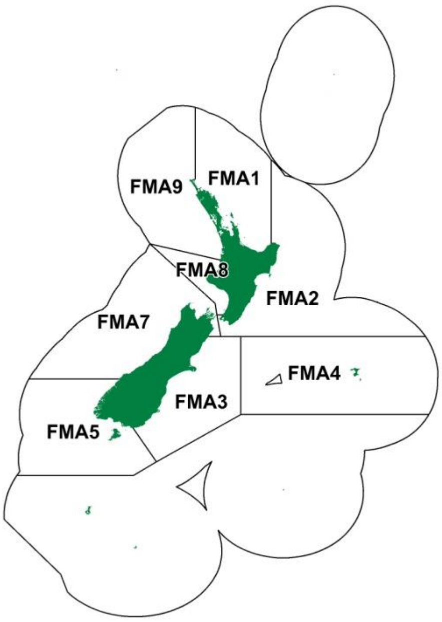
SURF CLAMS

Surf clam is a generic term used here to cover the following seven species:

Deepwater tuatua, *Paphies donacina* (PDO)
Fine (silky) dosinia, *Dosinia subrosea* (DSU)
Frilled venus shell, *Bassina yatei* (BYA)
Large trough shell, *Mactra murchisoni* (MMI)
Ringed dosinia, *Dosinia anus* (DAN)
Triangle shell, *Spisula aequilatera* (SAE)
Trough shell, *Mactra discors* (MDI)

The same FMAs apply to all these species and this introduction will cover issues common to all of these species.



All surf clams were introduced into the Quota Management System on 1 April 2004. The fishing year is from 1 April to 31 March and commercial catches are measured in greenweight. There is no minimum legal size (MLS) for surf clams. Surf clams are managed under Schedule 6 of the Fisheries Act 1996. This allows them to be returned to the sea soon after they are taken provided they are likely to survive.

1. INTRODUCTION

Commercial surf clam harvesting before 1995–96 was managed using special permits. From 1995–96 to 2002–03 no special permits were issued because of uncertainty about how best to manage these fisheries.

New Zealand operates a mandatory shellfish quality assurance programme for all bivalve shellfish grown and harvested in areas for human consumption. Shellfish caught outside this programme can only be sold for bait. This programme is based on international best practice and is managed by the New Zealand Food Safety Authority (NZFSA), in cooperation with the District Health Board Public Health Units and the shellfish industry[1]. This involves surveying the water catchment area for pollution, sampling water and shellfish microbiologically over at least 12 months, classifying and listing areas for

[1]. For full details of this programme, refer to the Animal Products (Regulated Control Scheme-Bivalve molluscan Shellfish) Regulations 2006 and the Animal Products (Specifications for Bivalve Molluscan Shellfish) Notice 2006 (both referred to as the BMSRCS), at: http://www.nzfsa.govt.nz/industry/sectors/seafood/bms/page-01.htm

harvest, regular monitoring of the water and shellfish, biotoxin testing, and closure after rainfall and when biotoxins are detected. Products are traceable by source and time of harvest in case of contamination.

2. BIOLOGY

Three families of surf clams dominate the biomass in different regions of New Zealand. At the northern locations, the venerids *D. anus* and *D. subrosea* make up the major proportion of the surf clam biomass, and *D. anus* is abundant at all other North Island locations. The mactrids and mesodesmatid become increasingly abundant south of Ohope (Bay of Plenty). The mesodesmatid *P. donacina* is most abundant around central New Zealand from Nuhaka on the east coast south to the Kapiti coast, Cloudy Bay and as far south as Pegasus Bay. The mactrids *M. murchisoni* and *M. discors* dominate in southern New Zealand (Blueskin Bay, Te Waewae, and Oreti), where they account for more than 80% of the total biomass (Cranfield et al 1994, Cranfield & Michael 2001).

Each species grows to a larger size in the South Island than in the North Island (Cranfield & Michael 2002). Growth parameters are available for many surf clam species from up to two locations. Length frequencies of sequential population samples were analysed by Cranfield et al (1993) using MULTIFAN to estimate the von Bertalanffy growth parameters (Table 1). MULTIFAN simultaneously analyses multiple sets of length frequency samples using a maximum likelihood method to estimate the proportion of clams in each age class and the von Bertalanffy growth parameters (see Fournier et al 1990, and Francis & Francis 1992).

Incremental growth of recaptured marked clams at Cloudy Bay was analysed using GROTAG to confirm the MULTIFAN estimates (Cranfield et al 1993). GROTAG uses a maximum-likelihood method to estimate growth rate (Francis 1988, Francis & Francis 1992). The estimates and annual mean growth estimates at lengths α and β are shown in Table 2.

Table 1: Von Bertalanffy growth parameter estimates from Cranfield et al (1993) for surf clams estimated using MULTIFAN (SE in parentheses). - Indicates where estimates were not generated

Stock	Site	L_∞ (mm)	K
BYA 7	Cloudy Bay	-	-
BYA 8	Kapiti Coast	-	-
DAN 7	Cloudy Bay	0.10 (0.03)	77.5 (0.71)
DAN 8	Kapiti Coast	0.13 (0.02)	58.7 (0.28)
DSU 7	Cloudy Bay	-	-
DSU 8	Kapiti Coast	-	-
MDI 7	Cloudy Bay	0.41 (0.03)	68.0 (0.35)
MDI 8	Kapiti Coast	0.42 (0.02)	56.0 (0.95)
MMI 7	Cloudy Bay	0.57 (0.01)	88.0 (0.44)
MMI 8	Kapiti Coast	0.35 (0.01)	75.2 (0.30)
PDO 7	Cloudy Bay	0.33 (0.01)	94.1 (0.29)
PDO 8	Kapiti Coast	-	-
SAE 7	Cloudy Bay	1.01 (0.02)	60.3 (0.92)
SAE 8	Kapiti Coast	0.80 (0.03)	52.1(0.25)

The maximum ages for these species were estimated from the number of age classes indicated in MULTIFAN analyses, and from shell sections. Estimates of natural mortality come from age estimates (Table 3). Higher mortality is seen where the surf clams are subject to higher wave energies, e.g., *S. aequilatera* and *M. murchisoni* are distributed within the primary wave break and hence show higher mortality (Cranfield et al 1993). Kapiti shells show higher mortality than Cloudy Bay, perhaps because these shells having a higher chance of being eroded out of the bed by storms as the Kapiti Coast is more exposed (Cranfield et al 1993). Surf clam populations are subject to 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)

Less confidence should be placed in the estimates from MULTIFAN for Cloudy Bay relative to the Kapiti

Coast as there was a small sample size at Cloudy Bay and a lack of juveniles.

Table 2: Mean annual growth estimates (mm/year) at lengths α and β (95% confidence intervals in parentheses for mean growth values) from Cloudy Bay (Cranfield et al 1996). L* is the transitional length, at which point the model allows an asymptotic reduction in growth rate and values of $L\infty$ are included for reference.

Species	α (mm)	g_α (mm year^{-1})	β (mm)	g_β (mm year^{-1})	L^* (mm)	L_∞ (mm)	Residual error (mm)
Paphies donacina	50.0	10.26 (9.7 – 10.8)	80.0	1.41 (1.1 – 1.7)	80.0	84.8	1.25
Spisula aequilatera	30.0	22.71 (22.2 – 23.0)	50.0	6.23 (6.0 – 6.4)	55.0	57.6	2.04
Mactra murchisoni	40.0	17.83 (17.4 – 18.2)	70.0	4.65 (4.3 – 4.9)	80.0	80.6	1.42
Mactra discors	35.0	11.01 (10.5 – 11.7)	55.0	2.69 (2.4 – 2.9)	62.0	61.5	0.63
Dosinia anus	20.0	12.5 (12.0 – 13.2)	55.0	1.99 (1.8 – 2.2)	63.0	61.6	0.44

Table 3: Estimates of the instantaneous natural mortality rate, *M*. A = minimum number of year classes indicated by MULTIFAN, B = maximum age indicated by shell sections, M1: mortality range estimated from using two equations: $lnM = 1.23\text{-}0.832\ln(t_{max})$ and $1nM = 1.44\text{-}0.9821n, (t_{max})$, (Hoenig 1983). M2 mortality estimated from $M = \ln100/(t_{max})$; t_{max} is the estimate of maximum age

Cloudy Bay	A	B	M1	M2
Mactra murchisoni	8	11	0.40–0.46	0.42
Mactra discors	7	14	0.32–0.38	0.33
Spisula aequilatera	5	7	0.63–0.68	0.66
Paphies donacina	10	17	0.26–0.32	0.27
Dosinia anus	16	22	0.20–0.26	0.21

Kapiti coast	A	B*	M1	M2
Mactra murchisoni	8	11	0.40–0.46	0.42
Mactra discors	8	16	0.28–0.34	0.29
Spisula aequilatera	3	5	0.87–0.89	0.92
Paphies donacina[i]				
Dosinia anus	19	26	0.17–0.23	0.18

*Shell sections not yet examined. Ages are inferred from Cloudy Bay data.
[i]Growth data could not be analysed.

4. ENVIRONMENTAL AND ECOSYSTEM CONSIDERATIONS

This section was new for the May 2011 Plenary after review by the Aquatic Environment Working Group. This summary is from the perspective of the surf clam fisheries; a more detailed summary from an issue-by-issue perspective is available in the Aquatic Environment and Biodiversity Annual Review.

4.1 Ecosystem role

Only two published papers examine aspects of the role of surf clams in the ecosystem in New Zealand. Predation of *Dosinia* spp. by rock lobsters has been documented from the reef/soft sediment interface zones (Langlois et al 2005, Langlois et al 2006), notably surf clams are usually harvested from exposed beaches, not reef/soft sediment interface zones.

Surf clams are filter-feeders; recent research suggests that most of their food is obtained from microalgae from the top 2 cm of the sediment and the bottom 2–3cm of the water column (Sasaki et al 2004). The effects of predation are difficult to study on exposed sandy beaches and it is believed internationally that there are no keystone species in this environment and predation is not important in structuring the community (Mclachlan & Brown 2006).

4.2 Fishery interactions (fish and invertebrates)

The only bycatch caught in large quantities associated with surf clam dredging in New Zealand is *Fellaster zelandiae* - the sand dollar or sea biscuit (Haddon et al 1996). Other species caught in association with surf clams include paddle crabs (*Ovalipes catharus*), a number of bivalves including the lance shell (*Resania lanceolata*), otter clams (*Zenatia acinaces*), battle axe (*Myadora striata*), olive tellinid (*Hiatula nitidia*), the wedge shell (*Peronaea gairmadi*), and the gastropods the olive shell (*Baryspira australis*) and ostrich foot shell (*Struthiolaria papulosa*). Fish are rarely caught, but include juvenile common soles (*Peltorhamphus novaezeelandiae*) and stargazers (*Kathetostoma* spp.) (NIWA, unpublished data).

4.3 Fishery interactions (seabirds and mammals)
Not relevant to surf clam fisheries.

4.4 Benthic impacts
Surf clams mainly inhabit the surf zone, a high-energy environment characterised by high sand mobility (Michael et al 1990). Divers observed that the rabbit dredge (which has been used for surf-clam surveys) formed a well defined track in the substrate, but within 24 hours the track was could not be distinguished, indicating that physical recovery of the substrate was rapid (Michael et al 1990). Commercially, a different dredge is used whose impacts should theoretically be less, but the impacts of this dredge have not been tested. Shallow water environments such as the surf zone or those subjected to frequent natural disturbance tend to recover faster from the effects of mobile fishing gears compared to those in deeper water (Kaiser et al 1996, Collie et al 2000, Hiddink et al 2006, Kaiser et al 2006).

Surf clam species show zonation by substrate type which is generally, although not always, correlated with depth and wave exposure. Species with good burrowing ability are generally found in shallow, mobile sediment zones (for example *Paphies donacina*), and those species less able to burrow (for example *Dosinia subrosea* and *Bassina yatei*) are generally found in softer more stable sediments. The present high-value species (*Spisula aequilatera, Mactra murchisoni, Paphies donacina and Mactra discors*) generally occur in shallower zones. Mobile fishing gear effects will be primarily determined by the characteristics of the beach and target species. Little fishing presently takes place in the most vulnerable areas characterised by stable, soft fine sediment communities.

An Italian study showed that widespread intensive hydraulic dredging can adversely modify some depths within this environment (4–6 m), although recovery in this study occurred within 6 months (Morello et al 2006). The applicability of this study’s finding to New Zealand is unknown.

4.5 Other considerations
None.

4.6 Key information gaps
The impacts of widespread and intensive dredging in New Zealand, which is not presently occurring, are unknown.

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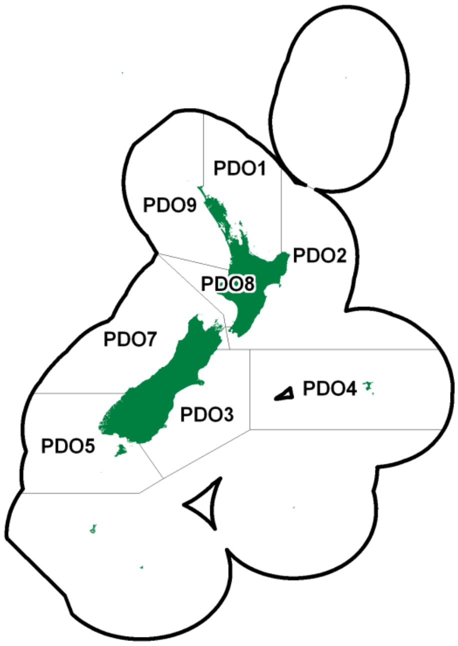
DEEPWATER TUATUA (PDO)

(*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 TACC for PDO5 to 466 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 (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	52	50	1	1	0
8	296	262	9	10	15
9	53	1	26	26	0
Total	1 068	890	68	69	40

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 24 t. Reported landings and TACCs are shown for fishstocks with historical landings in Table 2.

1.2 Recreational fisheries

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). The survey did not specify the species of tuatua landed, and most of the 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.

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. PDO 1, 4 and 9 all have TACC of 1 t and PDO 2 has a TACC of 466 t.

	PDO 3		PDO 5		PDO 7		PDO 8		Total	
Fishstock	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

*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.

1.3 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 localized 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 and from Pegasus Bay north in the South Island, and on the north coast of 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

All stocks are considered in effectively virgin state and an *MCY* is estimated from the surveyed 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 21 t, catches in other Fishstocks have been below 5 t.

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 one site in each of PDO 8 and PDO 3, and multiple sites within PDO 2 and PDO 7 (Tables 3 and 4). A stratified random survey using a hydraulic dredge was employed for all these surveys.

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 Clifford Bay, Marlborough (Michael et al 1994), Rabbit Island, Nelson (Michael & Olsen 1988), and Foxton beach, Manawatu coast (White et al 2012).

Area	Cloudy Bay (PDO 7)	Clifford Bay (PDO 7)	Foxton Beach (PDO 8)	Rabbit Island (PDO 7)
Length of beach (km)	11	21	46[2]	8
Biomass (t)	154 (60)	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, Triantifillos 2008a, 2008b). The shellfish working group 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) using the full range of $F_{0.1}$ estimates from Cranfield et al (1993) are shown in Table 5, but should be interpreted cautiously.

Estimates of *MCY* are available from numerous locations and were calculated using Method 1 for a virgin fishery (Annala et al 2001) with an estimate of virgin biomass B_0, where:

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

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).

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	0.36/0.52	296.1/427.6

Estimation of Current Annual Yield (*CAY*)

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

6. STATUS OF THE STOCKS

- PDO 2, 3, 7 & 8 - *Paphies donacina*

Stock Status	
Year of Most Recent Assessment	2008 for PDO 2 & 3, 1994 for PDO 7 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
Status in relation to Target	Because of the relatively low levels of exploitation of *P. donacina,* it is likely that all 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
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 minimal in all QMAs other than PDO 7. In PDO 7 fishing has been light, averaging 11.6 t since 2002–03.
Other Abundance Indices	-
Trends in Other Relevant Indicators or Variables	-

Projections and Prognosis		
Stock Projections or Prognosis	-	
Probability of Current Catch or TACC causing decline below Limits	For all stocks current catches are Very Unlikely (< 10%) to cause declines below soft or hard limits.	
Assessment Methodology		
Assessment Type	Level 2 - Partial Quantitative Stock Assessment	
Assessment Method	Absolute biomass estimates from quadrant surveys	
Main data inputs	Abundance and length frequency information	
Period of Assessment	Latest assessment: 2008 for PDO 2 & 3, 1994 for PDO 7 and 2012 for PDO 8	Next assessment: Unknown
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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Triantifillos, L (2008a) Survey of subtidal surf clams in Pegasus Bay, November–December 2007. 43 p. Prepared by NIWA for Seafood Innovations Limited and SurfCo. Limited.

Triantifillos, L (2008b) Survey of subtidal surf clams in Quota Management Area 2, June - August 2008. 40 p. Prepared by NIWA for Seafood Innovations Limited and SurfCo. Limited.

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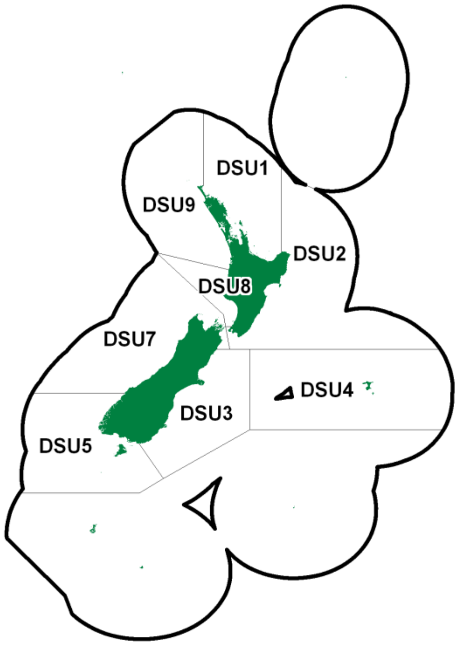
FINE (SILKY) DOSINIA (DSU)

(*Dosinia subrosea*)



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.

Fine Dosinia (*Dosinia subrosea*) were introduced into the Quota Management System on 1 April 2004 with a TAC of 8 t and TACC of 8 t (Table 1). There were no allowances for customary, recreational or other sources of mortality and no changes to any of these values have occurred since.

Table 1: Current TAC and TACC for *Dosinia subrosea*.

QMA	TAC (t)	TACC (t)
1	1	1
2	1	1
3	1	1
4	1	1
5	1	1
7	1	1
8	1	1
9	1	1
Total	8	8

1.1 Commercial fisheries

Landings have only ever been reported from DSU 1 and DSU 7. In 1993–94 total landings were 235 kg and since 1994–95, landings have been only been reported from DSU 7 and all have been less than 100 kg (Table 2).

1.2 Recreational fisheries

There are no known records of recreational use of this surf clam.

1.3 Customary fisheries

Offshore clams such as *D. subrosea* are likely to have been harvested for customary use only when washed ashore after storms (Carkeek 1966). There are no estimates of current customary use of this clam.

Table 2: TACCs and reported landings (t) of Fine Dosinia by Fishstock from 1993–94 to the present day from CELR and CLR data for Fishstocks where landings have been reported. DSU 2, 3, 4, 5, 8 and 9 all have TACCs of 1 t.

	DSU 1		DSU 7		Total	
	Landings	TACC	Landings	TACC	Landings	TACC
1993–94	0.123	-	0.112	-	0.235	-
1994–95	0	-	0.026	-	0.026	-
1995–96	0	-	0.011	-	0.038	-
1996–97	0	-	0	-	0	-
1997–98	0	-	0	-	0	-
1998–99	0	-	0	-	0	-
1999–00	0	-	0	-	0	-
2000–01	0	-	0	-	0	-
2001–02	0	-	0	-	0	-
2002–03	0	-	0	-	0	-
2003–04	0	1.0	0.089	1.0	0.089	8.0
2004–05	0	1.0	0.078	1.0	0.110*	8.0
2005–06	0	1.0	0.061	1.0	0.169*	8.0
2006–07	0	1.0	0.003	1.0	0.003	8.0
2007–08	0	1.0	0	1.0	0	8.0
2008–09	0	1.0	0.001	1.0	0.001	8.0
2009–10	0	1.0	0	1.0	0	8.0
2010–11	0	1.0	0	1.0	0	8.0
2011–12	0	1.0	0	1.0	0	8.0
2012-13	0	1.0	0	1.0	0	8.0
2013-14	0	1.0	0	1.0	0	8.0

*In 2004–05 and 2005–06 32.4 and 90 kg were reported but the QMA is not recorded. This amount is included in the total landings for these years.

1.4 Illegal catch
There is no known 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 probably sometimes taken as a bycatch in inshore trawling. Harvesters claim that the hydraulic clam rake does not damage surf clams and minimises damage to the few species of other macrofauna captured. Surf clam populations are also 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

D. subrosea has not been found in high densities in any survey work. It is found around the New Zealand coast in deeper softer sediment habitats. In the North Island it is found between 6 and 10 m in depth, and in the South Island between 5 and 8 m (Cranfield & Michael 2002). It is smaller and smoother than *D. anus*, and is usually found in more stable habitats. Maximum length is variable between areas, ranging from 41 to 68 mm (Cranfield et al 1993). The sexes are believed to be separate, and they are likely to be broadcast spawners with planktonic larvae (Cranfield & Michael 2001). Anecdotal evidence suggests that spawning is likely to occur in the summer months. Recruitment of surf clams is thought to be highly variable between years.

For information on, growth, age and natural mortality of this species and general statements about relative biomass of all surf clam species around the country (excluding *Bassinia yatei)* see the introductory surf clam chapter.

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 (such as rivers and headlands). 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

All stocks are considered in effectively virgin state and an *MCY* is estimated from the surveyed 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 of DSU have not exceeded 1 t in any Fishstock since then.

5.1 Estimates of fishery parameters and abundance

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

5.2 Biomass estimates

Biomass has been estimated from 11 km of beach at Cloudy Bay (DSU 7) with a stratified random survey using a hydraulic dredge (Cranfield et al 1994b). The virgin biomass for this area was estimated to be 21 t. Subsequent surveys estimated biomass from one site in DSU 3 and a number of sites in DSU 2 (Table 3).

Table 3: A summary of biomass estimates greenweight (t) from the surveys in DSU 2 and 3 (Triantifillos 2008a, Triantifillos 2008b). Note: Unless otherwise stated the CV is less than 0.2.

Location	Five sites (DSU 2)	Ashley River to 6 n. mile south of the Waimakariri River (DSU 3)
Area surveyed (km^2)	28.0	13.4
Biomass (t)	5.9	12.2*

* CV is 0.29.

5.3 Yield estimates and projections

Estimation of Maximum Constant Yield (*MCY*)

Growth and mortality data from Cloudy Bay in Marlborough and the Kapiti Coast in 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, Triantifillos 2008a, 2008b). The shellfish working group 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 (2008b) that use the full range of $F_{0.1}$ estimates from Cranfield et al (1993) are shown in Table 4 but should be interpreted cautiously.

Estimates of *MCY* are available from numerous locations and were calculated using Method 1 for a virgin fishery (Annala et al 2001) with an estimate of virgin biomass B_0, where:

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

Table 4: Mean *MCY* estimates (t) for *D. subrosea* from virgin biomass at locations sampled around New Zealand (Triantifillos 2008a and b).

Location	$F_{0.1}$	*MCY*
Five sites (DSU 2)	0.27/0.54	0.4/0.8

Estimation of Current Annual Yield (*CAY*)

CAY has not been estimated for *D. subrosea*.

6. STATUS OF THE STOCKS

- DSU-*Dosinia subrosea*

There is no evidence of appreciable biomass of this species in any area.

7. FOR FURTHER INFORMATION

Annala, J H; Sullivan, K J; O'Brien, C J; Smith, N W McL (compilers.) (2001) Report from the fishery assessment plenary, May 2001: stock assessments and yield estimates. 515 p. (Unpublished report held in NIWA library, Wellington).

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Haddon, M; Willis, T J; Wear, R G; Anderlini, V C (1996) Biomass and distribution of five species of surf clam off an exposed west coast North Island beach, New Zealand. *Journal of Shellfish Research* 15: 331–339.

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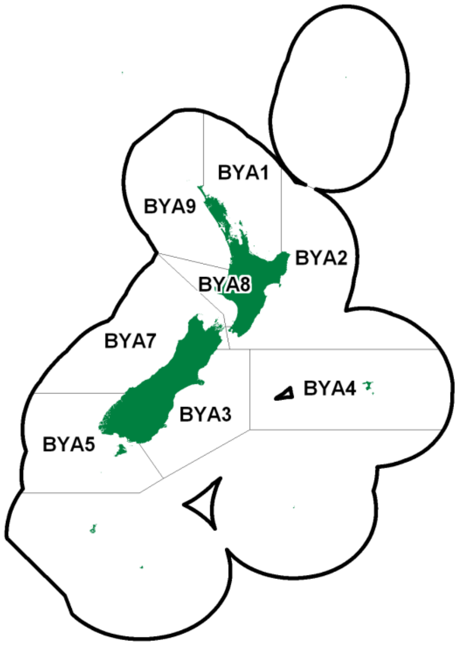
Triantifillos, L (2008b) Survey of subtidal surf clams in Quota Management Area 2, June – August 2008. 40 p. Report prepared by NIWA for Seafood Innovations Limited and SurfCo. Limited.

FRILLED VENUS SHELL (BYA)

(*Bassina yatei*)



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.

The Frilled Venus Shell (*Bassina yatei*) was introduced into the Quota Management System on 1 April 2004 with a combined TAC of 16 t and a TACC of 16 t. There were no allowances for customary, recreational or other sources of mortality. These limits have not been changed (Table 1).

Table 1: Current TAC and TACC for *Bassina yatei*.

QMA	TAC (t)	TACC (t)
1	1	1
2	1	1
3	1	1
4	1	1
5	1	1
7	9	9
8	1	1
9	1	1
Total	16	16

1.1 Commercial fisheries

Landings have been small (all around 1 t or less), from BYA 7 and only reported from 1992-5, 2001-5 and 2008-09. One landing of over 7 t was reported from BYA1 in 2002-3 (Table 2).

1.2 Recreational fisheries

There are no known records of recreational use of this surf clam.

1.3 Customary fisheries

Offshore clams such as *B. yatei* are likely to have been harvested for customary use only when washed ashore after storms. Shells of this clam have been found irregularly, and in small numbers in a few middens. There are no estimates of current customary use of this clam.

Table 2: TACCs and reported landings (t) of frilled venus shell by Fishstock from 1992-93 to 2012-13 from CELR and CLR data. There have never been any reported landings in BYA 2, 3, 4, 5, 8 or 9. These stocks each have a TACC of 1 t and are not tabulated below.

	BYA 1		BYA 7		Total	
	Landings	TACC	Landings	TACC	Landings	TACC
1992-93	0	-	0.026	-	0.026	-
1993-94	0	-	0.007	-	0.007	-
1994-95	0	-	0.001	-	0.001	-
1995-96	0	-	0	-	0	-
1996-97	0	-	0	-	0	-
1997-98	0	-	0	-	0	-
1998-99	0	-	0	-	0	-
1999-00	0	-	0	-	0	-
2000-01	0	-	0	-	0	-
2001-02	7.473	-	0.049	-	7.522	-
2002-03	0	-	1.132	9	1.132	16
2003-04	0	1	1.295	9	1.296	16
2004-05	0	1	0.207	9	0.207	16
2005-06*	0	1	0	9	0.036*	16
2006-07	0	1	0	9	0	16
2007-08	0	1	0	9	0	16
2008-09	0	1	0.003	9	0.003	16
2009-10	0	1	0	9	0	16
2010-11	0	1	0	9	0	16
2011-12	0	1	0.350	9	0.350	16
2012-13	0	1	1.174	9	1.174	16
2013-14	0	1	1.106	9	1.106	16

*In 2005-06 36.4 Kg were reportedly landed, but the QMA is not recorded. This amount is included in the total landings for that year.

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

B. yatei is endemic to New Zealand and is found around the coast in sediments at depths between 6 and 9 m. Maximum length is variable between areas, ranging from 48 to 88 mm (Cranfield & Michael 2002).The sexes are likely to be separate, and they are likely to be broadcast spawners with planktonic larvae. Anecdotal evidence suggests spawning is likely to occur in the summer months. Recruitment of surfclams is thought to be highly variable between years.

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

5.1 Estimates of fishery parameters and abundance

No estimates of fisheries parameters or abundance are available for this species.

5.2 Biomass estimates

Biomass has been estimated for two sites in the Marlborough Sounds with a stratified random survey using a hydraulic dredge. Estimates are shown in Table 3.

Table 3: A summary of biomass estimates in tonnes greenweight with standard deviation in parentheses from exploratory surveys of Cloudy Bay (Cranfield *et al*. 1994b), and Clifford Bay, both in Marlborough (Michael *et al*. 1994).

Area	Cloudy Bay (BYA 7)	Clifford Bay (BYA 7)
Length of beach (km)	11	21
Biomass (t)	123 (50)	0.2 (0.8)

5.3 Yield estimates and projections

Growth and mortality data from Cloudy Bay in Marlborough and the Kapiti Coast in 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 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.

CAY has not been estimated for *B. yatei*.

6. STATUS OF THE STOCKS

- BYA 7 - *Bassina yatei*

Stock Status	
Year of Most Recent Assessment	1994
Assessment Runs Presented	Survey biomass
Reference Points	Target: Not defined, but B_{MSY} assumed Soft Limit: 20% B_0 Hard Limit: 10% B_0
Status in relation to Target	Because of the relatively low levels of exploitation of *B. yatei*, it is likely that all 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
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 light in all Fishstocks. In BYA 7 landings have averaged 0.34 t since 2001-02.
Other Abundance Indices	-
Trends in Other Relevant Indicators or Variables	-

Projections and Prognosis		
Stock Projections or Prognosis	-	
Probability of Current Catch or TACC causing decline below Limits	For all stocks fishing is Very Unlikely (< 10%) to cause declines below soft or hard limits.	
Assessment Methodology		
Assessment Type	Level 2 - Partial Quantitative Stock Assessment	
Assessment Method	Absolute biomass estimates from quadrat surveys	
Main data inputs	Abundance and length frequency information	
Period of Assessment	Latest assessment: 1994	Next assessment: Unknown
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 fishery parameters for this species. Virgin stock size in areas sampled has been small. It is not known if peak abundances may be outside the surveyed areas.

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

For all other BYA stocks there is no current evidence of appreciable biomass.

7. FOR FURTHER INFORMATION

Annala J.H., Sullivan K.J., O'Brien C.J., Smith N.W.M. (comps.) 2001. Report from the fishery assessment plenary, May 2001: stock assessments and yield estimates. 515p. (Unpublished report held in NIWA library, Wellington).

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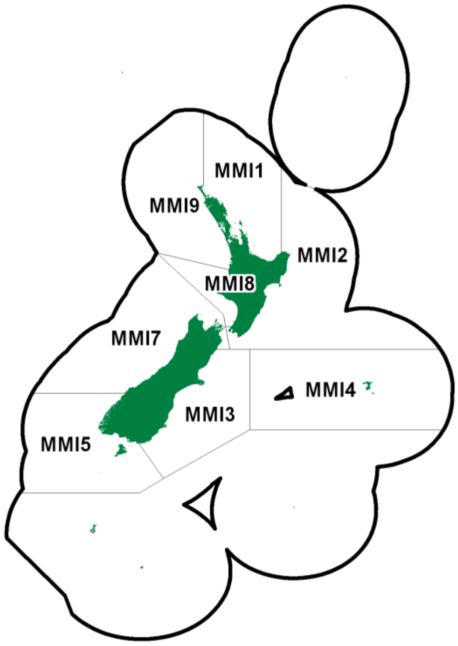
LARGE TROUGH SHELL (MMI)

(*Mactra murchisoni*)



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.

Large trough shells (*Mactra murchisoni*) were introduced into the Quota Management System on 1 April 2004 with a total TACC of 162 t. No allowances were made for customary, recreational or other sources of mortality. Biomass surveys in QMA 2 supported a TACC increase from April 2010. This increased the TACC for MMI 2 to 62 t. A subsequent biomass survey in 2012 supported a TAC increase in April 2013. This increased the TAC in MMI 8 from 25 to 631 t and the total MMI TAC from 183 to 789 t (Table 1).

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

Fishstock	TAC (t)	TACC (t)	Customary Allowance (t)	Other sources of mortality (t)
MMI 1	2	2	0	0
MMI 2	3	3	0	0
MMI 3	65	62	0	3
MMI 4	1	1	0	0
MMI 5	1	1	0	0
MMI 7	61	61	0	0
MMI 8	631	589	10	32
MMI 9	25	25	0	0
Total	789	744	10	35

1.1 Commercial fisheries

All reported landings have been from MMI 3 and MMI 7. Between the 1991–92 and 1995–96 fishing years landings were small and confined to MMI 7. No further landings were reported until 2002–03; since then the reported catch has ranged between about 20 t to 60 t (Table 2). Figure 1 shows the historical landings and TACCs for the two main MMI stocks.

1.2 Recreational fisheries

Offshore clams such as *M. murchisoni* are likely to have been harvested for recreational use only when washed ashore after storms. There are no estimates of recreational take for this surf clam.

Table 2: TACCs and reported landings (t) of Large Trough Shell by Fishstock from 1991–92 to 2013–14 from CELR and CLR data. Fishstocks where no catch has been reported are not tabulated. MM1 1, 2, 4, 5, 8 and 9 have TACCs of 2, 3, 1, 1, 569 and 25 t, respectively.

	MMI 3		MMI 7		Total	
Fishstock	Landings	TACC	Landings	TACC	Landings	TACC
1991–92	0	0	0.349	-	0.349	-
1992–93	0	0	1.541	-	1.541	-
1993–94	0	0	8.327	-	8.327	-
1994–95	0	0	10.432	-	10.432	-
1995–96	0	0	0.142	-	0.142	-
1996–97	0	0	0	-	0	-
1997–98	0	0	0	-	0	-
1998–99	0	0	0	-	0	-
1999–00	0	0	0	-	0	-
2000–01	0	0	0	-	0	-
2001–02	0	0	0	-	0	-
2002–03	0	0	22.623	-	22.623	-
2003–04	0	44	29.681	61	29.681	162
2004–05*	0	44	60.023	61	60.863	162
2005–06*	0	44	53.961	61	57.916	162
2006–07	7.476	44	54.091	61	61.567	162
2007–08	36.901	44	15.036	61	51.937	162
2008–09	32.149	44	6.657	61	38.806	162
2009–10	25.764	44	3.416	61	29.180	162
2010–11	12.600	62	17.432	61	30.032	180
2011–12	0	62	47.338	61	47.338	180
2012-13	44.445	62	32.81	61	77.265	180
2013-14	63.867	62	4.886	61	68.753	744

*In 2004–05 and 2005–06 0.84 and 3.9554 t respectively were reportedly landed, but the QMA is not recorded. These amounts are included in the total landings for these years.

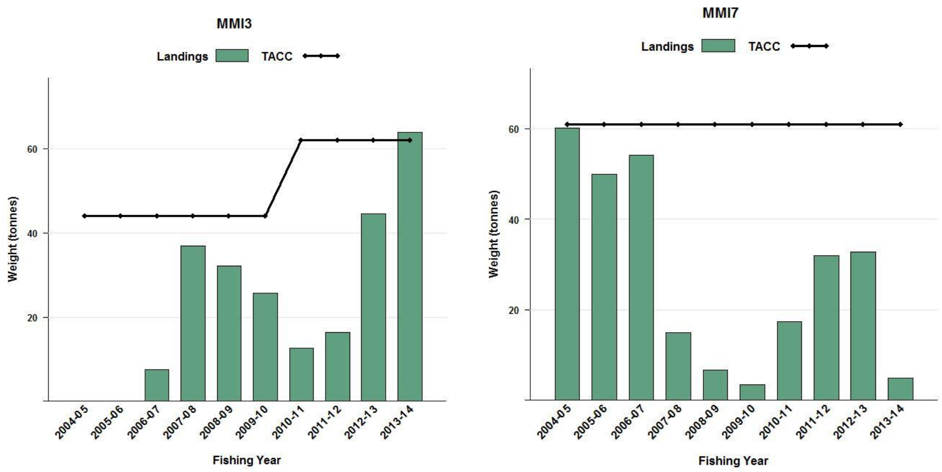


Figure 1: Reported commercial landings and TACC for MMI 3 (South East Coast), and MMI 7 (Challenger). Note that these figures do not show data prior to entry into the QMS.

1.3 Customary fisheries

Offshore clams such as *M. murchisoni* are likely to have been harvested for customary use only when washed ashore after storms. Shells of this clam have been found irregularly, and in small numbers, in a few middens (Conroy et al 1993). There are no estimates of current customary catch 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

M. murchisoni is most abundant in the lower half of the North Island and the South Island. It is found most commonly between about 4 m and 8 m in depth. Maximum length is variable between areas, ranging from 63 to 102 mm (Cranfield et al 1993) The sexes are separate, they are broadcast spawners, and the larvae are thought to be planktonic for between 20 and 30 days (Cranfield & Michael 2001). Recruitment of spat is to the same depth zone that adults occur in, although recruitment between years is highly variable (Conroy et al 1993).

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

5.1 Estimates of fishery parameters and abundance

No estimates of fisheries parameters or abundance are available for this species.

5.2 Biomass estimates

Biomass has been estimated at one site within MMI 3 and 8 and multiple sites within MMI 2 and 7 with stratified random surveying using a hydraulic dredge (Tables 3 and 4).

Table 3: A summary of biomass estimates in tonnes greenweight with standard deviation in parentheses from exploratory surveys of Cloudy Bay (Cranfield et al 1994a) and Clifford Bay in Marlborough (Michael et al 1994), and Foxton beach on the Manawatu coast (White et al 2012). - not estimated.

Area	Cloudy Bay (MMI 7)	Clifford Bay (MMI 7)	Foxton Beach (MMI 8)
Length of beach (km)	11	21	46[#]
Biomass (t)	248 (96)	192(79)	3603 (342)[#]

[#] Biomass was estimated at Foxton Beach from a mix of a systematic survey in the North and a stratified survey in the South of this location.

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

Location	Five sites (MMI 2)	Ashley River to 6 nm south of the Waimakariri River (MMI 3)
Area surveyed (km^2)	28.0	13.4
Biomass (t)	33.8	444.1

5.3 Yield estimates and projections

Growth and mortality data from Cloudy Bay in Marlborough and the Kapiti Coast in 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 1994a, Triantifillos 2008a, 2008b). The shellfish working group 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 Triantafillos (2008a, b) and White et al (2012) using the full range of $F_{0.1}$ estimates from Cranfield et al (1993) are shown in Table 5, but should be interpreted cautiously.

Estimates of *MCY* are available from numerous locations and were calculated using Method 1 for a virgin fishery (Annala et al 2001) with an estimate of virgin biomass B_0, where:

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

Table 5: *MCY* estimates (t) for *M. murchisoni* from virgin biomass at locations sampled around New Zealand (Triantifillos 2008a and b, White et al 2012).

Location	$F_{0.1}$	*MCY*
Five sites (MMI 2)	0.43/0.57	47.7/63.3
Ashley River to 6 nm south of the Waimakariri River (MMI 3)	0.70/0.89	5.9/7.5
46km of coast north and south of the Manawatu River (MMI 8)	0.70/0.89	630.6/801.7

CAY has not been estimated for *M. murchisoni*.

6. STATUS OF THE STOCKS

- MMI 3, 7 & 8 - *Mactra murchisoni*

Stock Status	
Year of Most Recent Assessment	2008 for MMI 3, 1994 for MMI 7 and 2012for MMI 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
Status in relation to Target	Because of the relatively low levels of exploitation of *M. muchisoni*, it is likely that all 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
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 light in all Fishstocks other than MMI 3 and MMI 7. In MMI 7 landings have averaged 34.6 t since 2002–03 and in MMI 3 landings have averaged 25.5 t since 2006–07.
Other Abundance Indices	-
Trends in Other Relevant Indicators or Variables	-

Projections and Prognosis	
Stock Projections or Prognosis	-
Probability of Current Catch or TACC causing decline below Limits	For all stocks current catches are Very Unlikely (< 10%) to cause declines below soft or hard limits.

Assessment Methodology	
Assessment Type	Level 2 - Partial Quantitative Stock Assessment
Assessment Method	Absolute biomass estimates from quadrat surveys
Main data inputs	Abundance and length frequency information

Period of Assessment	2008 for MMI 3, 1994 for MMI 7 and 2012 for MMI 8	Next assessment: Unknown
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 fishery parameters for this species.

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

For all other MMI stocks there is no current evidence of appreciable biomass.

7. FOR FURTHER INFORMATION

Annala, J H; Sullivan, K J; O'Brien. C J; Smith, N W M (compilers.) (2001) Report from the fishery assessment plenary, May 2001: stock assessments and yield estimates. 515 p. (Unpublished report held in NIWA library, Wellington.)

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Conroy, A; Smith, P; Michael, K; Stotter, D (1993) Identification and recruitment patterns of juvenile surf clams, *Mactra discors* and *M. murchisoni* from central New Zealand. *New Zealand Journal of Marine and Freshwater Research*, 27, 279–285.

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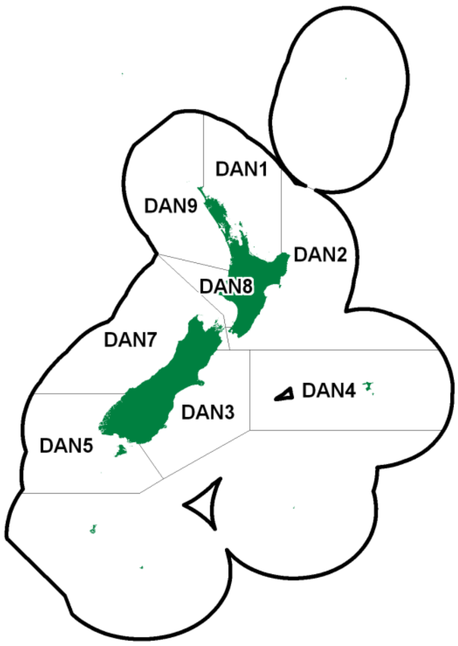
Triantifillos, L (2008b) Survey of subtidal surf clams in Quota Management Area 2, June–August 2008. Prepared by NIWA for Seafood Innovations Limited and SurfCo. Limited. : 40 p.

White, W; Millar, R; Breen, B; Farrington, G (2012) Survey of subtidal surf clams from the Manawatu Coast (FMA 8), October–November 2012, Report for the Shellfish Working Group Meeting 19th November 2012, 35 p. + Addendum.

RINGED DOSINIA (DAN)

(*Dosinia anus*)



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.

Ringed Dosinia (*Dosinia anus*) were introduced into the Quota Management System on 1 April 2004 with a combined TAC of 112 t and catches are measured in greenweight. There were no allowances for customary, recreational or other sources of mortality. Biomass surveys in QMA 2 and 3 supported a TACC increase from April 2010. This increased the TACC for DAN 2 from 18 to 61 t and DAN 3 from 4 to 52 t. A subsequent biomass survey in DAN 8 resulted in a TAC increase in April 2013. This increased the DAN 8 TAC from 33 to 236 t and the total TAC to 412 t (Table 1).

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

Fishstock	TAC (t)	TACC (t)	Customary Allowance (t)	Other sources of mortality (t)
DAN 1	7	7	0	0
DAN 2	64	61	0	3
DAN 3	55	52	0	3
DAN 4	1	1	0	0
DAN 5	1	1	0	0
DAN 7	15	15	0	0
DAN 8	236	214	10	12
DAN 9	33	33	0	0
Total	412	384	10	18

1.1 Commercial fisheries

Prior to 2006–07 landings had only been reported in DAN 7 and ranged from about 10 to 300 kg. Small catches (less than 1 t) were reported in DAN 3 for 2006–07, but increased to 1.4 t in 2008–09. From 2002–03 onwards, landings in DAN 7 increased up to a maximum of 2.4 t in 2006–07, but have since varied between 0.2 t in 2008-9 and 2009-10 and 5.3 t in 2011-12 (Table 2).

1.2 Recreational fisheries

There are no known records of recreational use of this surf clam.

Table 2: TACCs and reported landings (t) of Ringed Dosinia by Fishstock from 1991–92 to the present day from CELR and CLR data. Fishstocks where no catch has been reported are not tabulated. DAN 1, 2, 4, 5, 8 and 9 have TACCs of 7, 61, 1, 1, 33 and 33 t, respectively.

	DAN 3		DAN 7		Total	
Fishstock	Landings	TACC	Landings	TACC	Landings	TACC
1991–92	0	-	0	-	0	
1992–93	0	-	0.164	-	0.164	-
1993–94	0	-	0.293	-	0.293	-
1994–95	0	-	0.07	-	0	0.07
1995–96	0	-	0.012	-	0	0.012
1996–97	0	-	0	-	0	0
1997–98	0	-	0	-	0	-
1998–99	0	-	0	-	0	-
1999–00	0	-	0	-	0	-
2000–01	0	-	0	-	0	-
2001–02	0	-	0	-	0	-
2002–03	0	-	0.114	-	0.114	-
2003–04	0	4.0	0.895	15.0	0.895	112.0
2004–05	0	4.0	1.982	15.0	2.016*	112.0
2005–06	0	4.0	1.095	15.0	1.022*	112.0
2006–07	0.086	4.0	2.464	15.0	2.55	112.0
2007–08	0.768	4.0	0.821	15.0	1.589	112.0
2008–09	1.398	4.0	0.159	15.0	1.557	112.0
2009–10	0.836	4.0	0.209	15.0	1.045	112.0
2010–11	0.768	52.0	2.199	15.0	3.022	203.0
2011–12	0	52.0	5.303	15.0	5.303	203.0
2012–13	0.547	52	3.531	15	4.078	203.0
2013–14	5.483	52	0.729	15	6.212	384.0

*In 2004–05 and 2005–06, 32.4 and 90 kg were reported but the QMA is not recorded. This amount is included in the total landings for these years.

1.3 Customary fisheries

Offshore clams such as *D. anus* are likely to have been harvested for customary use only when washed ashore after storms. Shells of this clam have been found irregularly, and in small numbers in a few middens (Carkeek 1966). There are no estimates of current customary use of this clam.

1.4 Illegal catch

There is no known 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 probably sometimes taken as a bycatch in inshore trawling. Harvesters claim that the hydraulic clam rake does not damage surf clams and minimises damage to the few species of other macrofauna captured. Surf clam populations also are 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

D. anus is found around the New Zealand coast on sediments in the North Island at depths between 5 and 8 m, and in the South Island between 6 and 10 m. It is larger and rougher than *D. subrosea*, and is usually found on more exposed beaches shallower in the substrate. Maximum length is variable between areas, ranging from 58 to 82 mm (Cranfield et al 1993). The sexes are likely to be separate, and they are likely to be broadcast spawners with planktonic larvae. Anecdotal evidence suggests that spawning is likely to occur in the summer months and spat probably recruit to the deeper water of the outer region of the surf zone. Recruitment of surf clams is thought to be highly variable between years.

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 (such as rivers and headlands). 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

5.1 Estimates of fishery parameters and abundance

No estimates of fisheries parameters or abundance are available for this species.

5.2 Biomass estimates

Biomass has been estimated at Cloudy and Clifford Bay in DAN 7 with a stratified random survey using a hydraulic dredge (Table 3).

Table 3: A summary of biomass estimates for *D. anus* in tonnes green weight with standard deviation in parentheses from exploratory surveys of Cloudy Bay (Cranfield et al 1994b), and Clifford Bay, both in Marlborough (Michael et al 1994) as well as on the Manawatu coastline (White et al 2012).

Area	Cloudy Bay (DAN 7)	Clifford Bay (DAN 7)	Foxton Beach (DAN 8)
Length of beach (km)	11	21	46
Biomass (t)	72 (30)	5 (3)	3498 (329)

5.3 Yield estimates and projections

Growth and mortality data from Cloudy Bay in Marlborough and the Kapiti Coast in 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, Triantifillos 2008a and 2008b). The shellfish working group 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 and b) and White et al (2012) that use the full range of $F_{0.1}$ estimates from Cranfield et al (1993) are shown in Table 4, but should be interpreted cautiously.

Estimates of *MCY* were calculated using Method 1 for a virgin fishery (Annala et al 2001) with an estimate of virgin biomass B_0, where:

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

Table 4: Mean *MCY* estimates (t) for *D. anus* from virgin biomass at locations sampled around New Zealand (Triantifillos 2008a and b).

Location	$F_{0.1}$	*MCY*
Five sites (DAN 2)	0.25/0.42	52.8/88.7
Ashley River to 6 n. mile south of the Waimakariri River (DAN 3)	0.27/0.54	63.8/127.7
Foxton beach	0.27/0.54	236.1/472.2

CAY has not been estimated for *D. anus*.

6. STATUS OF THE STOCKS

- DAN 2, 3, 7 & 8- *Dosinia anus*

Stock Status	
Year of Most Recent Assessment	2008 for DAN 2 and 3, 1994 for DAN 7 and 2012 for DAN 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

Status in relation to Target	Because of the relatively low levels of exploitation of *D. anus*, it is likely that all 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
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 in all Fishstocks other than DAN 3 and 7. In DAN 7 fishing has been light with landings averaging 1.1 t since 2002–03.
Other Abundance Indices	-
Trends in Other Relevant Indicators or Variables	-

Projections and Prognosis	
Stock Projections or Prognosis	-
Probability of Current Catch or TACC causing decline below Limits	For all stocks current catches are Very Unlikely (< 10%) to cause declines below soft or hard limits.

Assessment Methodology		
Assessment Type	Level 2 - Partial Quantitative Stock Assessment	
Assessment Method	Absolute biomass estimates from quadrant surveys	
Main data inputs	Abundance and length frequency information	
Period of Assessment	Latest assessment: 2008 for DAN 2 and 3, 1994 for DAN 7, 2012 for DAN 8.	Next assessment: Unknown
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 fishery parameters for this species

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

For all other DAN stocks there is no current evidence of appreciable biomass.

7. FOR FURTHER INFORMATION

Annala, J H; Sullivan, K J; O'Brien, C J; Smith, N W McL (compilers) (2001) Report from the fishery assessment plenary, May 2001: stock assessments and yield estimates. 515 p. (Unpublished report held in NIWA library, Wellington.)

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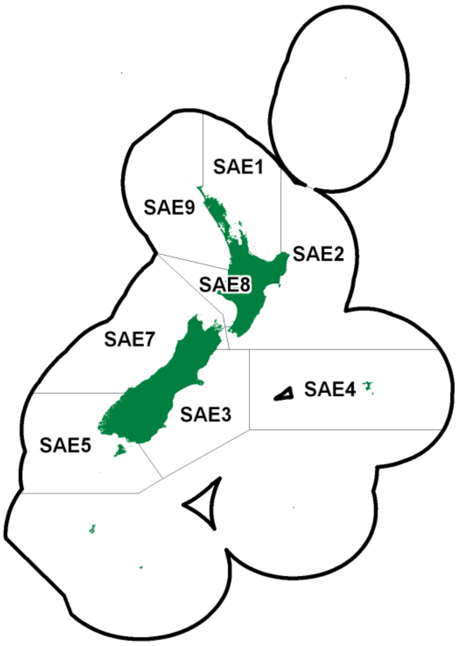
Triantifillos, L (2008b) Survey of subtidal surf clams in Quota Management Area 2, June – August 2008. Prepared by NIWA for Seafood Innovations Limited and SurfCo. limited. 40 p.

White, W; Millar, R; Breen, B; Farrington, G (2012) Survey of subtidal surf clams from the Manawatu Coast (FMA 8), October–November 2012, Report for the Shellfish Working Group Meeting 19th November 2012, 35 p + Addendum.

TRIANGLE SHELL (SAE)

(*Spisula aequilatera*)



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.

Triangle shells (*Spisula aequilatera*) were introduced into the QMS on 1 April 2004 with a total TACC of 406 t. No allowances were set for customary, non-commercial, recreational or other sources of mortality. Biomass surveys supported an increase in TAC in SAE 2 and SAE 3 from 1 April 2010 from 1 and 264 t respectively to 132 and 483 t, respectively. A subsequent biomass survey in SAE 8 resulted in a TAC increase in April 2013. This increased the SAE 8 TAC from 8 to 1821 t and the total TAC from 756 to its current level of 2569 t (Table 1).

Table 1: Current TAC, TACC and allowances for other sources of mortality for *Spisula aequilatera*

Fishstock	TAC (t)	TACC (t)	Customary Allowance (t)	Other sources of mortality (t)
SAE 1	9	9	0	0
SAE 2	132	125	0	7
SAE 3	483	459	0	24
SAE 4	1	1	0	0
SAE 5	3	3	0	0
SAE 7	112	112	0	0
SAE 8	1821	1720	10	91
SAE 9	8	8	0	0
Total	2569	2437	10	122

1.1 Commercial fisheries

Apart from a small catch in SAE 2 in 2003–04 and small catches in SAE 3 since 2006–07, all reported landings have been from SAE 7. Between the 1991–92 and 1995–96 fishing years, landings were small and no further landings were reported until 2002–03. Since then landings have increased with a maximum of 52 t in 2002–03. Reported landings and TACCs are shown for the fishstocks with historical landings in Table 2. Figure 1 shows historical landings and TACCs for the two main SAE stocks. Landings are market-driven and have not been constrained by the TACCs.

Table 2: TACCs and reported landings (t) of Triangle shell by Fishstock from 1990–91 to 2012–13 from CELR and CLR data. SAE 1, 4, 5, 8 and 9 have TACCs of 9, 1, 3, 1821 and 8 t, respectively.

	SAE 2		SAE 3		SAE 7		Total	
Fishstock	Landings	TACC	Landings	TACC	Landings	TACC	Landings	TACC
1991–92	0	-	0	-	0.175	-	0.175	-
1992–93	0	-	0	-	0.396	-	0.396	-
1993–94	0	-	0	-	2.846	-	2.846	-
1994–95	0	-	0	-	2.098	-	2.098	-
1995–96	0	-	0	-	0.12	-	0.120	-
1996–97	0	-	0	-	0	-	0	-
1997–98	0	-	0	-	0	-	0	-
1998–99	0	-	0	-	0	-	0	-
1999–00	0	-	0	-	0	-	0	-
2000–01	0	-	0	-	0	-	0	-
2001–02	0	-	0	-	0	-	0	-
2002–03	0	-	0	-	52.146	-	52.146	-
2003–04	0.198	1.0	0	264.0	9.583	112.0	9.781	406.0
2004–05	0	1.0	0	264.0	18.527	112.0	19.364*	406.0
2005–06	0	1.0	0	264.0	28.067	112.0	31.019*	406.0
2006–07	0	1.0	0.608	264.0	45.955	112.0	46.563	406.0
2007–08	0	1.0	3.912	264.0	5.022	112.0	8.934	406.0
2008–09	0	1.0	10.909	264.0	2.506	112.0	13.415	406.0
2009–10	0	1.0	8.619	264.0	1.460	112.0	10.078	406.0
2010–11	0	125.0	4.043	459.0	16.919	112.0	20.962	725.0
2011–12	0	125.0	0	459.0	82.266	112.0	82.266	725.0
2012-13	0	125.0	9.832	459	161.195	112.0	171.027	725.0
2013-14	0	125.0	3.613	459	191.073	112.0	195.316	2 437

*In 2004–05 and 2005–06, 0.837 and 2.952 t respectively were reported landed, but the QMA is not recorded. These amounts are included in the total landings for these years.

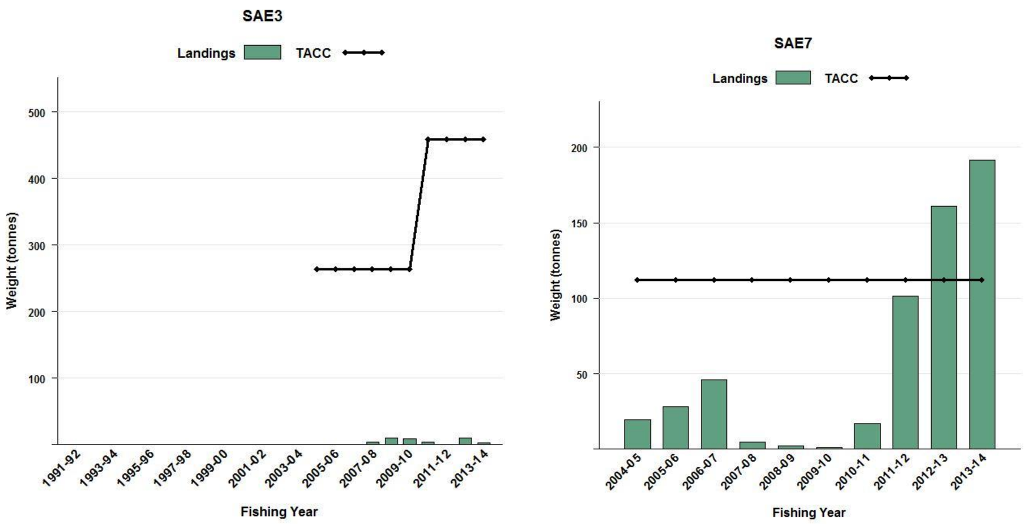


Figure 1: Reported commercial landings and TACC for selected areas.

1.2 Recreational fisheries

There are no estimates of recreational take for this surf clam.

1.3 Customary fisheries

Shells of this species have been found irregularly, and in small numbers in a few middens (Carkeek 1966). There are no estimates of current customary catch of this species.

1.4 Illegal catch

There is no documented illegal catch of this species.

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

S. aequilatera occurs from Bay of Plenty southwards on the east coast of both islands, and on the Wellington-Manawatu coast. No information is available concerning its distribution on the West Coast of the South Island. In the North Island this species is most abundant between 3 m and 5 m depth, and in the South Island between 4 m and 8 m depth. Maximum length is variable between areas, ranging from 39 to 74 mm (Cranfield & Michael 2002). The sexes are separate; they are broadcast spawners; they are reasonably fast growing and reach maximum size in 2–3 years. Nothing is known of their larval life.

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

5.1 Estimates of fishery parameters and abundance

No estimates of fisheries parameters or abundance are available for this species. Early estimates were made of M and $F_{0.1}$ but the SFWG considers that the methods were not well documented, and the estimates should not be used.

5.2 Biomass estimates

Biomass was estimated at one site in each of SAE 3 and SAE 8, and multiple sites within SAE 2 and SAE 7 with stratified random surveying using a hydraulic dredge (Tables 3 and 4).

Table 3: A summary of biomass estimates in tonnes greenweight with standard deviation in parentheses from exploratory surveys of Cloudy Bay (Cranfield et al 1994b) and Clifford Bay in Marlborough (Michael et al 1994), and Foxton beach on the Manawatu coast (White et al 2012). - Indicates where estimates were not generated.

Area	Cloudy Bay (SAE 7)	Clifford Bay (SAE 7)	Foxton Beach (SAE 8)
Length of beach (km)	11	21	46
Biomass (t)	53 (22)	358 (152)	7993 (759)

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

Location	Five sites (SAE 2)	Ashley River to 6 nm south of the Waimakariri River (SAE 3)
Area surveyed (km^2)	28.0	13.4
Biomass (t)	471.1	1567.2

5.3 Yield estimates and projections

Estimation of Maximum Constant Yield (*MCY*)

Growth and mortality data from Cloudy Bay in Marlborough and the Kapiti Coast in 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, Triantifillos 2008a, 2008b). The shellfish working group 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 and b) and White et al 2012 that use the full range of $F_{0.1}$ estimates from Cranfield et al (1993) are shown in Table 5, but should be interpreted cautiously.

Estimates of *MCY* are available from a number of locations and were calculated using Method 1 for a virgin fishery (Annala et al 2001) with an estimate of virgin biomass B_0, where:

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

Table 5: *MCY* estimates (t) for *S. aequilatera* from virgin biomass at locations sampled around New Zealand (Triantifillos 2008a and b).

Location	$F_{0.1}$	*MCY*
Five sites (SAE 2)	1.12/1.56	131.9/183.7
Ashley River to 6 nm south of the Waimakariri River (SAE 3)	1.06/1.37	415.3/536.8
Foxton beach (SAE 8)	1.06/1.37	2238/3117.2

Estimation of Current Annual Yield (*CAY*)

CAY has not been estimated for *S. aequilatera*.

6. STATUS OF THE STOCKS

- SAE 2, 3, 7 & 8- *Spisula aequilatera*

Stock Status	
Year of Most Recent Assessment	2008 for SAE 2 and 3, 1994 for SAE 7, 2012 for SAE 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
Status in relation to Target	Because of the relatively low levels of exploitation of *S. aequilatera*, it is likely that all 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
Historical Stock Status Trajectory and Current Status	
-	

Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	Unknown
Recent Trend in Fishing Mortality or Proxy	Fishing is light in all QMAs other than SAE 7. In SAE 7 it has averaged 23 t since 2002–03.
Other Abundance Indices	-
Trends in Other Relevant Indicators or Variables	-

Projections and Prognosis	
Stock Projections or Prognosis	-
Probability of Current Catch or TACC causing decline below Limits	For all stocks current catches are Very Unlikely (< 10%) to cause declines below soft or hard limits.

Assessment Methodology		
Assessment Type	Level 2 - Partial Quantitative Stock Assessment	
Assessment Method	Absolute biomass estimates from quadrant surveys	
Main data inputs	Abundance and length frequency information	
Period of Assessment	Latest assessment: 2008 for SAE 2 and 3, 1994 for SAE 7, 2012 for SAE 8.	Next assessment: Unknown
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. SAE have slower digging ability relative to PDO therefore are at higher relative risk of mortality during storms.

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

For all other SAE stocks there is no current evidence of appreciable biomass.

7. FOR FURTHER INFORMATION

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White, W; Millar, R; Breen, B; Farrington, G (2012) Survey of subtidal surf clams from the Manawatu Coast (FMA 8), October–November 2012, Report for the Shellfish Working Group Meeting 19th November 2012, 35 p + Addendum.