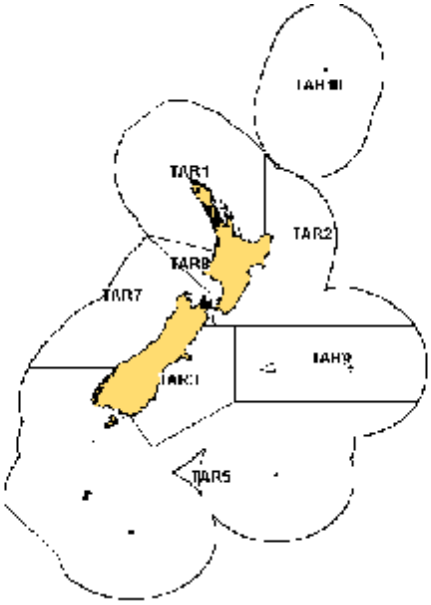
TARAKIHI (TAR)

(*Nemadactylus macropterus*)



1. FISHERY SUMMARY

(a) 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 been around 5000-6000 t. Reported landings and actual TACCs are shown in Table 2.

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

Year	Landings	Year	Landings	Year	Landings
1968	5 683	1974	5 294	1980–81 *	4 990
1969	4 082	1975	4 941	1981–82 *	5 193
1970	5 649	1976	4 689	1982–83 *	4 666
1971	5 702	1977	6 444		
1972	5 430	1978–79 *	4 427		
1973	4 439	1979–80 *	4 344		

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 by-catch 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 set net fishery off Kaikoura.

Table 2: Reported landings (t) of tarakihi by Fishstock from 1983–84 to 2004–05 and TACCs (t) from 1986–87 to 2004–05.

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

	TAR 7		TAR 8		TAR 10			
	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

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

(b) Recreational fisheries

Tarakihi are taken by recreational fishers using lines and set nets. 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**	**c.v.(%)**	**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 Dec1999-Nov 2000 (Boyd and 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**	**c.v.(%)**	**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
1999/2000				
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 the 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 to be considerably underestimated and not reliable. 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. FMA2 catches are nevertheless considered to be over-estimate, probably because of an unrepresentative diarist sample. The 1999/2000 Harvest estimates for each Fishstock should be evaluated with reference to the coefficient of variation.

The TAR 1 recreational harvest estimated during the 1999/2000 survey was almost half (i.e. 46%) of the commercial catch over that period.

(c) Maori customary fisheries

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

(d) Illegal catch

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

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

Few larval and postlarval tarakihi have been caught and identified. The postlarvae appear to be pelagic, occur in offshore waters, and are found in surface waters at night. Postlarval 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 are sexually mature.

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)
	M = 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	0.0400	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	**t_0**	**L_∞**	**K**	**t_0**	**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	0.2210	– 0.690	46.1	0.2510	– 0.550	43.2	Stevenson and 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 move 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. Taken together with the lack of any evidence of genetic isolation, this suggests that tarakihi around the main islands of New Zealand consist of one continuous stock, and for stock assessment purposes they are considered to be one stock. However, 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.

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.

(a) Estimates of fishery parameters and abundance

(i) 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)

(ii) Trawl survey indices

Indices of relative biomass are available from recent *Kaharoa* trawl surveys in TAR 2, TAR 3 and TAR 7 (Table 7). 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. Results will be available in early 2008.

Table 7: Relative biomass estimates (t) and coefficients of variation (*c.v.*) for tarakihi available from trawl survey data. S = summer and W = winter survey (Note : because trawl survey biomass estimates are indices, comparisons between different seasons eg. summer and winter in the same area are not strictly valid).

QMA	Area	Year	Trip Code	Biomass (t)	c.v. (%)
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
		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

Table 7 ***(Continued)***

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	2050	12

Summer surveys in the Bay of Plenty (from Mercury Islands to Cape Runaway) have been carried out since 1983. In February 1996 (KAH9601) and 1999 (KAH9902) the surveys were extended to 250 m 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.

(iii) CPUE analysis

Standardised CPUE indices (1989/0 -1998/99) were estimated for the bottom trawl fisheries in TAR 1W, 1E, 2, 3, and 7, and the set net fishery in TAR 3 as a possible means of monitoring abundance in these areas (Hanchet and Field 2001). All trawls where tarakihi were targeted and/or caught were extracted from the TCEPR and CELR databases. Linear models of log(catch/hour/vessel day) were calculated for each area. For the bottom trawl fisheries, standardised CPUE was estimated for all vessels combined and for a subset of vessels with a continuous representation in the fishery. In all cases there was little difference in the indices resulting from the two datasets. However, the all vessels models generally explained more of the variation in CPUE than the subset models, had 1.5–2 times the amount of data, and lower standard deviations.

An update of the TAR 2 bottom trawl indices (1989/90 – 2001/02) revealed that analyses using all vessels and the subset (with continuous representation in the fishery) had similar indices and explained similar amounts of variation in the data. However the diagnostics for the core vessels were superior, so it is recommended that core vessel results be used in any modeling.

Based on the results of the initial analysis (Hanchet and Field 2001), the Inshore FAWG concluded that the CPUE analyses calculated for TAR 3 from bottom trawl data were probably not tracking abundance. More recent analyses (SeaFIC 2003), based on both lognormal (successful tows) and binomial (probability of zero catch) indices, and spanning a longer period (1989/90 – 2001/02), have however shown more promise.

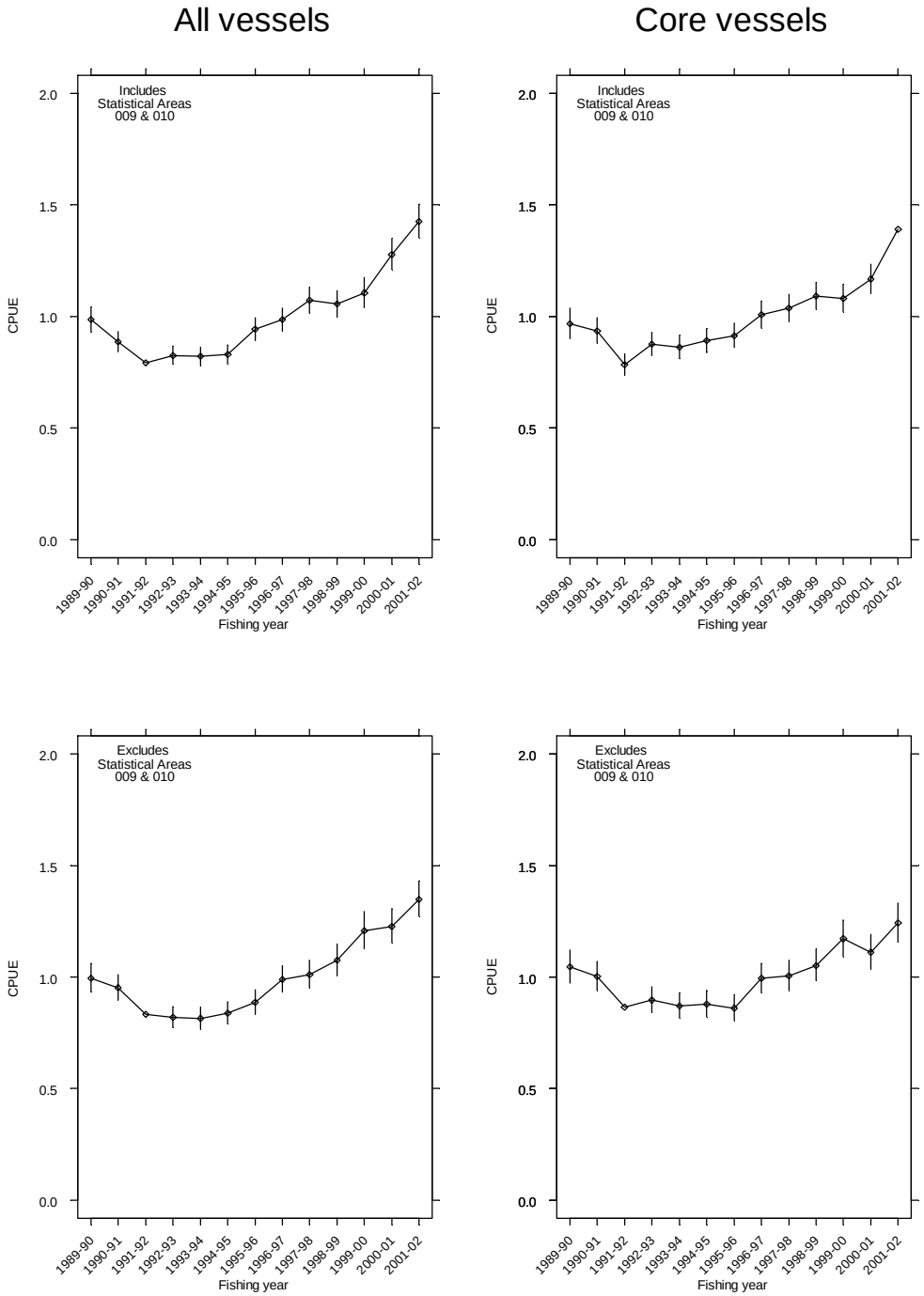


Figure 1: Relative year effects and approximate 95% confidence intervals for TAR 2 by vessel selection and Statistical area. Top left, all vessels including Statistical areas 009 & 010; top right, core vessels including Statistical areas 009 & 010; bottom left, all vessels excluding Statistical areas 009 & 010; bottom right, core vessels excluding Statistical areas 009 & 010.

TAR 1W, 1E, and 2

The indices for TAR 1W, 1E and 2 are based on relatively large data sets, and most of the tarakihi catch is targeted. The WG considered that the indices are probably monitoring tarakihi abundance in these areas. TAR 1 indices were recently updated to 2003/04 (Kendrick 2006). Standardized CPUE series for the West Coast and East Northland showed some structure, possibly related to recruitment strength, but no overall trend between 1989/90 and 2003/04. Standardized CPUE in the Bay of Plenty was reasonably stable until 1999/2000 and then increased sharply, possibly as a result of good recruitment in 2000/01. Standardized CPUE indices based on successful tows from the TAR 2 bottom trawl fishery declined slightly from 1989/90 to 1991/92, followed by moderate annual increases until 2001/02.

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. Standardised trawl CPUE for TAR 3 has increased steadily since 1992/93. Although equivalent estimates for the set net fishery have been fairly stable, the trawl CPUE is regarded to be a better index of abundance owing to much better spatial coverage.
The WG considered that the CPUE indices calculated for TAR 7 (1989/90 – 1998/99) were not monitoring tarakihi abundance in the area, and rejected them as indices of abundance.

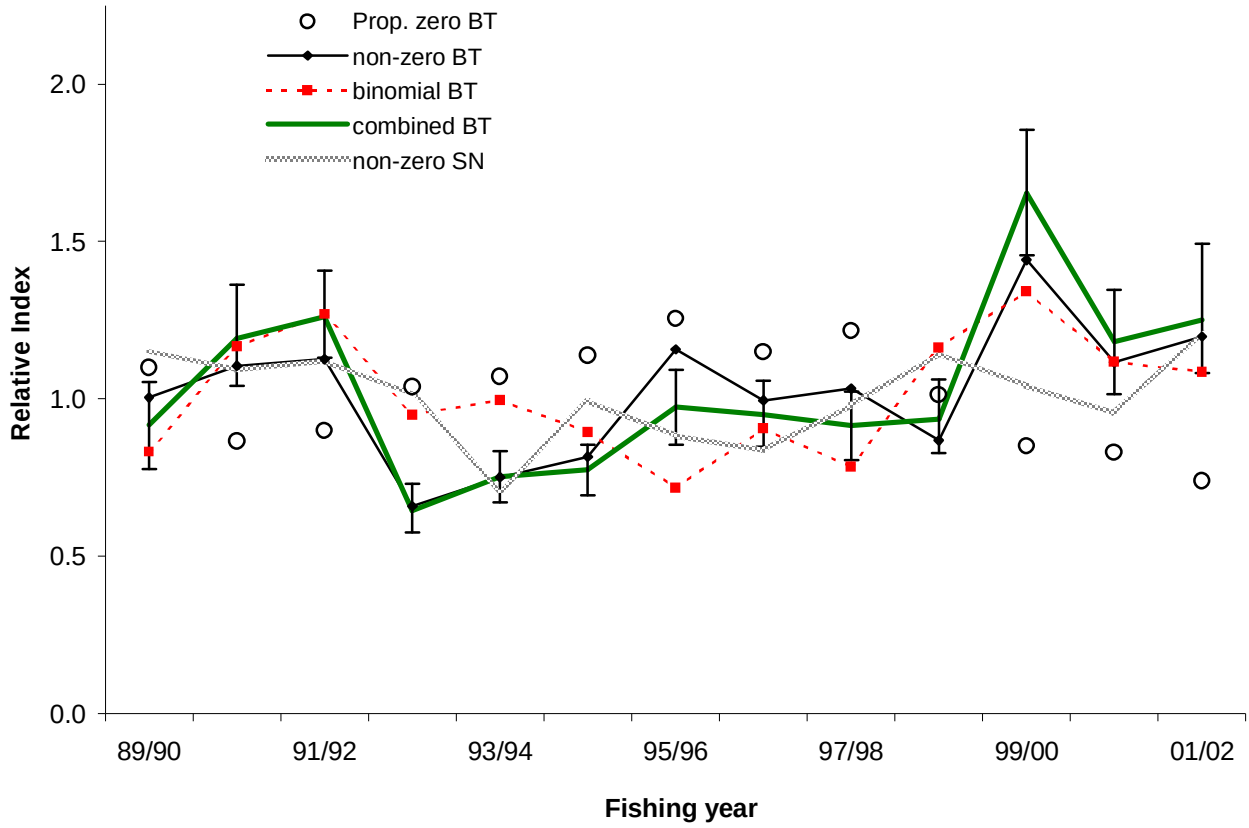


Figure 2. Plot of the lognormal, binomial and combined models from the east coast South Island bottom trawl fishery (SeaFIC 2003). Error bars for the combined BT index are 95% bias corrected confidence intervals based on 1000 bootstrap replicates. Also shown are the proportion of zero trips in the BT fishery and the lognormal index from the Area 018 setnet fishery. All indices and the proportion of zero catches have been standardised relative to the geometric mean of each series.

(b) Biomass estimates

Estimates of current absolute biomass are not available.

(c) Estimation of Maximum Constant Yield (MCY)

(i) 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 longlived (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.

(ii) Chatham Islands (TAR 4)

MCY cannot be determined.

(d) Estimation of Current Annual Yield (CAY)

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

Yield estimates are summarised in Table 9.

Table 9: 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

TAR 2 TACC was increased by 10% (from 1633 to 1796 tonnes) under AMP management, on 1 October 2004.

Annual Review of TAR 2 AMP in 2006

In 2006 the AMP FAWG reviewed the performance of the logbook monitoring programme (Anon 2006) after one year of the current 5-year term. The WG noted:

Log Book Programme

- The TAR 2 entered the AMP in October 2004.
- Proportional coverage was provided but based on low numbers of fish measured is likely to be <5%.
- Logbook coverage was far too low and needs improvement.

TAR 3

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

Annual Review of TAR 3 AMP in 2006

In 2006 the AMP FAWG reviewed the performance of the logbook monitoring programme (Lydon et al. 2006) after one year of the current 5-year term. The WG noted:

- Approximately two thirds of the TAR 3 catch is taken by bottom trawl. Target levels of coverage are 30% of fishing events in each of the setnet and trawl fisheries.
- Less than 4% of the bottom trawl catch was covered by the trawl log book programme, owing largely to reason given under SCH 3
- Logbook coverage is completely inadequate and requires dramatic improvement.

6. STATUS OF THE STOCKS

Based on relatively stable indices of abundance current catches and the TACC for TAR 1 appear to be sustainable.

For TAR 3 estimates made in the mid 1980s indicated that F was less than $F_{0.1}$. These estimates are probably still relevant due to the long, stable catch history in these areas. Levels of F near or below $F_{0.1}$ are generally considered sustainable. The increasing trend in the TAR 3 CPUE index (1989/90 - 2001/02) further indicates that current TACC and catch levels are sustainable. An abundance index of that has increased consistently since 1990/91 suggests that the current TACC (little change since 1988/89) for TAR 2 is sustainable. 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.

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.

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

Fishstock	QMA		MCY	2004–05 Actual TACC	2004–05 Reported landings
TAR 1	Auckland (East) (West)	1 & 9		1 399	1 527
TAR 2	Central (East)	2		1 796	1 692
TAR 3	South–East (Coast)	3	4540	1 403	905
TAR 4	South–East (Chatham)	4	–	316	262
TAR 5	Southland and Sub–Antarctic	5 & 6		153	57
TAR 7	Challenger	7		1 088	1 056
TAR 8	Central (West)	8		225	184
TAR 10	Kermadec	10	–	10	0
Total				6 390	5 683

7. FOR FURTHER INFORMATION

Anon. (2006). BNS 2 Adaptive Management Programme Report: 2004/05 fishing year. AMP-WG-06/16. Copies held by MFish.

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