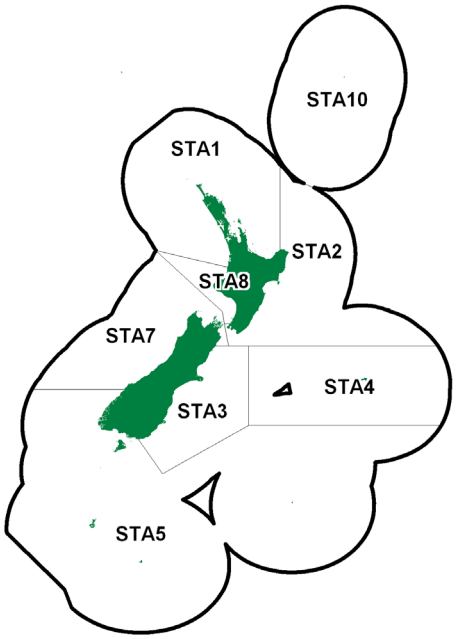
STARGAZER (STA)

(*Kathetostoma giganteum*)
Puwhara



1. FISHERY SUMMARY

1.1 Commercial fisheries

Giant stargazer (*Kathetostoma giganteum*, Uranoscopidae) is a moderate-sized benthic teleost distributed widely in New Zealand waters. It is found on muddy and sandy substrates to depths of 500 m, but is most common between 50–300 m on the continental shelf around the South Island (Anderson et al 1998), where it supports a moderate-value, commercial trawl fishery. It was incorporated into the QMS on 1 October 1997 and is managed as eight separate Quota Management Areas (QMAs) or Fishstocks at this time: STA 1–5, 7–8, and 10.

It is caught by both directed fishing and as bycatch of fisheries targeting other species. The main target fishery is on the Stewart-Snares shelf west of Stewart Island (Statistical Areas 029–030). Other target fisheries exist off the west coast of the South Island (WCSI) and off Cape Campbell on the east coast of the South Island (ECSI). It is also caught by small domestic trawl vessels targeting red cod (*Pseduophycis baccus*), tarakihi (*Nemadactylus macropterus*), flatfishes (*Colistum* spp., *Peltorhamphus* spp., and *Rhombosolea* spp.), and scampi (*Metanephrops challengeri*) on the continental shelf throughout its range and by larger, foreign-licensed and New Zealand-chartered foreign vessels targeting barracouta (*Thyrsites atun*), jack mackerels (*Trachurus* spp.), and squid (*Nototodarus* spp.) in deeper waters, in particular on the western Chatham Rise and on the continental slope surrounding the Stewart-Snares shelf. Giant stargazer is an important bycatch of scampi fishing in STA 2–4. Catches by methods other than bottom trawling are minimal. Reported landings from 1979 to 1987–88 are given in Table 1. Reported landings for the main QMAs for 1931 to 1982 are given in Table 2.

Table 1: Reported landings (t) of giant stargazer by vessel flag from 1979 to 1987–88.

	New Zealand		Foreign-			New Zealand		Foreign-	
Year	Domestic	Chartered	licensed	Total	Year	Domestic	Chartered	licensed	Total
1979*	387	155	159	701	1983–84†	1 463	525	360	2 348
1980*	723	–	–	723	1984–85†	1 027	321	178	1 526
1981*	1 010	314	84	1 408	1985–86†	1 304	386	142	1 832
1982*	902	340	283	1 526	1986–87†	1 126	379	63	1 568
1983*	1 189	329	465	1 983	1987–88†	839	331	26	1 196

*MAF data. †FSU data.

The total landings between 1979 and 1986–87 were variable, ranging between 701 and 2348 t and averaging 1481 t per year. Different trends are apparent for domestic and foreign vessels. The domestic and chartered catch was relatively stable throughout the middle and later half of the series, which probably reflects the stability of effort in the red cod, tarakihi, flatfish, and barracouta fisheries at this time as well as better reporting compliance. However, landings by foreign-licensed vessels declined steadily from a high of 465 t in 1983 to a low of 26 t in 1986–87, probably reflecting the declining importance of foreign-licensed vessels in New Zealand's deepwater fisheries following the phasing-in of the QMS, which began in 1983 and which was fully implemented by 1986–87. Reported landings since 1983 by Fishstock are given in Table 3 and Figure 1 graphs the historical landings and TACC values for the main STA stocks. The total catches for 1986–87 and 1987–88 in Table 1 are less than those in Table 3 because of under-reporting to the FSU during those years.

After 1983, the catch began to increase rapidly, reaching 3426 t in 1990–91, and averaging about 3000 t thereafter. The increase in catch is due to a number of factors, including: (a) increased target fishing in Southland (STA 5); (b) the availability of more quota through the decisions of the Quota Appeal Authority; (c) better management of quotas by quota owners; (d) quota trading in STA 3, 4, 5, and 7; (e) changes in fishing patterns in the Canterbury Bight (STA 3) and the west coast of the South Island (STA 7); (f) a possible increase in abundance of stargazer in STA 7; and (g) increases in STA 3, 5, and 7 TACCs introduced under the Adaptive Management Programme (AMP) in the 1991–92 fishing year.

The Adaptive Management Programme (AMP) was a management regime within the QMS for data-poor New Zealand Fishstocks that were considered able to sustain increased exploitation. Under the AMP, quota owners collected additional data from the fishery (typically fine-scale catch-effort data and rudimentary, but necessary, biological data such as fish length and sex) in return for an increased TACC. Under the AMP, TACCs for five giant stargazer Fishstocks (STA 1–3, 5, and 7) were increased at the start of the 1991–92 fishing year, and a sixth (STA 8) was increased in 1993–94. However, the TACCs for Fishstocks STA 1–3, 5, and 8 reverted to their pre-AMP levels in 1997–98 following the removal of these Fishstocks from the AMP in July 1997 because of the failure of quota owners to meet the data-collection requirements of the AMP. Subsequently, landings in three of these Fishstocks (STA 1, 2, and 5) exceeded their reduced, post-AMP TACCs; although of these, STA 5 was the only one with a TACC greater than 40 t at this time. STA 3 and STA 7 were reviewed in 1998 and retained in the AMP until the end of the 2002–03 fishing year. The TACC in STA 7 was further increased to 997 t at the start of the 2002–03 fishing year with a TAC of 1000 t (which included a 2 t recreational and a 1 t customary allowance). STA 7 was reviewed again in 2007 (Starr et al 2007b) and retained in the AMP. In October 2010 the TACC was increased to 1042 t, increasing the TAC to 1072 t, and in October 2015 the TACC was further increased to 1122 t. STA 3 was reviewed in 2008 (Starr et al 2008) and retained at the existing TACC of 902 t, with customary and recreational allocations of 1 t and 2 t respectively, giving a total TAC of 905 t. All AMP programmes ended on 30 September 2009.

STA 5, STA 7, and STA 3 are the most important Fishstocks, in terms of the recorded landed catch, among the eight Fishstocks, with smaller contributions from STA 2 and STA 4. The STA 4 TACC is set at 2158 t, the highest among the eight STA Fishstocks, although landings are only a tenth of this level in most years and the TACC has never been approached or exceeded. Most of the STA 4 catch is caught as bycatch of fishing directed at other target species. A relatively high recorded landed catch in 1990–91 (790 t) was due to exploratory fishing for these target species which has since ceased. Landings exceeded 100 t in STA 2 from 1990–91 to 1992–93 due to the development of the scampi fishery in this FMA. Landings subsequently decreased and averaged just 15 t in 2010–11 to 2019–20. Landings in STA 8 have also been lower than the TACC throughout the time series.

Although the TACC in STA 7 was increased to 700 t in 1991–92 under the terms of the AMP, it was over-caught in nearly every subsequent fishing year up to 2002–03, when the TACC was further increased to 997 t. Landings reached a high of 1440 t in 2000–01, before dropping back to 800 t in 2001–02. These high recorded landings resulted mainly from the use of bycatch trades with barracouta and flatfish. With the removal of the bycatch trade system in October 2001, fishers faced the penalty of high deemed values for any over-catch, and this may have reduced the over-catch in this Fishstock in the short term, although landings exceeded the TACC from 2004–05 until 2009–10. The TACC was increased in 2009 and again in 2015, and landings have increased with the TACC.

With the exception of STA 1, landings in recent years have generally not exceeded TACCs.

Table 2: Reported landings (t) for the main QMAs from 1931 to 1982.

Year	STA 1	STA 2	STA 3	STA 4	STA 5	STA 6	STA 7
1931–32	0	0	0	0	0	0	0
1932–33	0	0	0	0	0	0	0
1933–34	0	0	0	0	0	0	0
1934–35	0	0	0	0	0	0	0
1935–36	0	0	0	0	0	0	0
1936–37	0	0	0	0	0	0	0
1937–38	0	0	0	0	0	0	0
1938–39	0	0	0	0	0	0	0
1939–40	0	0	0	0	0	0	0
1940–41	0	0	0	0	0	0	0
1941–42	0	0	0	0	0	0	0
1942–43	0	0	0	0	0	0	0
1943–44	0	0	0	0	0	0	0
1944	0	0	0	0	0	0	0
1945	0	0	0	0	0	0	0
1946	0	0	0	0	0	0	0
1947	0	0	0	0	0	0	0
1948	0	0	0	0	0	0	0
1949	0	0	0	0	0	0	0
1950	0	1	0	0	0	0	0
1951	0	1	0	0	0	0	0
1952	0	8	0	0	0	1	1
1953	0	2	0	0	0	0	0
1954	0	7	0	0	0	1	1
1955	0	2	3	0	0	0	0
1956	0	12	4	0	0	2	2
1957	0	15	5	0	0	2	2
1958	0	25	11	0	0	4	3
1959	0	23	13	0	0	4	3
1960	0	18	17	0	0	4	2
1961	0	7	16	0	0	2	1
1962	0	6	22	0	5	2	1
1963	0	10	15	0	1	3	1
1964	0	9	22	0	0	3	1
1965	0	12	17	0	2	4	1
1966	0	12	31	0	27	4	2
1967	0	24	32	0	6	38	2
1968	0	28	32	0	7	24	3
1969	0	40	25	0	21	14	3
1970	0	42	80	0	124	78	2
1971	0	37	72	0	87	50	3
1972	0	30	71	0	70	41	2
1973	0	36	78	0	38	36	2
1974	0	31	73	7	128	29	3
1975	0	10	75	3	92	34	1
1976	0	26	99	10	348	54	2
1977	0	17	70	0	293	53	1
1978	0	29	72	8	268	61	2
1979	1	23	230	104	245	86	1
1980	3	28	331	57	467	132	1
1981	15	25	487	95	557	322	2
1982	4	22	565	89	500	270	3

Notes:

1. The 1931–1943 years are April–March but from 1944 onwards are calendar years.
2. Data up to 1985 are from fishing returns: data from 1986 to 1990 are from Quota Management Reports.
3. Data for the period 1931 to 1982 are based on reported landings by harbour and are likely to be underestimated as a result of under-reporting and discarding practices. Data include both foreign and domestic landings. Data were aggregated to FMA using methods and assumptions described by Francis & Paul (2013).

Table 3: Reported landings (t) of giant stargazer by QMS Fishstock (QMA) from 1983 to present. TACCs from 1986–87 to present are also provided. * MAF data. [Continued on next page]

Fishstock	STA 1		STA 2		STA 3		STA 4		STA 5	
FMA(s)	1 & 9		2		3		4		5 & 6	
	Landings	TACC	Landings	TACC	Landings	TACC	Landings	TACC	Landings	TACC
1983*	8	–	34	–	540	–	168	–	843	–
1984*	5	–	24	–	588	–	143	–	1023	–
1985*	9	–	15	–	438	–	82	–	695	–
1986*	12	–	24	–	415	–	95	–	566	–
1986–87	10	20	31	30	644	560	72	2 000	738	1 060
1987–88	3	20	46	33	783	581	110	2 005	886	1 144
1988–89	3	20	41	37	675	591	134	2 005	1 215	1 173
1989–90	9	21	53	37	747	703	218	2 009	1 150	1 175
1990–91	8	21	125	37	674	734	790	2 014	1 061	1 239
1991–92	18	50	105	100	756	900	366	2 014	1 056	1 500
1992–93	19	50	115	101	811	901	231	2 014	1 247	1 500
1993–94	8	50	73	101	871	902	113	2 014	1 327	1 500
1994–95	10	50	74	101	829	902	223	2 014	1 216	1 525
1995–96	17	50	69	101	876	902	259	2 014	1 159	1 525
1996–97	22	50	77	101	817	902	149	2 014	977	1 525
1997–98	29	21	54	38	667	902	263	2 014	544	1 264
1998–99	27	21	46	38	641	902	137	2 014	1 145	1 264
1999–00	36	21	42	38	719	902	161	2 014	1 327	1 264
2000–01	26	21	45	38	960	902	233	2 014	1 439	1 264
2001–02	34	21	58	38	816	902	391	2 158	1 137	1 264
2002–03	31	21	41	38	863	902	308	2 158	967	1 264
2003–04	23	21	27	38	578	902	186	2 158	1 193	1 264
2004–05	27	21	28	38	646	902	366	2 158	1 282	1 264
2005–06	34	21	30	38	824	902	359	2 158	1 347	1 264
2006–07	22	21	31	38	719	902	292	2 158	1 359	1 264
2007–08	36	21	26	38	572	902	436	2 158	1 171	1 264
2008–09	35	21	22	38	574	902	139	2 158	1 137	1 264
2009–10	17	21	26	38	576	902	198	2 158	1 339	1 264
2010–11	21	21	19	38	570	902	134	2 158	1 235	1 264
2011–12	21	28	17	38	397	902	213	2 158	1 288	1 264
2012–13	19	21	13	38	439	902	133	2 158	1 140	1 264
2013–14	20	21	14	38	499	902	133	2 158	1 274	1 264
2014–15	12	21	10	38	497	902	172	2 158	1 144	1 264
2015–16	10	21	11	38	490	902	115	2 158	1 264	1 264
2016–17	19	21	12	38	543	902	99	2 158	992	1 264
2017–18	25	21	18	38	669	902	108	2 158	1 151	1 264
2018–19	26	21	17	38	601	902	122	2 158	938	1 264
2019–20	27	21	14	38	559	902	108	2 158	939	1 264

Fishstock	STA 7		STA 8		STA 10			
FMA(s)	7		8		10		Total	
	Landings	TACC	Landings	TACC	Landings	TACC	Landings	TACC
1983*	323	–	3	–	0	–	1 919	–
1984*	444	–	3	–	0	–	2 230	–
1985*	328	–	4	–	0	–	1 571	–
1986*	362	–	3	–	0	–	1 477	–
1986–87	487	450	7	20	0	10	1 990	4 150
1987–88	505	493	5	20	0	10	2 338	4 306
1988–89	520	499	5	20	0	10	2 593	4 355
1989–90	585	525	1	22	0	10	2 763	4 502
1990–91	762	528	6	22	0	10	3 426	4 605
1991–92	920	700	18	22	0	10	3 239	5 296
1992–93	861	702	5	22	0	10	3 289	5 300
1993–94	715	702	4	50	0	10	3 111	5 329
1994–95	730	702	7	50	0	10	3 089	5 354
1995–96	877	702	4	50	0	10	3 261	5 354
1996–97	983	702	10	50	0	10	3 034	5 354
1997–98	564	702	10	22	0	10	2 132	4 973
1998–99	949	702	2	22	0	10	2 946	4 973
1999–00	1 184	702	3	22	0	10	3 472	4 973
2000–01	1 440	702	4	22	0	10	4 146	4 973
2001–02	802	702	4	22	0	10	3 238	5 117
2002–03	957	997	4	22	0	10	3 171	5 412
2003–04	934	997	6	22	0	10	2 947	5 412
2004–05	1 028	997	5	22	0	10	3 381	5 412
2005–06	1 010	997	3	22	0	10	3 606	5 412
2006–07	1 051	997	4	22	0	10	3 478	5 412
2007–08	1 014	997	3	22	0	10	3 258	5 412
2008–09	1 001	997	5	22	0	10	2 913	5 412
2009–10	1 093	997	6	22	0	10	3 247	5 456
2010–11	1 037	1 042	7	22	0	10	3 023	5 456
2011–12	1 056	1 042	7	22	0	10	3 006	5 456
2012–13	1 097	1 042	7	22	0	10	2 849	5 456
2013–14	1 062	1 042	6	22	0	10	3 007	5 456

Table 3 [Continued]

Fishstock	STA 7		STA 8		STA 10			
FMA(s)	7		8		10		Total	
	Landings	TACC	Landings	TACC	Landings	TACC	Landings	TACC
2014–15	1 093	1 042	5	22	0	10	2 933	5 456
2015–16	1 132	1 122	5	22	0	10	3 027	5 536
2016–17	1 114	1 122	3	22	0	10	2 782	5 536
2017–18	1 030	1 122	4	22	0	10	3 004	5 536
2018–19	1 131	1 122	5	22	0	10	2 840	5 536
2019–20	1 088	1 122	3	22	0	10	2 738	5 536

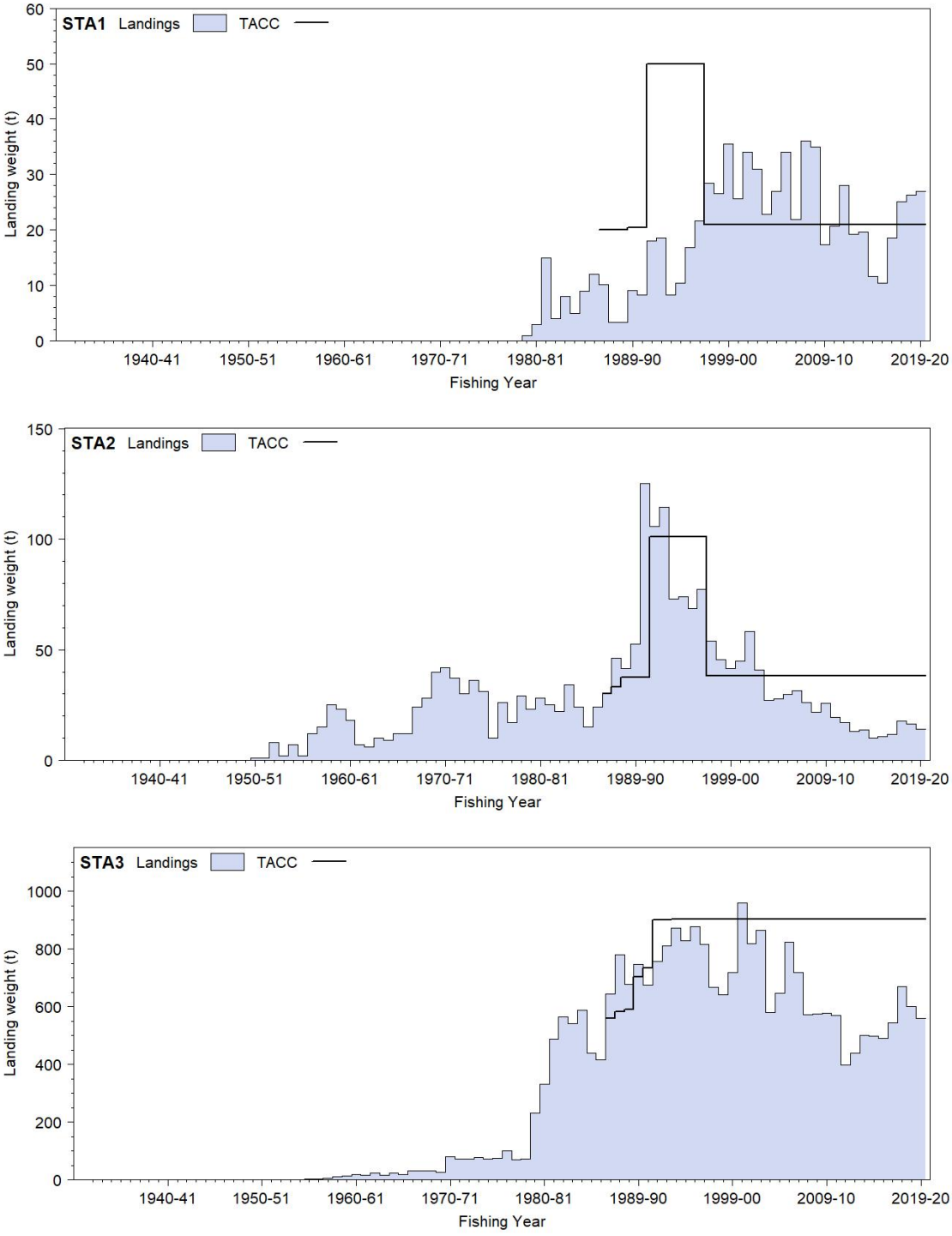


Figure 1: Reported commercial landings and TACC for the seven main STA stocks. From top to bottom: STA 1 (Auckland East), STA 2 (Central East), and STA 3 (South East Coast). [Continued on next page]

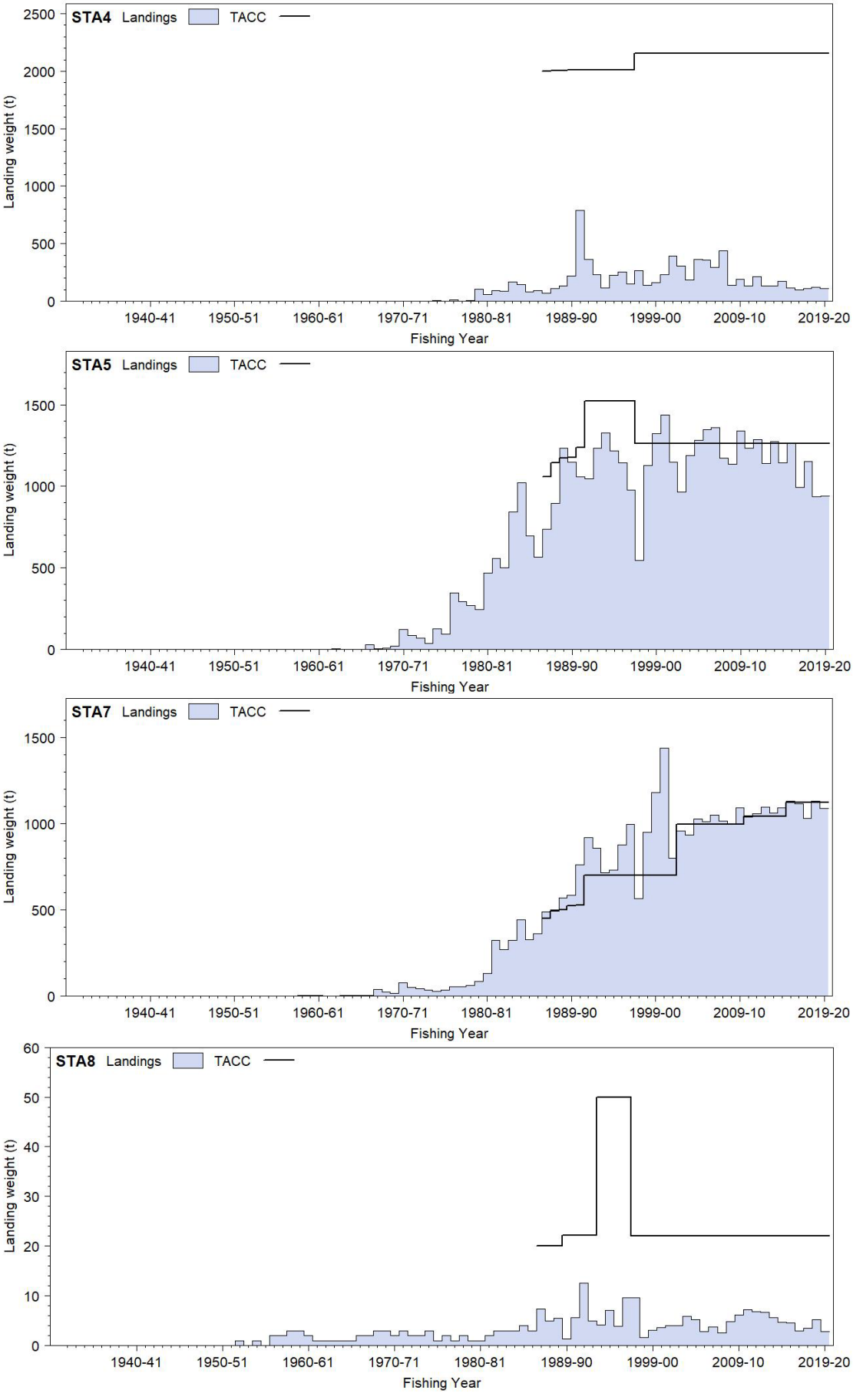


Figure 1 [Continued]: Reported commercial landings and TACC for the seven main STA stocks. From top to bottom: STA 4 (Chatham Rise), STA 5 (Southland), STA 7 (Challenger), and STA 8 (Central Egmont).

Most of the stargazer catch is landed in a processed state. The conversion factors for giant stargazer were revised during the early 1990s to determine a conversion factor that was consistent with the main processed state (DVC). Recent analyses of catch and effort data from the STA 5 and STA 7 fisheries have taken these changes in the conversion factors into account in determining the landed catch (in greenweight). For STA 5, the correction for the changes in the conversion factors resulted in an increase (9–34%) in the annual landed catch from 1989–90 to 1996–97 (Langley & Bentley 2014). Similarly, for STA 7 the correction resulted in an increase (17–37%) in the annual landed catches from 1989–90 to 1996–97 (Langley 2015). These changes in conversion factor have not been applied to the total reported landings from the stargazer Fishstocks in Tables 1 and 2 and Figure 1.

The landings data (Tables 1–3) probably include an unknown quantity of catch from other uranoscopid species misidentified as *K. giganteum*. Fishers in STA 1–3 and 8 have been known to report brown (*Gnathagnus innotabilis*) and spotted stargazer (*Genyagnus monopterygius*) as *K. giganteum* in the past. Landings in STA 4 and 5 probably include an unknown amount of an undescribed sister species, banded stargazer (*Kathetostoma* sp.). Although the true extent of misreporting due to misidentification is unknown, it is likely to be small.

1.2 Recreational fisheries

Stargazer were not reported as being caught by recreational fishers in surveys conducted in the MAF Fisheries South region in 1991–92, Central region in 1992–93 and North region in 1993–94. In a national survey in 1996, a few giant stargazer were reported in STA 1 and 3, with an estimated take of 1000 fish in STA 1 and less than 500 fish taken in STA 3 (Bradford 1998). No giant stargazer catch was recorded for the recreational fishers during the 1999–2000 national diary survey (Boyd & Reilly 2002). In the 2011–12 National Panel Survey (Wynne-Jones et al 2014), only four fishers reported catching stargazer and the estimated catches were 53 fish in STA 1 (CV = 100%) and 481 fish in STA 7 (CV = 71%). In the 2017–18 National Panel Survey (Wynne-Jones et al 2019), again only four fishers reported catching stargazer and the estimated catches were 156 fish in STA 1 (CV = 58%) and 399 fish in STA 7 (CV = 100%). Recreational catch thus appears to be negligible.

1.3 Customary non-commercial fisheries

No quantitative information is available on the level of customary non-commercial take.

1.4 Illegal catch

No quantitative information is available on the level of illegal catch.

1.5 Other sources of mortality

No quantitative information is available on the level of other sources of mortality.

2. BIOLOGY

Giant stargazer is found throughout the New Zealand EEZ. It is most plentiful around the South Island (STA 3, 5, & 7) and on the Mernoo Bank on the Chatham Rise (STA 4).

Using data collected from the West Coast South Island trawl survey series (Drummond & Stevenson, 1995a, 1995b, 1996; Stevenson 1998; Stevenson & Hanchet 2000; Stevenson 2002, 2004), Manning (2008) found that giant stargazer reach sexual maturity at a length of about 40–55 cm in total length (TL), depending on sex, at an age of between 5–7 years. Age and growth studies suggest that some individuals reach a maximum age of at least 25 years (Sutton 1999, Manning & Sutton 2004, Sutton 2004, Manning & Sutton 2007a, 2007b). Otolith growth zones have not been validated. A number of attempts at growth zone validation have been undertaken unsuccessfully. A tag and release programme was initiated with all released fish being injected with oxytetracycline as part of the East Coast South Island trawl survey. A single fish has been recaptured but the otoliths were not recovered. Andrews (2009) investigated the feasibility of using lead-radium dating of otoliths as a means of validating age. However, the levels of radium-226 in stargazer otoliths were too low (nearly 10 times lower than expected) to generate meaningful results. Using maximum-likelihood methods, Manning & Sutton (2004) found that giant stargazer growth differs significantly between the east, south, and west coasts

of the South Island. They suggested that these differences represented different biological stock units in these areas, although the true stock structure is unclear (Tate 1987). Manning (2005) investigated the effect of assuming alternative growth models with different functional forms on the data and conclusions presented by Manning & Sutton (2004). His results were consistent with the earlier results.

M was estimated using the equation $M = \ln 100 / t_{max}$, where t_{max} is the maximum age to which 1% of the population survives in an unexploited stock. Using an unvalidated maximum age of 26 years, yields $M = 0.18$. Preliminary results of the STA 7 quantitative stock assessment (Manning 2008) suggested 0.18 was an underestimate of the unknown true value. A revised estimate based on applying Hoenig's (1983) regression to the age composition data from the West Coast South Island survey series suggested that a value of 0.23 is more reasonable (Manning 2008). Although the West Coast South Island age composition data were collected from an exploited stock, 0.23 is considered to be closer to the true value than 0.18.

Stargazer have an annual reproductive cycle with a winter spawning season. Spawning probably occurs in mid and outer shelf waters all around New Zealand. The generalised spawning date assumed in the age and growth studies cited above is 1 July in any given calendar year.

Biological parameters relevant to the stock assessment are given in Table 4.

Table 4: Estimates of giant stargazer biological parameters

Fishstock	Estimate	Source
1. Natural mortality (*M*)		
STA 5	0.20	Sutton (2004)
STA 7	0.18	Manning & Sutton (2007a)

2. Weight = a(length)^b (Weight in g, length in cm fork length).

	Females		Males		All fish		
	a	b	a	b	a	b	
STA 3	-	-	-	-	0.015	3.01	McClatchie (uppub.data)
STA 5	-	-	-	-	0.024	2.92	McGregor (unpub. data)
STA 7	0.018	2.97	0.013	3.07	-	-	Manning & Sutton (2007a)

3. Length at maturity (cm total length)

	Females		Males		
	L_{50}	L_{95}	L_{50}	L_{95}	
STA 7	54.37	11.24	40.98	14.90	Manning (2008)

4. Age at maturity (years)

	Females		Males		
	A_{50}	A_{95}	A_{50}	A_{95}	
STA 7	7.23	4.34	5.53	4.38	Manning (2008)

5. von Bertalanffy length-at-age model parameter estimates

	Females			Males			
	L_∞	K (yr^{-1})	t_0 (yr)	L_∞	K (yr^{-1})	t_0 (yr)	
STA 3	78.11	0.14	-1.25	61.49	0.2	-0.97	Sutton (1999)
STA 5	73.92	0.18	-0.22	59.12	0.19	-1.19	Sutton (1999)
STA 5	72.61	0.17	-0.02	60.76	0.18	-1.16	Sutton (2004)
STA 7	85.74	0.13	-0.666	71.00	0.15	-0.664	Manning & Sutton (2007a); a revision of earlier results presented by Manning & Sutton (2004)

3. STOCKS AND AREAS

There are no new data that would alter the stock boundaries given in previous assessment documents. It is not known if there is more than one giant stargazer stock in New Zealand. The present QMAs were used as a basis for Fishstocks, except for QMAs 5 and 6, which were combined (STA 5). The basis for choosing these boundaries was a general review of the distribution and relative abundance of stargazer within the fishery.

As noted, length-at-age differs significantly between the east, south, and west coasts of the South Island (Manning & Sutton 2004, Manning 2005). This is consistent with the Fishstock boundaries.

4. STOCK ASSESSMENT

An integrated assessment for STA 7 was updated in 2008 with data that included the commercial catch, trawl survey biomass, and proportions-at-age estimates, and commercial catch proportions-at-age.

4.1 Trawl surveys

4.1.1 Relative biomass

Indices of relative biomass are available from recent *Tangaroa* and *Kaharoa* trawl surveys of the Chatham Rise, east coast South Island, and west coast South Island (Table 5, Figures 2–4).

Chatham Rise Trawl Survey

The Chatham Rise Trawl Survey was designed primarily for hoki and covers the depth range 200–400 m. It therefore excludes stargazer habitat around the Mernoo Bank in less than 200 m. The survey biomass estimates for STA have fluctuated without any trend since the series began in 1991 (Figure 2).

West Coast South Island (WCSI) Inshore Trawl Survey

Biomass estimates for the West Coast South Island Inshore Trawl Survey time series are presented in Figure 3. Estimates declined from 1995 to a low in 2003 but have been steadily increasing since. The 2019 estimate is second highest in the time series, down slightly from the time series high in 2015 (MacGibbon 2019). Most of the biomass has come from the west coast, with only minor contributions from Tasman Bay and Golden Bay. Most trawl stations capture stargazer, but strata in 100–200 m and south of Cape Foulwind contribute most of the total biomass. Throughout the time series most of the biomass has comprised adult fish with females contributing most of the adult biomass. For juveniles most of the biomass consists of male fish.

Most fish are between 40 and 70 cm, and virtually all are between 10 and 70 cm. There are often what appear to be small modes at 20–25 cm and 25–30 cm, but these are not thought to contain discrete year classes, rather they include fish aged 1–2 and 1–3 years respectively (Manning & Sutton 2007a). Few fish over 40 cm are caught in Tasman Bay and Golden Bay.

East Coast South Island (ECSI) Trawl Survey (STA 3)

The ECSI winter surveys from 1991 to 1996 in 30–400 m were replaced by summer trawl surveys (1996–97 to 2000–01) which also included the 10–30 m depth range, but these were discontinued after the fifth in the annual time series because of the extreme fluctuations in catchability between surveys (Francis et al 2001). The winter surveys were reinstated in 2007 and this time included additional 10–30 m strata in an attempt to index elephant fish and red gurnard which were officially included in the list of target species in 2012. Only the 2007, 2012, 2014, 2016, and 2018 surveys provide full coverage of the 10–30 m depth range.

Overall there is no consistent trend in giant stargazer core strata biomass in ECSI survey series (Table 4, Figure 4) (MacGibbon et al 2019). Pre-recruited biomass (< 30 cm) has been a small but consistent component of the total biomass estimate on all surveys (range 2–7% of total biomass) and in 2018 it was 7%. The juvenile to adult biomass ratio (based on length-at-50% maturity) was relatively constant over the time series at about 1 to 1, and in 2018 biomass was 55% juvenile.

The distribution of giant stargazer hotspots varies between years, but overall this species is consistently well represented over the entire survey area (71–92% of core strata tows), most commonly from 30 m to about 200 m with highest catch rates in 2018 in 30–100 m. There were no giant stargazer caught in 10–30 m on any of the five surveys and hence the addition of the shallow strata (10–30 m) is of no value for monitoring giant stargazer.

The size distributions of giant stargazer in each of the twelve core strata surveys were similar and generally had one large mode comprising multiple age classes and in some years a small juvenile mode. The 2016 survey appeared to have a relatively abundant mode from 15–25 cm which tracked through to 2018 and is now around 25–38 cm. Giant stargazer sampled on these ECSI surveys are generally smaller than those from the Chatham Rise, Southland, and WCSI inshore surveys (Bagley & Hurst 1996a, Stevenson &

Hanchet 2000, Livingston et al 2002, Stevenson & MacGibbon 2018, Stevens et al 2015), suggesting that this area may be an important nursery ground for juvenile giant stargazer.

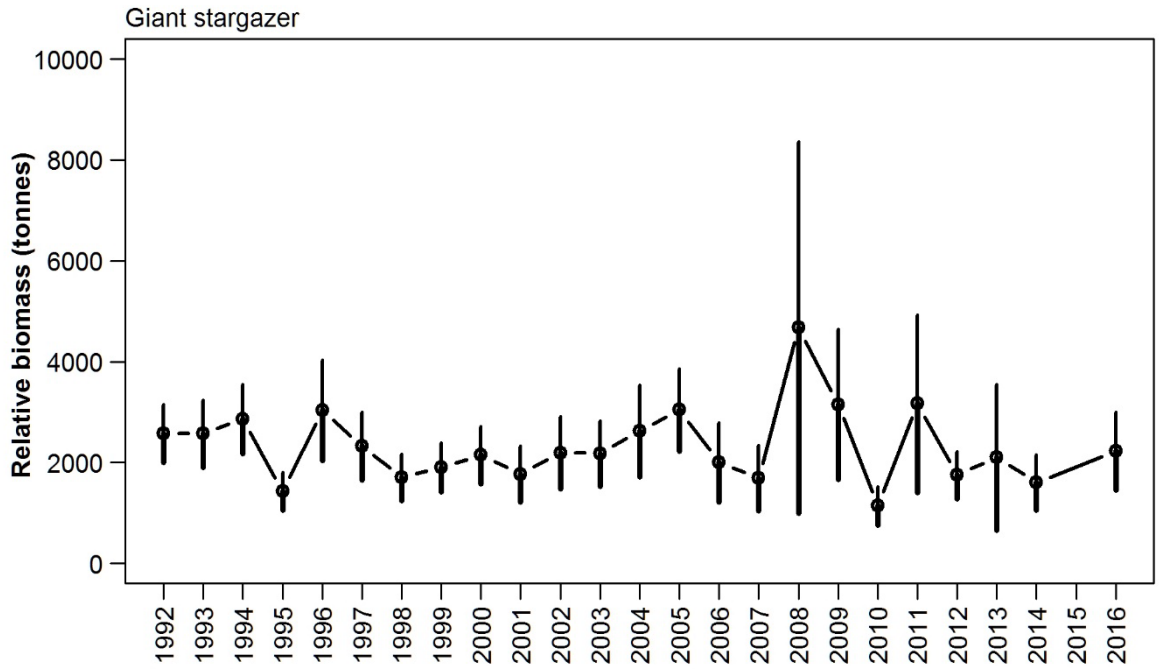


Figure 2: Giant stargazer biomass estimated from the Chatham Rise trawl survey. Error bars are ± two standard deviations.

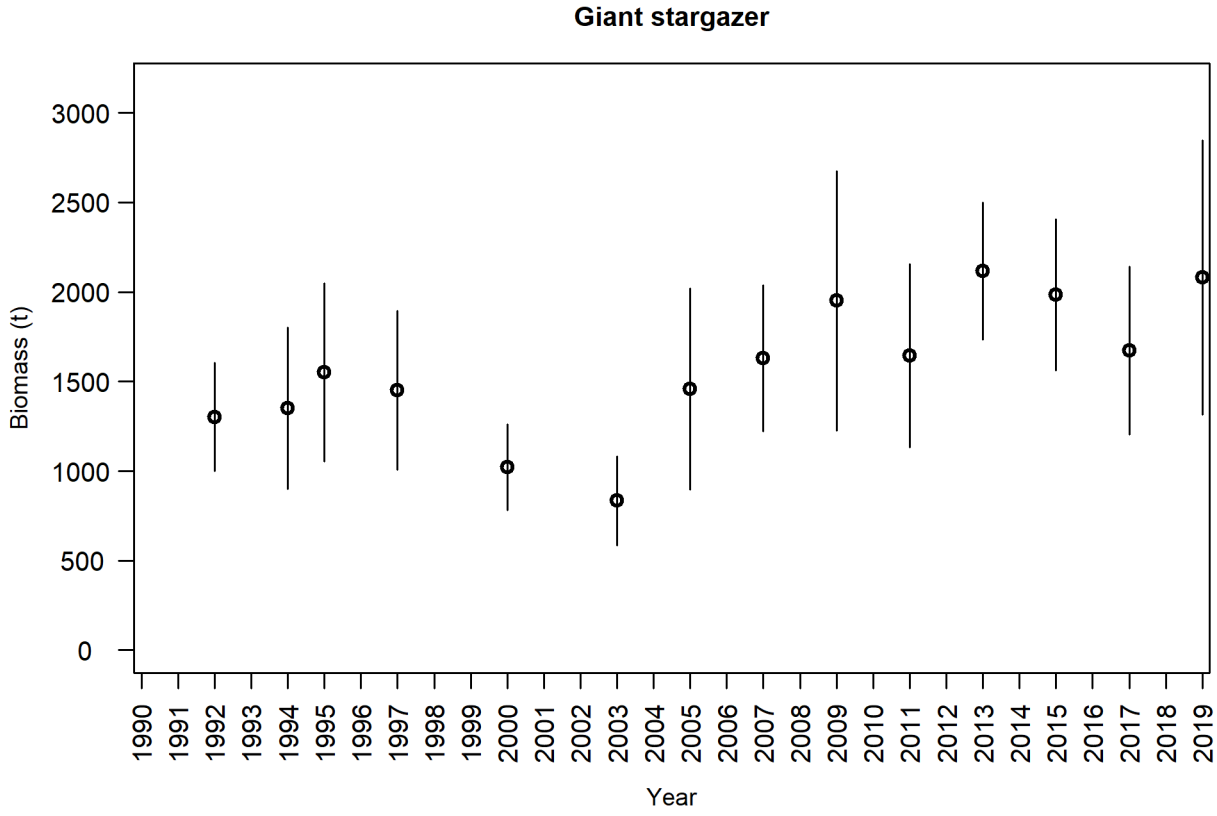


Figure 3: Giant stargazer biomass estimates for the West Coast South Island Inshore Trawl Survey time series. Error bars are ± two standard deviations.

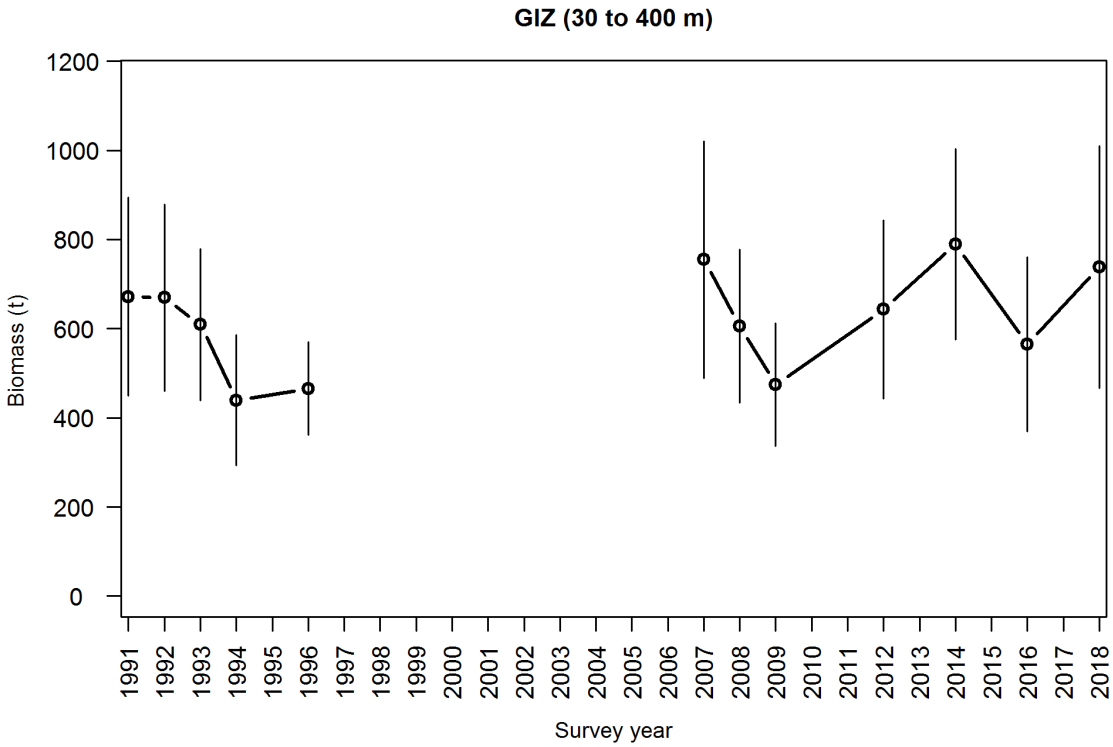


Figure 4: Giant stargazer (GIZ) total biomass for the all ECSI winter surveys in core strata (30–400 m). Error bars are ± two standard deviations.

Table 5: Relative biomass indices (t) and coefficients of variation (CV) for giant stargazer for the East Coast North Island (ECNI), East Coast South Island (ECSI) — summer and winter, Chatham Rise, West Coast South Island (WCSI), and the Stewart Island-Snares Island survey areas*. Biomass estimates for ECSI in 1991 have been adjusted to allow for non-sampled strata (7 & 9 equivalent to current strata 13, 16, & 17). The sum of pre-recruit and recruited biomass values do not always match the total biomass for the earlier surveys because at several stations length frequencies were not measured, affecting the biomass calculations for length intervals. –, not measured; NA, not applicable. Recruited is defined as the size-at-recruitment to the fishery (30 cm).

Region	Fishstock	Year	Trip number	Total Biomass estimate	CV (%)	Total Biomass estimate	CV (%)	Pre-recruit	CV (%)	Pre-recruit	CV (%)	Recruited	CV (%)	Recruited	CV (%)
ECNI (inshore)	STA 2	1993	KAH9304	184	22	–	–	–	–	–	–	–	–	–	–
		1994	KAH9402	58	47	–	–	–	–	–	–	–	–	–	–
		1995	KAH9502	44	35	–	–	–	–	–	–	–	–	–	–
		1996	KAH9602	57	17	–	–	–	–	–	–	–	–	–	–
ECNI(scampi)	STA 2	1993	KAH9301	250	16	–	–	–	–	–	–	–	–	–	–
		1994	KAH9401	215	20	–	–	–	–	–	–	–	–	–	–
		1995	KAH9501	122	17	–	–	–	–	–	–	–	–	–	–
				30–400m		10–400m		30–400m		10–400m		30–400m		10–400m	
ECSI (winter)	STA 3	1991	KAH9105	672	17	–	–	26	22	–	–	646	17	–	–
		1992	KAH9205	669	16	–	–	35	14	–	–	634	16	–	–
		1993	KAH9306	609	14	–	–	19	16	–	–	591	14	–	–
		1994	KAH9406	439	17	–	–	10	25	–	–	429	17	–	–
		1996	KAH9606	466	11	–	–	13	34	–	–	452	11	–	–
		2007	KAH0705	755	18	–	–	33	24	–	–	722	18	–	–
		2008	KAH0806	606	14	–	–	13	28	–	–	592	14	–	–
		2009	KAH0905	475	14	–	–	10	34	–	–	464	15	–	–
		2012	KAH1207	643	16	–	–	26	22	–	–	617	16	–	–
		2014	KAH1402	790	14	–	–	39	17	–	–	751	14	–	–
		2016	KAH1605	565	17	–	–	22	24	–	–	543	18	–	–
		2018	KAH1803	738	18	–	–	53	33	–	–	685	18	–	–
ECSI (summer)	STA 3	1996	KAH9618	897	12	–	–	–	–	–	–	–	–	–	–
		1997	KAH9704	543	11	–	–	–	–	–	–	–	–	–	–
		1998	KAH9809	999	10	–	–	–	–	–	–	–	–	–	–
		1999	KAH9917	472	14	–	–	–	–	–	–	–	–	–	–
		2000	KAH0014	214	16	–	–	–	–	–	–	–	–	–	–
Chatham Rise	STA 4	1992	TAN9106	2 570	11	–	–	–	–	–	–	–	–	–	–
		1993	TAN9212	2 560	13	–	–	–	–	–	–	–	–	–	–
		1994	TAN9401	2 853	12	–	–	–	–	–	–	–	–	–	–
		1995	TAN9501	1 429	13	–	–	–	–	–	–	–	–	–	–
		1996	TAN9601	3 039	16	–	–	–	–	–	–	–	–	–	–
		1997	TAN9701	2 328	15	–	–	–	–	–	–	–	–	–	–
		1998	TAN9801	1 702	14	–	–	–	–	–	–	–	–	–	–
		1999	TAN9901	1 903	13	–	–	–	–	–	–	–	–	–	–
		2000	TAN0001	2 148	13	–	–	–	–	–	–	–	–	–	–
		2001	TAN0101	1 772	16	–	–	–	–	–	–	–	–	–	–

*Assuming areal availability, vertical availability and vulnerability equal 1.0. Biomass is only estimated outside 10 m depth. Note: because trawl survey biomass estimates are indices, comparisons between different seasons (e.g., summer and winter ECSI) are not strictly valid.

Table 5 [continued]: Relative biomass indices (t) and coefficients of variation (CV) for giant stargazer for the East Coast North Island (ECNI), East Coast South Island (ECSI) - summer and winter, Chatham Rise, West Coast South Island (WCSI), and the Stewart Island-Snares Island survey areas*. Biomass estimates for ECSI in 1991 have been adjusted to allow for non-sampled strata (7 & 9 equivalent to current strata 13, 16, & 17). The sum of pre-recruit and recruited biomass values do not always match the total biomass for the earlier surveys because at several stations length frequencies were not measured, affecting the biomass calculations for length intervals. –, not measured; NA, not applicable. Recruited is defined as the size-at-recruitment to the fishery (30 cm). Note: WCSI total biomass estimates are updated (P. Starr pers. comm.) to match the values given for GIZ in table 4, MacGibbon (2019).

Region	Fishstock	Year	Trip number	Total Biomass estimate	CV (%)	Total Biomass estimate	CV (%)	Pre-recruit	CV (%)	Recruited	CV (%)
Chatham Rise	STA 4	2002	TAN0201	2 195	16	–	–	–	–	–	–
		2003	TAN0301	1 380	15	–	–	–	–	–	–
		2005	TAN0501	3 045	13	–	–	–	–	–	–
		2006	TAN0601	2 007	19	–	–	–	–	–	–
		2007	TAN0701	1 684	12	–	–	–	–	–	–
		2008	TAN0801	4 677	40	–	–	–	–	–	–
		2009	TAN0901	3 154	24	–	–	–	–	–	–
		2010	TAN1001	1 140	17	–	–	–	–	–	–
		2011	TAN1101	3 169	28	–	–	–	–	–	–
		2012	TAN1201	1 751	13	–	–	–	–	–	–
		2013	TAN1301	2 108	34	–	–	–	–	–	–
		2014	TAN1401	1 601	17						
		2016	TAN1601	2 228	17						
WCSI	STA 7	1992	KAH9204	1 450	14			–	–	–	–
		1994	KAH9404	1 358	17			–	–	–	–
		1995	KAH9504	1 556	16			–	–	–	–
		1997	KAH9701	1 450	15			–	–	–	–
		2000	KAH0004	1 023	12			–	–	–	–
		2003	KAH0304	834	15			–	–	–	–
		2005	KAH0503	1 458	19			–	–	–	–
		2007	KAH0704	1 630	13			–	–	–	–
		2009	KAH0904	1 952	19			–	–	–	–
		2011	KAH1104	1 620	16			–	–	–	–
		2013	KAH1305	2 118	9			–	–	–	–
		2015	KAH1503	1 984	11			–	–	–	–
		2017	KAH1703	1 674	14			–	–	–	–
		2019	KAH1902	2 081	18						
Stewart & Snares	STA 5	1993	TAN9301	2 650	20	–	–	–	–	–	–
		1994	TAN9402	3 755	11	–	–	–	–	–	–
		1995	TAN9502	2 452	11	–	–	–	–	–	–
		1996	TAN9604	1 733	11						
Stewart & Snares	Banded Stargazer BGZ 5	1993	TAN9301	409	27	–	–	–	–	–	–
		1994	TAN9402	250	21	–	–	–	–	–	–
		1995	TAN9502	316	29	–	–	–	–	–	–
		1996	TAN9604	232	34	–	–	–	–	–	–

4.2 CPUE analysis

STA 2 and 3

CPUE indices have been calculated for STA 2 (Vignaux 1997) and STA 3 (SEFMC 2002, SeaFIC 2005a, Starr et al 2008). The currently accepted CPUE series for STA 3 (Figure 5) is based on a mixed target species fishery including red cod, barracouta, tarakihi, and stargazer and shows no trend from about 2000–01 to the most recent year in 2006–07 (Starr et al 2008).

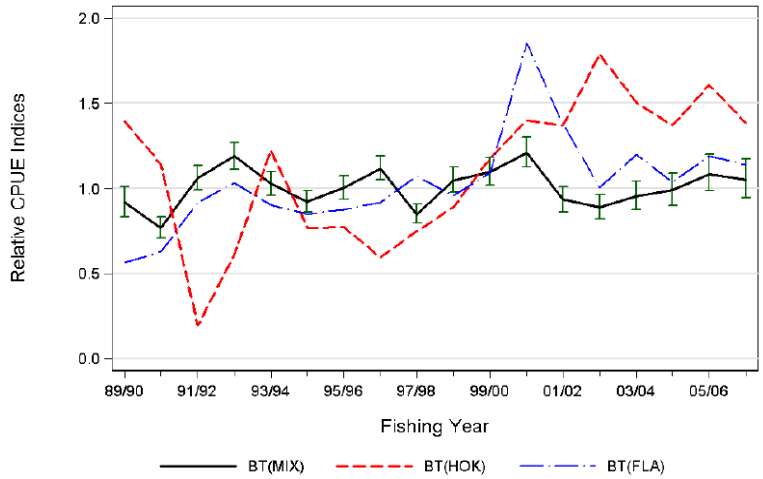


Figure 5: Comparison of the lognormal indices from the three bottom trawl CPUE series for STA 3; a) BT(MIX): mixed species target trawl fishery; b) BT(HOK): hoki target trawl fishery; c) BT(FLA): target flatfish trawl fishery. Each series is scaled to the geometric mean = 1 (Starr et al 2008).

STA 5

About 80% of the STA 5 catch is caught by small (< 43 m) inshore bottom trawl vessels targeting giant stargazer. The remainder of the catch is caught mostly by large (≥ 43 m) deepwater bottom trawl vessels targeting other species such as barracouta, jack mackerels, and squids. Catches by methods other than bottom trawling are very small.

Standardised CPUE indices currently represent the only available information for monitoring STA 5 abundance. There have been previous analyses of the CPUE data from this fishery by Vignaux (1997), Phillips (2001) and Manning (2007). In 2014, a new CPUE analysis was conducted that included catch and effort data from the inshore target stargazer trawl fleet operating in Statistical Areas 030, 029, and 025 during 1989–90 to 2012–13.

Data processing was similar to the approach of Manning (2007), whereby the declared landed catches were corrected for changes in the conversion factor of giant stargazer during the early 1990s. Landed catches from individual fishing trips were apportioned to the associated fishing effort records in proportion to the reported estimated catch of giant stargazer. An attempt to replicate the analysis of Manning (2007) yielded comparable CPUE indices for the 1989–90 to 2003–04 period.

Changes in statutory reporting in 2007–08 (from CELR to TCER forms) required that the more recent, location based TCER trawl effort data be aggregated into a format consistent with the CELR data format to configure a comparable times series. The aggregation procedure is described in detail by Langley & Bentley (2014). The final CPUE data set was limited to a core set of 14 vessels that accounted for 80% of the total target stargazer catch. One of the main vessels changed fishing gear from single trawl to a twin rig trawl in the mid-2000s and, on that basis, was assigned to a different vessel category depending on the fishing gear deployed.

The final CPUE data set included a trivial number of zero stargazer catches and those records were ignored in the final analysis. A generalised linear model, based on positive catch and effort targeted at stargazer, was formulated using an AIC based step-wise fitting procedure and investigated a number of alternative distributional assumptions. The final model included the natural logarithm of catch as the dependent variable; fishing year, vessel, and month as categorical predictor variables; and the effort variables: natural log of the number of trawls and fishing duration, included as third order polynomial

functions. The Weibull error distribution was accepted as the most suitable of those which were investigated (Langley & Bentley 2014).

In 2017, the CPUE model was updated to include three additional years: 2013–14 to 2015–16 (Langley 2017). The updated CPUE indices were virtually identical to the previous CPUE indices for the corresponding period, i.e., 1989–90 to 2012–13. The CPUE indices from the model have fluctuated without trend with peaks in 1991–92 to 1993–94 and 2006–07 to 2009–08 (Figure 6). The 2013–14 to 2015–16 indices are slightly below the average for the series. CPUE indices were also derived from the short time series of high resolution TCER data from 2007–08 to 2015–16. These indices had a similar trend to the corresponding annual indices from the primary CPUE model (Figure 6).

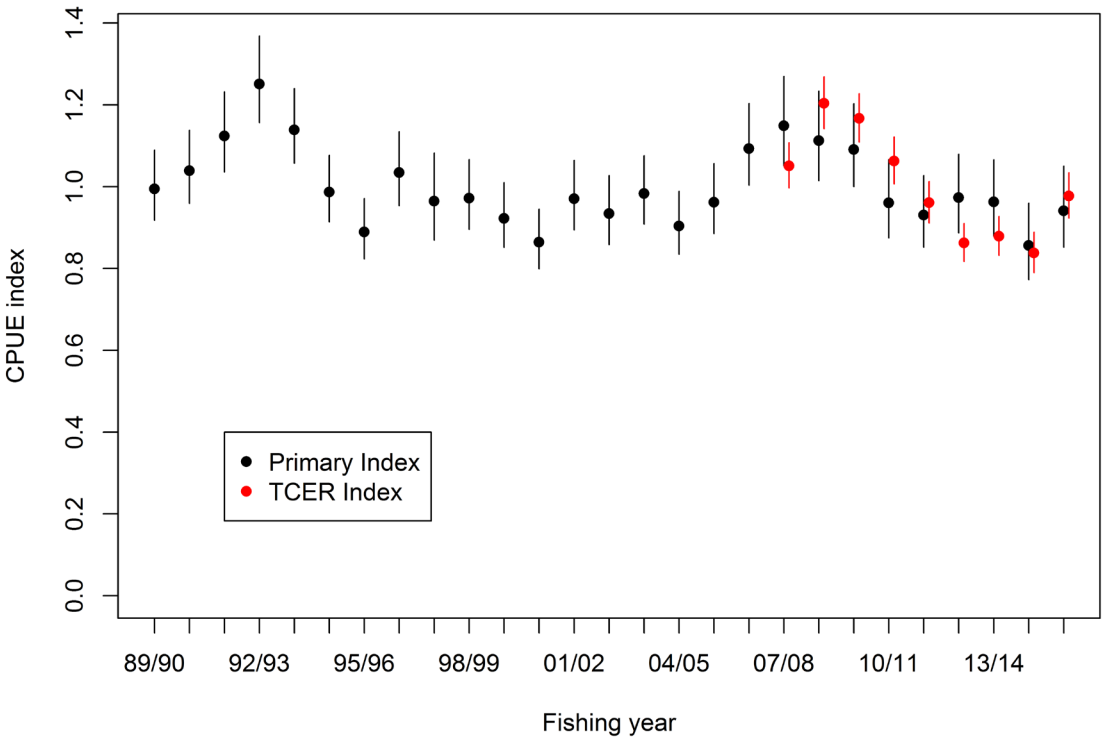


Figure 6: A comparison of STA 5 CPUE indices from the base model and indices derived from the high resolution, location based TCER data and the associated 95% confidence intervals.

Establishing B_{MSY} compatible reference points

In 2014, the Southern Inshore Working Group (SINSWG) accepted mean standardised CPUE for the period 1989–90 to 2012–13 as a B_{MSY}-compatible proxy for STA 5. The working group accepted the default Harvest Strategy Standard definitions that the Soft and Hard Limits would be one half and one quarter the target, respectively.

STA 7

A CPUE series calculated for STA 7 (SeaFIC 2002, 2003b, 2005b, Starr et al 2007b), based on a mixed west coast South Island target species fishery (stargazer, barracouta, red cod, and tarakihi), was not accepted by the AMP WG as an indicator of STA 7 abundance. The Southern Inshore and AMP Fishery Assessment Working Groups had concerns over using bycatch fisheries to monitor stargazer abundance in these areas due to possible changes in recording and fishing practices. A characterisation of the STA 7 fishery, including detailed trawl location data, identified a number of areas of higher stargazer abundance along the WCSI and it was speculated that the previous trends in STA 7 CPUE could have been influenced by the extent of fishing in these localised areas (Langley 2015). The SINSWG reaffirmed the previous conclusions regarding the utility of the aggregated (CELR based) CPUE time series.

An additional time series of CPUE indices was derived from the detailed trawl location data set. The data set included trawl records from bottom trawl fishing effort targeting barracouta, tarakihi, blue warehou, stargazer, or red cod in the WCSI inshore trawl fishery (Langley 2015) from 2007–08 to 2012–13. The standardised CPUE analysis included both positive catch and presence/absence models that incorporated fishing location and fishing depth variables. The resulting Combined indices were relatively stable, increasing slightly (5–8%) over the 6 year period (Table 6). The trawl survey biomass indices were also relatively stable over that period. The SINSWG concluded that the trawl location based CPUE indices have potential to monitor the relative abundance of STA 7; however, the utility of the CPUE indices can only be evaluated once a longer time series of CPUE indices are available for comparison with the relative abundance indices from the WCSI trawl survey.

Table 6: Annual combined STA 7 trawl location based CPUE indices, including the lower and upper bounds of the confidence intervals.

Fishing year	Index	LCI	UCI
2007–08	0.969	0.909	1.025
2008–09	0.956	0.905	1.010
2009–10	1.029	0.975	1.087
2010–11	0.982	0.926	1.037
2011–12	1.052	0.995	1.110
2012–13	1.013	0.954	1.069

4.3 Stock Assessment Models

STA 7

An age-structured model partitioned by age (0–25 years) and sex was fitted to the WCSI trawl survey relative abundance indices (1992–2005), WCSI survey proportions-at-age data (1992–2005), and WCSI fishery catch-at-age data (Manning 2008). This assessment has not been updated and the WCSI trawl survey is currently used to monitor the status of STA 7.

Establishing B_{MSY} compatible reference points

In 2018, the working group accepted the average WCSI trawl survey biomass estimates for the period 2005 to 2017 as the B_{MSY}-compatible proxy for STA 7, with the rationale that catches had been stable over that period while abundance remained high. The 2003 index was excluded because of extreme catchability values among a range of species (Stevenson & MacGibbon 2018). The working group accepted the default Harvest Strategy Standard definitions that the Soft and Hard Limits would be one half and one quarter the target, respectively.

4.4 Other factors

The use of a single conversion factor for deepwater and inshore vessels has resulted in about a 5–10% under-estimate pre 1990–91 of the reported greenweight landings. In 1990–91, separate deepwater and inshore conversion factors were introduced.

Stargazer landings have been influenced by changes in fishing patterns and fishing methods in the target species fisheries and indirectly by the abundance of those target species. Landings have also been influenced by changes in reporting behaviour for the different species. Stargazer were also taken historically in substantial quantities by foreign-licensed and chartered trawlers fishing offshore grounds for other species (see Table 1). Because stargazer was mainly a bycatch in these early fisheries, there may be under-reporting in these data. Therefore, any estimate of *MCY* based on catch data is likely to be conservative.

5. STATUS OF THE STOCKS

No estimates of current and reference biomass are available.

- **STA 1**

The TACC for STA 1 was increased from 21 t to 50 t in the 1991–92 fishing year under the AMP. In 1997, the TACC was reduced to 21 t upon its removal from the programme. Recent catches have exceeded this level. It is not known if recent catch levels and current TACC are sustainable. The status of STA 1 relative to B_{MSY} is unknown.

- **STA 2**

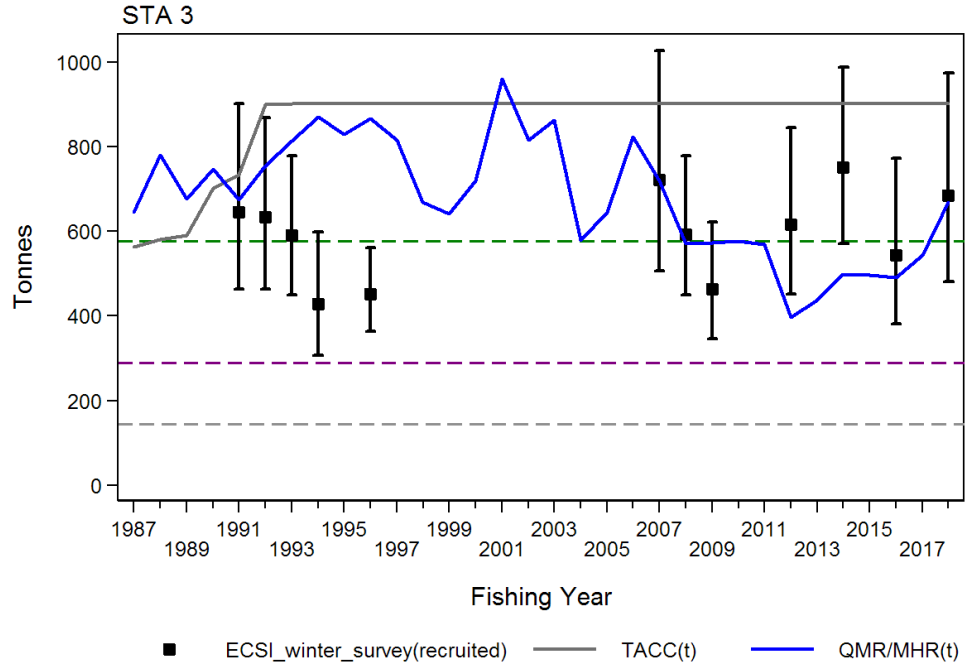
The TACC for STA 2 was increased from 37 t to 100 t in the 1991–92 fishing year under the AMP. Landings in the early 1990s peaked in the range of 105–125 t, but have subsequently declined.

The TACC was reduced to 38 t in the 1997–98 fishing year, upon the removal of STA 2 from the AMP. Landings have been below the TACC since 2003–04. It is not known whether recent catches and the current TACC will cause the STA 2 stock size to decline. The status of STA 2 relative to B_{MSY} is unknown.

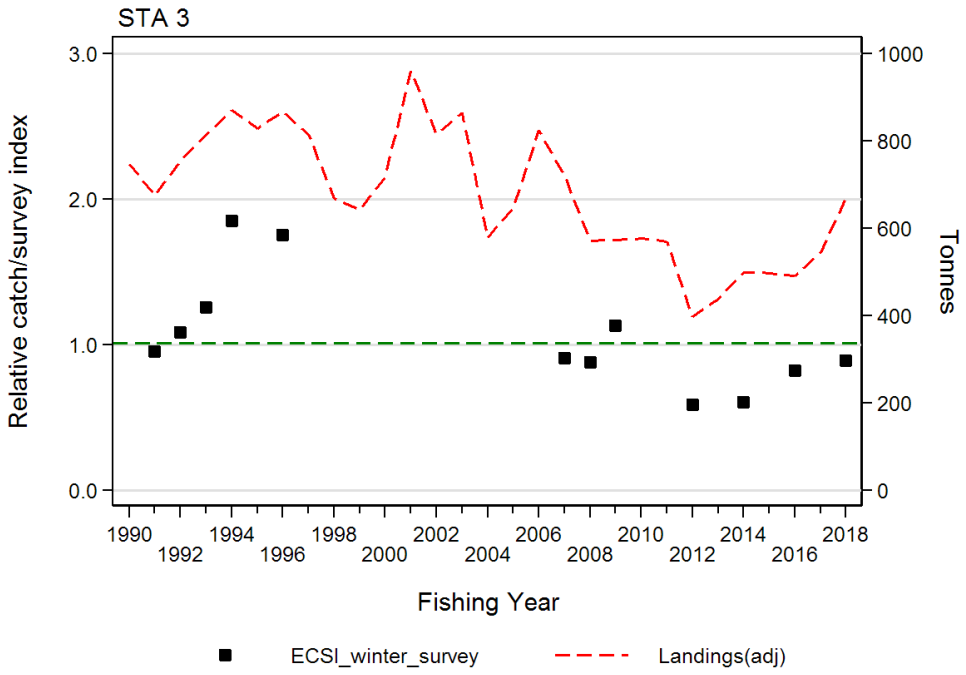
- **STA 3**

Stock Status	
Year of Most Recent Assessment	2019
Assessment Runs Presented	The series of biomass indices from the East Coast South Island trawl survey
Reference Points	Target: B_{MSY}-compatible proxy based on mean biomass from the East Coast South Island trawl survey for the period 1991 to 2016 Soft Limit: 50% of target Hard Limit: 25% of target Overfishing Threshold: Mean relative exploitation rate for the period 1991 to 2016
Status in relation to Target	About as Likely as Not (40–60%) to be at or above the target
Status in relation to Limits	Very Unlikely (< 10%) to be below both soft and hard limits
Status in relation to Overfishing	Unlikely (< 40%) to be overfishing

Historical Stock Status Trajectory and Current Status



Comparison of the GIZ ECSI recruited trawl survey indices with the QMR/MHR landings and TACC for STA 3. The agreed B_{MSY} proxy (geometric average: 1991–2016 ECSI winter survey biomass estimates=577 t) is shown as a green line; the calculated Soft Limit (=50% B_{MSY} proxy) is shown as a purple line; the calculated Hard Limit (=25% B_{MSY} proxy) is shown as a grey line.



Relative fishing pressure for STA 3 based on the ratio of QMR/MHR landings relative to the ECSI recruited winter trawl survey which has been normalised so that its geometric mean=1.0. Horizontal green line is the geometric mean fishing pressure from 1991 to 2016.

Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	Biomass appears to be fluctuating around the long-term mean, with the 2018 ECSI survey estimate above the long-term mean.
Recent Trend in Fishing Intensity or Proxy	Relative exploitation rate has increased steadily since 2012, but remained below the overfishing threshold in 2018.
Other Abundance Indices	A standardised CPUE series from 1989–90 to 2006–07 shows no trend, suggesting that there was little change during the period when no surveys were conducted.
Trends in Other Relevant Indicators or Variables	-

Projections and Prognosis	
Stock Projections or Prognosis	STA 3 remains primarily a bycatch in the mixed-species inshore trawl fishery. STA 3 stock size is Likely (> 60%) to remain near current levels at current catch levels (2007–08 to 2015–16). It is Unknown if catches near the TACC would cause the stock to decline.
Probability of Current Catch or TACC causing Biomass to remain below or to decline below Limits	Current catch: Soft Limit: Unlikely (< 40%) Hard Limit: Unlikely (< 40%) TACC: Unknown
Probability of Current Catch or TACC causing overfishing to continue or to commence	Current Catch: Unlikely (< 40%)TACC: Unknown

Assessment Methodology and Evaluation	
Assessment Type	Level 2 - Partial Quantitative Stock Assessment
Assessment Method	Trawl survey biomass and standardised CPUE based on lognormal error distribution and positive catches

Assessment Dates	Latest assessment: 2019	Next assessment: 2021
Overall assessment quality (rank)	1 – High Quality	
Main data inputs (rank)	- ECSI trawl survey series	1 – High Quality
Data not used (rank)	N/A	
Changes to Model Structure and Assumptions	-	
Major Sources of Uncertainty	-	

Qualifying Comments
-

Fishery Interactions
STA 3 are caught in fisheries for flatfish, barracouta, hoki, red cod, and tarakihi. Target STA only accounted for about 4% of total landings from 1989–90 to 2007–08. Interactions with other species are currently being characterised.

- **STA 4**

Stargazer in this Fishstock occur mainly on the Chatham Rise on the shelf around the Chatham Islands, but are sparsely distributed over the rest of the Chatham Rise. In most of this Fishstock they may not be economic to target. However, if fishing is overly concentrated in those areas where stargazer can be targeted, such as close to the Chatham Islands, there are concerns that local depletion may occur.

The 2011 estimate of biomass from the Chatham Rise trawl survey was above the long-term mean (1991–2011). The original TACC of 2014 t for STA 4 was based on a yield estimate from a single trawl survey in 1983. This method is now considered obsolete. The TACC was increased in 2000–01 to 2158 t. Catches have always been substantially less than the TACC. The average catch since the TACC increase has been 300 t. It is not known if catches at the level of the current TACC would be sustainable.

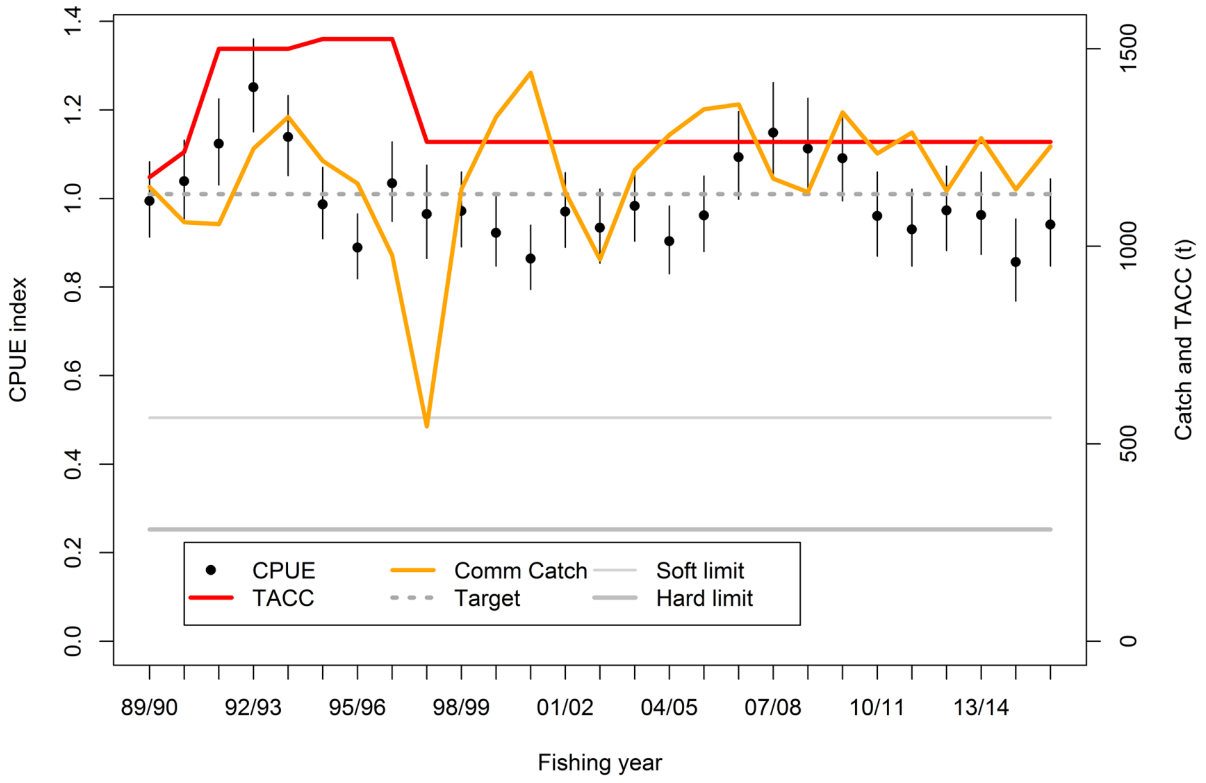
- **STA 5**

Stock Structure Assumptions

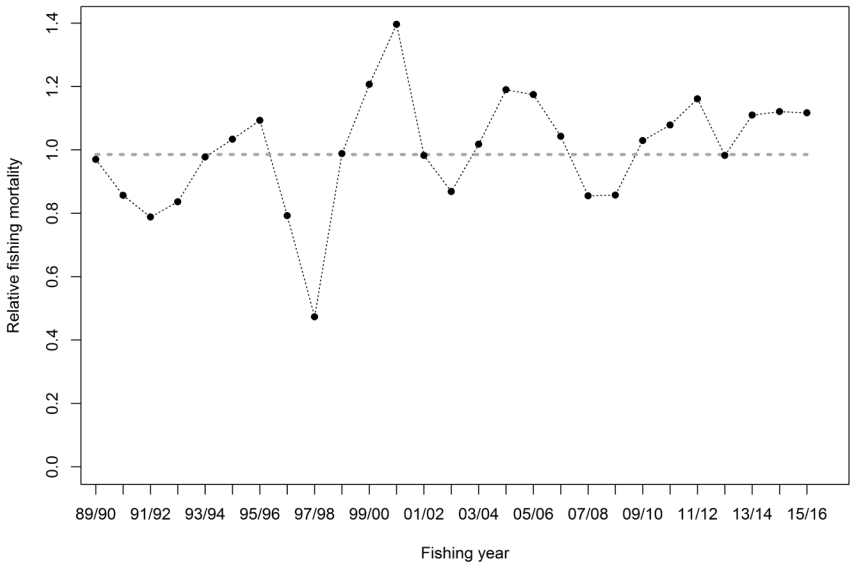
For the purpose of this summary STA 5 is considered to be a single stock.

Stock Status	
Year of Most Recent Assessment	2017
Assessment Runs Presented	Standardised CPUE based on bottom trawl positive catches and effort targeting STA 5
Reference Points	Target: B_{MSY}-compatible proxy based on mean CPUE for the period 1989–90 to 2012–13 Soft Limit: 50% of target Hard Limit: 25% of target Overfishing threshold: Mean relative exploitation rate for the period 1989–90 to 2012–13
Status in relation to Target	About As Likely As Not (40–60%) to be at or above the target
Status in relation to Limits	Soft Limit: Unlikely (< 40%) to be below Hard Limit: Very Unlikely (< 10%) to be below
Status in relation to Overfishing	Overfishing is About as Likely as Not (40–60%) to be Occurring

Historical Stock Status Trajectory and Current Status



A comparison of the CPUE indices and the annual catch and TACC. The horizontal grey line represents the average of the CPUE indices from 1989–90 to 2012–13 (target reference point).

Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	CPUE has fluctuated without trend (1989–90 to 2012–13) with peaks in 1991–92 to 1993–94 and 2006–07 to 2009–08. The 2015–16 value is at 94% of the target reference level.
Recent Trend in Fishing Intensity or Proxy	 Fishing mortality proxy is Standardised Fishing Effort = Total catch/CPUE (normalised). The dashed line represents the average of the series from 1989–90 to 2012–13 (corresponding to the target reference point). Fishing mortality has fluctuated about the long term average and recent levels of fishing mortality were slightly higher than the target level.

Other Abundance Indices	-
Trends in Other Relevant Indicators or Variables	-

Projections and Prognosis	
Stock Projections or Prognosis	Catches have been maintained near the current level for the last 28 years and there has been no indication of a decline in CPUE over that period, indicating that the current level of catch is probably sustainable, at least in the 3–5 year period.
Probability of Current Catch or TACC causing Biomass to remain below or to decline below Limits	Soft Limit: Unlikely (< 40%) for both catch and TACC Hard Limit: Very Unlikely (< 10%) for both catch and TACC
Probability of Current Catch or TACC causing Overfishing to continue or to commence	Current Catch: About as Likely as Not (40–60%) TACC: About as Likely as Not (40–60%)

Assessment Methodology and Evaluation		
Assessment Type	Level 2 - Partial Quantitative Stock Assessment	
Assessment Method	Standardised CPUE indices	
Assessment Dates	Latest assessment: 2017	Next assessment: Unknown
Overall assessment quality rank	1 – High Quality	
Main data inputs (rank)	- Catch and effort data	1 – High Quality
Data not used (rank)	N/A	
Changes to Model Structure and Assumptions	No change from previous (2014) assessment	

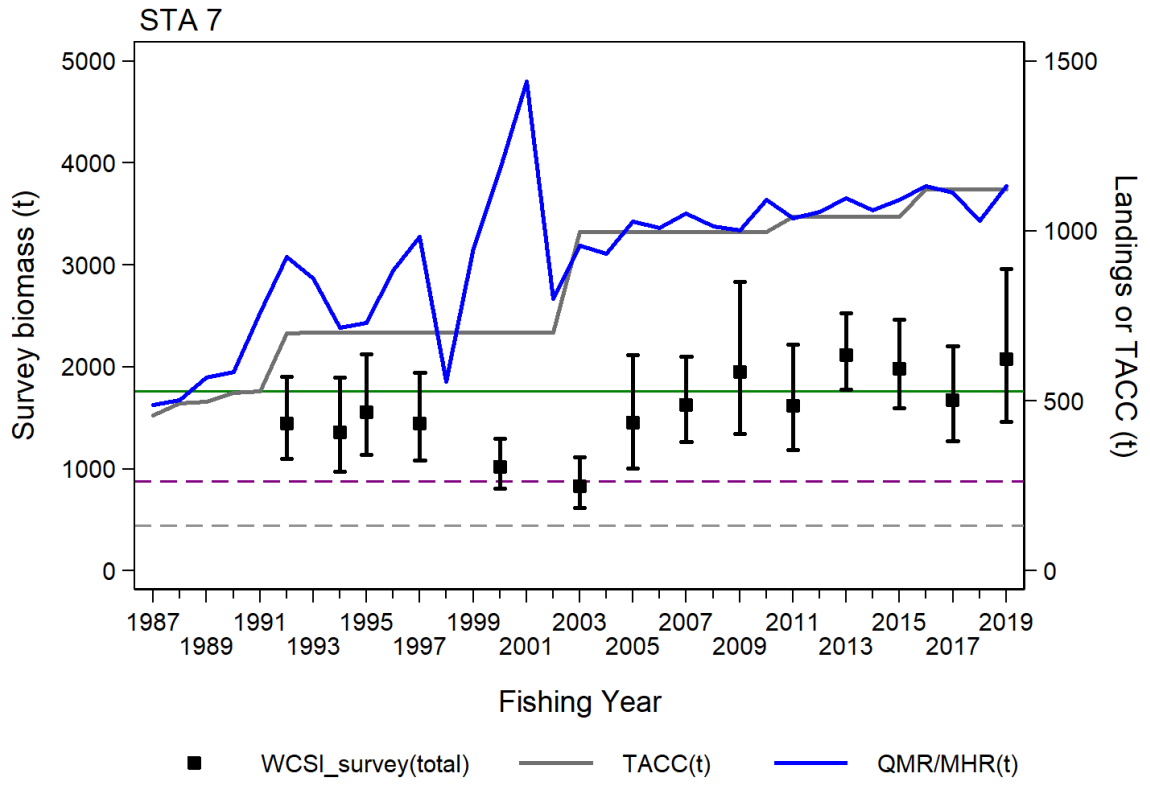
Qualifying Comments
-

Fishery Interactions
Most (70–80%) of the STA 5 catch is taken by the target trawl fishery with a smaller component of the catch taken by a flatfish trawl fishery. The species composition of the landed catch from the target fishery is dominated by stargazer with a small associated catch of ling, tarakihi, and spiny dogfish. Vessels participating in the target fishery may also conduct trawls in shallower water with associated catches of flatfish, red gurnard, and elephant fish. Interactions with other species are currently being characterised.

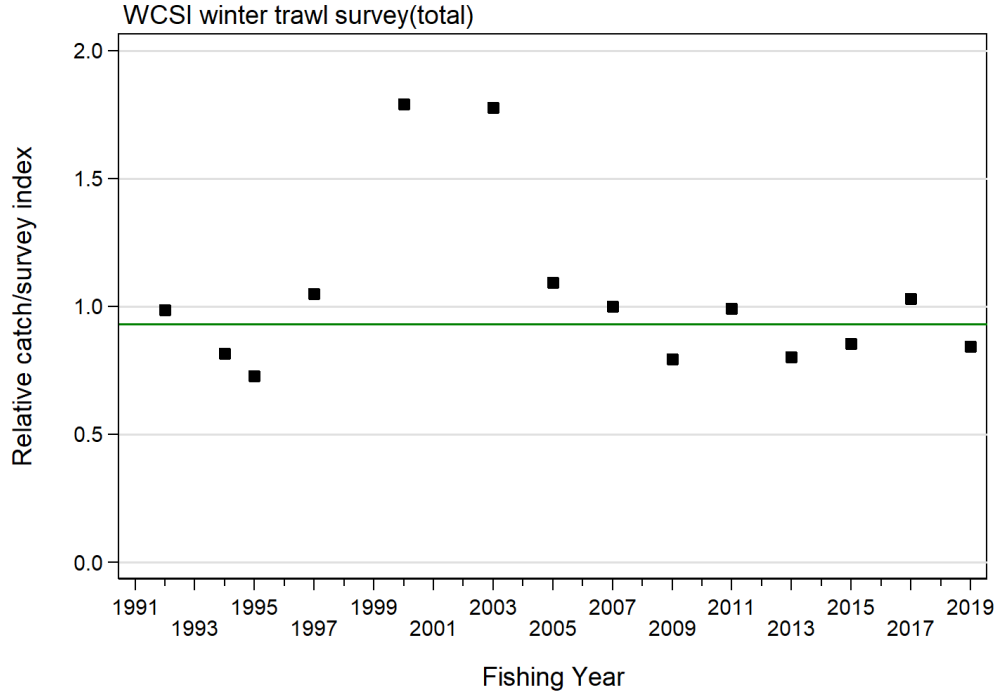
- **STA 7**

Stock Status	
Year of Most Recent Assessment	2020 - Analysis of WCSI survey indices of abundance
Assessment Runs Presented	Total biomass estimates from the WCSI trawl survey to 2019
Reference Points	Target: Mean WCSI trawl survey biomass estimates for the period 2005–2017 Soft Limit: 50% of target Hard Limit: 25% of target Overfishing threshold: Mean Fishing Intensity during the reference period (above)
Status in relation to Target	About as Likely as Not (40–60%) to be at or above target
Status in relation to Limits	Soft Limit: Very Unlikely (< 10%) to be below Hard limit: Very Unlikely (< 10%) to be below
Status in relation to Overfishing	Overfishing is About as Likely as Not (40–60%) to be occurring

Historical Stock Status Trajectory and Current Status



Comparison of the STA WCSI total trawl survey indices with the QMR/MHR landings and TACC for STA 7. The agreed *BMSY* proxy (geometric average: 2005–2017 WCSI survey biomass estimates=1777 t) is shown as a green line; the calculated Soft Limit (=50% *BMSY* proxy) is shown as a purple line; the calculated Hard Limit (=25% *BMSY* proxy) is shown as a grey line.



Relative fishing pressure for STA 7 based on the ratio of QMR/MHR landings relative to the WCSI recruited winter trawl survey which has been normalised so that its geometric mean=1.0. Horizontal green line is the geometric mean fishing pressure from 2005 to 2017.

Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	The WCSI trawl survey indices have been high since 2009, compared to those in the early 90s.
Recent Trend in Fishing Intensity or Proxy	Overfishing is About as Likely as Not (40–60%) to be occurring
Other Abundance Indices	CPUE indices from the WCSI mixed trawl fishery derived from individual trawl data (from 2007–08)
Trends in Other Relevant Indicators or Variables	CPUE indices were relatively stable from 2007–08 to 2012–13.

Assessment Methodology		
Assessment Type	Level 2 – Based on WCSI trawl survey series of abundance estimates	
Assessment Method	Evaluation of recent trawl survey indices (up to 2019)	
Assessment Dates	Latest assessment: 2020	Next assessment: 2022
Overall assessment quality (rank)	1 – High Quality	
Main data inputs (rank)	- Biomass estimates from the biennial WCSI Trawl survey up to 2019	1 – High Quality
Data not used (rank)	N/A	
Changes to Model Structure and Assumptions	- Assessment based only on WCSI trawl survey	
Major Sources of Uncertainty	-	

Projections and Prognosis	
Stock Projections or Prognosis	The STA 7 stock is About as Likely as Not (40-60%) to remain at or above the target at current catch levels.
Probability of Current Catch or TACC causing decline below Limits	Soft Limit: Very Unlikely (< 10%) Hard Limit: Very Unlikely (< 10%)

Fishery Interactions
Smooth skates are caught as a bycatch in this fishery. Interactions with other species are currently being characterised.

- **STA 8**

The TACC for STA 8 increased from 22 t to 50 t in the 1993–94 fishing year under the AMP. Landings increased to 18 t in 1991–92 but have since declined to less than 5 t. The TACC was reduced back to 22 t in 1997, upon the removal of STA 8 from the programme. It is not known if recent catch levels and current TACC are sustainable. The status of STA 8 relative to B_{MSY} is unknown.

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