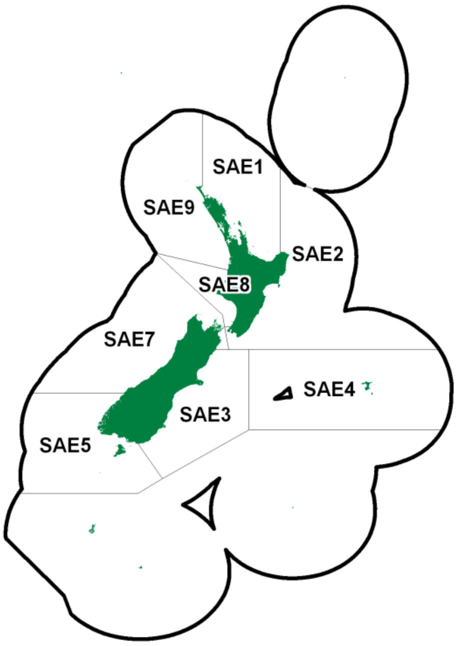
TRIANGLE SHELL (SAE)

(*Crassula aequilatera*)



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

Triangle shells (*Crassula aequilatera*, also known as *Spisula aequilatera*) were introduced into the QMS on 1 April 2004 with a total TACC of 406 t. No allowances were initially set for customary, non-commercial, recreational, or other sources of mortality, but some allowances were introduced to SAE 8 and 7 in 2013 and 2016, respectively. Biomass surveys supported an increase in TAC in SAE 2 and SAE 3 from 1 April 2010 from 1 t and 264 t respectively to 132 t and 483 t, respectively. A subsequent biomass survey in SAE 8 resulted in a TAC increase from 8 t to 1821 t in April 2013. Another biomass survey resulted in an increase in the SAE 7 TAC from 112 t to 235 t in April 2016, with a current total national TAC of 2692 t (Table 1).

Table 1: Total Allowable Catch (TAC, t), Total Allowable Commercial Catches (TACC, t), customary non-commercial (t), recreational (t), and other mortality allowances (t) for *Crassula aequilatera*.

Fishstock	Description	TAC (t)	Customary Allowance (t)	Recreational allowance (t)	Other sources of mortality (t)	TACC (t)
SAE 1	Auckland (East)	9	0	0	0	9
SAE 2	Central (East)	132	0	0	7	125
SAE 3	South East (Coast)	483	0	0	24	459
SAE 4	South East (Chatham Rise)	1	0	0	0	1
SAE 5	Southland	3	0	0	0	3
SAE 7	Challenger	235	5	1	12	217
SAE 8	Central (West)	1821	10	0	91	1720
SAE 9	Auckland (West)	8	0	0	0	8
Total		2692	15	1	134	2542

Apart from 200 kg in SAE 2 in 2003–04 and landings up to 32 t in SAE 8 since 2014–15, all reported landings have been from SAE 3 and SAE 7. For SAE 3, there were no landings until 2006–07. Between 2006–07 and 2014–15, landings in SAE 3 fluctuated between 0.6 t and 11 t, with no landings reported in 2011–12. From 2014–15 onwards, landings increased to 203 t in 2018–19, remaining below 200 t since

2019–20. For SAE 7, there were minimal landings from 1991–92 to 1995–96; no further landings were reported until 2002–03 (52 t). SAE 7 landings fluctuated between 1t and 45 t until 2010–11, and then increased to a peak of 319 t in 2015–16, before declining again; in 2019–20 109 t were recorded. Since 2020-21, landings have been very low compared to historical landings. 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 present from CELR and CLR data. See Table 1 for TACCs of stocks not landed. The fishing year is from 1 April to 31 March. Reported landings for the 2022–23 fishing year are considered preliminary. Total Landings and TACC correspond to all SAE stocks.

Fishstock	SAE 2		SAE 3		SAE 7		SAE 8		Total	
	Landing	TACC	Landing	TACC	Landing	TACC	Landing	TACC	Landing	TACC
1991–92	0	–	0	–	0.18	–	0	–	0.18	–
1992–93	0	–	0	–	0.40	–	0	–	0.40	–
1993–94	0	–	0	–	2.85	–	0	–	2.85	–
1994–95	0	–	0	–	2.10	–	0	–	2.10	–
1995–96	0	–	0	–	0.12	–	0	–	0.12	–
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	–	52.15	–	0	–	52.15	–
2003–04	0.20	1	0	264	9.58	112	0	8	9.78	406
2004–05	0	1	0	264	18.53	112	0	8	19.36*	406
2005–06	0	1	0	264	28.07	112	0	8	31.02*	406
2006–07	0	1	0.61	264	45.96	112	0	8	46.56	406
2007–08	0	1	3.91	264	5.02	112	0	8	8.93	406
2008–09	0	1	10.91	264	2.51	112	0	8	13.42	406
2009–10	0	1	8.62	264	1.46	112	0	8	10.08	406
2010–11	0	125	4.04	459	16.92	112	0	8	20.96	725
2011–12	0	125	0	459	82.27	112	0	8	82.27	725
2012–13	0	125	9.83	459	161.20	112	0	1 720	171.03	2 437
2013–14	0	125	3.61	459	191.07	112	0	1 720	195.32	2 437
2014–15	0	125	5.92	459	241.04	112	0.45	1 720	246.96	2 437
2015–16	0	125	34.97	459	319.09	217	21.02	1 720	375.09	2 867
2016–17	0	125	150.40	459	186.47	217	9.51	1 720	346.38	2 867
2017–18	0	125	133.98	459	157.49	217	5.05	1 720	296.52	2 867
2018–19	0	125	202.88	459	86.34	217	3.84	1 720	293.06	2 867
2019–20	0	125	187.45	459	109.10	217	24.92	1 720	321.47	2 867
2020–21	0	125	196.39	459	19.33	217	10.69	1 720	226.41	2 867
2021–22	0	125	185.88	459	33.05	217	31.95	1 720	250.88	2 867
2022–23	0	125	142.98	459	32.31	217	25.95	1 720	201.24	2 542

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

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).

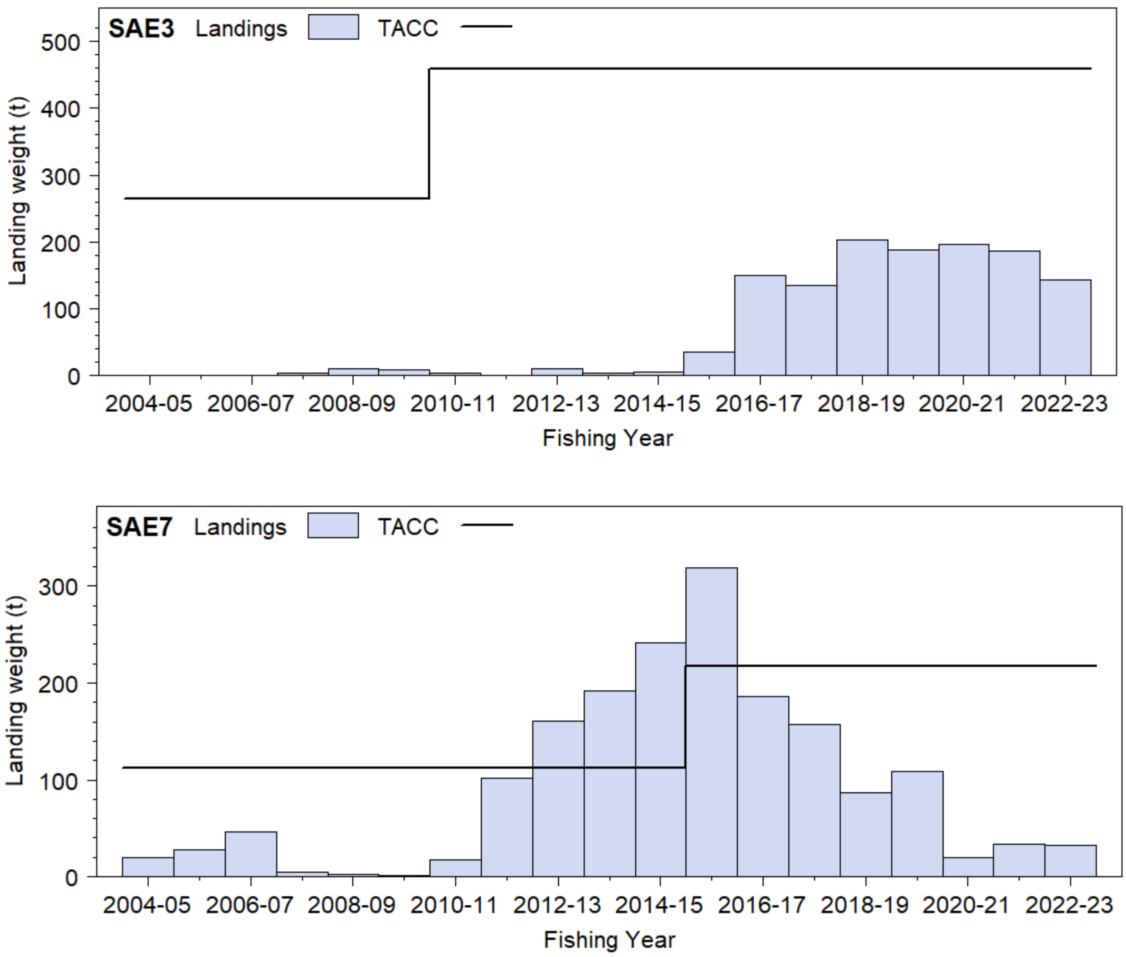


Figure 1:Reported commercial landings and TACC for the main triangle shell stocks: SAE 3 (top) and SAE 7 (bottom).

2. BIOLOGY

Crassula aequilatera occurs from the Bay of Plenty southwards on the east coast of both main 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 depths, and in the South Island between 4 m and 8 m depths. Maximum length is variable between areas, ranging from 39 mm to 74 mm (Cranfield & Michael 2002). The sexes are separate, and 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 Introduction – surf clams 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 Shellfish Working Group considers that the methods were not well documented, and the estimates should not be used.

5.2 Biomass estimates

Biomass has been estimated from SAE 2, 3, 7, and 8 at various times between 1994 and 2015 using stratified random surveying with a hydraulic dredge. Survey size has been expressed either as length of beach (Table 3), or as area (Table 4), which makes comparisons difficult.

In both 2012 (FMA 8) and 2015 (Cloudy Bay, FMA 7), White et al (2012, 2015) 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 was also recorded. Both the biomass densities and biomass estimates were calculated for all the commercial species of subtidal surf clams caught.

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).

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)	7 993 (759)[#]

[#] Biomass was estimated at Foxton Beach from a mix of a systematic survey to the north and a stratified survey to the south of this location.

Table 4: A summary of biomass estimates in tonnes greenweight from the surveys in SAE 2 (Triantifillos 2008b), SAE 3 (Triantifillos 2008a), and Cloudy Bay (White et al 2015). 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)	Cloudy Bay (SAE 7)
Area surveyed (km^2)	28.0	13.4	5.7
Biomass (t)	471.1	1 567.2	887

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). 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 Triantifillos (2008a, 2008b) and White et al (2012, 2015) that use the full range of $F_{0.1}$ estimates from Cranfield et al (1993) are shown in Table 5. 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 high uncertainty in the $F_{0.1}$ values for SAE, the SFWG advised using the lower $F_{0.1}$ values when estimating a sustainable *MCY* for this species; 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; and 3) an exploitation rate of 34% for SAE 7 (as suggested by the higher *MCY* value) was not recommended due to the current limited knowledge of the dynamics of surf clam species.

Estimates of *MCY* are available from a number of locations and were calculated using Method 1 for a virgin fishery (MPI 2015) with an estimate of virgin biomass B_0, where:

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

Table 5: *MCY* estimates (t) for *S. aequilatera* from virgin biomass at locations sampled around New Zealand (Triantifillos 2008a, 2008b). 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 (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
Cloudy Bay (SAE 7)	1.06/1.37	235.0/303.8
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*.

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

- **SAE 2 & 3 - Central and South East (Coast)**

The most recent survey conducted for SAE 2&3 was in 2008. There is no longer adequate information to inform current stock status which is therefore Unknown.

- **SAE 7 - Challenger**

Stock Status		
Most Recent Assessment Plenary Publication Year	2015	
Catch in most recent year of assessment	Year: 2013–14	Catch: 191 t
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	Unknown	
Status in relation to Limits	Unknown	
Status in relation to Overfishing	Unknown	

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 was variable between 52 t and 1 t landed between 2002–03 and 2009–10. Landings have then increased dramatically from 1 t in 2009–10 to 319.09 t in 2015–16 when the TACC was increased to 217 t. Since 2015-16,

	the overall trend has been declining with landings being very low compared to historical landings since 2020-21.
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	Current catches at or below the TACC are Unlikely (< 40%) to cause declines below soft or hard limits in the short to mid-term.
Probability of Current Catch or TACC causing Overfishing to continue or to commence	Unlikely (< 40%)

Assessment Methodology		
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	Abundance and length frequency information	
Data not used	-	
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.

- **SAE 8 – Central (West)**

The most recent survey conducted for SAE 8 was in 2012. There is no longer adequate information to inform current stock status which is therefore Unknown.

For all other SAE Fishstocks there is insufficient information to estimate current stock status.

7. FOR FURTHER INFORMATION

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