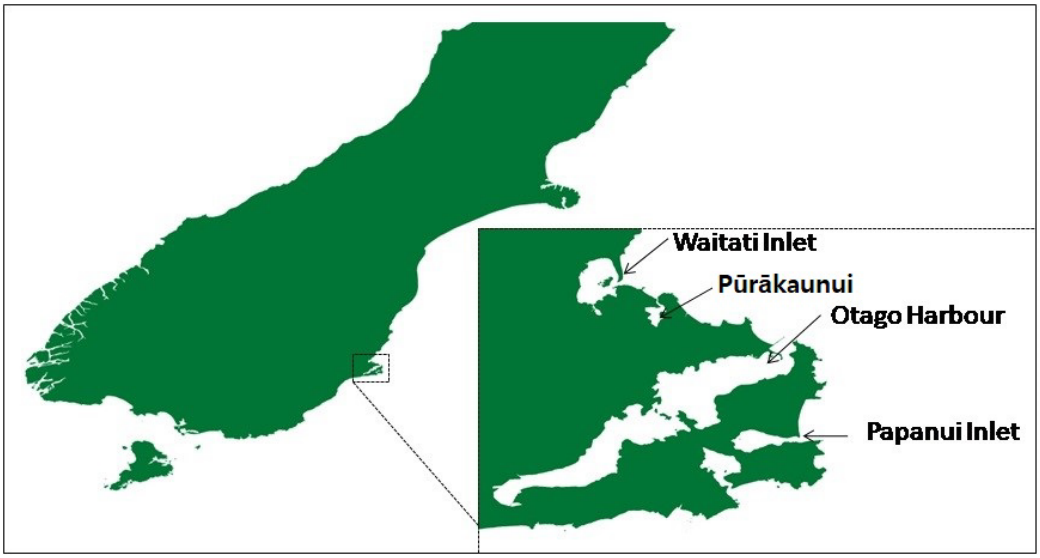
COCKLES (COC 3) – Otago Peninsula

(*Austrovenus stutchburyi*)
Tuangi



1. FISHERY SUMMARY

COC 3 was introduced into 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. Historical catch limits are shown in Table 1.

1.1 Commercial fisheries

Cockles are present at various locations around the Otago Peninsula but are only commercially fished from Papanui Inlet, Waitati Inlet, and Otago Harbour.

Commercial fishing in Papanui Inlet and Waitati Inlet began in 1983. A limit of 104 t was in effect for Papanui and Waitati inlets combined from 1986–87 until 1991–92 (Table 1). From 1992–93 to 1998–99, separate catch limits were set for each inlet: 90 t for Papanui Inlet and 252 t for Waitati Inlet. In April 2000, based on new *CAY* estimates (Breen et al 1999) for each area, the catch limits were increased to 427 t for Papanui Inlet and 746 t for Waitati Inlet. In 2002, when cockles entered the QMS, spatial restrictions upon harvest within COC 3 were removed.

From August 2009 until 31 January 2017, cockles were taken from Otago Harbour under a special permit to investigate the ecosystem effects of commercial cockle harvesting in this location (Table 1). This permit stated no explicit limit to the tonnage able to be taken but delimited the area where harvest would be taken. Subsequently, in November 2018, regulation 10 of the Fisheries (South-East Area Commercial Fishing) Regulations 1986 closing Otago Harbour to commercial shellfish harvest was amended to allow harvest from two beds corresponding to sanitation areas 1804 (Port Chalmers) and 1805 (Sawyers Bay).

Total landings have remained below the TACC since 2002–03, with the highest landings since the beginning of the time series recorded in 2018–19 (1008 t), but landings since then (888 t in 2021–22) declined slightly to amounts more similar to the recent average (Table 1, Figure 1).

In 1992, 35 mm shell length was the minimum size for commercial cockles. However, commercial fishers currently target the favoured market size of 28 mm or more.

Table 1: Reported landings (t) of cockles from Papanui and Waitati Inlets, Otago harbour (by each sanitation area and overall) and the entire FMA, since 1986–87 based on Licensed Fish Receiver Returns (LFRR). Catch splits are provided by Southern Clams Ltd. N/A = Not Applicable.

	Papanui Inlet		Waitati Inlet		Otago Harbour catch (t)			Total	
Year	catch (t)	limit (t)	catch (t)	limit (t)	Sanitation area, 1804	Sanitation area, 1805	Total	catch (t)	limit (t)
1986–87	14	–	–	–			–	14	104
1987–88	8	–	–	–			–	8	104
1988–89	5	–	–	–			–	5	104
1989–90	25	–	–	–			–	25	104
1990–91	90	–	16	–			–	106	104
1991–92	90	–	14	–			–	104	104
1992–93	90	90	92	252			–	182	342
1993–94	90	90	109	252			–	199	342
1994–95	90	90	252	252			–	342	342
1995–96	90	90	252	252			–	342	342
1996–97	90	90	252	252			–	342	342
1997–98	90	90	252	252			–	342	342
1998–99	90	90	293	252			–	383	342
1999–00	118	427	434	746			–	552	1 273
2000–01	90	427	606	746			–	696	1 273
2001–02	49	N/A	591	N/A			–	640	1 273
2002–03	52	N/A	717	N/A			–	767	1 470
2003–04	73	N/A	689	N/A			–	762	1 470
2004–05	91	N/A	709	N/A			–	800	1 470
2005–06	68	N/A	870	N/A			–	943	1 470
2006–07	0*	N/A	907	N/A			–	907	1 470
2007–08	–	N/A	760	N/A			–	760	1 470
2008–09	–	N/A	751	N/A	2	21	24	775	1 470
2009–10	–	N/A	379	N/A	188	253	441	820	1 470
2010–11	–	N/A	240	N/A	567	30	596	836	1 470
2011–12	–	N/A	358	N/A	153	284	437	795	1 470
2012–13	–	N/A	403	N/A	98	290	387	790	1 470
2013–14	–	N/A	438	N/A	201	161	362	800	1 470
2014–15	–	N/A	466	N/A	90	259	349	815	1 470
2015–16	–	N/A	453	N/A	193	276	469	923	1 470
2016–17	–	N/A	825	N/A	44	94	138	967	1 470
2017–18	48	N/A	906	N/A	0	0	0	954	1 470
2018–19	27	N/A	153	N/A	348	480	828	1 008	1 470
2019–20	0	N/A	417	N/A	205	250	455	872	1 470
2020–21	4	N/A	629	N/A	143	118	261	894	1 470
2021–22	34	N?A	731	N/A	33	90	122	888	1 470

*No catches have been taken from Papanui Inlet between 2006–07 and 2016–17 because of water quality problems.

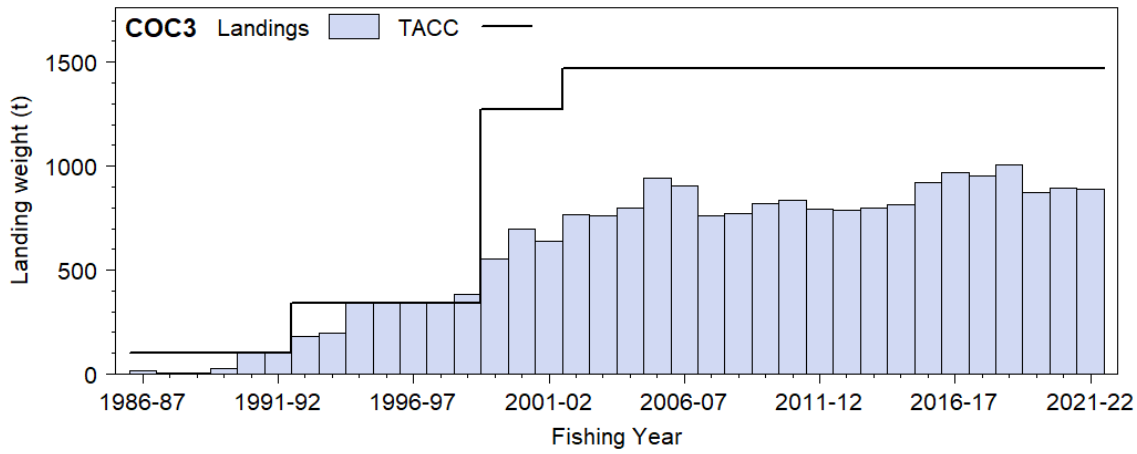


Figure 1: Reported commercial landings and TACC for COC 3 (Otago).

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.

No recreational harvest estimates specific to the COC 3 commercial fishery areas are available. History of the estimates of recreational catch is provided in the Introduction – Cockle chapter. Estimated numbers of cockles harvested by recreational fishers in QMA 3 are provided in Table 2.

Table 2: Estimated numbers of cockles harvested by recreational fishers in QMA 3, and the corresponding harvest tonnage based on an assumed mean weight of 25 g. Figures were extracted from telephone-diary survey in 1993–94, 1996, and 1999–00, and from the national panel surveys in 2011–12 and 2017–18.

Survey	Numbers	% CV	Tonnes	Reference
1993–94 South	106 000	51	2.7	Teirney et al (1997)
1996	144 000	–	3.6	Bradford (1998)
1999–00	1 476 000	45	36.9	Boyd & Reilly (2004)
2011–12	300 158	67	7.5	Wynne-Jones et al (2014)
2017–18	103 359		2.6	Wynne-Jones et al (2019)

1.3 Customary non-commercial fisheries

Many intertidal bivalves, including cockles, are very important to Māori as traditional food, particularly to Huirapa and Ōtākou Māori in the Otago area. For information on customary catch regulations and reporting refer to the Introduction – Cockle chapter.

Estimates of customary catch under the provisions made for customary fishing for COC 3 are shown in Table 3. These numbers are likely to be an underestimate of customary harvest because only the approved and harvested catch in weight (kg) and in numbers are reported in the table. In addition, many tangata whenua also harvest cockles under their recreational allowance and these are not included in records of customary catch.

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

	Weight (kg)		Numbers	
Fishing year	Approved	Harvested	Approved	Harvested
2000–01	–	–	400	400
2001–02	–	–	37	37
2002–03	–	–	1 200	1 200
2003–04	–	–	–	–
2004–05	–	–	–	–
2005–06	–	–	–	–
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
2012–13	–	–	–	–
2013–14	–	–	2 300	2 100
2014–15	–	–	–	–
2015–16	80	80	9 610	9 510
2016–17	–	–	5 500	5 240
2017–18	–	–	4 950	4 800
2018–19	–	–	–	–
2019–20	–	–	3 140	3 140
2020–21	–	–	7 400	7 400
2021–22	–	–	4 610	4 280

On 1 October 2010, on the recommendation of the Taiāpure Committee, the Minister of Fisheries introduced new regulations for the East Otago Taiāpure[1]. These included a new amateur daily bag limit of 50 for shellfish, including cockles, and a ban on the commercial take of cockles from any part of the taiāpure, except for the existing sanitation areas within Waitati Inlet. The new regulations reflect the Committee's concern about fishing pressure on shellfish stocks, including cockles, within the taiāpure.

A long-running time series of surveys suggest that there are no sustainability concerns for cockles within the taiāpure. However, they do indicate a shift in some beds towards smaller size classes of cockle. The

[1] The Kāti Huirapa Rūnanga ki Puketeraki application for a taiāpure-local fishery was gazetted as the East Otago Taiāpure-Local Fishery in 1999. A management committee, made up of representatives from the rūnanga and various recreational, environmental, commercial, community and scientific groups, was appointed in 2001.

Committee hopes that reducing the bag limit and limiting the spatial extent of commercial harvest will lead to an increase in the number of large cockles.

The Ōtākou Mātaitai Reserve was established over the outer Otago Harbour in 2016 in recognition of the importance of this area as a traditional customary food source.

1.4 Illegal catch

There are qualitative data to suggest illegal, unreported, unregulated (IUU) activity in this fishery.

1.5 Other sources of mortality

For further information on other sources of mortality, please refer to the Introduction – Cockle chapter.

Other mortality sources would include predation from oystercatchers (*Haematopus ostralegus*) and other wading birds, and sediment burial via landslips or shifting sediments (Stephenson 1981).

2. BIOLOGY

Biological parameters used in this assessment are presented in the Introduction – Cockle chapter.

3. STOCKS AND AREAS

Each inlet is assumed to be an independent fishery within the stock.

4. 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* (See Introduction chapter of Plenary). From a 1998–99 survey, Breen et al (1999) also estimated biomasses and yields and size composition for clams in Papanui Inlet and Waitati Inlet (see Table 7) as well as five beds within Otago Harbour (Harwood, Aramoana, Port Chalmers, Sawyers Bay, and St Leonards), and Pūrākaunui. Stewart (2006, 2008a) estimated biomass and yields for Papanui and Waitati inlets in 2004 and Waitati Inlet in 2007. Similarly, Jiang et al estimated biomass and yields for Papanui and Waitati Inlets in 2011 (Jiang et al 2011). Stewart (2017) also estimated the size structure and biomass for clams in part of sanitation areas 1804 and 1805 in Otago Harbour in January 2007, 2012, and 2017. Miller & Black (2019) calculated *MCY* and *CAY* for the recruited biomass of commercial beds in Waitati Inlet using Method 1 and yield per recruit (*YPR*) values calculated by previous surveys. In 2020 the five Otago Harbour beds were resurveyed providing estimates of biomass and size composition (Beentjes 2021). Sanitation area 1804 includes the Port Chalmers bed, and sanitation area 1805 includes the Sawyers Bay bed.

4.1 Estimates of fishery parameters and abundance

A project to estimate growth and mortality in Papanui and Waitati inlets, Pūrākaunui, and Otago Harbour 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).

Yield-per-recruit modelling has been conducted for Papanui and Waitati inlets separately (Stewart 2006, 2008a, Jiang et al 2011, Miller & Black 2019) and for Otago Harbour (Stewart 2017). The most recent parameters used in this modelling are detailed in table 2 of the Introduction – Cockle chapter. Estimates of $F_{0.1}$ from these studies are given in Table 4. The exploitation rate has never exceeded 13% for Waitati Inlet, Papanui Inlet, and Otago Harbour sanitation areas (beds 1804 and 1805 combined and individually) (Table 5, Figure 2).

Table 4: Estimates of fishery parameters (recruitment to this fishery is at ≥ 28 mm).

M	$F_{0.1}$ 2004	$F_{0.1}$ 2007	$F_{0.1}$ 2011		$F_{0.1}$ 2017	$F_{0.1}$ 2019
			Waitati	Papanui	Otago Harbour	Waitati
0.2	0.2321	0.2899	0.2600	0.2900	0.2899	0.2899
0.3	0.3412	0.3863	0.3900	0.4400	0.3863	0.3863
0.4	0.4767	0.5537	0.5300	0.6000	0.5537	0.5537

Table 5: Exploitation rate (%) as calculated by commercial landings divided by biomass (≥ 30 mm) from Papanui Inlet (whole inlet), Waitati Inlet (whole inlet), and Otago Harbour sanitation areas (beds 1804 and 1805 combined)*.

Year	Papanui Inlet	Waitati Inlet	Otago Harbour		
			Sanitation areas combined	Sanitation area, 1804	Sanitation area, 1805
1998	2	3			
2002	1	8			
2004	2	9			
2007		13	0	0	0
2011	0	2	5	4	7
2017			2	1	4
2019		3			

* This measure is likely to overestimate exploitation as harvest occurs down to a size limit of 28 mm.

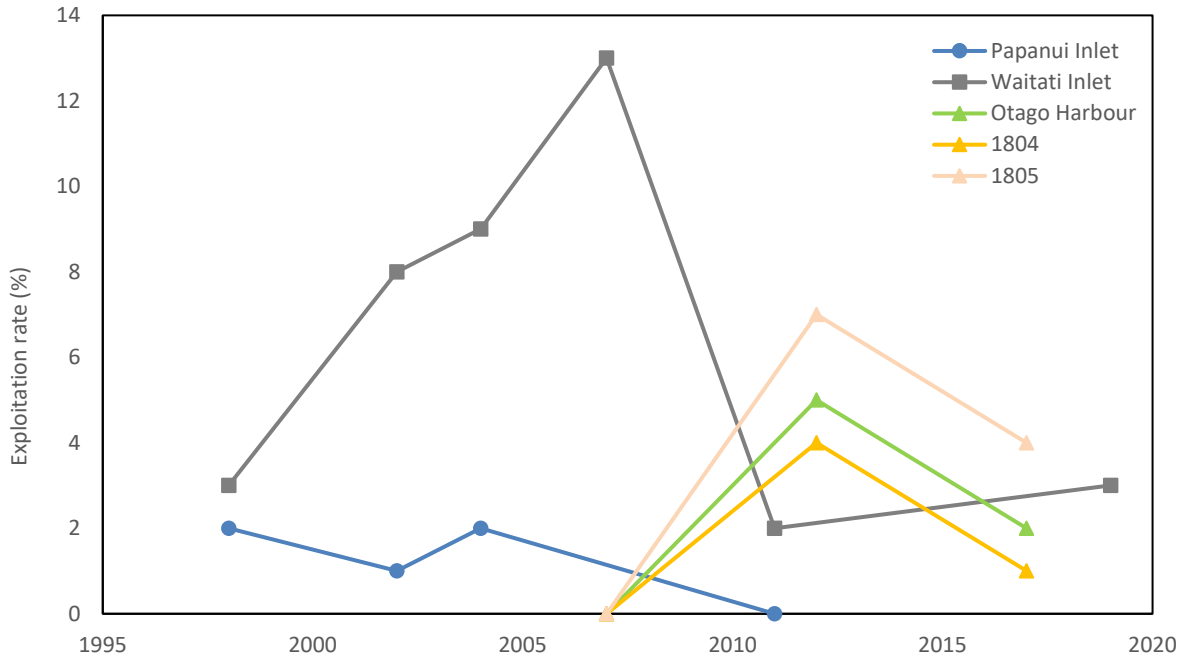


Figure 2: Exploitation rate (%) as calculated by commercial landings divided by biomass (≥ 30 mm) from Papanui Inlet (whole inlet), Waitati Inlet (whole inlet), and Otago Harbour sanitation areas (beds 1804 and 1805 combined). Note: This measure is likely to overestimate exploitation as harvest occurs down to a size limit of 28 mm.

4.2 Biomass estimates

Biomass surveys have been undertaken periodically in COC 3 since 1984. The methods for the calculation of biomass have changed over time[2] which means that comparison of biomass values between times of different calculation methodologies should be conducted cautiously.

The spawning stock biomass (19 mm or more, shell length) was stable around the level of virgin biomass in Waitati Inlet until 2007 and has increased since (Table 6, Figure 3). In Papanui Inlet the spawning stock biomass (19 mm or more shell length) showed a trend of gradual decline from 1984

[2] Wildish (1984a and b) 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 2006, 2008a). These data were then used to generate length to weight relationships. The 2017 survey replicated the method used in the 2004 and 2007 surveys. The 2020 survey of Otago Harbour followed the methods of Breen et al 1999 (Beentjes 2021).

until 2011, when it was at 73% of virgin biomass. No commercial harvesting has occurred in Papanui Inlet between 2006–07 and 2016-17. The recruited biomass (30 mm or more shell length) in the sanitation areas (beds 1804 and 1805) in Otago Harbour decreased before the start of harvesting in 2008 and has decreased more since then (to 60% of virgin biomass). A new survey was conducted in January-February 2020 (Beentjes 2021). From 58 stations at bed 1804 and 86 stations at bed 1805 the total clam biomass for each bed was estimated to be 3715 tonnes for 1804 and 5353 tonnes for 1805.

Table 6: Survey biomass estimates (B in tonnes) and ± 95% confidence intervals (CI) from COC 3*.

Size classes	>2 to 18 mm (juveniles)		19 – 34 mm (adults)		≥ 30 mm		≥ 35 mm		Total (t)	
	B	± 95% CI	B	± 95% CI	B	± 95% CI	B	± 95% CI	B	± 95% CI
Papanui Inlet										
1984	65		3 705				2 370		6 140	
1992	139	41	3 721	852			1 706	635	5 567	1 058
1998	33	11	3 435	645	3 990	1 115	2 231	708	5 699	1 154
2002 (total inlet)	17	1.7	1 970	192	3 860	365	2 579	252	4 565	424
2002 (Commercial area)	8	1.2	888	111			1731	210	2 628	305
2004 (total inlet)	36	2.2	2 415	151	3 677	367	2 301	273	4 752	425
2004 (Commercial area)	13	1.3	825	88	2 420	271	1 847	208	2 685	298
2011 (total inlet)	8	1.4	1 400	168	4 025	542	3 048	429	4 457	601
2011 (Commercial area)	4		401				1 508		1 913	
Waitati Inlet**										
1984	619		7 614				3 844		12 080	
1992	1 210	115	5 198	363			4 620	596	11 027	707
1998	304	63	8 519	1 241	7 235	1 625	4 381	1 335	13 204	1 947
2002 (total inlet)	153	20	6 653	652	7 183	463	4 298	298	11 103	848
2002 (Commercial area)	26	1.8	2 622	168			3 630	260	6 278	410
2004 (total inlet)	257	14	7 272	403	7 993	720	4 535	508	12 064	925
2004 (Commercial area)	77	4	2 735	129	5 612	681	3 872	384	6 685	517
2007 (total inlet)	335	26	4 507	347*[3]	7 106	548	3 941	462	11 948	921
2007 (Commercial area)	102	7.5	1 284	95*[3]	4 726	352			6 112	456
2011 (total inlet)	220	14	7 348	501	11 441	946	6 323	643	13 892	1 149
2011 (Commercial area)	48		2 846		6 881		5 114		8 008	
2019 (total inlet)	885	67	5 403	369*[3]	7 875	601			14 162	1 082
2019 (Commercial area)	105	7	1 677	109*[3]	4 535	294			6 317	410
Purakunui Inlet										
1998					1 825					
Otago Harbour										
1998					32 975					
2020					20 606				22 978	
Otago Harbour Sanitation area, 1804										
1998					8 091*[4]					
2007	208	15	472	35	5 473	402			6 153	452
2012	155	19	348	44	4 183	497			4 686	560
2017	312	42.35	148	20	4 100	554			4 550	616
2020					3 675*[4]	1 374			3 715*[4]	1 386
Otago Harbour Sanitation area, 1805										
1998					5 546*[4]					
2007	375	41	3 387	367	3 526	382			7 288	790
2012	385	46	2 016	241	4 078	472			6 479	764
2017	1 106	201	1 465	271	2 258	416			4 829	888
2020					4 384*[4]	978			5 353*[4]	1 165

*Wildish 1984a; Stewart et al 1992; Breen et al 1999; Wing et al 2002; Stewart, 2006; Stewart 2008a (table 4.1.5), Stewart 2008b; Jiang et al 2011; Stewart 2013, Stewart 2017, Beentjes 2021. Area of current commercial beds, Papanui Inlet = 815 811 m^2. **Area of current commercial beds, Waitati Inlet = 943 986 m^2. *[3] = this value is only for ≥19 mm to <30 mm cockles. *[4] The surveys of Breen et al 1999 and Beentjes 2021 covered a larger extent of these beds than the three surveys in 2007–08, 2012, and 2017.

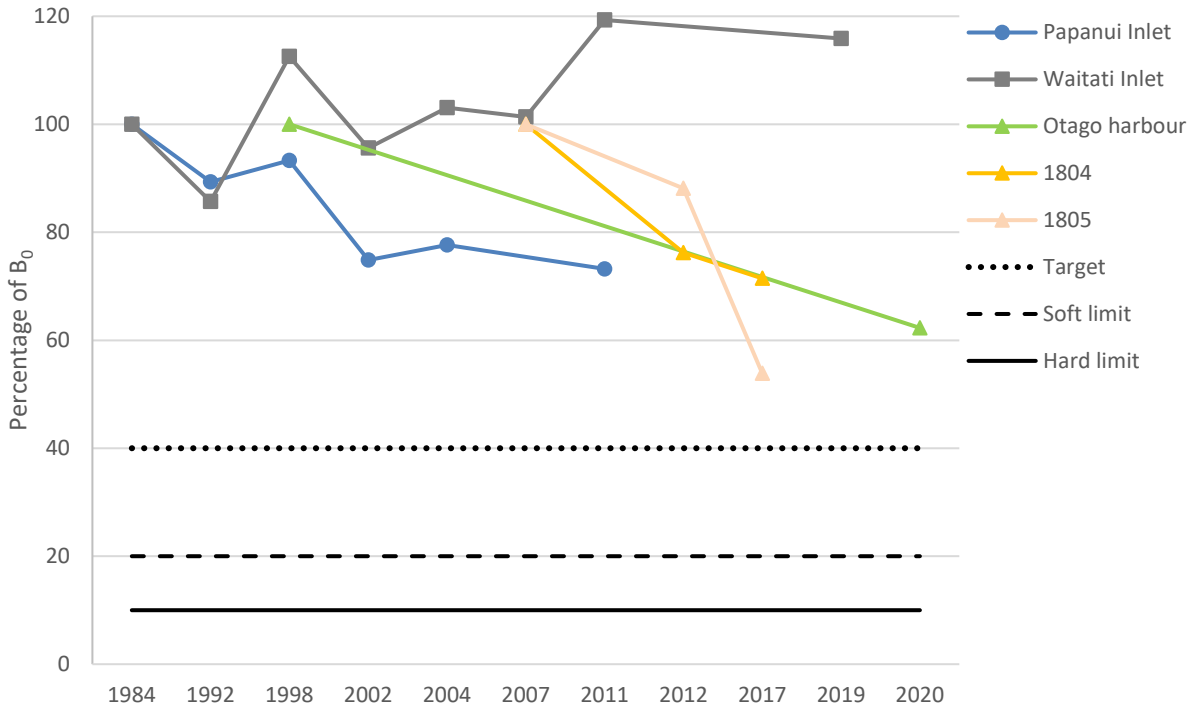


Figure 3: Biomass as a proportion of B_0. For Papanui Inlet, Waitati Inlet, and the two sanitation areas (1804 and 1805) this is estimated for biomass ≥ 19 mm. For Otago Harbour, the estimates are for biomass ≥ 30 mm. For the 2020 Otago Harbour survey, the biomass of the additional bed (Te Rauone, 69 t) was removed so the 1998 and 2020 surveys could be compared. Virgin biomass was taken as biomass estimated during the first survey for each area. Note: No commercial catch was taken from Papanui Inlet between 2006–07 and 2016–17.

4.4 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. Māori and recreational fishers prefer larger cockles (45 mm shell length and greater) whereas commercial fishers currently prefer cockles of around 28–34 mm. Commercial fishers currently target cockles 28 mm or more, therefore 28 mm is used as the effective minimum size in yield calculations; 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 18 mm) 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 10 mm) across the various beds is variable and no consistent differences exist for this size of shellfish between commercial and non-commercial beds (Stewart 2008a). 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 effects of the illegal catch, the Māori 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.

Table 7: *CAY* estimates (*t*) for COC 3. WI = Waitati Inlet, PI = Papanui Inlet, WIc and PIc are estimates for commercial areas only, B_{beg} = Projected biomass at the beginning of the fishing year. References: (a) Breen et al (1999), (b) Wing et al (2002), (c) Stewart (2006), (d) Stewart (2008a), (e) Jiang et al (2011) and (f) Miller & Black (2019).

				WI		WIc		PI		PIc		
Year	*M*	$F_{0.1}$	≥ SL (mm)	B_{beg}	*CAY*	B_{beg}	*CAY*	B_{beg}	*CAY*	B_{beg}	*CAY*	Reference
1999	0.2	0.258	30	7 235	1 498			3 990	826			(a)
1999	0.3	0.357	30	7 235	1 848			3 990	1 019			(a)
1999	0.4	0.457	30	7 235	2 221			3 990	1 225			(a)
2002	0.2	0.2017	30	7 183	1 193	5 364	891	3 860	641	2 322	386	(b)
2002	0.3	0.3015	30	7 183	1 627	5 364	1 215	3 860	874	2 322	526	(b)
2002	0.4	0.3956	30	7 183	1 960	5 364	1 464	3 860	1 053	2 322	634	(b)
2004	0.2	0.2321	30	9 399	1 771	6 081	1 146	4 119	776	2 454	462	(c)
2004	0.3	0.3412	30	9 399	2 367	6 081	1 532	4 119	1 038	2 454	618	(c)
2004	0.4	0.4767	30	9 399	2 984	6 081	1 930	4 119	1 308	2 454	779	(c)
2007	0.2	0.2899	28	8 378	1 920	5 261	1 206					(d)
2007	0.3	0.3863	28	8 378	2 342	5 261	1 471					(d)
2007	0.4	0.5537	28	8 378	2 990	5 261	1 878					(d)
2007	0.2	0.2899	30	7 106	1 629	4 725	1 083					(d)
2007	0.3	0.3863	30	7 106	1 986	4 725	1 321					(d)
2007	0.4	0.5537	30	7 106	2 536	4 725	1 686					(d)
2011	0.2	0.26	30	11 441	2 385	6 881	1 434					(e)
2011	0.3	0.39	30	11 441	3 223	6 881	1 938					(e)
2011	0.4	0.53	30	11 441	3 948	6 881	2 374					(e)
2011	0.2	0.29	30					4 026	923	1 784	409	(e)
2011	0.3	0.44	30					4 026	1 252	1 784	555	(e)
2011	0.4	0.60	30					4 026	1 527	1 784	677	(e)
2019	0.2	0.2899	28	9 330	2 138	5 089	1 166					(f)
2019	0.3	0.3863	28	9 330	2 608	5 089	1 423					(f)
2019	0.4	0.5537	28	9 330	3 330	5 089	1 816					(f)

5. STATUS OF THE STOCKS

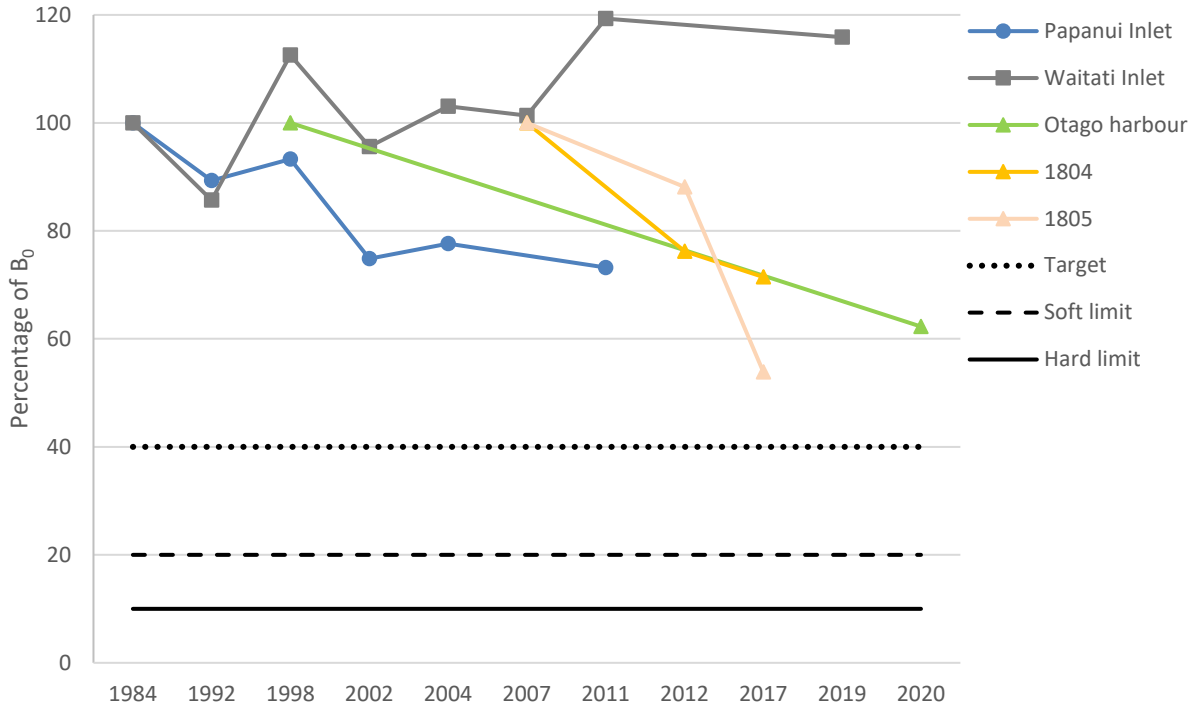
Stock structure assumptions

Each inlet is assessed separately.

- **COC 3 – Otago harbour**

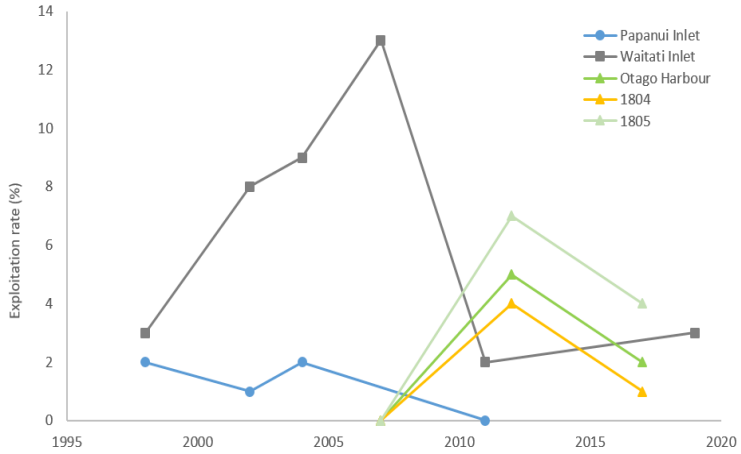
Stock Status	
Year of Most Recent Assessment	2020 - Otago harbour
Assessment Runs Presented	Survey biomass estimate for ≥ 19 mm shell length
Reference Points	Target: 40% B_0 Soft Limit: 20% B_0 Hard Limit: 10% B_0 Overfishing threshold: Not defined
Status in relation to Target	Likely (> 60%) to be at or above the target
Status in relation to Limits	For Papanui Inlet, Waitati Inlet, Otago Harbour and each sanitation area (1804 and 1805): Very Unlikely (< 10%) to be below both soft and hard limits
Status in relation to overfishing	Exploitation rate has never exceeded 13% at any of the harvested sites. It is Very Unlikely (< 10%) that overfishing is occurring.

Historical Stock Status Trajectory and Current Status



Biomass as a proportion of B_0. For Papanui Inlet, Waitati Inlet, and the two sanitation areas (1804 and 1805); this is estimated for the biomass ≥ 19 mm. For Otago harbour, the estimates are for biomass ≥ 30 mm. For the 2020 Otago harbour survey, the biomass of the additional bed (Te Rauone, 69 t) was removed so the 1998 and 2020 surveys would be comparable. Virgin biomass was assumed as the biomass estimated during the first survey for each area. Note: No commercial catch was taken from Papanui Inlet between 2006–07 and 2016–17.

Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	The biomass at Waitati Inlet has been stable or increasing and has never decreased below 85% B_0. At Papanui Inlet, biomass generally decreased to approximately 70% of B_0 in 2004 but little commercial catch has come out of this inlet since. In Otago Harbour, recruited biomass has shown a declining trend in the commercially fished sanitation bed 1804 (54% decline from 1999 to 2020), whereas in sanitation bed 1805 it has been variable but stable from 1999 to 2020. The three other non-commercial beds in Otago Harbour showed declines of 26 – 65% between 1999 and 2020.
Recent Trend in Fishing Intensity or Proxy	Exploitation rate has never exceeded 13% at any of the harvested sites, and even the 13% rate was a single-year event that subsequently declined considerably. It is Very Unlikely (< 10%) that overfishing is occurring.

	 **Exploitation rate (%) as calculated by commercial landings divided by biomass (≥ 30 mm) from Papanui Inlet (whole inlet), Waitati Inlet (whole inlet), and Otago Harbour Sanitation areas (beds 1804 and 1805 combined).**
Other Abundance Indices	-
Trends in Other Relevant Indicators or Variables	-

Projections and Prognosis	
Stock Projections or Prognosis	-
Probability of Current Catch or TACC causing Biomass to remain below or to decline below Limits	Fishing at recent levels is Very Unlikely (< 10%) to cause declines below soft or hard limits
Probability of Current Catch or TACC causing Overfishing to continue or to commence	Very Unlikely (<10%)

Assessment Methodology and Evaluation		
Assessment Type	Level 2 - Partial Quantitative Stock Assessment	
Assessment Method	Absolute biomass estimates from quadrat surveys	
Assessment Dates	Latest assessment: 2020	Next assessment: Unknown
Overall assessment quality rank	-	
Main data inputs (rank)	- Abundance survey - Length frequency	
Data not used (rank)	-	
Changes to Model Structure and Assumptions	-	
Major Sources of Uncertainty	-	

Qualifying Comments
For Papanui Inlet, the classification of this area changed from Conditionally Approved to Restricted on 9 June 2009. The Restricted classification allows for harvesting to take place under the following conditions: by a special permit as required for relaying, for depuration, or for harvest treatment.

Fishery Interactions
Harvesting had a severe but short-lived impact on macroinfaunal community structure and no change in sediment structure was found after harvesting (Irwin 2004). Overall, adverse effects from harvesting at the current level appear to be no more than minor and of a transitory nature (Stewart 2017).

6. FOR FURTHER INFORMATION

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