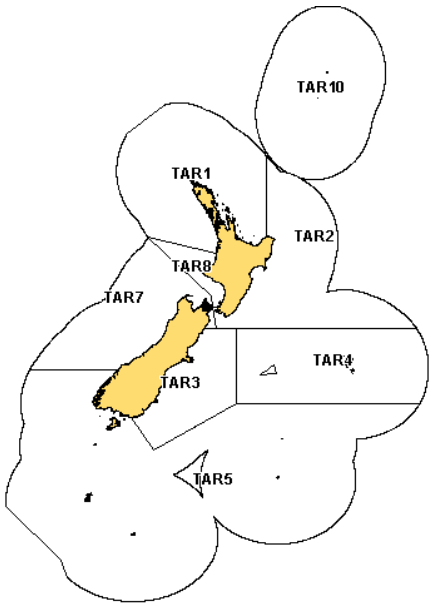
TARAKIHI (TAR)

(*Nemadactylus macropterus*)
Tarakihi



1. FISHERY SUMMARY

1.1 Commercial fisheries

Tarakihi are caught in coastal waters of the North and South Islands, Stewart Island and the Chatham Islands, down to depths of about 250 m. The fishery appears to have been relatively stable since the initial development phase. Between 1968 and 1985 domestic and foreign landings combined ranged between 4082 t and 6444 t, averaging 5042 t per year (Tables 1 and 2). Since the introduction of the QMS, the total landings have fluctuated between 4090 t and 6205 t. Reported landings and actual TACCs are shown in Table 2. From 1st October 2007 the TAC for TAR 1 was increased to 2029t and the TACC was increased from 1399 to 1447 t. Under the new TAC, the allowances for customary non-commercial, recreational and other sources of mortality were increased to 70 t, 470 t, and 20 t respectively.

Table 1: Reported total landings (t) of tarakihi from 1968 to 1982–83.

Year	Landings	Year	Landings	Year	Landings
1968	5 683	1974	5294	1980–81*	4 990
1969	4 082	1975	4941	1981–82*	5 193
1970	5 649	1976	4689	1982–83*	4 666
1971	5 702	1977	6444		
1972	5 430	1978–79*	4427		
1973	4 439	1979–80*	4344		

Source – MAF data.
* Sums of domestic catch for calendar years 1978 to 1982, and foreign and chartered vessel catch for fishing year April 1 to March 31.

Tarakihi are caught by commercial vessels in all areas of New Zealand from the Three Kings Islands in the north to Stewart Island in the south. The main fishing method is trawling. The major target trawl fisheries occur at depths of 100–200 m and tarakihi are taken as a bycatch at other depths as well. The major fishing grounds are west and east Northland (QMA 1), the western Bay of Plenty to Cape Turnagain (QMAs 1 and 2), Cook Strait to the Canterbury Bight (mainly QMA 3), and Jackson Head to Cape Foulwind (QMA 7). Around the North Island 70–80% of the tarakihi catch is targeted. Around the South Island only about 30% of the tarakihi are targeted; much of the remainder is

reported as bycatch in target barracouta and red cod bottom trawl fisheries. In addition, there is a small target tarakihi setnet fishery off Kaikoura.

Table 2: Reported landings (t) of tarakihi by Fishstock from 1983–84 to 2005–06 and TACCs (t) from 1986–87 to 2006–07.

Fishstock	TAR 1		TAR 2		TAR 3		TAR 4		TAR 5	
FMA (s)	1 & 9		2		3		4		5 & 6	
	Landings	TACC	Landings	TACC	Landings	TACC	Landings	TACC	Landings	TACC
1983–84*	1 326	–	1 118	–	902	–	287	–	115	–
1984–85*	1 022	–	1 129	–	1 283	–	132	–	100	–
1985–86*	1 038	–	1 318	–	1 147	–	173	–	48	–
1986–87†	912	1 210	1 382	1 410	938	970	83	300	42	140
1987–88†	1 093	1 286	1 386	1 568	1 024	1 036	227	314	88	142
1988–89†	940	1 328	1 412	1 611	758	1 061	182	314	47	147
1989–90†	973	1 387	1 374	1 627	1 007	1 107	190	315	60	150
1990–91†	1 125	1 387	1 729	1 627	1 070	1 148	367	316	35	153
1991–92†	1 415	1 387	1 700	1 627	1 132	1 148	213	316	55	153
1992–93†	1 477	1 397	1 654	1 633	813	1 168	45	316	51	153
1993–94†	1 431	1 397	1 594	1 633	735	1 169	82	316	65	153
1994–95†	1 390	1 398	1 580	1 633	849	1 169	71	316	90	153
1995–96†	1 422	1 398	1 551	1 633	1 125	1 169	209	316	73	153
1996–97†	1 425	1 398	1 639	1 633	1 088	1 169	133	316	81	153
1997–98†	1 509	1 398	1 678	1 633	1 026	1 169	202	316	21	153
1998–99†	1 436	1 398	1 594	1 633	1 097	1 169	104	316	51	153
1999–00†	1 387	1 398	1 741	1 633	1 260	1 169	98	316	80	153
2000–01†	1 403	1 398	1 658	1 633	1 218	1 169	242	316	58	153
2001–02†	1 480	1 399	1 742	1 633	1 244	1 169	383	316	75	153
2002–03†	1 517	1 399	1 745	1 633	1 156	1 169	218	316	92	153
2003–04†	1 541	1 399	1 638	1 633	1 089	1 169	169	316	53	153
2004–05†	1 527	1 399	1 692	1 796	905	1 403	262	316	57	153
2005–06†	1 409	1 399	1 986	1 796	1 010	1 403	339	316	62	153
2006–07†	1 193	1 399	1 729	1 796	1 080	1 403	263	316	93	152

Fishstock	TAR 7		TAR 8		TAR 10			
FMA (s)	7		8		10		Total	
	Landings	TACC	Landings	TACC	Landings	TACC	Landings§	TACC
1983–84*	896	–	109	–	0	–	5 430	–
1984–85*	609	–	102	–	0	–	4 816	–
1985–86*	519	–	122	–	0	–	5 051	–
1986–87†	904	930	185	190	0	10	4 446	5 160
1987–88†	840	1 046	197	196	0	10	4 855	5 598
1988–89†	630	1 059	121	197	0	10	4 090	5 727
1989–90†	793	1 069	114	208	0	10	4 473	5 873
1991–92†	710	1 087	190	225	2	10	5 417	5 953
1992–93†	929	1 087	189	225	0	10	5 158	5 989
1990–91†	629	1 087	131	225	<1	10	5 086	5 953
1993–94†	780	1 087	191	225	0	10	4 878	5 990
1994–95†	978	1 087	171	225	0	10	5 129	5 991
1995–96†	890	1 087	105	225	0	10	5 375	5 991
1996–97†	1 013	1 087	133	225	0	10	5 512	5 991
1997–98†	685	1 087	153	225	0	10	5 287	5 991
1998–99†	1 041	1 087	175	225	0	10	5 501	5 991
1999–00†	964	1 087	189	225	0	10	5 719	5 991
2000–01†	1 178	1 087	178	225	0	10	5 935	5 991
2001–02†	1 000	1 088	223	225	0	10	6 119	5 993
2002–03†	1 069	1 088	211	225	0	10	6 008	5 993
2003–04†	1 116	1 088	197	225	0	10	5 723	5 993
2004–05†	1 056	1 088	184	225	0	10	5 683	6 390
2005–06†	1 114	1 088	285	225	0	10	6 205	6 390
2006–07†	1 115	1 088	254	225	0	10	5 729	6 390

* FSU data.
† QMS data.
§ Includes landings from unknown areas before 1986–87.

1.2 Recreational fisheries

Tarakihi are taken by recreational fishers using lines and setnets. Estimates of recreational catch of tarakihi are given for three separate surveys in Tables 3 and 4. The most recent nationwide recreational survey was undertaken in 2001, but the results are still under review and are not currently available.

Table 3: Estimated number and weight of tarakihi harvested by recreational fishers by Fishstock and survey. Surveys were carried out in different years in the Ministry of Fisheries regions: South in 1991–92, Central in 1992–93 and North in 1993–94 (Teirney *et al*., 1997).

		Total		
Fishstock	Survey	Number	CV (%)	Survey harvest (t)
TAR 1	North	333 000	15	225–400
TAR 1	Central	18 000	55	10–20
TAR 2	North	7 000	–	0–5
TAR 2	Central	48 000	25	20–40
TAR 3	South	1 000	–	0–5
TAR 5	South	1 000	–	0–5
TAR 7	Central	29 000	25	5–15
TAR 7	South	6 000	33	0–5
TAR 8	Central	10 800	60%	0–10

Table 4: Estimates of annual number and weight of tarakihi harvested by recreational fishers from national diary surveys in 1996 (Bradford 1998) and Dec 1999-Nov 2000 (Boyd & Reilly, 2005). The mean weights used to convert numbers to catch weight are considered the best available estimates. Estimated harvest is also presented as a range to reflect the uncertainty in the point estimates.

Fishstock	Number caught	CV (%)	Estimated harvest range (t)	Point estimate (t)
1996				
TAR 1	498 000	8	280–330	305
TAR 2	114 000	14	55–75	65
TAR 3	3 000	–	–	–
TAR 5	3 000	–	–	–
TAR 7	69 000	13	20–30	24
TAR 8	46 000	17	25–35	28
1999–00				
TAR 1	1 035 000	19	516-755	636
TAR 2	310 000	27	139-243	191
TAR 3	25 000	51	8-23	15
TAR 5	10 000	57	3-9	6
TAR 7	87 000	18	27–39	33
TAR 8	66 000	38	19-42	30

A key component of estimating recreational harvest from diary surveys is determining the proportion of the population that fish. The Recreational Working Group has concluded that the methodological framework used for telephone interviews produced incorrect eligibility figures for the 1996 and previous surveys. Consequently the harvest estimates derived from these surveys are considered unreliable. However, relative comparisons can be made between stocks within these surveys. The Recreational Working Group considered that the 2000 survey using face-to-face interviews better estimated eligibility and that the derived recreational harvest estimates are believed to be more accurate. FMA 2 catches are nevertheless considered to be an over-estimate, probably because of an unrepresentative diarist sample. The 1999/00 harvest estimates for each Fishstock should be evaluated with reference to the coefficient of variation.

The TAR 1 recreational harvest estimated during the 1999/00 survey was almost half (i.e., 46%) of the commercial catch over that period.

1.3 Customary non-commercial fisheries

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

1.4 Illegal catch

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

1.5 Other sources of mortality

No information is available.

2. BIOLOGY

Sexual maturity is reached at 25–35 cm fork length (FL) at an age of 4–6 years, after which the growth rate slows. This species reaches a maximum age of 40+ years.

Tarakihi spawn in summer and autumn in several areas around New Zealand. The three main spawning grounds identified are Cape Runaway to East Cape, Kaikoura to Pegasus Bay, and the west coast of the South Island near Jackson Bay.

Few larval and post-larval tarakihi have been caught and identified. The post-larvae appear to be pelagic, occur in offshore waters, and are found in surface waters at night. Post-larval metamorphosis to the juvenile stage occurs in spring or early summer when the fish are 7–9 cm FL and 7–12 months old.

Several juvenile nursery areas have been identified in shallower, inshore waters, including the southwest coast of the North Island, Tasman Bay, near Kaikoura, northern Pegasus Bay, Canterbury Bight, Otago and the Chatham Islands. Juveniles move out to deeper water at a length of about 25 cm FL at an age of 3–4 years. Only a small proportion of tarakihi found in commercial catches are immature, suggesting that they do not become vulnerable to fishing operations until they reach sexually maturity.

The results of tagging experiments carried out near Kaikoura during 1986 and 1987 indicate that some tarakihi are capable of moving long distances. Fish have been recaptured from as far away as the Kaipara Harbour on the west coast of the North Island, south of Whangarei on the east coast of the North Island, and Timaru on the east coast of the South Island.

The best available estimate of M is a value of 0.10 as determined from the age frequency distribution of unexploited and lightly exploited populations. Estimates of Z for the area near Kaikoura made during 1987 ranged from 0.12–0.16 for fish between 8 and 20 years old. Assuming $M = 0.10$ suggests that F ranged between 0.02–0.06. Estimates of Z for the area near the Chatham Islands made during 1984 were equal to or less than 0.20.

Biological parameters relevant to the stock assessment are shown in Table 5.

Table 5: Estimates of biological parameters of tarakihi.

Fishstock	Estimate	Source
1. Natural mortality (M)		
All	0.08–0.15	Annala (1987)
	0.10 considered best estimate for all areas for both sexes	Annala *et al*. (1989, 1990)

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

	Females		Males		
	a	b	a	b	
TAR 3	0.04	2.79	0.0433	2.77	Annala *et al*. (1990)
TAR 4	0.023	2.94	0.017	3.02	Annala *et al*. (1989)

3. von Bertalanffy growth parameters

	Females			Males			
	K	t0	L∞	K	t0	L∞	
TAR 3	0.2009	– 1.103	44.6	0.2085	– 1.397	42.1	Annala *et al*. (1990)
TAR 4	0.2205	– 1.026	44.6	0.1666	– 2.479	44.7	Annala *et al*. (1989)
TAR 7	0.221	– 0.690	46.1	0.251	– 0.550	43.2	Stevenson & Horn (2004)

3. STOCKS AND AREAS

There are no new data that would alter the stock boundaries given in previous assessment documents.

The results of tagging experiments have shown that tarakihi are capable of moving large distances around the coasts of the main islands of New Zealand. The long pelagic larval phase of 7–12 months indicates that larvae will also be widely dispersed. Previously these two factors, in addition to the lack of any evidence of genetic isolation, had been used to suggest that tarakihi around the main islands of New Zealand consist of one continuous stock, and for stock assessment purposes they be considered to be one stock. Further it was concluded that because of the large distance between the mainland and the Chatham Islands, and the separation of these two areas by water deeper than that which is usually inhabited by adult tarakihi, the tarakihi around the Chatham Islands are considered to be a separate stock.

In 2008 the Working Group suggested that the tagging programmes have not been designed in such a way to adequately test stock structure hypotheses and the results were not conclusive. Further analysis is necessary before any firm conclusions can be made about the number of stocks around the mainland.

A second species of tarakihi, "king" tarakihi, has recently been described. Catches of this newly described species have been reported as *N. macropterus* in the past.

4. STOCK ASSESSMENT

There are no new data which would alter the yield estimates given in the 1996 Plenary Report. The yield estimates are based on commercial landings data. Estimates of fishery parameters are given in Table 6.

4.1 Estimates of fishery parameters and abundance

4.1.4 Biological parameters

Table 6: Estimates of fishery parameters for tarakihi.

		Fishstock	Estimate	Comments	Source
1. Fishing mortality (F)					
		TAR 3	0.02–0.06	For both sexes during 1987	Annala *et al*. (1990)
		TAR 4	≤0.10	For both sexes during 1984	Annala *et al*. (1989)
2. Total mortality (Z)					
		TAR 3	0.12–0.16	For both sexes during 1987	Annala *et al*. (1990)
		TAR 4	≤0.20	For both sexes during 1984	Annala *et al*. (1989)
3. $F_{0.1}$					
	Females	TAR 3	0.11	With $M = 0.10$	Annala *et al*. (1990)
		TAR 4	0.11	With $M = 0.10$	Annala *et al*. (1989)
	Males	TAR 3	0.12	With $M = 0.10$	Annala *et al*. (1990)
		TAR 4	0.11	With $M = 0.10$	Annala *et al*. (1989)

4.1.2 Trawl survey indices

Indices of relative biomass are available from recent *Kaharoa* trawl surveys in TAR 2, TAR 3 and TAR 7 (Table 7, Figure 1). Note that these estimates were revised in 1996 as a result of new doorspread estimates becoming available from SCANMAR measurements. In TAR 2 and TAR 3 no trend is apparent in the biomass estimates. In TAR 7 the biomass estimates declined from 1992 to 2003 with a dramatic increase in 2005. Relative biomass indices are currently being used to estimate biomass and yields for TAR 7.

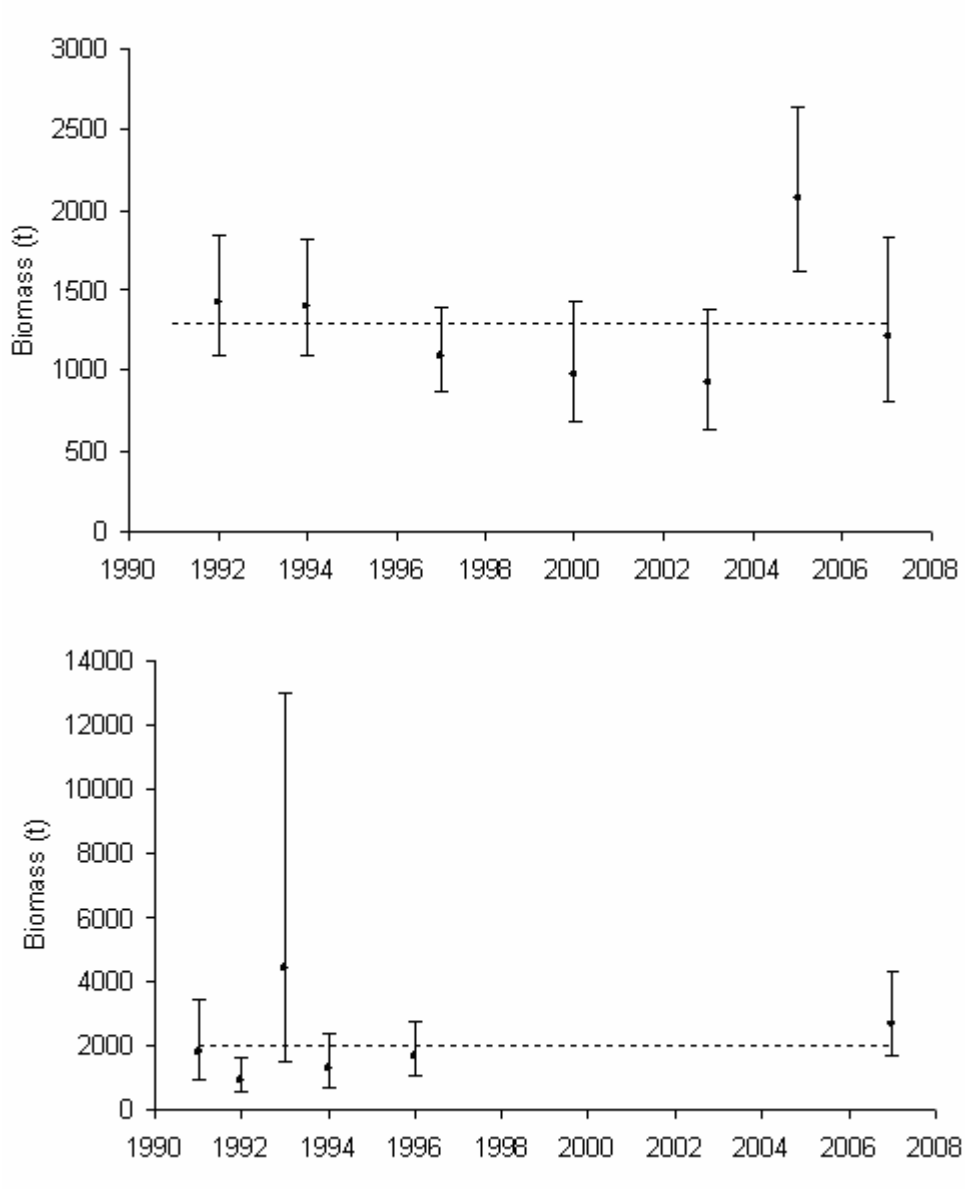


Figure 1: Biomass trends ±95% CI (estimated from survey CV's assuming a lognormal distribution) and the time series mean (dotted line) from the West (top) and East (bottom) Coast South Island trawl surveys.

Summer surveys in the Bay of Plenty (from Mercury Islands to Cape Runaway) have been carried out since 1983. The surveys were extended to 250 m, in February 1996 (KAH9601) and 1999 (KAH9902), so that tarakihi depths would be covered. However, the estimates of biomass were low (35 t CV 46% in 1996 and 50 t CV 27% in 1999). Most of the catch in the 1999 survey was taken in 150 to 200 m.

4.1.3 CPUE analysis

TAR 1W, 1E, and 1BP

In 2008, CPUE was updated for the three assumed substocks in TAR 1 (Figures 2-4). In the QMA 1 inshore bottom trawl fishery there has been a systematic switch in reporting from the daily CELR form to the TCEPR tow-by-tow form with consequential effects on catch rates that could potentially confound the year effects. The analyses are therefore done separately by form type and truncated to the years in which they are most relevant.

Table 7: Relative biomass estimates (t) and coefficients of variation (CV) for tarakihi available from trawl survey data.

QMA	Area	Year	Trip Code	Biomass (t)	CV (%)
TAR 2	Cape Runaway to Cook Strait	1993	KAH9304	885	27
		1994	KAH9402	1 128	20
		1995	KAH9502	791	23
		1996	KAH9602	943	15
TAR 3	Pegasus Bay to Canterbury Bight	1991 W	KAH9105	1 657	33
		1992 W	KAH9205	932	26
		1993 W	KAH9306	3 805	55
		1994 W	KAH9406	2 050	41
		1996 W	KAH9606	1 656	24
		2007 W	KAH0705	2 589	24
		1996 S	KAH9618	3 818	21
		1997 S	KAH9704	2 036	24
		1998 S	KAH9809	4 277	24
		1999 S	KAH9917	2 606	15
		2000 S	KAH0014	1 510	13
TAR 7	Tasman Bay to Haast	1992	KAH9204	1 409	14
		1994	KAH9404	1 420	14
		1995	KAH9504	1 389	11
		1997	KAH9701	1 087	12
		2000	KAH0004	964	19
		2003	KAH0304	912	20
		2005	KAH0503	2 050	12

S = summer and W = winter survey (Note: because trawl survey biomass estimates are indices, comparisons between different seasons e.g. summer and winter in the same area are not strictly valid).

In each substock the fishery was defined as trips that fished using bottom trawl and landed TAR 1 regardless of fisher-nominated target species. The data for analysis were further restricted to that from a core fleet of vessels with consistent participation in the fishery. Lognormal models were used to standardise positive estimated catches of tarakihi as reported on TCEPR (from 1995–96) and CELR (before 2000–01). For the TCEPR series bottom depth was offered as a proxy for targeting behaviour to de-emphasize the importance of fisher-nominated target species. For the model of CELR data, target was offered with an "other" level for the less common target species.

Log of catch was the dependant variable in all models, the log of tow distance was selected into the TCEPR model and log of number of tows into the CELR models for each substock. Vessel, season, and area also had significant explanatory power in every model.

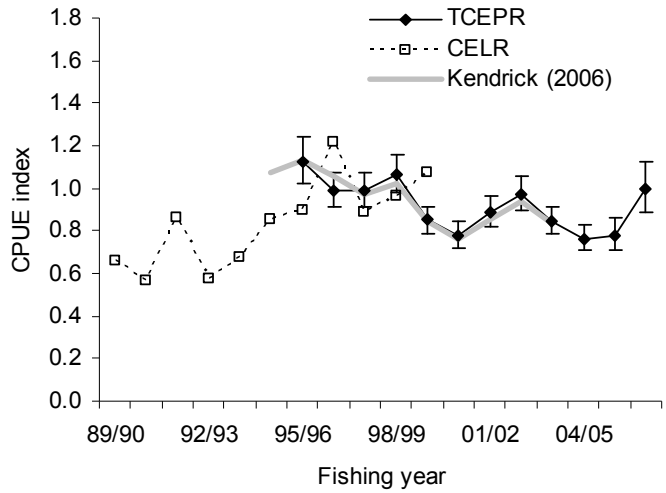


Figure 2: Comparison of indices for the west coast substock of TAR 1 (TAR 1W); Lognormal indices for the earlier series based on CELR format data, the lognormal series based on TCEPR format data, and the previously presented series (based on TCEPR data) overlaid.

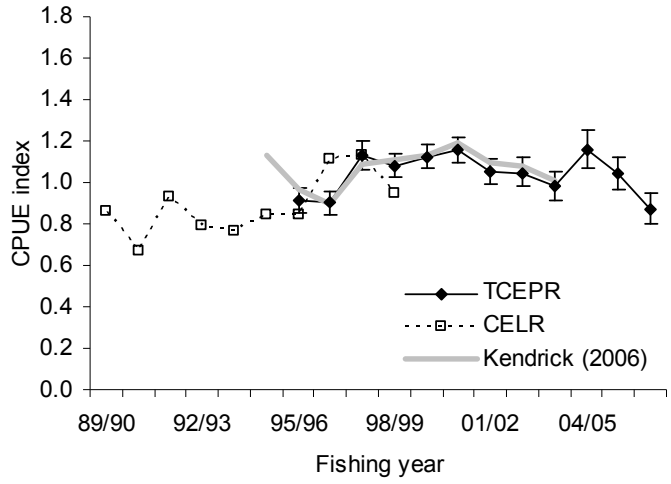


Figure 3: Comparison of indices for the east Northland substock of TAR 1 (TAR 1 EN); Lognormal indices for the earlier series based on CELR format data, the lognormal series based on TCEPR format data, and the previously presented series (based on TCEPR data) overlaid.

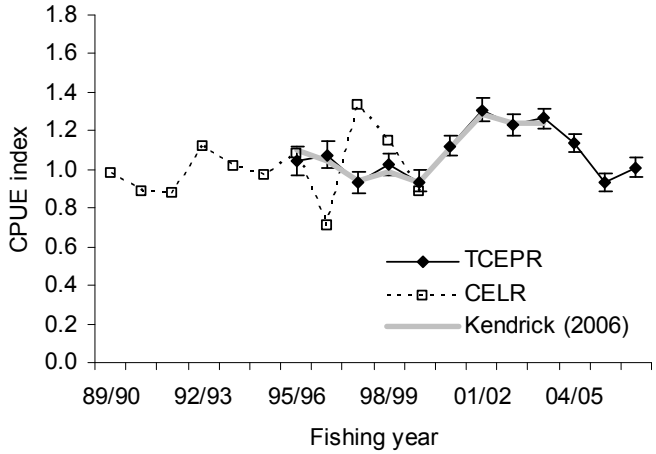


Figure 4: Comparison of indices for the Bay of Plenty coast substock of TAR 1 (TAR 1 BP); Lognormal indices for the earlier series based on CELR format data, the lognormal series based on TCEPR format data, and the previously presented series (based on TCEPR data) overlaid.

In all areas recent CPUE was within the range estimated over the period 1989–90 to 2006–07 and there have been no strong trends in CPUE. This suggests that there have been no large changes in abundance (Figures 2-4). When compared to the time of the last CPUE analysis, CPUE in the west coast in slightly up and that in east Northland and the Bay of Plenty is slightly down.

TAR 3, 7

In TAR 3 and 7, tarakihi are mainly reported as bycatch of the red cod and barracouta fisheries. This partly reflects the mixed species nature of these fisheries, but also the target species nominated to allow the bycatch trade. The standardised trawl CPUE for TAR 3 increased steadily from 1992–93, until 1999–00, before declining steadily until 2005–06, although equivalent estimates for the setnet fishery have been fairly stable. The Working Group considered that the CPUE indices calculated for TAR 7 (1989–90 to 1998–99) were not monitoring tarakihi abundance in the area, and rejected them as indices of abundance.

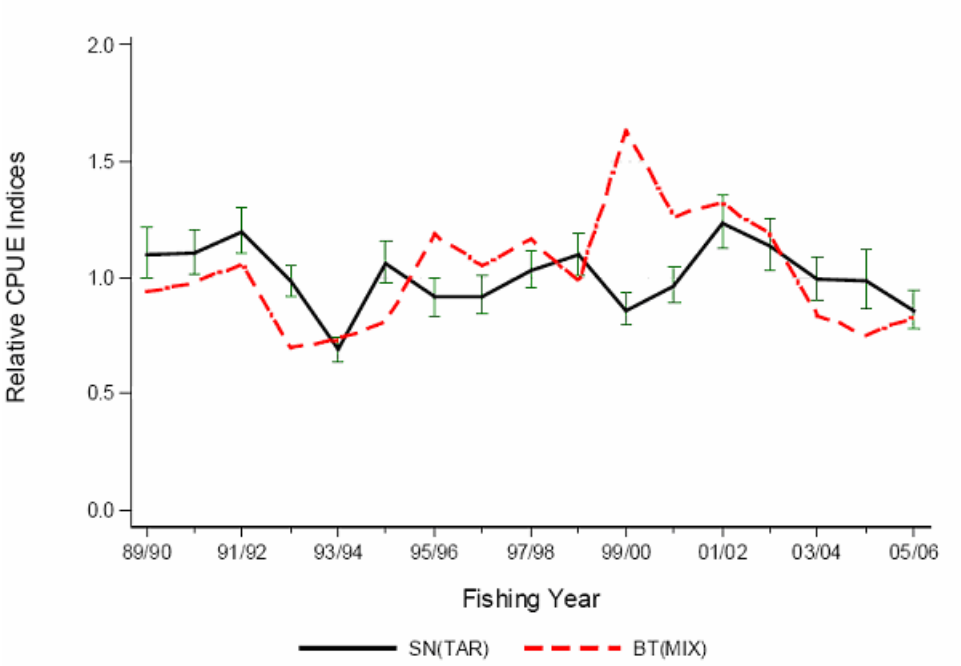


Figure 5. Comparison of the lognormal indices from the two CPUE series for TAR 3: target RCO, BAR, TAR bottom trawl [BT(MIX)], and target tarakihi setnet [SN(TAR)]. Starr *et al.* 2007.

4.2 Biomass estimates

Estimates of current absolute biomass are not available.

4.3 Estimation of Maximum Constant Yield (MCY)

4.3.1 North and South Islands (all areas except TAR 4 & 10)

MCY was estimated using the equation MCY = cY_{AV} (Method 4). Y_{AV} was the average of the combined domestic and foreign landings from 1968 to 1985 (5042 t). This period was one of comparative stability following the developmental phase of the fishery, and fishing mortality and effort were assumed to be relatively constant. Natural mortality is low (0.08 to 0.15), the species is long lived (40+ years), and there are generally at least 10 year classes in the fishery. Recruitment is not known to vary much. The value of c was set at 0.9 based on the estimate of $M = 0.10$.

MCY = 0.9 * 5042 t = 4538 t (rounded to 4540 t).

The MCY estimate has not changed since 1989.

4.3.2 Chatham Islands (TAR 4)

MCY cannot be determined.

4.4 Estimation of Current Annual Yield (CAY)

Estimates of current biomass are not available and CAY cannot be determined.

Yield estimates are summarised in Table 8.

Table 8: Yield estimates (t) of tarakihi.

Parameter	Fishstock	Estimate
MCY	All except TAR 4 & 10	4 540
CAY	All	Cannot be determined

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.

TAR 2

A full review of the TAR 2 AMP was undertaken in April 2008.

AMP History

- The tarakihi fishery dates back to about 1933 (Annala 1987). Data available from 1968 show that New Zealand wide total landings were between 4 000 t and 6 444 t over the period 1968 to 1985. In TAR 2, landings increased from 1 118 t in 1984 to 1 318 t in 1986, prior to entry into the QMS.
- TAR 2 entered the QMS in 1986–87 with an initial TACC of 1410 t, which was almost reached with a catch of 1 382 t in that fishing year. The TACC rose to 1 633 t by 1992–93 due to quota appeals, at which level it remained through to 2003–04. Catches initially lagged behind the TACC until 1989–90, but have remained close to the TACC thereafter, averaging 1 660 t from 1990–91 to 2003–04.
- TAR 2 entered an AMP in 2004–05, with a TACC increase to 1 796 t. After entry into an AMP, catches increased to a peak of 1 986 t in 2005–06, and have since dropped back to 1 729 t in 2006-07, slightly below the TACC. The first mid-term review of TAR 2 was conducted in 2007, at which time the AMP Working Group requested that certain aspects of the CPUE analyses be repeated. The review conducted in 2008 was therefore a repeat of the 2007 review, to allow an evaluation of the revised analyses.

Fishery Characterization

- Over 99% of TAR 2 catches are taken by bottom trawl (BT) and the annual proportion of catch by bottom trawl has remained stable since 1989–90. Although inshore fisheries in FMA 2 have caught more than 90 species since 1989–90, 82% of TAR 2 is taken in the TAR targeted bottom trawl fishery. Bycatches of tarakihi are low in most other target bottom trawl fisheries, with significant quantities only being caught in the GUR (7%), and SKI (4%) targeted fisheries.
- In contrast, most TAR caught in the mid-water trawl (MWT) and setnet (SN) fisheries are caught while targeting other species such as SKI, GUR, HOK and WAR. Statistical areas 011, 012 and 013 have together contributed 78% of the total TAR 2 catch since 1989–90. Area 013 has been the most important area for bottom trawling, but catches from this area have been decreasing for the last 5 to 6 fishing years, while catches from areas 011 and 014 have increased.
- There is no clear historic seasonal pattern in the TAR 2 fishery, although more catch was landed from February to July in 2006–07.
- Tarakihi are caught by bottom trawl over a wide depth range from 50 m to >400 m, depending on target, but with an overall median of 140 m, and with the TAR targeted BT fishery mostly operating somewhat shallower than this. The mid-water trawl fishery catches TAR from 80 m to 800 m, with an overall median depth of 300 m, but again with TAR with targeted tows shallower than 150 m.

CPUE Analysis

- Following initial increases from 1989–90 to 1991–92, the number of hours fished declined slightly, and has remained fairly stable since about 1996–97. In contrast, the number of vessels participating in this fishery has declined steadily from a peak of around 80 vessels in 1994–95 to 40 vessels in 2006–07.
- CPUE standardisations were done for two fisheries where defined based on method, target species, and/or region (Figure 6):
  - BT.TAR: bottom trawling targeting TAR. This is considered to be The BT.TAR index is considered to be the more reliable index for TAR 2, as it represents 82% of the catch and more than 90% of records have positive catches.
  - BT.OTH: bottom trawling not targeting TAR - an index for the bycatch fishery, representing < 18% of the catch.

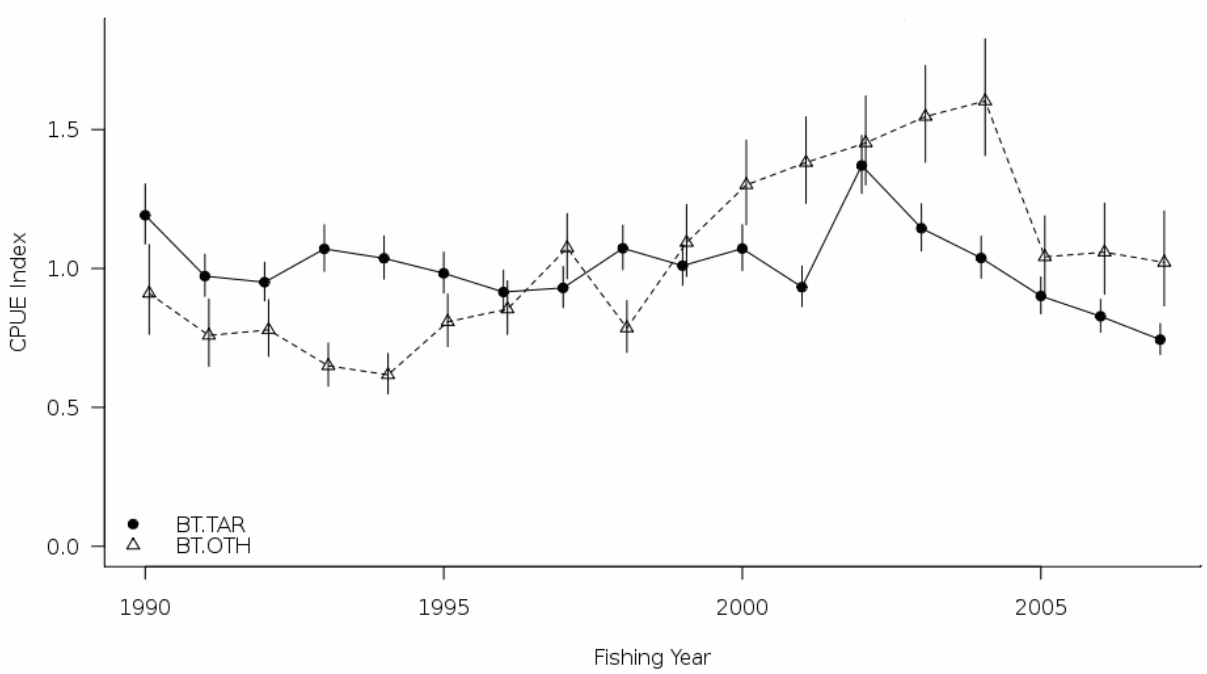


Figure 6: Standardised CPUE indices from the target bottom trawl (BT.TAR) and bottom trawl not targeting TAR (BT.OTH) fisheries.

- Prior to 2003–04, the BT.TAR index was relatively stable, rising to a peak in 2001–02, and then declining steadily. In contrast, the BT.OTH index increases steadily from 1993–94 to a peak in 2003–04, with a decline back to levels consistent with the late 1990s in 2004–05, and flat thereafter. Both indices show a decline from 2003–04 onwards, but have not dropped much below their geometric means over the history of the fishery. In 2006–07, the BT.TAR index was at its lowest level since the start of the series at 0.74, whereas the BT.OTH index was at 1.02.
- The effects of standardisation differ between these two series. Standardisation has the effect of converting a slow increase in the BT.TAR index over 1989–90 to 2000–01 into a flat trend. The decline has steepened since 2001–02, primarily as a result of correcting for an increasing number of tows in recent years, and a strong, increasing trend in vessel effect over the history of the fishery, as newer vessels with better catch rates have replaced less efficient vessels.
- Standardisation of the BT.OTH index dampens fluctuations in the series to 2003–04, and converts a decline in the last three years to a flat trend. Primarily correcting a declining trend in effect of targeting, as targeting has shifted to SNA and FLA, as well as effects of vessel and tow duration.

Logbook Programme

- There has been no logbook coverage of the TAR 2 fishery.

- The Working Group noted that the lack of biological data from TAR 2 was a concern, and that QMA 2 had the worst record of performance with regard to implementation of logbook programmes under AMP's.

Effects of Fishing

- Almost all of the catch in TAR 2 is landed whole, thereby reducing the seabird interactions that might otherwise result from offal discharge. From 2005–06 to 2007–08, observers have recorded one fur seal mortality, five seabird mortalities and nine live-releases of seabirds in FMA 2. However, observer coverage in the inshore fisheries has been low, with no coverage prior to 2005–06.
- Starting in July 2008, a Department of Conservation project will investigate protected species interactions in QMA 2. This project intends to assess risks, promote the new Protected Species Non-Fish Bycatch Form and improve reporting, mitigation measures and monitoring of protected species interactions and environmental effects of fishing.

AMP Review Checklist

1. The TAR 2 targeted fishery has a long history of participation by many vessels which take 82% of the TAR 2 catch, and covers a high proportion of the area. The TAR targeted bottom trawl (BT.TAR) CPUE index is therefore considered to probably be a reasonable and representative index of abundance of TAR 2.

2. All attempts to date to establish a logbook programme for TAR 2 (and BNS 2) have been unsuccessful, and no biological information has been collected from this fishery. The Working Group emphasised the importance of implementing appropriate programmes (whether logbooks, observers or shed sampling) for collection of spatially and temporally representative biological information for TAR 2.

3. Additional analyses recommended by the Working Group included:
   - For future analyses, rather than excluding certain data from the initial extract based on target species (such as ORH, OEO or CDL), data for all trips that caught or targeted TAR 2 and other associated species should be extracted. Data for some targeted fisheries that catch negligible quantities of TAR (such as SCI) can then be excluded after initial inspection of the data.

4. The TAR 2 fishery has provided fairly stable harvests of over 1 000t since the 1950s, and catches around 1 600t to 1 700t since the 1970s. Current catches (1 729t in 2006–07) are most likely sustainable. However, CPUE should be monitored to see whether the CPUE decline observed in the target fishery index over the past six years continues to significantly lower levels.

5. The state of the TAR 2 stock in relation to B_{MSY} is not known. Long periods of sustained catches around 1 600t to 1 700t indicate a flat yield curve for the stock, and suggest that the stock is probably close to B_{MSY}.

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. 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. This stock does not need to be referred to the Plenary for review.

TAR 3

The TAR 3 TACC by 20%, from 1169 t to 1403 t, under AMP management, on 1 October 2004.

Review of TAR 3 AMP in 2007

In 2007 the AMP FAWG reviewed the performance of the logbook monitoring programme. The WG noted:

Catch History

- The TACC for tarakihi was set at 970 t when the stock first entered the QMA in 1986–87. This was sequentially raised in response to appeals to 1169 t by 1993–94. The TACC was increased by 20% in October 2004 from 1169 t to 1403 t when it entered the AMP programme. An additional allowance for recreational and customary catches brought the total TAC to 1503 t.
- The tarakihi fishery has a long history, being the third most important species in domestic catches until the mid 1970s. Substantial unreported catches were also made at that time by foreign vessels.
- Past reporting areas differ from current QMA boundary definitions, but an approximate reconstructed catch history for TAR 3 estimates that catches doubled after 1945 from ~1000 t to about the 2000 t level. Catches fluctuated around this level until the mid 1960s. Average annual catches over the 22 year period from 1945–66 were ~1760 t.
- Catches dropped sharply back to the ~100 t level in 1967, primarily as a result of many east coast fishing vessels departing to participate in the Chatham Islands rock lobster fishery at the time. Subsequent catches over the period 1970 to 1986 fluctuated between about 650 t – 1350 t.
- TAR 3 catches fluctuated from 750 t to 1200 t until 1998–99, and then exceeded the TACC from 1999–00 to 2001–02, prompting the request for entry into an AMP. However, catches immediately declined to < 1000 t, well below the previous TACC, and have remained at about the 1000 t level.
- Estimates of recreational tarakihi catch are highly uncertain, but the recreational catch is unlikely to exceed 10 t per year.

Fishery Characterisation

- Seventy percent of the QMA 3 tarakihi catch is taken in the bottom trawl fisheries targeting red cod, tarakihi, barracouta or flatfish. There is a high level of targeting, and 40% of the TAR 3 catch is taken in the tarakihi targeted trawl fishery. The remaining 30% of the catch is virtually all taken in the setnet fishery.
- Trawled tarakihi are mainly caught in the Pegasus Bay and Canterbury Bight areas, with reasonable catches in the Kaikoura area. The setnet catch is almost all taken in the Kaikoura area.
- The bottom trawl fishery takes tarakihi throughout the year, whereas the setnet fishery is seasonal, from December - June.

CPUE Analysis

- Two fishery definitions were used in developing standardised CPUE indices for TAR 3: the bottom trawl fishery targeting red cod, tarakihi and barracouta, and the tarakihi-targeted setnet fishery.
- CPUE for these fishery definitions were 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.
- The standardised bottom trawl index shows a generally increasing trend in catch rate from 1989–90 to a peak in 1999–00, followed by a marked decline to near the lowest levels in the series by 2005–06. Standardisation has a substantial effect on recent CPUE, converting the increase in unstandardised CPUE in the past few years into a decline. Increased targeting for tarakihi appears to be the main cause of this standardisation effect.
- The setnet index shows a similar trend, except that it shows a trough in catch rates where the trawl index shows a peak in 1999–00, and is rather stable from 1989–90 to 1998–99. It is not clear whether the inverse relationship between the two series in 1999–00 may have resulted from a shift in catchability from the setnet fishery to the trawl fishery in that year. The decline 2001–02 to 2005–06 is similar in the two series.
- The Working Group noted that increased targeting may not be the only driver causing the changes seen in the standardisation, and concluded that area effects were probably being

underestimated as a result of combining areas, and due to vessels aliasing for area. The Working Group recommended that trawl CPUE analyses should be conducted separately for north and south of the Banks Peninsula in the next review.

Trawl Surveys

- Indices of tarakihi abundance were produced by the five east coast South Island (ECSI) winter trawl surveys from 1991–96, and the four summer trawl surveys from 1997–01. However, these surveys primarily catch pre-recruit tarakihi, and show very low precision and high inter-annual variability. These surveys therefore do not appear to have provided reliable abundance estimates for tarakihi.
- Tarakihi has been included in the ECSI winter trawl survey programme when these surveys resume in May–June 2007, and is one of the species for which these surveys will be optimised.

Logbook Programme

- A bottom trawl logbook programme was initiated by the SE Finfish Management Company in 2002, primarily as part of the ELE 3 AMP proposal. The program was extended to tarakihi in 2004–05.
- Although quite a few vessels participated (11 and 7), coverage of TAR 3 catch has been very low in the two years of this program, achieving 3.1% in the first year, and declining to only 0.6% in 2005–06. The numbers of fish sampled were 361 and 416.
- The program has been focussed in area 22, and failed to sample catches in the equally important area 20. Seasonal coverage has been poor.
- Length-frequency distributions of fish sampled differ between the two years, with a spread of larger fish above the mode in 2005–06.
- Noting the possibility of different tarakihi stock components north and south of Banks Peninsula, the Working Group emphasized the need to ensure representative logbook coverage of the Pegasus Bay area as well.

Effects of Fishing

- A general overview of the effects of setnet and trawl fishing along the South Island East Coast is presented under AMP reviews for SPO 3, SCH 3 and GUR 3.
- No additional information was presented on specific effects of the TAR 3 fishery.
- It was noted that current TACC catches under the AMP do not represent an increase over recent historic levels, and are about half the catch levels in the 1950s and 1960s. It is unlikely that the AMP has had much effect in increasing the area or intensity of fishing impacts.

Conclusions

- The standardised bottom trawl CPUE index indicates that abundance is near its lowest point across the series, having declined steadily from a peak in 1999–00. However, the Working Group noted that the bottom trawl fishery catches smaller fish, and primarily provides a recruitment index. Trends in the trawl fishery also appear to have resulted to a large extent from increased targeting and/or shifts between areas. It is therefore difficult to interpret to what extent this is an index of abundance.
- The setnet fishery is indexing the adult population, and this index is flatter, but still shows a declining trend since 2001–02, similar to that in the trawl index.

6. STATUS OF THE STOCKS

TAR 1

CPUE indices for the three substocks within TAR 1 were calculated using data through to the end of the 2006–07 fishing year. The indices remain stable suggesting that current catches and the TACC for TAR 1 are sustainable. In 2002 the Inshore WG concluded that TAR 1 was likely to be above B_{MSY}.

There is no evidence from the CPUE analyses to suggest any major changes in abundance since this time.

TAR 2

The TAR 2 fishery has provided fairly stable harvests of over 1 000t since the 1950s, and catches around 1 600t to 1 700t since the 1970s. Current catches (1 729t in 2006–07) are most likely sustainable. However, CPUE should be monitored to see whether the recent declines in CPUE from the target fishery continue.

The state of the TAR 2 stock in relation to B_{MSY} is not known. Long periods of sustained catches around 1 600t to 1 700t indicate a flat yield curve for the stock, and suggest that the stock is probably close to B_{MSY}.

TAR 3

A standardised bottom trawl CPUE index indicated that abundance in 2006 was near its lowest point across the series, having declined steadily from a peak in 1999–00. However, the Working Group noted that the bottom trawl fishery tends to catch smaller fish, and will provide a mixed signal, tending towards a recruitment index. It is therefore difficult to interpret to what extent this is an index of abundance. The setnet fishery is indexing a migrating adult spawning population, and this index is flatter, but still shows a declining trend since 2001–02, similar to that in the trawl index. CPUE should be monitored to see whether the CPUE decline observed in these two fisheries continues to decline. The 2007 index for tarakihi from the reinstated winter survey off the east coast of the South Island was the second-highest in the series.

The status of the TAR 3 Fishstock in relation to B_{MSY} is not known. It is not known if the current TACC and recent catch levels will allow the stock to move towards a size that will support the maximum sustainable yield.

TAR 4

For TAR 4, the fishery around the Chatham Islands has generally been lightly fished and the stock can probably support higher catch levels for the next few years.

TAR 7

Reported landings in this Fishstock increased throughout the 1990s, but did not exceed the TACC until 2001–02. Since then, reported landings have been maintained at or near the TACC. By 2003, the WCSI survey relative biomass index had declined by about 35% from the 1992 value. However, the 2005 survey index suggested that the stock had doubled in size since 2003, but an increase in population size of this amount on this time scale is not credible, indicating that there is a large amount of process error associated with this species in this survey. The 2007 survey index continues to be greater than the 2003 index but is lower than the 2005 index, although the uncertainty in this estimate is relatively high. The current catch and TACC are likely to be sustainable in the short term.

It is not known if the current TACC and recent catch levels will allow the stock to move towards a size that will support the maximum sustainable yield. A stock assessment for TAR 7 will be completed during 2008–09.

TAR 8

Overall, landings from the North and South Islands have remained relatively stable, since at least the late 1960s, despite changes in effort and methods of fishing. Given the long, stable catch history of this fishery, current catch levels and TACCs are thought to be sustainable. However, for all Fishstocks it is not known if the current TACCs and recent catch levels will allow the stocks to move towards a size that will support the maximum sustainable yield.

Yield estimates, TACCs and reported landings for the 2006–07 fishing year are summarised in Table 9.

Table 9: Summary of yield estimates (t), TACCs (t) and reported landings (t) of tarakihi for the most recent fishing year.

Fishstock	QMA		MCY	2006–07 Actual TACC	2006–07 Reported landings
TAR 1	Auckland (East) (West)	1 & 9		1 399	1 193
TAR 2	Central (East)	2		1 796	1 729
TAR 3	South–East (Coast)	3	4540	1 403	1 080
TAR 4	South–East (Chatham)	4	–	316	263
TAR 5	Southland and Sub–Antarctic	5 & 6		153	93
TAR 7	Challenger	7		1 088	1 115
TAR 8	Central (West)	8		225	254
TAR 10	Kermadec	10	–	10	0
Total				6 390	6 205

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