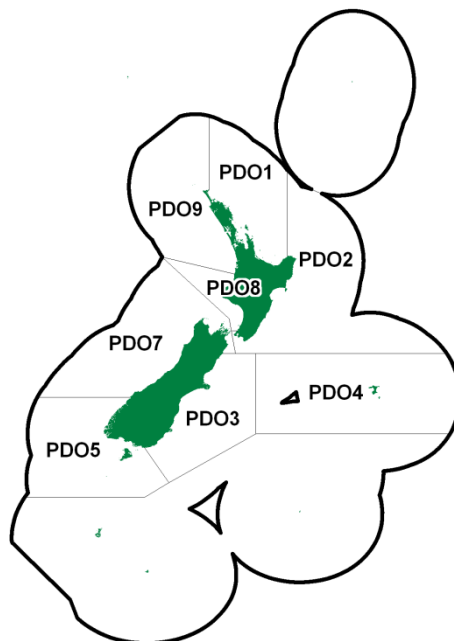


DEEPWATER TUATUA (PDO)

(*Paphies donacina*)
Tuatua



1. FISHERY SUMMARY

This species is part of the surf clam fishery and the reader is guided to the surf clam introductory chapter for information common to all relevant species.

Deepwater Tuatua (*Paphies donacina*) were introduced into the Quota Management System on 1 April 2004 with a total TACC of 168 t. Biomass surveys in QMA 2 supported a TAC increase from April 2010. This increased the TAC for PDO 2 to 509 t. In April 2013 a biomass survey in QMA 8 supported a further increase. This increased the TAC in PDO 8 from 19 to 296 t and the total PDO TAC from 791 to 1068 t. An additional biomass survey supported an increase in the TAC of PDO 7 in April 2016 to 200 t and the national TAC of PDO to 1215 t (Table 1).

Table 1: Current TAC, TACC and allowances for other sources of mortality for *Paphies donacina*.

QMA	TAC (t)	TACC (t)	Recreational catch	Customary catch	Other sources of mortality (t)
1	1	1	0	0	0
2	509	466	9	9	25
3	150	108	21	21	0
4	3	1	1	1	0
5	3	1	1	1	0
7	200	184	1	5	10
8	296	262	9	10	15
9	53	1	26	26	0
Total	1 215	1 024	68	73	50

1.1 Commercial fisheries

Landings have only been reported from PDO 3, PDO 5, PDO 7 and PDO 8. Between the years 1992–93 and 1995–96, reported landings ranged from a few kilograms to about 6 t. No further landings were reported until 2002–03; since then reported total landings have ranged between 2 and 66 t. Reported landings and TACCs are shown for fishstocks with historical landings in Table 2.

Table 2: TACCs and reported landings (t) of Deepwater Tuatua by Fishstock from 1992–93 to the present day from CELR and CLR data. PDO areas where catch has never been reported are not tabulated. See Table 1 for TACC of stocks not landed.

Fishstock	PDO 3		PDO 5		PDO 7		PDO 8		Total	
	Landings	TACC	Landings	TACC	Landings	TACC	Landings	TACC	Landings	TACC
1992–93	0	-	0	-	0.289	-	0	-	0.294	-
1993–94	0	-	0.005	-	3.384	-	0	-	3.384	-
1994–95	0	-	0	-	5.036	-	0	-	5.036	-
1995–96	4.439	-	0	-	1.668	-	0	-	6.107	-
1996–97	0	-	0	-	0	-	0	-	0	-
1997–98	0	-	0	-	0	-	0	-	0	-
1998–99	0	-	0	-	0	-	0	-	0	-
1999–00	0	-	0	-	0	-	0	-	0	-
2000–01	0	-	0	-	0	-	0	-	0	-
2001–02	0	-	0	-	0	-	0	-	0	-
2002–03	0	-	0	-	2.253	-	0	-	2.253	-
2003–04	0	108	0	1	10.144	50	0	1	10.144	168
2004–05	0	108	0	1	12.532	50	0	1	12.692	168
2005–06	0	108	0	1	10.627	50	0.148	1	13.728	168
2006–07	1.17	108	0	1	19.995	50	0	1	21.16	168
2007–08	3.17	108	0	1	21.145	50	0	1	24.315	168
2008–09	4.09	108	0	1	4.320	50	0	1	8.41	168
2009–10	11.21	108	0	1	1.50	50	0	1	12.71	168
2010–11	3.928	108	0	1	38.800	50	0	1	42.728	629
2011–12	0	108	0	1	17.050	50	0	1	17.050	629
2012–13	6.952	108	0	1	30.13	50	0	1	37.082	629
2013–14	24.16	108	0	1	39.12	50	0	262	63.275	890
2014–15	46.12	108	0	1	66	184	0	262	112.912	890

*In 2004–05 and 2005–06, 0.16 and 2.953 t respectively were reportedly landed, but the QMA is not recorded. These amounts are included in the total landings for those years.

1.2 Recreational fisheries

Deepwater tuatua inhabit the shallowest part of the subtidal, by comparison to other surf clams, and therefore are most vulnerable to shore-based harvesting. Estimates of recreational landings of tuatua were made between 1991 and 1994 and ranged from 237 t in FMA 1 in 1993–94 to zero tonnes in most FMAs in most years (Bradford 1998). A subsequent nationwide panel survey in 2011–12 (Wynne-Jones et al 2014) also estimated recreational landings. That survey estimated catch to vary between zero and 565 207 individuals per FMA per year. The 2014 survey estimate is noted in Wynne-Jones et al (2014) as seeming lower than expected, although this was judged as hard to gauge in a year of toxic algal blooms. The estimated numbers of cockles harvested from single beaches in the Auckland area (ranging from about 1 to 45 million per year) in Hartill et al (2005), given that these values are in excess of the Wynne-Jones et al (2014) estimates, also suggest that the 2014 value grossly under-estimates the true value for intertidal shellfish. Neither survey specified the species of tuatua landed, and most of the tuatua catch is thought to comprise the intertidal tuatua *P. subtriangulata* (Cranfield & Michael 2001). On beaches where *P. donacina* extends to just below low water, some recreational catch occurs of this species, during low spring tides.

1.3 Customary fisheries

P. donacina is an important handpicked resource of local iwi, especially in Pegasus Bay, Canterbury. There are no estimates of current customary use of this clam.

1.4 Illegal catch

There is no documented illegal catch of this clam.

1.5 Other sources of mortality

There is no quantitative information on other sources of mortality, although this clam is subject to localised catastrophic mortality from erosion during storms, high temperatures and low oxygen levels during calm summer periods, blooms of toxic algae and excessive freshwater outflow (Cranfield & Michael 2001).

2. BIOLOGY

P. donacina occurs mainly around the lower half of the North Island, the South Island and Stewart Island. It is found from low tide to about 4 m, although juveniles may extend to the mid-tide mark. Maximum length is variable between areas, ranging from 73 to 109 mm (Cranfield et al 1993). The sexes are separate, they are broadcast spawners, and the larvae are thought to be planktonic for between 18 and 21 days (Cranfield et al 1993). Settlement and early juveniles occur in the intertidal zone; these animals are mobile and migrate offshore as they grow. The deepwater tuatua (*Paphies donacina*) showed seasonal adjustment in its oxygen uptake and filtration rates to compensate for seasonal temperature variation in the habitat (Marsden 1999).

3. STOCKS AND AREAS

For management purposes stock boundaries are based on FMAs, however, the boundaries of stocks of surf clams are likely to be the continuous lengths of exposed sandy beaches between geographical features (rivers, headlands etc). Circulation patterns may isolate surf clams genetically as well as ecologically.

4. ENVIRONMENTAL AND ECOSYSTEM CONSIDERATIONS

See the introductory surf clam chapter.

5. STOCK ASSESSMENT

MCY is estimated from the survey biomass estimates. All stocks were considered in an effectively virgin state in 1993–94 when the initial biomass estimates were made (Cranfield et al 1993). Total catches in PDO 7 have since been in the range of 2.2 to 66 t since 2002–03 and catches in PDO 3 have ranged from 0 to 46 t since 2006–07. Less than one tonne has ever been landed in PDO 5 or PDO 8.

5.1 Estimates of fishery parameters and abundance

No fisheries parameters or abundance estimates are available for any deepwater tuatua stocks.

5.2 Biomass estimates

Biomass has been estimated from PDO 2, 3, 7 and 8 at a variety of dates from 1994 to 2015. A stratified random survey using a hydraulic dredge was employed for all these surveys. Survey size has been expressed either as length of beach (Table 3), or as area (Table 4), which makes comparisons difficult.

Table 3: A summary of biomass estimates in tonnes green weight with standard deviation in parentheses from exploratory surveys of Cloudy Bay, Marlborough (Cranfield et al 1994b and White et al 2015, respectively), Clifford Bay, Marlborough (Michael et al 1994), Foxton beach, Manawatu coast (White et al 2012) and Rabbit Island, Nelson (Michael & Olsen 1988).

Area	Cloudy Bay (PDO 7)	Clifford Bay (PDO 7)	Foxton Beach (PDO 8)	Rabbit Island (PDO 7)
Length of beach (km)	11, 11	21	46	8
Biomass (t)	154 (60), 1541 (247)	284 (123)	3289 (546)	108

Table 4: A summary of biomass estimates in tonnes green weight from the surveys in PDO 2 and 3 (Triantifillos 2008a, 2008b). Note: unless otherwise stated the CV is less than 20%.

Location	Five sites (PDO 2)	Ashley River to 6 nm south of the Waimakariri River (PDO 3)
Area surveyed (km ²)	28.0	13.4
Biomass (t)	5651.8	320.8

5.3 Yield estimates and projections

Estimation of Maximum Constant Yield (MCY)

Growth and mortality data from Cloudy Bay, Marlborough and the Kapiti Coast, Manawatu (Cranfield et al 1993) have been used in a yield per recruit model to estimate the reference fishing mortality $F_{0.1}$ (Cranfield et al 1994b). The shellfish working group (SFWG) did not accept these estimates of $F_{0.1}$ as there was considerable uncertainty in both the estimate and the method used to generate them. The MCY estimates of Triantifillos (2008a, b) and White et al (2012, 2015) used the full range of $F_{0.1}$ estimates from Cranfield et al (1993) and are shown in Table 5. Estimates of MCY are available from numerous locations and were calculated using Method 1 for a virgin fishery (MPI 2015) with an estimate of virgin biomass B_0 , where:

$$MCY = 0.25 * F_{0.1} B_0$$

The SFWG recommended that MCY estimates are adequate to use to inform management decisions relevant to all surf clam fisheries, with the following caveats: 1) due to the uncertainty in $F_{0.1}$ values, for all species other than SAE, the MCY estimates should use the $F_{0.1}$ values toward the higher end of the range, and 2) there is a need to account for any substantial catch that has already come out of any surf clam fishery when estimating MCY, however there was no consensus on the best way to do this.

Table 5: Mean MCY estimates (t) for *P. donacina* from virgin biomass at locations sampled around New Zealand (Triantifillos 2008a, 2008b, White et al 2012, White et al 2015). The two $F_{0.1}$ values, which are subsequently used to estimate MCY, are the minimum and maximum estimates from Cranfield et al. (1993).

Location	$F_{0.1}$	MCY
Five sites (PDO 2)	0.36/0.52	508.7/734.7
Ashley River to 6 n. miles south of the Waimakariri River (PDO 3)	0.36/0.52	28.9/41.7
Foxton Beach (PDO 8)	0.36/0.52	296.1/427.6
Cloudy Bay (PDO 7)	0.36/0.52	138.7/200.3

Estimation of Current Annual Yield (CAY)

CAY has not been estimated for *P. donacina*.

The SFWG recommended moving all surfclam fisheries away from an MCY management strategy and towards an exploitation rate management strategy. The SFWG recognised that an exploitation rate approach is more survey intensive, but better allows for the variable nature of biomass for surf clams as it allows greater flexibility in catch (in order to take greater landings from available biomass) whilst keeping catches sustainable.

6. STATUS OF THE STOCKS

- PDO 2 & 8 - *Paphies donacina*

Stock Status	
Year of Most Recent Assessment	2008 for PDO 2 and 2012 for PDO 8
Assessment Runs Presented	Survey biomass
Reference Points	Target: Not defined, but B_{MSY} assumed Soft Limit: 20% B_0 Hard Limit: 10% B_0 Overfishing threshold: -
Status in relation to Target	Because of the relatively low levels of exploitation of <i>P. donacina</i> , it is likely that PDO 2 and 8 stocks are still effectively in a virgin state, therefore they are Very Likely (> 90%) to be at or above the target.
Status in relation to Limits	Very Unlikely (< 10%) to be below the soft and hard limits
Status in relation to Overfishing	Overfishing is Very Unlikely (< 10%) to be occurring

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Historical Stock Status Trajectory and Current Status Unknown

Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	Unknown
Recent Trend in Fishing Mortality or Proxy	Fishing is minimal
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	For all stocks current catches are Very Unlikely (< 10%) to cause declines below soft or hard limits in the short to medium term.
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: 2008 for PDO 2 and 2012 for PDO 8	Next assessment: Unknown
Overall assessment quality rank	-	
Main data inputs (rank)	Abundance and length frequency information	
Data not used (rank)	-	
Changes to Model Structure and Assumptions	-	
Major Sources of Uncertainty	-	

Qualifying Comments
Stock size could fluctuate markedly as a result of catastrophic mortality from a number of causes.
There is a need to review the fishery parameters for this species.

Fishery Interactions
PDO can be caught together with other surf clam species and non-QMS bivalves.

- PDO 3

Stock Status	
Year of Most Recent Assessment	2008
Assessment Runs Presented	Survey biomass
Reference Points	Target: Not defined, but B_{MSY} assumed Soft Limit: 20% B_0 Hard Limit: 10% B_0 Overfishing threshold: -
Status in relation to Target	Unknown
Status in relation to Limits	Very Unlikely (< 10%) to be below the soft and hard limits
Status in relation to Overfishing	Overfishing is Very Unlikely (< 10%) to be occurring
Historical Stock Status Trajectory and Current Status Unknown	

Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	Unknown
Recent Trend in Fishing Mortality or Proxy	Fishing has averaged 11 t since 2006–07, but the two highest catches of 24 and 46 t have occurred in the 2013–14 and 2014–15 years respectively.
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	Current catches are Very Unlikely (< 10%) to cause declines below soft or hard limits in the short to medium term.	
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	2008	Next assessment: Unknown
Overall assessment quality rank	-	
Main data inputs (rank)	Abundance and length frequency information	
Data not used (rank)	-	
Changes to Model Structure and Assumptions	-	
Major Sources of Uncertainty	-	

Qualifying Comments
Stock size could fluctuate markedly as a result of catastrophic mortality from a number of causes. There is a need to review the fishery parameters for this species.

Fishery Interactions
PDO can be caught together with other surf clam species and non-QMS bivalves.

- PDO 7

Stock Status	
Year of Most Recent Assessment	2015
Assessment Runs Presented	Survey biomass
Reference Points	Target: Not defined, but B_{MSY} assumed Soft Limit: 20% B_0 Hard Limit: 10% B_0 Overfishing threshold: -
Status in relation to Target	Very Likely (> 90%) to be at or above the target.
Status in relation to Limits	Very Unlikely (< 10%) to be below the soft and hard limits
Status in relation to Overfishing	Overfishing is Very Unlikely (< 10%) to be occurring
Historical Stock Status Trajectory and Current Status	
Unknown	

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Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	Unknown
Recent Trend in Fishing Intensity or Proxy	Fishing has averaged 21 t since 2002–03, but the two highest catches of 39 and 66 t have occurred in the 2013–14 and 2014–15 years, respectively.
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	Current catches at the TACC are 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	2015	Next assessment: Unknown
Overall assessment quality rank		
Main data inputs (rank)	Abundance and length frequency information	
Data not used (rank)	-	
Changes to Model Structure and Assumptions	-	
Major Sources of Uncertainty	-	

Qualifying Comments
Stock size could fluctuate markedly as a result of catastrophic mortality from a number of causes. There is a need to review the fishery parameters for this species.

Fishery Interactions
PDO can be caught together with other surf clam species and non-QMS bivalves.

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