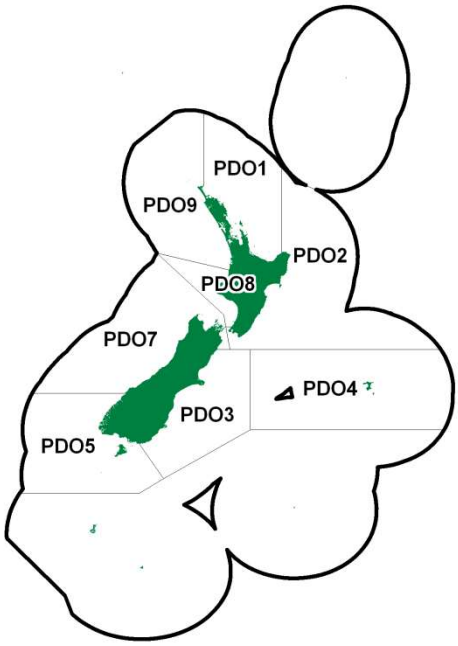
DEEPWATER TUATUA (PDO)

(*Paphies donacina*)
Tuatua



1. FISHERY SUMMARY

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

1.1 Commercial fisheries

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 from 2 t 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 t to 296 t and the total PDO TAC from 791 t to 1215 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

Reported landings and TACCs are shown for Fishstocks with historical landings in Table 2 and in Figure 1 for PDO 3 and PDO 7. Landings have 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. Reported total landings subsequently varied, with recent years showing a marked upward trend in PDO 3, PDO 7, and PDO 8. Landings in PDO 3 ranged from 0.0 t to 11.21 t between 2006–07 and 2012–13 and increased to about 90 t in 2018–19 and 2019–20. Since 2002–03, landings in PDO 7 have ranged between 2.2 t and 182 t (in 2016–17), but dropped to 125 t in 2019–20. Landings in PDO 8 increased from 2 t in 2015–16 to 30 t in 2018–19 and 66 t in 2019–20. Total PDO landings peaked at 282 t in 2018–19, with over 50% of catches originating in PDO 7.

Table 2: TACCs and reported landings (t) of deepwater tuatua by Fishstock from 1992–93 to the present 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	
	Landing	TACC	Landing	TACC	Landing	TACC	Landing	TACC	Landing	TACC
1992–93	0	–	0	–	0.29	–	0	–	0.29	–
1993–94	0	–	0.005	–	3.38	–	0	–	3.38	–
1994–95	0	–	0	–	5.04	–	0	–	5.04	–
1995–96	4.44	–	0	–	1.67	–	0	–	6.11	–
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	–	2.25	–	0	–	2.25	–
2003–04	0	108	0	1	10.14	50	0	1	10.14	168
2004–05	0	108	0	1	12.53	50	0	1	12.69	168
2005–06	0	108	0	1	10.63	50	0.148	1	13.73	168
2006–07	1.17	108	0	1	20.00	50	0	1	21.16	168
2007–08	3.17	108	0	1	21.15	50	0	1	24.32	168
2008–09	4.09	108	0	1	4.32	50	0	1	8.41	168
2009–10	11.21	108	0	1	1.50	50	0	1	12.71	168
2010–11	3.93	108	0	1	38.80	50	0	1	42.73	629
2011–12	0	108	0	1	17.10	50	0	1	17.05	629
2012–13	6.95	108	0	1	30.13	50	0	1	37.08	629
2013–14	24.16	108	0	1	39.12	50	0	262	63.28	890
2014–15	46.22	108	0	1	54.01	184	0	262	112.91	890
2015–16	59.49	108	0	1	98.03	184	2.22	262	207.44	890
2016–17	25.61	108	0	1	182.12	184	8.61	262	214.34	890
2017–18	70.48	108	0	1	180.40	184	8.42	262	259.30	890
2018–19	92.12	108	0	1	159.20	184	30.79	262	282.11	890
2019–20	89.57	108	0	1	125.41	184	66.47	262	281.45	890
2020–21	85.26	108	0	1	86.86	184	33.55	262	205.67	890
2021–22	85.47	108	0	1	15.89	184	70.43	262	171.79	890

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

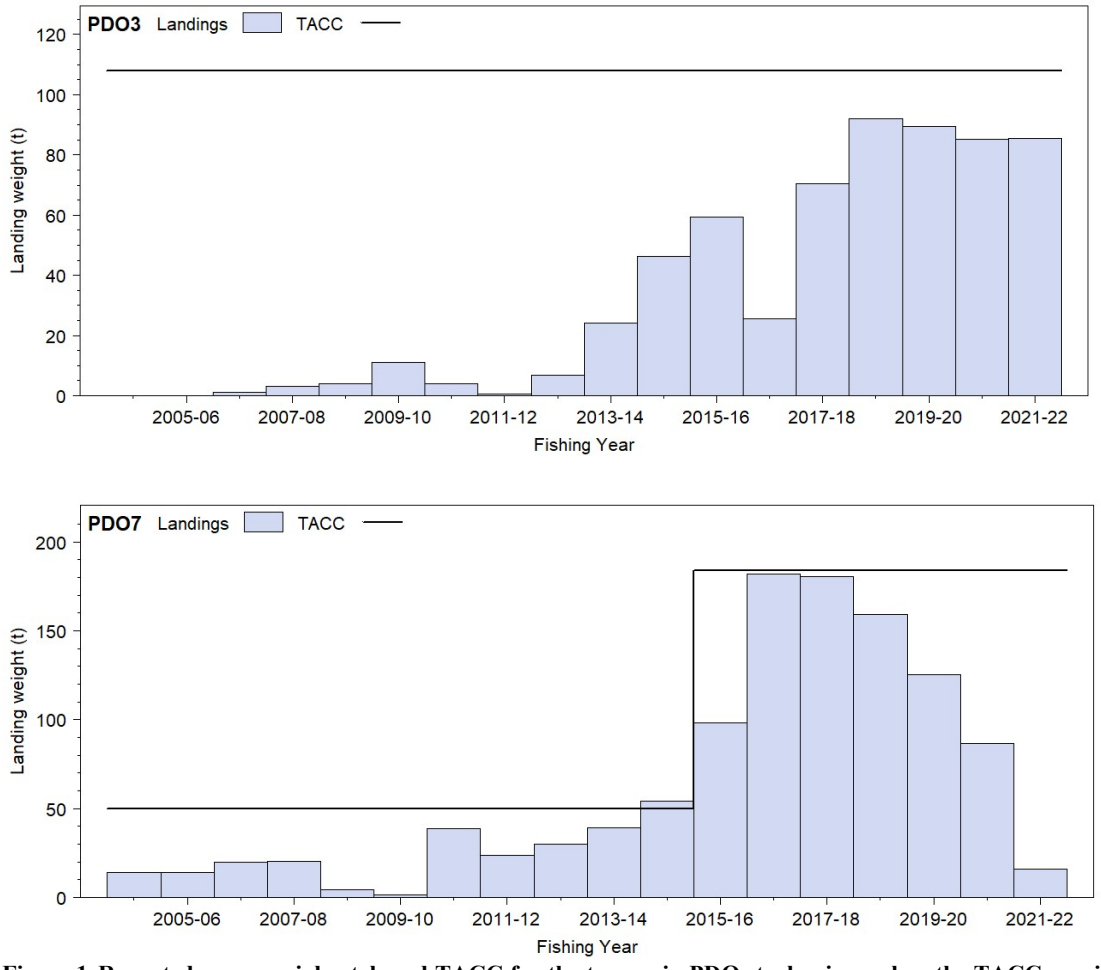


Figure 1: Reported commercial catch and TACC for the two main PDO stocks since when the TACC was introduced in the 2004–05 fishing year: PDO3 (South-East Coast) and PDO7 (Challenger).

1.2 Recreational fisheries

Deepwater tuatua inhabit the shallowest part of the subtidal zone compared with other surf clams, and therefore are potentially the most vulnerable to shore-based harvesting. However, neither the telephone-diary surveys in the 1990s nor the two national panel surveys in 2011–12 (Wynne-Jones et al 2014) and in 2017–18 (Wynne-Jones et al 2019) differentiated species of tuatua, and the harvest is thought to comprise mostly intertidal tuatua *P. subtriangulata* (Cranfield & Michael 2001). On beaches where *P. donacina* extends to just below low water, some recreational catch of this species may occur during spring low tides.

1.3 Customary fisheries

P. donacina is an important handpicked resource of local iwi, especially in Pegasus Bay, Canterbury. Deepwater tuatua form an important fishery for customary non-commercial, but the total annual catch is not known.

Māori customary fishers utilise the provisions under both the recreational fishing regulations and the various customary regulations. Many tangata whenua harvest deepwater tuatua under their recreational allowance and these are not included in records of customary catch. Customary reporting requirements vary around the country. Customary fishing authorisations issued in the South Island and Stewart Island would be under the Fisheries (South Island Customary Fishing) Regulations 1999. Many rohe moana / areas of the coastline in the North Island and Chatham Islands are gazetted under the Fisheries (Kaimoana Customary Fishing) Regulations 1998 which require reporting on authorisations. In the areas not gazetted, customary fishing permits would be issued would be under the Fisheries (Amateur Fishing) Regulations 2013, where there is no requirement to report catch.

The information on Māori customary harvest under the provisions made for customary fishing can be limited (Table 3). These numbers are likely to be an underestimate of customary harvest as only the catch approved and harvested in numbers are reported in the table.

Table 3: Fisheries New Zealand records of customary harvest of deepwater tuatua in PDO 2 (approved and reported in numbers), between 2011–12 and 2013–14. No records since. – no data.

	PDO 2 Numbers	
Fishing year	Approved	Harvested
2011–12	2 000	500
2012–13	–	–
2013–14	1 000	390

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 depth, although juveniles may extend to the mid-tide mark. Maximum length is variable between areas, ranging from 73 mm to 109 mm (Cranfield et al 1993). The sexes are separate and they are broadcast spawners; 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

For further information on environmental and ecosystem considerations refer to the Introduction – surf clams chapter.

5. STOCK ASSESSMENT

MCY is estimated from the survey biomass estimates. All stocks were considered as an effectively virgin state in 1993–94 when the initial biomass estimates were made (Cranfield et al 1993).

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 for PDO 2, 3, 7, and 8 at various times during 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 4), or as area (Table 5), which makes comparisons difficult.

In both 2012 (FMA 8) and 2015 (Cloudy Bay, FMA 7), White et al (2012, 2015) have conducted a 2-phase stratified random sampling survey. The survey area was stratified by 4 depth strata (0–2 m, 2–4 m, 4–6 m, and 6–8 m, each with respect to Chart Datum). Each station comprised a ~50 m tow, sampling ~80 m^2 of seabed. All commercial species of subtidal surf clams caught were sorted by species. The total weight of each of these species was measured on board. Individuals from each species were collected and measured for shell length along the anterior-posterior axis (to the nearest millimetre). For tows with less than ~500 individuals, the maximum of either 20 individuals or 20% of the total was measured. For tows with higher than ~500 individuals, 10% with an upper limit of ~200 individuals per tow were measured. To subsample large catches and to avoid issues of size sorting inside the dredge, each of the bins was subsampled by tipping one bin into two bins and repeating until the requisite sub sample size was reached. The number and weight of the main bycatch species were also recorded. Both the biomass densities and biomass estimates were calculated for all the commercial species of subtidal surf clams caught.

Table 4: 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, 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	21	46	8
Biomass (t)	154 (60), 1 541 (247)	284 (123)	3 289 (546)	108

Table 5: A summary of biomass estimates in tonnes green weight from the surveys in PDO 2 and 3 (Triantafillos 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)	5 651.8	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 $F_{0.1}$ because there was considerable uncertainty in both the estimates and the method used to generate them. The *MCY* estimates of Triantafillos (2008a, 2008b) 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 6. Estimates of *MCY* are available from numerous locations and were calculated using Method 1 for a virgin fishery (Ministry for Primary Industries 2015) with an estimate of virgin biomass B_0, where:

$$MCY = 0.25 \times F_{0.1} B_0$$

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 6: Mean *MCY* estimates (t) for *P. donacina* from virgin biomass at locations sampled around New Zealand (Triantafillos 2008a, 2008b; White et al 2012, 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. mile 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 surf clam 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 because it allows greater flexibility in catch (to take greater landings from available biomass) whilst keeping catches sustainable.

6. STATUS OF THE STOCKS

- **PDO 2**

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	Unknown
Status in relation to Overfishing	Unknown

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	-
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	Unknown
Probability of Current Catch or TACC causing Overfishing to continue or to commence	Unknown

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	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	Unknown
Status in relation to Overfishing	Unknown

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	Catches in PDO 3 have ranged from 0 to 11.21 t between 2006–07 and 2012–13 and overall increased since to reach 92.12 t in 2018–19.
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	Unknown
Probability of Current Catch or TACC causing Overfishing to continue or to commence	Unknown

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	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

Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	Unknown
Recent Trend in Fishing Intensity or Proxy	Fishing has increased from 17.10 t in 2011–12 to 182.12 t in 2016–17 and reduced to 159.2 t in 2018–19.

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	Latest assessment: 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.

- **PDO 8**

Stock Status	
Year of Most Recent Assessment	2012
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	Unknown
Status in relation to Overfishing	Unknown

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 increased since 2018-19 but it remains at a relatively low level
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	Unknown
Probability of Current Catch or TACC causing Overfishing to continue or to commence	Unknown

Assessment Methodology and Evaluation		
Assessment Type	Level 2 - Partial Quantitative Stock Assessment	
Assessment Method	Absolute biomass estimates from quadrat surveys	
Assessment Dates	Latest assessment: 2012	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.

7. FOR FURTHER INFORMATION

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