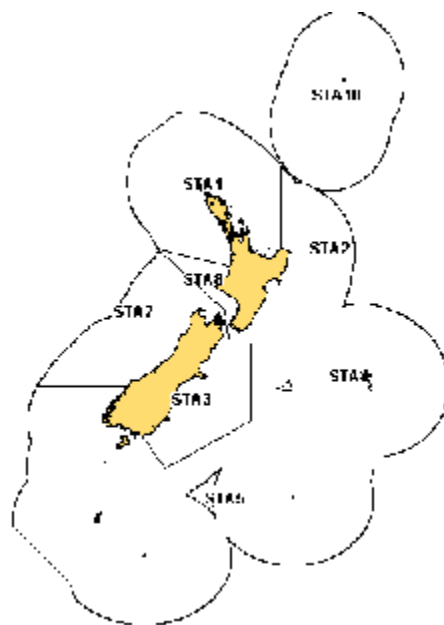


STARGAZER (STA)

(*Kathetostoma giganteum*)



1. FISHERY SUMMARY

(a) 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 in waters to 500 m in depth, but is most common in depths between 50–300 m on the continental shelf around the South Island (Anderson et al. 1998), where it supports moderate-value, commercial trawl fisheries. 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 or target fishing and as bycatch of fishing 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 and off Cape Campbell on the east coast of the South Island. It is also caught by small domestic trawl vessels targeting red cod (*Pseudophycis baccus*), tarakihi (*Nemadactylus macropterus*), flatfishes (*Colistum* spp., *Peltorhamphus* spp., and *Rhombosolea* spp.), and scampi (*Metanephrops challengerii*) 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. Catches by methods other than bottom-trawling are minimal. Reported landings by vessel flag 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.

Year	New Zealand		Foreign licensed	Total	Year	New Zealand		Foreign licensed	Total
	Domestic	Chartered				Domestic	Chartered		
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.

Table 2: Reported landings (t) of giant stargazer by QMS Fishstock (QMA) from 1983 to 2004–05. TACCs from 1986–87 to 2004–05 are also provided.

Fishstock FMA(s)	STA 1 1 & 9		STA 2 2		STA 3 3		STA 4 4		STA 5 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

Fishstock FMA(s)	STA 7 7		STA 8 8		STA 10 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†	1028	997	5	22	0	10	3 381	5 412

* FSU data.

† QMS 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 was fully implemented by 1986–87. Reported landings since 1983 by QMS Fishstock are given in Table 2. The total catches for 1986–87 and 1987–88 in Table 1 are less than the those in Table 2 because of under-reporting to the FSU during these years.

After 1983, the catch began to increase rapidly, reaching 3426 t in 1990–91, and averaging 3192 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. Fishstock STA 7 was reviewed in 1998 and retained in the AMP until the end of the 2001–02 fishing year. It was reviewed again in 2002 and retained in the AMP for a third five-year term until the end of 2006–07. The TACC in STA 7 was 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 fishing and a 1 t customary fishing allowance).

Of the eight Fishstocks, the most important in terms of the amount of recorded landed catch are STA 5, STA 7, and STA 3 (where landings since 1990–91 have averaged 1048 t, 914 t, and 760 t, respectively) with lesser contributions from STA 4 and STA 2. Although a high TACC is set for STA 4 compared with the other seven Fishstocks, it has never been approached let alone exceeded. Most of the (STA 4) catch is caught as bycatch of fishing directed at other target species and a high recorded landed catch in 1990–91 (790 t) was due to exploratory fishing for these target species that 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 to the development of the scampi fishery in this Fishstock. Giant stargazer is an important bycatch of scampi fishing in Fishstocks STA 2–4.

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.

The landings data (Table 1 and Table 2) probably include an unknown amount of catch from other uranoscopid species misidentified as *K. giganteum*. Fishers in STA 1–3 and 8 are known to have reported 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.

(b) 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 catch of only a few giant stargazers was 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 during the 1999–2000 national diary survey (Boyd & Reilly 2005).

(c) **Maori customary fisheries**

No quantitative information is available on the level of Maori customary take.

(d) **Illegal catch**

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

(e) **Other sources of mortality**

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

2. BIOLOGY

As noted, 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 and west of the Chatham Islands 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 (2006a) 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 2006b, 2006a), although otolith growth zones are yet to be validated.

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 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 2006a). 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
I. Natural mortality		
STA 5	0.20	Sutton (2004)
STA 7	0.18	Manning (2006a)

Table 3 (continued)

2. Weight = a(length)^b (weight in g; length in cm total length)

STA	Males	Females	All fish	
STA 3				
a	–	–	0.015	S. McClatchie (unpubl. data)
b	–	–	3.01	
STA 5				
a	–	–	0.024	G. McGregor (unpubl. data)
b	–	–	2.92	
STA 7				
a	0.008	0.008	0.007	Manning & Sutton (2006a)
b	3.18	3.21	3.23	

3. Length at maturity (cm total length)

STA	Males	Females	
STA 7			Manning (2006a)
150	40.98	54.37	
195	14.90	11.24	

4. Age at maturity (years)

STA	Males	Females	
STA 7			Manning (2006a)
a50	5.53	7.23	
a95	4.38	4.34	

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

STA	Males	Females	
STA3			
K (yr ⁻¹)	0.2	0.14	Sutton (1999)
L _∞ (cm)	61.49	78.11	
t ₀ (yr)	-0.97	-1.25	
STA5			
K (yr ⁻¹)	0.19	0.18	Sutton (1999)
L _∞ (cm)	59.12	73.92	
t ₀ (yr)	-1.19	-0.22	
STA5			
K (yr ⁻¹)	0.18	0.17	Sutton (2004)
L _∞ (cm)	60.76	72.61	
t ₀ (yr)	-1.16	-0.02	
STA 7			
K (yr ⁻¹)	0.15	0.13	Manning & Sutton (2006a); a
L _∞ (cm)	71.00	85.74	revision of earlier results presented
t ₀ (yr)	-0.664	-0.666	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. 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 to differ significantly between the east, south, and west coasts of the South Island (Manning & Sutton 2004, Manning 2005). This is consistent with the Fishstock boundaries in use at this time.

4. STOCK ASSESSMENT

There are no new data that are available at this time that would alter the yield estimates given in the 1997 Plenary Report. The yield estimates are based on commercial landings data.

(a) Estimates of fishery parameters and abundance(i) 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 (c.v.) 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)	c.v. (%)
Giant stargazer	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
	ECSI (Winter)	STA 3	1991	KAH9105	600	17
			1992	KAH9205	669	16
			1993	KAH9306	609	14
			1994	KAH9406	462	15
			1996	KAH9606	465	11
	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
2002			TAN0201	2 195	16	
2003			TAN0301	1 380	15	
2004	TAN0401	2 625	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	KAH05	1 429	19			
		1 429	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

(ii) CPUE analysis**STA 2 and 3**

CPUE indices calculated for STA 2 (Vignaux 1997), STA 3 (SEFMC 2002, SeaFIC 2005a) and STA 7 (SeaFIC 2002, 2003b, 2005b) have been based on bycatch fisheries. The Inshore and AMP Fishery Assessment Working Groups have had concerns over using bycatch fisheries to monitor stargazer abundance in these areas due to the low proportion of the total QMR landings used in the analyses, and possible changes in recording and fishing practices. In 2002, the AMP FAWG accepted an interim decision rule based on CPUE indices for bycatch of STA 3 in the RCO 3 trawl fishery (SEFMC 2002). The standardized CPUE trend was updated to 2003/04 in 2005 (SeaFIC 2003a), based on tows targeting red cod, barracouta and tarakihi.

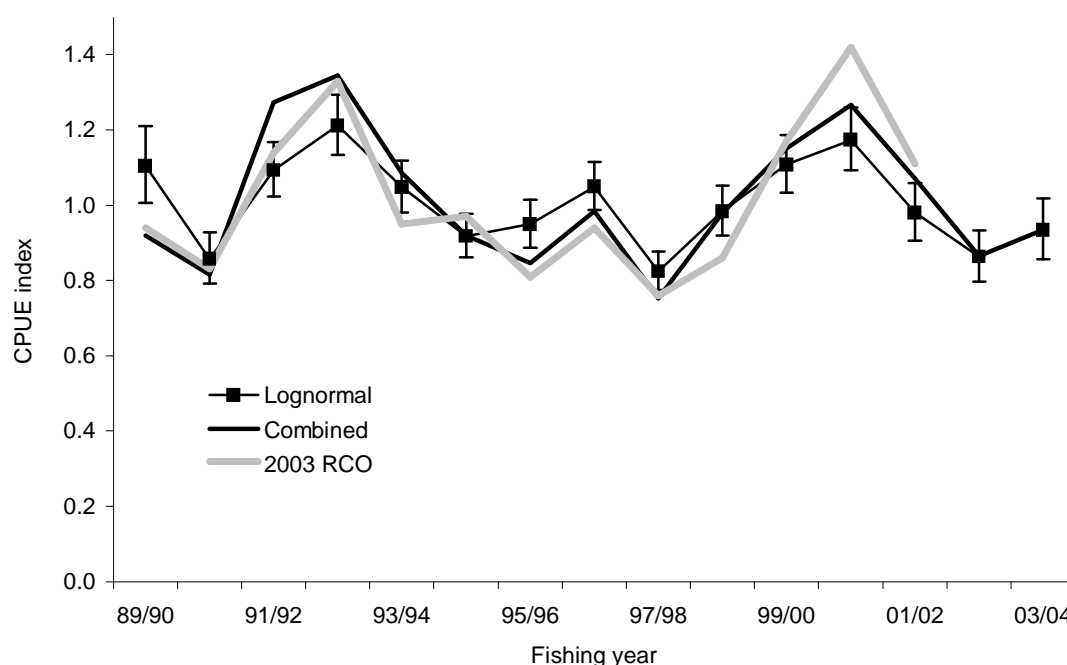


Figure 1: Comparison of three CPUE series for STA 3: [square markers] lognormal analysis of the MIX fishery; [thick line] combined lognormal and binomial model for the MIX fishery; [grey line] lognormal model from 2003 RCO analysis. The MIX analysis was based on tows targeting RCO, BAR and TAR. Target species was offered to the model as an explanatory variable.

STA 4

Stargazer in STA 4 are taken as a bycatch of the fisheries for hoki, ling, silver warehou, squid, barracouta, red cod and scampi on the Chatham Rise, as bycatch of 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 (*Thyrstites atun*), jack mackerels (*Trachurus* spp.), and squids (*Nototodarus* spp.). Catches by methods other than bottom-trawling are very small.

Vignaux (1997) was the first to present standardised CPUE indices for STA 5. She analysed data 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 (2006b) 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 (2006b) 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 2). The trend in the standardised CPUE indices between the 1992–3 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*, 1993–1996 (Figure 2) (Hurst & Bagley 1994, Bagley & Hurst 1995, 1996a, 1996b, Hurst & Bagley 1997). The peak then decline in the standardised CPUE and trawl survey relative biomass indices may, however, reflect a change in catchability rather than in stock abundance.

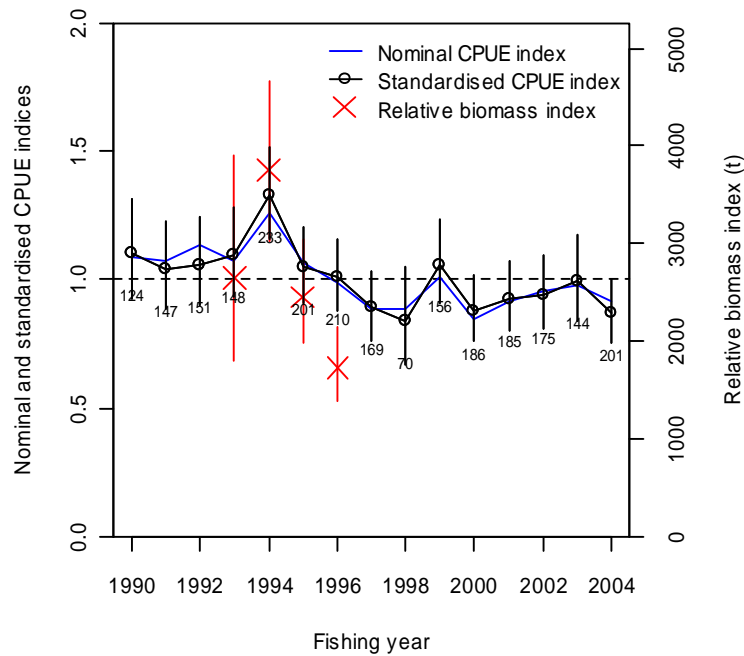


Figure 2: The standardised CPUE indices from the fit of model 2.4 presented by Manning (2006a). The nominal CPUE and trawl survey relative biomass estimates from the SCSi survey series by RV Tangaroa (1993–1996) have been overlaid for comparison. The nominal CPUE and trawl survey relative biomass indices have been rescaled so that all three series can be displayed on the same plot.

(b) 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 (1992–2005), WCSi survey proportions-at-age data (1992–2005), and WCSi fishery catch-at-age data (2005 only) (Manning 2006a). 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. Three sets of preliminary model results comprising a total of 23 different model runs were presented during 2006, but a final assessment model was not agreed on by the Inshore FAWG. The Inshore FAWG agreed to defer the final assessment until 2007–08, after the 2007 West Coast South Island survey relative biomass, survey proportions-at-age, and fishery proportions-at-age data become available.

Considering that a final model has not yet been decided on and maximum-sustainable yields and stock-status projections for the final model have not yet been carried out (these have been done for the base

Table 6: The STA 7 model’s annual cycle (Manning 2006a). 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.

Time step	Duration	Processes applied	Proportions			Observations
			M	F	Age	
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 (instantaneous)	Spawning Age incrementation	0.00	0.00	0.00	Nil
3	Jun–Sep	Recruitment Mortality (M, F)	0.25	0.23	0.00	Fishery catch-at-age

case or initial model but should not be viewed as anything other than preliminary results), the stock appears to be at or above its maximum sustainable yield. It is very unlikely to be below. Comparing all model runs presented to date, current biomass (B_{2005}) as a percentage of virgin or unfished biomass (B_0) is very likely to be at least 27%, and more probably in the range of 35–45% (Table 7; Figure 3).

Table 7: MCMC initial and current biomass estimates for the STA 7 model runs R3.1 to R3.4 (Manning 2006a). 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 , i th quantile. The interval $(Q_{0.025}, Q_{0.975})$ is a Bayesian credibility interval (a Bayesian analogue of frequentist confidence intervals).

	R3.1			R3.2		
	B_0	B_{2005}	$(B_0 / B_{2005})\%$	B_0	B_{2005}	$(B_0 / B_{2005})\%$
Min	7211	1576	21.86	7867	1749	22.18
$Q_{0.025}$	7526	1984	26.18	7983	1951	24.35
Median	8011	2570	32.16	8262	2249	27.22
Mean	8033	2606	32.33	8281	2264	27.30
$Q_{0.975}$	8671	3413	39.51	8673	2671	30.83
Max	9187	3945	43.71	9218	3195	34.75
	R3.3			R3.4		
	B_0	B_{2005}	$(B_0 / B_{2005})\%$	B_0	B_{2005}	$(B_0 / B_{2005})\%$
Min	6888	3122	42.36	6644	3002	43.60
$Q_{0.025}$	7980	4685	58.48	7035	3655	51.24
Median	11167	8666	77.49	8140	5168	63.65
Mean	11958	9467	77.06	8455	5493	64.05
$Q_{0.975}$	20536	19146	94.17	11593	9104	78.50
Max	32287	30926	104.27	20964	18805	89.70

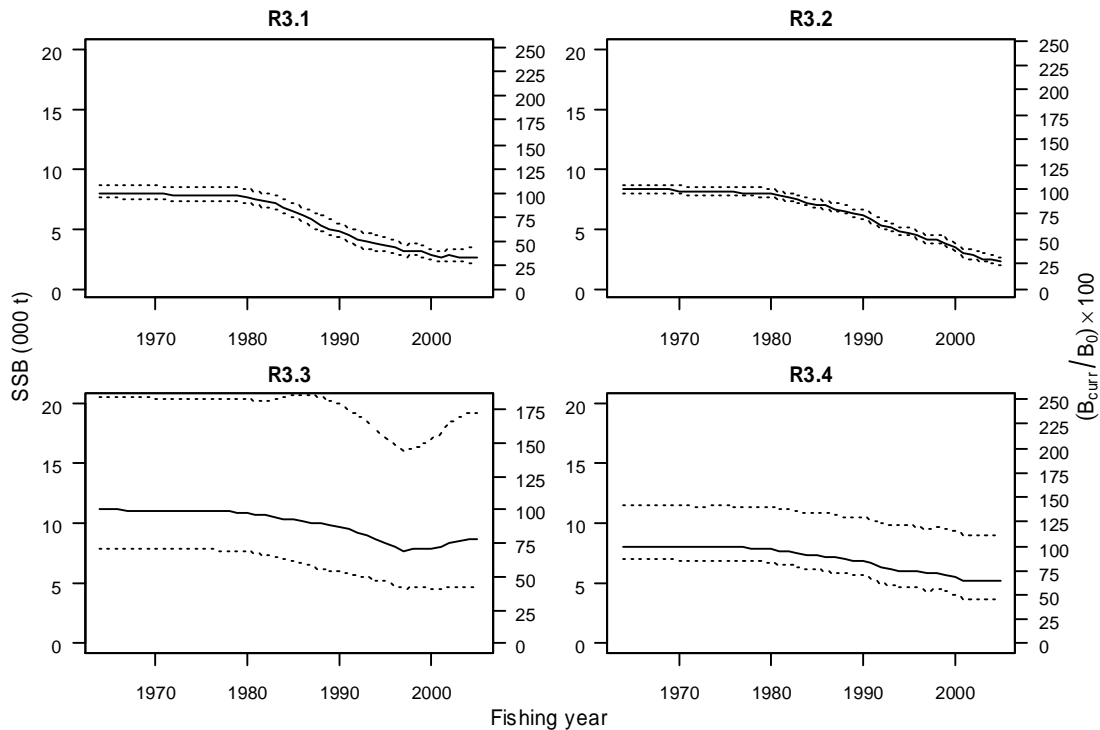


Figure 3: Biomass trajectories for runs R3.1 to R3.4 calculated from the corresponding MCMC samples of each model run's posterior distribution. The solid line is the median current spawning-stock biomass (SSB) in a given fishing year. The dotted lines indicate the 95% plausibility region about the median biomass. Note the different scales on the y-axis of each plot.

Estimates of current biomass are not yet available for any Fishstocks.

(c) **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.

(d) 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 Table 8.

Table 8: Giant stargazer yield estimates (t).

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 7	280
	STA 8	5
	CAY	All

(e) 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.

(f) 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 uneconomic to target stargazer except near the Chatham Islands. However, 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. Stargazers 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 adaptive management programme (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.

Mid-term Review of STA 3 AMP in 2005

In 2005 the AMP FAWG reviewed the performance of the STA 3 AMP after two years in the current 5-year term and 12 years at the higher TACC (SeaFIC 2005a). The WG noted that:

Characterisation

- Almost 95% of the annual STA 3 landings are bottom trawled. Most of the catch is taken in the mixed species bottom trawl fishery targeting RCO (40%), BAR (13%) and TAR (6%) and in the bottom trawl fisheries targeting FLA (12%) and Hoki (11%).
- The annual reported catch dropped from 863 t in 2002/03 to 578 t in 2003/04; the lowest since 1986. Anecdotal evidence suggests that there was likely to have been a drop in market demand for this product in 2003/04.

Abundance Index

- When the East Coast South Island trawl survey was discontinued (after 2001), standardized CPUE based on non-zero STA 3 catches in the RCO 3 bottom trawl fishery was accepted as an alternative index of abundance. Industry expanded the model in 2005 to include catches made whilst targeting BAR and TAR. Target was offered as an explanatory variable (MIX model).
- Standardized CPUE showed cyclical trends with an overall pattern that was essentially flat (1989/90 – 2003/04). Trends were very similar to those of the previous analysis based on RCO only. The variance and diagnostics were acceptable. The current analysis also included improvements to the grooming procedure.
- Inshore and offshore strata were combined for the current analysis. Owing to possible confounding effects introduced by inter-annual patterns of fishing behaviour, the offshore strata should be excluded from future CPUE standardization.
- The decision rule for STA 3 is based on the mean CPUE index between 1991/92 and 2000/01. The current index is almost twice the 50% threshold.
- Possible changes to the conversion factor (as encountered with SPO 3) would, however, have biased the CPUE trends. This should be investigated before the full-term review.
- Industry also provided two additional standardized CPUE trends based on STA 3 catches in the FLA and HOK fisheries. The HOK index depicted an increasing trend while the FLA index showed a sharp increase in 2000/01 followed by a strong decline. Given that FLA and HOK fisheries operate at the lower and upper limits of the depth distribution of STA3, the MIX model is believed to better represent abundance of STA3.
- Relative biomass indices from annual trawl surveys on the western end of Chatham rise (west of 180 degrees) showed no overall trend. It is not clear whether this index represents a consistent index of the population biomass or a variable portion within the survey area because the survey only begins its coverage at 200 m, which does not cover the full depth range for stargazer. Representative distribution of STA for recent surveys should also be provided in future presentations but this cannot address the coverage of depths more shallow than 200 m.

STA 3 Decision Rule

- If the CPUE biomass index based on the target RCO 3 trawl fishery falls below a threshold of 50% of the mean biomass index between 1991–92 and 2000–01, then the AMP FAWG will review the current stock status information for STA 3 to determine if the Fishstock has dropped below the level which will support the MSY. However, the AMP FAWG will consider all available data when this AMP is reviewed.
- The 2003/04 relative index was almost twice the threshold value.

Environmental Considerations

- STA 3 is taken as a bycatch in the mixed species bottom trawl fishery. This fishery has had a long history and the increase in STA 3 TACC may not have resulted in new areas fished or significant increases in effort.
- On the other hand the introduction of closed areas (voluntary or statutory) is likely to have displaced some effort and this should be addressed in future presentations.

Log Book Programme

- Given the uncertainty regarding standardized CPUE as an index of abundance, patterns in age/size structure of the catch are useful for both validating and interpreting CPUE trends
- The east coast South Island bottom trawl fishery logbook programme was initially developed to sample elephantfish and no vessel reported stargazer during the 2002/03 fishing year.
- One vessel measured 160 fish that were taken during 8 tows of a single trip which took place in 2003/04.
- The AMP FAWG reported in 2004 that “Appropriate logbook coverage for STA 3 should be initiated as soon as possible”. Log book coverage remains inadequate and should be increased to appropriate levels as soon as possible.

Conclusion

- Assuming that the standardized CPUE indices of the mixed model do track STA 3 abundance, the stock does not appear to have declined since it was introduced into the AMP 13 years ago.
- There is no biological information to corroborate this conclusion as the trawl sampling programme has not yet been implemented.
- It is not known where the stock is in relation to Bmsy
- Future CPUE standardization should exclude offshore strata.
- Maps of STA distribution should in future be presented in conjunction with the relative biomass indices generated by the Chatham Rise trawl survey.

Annual Review of STA 3 AMP in 2006

In 2006 the AMP FAWG reviewed the performance of the STA 3 AMP after 3 years in the current 5-year term and 13 years at the higher TACC (Lydon et al. 2006). The WG noted that:

Background

- The previous 5-year AMP term for STA 3 ended in September 2003 with the current AMP 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.
- The original AMP proposal included log-book coverage of ELE and STA caught in the target RCO 3 bottom trawl fishery.
- At the full-term review of the previous AMP term (March 2003), the AMP FAWG suggested that the biological monitoring of this Fishstock be revised due to the discontinuation of the east coast South Island trawl survey and requested logbook coverage of RCO 3 bottom trawl fishery.

Logbook programme

- More than 95% of the STA 3 TACC is taken by bottom trawl.
- Less than 0.5% of the catch was sampled by the logbook programme. The main reason for this poor performance is the lack of participation by vessels targeting RCO, BAR and TAR.
- In 2005 the AMP FAWG concluded that “Logbook coverage remains inadequate and should be increased to appropriate levels as soon as possible”. This conclusion remains unchanged.

STA 7

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

Mid-term Review of STA 7 AMP in 2005

In 2005 the AMP FAWG reviewed the performance of the AMP after 2 years in the current 5-year term (SeaFIC 2005b). The WG noted:

Characterisation

- Although the TACC was substantially overcaught prior to October 2002, annual landings have remained within the new TACC.
- STA 7 are mostly taken by bottom trawl in the southern part (i.e. statistical area 32,33,34) of FMA 7 as a bycatch of a mixed species bottom trawl fishery.

Abundance index

- The accepted abundance index for the STA 7 AMP is the series of relative biomass generated by WCSI fishery independent bottom trawl surveys.
- The decision rule is based on the mean relative biomass of STA 7 for the period 1992-1997 (1413t).
- This index declined from 1551 in 1995 to 827 in 2003 (i.e. 58.6% of 1413). The relative biomass index from the 2005 survey was 1426t, suggesting that stock size had increased since the 2003 survey.
- Although the abundance index accepted for this AMP is based on fishery independent surveys, Challenger Finfish MC provided standardized CPUE series for STA 7 taken in the west coast South Island flatfish and the mixed species (STA, BAR, TAR & RCO) bottom trawl fisheries as well as the Cook Strait mixed species (STA, BAR, TAR & RCO) bottom trawl fishery.
- The diagnostics for the lognormal model of positive catches in the mixed species fishery were very poor although the diagnostics for the other two trawl fisheries were better. However, the CPUE trends in all three fisheries were similar, indicating a peak abundance in 2000/01 and a flat trajectory since 2002/03.
- Fishery dependant CPUE was previously rejected by the AMP FAWG as an index of abundance.
- Trends in CPUE and the survey biomass indices were poorly correlated, but currently show similar levels of relative abundance.

STA 7 Decision Rule (current)

- If the biomass index of STA 7, as determined by the WCSI trawl survey, falls by 30% or more from the average level achieved from 1992 to 1997, then the assessment must be referred back to the AMP FAWG for evaluation.
- The decision rule was triggered in 2003 because the biomass index for giant stargazer (827 t) was 41% below the average of the 1992–97 surveys (1413 t).
- The 2005 relative biomass (1429t) is above the mean for the 1992-1997 period.

Log Book Programme

- Logbook coverage is not required as both the abundance index and biological data are collected by the WCSI trawl survey.
- Some high spatial resolution catch and effort data are collected by logbook programmes targeting SPO 7 and bluenose.

Environmental considerations

- STA 7 is taken as a bycatch of a mixed species bottom trawl fishery. This fishery has had a long history and the increase in STA7 is unlikely have resulted in new areas fished or significant increases in effort.

Conclusion

- Current relative biomass (1429t) is above the mean for the 1992-1997 period.
- It is not clear whether STA 7 is above or below Bmsy. A stock assessment of STA 7 is currently underway.

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 adaptive management programme. 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 or if they are at levels that will allow the stocks to move towards a size that will support the MSY.

STA 2

The TACC for STA 2 was increased from 37 t to 100 t in the 1991–92 fishing year under the adaptive management programme. Landings in the early 1990s peaked in the range of 105–125 t, but have subsequently declined. Recent relative abundance indices from both the ECNI inshore trawl survey and the ECNI scampi trawl survey are lower than those in 1993. The 1997 assessment suggested that the exploitation rate was very high, but the model results were 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 was considered unrealistically high.

The TACC was reduced back to 38 t in the 1997–98 fishing year, upon the removal of STA 2 from the adaptive management programme. Landings have been slightly above the TACC in recent years. It is not known whether recent catches and the current TACC are sustainable or whether they would allow the stock to move towards a size that would support the MSY.

STA 3

STA 3 is being managed within an adaptive management programme with a decision rule relating to a biomass index and the review of a range of information to ascertain stock status. The TACC for STA 3 was increased from 734 t to 900 t in the 1991–92 fishing year under the adaptive management programme. In 2001, the Plenary agreed that the decision rule needed to be replaced, as the ECSI summer trawl survey had been discontinued. A new decision rule based on the CPUE biomass index in the target RCO 3 trawl fishery was proposed as an interim decision rule until the new trawl survey is established. This decision rule was not triggered in 2005, as CPUE remained at almost twice the threshold value.

Relative biomass indices for stargazer from the annual trawl survey of the western end of the Chatham Rise have remained stable. It is not known if recent catch levels and the current TACC are sustainable in the long-term, or whether they are at levels that will allow the stock to move towards a size that would support the maximum sustainable yield.

STA 4

Stargazers 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 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 current 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. Recent catches have been substantially less than the TACC; the stock appears to have been lightly fished and is still likely to be in the fishing down phase. It is not known if catches at the level of the current TACC would be sustainable or would allow the stock to move towards a size that will support the MSY.

STA 5

The TACC for STA 5 was increased from 1239 t to 1500 t in the 1991–92 fishing year under the adaptive management programme. 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 adaptive management programme. This is at the level of recent catches, and is probably sustainable. It is not known if recent catch levels and current TACC are at levels that will allow the stock to move towards a size that will support the MSY.

STA 7

The TACC for STA 7 was increased from 700 t to 997 t from 1 October 2002. STA 7 is being managed within an adaptive management programme with a decision rule relating to a biomass index from trawl surveys and a review of other data. Despite the biomass index in the 2003 trawl survey being 41% below the average biomass index between 1992–97, the results of a preliminary stock assessment suggest that STA 7 is at or above the level that will support MSY.

STA 8

The TACC for STA 8 increased from 22 t to 50 t in the 1993–94 fishing year under the adaptive management programme. 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 adaptive management programme. It is not known if recent catch levels and current TACC are sustainable or if they are at levels that will allow the stock to move towards a size that will support the MSY.

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

Fishstock	QMA		MCY	TACC	landings
STA 1	Auckland (East and West)	1 & 9	5	21	27
STA 2	Central (East)	2	20	38	28
STA 3	South-East (Coast)	3	390	902	646
STA 4	South-East (Chatham)	4	–	2 158	366
STA 5	Southland and Sub-Antarctic	5 & 6	–	1 264	1 282
STA 7	Challenger	7	280	997	1 028
STA 8	Central (West)	8	5	22	5
STA 10	Kermadec	10	–	10	0
Total			–	5 412	3 381

7. FOR FURTHER INFORMATION

- Anderson, O.F.; Bagley, N.W.; Hurst, J.; Francis, M.P.; Clark, M.R.; McMillan, P.J. (1998). Atlas of New Zealand fish and squid distributions from research bottom trawls. *NIWA Technical Report 42*. 303 p.
- Bagley, N.W.; Hurst, R.J. (1995). Trawl survey of middle depth and inshore bottom species off Southland, February–March 1994 (TAN9402). *New Zealand Fisheries Data Report 57*. 50 p.
- Bagley, N.W.; Hurst, R.J. (1996a). Trawl survey of middle depth and inshore bottom species off Southland, February–March 1995 (TAN9502). *New Zealand Fisheries Data Report 73*. 47 p.
- Bagley, N.W.; Hurst, R.J. (1996b). Trawl survey of middle depth and inshore bottom species off Southland, February–March 1996 (TAN9604). *New Zealand Fisheries Data Report 77*. 51 p.
- Boyd, R.O.; Reilly, J.L. (2005). 1999/2000 national marine recreational fishing survey: harvest estimates. *Draft New Zealand Fisheries Assessment Report*. p.
- Bradford, E. (1998). Harvest estimates from the 1996 national marine recreational fishing surveys. New Zealand Fisheries Assessment Research Document 98/16. 27 p. (Unpublished report held in NIWA library, Wellington.)
- Drummond, K.L.; Stevenson, M.L. (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*. 58 p.
- Drummond, K.L.; Stevenson, M.L. (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*. 55 p.
- Drummond, K.L.; Stevenson, M.L. (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*. 60 p.
- Hoening, J.M. (1983). Empirical use of longevity data to estimate mortality rates. *Fishery Bulletin 81*: 898–903.
- Hurst, R.J.; Bagley, N.W.; 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*. 50 p.
- Hurst, R.J.; Bagley, N.W. (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*. 44 p.
- Hurst, R.J.; Fenaughty, J.M. (1986). Report on biomass surveys 1980–84; summaries and additional information. Fisheries Research Division Internal Report No. 21.
- Hurst, R.J.; Bagley, N.W. (1994). Trawl survey of middle depth and inshore bottom species off Southland, February–March 1993 (TAN9301). *New Zealand Fisheries Data Report 52*. 58 p.
- Hurst, R.J.; Bagley, N.W. (1997). Trends in Southland trawl surveys of inshore and middle depth species, 1993–96. *New Zealand Fisheries Technical Report 50*. 66 p.
- Langley, A.D. (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, G.J.; Middleton, D.A.J.; Starr, P.J. (2006). Performance of the STA 3 Logbook Programmes. AMP-WG-06/21. (Unpublished manuscript available from the NZ Seafood Industry Council, Wellington.)
- Manning, M.J. (2005). On fitting and comparing selected statistical models of fish growth. Unpublished MSc thesis, University of Auckland, Auckland, New Zealand. 162 p.
- Manning, M.J. (2006a). The first quantitative stock assessment of giant stargazer (*Kathetostoma giganteum*) in STA 7. *Draft New Zealand Fisheries Assessment Report March 2006*. 35 p. (presented to the New Zealand Inshore Fishery Assessment Working Group as document WG-INSHORE-06/04).
- Manning, M.J. (2006b). Relative abundance of giant stargazer (*Kathetostoma giganteum*) in STA 5 based on commercial catch-per-unit-effort data. *Draft New Zealand Fisheries Assessment Report*. 42 p.
- Manning, M.J.; Sutton, C.P. (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*. 60 p.
- Manning, M.J.; Sutton, C.P. (2006a). 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. *Draft New Zealand Fisheries Assessment Report March 2006*. 21 p.
- Manning, M.J.; Sutton, C.P. (2006b). Further studies on the age and growth of giant stargazer, *Kathetostoma giganteum*, from the West Coast of the South Island (STA 7). *Draft New Zealand Fisheries Assessment Report*. 50 p.
- Phillips, N.L. (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*. 65 p.
- 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.)
- 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.)
- 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.)
- 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.)
- 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.)
- Stevenson, M.L. (1998). Inshore trawl survey of the west coast South Island and Tasman and Golden Bays, March–April 1997 (KAH9701). *NIWA Technical Report 12*. 70 p.
- Stevenson, M.L. (2002). Inshore trawl survey of the west coast South Island and Tasman and Golden Bays, March–April 2000 (KAH0004). *NIWA Technical Report 115*. 71 p.
- Stevenson, M.L. (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*. 69 p.
- Stevenson, M.L.; Hanchet, S.M. (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*. 79 p.

- Sutton, C.P. (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 99/15. 19 p. (Unpublished report held in NIWA library, Wellington.)
- Sutton, C.P. (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*. 14 p.
- Tate, M.L. (1987). The species and stock structure of the New Zealand inshore fishery for giant stargazer. University of Otago, Dunedin. 134 p.
- Vignaux, M. (1997). CPUE analyses for fishstocks in the adaptive management programme. New Zealand Fisheries Assessment Research Document 97/24. 68 p. (Unpublished report held in the NIWA library, Wellington)