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EXECUTIVE SUMMARY

Blackwell, R.G.; Gilbert, D.J. (2008). Age composition of commercial snapper landings in Tasman Bay/Golden Bay (SNA 7), 2006–07.

***New Zealand Fisheries Assessment Report 2008/67.* 22 p.**

This report fulfils the requirements for Objective 1 of Project SNA2006/05, "To estimate the year class strengths of snapper, *Pagrus auratus*, in SNA 7." It summarises the estimates of commercial catch at age for the Tasman Bay/Golden Bay portion of the SNA 7 stock (excluding the Marlborough Sounds substock) for the 2006–07 fishing year, and compares relative year class strengths with previous estimates.

The SNA 7 fishery is relatively small and is at the southern limit of the distribution of snapper in New Zealand. SNA 7 has the fastest growth rate of all snapper stocks in New Zealand.

The 2006–07 catch at age estimates for Tasman Bay/Golden Bay indicate the presence of two very strong year classes (2000 and 2003) in the fishery. The 2000 year class (7 year olds) represents 47% of the catch at age, while the 2003 year class (4 year olds) represents 28% of the catch at age. The previously strong 1988, 1990, and 1996 year classes are still present, but their relative influence has lessened due to strong recent recruitment. These trends have substantially changed the character of the SNA 7 fishery. Between 1997–98 and 2000–01 there was a strong dependence on fish over 8 y. Since 2003–04 most of the catch has been of fish under 8 y. The mean weight of 1.7 kg for 2006–07 is similar to that for 2003–04, which contrasts with the mean weight of about 3.0 kg before 2000–01.

Most snapper are taken as bycatch of inshore trawling, although a small amount of target pair trawling occurs during summer (January-February). The 2006–07 commercial catch of 248 t exceeds the TACC of 200 t. It represents a 33% increase on the average catch between 2003–04 and 2005–06 of 186 t.

The warm period 1998 to 2002 has seen strong snapper recruitment throughout New Zealand although different year classes dominate in different populations. In SNA 7 our estimate shows the 2000 year class to be exceptionally strong and we would expect it to contribute significantly to the fishery for perhaps a decade. The 2003 year class also appears to be above average. The years of weak recruitment in the early 1990s are consistent with trawl survey results from Tasman Bay/Golden Bay in 1995 and

1. INTRODUCTION

1.1 Overview

Snapper (*Pagrus auratus*) is an inshore demersal species of the family Sparidae, commonly found in depths of 10–200 m throughout the northern and central areas of the New Zealand EEZ (QMAs SNA 1, SNA 2, SNA 7, & SNA 8). The number of juveniles that result from a spawning may vary widely, which results in strong or weak year classes entering the stock (Smith & Francis 1991). A high positive correlation between year class strength and sea surface temperature was found in the Hauraki Gulf (Francis 1993, Gilbert et al. 2000), and similar results have been shown for SNA 2, SNA 8, and for the Tasman Bay/Golden Bay (SNA 7) substock (Davies & McKenzie 2001, Gilbert & Taylor 2001).

This report describes the results of the sixth year of a commercial catch sampling programme and estimates catch at age from the Tasman Bay/Golden Bay substock (Figure 1) of SNA 7 during the 2006–07 fishing year. It supplements and extends previous age structure data collected during the 1997–98 (Blackwell et al. 1999), 1998–99 (Blackwell et al. 2000), 1999–2000 (Blackwell et al. 2001), 2000–01 (Blackwell & Gilbert 2002), and the 2003–04 (Blackwell & Gilbert 2005) fishing years (1 October to 30 September). This series supplements data from several previous estimates for the Tasman Bay/Golden Bay substock (Mace & Drummond 1982a, 1982b, Drummond & Kirk 1986, Drummond 1994, Annala & Sullivan 1996). Catch at age is not estimated for the small separate Marlborough Sounds substock of SNA 7.

1.2 Description of the fisheries

A small–medium sized commercial snapper fishery has operated in Tasman Bay/Golden Bay since at least 1945, but landings have varied widely. Landings ranging from 500 to 1500 t were taken from the 1960s to the late 1970s (Mace & Drummond 1982a, Annala et al. 2001). They quickly increased during the late 1970s and early 1980s, after the identification of near-surface schools of spawning snapper by aerial spotting, and the introduction of pair trawling and purse-seine methods into the fishery (Drummond 1994). Landings peaked at 2700 t in the 1978 calendar year, but declined throughout the 1980s (Annala et al. 2001).

SNA 7 (including the Tasman/Golden Bays and Marlborough Sounds substocks) was introduced into the QMS in 1986. The initial TACC of 330 t was set to allow the stock to rebuild (Colman et al. 1985), but was increased to 372 t following quota appeals. Landings remained below the TACC during the late 1980s. The biomass estimates determined from the 1987 tagging study in SNA 7 were low (Annala et al. 2001), and the TACC was reduced to 160 t in 1989–90. The TACC was subsequently increased from 160 t to 200 t in 1996–97, and landings have generally remained lower than, or equal to, the TACC (Table 1).

The 2006–07 reported landings of 248 t for SNA 7 represent a 33% increase over recent landings, which averaged 186 t between 2003–04 and 2005–06. Snapper move inshore to spawn during spring-summer, and some target fishing on these spawning aggregations has occurred since 2000–01. Landings of 30–60 t have been taken by longline, single trawlers, and two sets of pair trawlers, but insufficient quota is available to support a larger target fishery (D. Loder, Talley's Fisheries, pers. comm., 2005).

Most snapper landings in SNA 7 (Tables 2 and 3) continue to be taken as bycatch of trawl fishing, particularly for red gurnard and flatfish during late summer, autumn, and winter. Effort in these trawl fisheries appears to be inversely related to the relative strength of the fisheries for albacore tuna and dredge oysters in QMA 7 (D. Loder, pers. comm., 2005). Snapper are also a minor bycatch of set netting for rig, warehou, and school shark and of line fishing for school shark during the summer (see Table 2). The stock appears to be continuing to rebuild. Input controls remain, including regulatory and voluntary closed areas (Anon. 1994).

The SNA 7 fishstock is an important recreational target species, particularly in Tasman and Golden Bays. Recent recreational catch estimates range from 193 t (1993) to 125 t (2001). These diary survey-based estimates may be unreliable (Ministry of Fishisheries 2007), but suggest that landings by the recreational fishery may be as important as the commercial fishery for this snapper stock.

1.3 Previous research

As snapper prefer warm-temperate waters, the SNA 7 stock is at the southern limit of their distribution. The stock is recognised as separate from the larger SNA 8 (Auckland-west coast North Island) stock, based on tagging recovery data (Drummond 1994). Within SNA 7, two separate substocks are recognised (Tasman Bay/Golden Bay and Marlborough Sounds/Cloudy Bay), based on stock separation studies carried out during 1978–81, 1984, and 1986–87 (Drummond 1994). The small catch taken on the north of the west coast of the South Island is considered to be part of the Tasman Bay/Golden Bay substock. Fishers commonly follow snapper schools as they move around Farewell Spit, particularly in midsummer (D. Loder. pers. comm., 2003).

Harley & Gilbert (2000) modelled the Tasman Bay/Golden Bay substock using an age-structured population model fitted to a tag-recapture biomass estimate and commercial and research proportion at age estimates from samples taken between 1968–69 and 1997–98. They estimated current stock biomass at the start of 1998–99 to be $1.43B_{MSY}$ and MSY to be 650 t. The latter included a long historical period of landings into Port Nelson that exceeded 500 t and were assumed to come from SNA 7, an assumed recent recreational catch of 84 t and commercial under-reporting of 10% (Hartill et al. 1998). Gilbert & Phillips (2003) updated this model to include the 2001–02 fishing year. They estimated stock biomass to be 1.43 to $2.71B_{MSY}$ and predicted B_{2006} to be between 14 032 and 32 016 t. These estimates were considered unreliable and were not accepted by the Inshore Working Group (Sullivan et al. 2005).

Recent catch-at-age estimates (Blackwell & Gilbert 2002, 2005) recorded the presence of strong year classes in 1998, 1999, and 2000 (now 7–9 year olds), and the continued presence of the above average 1986, 1988, 1990, and 1996 year classes in the fishery, as well as the 20+ y group. Recruitment had been particularly poor between 1991 and 1994, and the 1997 year class appeared to be weak.

2. METHODS

Sampling in SNA 7 was restricted to the Tasman Bay/Golden Bay substock. The small Marlborough Sounds/Cloudy Bay substock was not sampled.

2.1 Stratification

The purpose of stratification is to increase the precision of the catch-at-age estimates and to reduce the effects of departure from strictly random sampling. Sampling theory shows that this will be achieved if the strata are well chosen, i.e., if variability between strata is larger than within strata. Estimation requires the sampling of landings to be random. Strict adherence to practices that would achieve this is impractical. However, departure from strict randomness has less effect under a stratified sampling regime, if the strata are well chosen. The previous analyses were based on stratification of vessels (main trawl vessels, and others); and of seasons (spring: October–December; summer: January–March; and autumn/winter: April–September). When this stratification was last employed (Blackwell & Gilbert 2005), the main catch vessels were expected to catch about 55% of the landings based on average catches of the previous three years. However, in the 2003–04 analysis, these vessels caught only 36%of the snapper catch. During this time, several larger fishing vessels transferred out of the fishery. We concluded that placing the main catch vessels into a separate stratum was not achieving the desired benefits and so the stratification used in the 2006–07 analysis was simplified from that of

Blackwell & Gilbert (2005). For the 2006–07 sampling programme we used one vessel stratum, and three seasonal strata (spring: October 2006 to December 2006; summer: January 2007 to March 2007); and autumn/winter: (April 2007 to September 2007). The planned numbers of samples allocated to each seasonal stratum was based on average catches for these strata in the three previous years, as in the previous SNA 7 catch sampling programme.

2.2 Sampling

The 2006–07 actual reported landings for SNA 7 (all) of 248 t (see Table 1) is slightly lower than the estimated catch for SNA 7 (all) of 255 t (see Table 2). This doe not include a further catch of 10 t reported from S/A 37, as these landings cannot be separated from the SNA 8 stock. Of this estimated catch, 242 t was taken from the Tasman Bay/Golden Bay substock, and 13 t was taken from the Marlborough Sounds substock (S/A 17). The planned number of landings was sampled in all strata (Table 4). Sampling started in October, and extra samples were collected during spring to correspond to an apparent increase in fishing in this stratum. The large changes in the timing of the fishery from year to year make it difficult to sample the strata optimally.

2.3 Sampling procedure

A random sample of about 30 fish (more or less for larger or smaller landings) was collected from each landing from a random selection of fish bins, as described by Blackwell & Gilbert (2002). The saggital otoliths were collected from each fish and the length (to the nearest centimetre below the fork length) was measured. The sex was not determined, as snapper show no differential growth between sexes (Paul 1976). The otoliths were inventoried and stored in the otolith collection maintained by NIWA.

2.4 Ageing

The numbers of otoliths collected exceeded the target number of 1000, so random subsamples were selected for ageing. Subsample sizes were chosen to bring the number of fish towards proportionality with the landing weight (with a minimum of four otoliths per landing).

Snapper otoliths collected were processed individually following the methods described by Davies & Walsh (1995). Each otolith was prepared by cutting dorsoventrally through the nucleus, then the cut surface was polished by wet grinding using 400 grit and 1200 grit diamond polishing wheels, and read under a binocular dissecting microscope at x20–30 magnification, as described by Blackwell & Gilbert (2002).

A standardised procedure for reading the otoliths and ageing the snapper was followed (after Davies & Walsh 1995). Ages were defined from a nominal birthday at 1 January. Age was recorded in the *age* database rounded down to one decimal place, based on the date of sampling, e.g., a 1989 year class fish would be aged 8.7 years if sampled in early October 1997, 8.9 years in December and 9.4 years in May 1998. Because sampling was from October to September, fish were combined into an age class by rounding down to the nearest year and then adding an extra year to the ages of the fish sampled between October and December 2006.

Proportions at age, $\hat{p}_i$, were calculated for each stratum and combined using the total stratum landings for 2006–07 (Table 4). The coefficients of variation for the proportion at age estimates, with a finite population correction, $\mathrm{c\hat{v}}(\hat{p}_i)$, were calculated by bootstrapping, as described by Blackwell et al. (2000: appendix A1). The sampled landings and age data were stored on the Ministry of Fisheries *market* and *age* databases, respectively, maintained by NIWA.

3. RESULTS

The numbers of snapper aged from each stratum are given in Table 5, and the proportions at age, $\hat{p}_i$, and the estimated coefficients of variation, $\text{cv}(\hat{p}_i)$, are presented in Figures 2 and 3. Values are given in Appendices A1 and A2. The mean weighted c.v. for Tasman Bay/Golden Bay snapper was 0.28 (0.27 for 1–20+ years) from 60 samples. Numbers sampled by age and length are given in Appendix A3 and the estimated proportions by age and length in Appendix A4.

The fishery is dominated numerically by the 2000 and 2003 year classes (3 and 7 year-olds). The 2000 year class represents over 46% of the 2006–07 landings, and the 2003 year class represents an additional 28% of the 2006–07 landings, by numbers of fish. The previously dominant 1986, 1988, 1990, 1996, 1998, and 1999 year classes can still be seen. While the size of the 20+ y age class is relatively larger than in 2003–04, it remains smaller than in all the estimates between 1997–98 and 2000–01. The relative weakness of the 1991 to 1994 year classes, which correspond to the cold El Niño years, continues to be apparent. The 1997 year class appears to be particularly weak.

Comparison of proportions at age and mean weights (Figure 3 and Table 6) indicates that some differences in the age distributions occur between the seasonal strata. As sampling occurred throughout the year, the age-length distribution given in Appendix A4 represents the year's landings and shows greater spread of length at age because of growth of fish during the year. The 2000 year class dominated catches in all strata, while fewer 2003 year class fish were taken in summer. The overall mean fish weight was 1.7 kg.

4. DISCUSSION

Samples were collected from a representative cross section of the fishery, including both targeting and bycatch fishing in SNA 7. This fishery comprises a wide range of age classes, and variability occurs in age distributions of landings within strata and between strata. The actual number of samples was increased from 55 to 60, which represents over 60% of all landings in the fishery. The achieved c.v. of 28% (27% for the 0–20+ age classes, is higher than the planned c.v. of 20%. This was due to the wide spread of age classes in the fishery. The c.v. is similar to the c.v. of 0.29 (0.27 for age classes 0–20+) achieved in sampling during 2000–01 (Blackwell & Gilbert 2002), but higher than the c.v. of 20% from the previous (2003–04) SNA 7 catch sampling (Blackwell & Gilbert 2003), where the fishery was strongly dominated by a single (2000) year class. The variability in the landings pattern between years and among strata is essentially unpredictable, and our planned but dynamically adjustable sampling regime appears to be the best method of sample allocation available.

The 2006–07 Tasman Bay/Golden Bay snapper fishery overall mean fish weight of 1.7 kg was similar to the 1.5 kg reported for 2003–04 (Blackwell & Gilbert 2005), reflecting the dominance of younger age classes in the fishery. Previous analyses reported an increasing trend in overall mean weight from 2.5 kg in 1998–99, to 3.2 kg in 1999–2000, then a decline to 3.0 kg in (2000–01) and to 1.5 kg in 2003–04 (see Blackwell et al. 1999, 2000, Blackwell & Gilbert 2002). The range in mean weight among strata during 2006–07 (1.2 kg in spring to 2.2 kg in summer) was similar to that in 2003–04 (range 1.0 in winter to 1.7 in spring). This contrasts with the 2000–01 analysis where mean weight varied from 4.0 kg (OTH-spring), to 1.9 kg (OTH-autumn/winter). We presume that the variability between strata is due to spatial heterogeneity and variable targeting in the fishery, and represents normal variability in fishing patterns.

The weakness of the 1991–94 year classes in the Tasman Bay/Golden Bay substock is consistent with the results of trawl surveys in Tasman Bay/Golden Bay during 1995 and 1996 in which the catches of juveniles were extremely low (Stevenson 1996, Blackwell & Stevenson 1997).

The Tasman Bay/Golden Bay substock appears to have experienced strong recruitment during the 1998–2003 calendar years (4–9-year-old fish), consistent with warm summers during this period (see Figure 2), and almost 89% by number of the 2006–07 fishery was derived from fish less than 10 years old. This represents a substantial change in a fishery which previously had shown the highest proportions of 20+-year-old fish of any New Zealand snapper stock (Appendix A5) (Blackwell et al. 2001, Walsh et al. 2001). The apparent increase in the relative proportions of younger fish is consistent with the rebuilding of the stock as predicted by the model of Gilbert & Phillips (2002). However, a stock rebuild appears to be inconsistent with the relative stability of the overall catches from the fishery which have only exceeded the 200 t TACC twice in the last 10 years. Many fishers actively avoid snapper, particularly in autumn-winter when quota is scarce (D. Loder, pers.comm., 2007), and a review of the commercial catch data is recommended to determine any trends in CPUE (catch per unit effort) in the fishery.

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Table 1: Reported landings (t) of snapper by stock from 1983–84 to 2005–06 and gazetted and actual TACCs (t) for 1986–87 to 2006–07 (after Ministry of Fisheries 2007).

Fishstock	SNA 1		SNA 2		SNA 3		SNA 7		SNA 8		SNA 10			
QMAs	1		2		3,4,5,6		7		8,9		10		Total	
	Landings	TACC	Landings	TACC	Landings	TACC	Landings	TACC	Landings	TACC	Landings	TACC	Landings§	TACC
1983–84†	6539	–	145	–	2	–	375	–	1725	–	0	–	9153	–
1984–85†	6898	–	163	–	2	–	255	–	1546	–	0	–	9228	–
1985–86†	5876	–	177	–	0	–	188	–	1828	–	0	–	8653	–
1986–87‡	4016	4710	130	130	0	30	257	330	893	1330	0	10	5314	6540
1987–88‡	5061	5098	152	137	1	30	256	363	1401	1383	0	10	6900	7021
1988–89‡	5793	5614	210	157	1	30	176	372	1526	1508	0	10	7706	7691
1989–90‡	5826	5981	364	157	< 1	30	294	160	1550	1594	0	10	8034	7932
1990–91‡	5315	6002	427	157	< 1	31	160	160	1658	1594	0	10	7570	7944
1991–92‡	6191	6010	373	157	< 1	31	148	160	1464	1594	0	10	8176	7962
1992–93‡	5423	4904	316	252	2	32	165	160	1543	1500	0	10	7448	6858
1993–94‡	4846	4928	307	252	< 1	32	147	160	1542	1500	0	10	6842	6883
1994–95‡	4831	4938	307	252	< 1	32	150	160	1434	1500	0	10	6723	6893
1995–96‡	4941	4938	279	252	< 1	32	146	160	1558	1500	0	10	6924	6893
1996–97‡	5049	4938	352	252	< 1	32	162	160	1613	1500	0	10	7176	6893
1997–98‡	4524	4500	286	252	< 1	32	182	200	1589	1500	0	10	6583	6494
1998–99‡	4411	4500	283	252	3	32	142	200	1636	1500	0	10	6475	6494
1999–00‡	4500	4500	391	252	< 1	32	174	200	1604	1500	0	10	6669	6494
2000–01‡	4347	4500	360	252	< 1	32	156	200	1630	1500	0	10	6496	6494
2001–02‡	4372	4500	252	252	1	32	141	200	1577	1500	0	10	6342	6494
2002–03‡	4484	4500	334	315	<1	32	187	200	1558	1500	0	10	6563	6557
2003–04‡	4466	4500	339	315	<1	32	215	200	1667	1500	0	10	6686	6557
2004–05‡	4641	4500	399	315	<1	32	178	200	1663	1500	0	10	6881	6557
2005–06‡	4530	4500	389	315	<1	32	166	200	1434	1300	0	10	6527	6357
2006–07‡	4424	4500	329	315	<1	32	248	200	1327	1300	0	10	6328	6357

† FSU data. SNA 1 = stat areas 1–10; SNA 2 = stat areas 11–16; SNA 3 = stat areas 18–32; SNA 7 = stat areas 17, 33–36, 38; SNA 8 = stat areas 37, 39–48.

‡ QMS data.

§ Includes landings from unknown areas before 1986–87.

Table 2: Summary of estimated catch (kg) by method (BPT, bottom pair trawl; BT, bottom trawl; SN, set net; Other, all other methods), and by month in the SNA 7 fishery for the 2006–07 fishing year. Source: Ministry of Fisheries data extract January 2008.

	Method				
Month	BT	BPT	SN	Other	Total
October	24 592		212	4 028	28 832
November	30 134		578	30 879	61 591
December	27 055		93	21 599	48 747
January	25 463	8 516	86	94	34 159
February	5 719	18	64		5 801
March	10 442		297	10	10 749
April	23 126		55	3	23 184
May	15 546		2	126	15 674
June	11 246		23	2 200	13 469
July	5 232		234	200	5 666
August	998		26	900	1 924
September	5 154		266	32	5 452
Total	184 707	8 534	1 936	60 071	255 248

Table 3: Summary of estimated catch by subregion (Tasman/Golden Bay, Rest of SNA 7), statistical area, and month in the 2006–07 fishing year. Source: Ministry of Fisheries data extract January 2008.

Statistical	Rest of SNA 7			Tasman/Golden Bay					SNA 7
area	17	37	Total	34	35	36	38	Total	total
Month									
October	2 831	4 615	7 446	70	510	7 934	12 872	21 386	28 832
November	3 055	1 191	4 246		120	4 275	52 950	57 345	61 591
December	1 000	870	1 870		40	1 425	45 412	46 877	48 747
January	850	320	1 170		1 463		31 526	32 989	34 159
February	175	165	340		579	162	4 720	5 461	5 801
March	250	1 110	1 360		39	855	8 491	9 389	10 749
April	1 943	410	2 353		1 178	1 855	17 798	20 831	23 184
May	1 519	265	1 784	4	9 354	855	3 677	13 890	15 674
June		560	560		3 362	2 803	6 744	12 909	13 469
July				30	445	1 784	3 409	5 666	5 666
August	341		341		309	1 125	149	1 583	1 924
September	1 550	1 003	2 553	44	841	1 775	239	2 899	5 452
Total	13 514	10 509	24 023	148	18 240	24 848	187 987	231 225	255 248

Table 4: Estimated total catch (t) and proportion of estimated landings in Tasman Bay/Golden Bay (SNA 7) between 2003–04 and 2005–06, estimated total catch in 2006–07, actual proportion of catch by weight, and the number of samples by stratum for 2006–07. Source: Ministry of Fisheries data extract January 2008.

2006–07 stratum	Planned number of landings to sample	2003–04 to 2005–06 proportion of catch in stratum by weight	2006–07 proportion of catch in stratum by weight	2006–07 number of landings sampled
Spring	20	0.24	0.54	20
Summer	29	0.27	0.20	29
Autumn/Winter	11	0.48	0.25	11
Total	55	505.9 (t)	242 (t)	60

Table 5: Summary of snapper otolith samples in Tasman Bay/Golden Bay (SNA 7), 2006–07.

Stratum	Length range (cm)	Mean length (cm)	Number aged
Spring	25–82	41.6	279
Summer	25–78	43.0	175
Autumn/winter	27–68	34.7	165
Total			1 007

Table 6: Summary of estimates for 2006–07 by sampling stratum in Tasman Bay/Golden Bay (SNA 7).

Stratum	Spring	Summer	Autumn/ winter	Total
Landings sampled	20	29	11	60
Mean weight, $\hat{w}_j$ (kg)	1.2	2.2	1.8	1.7
Weight sampled landings, t_j (t)	14.9	28.1	3.2	46.2
Total landings, T_j (t)	132.2	49.4	60.0	242.2
Mean weighted c.v. of proportions at age (1–20+ y)	0.26	0.03	0.05	0.27

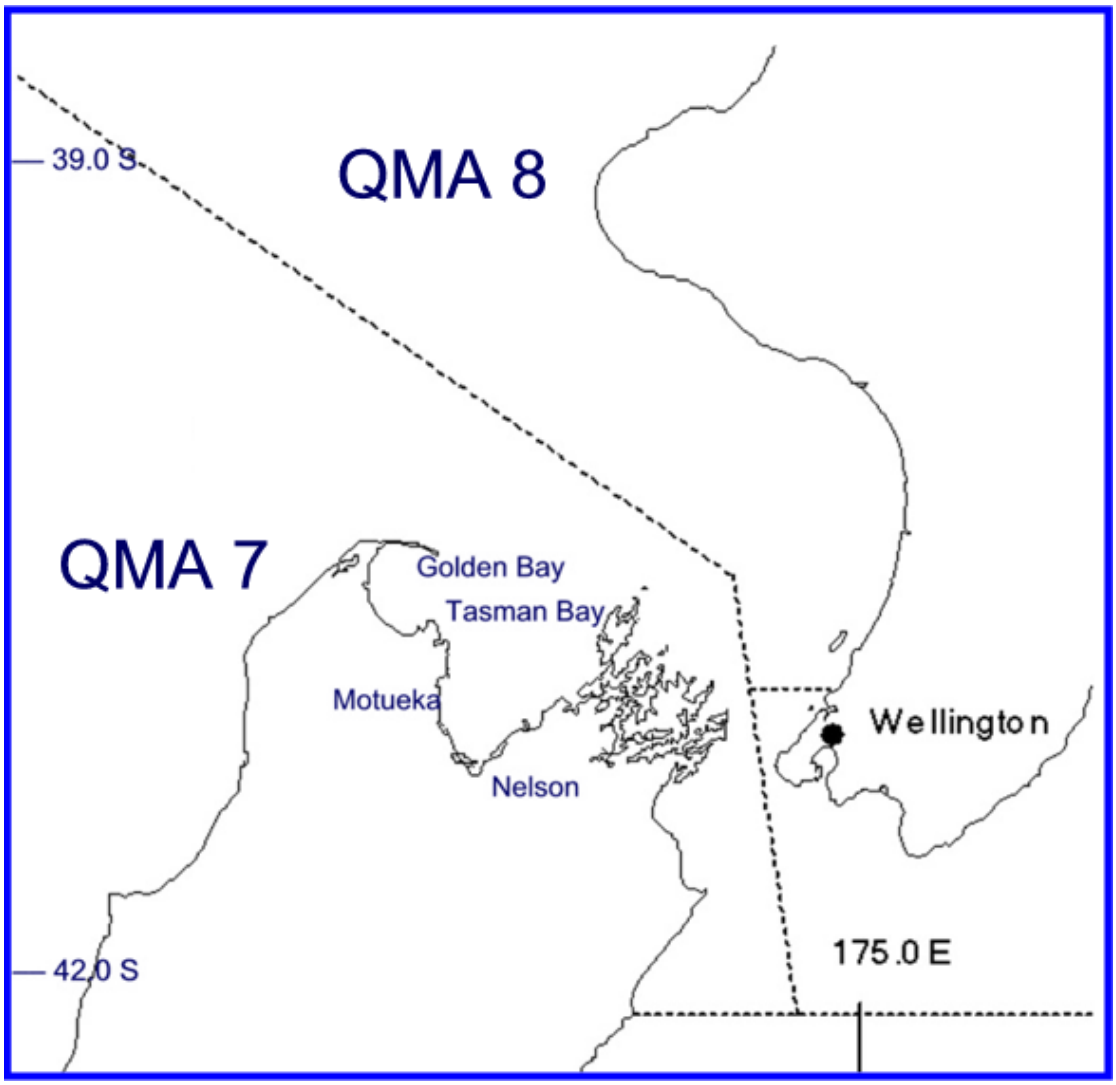


Figure 1: QMA 7, showing main ports of landing in the fishery. Tasman Bay is the large bay in which Motueka and Nelson are situated and Golden Bay is the large bay immediately to its northwest.

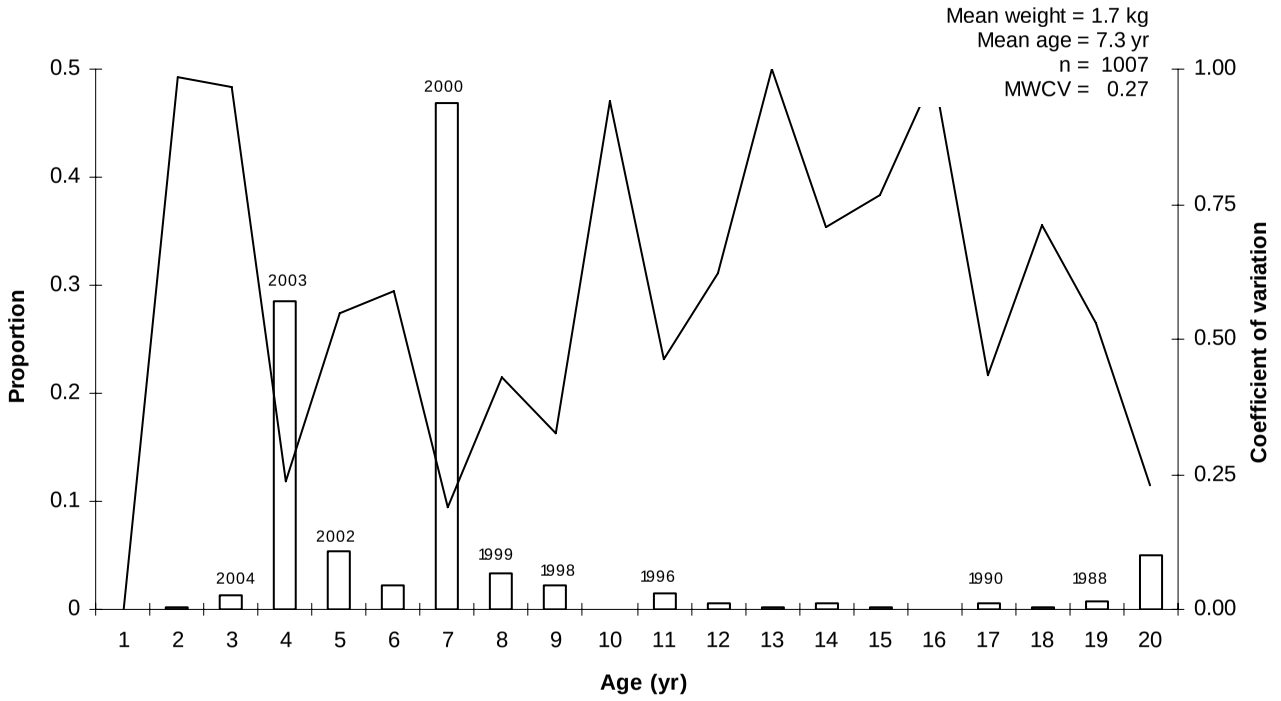


Figure 2: Proportion at age estimates (histogram) and c.v.s (line) for Tasman Bay/Golden Bay (SNA 7) landings, fishing year 2006–07. Years indicate calendar years of recruitment standardised to 1 January.

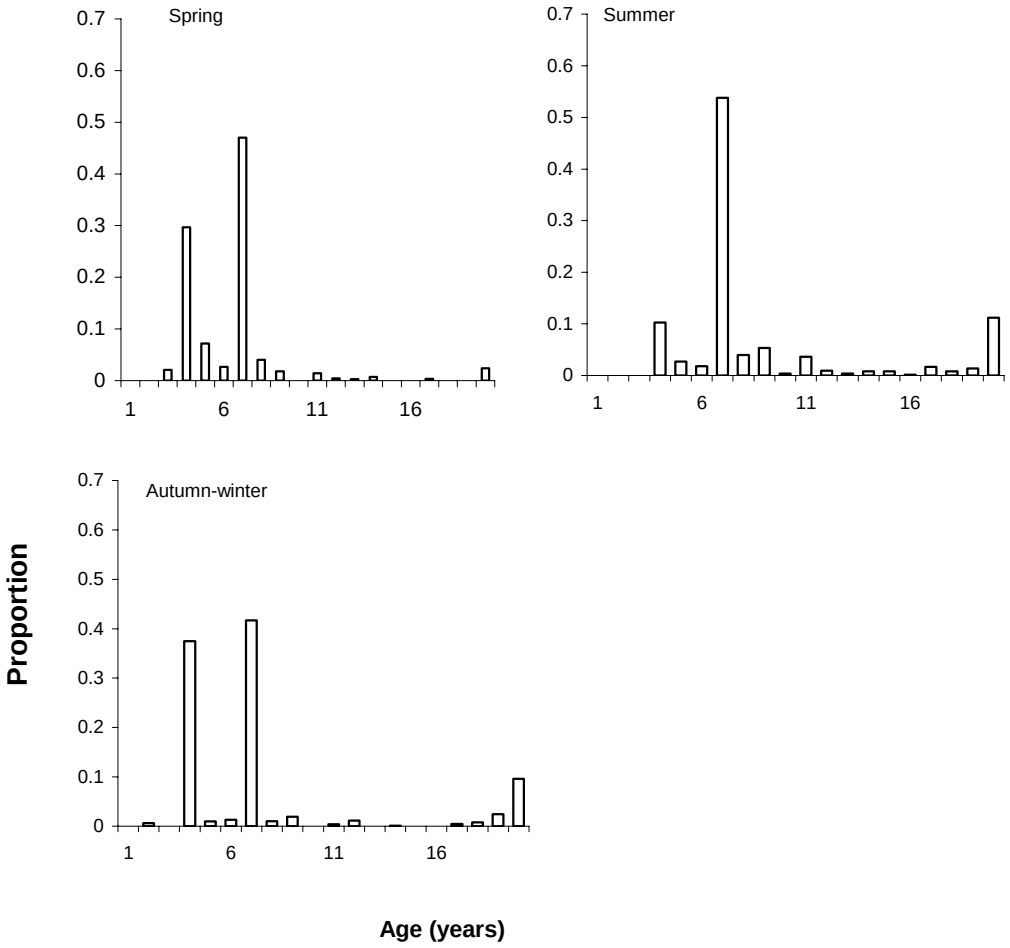


Figure 3: Proportion at age estimates for Tasman Bay/Golden Bay (SNA 7) landings, fishing year 2006–07 by sampling stratum (see text for stratum definitions).

Appendix A1: Estimated proportion at age (P_j) by stratum, and overall, for 2006–07 Tasman Bay/Golden Bay (SNA 7) landings.

	Stratum			
Age	Spring	Summer	Autumn-winter	Overall
1	0.00000	0.00000	0.00000	0.00000
2	0.00000	0.00000	0.00650	0.00128
3	0.02071	0.00000	0.00000	0.01386
4	0.29653	0.10285	0.37482	0.28601
5	0.07189	0.02720	0.00964	0.05363
6	0.02668	0.01784	0.01332	0.02286
7	0.46987	0.53799	0.41669	0.46852
8	0.04030	0.03973	0.00998	0.03425
9	0.01820	0.05310	0.01946	0.02312
10	0.00000	0.00395	0.00000	0.00053
11	0.01440	0.03624	0.00407	0.01529
12	0.00447	0.00908	0.01112	0.00640
13	0.00298	0.00395	0.00000	0.00252
14	0.00712	0.00791	0.00107	0.00604
15	0.00000	0.00791	0.00000	0.00106
16	0.00000	0.00146	0.00000	0.00020
17	0.00316	0.01701	0.00455	0.00529
18	0.00000	0.00815	0.00809	0.00269
19	0.00000	0.01379	0.02442	0.00666
20	0.00000	0.00549	0.00796	0.00230
21	0.01027	0.06446	0.03133	0.02168
22	0.00462	0.01186	0.00267	0.00521
23	0.00149	0.00395	0.00397	0.00231
24	0.00000	0.00000	0.00000	0.00000
25	0.00000	0.00000	0.00202	0.00040
26	0.00000	0.00000	0.00532	0.00105
27	0.00149	0.00000	0.00000	0.00100
28	0.00000	0.00192	0.00130	0.00051
29	0.00000	0.00000	0.00000	0.00000
30	0.00000	0.00000	0.00000	0.00000
31	0.00000	0.00224	0.00000	0.00030
32	0.00119	0.00000	0.00480	0.00174
33	0.00462	0.00000	0.00000	0.00309
34	0.00000	0.00000	0.00202	0.00040
35	0.00000	0.00791	0.00000	0.00106
36	0.00000	0.01238	0.01598	0.00481
37	0.00000	0.00000	0.00544	0.00107
38	0.00000	0.00162	0.00000	0.00022
39	0.00000	0.00000	0.00000	0.00000
40	0.00000	0.00000	0.00000	0.00000
41	0.00000	0.00000	0.00000	0.00000
42	0.00000	0.00000	0.00139	0.00027
43	0.00000	0.00000	0.00000	0.00000
44	0.00000	0.00000	0.00107	0.00021
45	0.00000	0.00000	0.00139	0.00027
46	0.00000	0.00000	0.00544	0.00107
47	0.00000	0.00000	0.00139	0.00027
48	0.00000	0.00000	0.00139	0.00027
49	0.00000	0.00000	0.00000	0.00000
50	0.00000	0.00000	0.00139	0.00027
51	0.00000	0.00000	0.00000	0.00000
52	0.00000	0.00000	0.00000	0.00000
53	0.00000	0.00000	0.00000	0.00000
54	0.00000	0.00000	0.00000	0.00000
55	0.00000	0.00000	0.00000	0.00000
56	0.00000	0.00000	0.00000	0.00000
57	0.00000	0.00000	0.00000	0.00000
58	0.00000	0.00000	0.00000	0.00000
59	0.00000	0.00000	0.00000	0.00000
60	0.00000	0.00000	0.00000	0.00000

Appendix A2: Coefficients of variation of proportions at age with finite population correction, estimated by simulation for 2006–07 Tasman Bay/Golden Bay (SNA 7) landings.

	Stratum			
Age	Spring	Summer	Autumn-winter	Overall
1	0.00000	0.00000	0.00000	0.00000
2	0.00000	0.00000	0.98635	0.98635
3	0.96518	0.00000	0.00000	0.96518
4	0.32467	0.33201	0.25664	0.23526
5	0.60875	0.39122	0.73657	0.54708
6	0.73791	0.44166	0.97037	0.58849
7	0.27550	0.12908	0.23854	0.19053
8	0.53578	0.50819	0.70664	0.43097
9	0.53918	0.37447	0.64157	0.32430
10	0.00000	0.93968	0.00000	0.93968
11	0.68758	0.49358	1.02765	0.46376
12	1.18570	0.58318	0.76596	0.62307
13	1.24111	0.93884	0.00000	1.00018
14	0.87655	0.80465	1.56115	0.70849
15	0.00000	0.76685	0.00000	0.76685
16	0.00000	0.98844	0.00000	0.98844
17	0.89238	0.41808	0.98035	0.43255
18	0.00000	0.60575	1.12197	0.71002
19	0.00000	0.56895	0.70061	0.53031
20	0.00000	0.66898	0.89291	0.64442
21	0.66613	0.26430	0.75524	0.31921
22	1.29765	0.74004	1.07951	0.81035
23	1.36809	0.93050	0.98110	0.71065
24	0.00000	0.00000	0.00000	0.00000
25	0.00000	0.00000	1.49358	1.49358
26	0.00000	0.00000	1.04685	1.04685
27	1.50460	0.00000	0.00000	1.50460
28	0.00000	0.68590	1.49265	0.82008
29	0.00000	0.00000	0.00000	0.00000
30	0.00000	0.00000	0.00000	0.00000
31	0.00000	0.77368	0.00000	0.77368
32	1.36486	0.00000	0.98556	0.82173
33	1.19786	0.00000	0.00000	1.19786
34	0.00000	0.00000	1.44145	1.44145
35	0.00000	0.78154	0.00000	0.78154
36	0.00000	0.57619	0.88539	0.61306
37	0.00000	0.00000	0.97550	0.97550
38	0.00000	0.97213	0.00000	0.97213
39	0.00000	0.00000	0.00000	0.00000
40	0.00000	0.00000	0.00000	0.00000
41	0.00000	0.00000	0.00000	0.00000
42	0.00000	0.00000	1.51523	1.51523
43	0.00000	0.00000	0.00000	0.00000
44	0.00000	0.00000	1.53095	1.53095
45	0.00000	0.00000	1.48756	1.48756
46	0.00000	0.00000	1.04336	1.04336
47	0.00000	0.00000	1.56511	1.56511
48	0.00000	0.00000	1.51557	1.51557
49	0.00000	0.00000	0.00000	0.00000
50	0.00000	0.00000	1.47689	1.47689
51	0.00000	0.00000	0.00000	0.00000
52	0.00000	0.00000	0.00000	0.00000
53	0.00000	0.00000	0.00000	0.00000
54	0.00000	0.00000	0.00000	0.00000
55	0.00000	0.00000	0.00000	0.00000
56	0.00000	0.00000	0.00000	0.00000
57	0.00000	0.00000	0.00000	0.00000
58	0.00000	0.00000	0.00000	0.00000
59	0.00000	0.00000	0.00000	0.00000
60	0.00000	0.00000	0.00000	0.00000

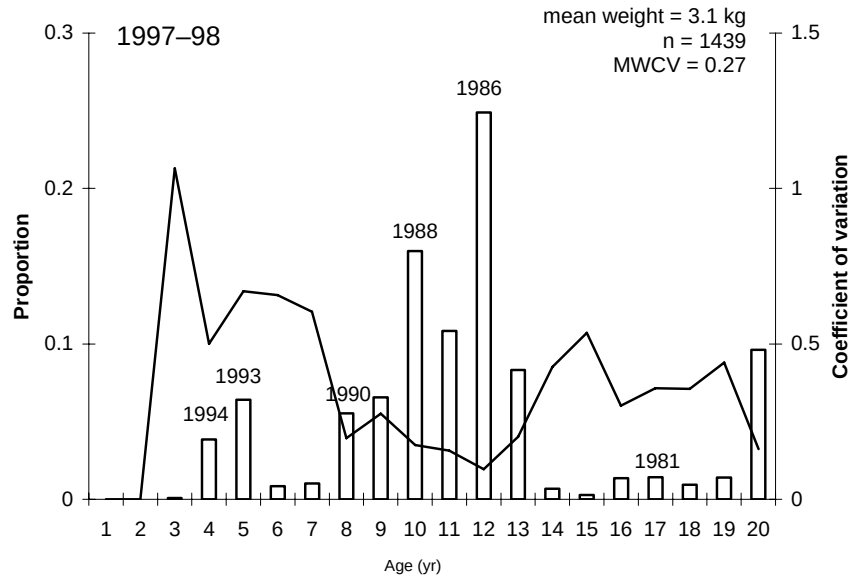
Appendix A3: Numbers of otoliths examined by age and length, for 2006–07 Tasman Bay/Golden Bay (SNA 7) landings (age standardised to 1 January birthday).

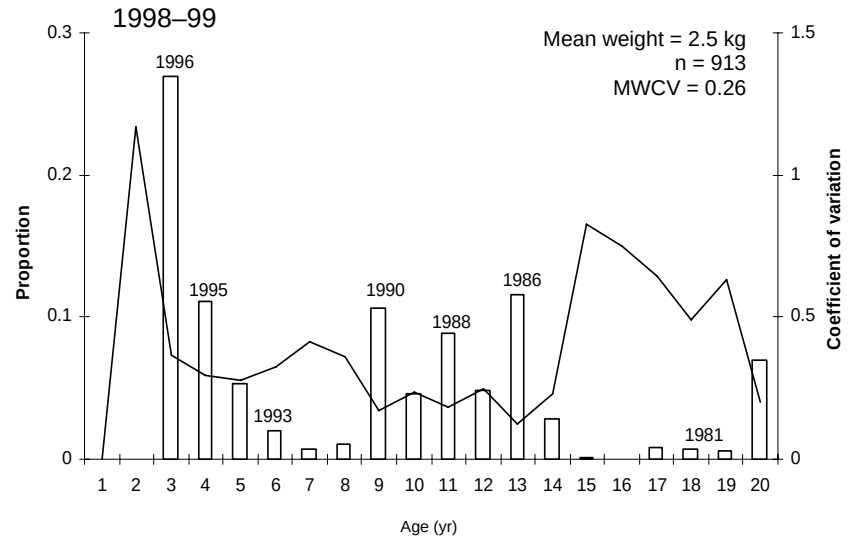
Length																					No.
(cm)	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	20+	aged
23			1																		1
25			3																		3
26	4		7	1																	12
27		2	20	2																	24
28		2	27																		29
29			24	2																	26
30		1	26	1		2															30
31			30	1		1															32
32			28	1		1															30
33			25	1		3															29
34			19	5		9															33
35			21	8		8															37
36			7	1	1	15															24
37				5	2	28															35
38			5	3	5	38				1											52
39					1	41	1														43
40			1	1	2	60															64
41					3	37	4														44
42				2	4	49	5	1													61
43				2	1	50	8	1													62
44						27	5	2													34
45					1	23	4	2		1											31
46						11	7	7													25
47						8	4	2			1										15
48						8	2	3		2											15
49					1	4		2			1										8
50						2		3				1	1								7
51				1		1		3		2	2										9
52							1	2		4	4										11
53								1		1	1										3
54							1	4		2			1			1					9
55								1	1		2	1		1		1	2			2	11
56											1						2		1	3	7
57										1											1
58						1				1	1		2	1		1	1	3		3	14
59										1					1		1			1	4
60																		1		1	2
61											1		1				2			3	7
62												1				1		1		7	10
63										1										6	7
64																1		1		8	10
65																4		1		5	10
66																2		1	1	5	9
67																1				4	5
68																				5	5
69																1	1	1	1	10	14
70													1			1		2		6	10
71																		2	1	5	8
72																		2		5	7
73																		1	1	4	6
74																		1		3	4
75																			1	2	3
76																			1	4	5
77																				2	2
78																				1	1
Total	4	5	244	37	21	427	42	34	1	17	14	3	6	2	1	14	9	17	7	95	1000

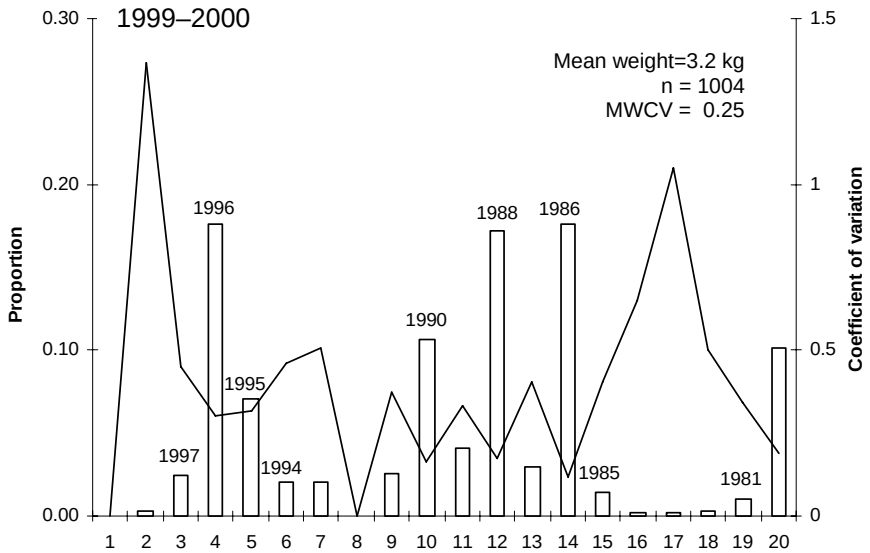
Appendix A4: Estimates of the percentage at length and age for commercially caught snapper in Tasman Bay/Golden Bay (SNA 7) in 2006–07. Table sums to 100.

	Age (year)																			
Length	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	Total
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	0	0	0	0.00040	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	0	0	0	0.00708	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
26	0	0.00128	0	0.01245	0.00021	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12
27	0	0	0.00555	0.03173	0.00043	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	24
28	0	0	0.00555	0.03623	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	29
29	0	0	0	0.02950	0.00279	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	26
30	0	0	0.00277	0.04066	0.00021	0	0.00333	0	0	0	0	0	0	0	0	0	0	0	0	0	30
31	0	0	0	0.02656	0.00027	0	0.00200	0	0	0	0	0	0	0	0	0	0	0	0	0	32
32	0	0	0	0.02846	0.00050	0	0.00204	0	0	0	0	0	0	0	0	0	0	0	0	0	30
33	0	0	0	0.02991	0.00309	0	0.00771	0	0	0	0	0	0	0	0	0	0	0	0	0	29
34	0	0	0	0.02234	0.01168	0	0.02201	0	0	0	0	0	0	0	0	0	0	0	0	0	33
35	0	0	0	0.01575	0.01732	0	0.01551	0	0	0	0	0	0	0	0	0	0	0	0	0	37
36	0	0	0	0.00249	0.00277	0.00277	0.02759	0	0	0	0	0	0	0	0	0	0	0	0	0	24
37	0	0	0	0	0.00664	0.00312	0.05022	0	0	0	0	0	0	0	0	0	0	0	0	0	35
38	0	0	0	0.00189	0.00589	0.00748	0.05551	0	0	0	0.00277	0	0	0	0	0	0	0	0	0	52
39	0	0	0	0	0	0.00034	0.05572	0.00034	0	0	0	0	0	0	0	0	0	0	0	0	42
40	0	0	0	0.00059	0.00027	0.00081	0.05146	0	0	0	0	0	0	0	0	0	0	0	0	0	63
41	0	0	0	0	0	0.00161	0.05326	0.00550	0	0	0	0	0	0	0	0	0	0	0	0	44
42	0	0	0	0	0.00090	0.00271	0.03393	0.00350	0.00277	0	0	0	0	0	0	0	0	0	0	0	60
43	0	0	0	0	0.00051	0.00100	0.04528	0.00747	0.00155	0	0	0	0	0	0	0	0	0	0	0	62
44	0	0	0	0	0	0	0.01666	0.00540	0.00069	0	0	0	0	0	0	0	0	0	0	0	34
45	0	0	0	0	0	0.00026	0.01047	0.00316	0.00294	0	0.00277	0	0	0	0	0	0	0	0	0	31
46	0	0	0	0	0	0	0.00375	0.00240	0.00334	0	0	0	0	0	0	0	0	0	0	0	25
47	0	0	0	0	0	0	0.00573	0.00179	0.00078	0	0	0.00021	0	0	0	0	0	0	0	0	15
48	0	0	0	0	0	0	0.00393	0.00409	0.00174	0	0.00069	0	0	0	0	0	0	0	0	0	15
49	0	0	0	0	0	0.00277	0.00095	0	0.00069	0	0	0.00021	0	0	0	0	0	0	0	0	8
50	0	0	0	0	0	0	0.00078	0	0.00121	0	0	0	0.00100	0.00100	0	0	0	0	0	0	7
51	0	0	0	0	0.00017	0	0.00026	0	0.00403	0	0.00153	0.00140	0	0	0	0	0	0	0	0	9
52	0	0	0	0	0	0	0	0.00026	0.00059	0	0.00180	0.00259	0	0	0	0	0	0	0	0	11
53	0	0	0	0	0	0	0	0	0.00020	0	0.00059	0.00021	0	0	0	0	0	0	0	0	3
54	0	0	0	0	0	0	0	0.00035	0.00205	0	0.00072	0	0	0.00100	0	0	0.00010	0	0	0	9
55	0	0	0	0	0	0	0	0	0.00053	0.00053	0	0.00074	0.00053	0	0.00053	0	0.00072	0.00060	0	0.00062	11
56	0	0	0	0	0	0	0	0	0	0	0	0.00053	0	0	0	0	0	0	0	0.00241	7
57	0	0	0	0	0	0	0	0	0	0	0.00309	0	0	0	0	0	0	0	0	0	1
58	0	0	0	0	0	0	0.00040	0	0	0	0.00053	0.00025	0	0.00074	0.00053	0	0.00053	0.00040	0.00100	0.00120	14
59	0	0	0	0	0	0	0	0	0	0	0.00026	0	0	0	0	0.0002	0	0.00020	0	0.00040	4
60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00040	0.00040	2
61	0	0	0	0	0	0	0	0	0	0	0	0.00026	0	0.00277	0	0	0	0.00080	0	0.00078	7
62	0	0	0	0	0	0	0	0	0	0	0	0	0.00100	0	0	0	0.00018	0	0.00020	0.00360	10
63	0	0	0	0	0	0	0	0	0	0	0.00053	0	0	0	0	0	0	0	0	0.00184	7
64	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00007	0	0.00040	0.00301	10
65	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00195	0	0.00123	0.00199	10
66	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00076	0	0.00013	0.00497	9
67	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00018	0	0	0.00145	5
68	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00251	5
69	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00018	0.00028	0.00007	0.00415	14
70	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00053	0	0	0.00061	0	0.00099	0.00471	10
71	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00065	0.00272	8
72	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00067	0.00430	7
73	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00050	0.00286	6
74	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00040	0.00064	4
75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00112	3
76	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00265	5
77	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00107	2
78	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00040	1
79	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
80	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Appendix A5: Proportion at age estimates for Tasman Bay/Golden Bay by fishing year, 1997–98 to 2003–04 (after Blackwell et al. 1999, 2000, 2001, Blackwell & Gilbert 2002).

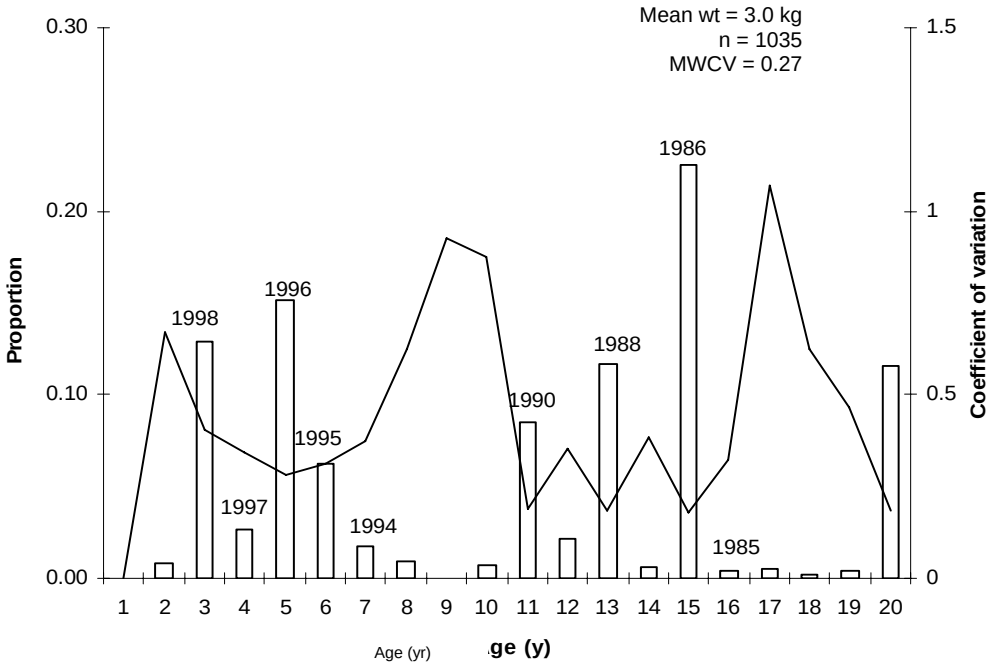






Appendix A5: – continued

2000–01



2003–04