	
Main data inputs (rank)	- Abundance survey - Length frequency	1 – High Quality 1 – High Quality
Data not used (rank)		
Changes to Model Structure and Assumptions	-	
Major Sources of Uncertainty	-	

<b>Qualifying Comments</b>
Water quality issues have influenced the amount of time when cockles can be harvested from Ferry Point in recent years.

<b>Fishery Interactions</b>
Cockles are an important food source for shorebirds including oyster catchers and godwits. Pakawau Beach is classed as a site of international importance for the South Island Pied Oystercatcher. Monitoring population sizes has shown that South Island Pied Oystercatcher (nationally at risk, declining) and Variable Oystercatcher (nationally at risk, recovering) have been stable or increased in numbers in Golden Bay over the period 1983 to 2012.

## 6. FOR FURTHER INFORMATION

- Belton, R J (1986) A resource survey of the *Chione stutchburyi* stocks in the Marlborough Sounds. Unpublished report prepared for M. Hones & B. Huntley. Contact Southern Clams for more information.
- Boyd, R O; Reilly, J L (2002) 1999/2000 National Marine Recreational Fishing Survey: harvest estimates. New Zealand Fisheries Research Report. (Unpublished document held by Fisheries New Zealand, Wellington.)
- Bradford, E (1998) Harvest estimates from the 1996 national recreational fishing surveys. New Zealand Fisheries Assessment Research Document 1998/16. 27 p. (Unpublished document held by NIWA library, Wellington.)
- Breen, P A (1996) Yield estimates for the Tapu Bay - Riwaka fishery for cockles (*Austrovenus stutchburyi*). (Unpublished NIWA Client Report WLG1996/27 prepared for Talley's Fisheries Ltd.)
- Breen, P A (1997a) Yield calculations for cockles (*Austrovenus stutchburyi*) at Ferry Point, Golden Bay. (Unpublished NIWA Client Report WLG1997/17 prepared for Talley's Fisheries Ltd.)
- Breen, P A (1997b) An evaluation of a biomass survey for cockles on Pakawau Beach, consideration of reasonable *CAY* estimates and consideration of increased catch. (Unpublished NIWA Client Report WLG97/32 prepared for Westhaven Shellfish Co. Ltd.)
- Bull, M (1984) A brief study of intertidal clam beds in Western Golden Bay associated with trials of a mechanical clam harvester. Unpublished Ministry of Fisheries report. 11 p.
- Forrest, B; Asher, R (1997) Ferry Point cockle survey: revised report. (Unpublished report prepared for Talley's Fisheries Ltd. as Cawthron Report No. 411.)
- Grange, K (1995) Biological communities of the intertidal sandflats, Motupipi, Golden Bay. (Unpublished NIWA Client Report 1995/NEL911/1 prepared for Sealife Investments Ltd.)
- Hartill, B; Cryer, M; Morrison, M (2005) Estimates of biomass, sustainable yield, and harvest: neither necessary nor sufficient for the management of non-commercial urban intertidal shellfish fisheries. *Fisheries Research* 71: 209–222.
- Ministry of Fisheries (2010) Report from the Fisheries Assessment Plenary, May 2010: stock assessments and yield estimates. 1158 p. (Unpublished report held by Fisheries New Zealand, Wellington.)
- Osborne, T (2014) Biomass survey and stock assessment of cockles (*Austrovenus stutchburyi*) at Pakawau Beach in area COC 7A 2014. (Unpublished ORCO report produced for Westhaven Shellfish Company Ltd.) 18 p.
- Osborne, T (2021) Biomass surveys and stock assessment of cockles (*Austrovenus stutchburyi*) at Pakawau Beach in area COC7A. 2021. (Unpublished ORCO report produced for Westhaven Shellfish Company Ltd.) 32 p.
- Osborne, T A (1992) Biomass survey and stock assessment of the New Zealand littleneck clam (*Chione stutchburyi*) on Pakawau Beach, Golden Bay. (Unpublished report prepared for Westhaven Shellfish Co. Ltd.) 27 p.
- Osborne, T A (1997) Biomass survey and stock assessment of the New Zealand littleneck clam (*Chione stutchburyi*) on Pakawau Beach, Golden Bay. (Unpublished report prepared for Westhaven Shellfish Co. Ltd.) 16 p.

## COCKLES (COC 7A)

- Osborne, T A (1998) 1998 biomass survey and stock assessment of the New Zealand littleneck clam (*Chione stutchburyi*) on Pakawau Beach, Golden Bay. (Unpublished report prepared by Osborne Research Co. Ltd. for Westhaven Shellfish Co. Ltd.) 23 p.
- Osborne, T A (1999) 1999 biomass survey and stock assessment of the New Zealand littleneck clam (*Chione stutchburyi*) on Pakawau Beach, Golden Bay. (Unpublished report prepared by Osborne Research Co. Ltd. for Westhaven Shellfish Co. Ltd.) 15 p.
- Osborne, T A (2001) Annual biomass survey and stock assessment of cockles on Pakawau Beach, Golden Bay - 2001. (Unpublished report prepared by Osborne Research Co. Ltd. for Westhaven Shellfish Co. Ltd.) 23 p.
- Osborne, T A (2004) Annual biomass survey and stock assessment of cockles on Pakawau Beach, Golden Bay - 2001. (Unpublished report prepared by Osborne Research Co. Ltd. for Westhaven Shellfish Co. Ltd.)
- Osborne, T A (2010) Biomass survey and stock assessment of cockles (*Austrovenus stutchburyi*) in area COC 7A: Tapu Bay, Ferry Point, and Pakawau. *New Zealand Fisheries Assessment Report 2010/44*.
- Osborne, T A; Seager, V (1994) Biomass survey and stock assessment of the New Zealand littleneck clam (*Chione stutchburyi*) on three beaches in Golden Bay. (Unpublished report prepared for Wakatu Incorporation and Te Tau Ihu Ltd Joint Venture.)
- Stark, J D; Asher, R A (1991) Cockle resource survey Tapu Bay - Motueka River (February 1991). (Unpublished report prepared by Cawthron Institute for Talley's Fisheries Ltd.)
- Teirney, L D; Kilner, A R; Millar, R E; Bell, J D (1997) Estimation of recreational catch from 1991/92 to 1993/94. *New Zealand Fisheries Assessment Research Document 1997/15*. 43 p. (Unpublished document held by NIWA library, Wellington).
- Wilson, N; Stevens, J; Alspach, P; Butler, D (1988) Environmental Impact Assessment. Effects of mechanical harvesting of cockles from the Pakawau/Puoponga intertidal area. (Report prepared by DSIR Division of Horticulture and Processing, Fish Technology Section, Nelson, for Westhaven Shellfish Co. Ltd.)
- Wynne-Jones, J; Gray, A; Heinemann, A; Hill, L; Walton, L (2019) National Panel Survey of Marine Recreational Fishers 2017–2018. *New Zealand Fisheries Assessment Report 2019/24*. 104 p.
- Wynne-Jones, J; Gray, A; Hill, L; Heinemann, A (2014) National Panel Survey of Marine Recreational Fishers 2011–12: Harvest Estimates. *New Zealand Fisheries Assessment Report 2014/67*. 139 p.