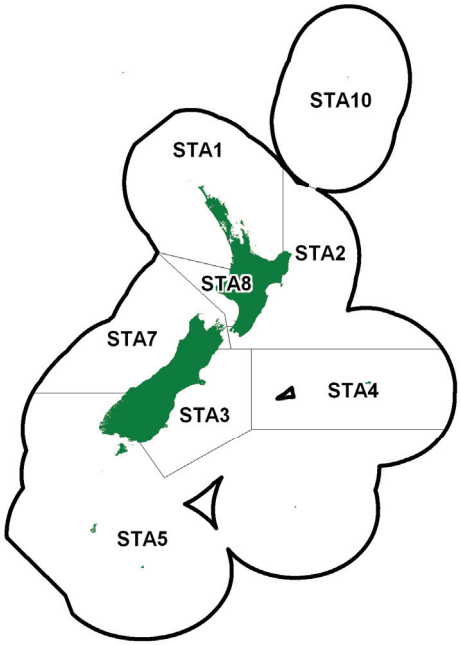
STARGAZER (STA)

(*Kathetostoma giganteum*)
Puwhara



1. FISHERY SUMMARY

1.1 Commercial fisheries

Giant stargazer (*Kathetostoma giganteum*, Uranocopidae) 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 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 on 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 squids *(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.

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 catch between 1979 and 1986–87 was variable, ranging between 701–2348 t and averaging 1481 t. 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 licensed foreign 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 licensed foreign 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 2, 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 2 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 3204 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 QAA; (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 the STA 3, 5, and 7 TACCs introduced under the Adaptive Management Programme (AMP) in the 1991–92 fishing year.

The AMP is a management regime within the QMS for data-poor New Zealand Fishstocks that are likely to be able to sustain increased exploitation. Under the AMP, quota owners collect 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. In recent years, landings in three of these Fishstocks (STA 1–2 and 5) have exceeded their reduced, post-AMP TACCs; although of these, STA 5 is 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 further increased to 997 t at the start of the 2002–03 fishing year within a TAC of 1000 t (which includes a 2 t recreational and a 1 t customary allowance). STA 7 was reviewed again in 2007 (Starr et al 2007) and retained in the AMP while STA 3 was reviewed in 2008 (Starr et al 2008) and retained at the existing TACC.

Of the eight Fishstocks, the most important, in terms of the recorded landed catch, are STA 5, STA 7, and STA 3 (where landings since 1990–91 have averaged 1163 t, 883 t, and 748 t, for each stock respectively) with smaller contributions from STA 2 and STA 4, although a high TACC is set for STA 4 compared with the other seven Fishstocks, it has never been approached or exceeded. Most of the STA 4 catch is caught as bycatch of fishing directed at other target species. A high recorded landed catch in 1990–91 (790 t) was due to exploratory fishing for these target species, this has since declined. The recorded landed catch has averaged 278 t per fishing year since then. Increased catches in STA 2 from 1990–91 were due to the development of the scampi fishery in this Fishstock.

As noted, the TACC in STA 7 was increased to 700 t in 1991–92 under the terms of the AMP. The TACC was overcaught 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 flatfishes. With the removal of the bycatch trade system in October 2001, fishers now face the penalty of high deemed-values for any overcatch, and it is likely that these penalties have been the cause of the reduction in the overcatch in this Fishstock.

Table 2: Reported landings (t) of giant stargazer by QMS Fishstock (QMA) from 1983 to 2008–09. TACCs from 1986–87 to 2008–09 are also provided

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

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

The landings data (Table 1 and Table 2) 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.

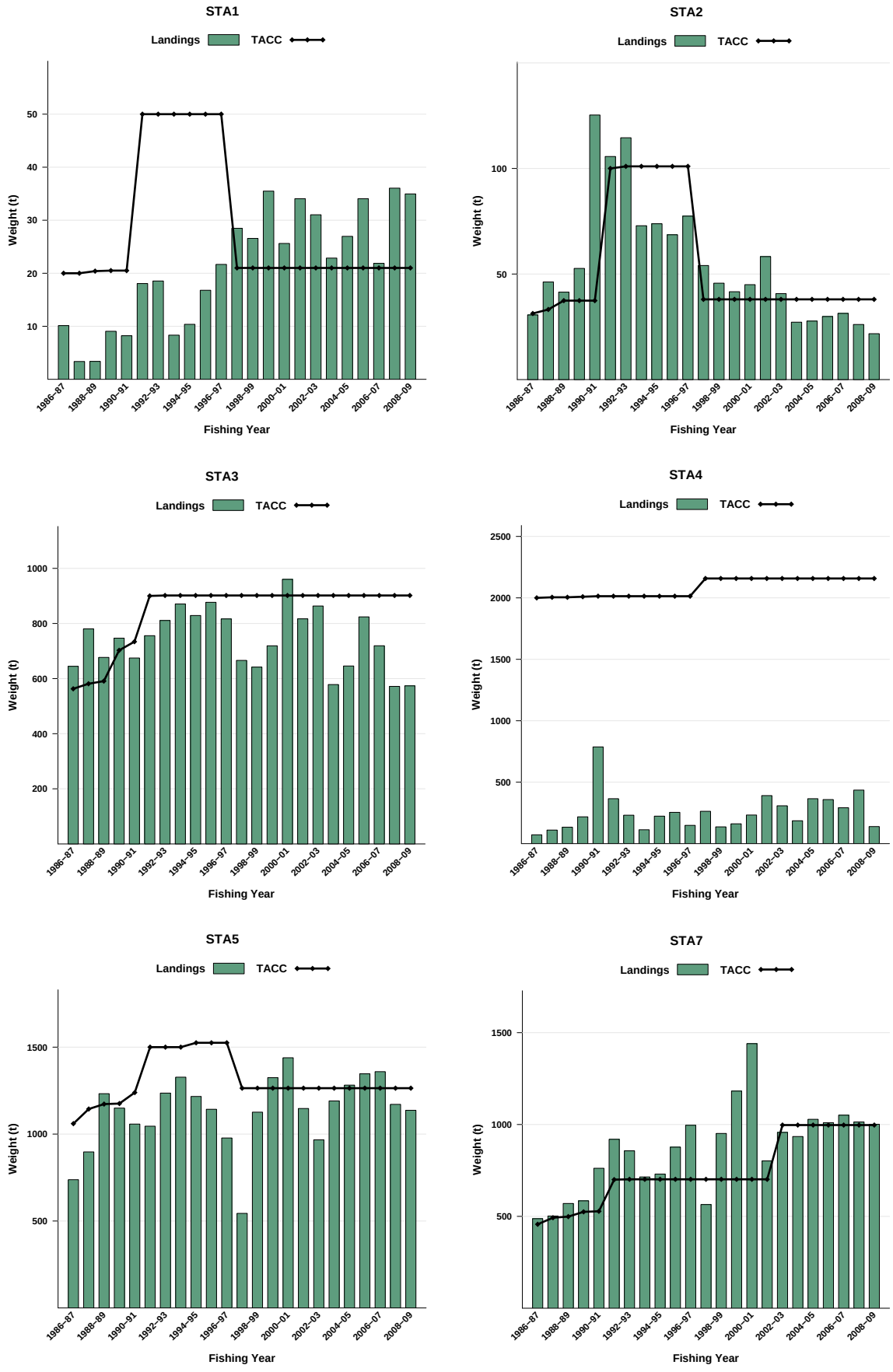


Figure 1: Historical landings and TACC for the seven main STA stocks. From top left: STA1 (Auckland East), STA2 (Central East), STA3 (South East Coast), STA4 (Chatham Rise), STA5 (Southland), and STA7 (Challenger). [Continued on next page]…

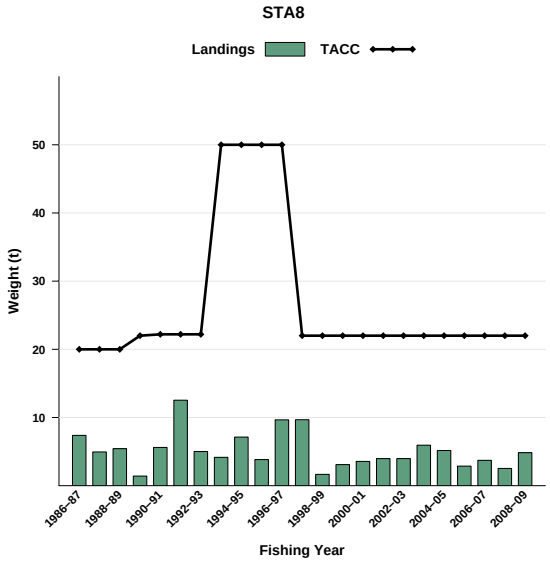


Figure 1 [Continued]: Historical landings and TACC for the seven main STA stocks. STA8 (Central Egmont). Note that these figures do not contain data prior to entry into the QMS.

1.2 Recreational fisheries

Stargazer were not reported as being caught by recreational fishers in surveys conducted in the Ministry of Fisheries South region in 1991–92, Central region in 1992–93 and North region in 1993–94. In a Ministry of Fisheries 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, 2005).

1.4 Customary non-commercial fisheries

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

1.5 Illegal catch

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

1.6 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 at 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 that is underway at this time (2008) suggest that 0.18 is 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 3.

Table 3: Estimates of giant stargazer biological parameters

Fishstock	Estimate	Source
1. Natural mortality (*M*)		
STA 5	0.20	Sutton (2004)
STA 7	0.18	Manning (2006a)

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}	
STA7	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}	
STA7	7.23	4.34	5.53	4.38	Manning (2008)

3. 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, growth appears do differ significantly between the east, south, and west coasts of the South Island (Manning & Sutton 2004, Manning 2005). This is consistent with the 2008 Fishstock boundaries.

4. STOCK ASSESSMENT

There are no new data that are available at this time that would alter the yield estimates of STA 1, 2, 3, 4, 5, and 8 given in the 1997 Plenary Report. The yield estimates are based on commercial landings data.

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 Estimates of fishery parameters and abundance

Trawl surveys
Indices of relative biomass are available from recent *Tangaroa* and *Kaharoa* trawl surveys (Table 4).

Table 4: Relative biomass indices of stargazer and coefficients of variation (CV) for east coast North Island (ECNI), east coast South Island (ECSI) – winter and summer, Chatham Rise, west coast South Island (WCSI) and the Stewart-Snares Island survey areas assuming areal availability, vertical availability and vulnerability equal 1.0. Note: because trawl survey biomass estimates are relative indices, comparisons between different seasons (e.g., summer and winter ECSI) are not strictly valid.

Species	Region	Fishstock	Year	(Trip Code)	Relative biomass (t)	CV (%)
Giant stargazer	ECNI	STA 2	1993	KAH9304	184	22
	Inshore		1994	KAH9402	58	47
			1995	KAH9502	44	35
			1996	KAH9602	57	17
	ECNI	STA 2	1993	KAH9301	250	16
	(Scampi)		1994	KAH9401	215	20
			1995	KAH9501	122	17
	ECSI	STA 3	1991	KAH9105	600	17
	(Winter)		1992	KAH9205	669	16
			1993	KAH9306	609	14
			1994	KAH9406	462	15
			1996	KAH9606	465	11
			2007	KAH0705	755	18
			2008	KAH0806	606	14
			2009	KAH0905	475	15
	ECSI	STA 3	1996	KAH9618	897	12
	(Summer)		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
			2002	TAN0201	2 195	16
			2003	TAN0301	1 380	15

Table 4 Continued:

Species	Region	Fishstock	Year	(Trip Code)	Relative biomass (t)	CV (%)
	Chatham Rise	STA 4	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
	WCSI	STA 7	1992	KAH9204	1 302	12
			1994	KAH9404	1 350	17
			1995	KAH9504	1 551	16
			1997	KAH9701	1 450	15
			2000	KAH0004	1 023	12
			2003	KAH0304	827	15
			2005	KAH0503	1 429	19
			2007	KAH0704	1 630	12
			2009	KAH0904	1 952	19
	Stewart-Snares	STA 5	1993	TAN9301	2 650	20
			1994	TAN9402	3 755	11
			1995	TAN9502	2 452	11
			1996	TAN9604	1 733	11
Banded stargazer	Stewart-Snares	BGZ 5	1993	TAN9301	409	27
			1994	TAN9402	250	21
			1995	TAN9502	316	29
			1996	TAN9604	232	34

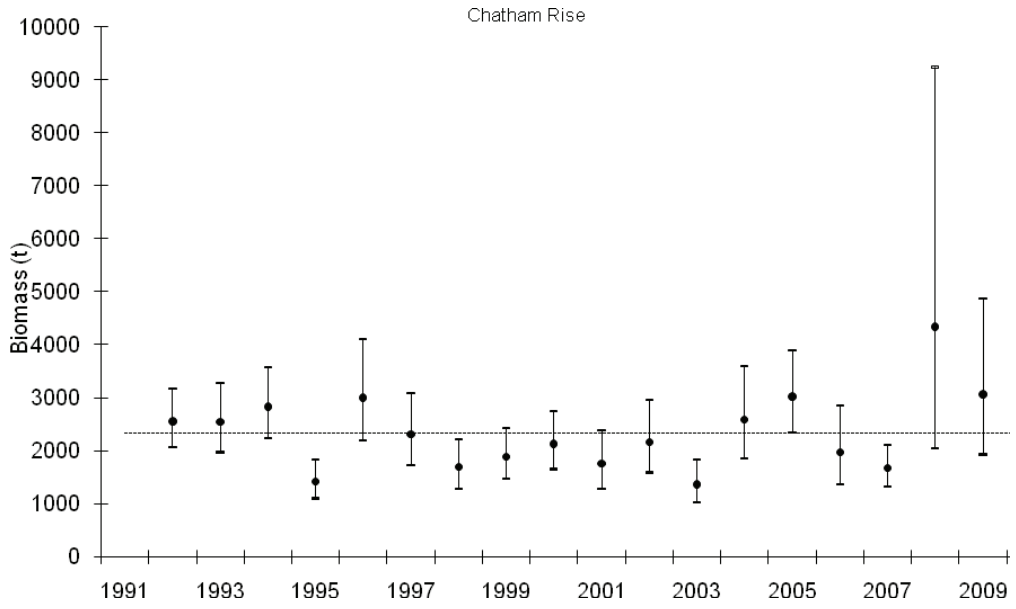


Figure 2: Stargazer biomass ±95% CI (estimated from survey CV's assuming a lognormal distribution) and the time series mean (dotted line) estimated from the Chatham Rise trawl survey.

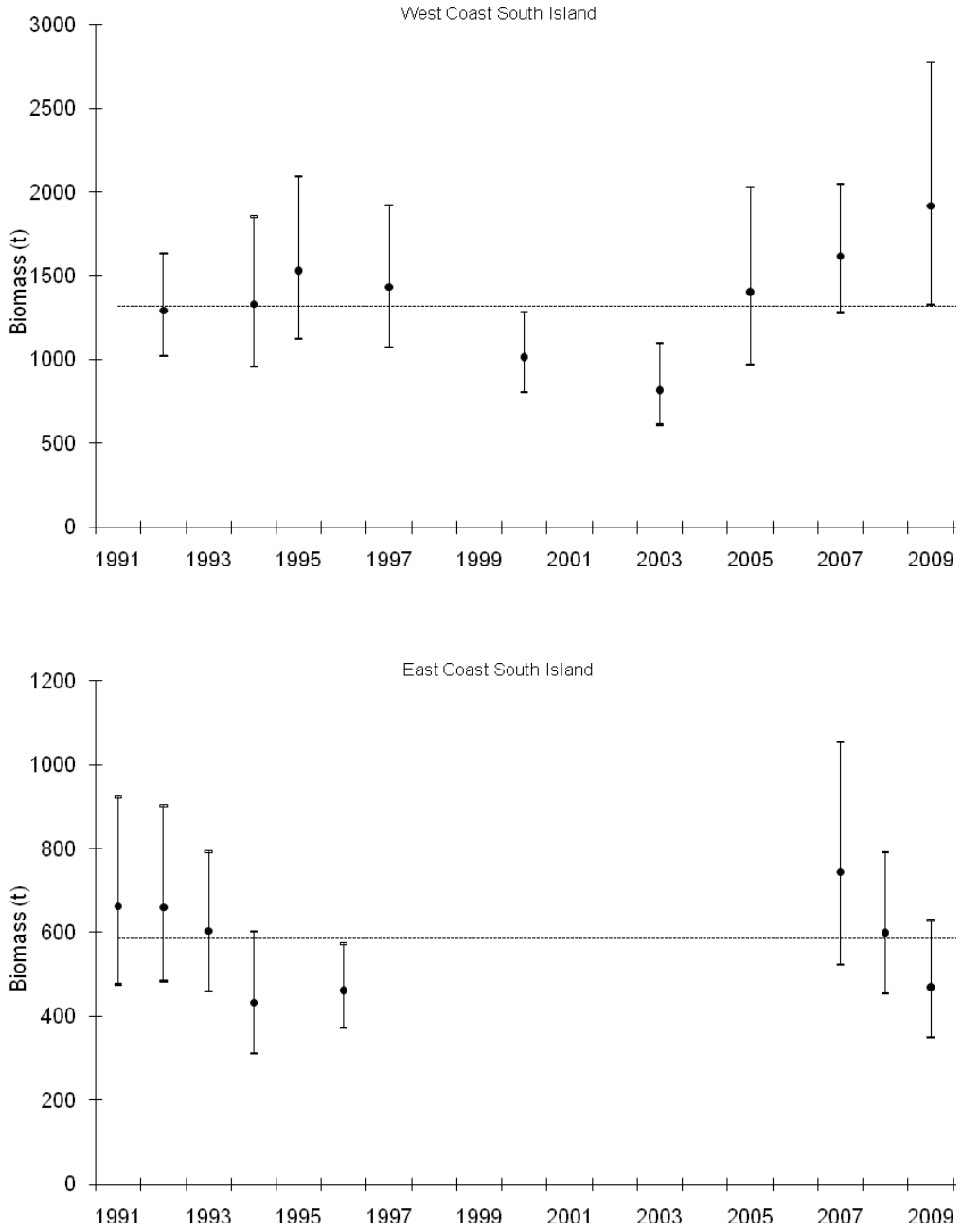


Figure 3: Stargazer biomass ±95% CI (estimated from survey CV's assuming a lognormal distribution) and the time series mean (dotted line) estimated from the West (top) and East (bottom) Coast South Island trawl survey.

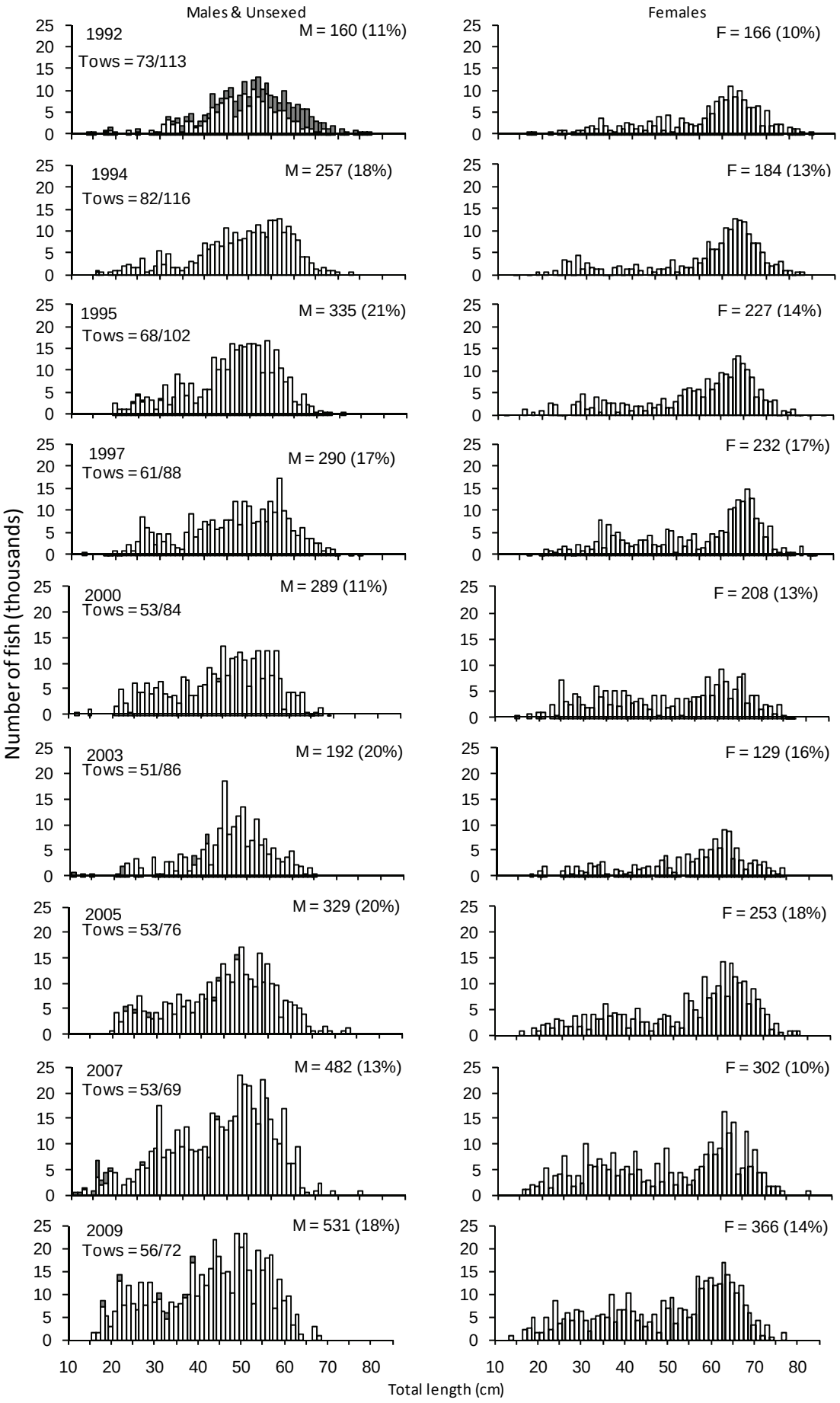


Figure 4: Scaled length frequency distributions for giant stargazer in 30–400 m, for WCSI surveys. M, males; F, female and u, unsexed, () (CV) (Stevenson 2007).

4.2 CPUE analysis

STA 2, 3, and 7

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 since about 2000–01. A CPUE series calculated for STA 7 (SeaFIC 2002, 2003b, 2005b, Starr et al 2007), based on a mixed west coast South Island target species (stargazer, barracouta, red cod and tarakihi) fishery, has not been accepted by the AMP WG as an indicator of STA 7 abundance. The Inshore and AMP Fishery Assessment Working Groups (FAWG) have had concerns over using bycatch fisheries to monitor stargazer abundance in these areas due to possible changes in recording and fishing practices.

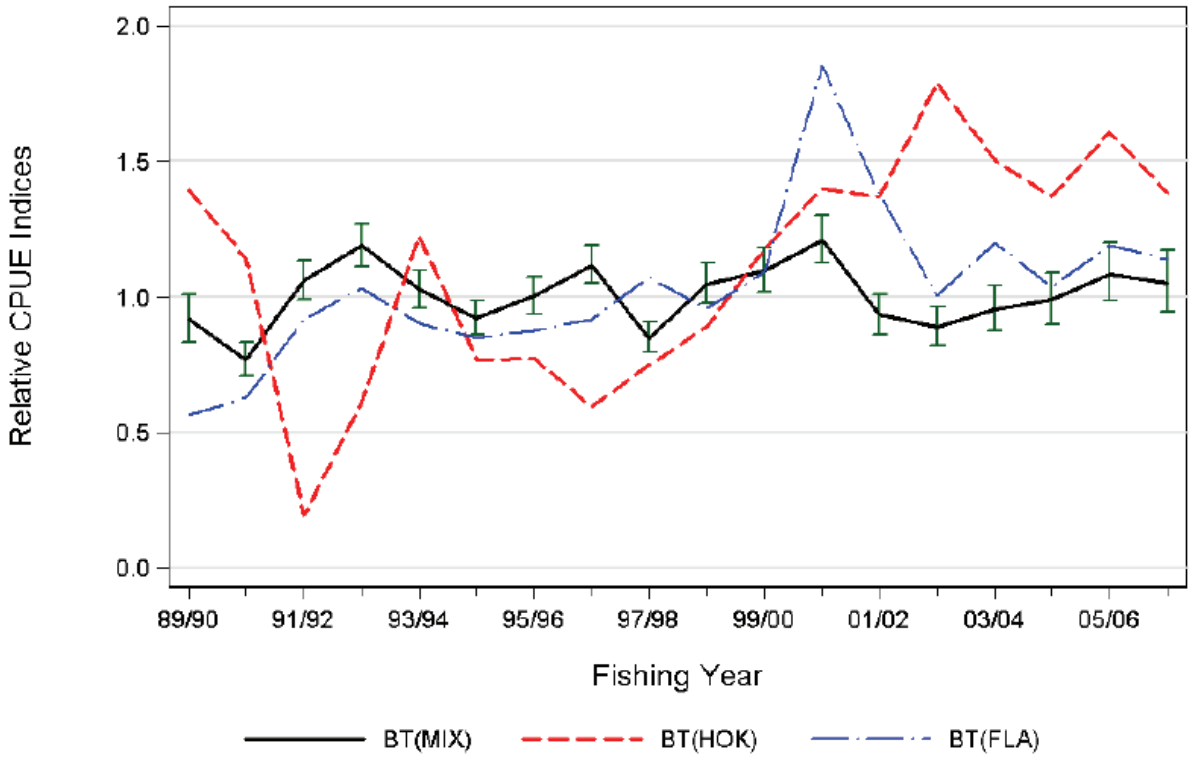


Figure 5: Comparison of the lognormal indices from the three bottom trawl CPUE series for STA 3; a) BT(MIX): mixed species target trawl fishery; b) BT(FLA): hoki target trawl fishery; c) BT(FLA): target flatfish trawl fishery. Each series is scaled to the geometric mean = 1. (Starr *et al.*, 2008).

STA 4

Stargazer in STA 4 are taken as a bycatch in the fisheries for hoki, ling, silver warehou, squid, barracouta, red cod and scampi on the Chatham Rise, as bycatch in a barracouta fishery near the Chatham Islands, and in a small targeted stargazer fishery north of the Chatham Islands.

An unstandardised CPUE analysis of stargazer in these fisheries, singly and in appropriate combinations, showed no clear trend (Table 5). The stargazer CPUE is strongly correlated with the stargazer catch, suggesting that it is influenced by being in or out of the top five species reported on fishing returns. The unstandardised CPUE indices of the stargazer bycatch are not considered reliable, and are not used in stock assessment. Further, the Working Group noted the localised nature of the fishing effort in STA 4 and that fishing occurs in two geographically distinct locations, one around the Chatham Islands and the other to the west, adjacent to eastern STA 3. The Working Group agreed that the catch statistics from statistical areas 19, 21 and 23 (in STA 3) should be considered in any STA 4 analysis.

Table 5: Summary of unstandardised CPUE indices* for stargazer as a bycatch in STA 4† target fisheries.

Years	Hoki	Ling	S. warehou	Squid	Barracouta	Red cod	Scampi	Combined‡
1989–90	0.14	0.72	0.31	1.00	0.29	0.86	–	0.34
1990–91	0.88	0.83	1.15	1.26	0.56	1.03	0.06	0.87
1991–92	0.39	0.56	0.61	0.47	0.66	0.97	0.04	0.46
1992–93	0.32	0.89	0.33	0.80	0.62	0.32	0.07	0.37
1993–94	0.22	0.27	0.40	0.53	0.68	0.55	0.07	0.38
1994–95	0.54	2.56	0.65	0.48	0.59	0.43	0.10	0.61
1995–96	0.38	0.41	0.43	0.54	0.39	0.67	0.09	0.44

* Catch per tow, for tows in which stargazer were reported caught.
† Statistical areas 021 and 023 (STA 3) and 401 and 407 (STA 4), covering the western end of Chatham Rise.
‡ Hoki, ling, silver warehou, squid, barracouta, red cod, but not scampi

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.

Vignaux (1997) was the first to present standardised CPUE indices for STA 5. Data were analysed from the 1991–92 to 1995–96 fishing years only and the indices she presented showed no trend. Her analysis was superseded by that of Phillips (2001), who analysed data from the 1989–90 to 1999–00 fishing years. He used a log normal generalised linear model to describe non-zero estimated catches reported by both the inshore and deepwater fleets. However, the indices he presented also showed no trend and were rejected as a relative abundance index by the New Zealand Inshore Fisheries Working Group (Inshore FAWG).

Manning (2007) updated Phillips' (2001) analysis with four more fishing years of data and used a different data processing method. His analysis spanned the 1989–90 to 2003–04 fishing years, and he groomed and restratified the catch-effort data in his series tripwise, allocating the groomed landed catch for each trip to the recomputed effort strata using Starr's (2003) method for processing MFish catch-effort and landings data, as implemented by Manning *et al.* (2004). His analysis also rigorously considered and accounted for changes in stargazer conversion factors over time, which neither Vignaux's (1997) nor Phillips' (2001) analyses did.

Manning (2007) fitted a suite of different generalised-linear-models (GLMs) to different subsets of the groomed dataset. The model, accepted by the Inshore FAWG as the best indication of STA 5 relative abundance, was a log normal GLM fitted to non-zero records associated with small, inshore bottom trawl vessels where giant stargazer was recorded as the target species, where the vessels had a consistent presence in the fishery (i.e., those vessels active in the fishery for five years or more with ten or more associated records per fishing year; a so-called "core" vessel subset), and where the response variable was defined as giant stargazer *catch* rather than *catch-per-unit-effort* (model fit 2.4). The canonical indices obtained from this model suggest that stargazer abundance in STA 5 has remained static, or at worst, declined only slightly over the data series (Figure 3). The trend in the standardised CPUE indices between the 1992–93 to 1995–96 fishing years appears consistent with stargazer relative biomass estimates from research trawl surveys of the Stewart–Snares shelf carried out by RV *Tangaroa*, 1993–96 (Figure 6) (Hurst & Bagley 1994, Bagley & Hurst 1995, 1996a, 1996b, Hurst & Bagley 1997). The peak then declined in the standardised CPUE and trawl survey relative biomass indices may, however, reflect a change in catchability rather than in stock abundance.

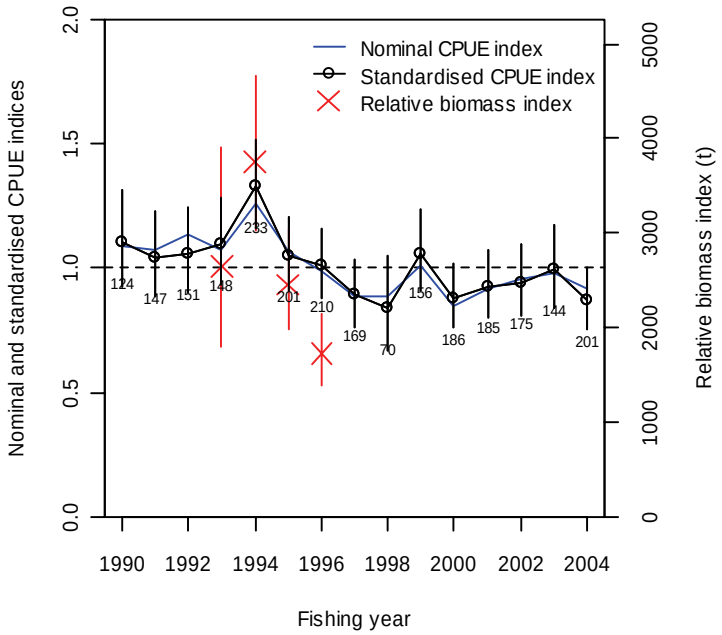


Figure 6: The standardised CPUE indices from the fit of model 2.4 presented by Manning (2008). The nominal CPUE and trawl survey relative biomass estimates from the SCSI survey series by RV Tangaroa (1993–1996) have been overlaid for comparison. The nominal CPUE and trawl survey relative biomass indices have been rescaled so that all three series can be displayed on the same plot.

4.3 Biomass estimates

STA 2

An age structured model using deterministic recruitment was fitted to the abundance indices from the ECNI inshore and the ECNI scampi trawl surveys results (Table 4). The declines in the indices suggest that the current exploitation rate is very high, but the model results are determined by the choice of maximum allowable exploitation rate. An upper bound of 80% for the catch/biomass ratio was used in the base case, but this is considered unrealistically high, because stargazer is mainly caught as a bycatch of other fisheries and because the ECNI inshore trawl surveys suggest that there are parts of the stock not being fished. The virgin biomass estimated by the model of 563 t is therefore considered a minimum estimate of virgin biomass.

STA 7

An age-structured model partitioned by age (0–25 years) and sex was fitted to the WCSI trawl survey relative abundance indices (1992–05), WCSI survey proportions-at-age data (1992–05), and WCSI fishery catch-at-age data (2005 only) (Manning 2008). The stock boundary assumed in the model included the west coast of the South Island, Tasman and Golden Bays, but not eastern Cook Strait (a catch history was compiled for the model stock that excluded eastern Cook Strait). A summary of the model's annual cycle is given in Table 6. A preliminary model that included data up to the end of the 2005 year was revised and updated with additional data from 2007 West Coast South Island survey relative biomass, survey proportions-at-age, and fishery proportions-at-age data.

Monte Carlo Markov chain estimates for three models (3.3, 3.6, and 3.7) are given in Table 7. Sensitivities to the base case model (R3.3) assumed domed survey selectivities (R3.6), and down-weighted the 2000 and 2003 survey indices (R3.7). Spawning stock biomass was estimated as 29-51% B_0 for the base case model, and ranged between 29 and 76% B_0 for the two model sensitivities (Table 7).

Table 6: The STA 7 model's annual cycle (Manning 2008). Processes within each time step are listed in the time step in which they occur in particular order (e.g., in time step 3, new recruits enter the model partition first followed by the application of natural and fishing mortality to the partition). *M*, the proportion of natural mortality assumed during each time step. *F*, the nominal amount of fishing mortality assumed during each time step as a proportion of the total catch in the stock area. Age, the proportion of fish growth that occurs during each time step in each model year

			Proportions			
Time step	Duration	Process applied	*M*	*F*	Age	Observations
1	Oct-Jun	Mortality (*M*, *F*)	0.75	0.77	1.00	Survey relative biomass Survey proportions-at-age Survey length-at-age Fishery catch-at-age Fishery relative abundance
2	Jun (instantaneaous)	Spawning Age incrementation	0.00	0.00	0.00	NIL
3	Jun-Sept	Recruitment Mortality (*M*, *F*)	0.25	0.23	0.00	Fishery catch-at-age

Table 7: MCMC initial and current biomass estimates for the STA 7 model runs R3.1 R3.6 and R3.7 (Manning in prep). B_0, virgin or unfished biomass; B_{2005}, mid-year biomass in 2005 (current biomass); (B_0 / B_{2005}) %, B_0 as a percentage of B_{2005}; Min, minimum; Max, maximum; Q_i, ith quantile. The interval ($Q_{0.025}$, $Q_{0.975}$) is a Bayesian credibility interval (a Bayesian analogue of frequentist confidence intervals).

	R3.3			R3.6		
	B_0	B_{2007}	(B_0 / B_{2007}) %	B_0	B_{2007}	(B_0 / B_{2007}) %
Min	7 740	1 860	24.1	8 960	2 390	25.5
$Q_{0.025}$	8 290	2 410	28.5	10 170	3 680	35.9
Median	9 210	3 580	38.8	13 750	7 490	54.2
Mean	9 250	3 640	39.1	14 630	8 330	54.5
$Q_{0.975}$	10 580	5 290	50.7	24 910	18 580	76.3
Max	11 800	6 350	55.0	35 920	31 310	87.4
	R3.7					
Min	7 840	1 900	24.2			
$Q_{0.025}$	8 220	2 370	28.8			
Median	9 190	3 580	39.0			
Mean	9 220	3 640	39.1			
$Q_{0.975}$	10 470	5 260	50.1			
Max	11 300	6 120	58.2			

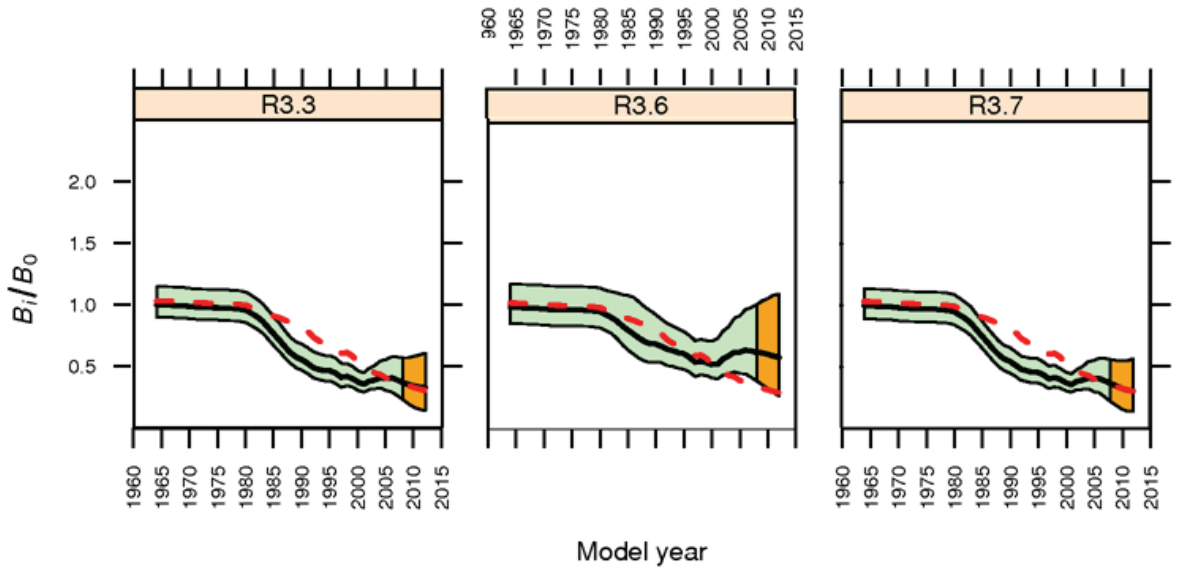


Figure 7: Relative SSB trajectories (green) and projected status assuming a future constant catch equal to the current catch (orange) calculated from the MCMC runs for model runs 3.3, 3.6, and 3.7 in the quantitative stock assessment of STA 7. The shaded region indicates the 95% credibility region about median SSB (dotted lines) calculated from each model's SSB posterior distribution.

4.4 Estimation of Maximum Constant Yield (MCY)

(i) Chatham Rise (STA 4) and Southland and Sub-Antarctic (STA 5)

In previous assessments MCY was estimated from the absolute biomass estimates from trawl surveys. This method is now considered obsolete and the yield estimates are not reported here.

(ii) Other areas

MCY was estimated using the equation, MCY = cY_{AV} (Method 4). The landings data from 1981–86 were relatively stable and were used to estimate Y_{AV}. The parameter c was set equal to 0.8 based on the estimate of M = 0.23.

The estimates of MCY were:

STA 1:	0.8 *	5.8 t	=	5 t	
STA 2:	0.8 *	21.8 t	=	17 t	(rounded to 20 t)
STA 3:	0.8 *	492.3 t	=	394 t	(rounded to 390 t)
STA 7:	0.8 *	346.6 t	=	277 t	(rounded to 280 t)
STA 8:	0.8 *	4.8 t	=	4 t	(rounded to 5 t)

These estimates of MCY are likely to be conservative because of under-reporting in the past and are highly uncertain. These estimates of MCY have not changed since the 1989 Plenary Report.

The level of risk to the stock by harvesting the population at the estimated MCY value cannot be determined.

4.5 Estimation of Current Annual Yield (CAY)

Estimates of current biomass are not yet available and CAY cannot yet be estimated for any giant stargazer Fishstock.

Yield estimates are summarised in Tables 8 and 9.

Table 8: Giant stargazer yield estimates (t) for all stocks except STA 7.

Parameter	Fishstock	Yield estimate
MCY	STA 1	5
	STA 2	20
	STA 3	390
	STA 4	Cannot be determined
	STA 5	Cannot be determined
	STA 8	5
CAY	All	Cannot be determined

Table 9: Yield estimates (t) for STA 7

			Run
Parameter	3.3	3.6	3.7
MCY	595	649	600
B_{MCY}	6 813	11 282	6 720
CAY	936	2 065	938
F_{CAY}	0.24	0.24	0.24
MAY	854	1 124	852
B_{MAY}	3 205	4 348	3 209

4.6 Other yield estimates and stock assessment results

For STA 2, long-term yields are of the order of 50–60 t based on the minimum virgin biomass estimated by the model. No other yield estimates are yet available.

4.7 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.

The TACC in STA 4 has been under-caught because it is apparently uneconomical to target stargazer except near the Chatham Islands. It is a bycatch in the trawl fisheries for hoki, ling, silver warehou, squid, red cod and scampi on the Chatham Rise.

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 large quantities by foreign licensed and chartered trawlers fishing offshore grounds for other species (see Table 1). Because stargazer is mainly a bycatch, there is likely to be under-reporting in these data. Therefore, any estimate of MCY based on catch data is likely to be conservative.

5. ANALYSIS OF ADAPTIVE MANAGEMENT PROGRAMMES (AMP)

The Ministry of Fisheries revised the AMP framework in December 2000. The AMP framework is intended to apply to all proposals for a TAC or TACC increase, with the exception of fisheries for which there is a robust stock assessment. In March 2002, the first meeting of the new Adaptive Management Programme Working Group was held. Two changes to the AMP were adopted:

- a new checklist was implemented with more attention being made to the environmental impacts of any new proposal
- the annual review process was replaced with an annual review of the monitoring requirements only. Full analysis of information is required a minimum of twice during the 5 year AMP.

STA 3

The STA 3 TACC was increased from 734 t to 900 t under the AMP, beginning in the 1991–92 fishing year. The previous 5-year AMP term for STA 3 ended in September 2003 with the current one beginning in October of that year. A formal proposal was not required for the current term as the AMP FAWG supported the continuation of the AMP (March 2003) and no change was requested to the TACC.

2008 Review of STA 3

STA 3 was one of the initial stocks to enter an AMP, with a TACC increase from 734t to 900t in October 1991. Slight adjustments to this TACC have since occurred. The STA 3 AMP was reviewed in 1998 and retained in the programme until the end of 2002–03. It was further extended for another five years in October 2003. The STA 3 AMP was scheduled to end in September 2008, but will now be retained in an AMP until this Fishstock is incorporated into a Fisheries Plan. STA 3 catches increased quite rapidly in response to the AMP TACC increase from a pre–1991 level of around 600t to around the new TACC level from 1993–94 to 1995–96. Catches have since fluctuated between about 600t and 900t, being below the TACC in all years except 2000–01 (960t). Catches have averaged 750t / year over 1996–97 to 2006–07, with 719t reported in 2006–07. The Working Group noted that:

Fishery characterisation

- Most (95%) of STA 3 are caught using bottom trawl (BT), with a few landings in the setnet fishery (5%). About two-thirds of the bottom trawl landings have historically come from the two statistical areas north and south of Banks Peninsula: Area 020 - Pegasus Bay, and Area 022 - Canterbury Bight. The remaining third of the STA 3 BT landings are evenly distributed amongst the remaining inshore statistical areas. Only one offshore statistical area (Area 023) registered any STA 3 landings. Area 018 accounts for three-quarters of the STA 3 setnet landings.
- 40% of the BT landings of STA 3 are taken in the target red cod fishery, with remaining catches coming from the target flatfish, barracouta, hoki and tarakihi fisheries. STA itself only accounts for about 4% of the landings since 1989–90. The small amount of STA 3 setnet landings come from targeting on a range of species, including ling, hapuku/bass, and rig.
- Target species vary by area, with BT fishing for red cod predominating in the northern statistical areas (Areas 018, 020 and 022), and fishing for flatfish in the southern part of the

East Coast South Island. Target BT fishing for barracouta is primarily confined to Area 22, while target fishing for hoki and scampi predominate in offshore areas. Ling, hapuku/bass, rig and tarakihi all take stargazer as a setnet bycatch in Area 018 while rig is the predominant setnet target species in Area 024

- There is some monthly variability, but little evidence of seasonality in landings of either bottom trawl or setnet catches of STA 3. Depending on target species, stargazer are caught over a wide depth range, between 50 m and 530 m depth (median 300 m).

CPUE analysis

- Three CPUE analyses were conducted for STA 3 catch and effort data, using the following fishery definitions from trips which fished in statistical areas valid for STA 3:
  - BT(MIX): a mixed target trawl fishery targeting a range of species: red cod, barracouta, tarakihi and stargazer.
  - BT(FLA): a target flatfish bottom trawl fishery operating at the shallower end of the stargazer depth distribution.
  - BT(HOK): a target hoki trawl fishery operating at the deeper end of the stargazer depth distribution.

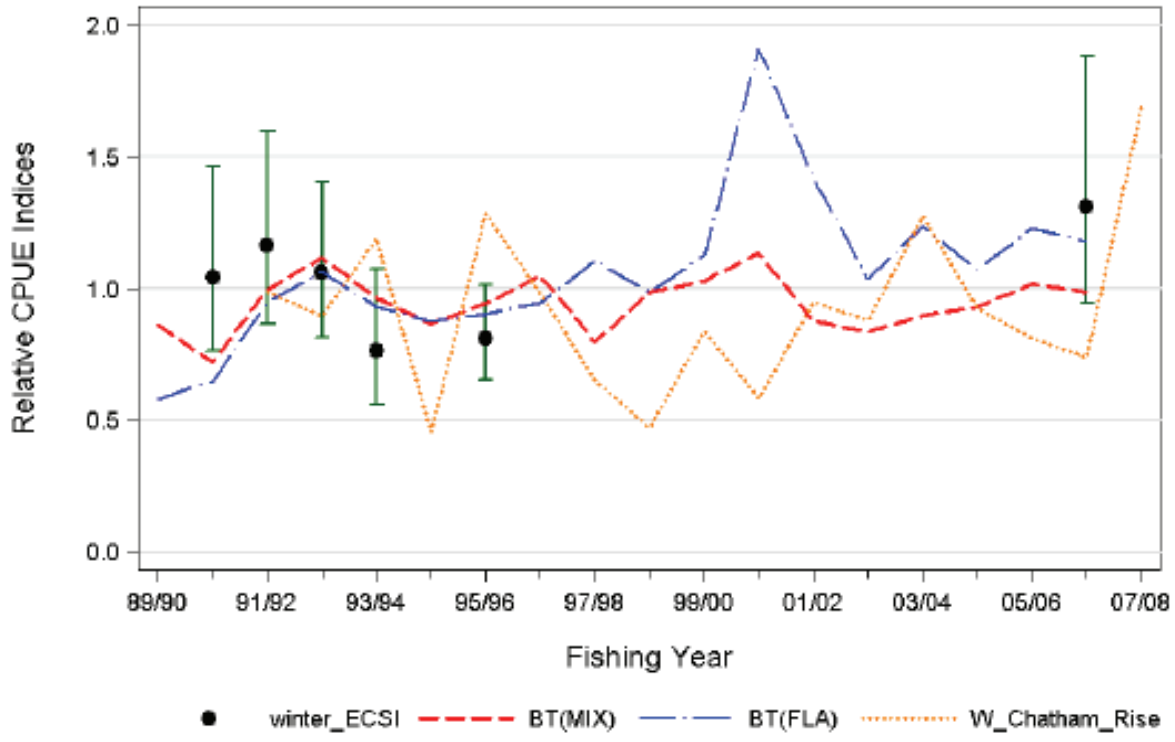


Figure 8: Comparison plot of two STA CPUE biomass indices [BT(MIX) and BT(FLA)] plotted with the survey biomass indices for stargazer from the winter ECSI and western Chatham Rise trawl surveys. The trawl surveys were assumed to relate to the final year of the fishing year pair. Each series has been standardised to a common geometric mean from 1990–91 to 1993–94, 1995–96 and 2006–07.

- The lognormal BT(MIX) mixed target bottom trawl fishery model shows only minor inter-annual variability, and no long-term trend since 1989–90 (Figure 8). Unstandardised series for this fishery are very similar to the standardised series, although standardisation does flatten the increasing trend in unstandardised CPUE over past five years.
- The lognormal BT(FLA) flatfish series also shows an increasing trend and, apart from an unexplained doubling of CPUE between 2000–01 and 2001–02, has lower variability than the hoki target fishery index (Figure 7). Unstandardised indices closely match the standardised BT(FLA).
- The lognormal BT(HOK) hoki target trawl series is more variable, with larger error bars, and shows greater deviation from the unstandardised indices. This index shows a generally increasing trend since 1991–92, which may result from the manner that this fishery is

conducted. The high variation in this index probably results from the fact that this fishery operates at the deeper end of the stargazer depth range, where STA catch rates are relatively low.

- There appears to be reasonable similarity between the BT(MIX) and BT(FLA) series, particularly in the early to mid–1990s, and an overlay of the three series suggests a slowly increasing trend over the past decade. All three series also show a steady decline in the proportion of records with zero STA landings, which may result either from improved availability of STA, or from changes in fishing practices.

Trawl survey abundance indices

- Abundance indices for STA have been summarised for four trawl surveys series: East Coast South Island (ECSI) winter surveys from 1991 to 1996 (five surveys); ECSI winter survey in 2007 (one survey); ECSI summer surveys from 1997 to 2001 (five surveys); and Chatham Rise surveys from 1992 to 2008 (17 surveys) (Figures 2 and 3).
- Annual STA biomass estimates for the ECSI derived from these surveys (Figure 3) have good precision (CVs of 11% to 18%). The initial five winter surveys conducted in the first half of the 1990s did not show any trend, although the last two indices were lower than the first three. This survey was resumed in May 2007, with the most recent estimate similar to the early survey indices and showing no trend over the 11 year gap. These survey indices also correspond well to the three CPUE series discussed in the previous section (Figure 7). The discontinued summer survey series from 1997 to 2001 was highly variable, showing a strong decline in the last three surveys that appeared to be inconsistent with biomass changes, and was judged to be most likely caused by a change in relative catchability / availability of stargazer.
- An index for the western end of the Chatham Rise has been created for stargazer from annual *RV Tangaroa* surveys during December and January. Although this index is likely to be representative of the stargazer population on the western Chatham Rise, it is highly variable and imprecise, particularly in the most recent survey, where the survey CV exceeds 60%. However, there appears to be no overall trend over this series.

Logbook programme

- A logbook programme to sample the east coast South Island trawl fishery was implemented in 2003–04. Initially, this programme only sampled elephantfish, but it was gradually extended to sample other AMP species in this fishery, including stargazer.
- As a result of diversity of the fishery and scarcity of stargazer catches in individual tows, this programme has never obtained good coverage. The number of tows reported has ranged from 230 to 905 over all species sampled, but which represents only 300 kg to 3.7 t of estimated stargazer catch. Coverage levels ranged from 0.1 to 0.5% of the total STA 3 trawl catch, based on simple ratios of estimated catches. Coverage has been low, even when only the target stargazer fishery is considered, which achieved coverage from 0% to 8.5%.
- Comparison of the logbook coverage by statistical area with comparable catch/effort data shows that the logbook programme over-sampled Area 022, under-sampled in Area 020 and sampled appropriately in Area 024. The bottom trawl logbook programme has failed to achieve consistent seasonal representation of the stargazer catch in any year.
- Most of the reported logbook data are from the Canterbury Bight, in inner shallow areas, and along the shelf edge. Some tows were reported on the shelf off of Banks Peninsula. The depth range fished ranged from 42 to 125 m (median 55 m, mean 69 m).
- Analyses of length-frequency data showed general consistency between years for each surveys series, with no evidence of trends in mean size. However, females were often larger than males across surveys, and STA in the Chatham Rise surveys were consistently larger than those caught in the ECSI surveys. This raises questions regarding relationships and/or differences between the ECSI and Chatham Rise populations.

Effects of fishing

- Low observer coverage and lack of fine scale catch reporting has made it difficult to objectively evaluate the environmental effects of fishing under the STA 3 AMP. The rates of

non-fish bycatch are unknown, monitoring is not adequate. Since the last review of STA 3 in 2006:

- The Non-fish/Protected Species Catch Return to be implemented from 1 October 2008 should provide information on the level of non-fish/protected species bycatch for the next review of STA 3. However, adequate observer coverage will still be required to validate reporting rates.
- The draft Hector's and Maui's Dolphin Threat Management Plan (TMP) released for consultation (MFish and DOC 2007) proposes an extension to the existing Banks Peninsula marine mammal sanctuary.
- Under seabird sustainability measures begin on 1 June 2008. Trawlers can not discharge offal or fish on more than one occasion per tow or during shooting or hauling or within 20 minutes before shooting.

Conclusions

- A comparison of the most credible abundance indices for the STA 3 stock (BT(MIX) and BT(FLA) CPUE indices, ECSI winter and western Chatham Rise summer trawl surveys) shows fairly good correspondence between the series, suggesting a flat or slowly increasing trend over the history of the fishery, particularly in the preferred BT(MIX) CPUE index (Figure 5).
- These results support the conclusions of the Inshore Fishery Assessment Working Group in 1997 that recent catch levels are probably sustainable. It is not known if the TACC is sustainable because catches have averaged about 15% below the TACC since 1989–90.

AMP review checklist

1. The Working Group concluded that the ECSI winter trawl surveys and, in their absence, the BT(MIX) standardised CPUE series, provide reasonable indices of the STA 3 stargazer population. Analyses prepared in 2008 show these two indices to be consistent with one another, and with the BT(FLA) index derived from a fishery operating shallower depths. Together, these indices are considered to monitor abundance of the fished component of the stock reasonably well. However, the full extent of the stargazer population which contributes to the STA 3 fisheries may not be covered by these fisheries, and there are questions about the relationships of the fished population with STA stock components in deeper water, or on the western Chatham Rise.
2. The current logbook programme provides reasonable coverage of the mixed-species bottom trawl fishery in FMA 3. However, its coverage of STA catches in this fishery has been very low, and improvements are needed to improve seasonal and spatial representivity of the fishery, and of variable distribution of STA in the area.
3. Additional analyses recommended by the Working Group included:
   - The relationship between the stargazer populations in STA 3 and STA 4 could be investigated by comparing Chatham Rise trawl survey biological data with equivalent data from the inshore east coast survey and possibly the target hoki fishery to ascertain whether there is a size / depth relationship for STA.
   - It may be possible to perform a stock assessment on the available stargazer data, now that a reasonable set of CPUE biomass indices are available and the winter ECSI trawl survey has been reinstated. Such an assessment would need to understand the relationship between STA 3 and STA 4, as there may be migration between these two areas. Ageing of stargazer from the more recent winter surveys will also be required for such an assessment,
4. Consistency between all of the credible indices for the STA 3 fishery, all of which show a flat, or perhaps slightly increasing, trend across the history of the fishery, indicate that current catches are sustainable.
5. STA 3 remains primarily a bycatch in the mixed-species inshore trawl fishery. At time of entry into the AMP, the STA 3 stock was considered to be most likely above B_{MSY} and views regarding the status of the STA 3 stock have not changed subsequently.
6. Observer coverage levels of the inshore trawl fisheries are low, and the effects of fishing are not currently adequately monitored. Introduction of the '*Non-fish/Protected Species Catch Return*' into the suite of regulated MFish forms from 1 October 2008, may provide a credible source of information on the level of protected species bycatch in STA 3. However, observer coverage will still be required to validate fisher reporting rates.

7. Given the low observer coverage in this fishery, rates of non-fish bycatch are not known with any confidence, and it is not known whether rates of bycatch are acceptable.
8. The Working Group agreed that this stock did not need to be referred to the Plenary for review.

STA 7

The STA 7 TACC was first increased under the AMP from 734 t to 900 t, beginning in the 1991–92 fishing year. The TACC was further increased to 997 t (TAC 1000 t) in October 2003.

Review of STA 7 AMP in 2007

In 2007 the AMP FAWG reviewed the performance of the AMP after 5 years (Starr *et al*. 2007b). This report was not updated in 2008. In 2007 the Working Group noted:

Fishery characterisation

- The STA7 TACC was increased from 528 t to 700 t in 1991–92 under an AMP. Two proposals were made in 2002 to increase this TACC, and the TACC was increased to 997 t in October 2002, with an additional 3 t for non-commercial catch, giving a total TAC of 1000 t.
- Catches exceeded the TACC in this fishery from entry into the QMS in 1986–87 until implementation of the most recent TACC increase in 2002–03, except in 1997–98 when a decline in the Asian market caused catches to dip below the TACC. In particular, catches escalated dramatically from 1997–98 to reach about double the TACC in 2000–01.
- Active management intervention (stopping of bycatch trading, implementation of the ACE provisions of the Fisheries Act and implementation of ramped deemed values) caused an even more dramatic drop in catches to just above the TACC level in 2001–02. Following the increase in TACC to 997 t in 2002–03, catches have remained near the TACC level.
- The Working Group noted that the ~50% drop in catch in 2001–02 in response to changes in the ACE and deemed value systems indicated a particularly strong ability to actively target or avoid stargazer in this fishery. It is certainly clear that the rapid increase in stargazer occurred in the 'barracouta' target fishery, probably due to the fact that barracouta was the cheapest quota to obtain at the time.
- Catch reporting in this fishery is poor, with estimated catches averaging 50% of landed catch, and landings exceeding estimated catches by up to 6 times. The Working Group also noted some unexplainable changes in conversion factors. RDM will be asked whether these are data capture errors, or actual entries on return forms.
- 97% of STA 7 are caught in bottom trawls, with 80% of the trawl landings coming from the southern half of the west coast South Island (Areas 032 to 034). Small amounts of catches are made by setnet or mid-water trawl. The trawl fishery catches STA year-round, whereas setnet fishery catches are mainly made from July to September. Seasons differ by area, with the Cook Strait mainly being fished in summer, whereas the southern areas are fished all year.
- Stargazer are mainly reported from the barracouta targeted trawl fishery, but data presented at previous meetings showed that no barracouta were caught when the large catches of stargazers were made.
- There has been a recent increase in STA catch in the tarakihi, red cod and stargazer targeted trawl fisheries, particularly in the southern areas. The bycatch of stargazer in the barracouta target fishery, has decreased in recent years, possibly due to regulation changes which reduced the incentive to declare this species as the target. Setnet STA catches are mainly made while targeting ling.

CPUE analysis

- Three fishery definitions were used in developing standardised CPUE indices for STA7: Trawl fishery targeting STA, BAR, RCO or TAR on the WCSI; the same mixed bottom trawl fishery in the Cook Strait; and the flatfish targeted WCSI trawl fishery.
- CPUE for these fishery definitions was standardised using a lognormal model based on non-zero catches. In addition, a binomial model was used to investigate the effect of changing proportion of non-zero catches.

- Standardisation had very little effect on the indices for the mixed target trawl fisheries relative to the unstandardised index. The standardised WCSI MIX index shows a steady increase to a peak in 2000–01, followed by a sharp drop to near the long-term average, coinciding with the drop in catches. The Cook Strait index shows a flat, stable trend across most of the series, but also with a sharp peak in 2000–01. It seems likely that the CPUE peaks and subsequent drop in catch rates relate more to targeting practices than to abundance.
- The FLA target index shows a steady increase from 1993–94 to a very strong peak in 1999–00, followed by a rapid decline back to the lowest levels by 2003–04. These changes are too large to relate to proportional changes in abundance, and may relate more to changes in availability to the near-shore flatfish fleet, fishing on the inshore edge of the stargazer depth distribution.
- The Working Group noted that the rapid doubling and halving of catch rates in the standardised CPUE indices cannot reflect proportional changes in abundance, and was rather an indication of very strong changes in fleet behaviour and targeting practices. This makes it difficult to decide what confidence to place in the indices.
- The group did note, however, that rapid changes in CPUE in the shallow flatfish fishery could reflect changes in availability of stargazer to this fleet, on the edge of the stargazer depth distribution.
- The strong effect that management changes (the introduction of ACE and changes in deemed values), and targeting responses by the industry, have likely had on CPUE were emphasized. The Working Group considered CPUE after these changes in 2000 to be less reliable and probably not comparable with CPUE prior to 2000.
- The Working Group again noted problems in interpreting reasons for the increase in non-zero catches in many fisheries, and confirmed that the binomial analyses should be accorded very little weight.
- In overview, the overlay of the trawl fishery indices seems to suggest fluctuations (related to targeting?) around a fairly flat trend across the series.

Trawl surveys

- The west coast trawl surveys are considered to be more reliable as indicators of abundance than those conducted on the east coast. Eight surveys have now been conducted from 1992 to 2007.
- Trawl survey estimates suggested a substantial decline in STA abundance in 2000, and again in 2003, after a period of stable estimates from 1992 - 1997, prompting concern that the stock was declining.
- However, estimates for 2005 and 2007 are again at or above the average of the 1992 to 1997 historic estimates. These recent estimates indicate that the low levels in 2000 and 2003 may have been due to catchability changes, as has occurred in the east coast survey.
- The overall trawl survey series indicates that the stock has remained stable at a fairly constant level, which seems to support indications in the trawl CPUE indices of a stable long-term trend.

Logbook programme

- Coverage of the west coast South Island trawl fishery is good, but no biological data for stargazer are being collected.

Effects of fishing

- Hector's dolphins aggregate in two areas of STA 7, Westport and Hokitika. However, there have been no known interactions between these trawl fisheries and dolphins off the WCSI. The Challenger Code of Practice states that trawlers are required not to haul nets when dolphins are present.
- Seabirds do occasionally get caught in BAR targeted fisheries in which STA 7 is caught. During 2005–06, 24 seabird captures were observed on 277 BAR trawls; an incidence rate was estimated to be 6.5%. However, observer coverage is inadequate to provide reliable estimates of effects of fishing across the fishery.

- The Working Group noted that fishers are able to target stargazer, which has lead to changes in fleet behaviour, probably related to changing fishing area and depth. This suggests that seabed effects, at least, may have changed. Changes such as this need to be measured and reported on.

Conclusions

- The results of the trawl surveys indicate that the STA 7 stock has remained stable since 1992. The standardised CPUE indices presented do not change that conclusion.

6. 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

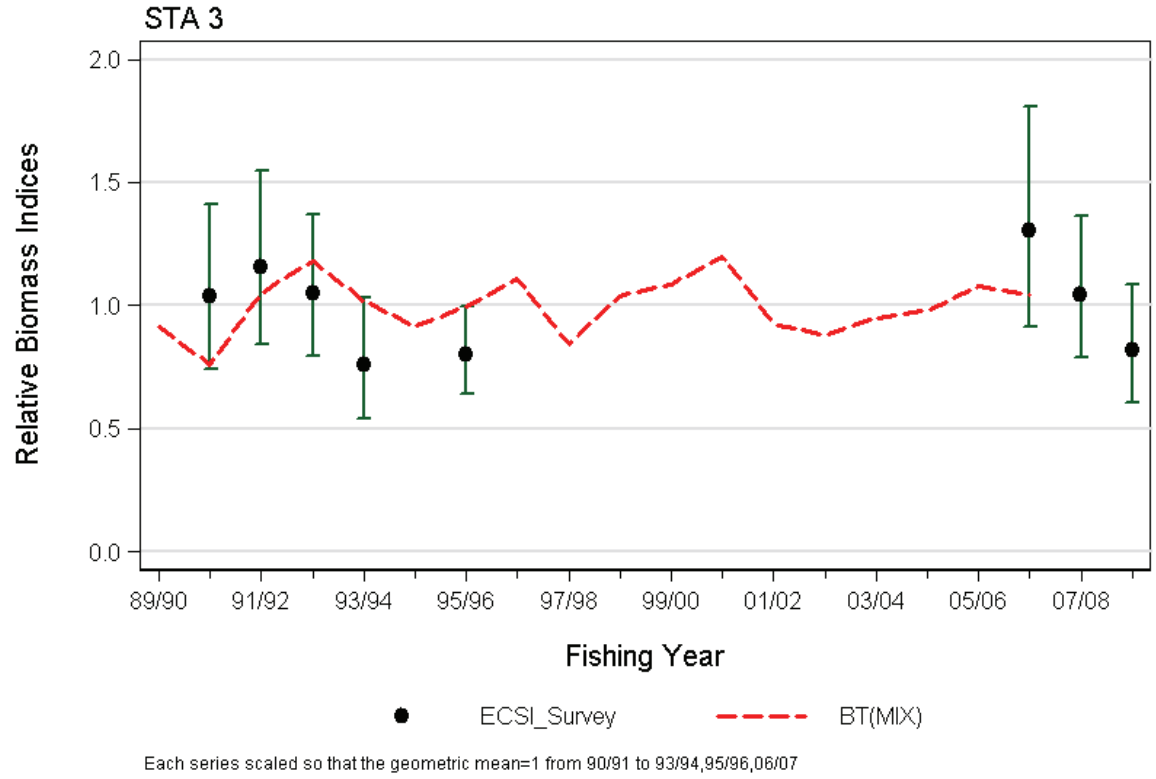
The TACC for STA 2 was increased from 37 t to 100 t in the 1991–92 fishing year under the AMP. Landings in the early 1990s peaked in the range of 105–125 t, but have subsequently declined.

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	2008
Assessment Runs Presented	
Reference Points	Target(s): Not established Soft Limit: 20% B_0 Hard Limit: 10%B_0
Status in relation to Target	Unknown
Status in relation to Limits	Unknown

Historical Stock Status Trajectory and Current Status



Comparison plot of a STA CPUE biomass index with the west coast South Island survey biomass index for. The trawl surveys were assumed to relate to the final year of the fishing year pair.

Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	While the CPUE indices have been relatively flat, fluctuating about the long-term mean, the two recent (2008 and 2009) ECSI survey estimates have shown progressive declines from the high in 2007 to just below the long-term mean.
Recent Trend in Fishing Mortality or Proxy	None
Other Abundance Indices	None
Trends in Other Relevant Indicators or Variables	None

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 to remain near current levels under current catch (2007/08 and 2008/09). It is Unknown if catches near the TACC would cause the stock to decline.
Probability of Current Catch or TACC causing decline below Limits	Soft Limit: Unlikely (< 40%) Hard Limit: Unlikely (< 40%)

Assessment Methodology		
Assessment Type	Level 2 – Partial quantitative stock assessment	
Assessment Method	Trawl survey biomass and standardized CPUE based on lognormal error distribution and positive catches.	
Main data inputs	Catch and effort data	
Period of Assessment	Latest assessment: 2008 (CPUE) 2010 (trawl survey)	Next assessment: 2011 (trawl survey)

Changes to Model Structure and Assumptions	None
Major Sources of Uncertainty	

Qualifying Comments

Fishery Interactions
40% of the bottom trawl landings of STA 3 are taken in the target red cod fishery, with remaining catches coming from the target flatfish, barracouta, hoki and tarakihi fisheries. Target STA only accounts for about 4% of the landings since 1989–90.

STA 4

Stargazer in this Fishstock occur mainly on the Chatham Rise and on the shelf around the Chatham Islands, but are sparsely distributed over the rest of the Rise. In most of this Fishstock they may not be economical 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 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 2158t. Catches have always been substantially less than the TACC. The average catch since the TACC increase has been 300t. It is not known if catches at the level of the current TACC would be sustainable. The status of STA 4 relative to B_{MSY} is unknown.

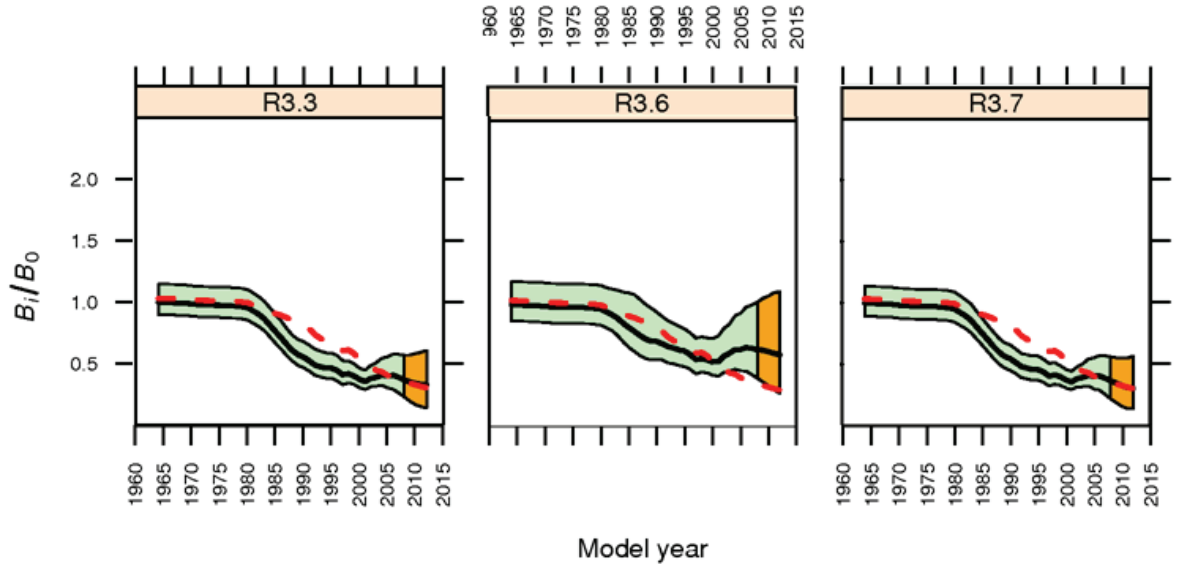
STA 5

The TACC for STA 5 was increased from 1239 t to 1500 t in the 1991–92 fishing year under the AMP. Landings increased to 1327 t in 1993–94, declined to 544 t in 1997–98, but have subsequently increased. The TACC was reduced to 1264 t in 1997, upon the removal of STA 5 from the AMP. This new TACC is at the level of recent catches, and is probably sustainable. The status of STA 5 relative to B_{MSY} is unknown.

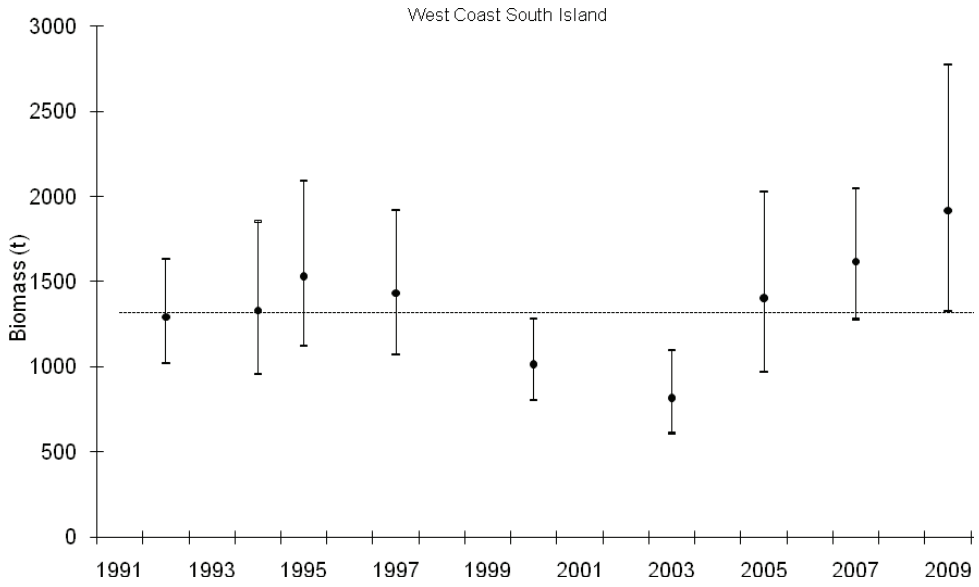
STA 7

Stock Status	
Year of Most Recent Assessment	2008 – Stock assessment 2009 – Analysis of survey indices of abundance
Assessment Runs Presented	Run 3.3 (base case), 3.6 (domed selectivity) and 3.7 (down weight 2000 and 2003 survey data points)
Reference Points	Target(s): Not established but B_{MSY} assumed Soft Limit: 20% B_0 Hard Limit: 10%B_0
Status in relation to Target	The range of model results for STA 7 west coast stock assessment suggests that, given the assumptions about recruitment, the stock is Likely (> 60%) to be near or above B_{MSY}.
Status in relation to Limits	Soft Limit: Very Unlikely (< 10%) to be below Hard limit: Very Unlikely (< 10%) to be below

Historical Stock Status Trajectory and Current Status



Relative SSB trajectories (green) and projected status assuming a future constant catch equal to the current catch (orange) calculated from the MCMC runs for model runs 3.3, 3.6, and 3.7 in the quantitative stock assessment of STA 7. The shaded region indicates the 95% credibility region about median SSB (dotted lines) calculated from each model's SSB posterior distribution.



Stargazer biomass ±95% CI (estimated from survey CV's assuming a lognormal distribution) and the time series mean (dotted line) estimated from the West Coast South Island trawl survey.

Fishery and Stock Trends	
Recent Trend in Biomass or Proxy	The WCSI trawl survey indices have increased from a low observed in 2003 to the highest in the series in 2009.
Recent Trend in Fishing Mortality or Proxy	None
Other Abundance Indices	None
Trends in Other Relevant Indicators or Variables	None

Projections and Prognosis	
Stock Projections or Prognosis	STA 7 stock is Likely (> 60%) to remain at or above B_{MSY} at current catch levels.

Probability of Current Catch or TACC causing decline below Limits	Soft Limit: Very Unlikely (< 10%) Hard Limit: Very Unlikely (< 10%)

Assessment Methodology		
Assessment Type	Level 1 –Quantitative stock assessment Level 2 – Agreed biomass index (WCSI trawl survey)	
Assessment Method	Bayesian Statistical stock assessment model implemented in CASAL. Evaluation of recent trawl survey indices (up to 2009).	
Main data inputs	An age-structured model partitioned by age (0–25 years) and sex was fitted to the WCSI trawl survey relative abundance indices (1992–05), WCSI survey proportions-at-age data (1992–05), and WCSI fishery catch-at-age data (2005 only) Commercial catch, trawl survey biomass and proportions-at-age estimates, and commercial catch proportions-at-age.	
Period of Assessment	Latest assessment: 2008 (assessment) 2009 (survey)	Next assessment: 2011 (survey)
Changes to Model Structure and Assumptions	None	
Major Sources of Uncertainty		

Qualifying Comments

Fishery Interactions
Smooth skates are caught as a bycatch in this fishery, and the biomass index for smooth skates in the west coast trawl survey has declined substantially since 1997. There may be similar concerns for rough skates but the evidence is less conclusive.

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.

Yield estimates, TACCs, and reported landings for the 2008–09 fishing year are summarised in Table 10.

Table 10: Summary of yields (t), TACC (t), and reported landings (t) of giant stargazer for the most recent fishing year.

Fishstock	QMA		MCY	CAY	TACC	Landings
STA 1	Auckland (East and West)	1 & 9	5	–	21	35
STA 2	Central (East)	2	20	–	38	22
STA 3	South-East (Coast)	3	390	–	902	574
STA 4	South-East (Chatham)	4	–	–	2 158	139
STA 5	Southland and Sub-Antarctic	5 & 6	–	–	1 264	1 137
STA 7	Challenger	7	595	936	997	1 001
STA 8	Central (West)	8	5		22	5
STA 10	Kermadec	10	–	–	10	0
Total			–	–	5 411	2 912

7. FOR FURTHER INFORMATION

Anderson OF., Bagley NW., Hurst J., Francis MP., Clark MR., McMillan PJ. 1998. Atlas of New Zealand fish and squid distributions from research bottom trawls. NIWA Technical Report 42. 303p.

Andrews, A.H. 2009. Feasibility of lead-radium dating giant stargazer (*Kathetostoma giganteum*). Final report submitted to the Ministry of Fisheries. Project STA2004-03, 6pp.

Bagley NW., Hurst RJ. 1995. Trawl survey of middle depth and inshore bottom species off Southland, February–March 1994 (TAN9402). New Zealand Fisheries Data Report 57. 50p.

Bagley NW., Hurst RJ. 1996a. Trawl survey of middle depth and inshore bottom species off Southland, February–March 1995 (TAN9502). New Zealand Fisheries Data Report 73. 47p.

Bagley NW., Hurst RJ. 1996b. Trawl survey of middle depth and inshore bottom species off Southland, February–March 1996 (TAN9604). New Zealand Fisheries Data Report 77. 51p.

Boyd RO., Reilly JL. 2005. 1999/2000 national marine recreational fishing survey: harvest estimates. Draft New Zealand Fisheries Assessment Report.

Bradford E. 1998. Harvest estimates from the 1996 national marine recreational fishing surveys. New Zealand Fisheries Assessment Research Document 1998/16. 27p. (Unpublished report held in NIWA library, Wellington).

Drummond KL., Stevenson ML. 1995a. Inshore trawl survey of the west coast South Island and Tasman and Golden Bays, March–April 1992 (KAH9204). New Zealand Fisheries Data Report 63. 58p.

Drummond KL., Stevenson ML. 1995b. Inshore trawl survey of the west coast South Island and Tasman and Golden Bays, March–April 1994 (KAH9404). New Zealand Fisheries Data Report 64. 55p.

Drummond KL., Stevenson ML. 1996. Inshore trawl survey of the west coast South Island and Tasman and Golden Bays, March–April 1995 (KAH9504). New Zealand Fisheries Data Report 74. 60p.

Hoenig JM. 1983. Empirical use of longevity data to estimate mortality rates. Fishery Bulletin 81: 898–903.

Hurst RJ., Bagley NW., Uozumi Y. 1990. New Zealand-Japan trawl survey of shelf and upper slope species off southern New Zealand, June 1986. New Zealand Fisheries Technical Report No. 18. 50p.

Hurst RJ., Bagley NW. 1987. Results of a trawl survey of barracouta and associated finfish near the Chatham Islands, New Zealand, December 1984. New Zealand Fisheries Technical Report No. 3. 44p.

Hurst RJ., Fenaughty JM. 1986. Report on biomass surveys 1980–84; summaries and additional information. Fisheries Research Division Internal Report No. 21.

Hurst RJ., Bagley NW. 1994. Trawl survey of middle depth and inshore bottom species off Southland, February–March 1993 (TAN9301). New Zealand Fisheries Data Report 52. 58p.

Hurst RJ., Bagley NW. 1997. Trends in Southland trawl surveys of inshore and middle depth species, 1993–96. New Zealand Fisheries Technical Report 50. 66p.

Langley AD. 2002. The analysis of STA 3 catch and effort data from the RCO 3 target trawl fishery, 1989–90 to 2000–01. Draft New Zealand Fisheries Assessment Report.

Lydon GJ., Middleton DAJ., Starr PJ. 2006. Performance of the STA 3 Logbook Programmes. AMP-WG-06/21. (Unpublished manuscript available from the NZ Seafood Industry Council, Wellington).

Manning MJ. 2005. On fitting and comparing selected statistical models of fish growth. Unpublished MSc thesis, University of Auckland, Auckland, New Zealand. 162p.

Manning, M.J. (2008). The first quantitative stock assessment of giant stargazer (*Kathetostoma giganteum*) in STA 7. New Zealand Fisheries Assessment Report 2008/33. 82 p.

Manning, M.J. (2007). Relative abundance of giant stargazer (*Kathetostoma giganteum*) in STA 5 based on commercial catch-per-unit-effort data. New Zealand Fisheries Assessment Report 2007/14. 42 p.

Manning MJ., Sutton CP. 2004. Age and growth of giant stargazer, *Kathetostoma giganteum*, from the West Coast of the South Island (STA 7). New Zealand Fisheries Assessment Report 2004/17. 60p.

Manning, M.J.; Sutton, C.P. (2007). Further study on the age and growth of giant stargazer, *Kathetostoma giganteum*, from the west coast of the South Island (STA 7). New Zealand Fisheries Assessment Report 2007/12. 68 p.

Manning, M.J.; Sutton, C.P. (2007). The composition of the commercial and research stargazer (*Kathetostoma giganteum*) catch off the west coast of the South Island (STA 7) during the 2004–05 fishing year. New Zealand Fisheries Assessment Report 2007/36. 43p.

Phillips NL. 2001. Descriptive and CPUE analysis of catch and effort data for the giant stargazer (*Kathetostoma giganteum*) in the STA 5 fishery from the 1989–90 to the 1999–00 fishing year. Draft New Zealand Fisheries Assessment Report.

Seafood Industry Council (SeaFIC) 2002. Performance of the STA 7 Adaptive Management Programme. Unpublished report presented to the Adaptive Management Programme Fishery Assessment Working Group on 4 March 2002. p. (Unpublished report available from Ministry of Fisheries, Wellington).

Seafood Industry Council (SeaFIC) 2003a. Performance of the STA 3 Adaptive Management Programme. Unpublished report presented to the Adaptive Management Programme Fishery Assessment Working Group as document AMP-WG-2003/02. 43 p. (Unpublished report available from Ministry of Fisheries, Wellington).

Seafood Industry Council (SeaFIC) 2003b. Performance of the STA 7 Adaptive Management Programme. Unpublished report presented to the Adaptive Management Programme Fishery Assessment Working Group as document AMP-WG-2003/14. 42 p. (Unpublished report available from Ministry of Fisheries, Wellington).

Seafood Industry Council (SeaFIC) 2005a. Performance of the STA 3 Adaptive Management Programme. Unpublished report presented to the Adaptive Management Programme Fishery Assessment Working Group as document AMP-WG-2005/19. p. (Unpublished report available from Ministry of Fisheries, Wellington).

Seafood Industry Council (SeaFIC) 2005b. Performance of the STA 7 Adaptive Management Programme. Unpublished report presented to the Adaptive Management Programme Fishery Assessment Working Group as document AMP-WG-2005/09. p. (Unpublished report available from Ministry of Fisheries, Wellington).

SEFMC 2002. 2002 report to the Adaptive Management Programme Fishery Assessment Working Group: review of the STA 3 Adaptive Management Programme. Unpublished report presented to the Adaptive Management Programme Fishery Assessment Working Group on 1 March 2002. p. (Unpublished report available from Ministry of Fisheries, Wellington).

Starr PJ., Kendrick TH., Lydon GJ., and Bentley N. 2007a. Report to the Adaptive Management Programme Fishery Assessment Working Group: STA 3 Adaptive Management Programme. AMP-WG-07/27. (Unpublished manuscript available from the NZ Seafood Industry Council, Wellington). 6p.

Starr PJ., Kendrick TH., Lydon GJ., and Bentley N. 2007b. Report to the Adaptive Management Programme Fishery Assessment Working Group: Full-term review of the STA 7 Adaptive Management Programme. AMP-WG-07/14. (Unpublished manuscript available from the NZ Seafood Industry Council, Wellington). 65p.

Starr PJ., Kendrick TH., Lydon GJ., and Bentley N. 2008. Report to the Adaptive Management Programme Fishery Assessment Working Group: Full-term review of the STA 3 Adaptive Management Programme. AMP-WG-08/07-rev.2 (Unpublished manuscript available from the NZ Seafood Industry Council, Wellington). 102p.

Stevenson ML. 1998. Inshore trawl survey of the west coast South Island and Tasman and Golden Bays, March–April 1997 (KAH9701). NIWA Technical Report 12. 70p.

Stevenson ML. 2002. Inshore trawl survey of the west coast South Island and Tasman and Golden Bays, March–April 2000 (KAH0004). NIWA Technical Report 115. 71p.

Stevenson ML. 2004. Trawl survey of the west coast of the South Island and Tasman and Golden Bays, March–April 2003 (KAH0304). New Zealand Fisheries Assessment Report 2004/4. 69p.

Stevenson ML., Hanchet SM. 2000. Review of the inshore trawl survey series of the west coast South Island and Tasman and Golden Bays, 1992–1997. NIWA Technical Report 82. 79p.

Stevenson, M/L. 2007. Inshore trawl surveys of the west coast of the South Island and Tasman and Golden Bays, March-April 2007 (KAH0704). New Zealand Fisheries Assessment Research Document 2007/41: 64p

Sutton CP. 1999. Ageing methodology, growth parameters, and estimates of mortality for giant stargazer (*Kathetostoma giganteum*) from the east and south coasts of the South Island. New Zealand Fisheries Assessment Research Document 1999/15. 19 p.

Sutton CP. 2004. Estimation of age, growth, and mortality of giant stargazer (*Kathetostoma giganteum*) from Southland trawl surveys between 1993 and 1996. New Zealand Fisheries Assessment Report 2004/38. 14p.

Tate ML. 1987. The species and stock structure of the New Zealand inshore fishery for giant stargazer. University of Otago, Dunedin. 134p.

Vignaux M. 1997. CPUE analyses for fishstocks in the adaptive management programme. New Zealand Fisheries Assessment Research Document 1997/24. 68p.