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EXECUTIVE SUMMARY

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This report presents the results of Objective 1 of the Ministry of Fisheries project "Estimation of snapper year class strength in SNA 8" (SNA2003/03). The general objective was to determine the length frequency and age structure of commercial landings from SNA 8 for use in stock assessment models by market sampling.

The length frequency and age-length key sampling approach was employed in 2003–04 to estimate catch-at-age for snapper for the main fishing methods in SNA 8. Length frequency samples were collected from the SNA 8 single trawl and pair trawl fisheries, and age data were collected randomly in the form of a proportional allocation age-length key. A total sample size of 15 and 14 landings were sampled for length frequency from the single trawl and pair trawl fisheries respectively, with an age-length key collection of over 500 otoliths.

Year class strengths inferred for the SNA 8 stock were similar to those from previous years. The strong 1998 year class continues to dominate the age distributions for the single trawl and pair trawl fisheries making up about one in every three fish landed. The 1999 and 2000 year classes appear to be of average strength and, together with the 1998 year class, account for about 70% of the catch. Apart from the 1996 year class, most others, especially those 11 years or older, are of low to very low abundance relative to other age classes.

Both the length and age distributions of the SNA 8 single trawl and pair trawl fisheries for 2003–04 were very similar, and had almost identical estimates of mean length, mean age, and mean weighted coefficients of variation (MWCV). MWCVs (for analytical estimates) of below 20% across all age classes in the SNA 8 catch-at-age compositions were achieved.

1. INTRODUCTION

Staff of the National Institute of Water and Atmospheric Research (NIWA) and, formerly, MAF Fisheries have sampled the length and age compositions of snapper (*Pagrus auratus*) from commercial landings in port (market sampling) intermittently since 1963 (Davies et al. 1993). In the 1988–89 fishing year, a structured sampling programme was designed to establish a time series of length and age composition data for the main snapper fisheries in the east and west coast North Island stocks, SNA 1 and SNA 8 respectively. The time series of length and age information has been summarised in previous reports (Davies & Walsh 1995, Walsh et al. 1995, 1997, 1998, 1999, 2000, 2001, 2002, 2003, 2004). This report presents the results of market sampling from the SNA 8 stock between October 2003 and February 2004, thus continuing the time series. Funding for this project, SNA2003/03, was provided by the Ministry of Fisheries.

The specific objective of this project for 2003–04 was:

1. To carry out sampling and estimate the relative proportion at age and length of recruited snapper sampled from the commercial trawl catch in SNA 8 during spring and summer 2003–04. The target coefficient of variation (c.v.) for the catch-at-age will be 20% (mean weighted c.v. across all age classes).

2. METHODS

The SNA 8 stock encompasses almost all the west coast of New Zealand's North Island (Figure 1). Landings from the SNA 8 fishery were stratified by fishing method and quarter, e.g., single trawl – spring. The fishing methods sampled were single trawl (BT) and pair trawl (BPT) and samples were collected in the spring (September–November) and summer (December–February) quarters only.

Details of the sampling design were described by Davies & Walsh (1995). Length frequency samples were collected from the SNA 8 single trawl and pair trawl fisheries using a two-stage sampling procedure (West 1978). The random selection of landings and a random sample of bins within landings represent the first and second stages respectively. The sampling procedure was modified to account for the grading of fish according to length and quality by taking a stratified random sample of bins within a landing (Davies et al. 1993). All fish in bins making up the sample were measured to the nearest centimetre below the fork length. As snapper show no differential growth between sexes (Paul 1976), sex was not determined.

The age-length key method was used for collecting otoliths as described by Davies & Walsh (1995). The sample allocation for each length class interval was made according to the west coast pair trawl proportion at length distribution as estimated for the previous year. The west coast pair trawl length distribution was used (as opposed to that for the single trawl method) because it was slightly broader and was thought to better represent the recruited population. Also, given that the catch-at-age distributions for the single trawl and pair trawl catches in 2002–03 largely (60–63%) comprised two year classes, 1998 and 1999 (Walsh et al. 2004), the broader pair trawl length distribution was more likely to include the length intervals into which these year classes would grow. To allow for annual variability in the abundance of fish in the 25–26 cm size range, a fixed sample size of 10 otoliths was collected from each of these length intervals. Similarly, a minimum sample size of one fish for size classes greater than 60 cm was specified to ensure the right hand limb was adequately represented. Although the numbers of fish collected in the 28–35 cm size range appears to be fixed at about 30 fish per interval, this was coincidental. These numbers reflect the actual proportions at length of the pair trawl catch in 2002–03. The otolith sample size for the west coast collection (n = 500) was based on previous SNA 8 catch-at-age simulations using past length and age data that produce mean weighted coefficients of variation (MWCV) of below 20% for catch-at-age estimates.

A standardised procedure for reading otoliths was followed (Davies & Walsh 1995). Age was defined as the rounded whole year from a nominal birth date of 1 January, e.g., in 2003–04, the 1998 year class was 6 years old, whether sampled in December 2003 or February 2004.

The age-length key derived from the age data is assumed to be representative of the spring-summer period. The main assumption to be satisfied for an age-length key is that the sample was taken randomly with respect to age from within each length interval (Southward 1976).

Calculation of proportions at length and age, and variances from length frequency samples and age-length keys, followed that of Davies & Walsh (1995). Bootstrap mean and variance estimates were not determined because the difference between bootstrap and analytical estimates for snapper samples has been found to be negligible (Davies et al. 2003). Calculation of mean weight-at-age was based on $w\,(g) = 0.04467\, l^{2.793}$ (cm) (Paul 1976), and variances followed Quinn II et al. (1983). Proportions at age and mean weight-at-age (with analytical estimates of coefficient of variation, c.v.), were calculated for the range of age classes recruited, with the maximum age being an aggregate of all age classes over 19 years.

Snapper length and age data were stored on the Ministry of Fisheries *market* and *age* databases respectively, administered by NIWA.

3. RESULTS

3.1 Sample collections

Summaries of the length frequency sample sizes for method-season strata are given in Table 1, and summaries of the otolith sample collection in Table 2. Catch data from autumn 2003 to summer 2003–04 are provided in Table 1, displaying seasonal patterns in the fisheries. The single trawl fishery operated mainly over spring and summer, and the pair trawl fishery concentrated around summer. The relative catch by method for the SNA 8 stock over the sampling period (October 2003–February 2004) was similar to that of the previous year with single trawl and pair trawl making up 77% and 18% of the catch respectively. Considerable differences are apparent between the percentage of number of landings sampled and the percentage of weight of landings sampled in the west coast single trawl and pair trawl fisheries (Table 1). In single trawl landings, this was because samples were taken mainly from landings where snapper was the target species. Landings where snapper is a bycatch are generally of lower weight. However, in all pair trawl landings, where trevally (*Pseudocaranx dentex*) was the targeted species, snapper still made up a large proportion of the overall catch. The summarised information in Table 1 is for all landings containing snapper (target and bycatch) caught from SNA 8.

A total sample size of 15 landings was targeted from the single trawl and pair trawl fisheries in 2003–04, with 15 and 14 landings being sampled for length frequency from each of the fisheries respectively.

3.2 Length and age distributions

For all fisheries sampled in 2003–04, catch-at-age compositions (using the length frequency and age-length key approach) were derived from the combined spring and summer length distributions, and were used to compare method strata and identify year class strengths. However, otoliths were not collected consistently in either spring or summer. In combining the seasonal data, it is assumed that

an age-length key collected from spring and/or summer can be applied to the combined spring and summer length data. Because the growth of snapper over 25 cm long is not great between spring and summer, this assumption is reasonable. This assumption has been accepted for other species with growth rates comparable to those of snapper (Westrheim & Ricker 1978).

Sample length and age distributions for the SNA 8 fisheries in 2003–04 are presented as histograms and line graphs (Figures 2–7). The estimated proportions at length, and age, and mean weight-at-age, are tabulated in Appendices 1–3. The age-length key is presented in Appendix 4.

The estimated total number of fish caught in each method-season stratum was calculated from the reported total weight landed and the mean fish weight derived from stratum length compositions (Appendix 1). The estimated total number of fish caught for the spring-summer combined stratum may not correspond exactly to the sum of the individual season estimates because of differences in mean fish weight when spring and summer are treated separately.

3.3 SNA 8

The length distribution of the single trawl catch in 2003–04 was characterised by one main mode at 33–34 cm, and minor modes at about 40 and 47 cm (Figures 2 and 6). The tail of the distribution extended to over 65 cm. The mean length of snapper sampled from the fishery was 36.9 cm, and the proportion-at-length MWCV was 0.09. The pair trawl length distribution was very similar to that of single trawl and showed the same pattern of modal peaks (Figures 4 and 6). The main mode of the pair trawl length distribution was at 33 cm, with minor modes at 40 and 46 cm, respectively. The distribution had a tail extending to over 65 cm, a mean length of 36.8 cm, and the proportion-at-length MWCV was 0.09.

The age distributions for the single trawl and pair trawl catches in 2003–04 were dominated by the 2000, 1999, and 1998 year classes (4, 5, and 6 year olds), and make up over 70% of fish landed in SNA 8 (Figures 3, 5, and 7). Both distributions are very similar and largely comprise fish between 4 and 8 years old, with less than 5% of fish being 11 years old or more (Figure 7). Some older age classes are absent and the aggregate (over 19) age class makes up under 1% of the overall catch. As in the previous two years, the 1998 year class is the strongest year class in the SNA 8 fishery, accounting for about one in every three fish landed by trawl in 2003–04. The 2000 and 1999 year classes appear to be of about average strength and fully recruited as they contain no fish less than 27 cm (see Appendix 4). The once strong 1996 year class (8 year olds) now makes up about 10% of fish in single trawl and pair trawl catches by number respectively, while the very weak 1997 year class (7 year olds) accounts for only 1% (Figures 3 and 5). The mean age of snapper from the single trawl and pair trawl fisheries was 6.0 years, and catch-at-age MWCVs were 0.11.

4. DISCUSSION

The relative year class strengths inferred in the length and age distributions sampled from the SNA 8 single trawl and pair trawl fisheries in the 2003–04 are generally consistent with trends observed in recent years (Walsh et al. 2001, 2002, 2003, 2004).

The west coast single trawl and pair trawl age distributions were dominated by the 2000, 1999, and 1998 year classes, accounting for about 70% of fish landed in 2003–04. The 1998 year class continues to be the single most dominant year class in the fishery accounting for about one in every three fish landed. As a consequence, most of the older year classes in SNA 8, except 1996 and 1995, appear to be of low to very low abundance with less than 5% of fish being 11 years old or more. As

in the last 15 years, the aggregate (over 19) age class was less than 1% of the overall catch, the lowest proportion for any New Zealand snapper stock.

In 2001–02 and 2002–03, the 1998 year class accounted for about 30–40% of fish in single trawl and pair trawl landings, and has continued to dominate catches this year. Similarly, the 1996 year class dominated SNA 8 catches in 1999–2000 to 2001–02, and was predicted from trawl surveys undertaken in SNA 8 to be the second highest year strength observed (Morrison & Parkinson 2001). It appears probable from a comparison of catch-at-age estimates over the past five years that the 1998 year class may be of similar relative strength to the 1996 year class, and can therefore be considered important in sustaining the SNA 8 fishery. Preliminary results from a recent assessment of the SNA 8 fishery predict the 1998 year class to have the highest index of abundance of any year class for the last 25 years (Authors unpublished data, MFish project SNA2003/01).

A likely reason for the 1998 year class being so strong is an environmental factor such as water temperature, as has happened in other New Zealand snapper fisheries (Paul 1976, Francis 1993). Sea surface temperature (SST) data (source NIWA) for January–April 1998 indicated the northern coastal margins of the SNA 8 stock had some of the highest recorded SST levels in recent years, with average monthly deviations from a long-term mean of about +1.5 °C. Should SST data become a useful tool to estimate the recruitment strength of snapper in SNA 8, as it has for some areas in SNA 1 (Francis 1993), then it may be a better environmental predictor of year class strength than suggested previously by Davies & McKenzie (2001). They found a significant interaction between month and year, but a poor correlation to current year class strength estimates. The spatial strata they used may have been too coarse (1x1 degree boxes), with temperature influenced by coastal land, or the strata may have been too distant from the coastal margin where snapper actually reside. A 12-year time series of high resolution SST data is now available at NIWA and may become a useful tool in determining if a strong relationship exists with year class strength for the SNA 8 stock.

It is almost certain that the 1998 year class will continue to dominate single trawl and pair trawl catches in 2004–05 for the fourth consecutive year for the following reasons. Firstly, the recruiting 2001 year class appears to be of below average strength, accounting for only about 5% of fish in the age distributions in 2003–04 and is unlikely to increase substantially in 2004–05. Walsh et al. (2001) predicted that three-year-old age classes of above average strength from SNA 8 appear strongly in the length frequency distribution, either by broadening the distribution below 30 cm, or as a clearly identifiable length mode dominating the 25–30 cm length intervals. This did not happen, but the 2001 year class still contains a proportion of fish at 25 cm, so the full relative strength of the cohort may not yet be accurately known. This may be because of slower growth and hence delayed recruitment to the commercial fishery (see Appendix 4). A comparison of the 2001 year class relative to other year classes may be better seen in 2004–05 when it will be fully recruited. Secondly, the 2000 year class appears already fully recruited to the fishery and it too is likely to have little influence in reducing the relative proportion of the 1998 year class in the coming year.

The 1996 year class and, to a lesser degree, the 1995 year class, continue to constitute a large proportion of the tail of the length distribution, especially in the 40–50 cm size range. Fish from both these year classes have a combined average weight of just below 2.0 kg (see Appendix 3) and although they only make up a combined proportion of about 14% of fish landed by number, they contribute substantially more by weight, close to that of the 1998 year class. For a fishery managed by an annual harvest weight strategy (total allowable commercial catch), the relative importance of these moderately aged heavier fish to the fishery, especially the 1996 year class, should not be overlooked.

Single trawl samples were collected mainly throughout the spring and pair trawl samples in summer, with both methods operating in the same general areas. Despite the differences in the season of

collection, length distributions sampled from the single trawl and pair trawl fisheries in 2003–04 were very similar, having the same estimates of mean length, and similar modal peaks reflecting year classes that currently (or previously) dominate the fishery. In both methods the main mode was centred at about 33–34 cm and evenly comprised fish from the 2000, 1999, and 1998 year classes, while the minor peaks at 40 and 46–47 cm reflect the strong 1998, and once strong 1996 and 1995 year classes respectively (see Appendix 4). Differences in the selectivity patterns between single trawl and pair trawl were evident from length distributions some years ago when larger and older snapper were more abundant in catches (Sullivan & Gilbert 1978). However, in more recent years (Walsh et al. 2001, 2002, 2003, 2004), similarities in the length composition of landings from SNA 8 indicate that the selectivity characteristics of the methods are very similar. Differences are likely to become apparent when fish from a strong year class grow to lengths that exceed the optimum selectivity of the single trawl method yet remain vulnerable to the pair trawl method. Although pair trawl snapper landings were largely a bycatch with trevally the target species, both species are common in catches in the west coast fishery. In fact, in about half the pair trawl landings sampled, an even amount of both species was landed. It is therefore unlikely that the target species will have influenced the length composition of the pair trawl catch.

The snapper landings sampled in this study were from fishing operations in the northern half of the SNA 8 stock above latitude 38° S. These have been some of the most heavily fished grounds since the fishery was fully established in the mid 1950s (Reid 1969) and are still considered the main areas to catch snapper today. Walsh et al. (NIWA, unpublished data) found considerable latitudinal variability in the length and age structure of snapper landings from the SNA 8 stock. These differences were detected to a finer spatial resolution than was possible in this study. However, from the similarities in the data presented here between the single trawl and pair trawl catch compositions in 2003–04, and from comparisons with collections made since 1999–2000 (Walsh et al. 2001, 2002, 2003, 2004), it appears the data are representative of the SNA 8 fishery and reflect the areas fished by vessels operating from Onehunga or Auckland fishing over spring and summer.

Since 1998–99, the west coast trawl age distributions have been dominated largely by single strong year classes, usually only recently fully recruited to the commercial fishery, with relatively low numbers of larger and older fish (see Walsh et al. 2000, 2001, 2002, 2003, 2004). It was thought that either high fishing mortality had reduced the relative abundance of older fish, or recent year classes had recruited with above average strength and dominated the distributions (Walsh et al. 2001, 2002). The population age structure appears to be constantly changing in SNA 8 as apparently strong year classes recruit to the fishery and are subsequently heavily fished down in the following years (Walsh et al. 2003). Walsh et al. (2004) proposed a number of factors that indicate the SNA 8 stock abundance has remained at about the same level in recent years: the dramatic rate of decline of strong year classes, the lack of accumulation of fish in the old age classes through time, the similarities in the length and age distributions for both single trawl and pair trawl catches in recent years, and the consistently low mean age. Estimates of biomass from tagging programmes conducted in 1990 (9500 t) and 2002–03 (10 400 t) (Gilbert et al., NIWA, unpublished data, Annala et al. 2004) confirm that the SNA 8 stock has indeed remained at about the same level for many years.

The MWCV for the length and age distributions sampled from the SNA 8 fisheries in 2003–04 were the same for each method at 0.09 and 0.11 respectively. The c.v. estimates for the pair trawl spring length frequency data were low because 100% of landings were sampled, and there were no c.v. estimates for the single trawl summer data because only one landing was sampled from this fishery (Appendix 1).

5. CONCLUSIONS

1. The length and age distributions sampled from the SNA 8 fisheries in 2003–04 were generally consistent with trends observed in recent years. The summarised data show a high resemblance between methods and have the same mean length and mean age estimates.

2. The 1998 year class dominates the age distributions of the SNA 8 stock, making up about one in every three fish landed by single trawl and pair trawl in 2003–04. Apart from the 2000, 1999, and 1996 year classes, most other year classes are of low to very low abundance, including the aggregate (over 19) age class.

6. ACKNOWLEDGMENTS

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Table 1: Summary of the catch (total number and weight of landings) and samples (number of landings and weight sampled, and number of fish measured) in method–season strata for the SNA 8 snapper fisheries from autumn 2003 to summer 2003–04.*

Method	Season	Number of landings			No. of fish measured	Weight of landings (t)		
		Total	Sampled	% of total		Total	Sampled	% of total
BPT	Autumn	4	0	0	0	6	0	0
	Winter	7	0	0	0	17	0	0
	Spring	4	4	100.0	3 313	76	76	100.0
	Summer	21	10	47.6	7 111	146	87	59.6
BT	Autumn	136	0	0	0	163	0	0
	Winter	89	0	0	0	85	0	0
	Spring	113	14	12.4	8 780	622	227	36.5
	Summer	120	1	0.8	378	382	11	2.9

* BPT, pair trawl; BT, single trawl.

Table 2: Details of snapper otolith samples collected in 2003–04 from SNA 8.

Area	Fishing method†	Sampling period	Sample method††	Length range (cm)	No. aged
SNA 8	BPT, BT	Spring, summer	SR	25–77	503

† BPT, pair trawl; BT, single trawl.

†† SR, stratified random sample.

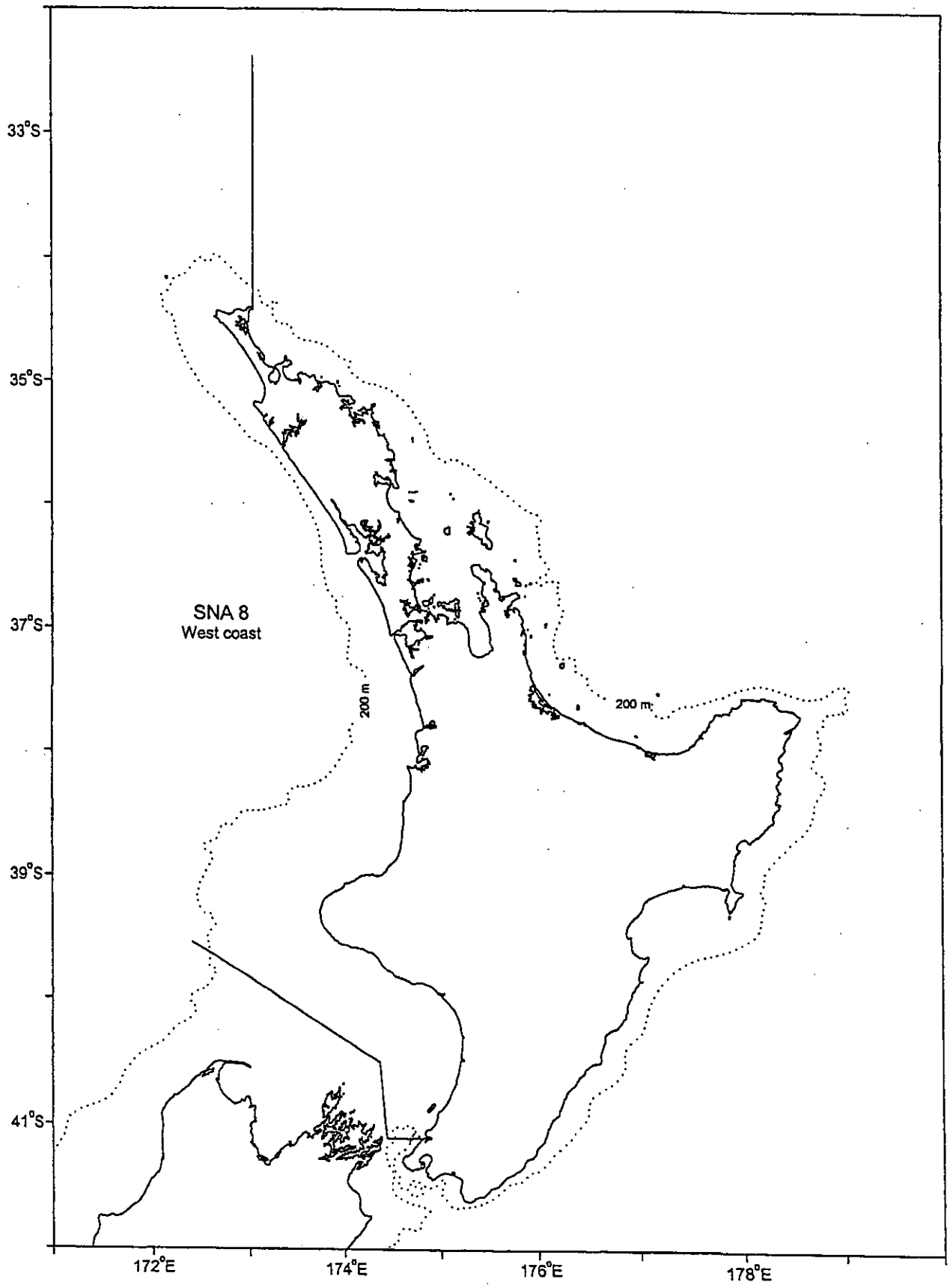

Figure 1: Quota management area for the west coast North Island snapper stock, SNA 8.

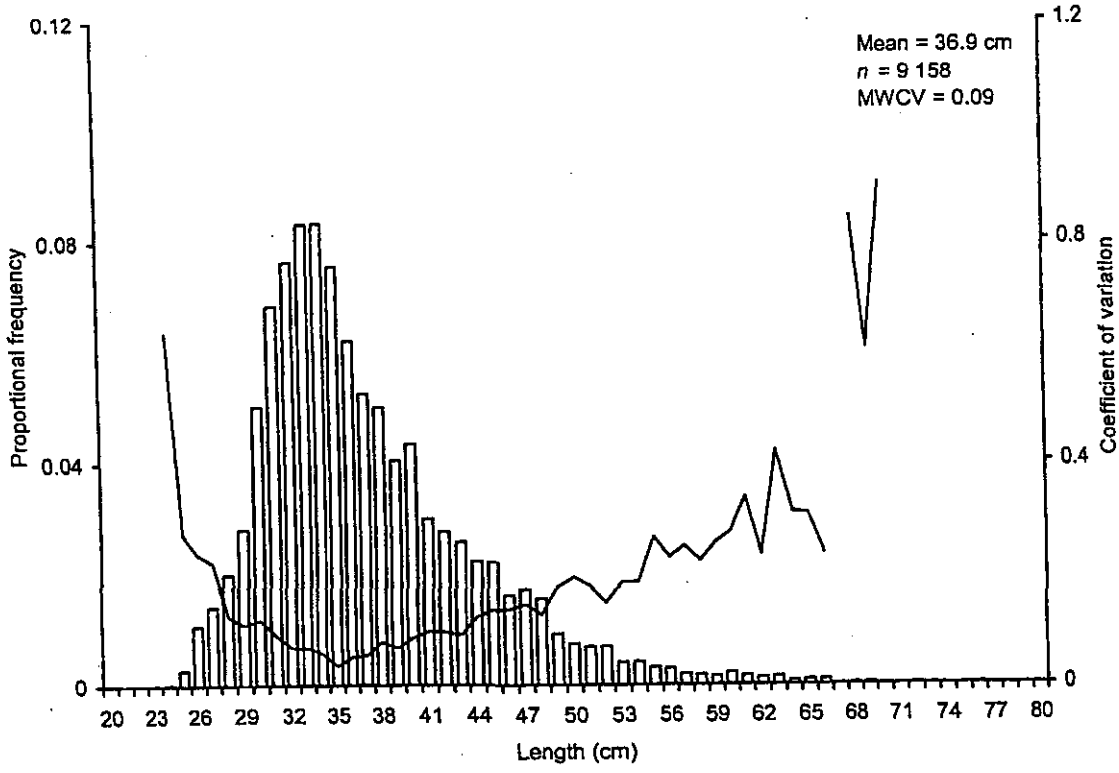

Figure 2: Proportion at length distribution (histogram) and c.v.s (solid line) determined from snapper landings sampled from the SNA 8 single trawl fishery in 2003–04 (*n*, length sample size; MWCV, mean weighted c.v.).

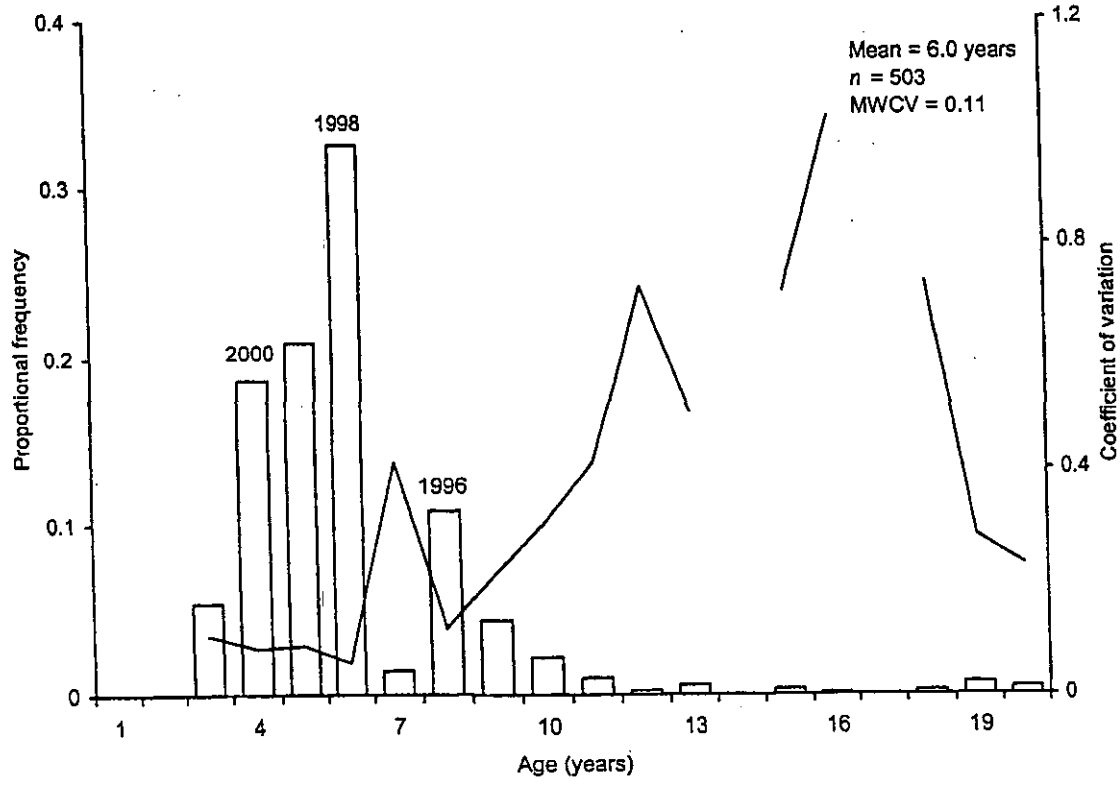

Figure 3: Proportion at age distribution (histogram) and c.v.s (solid line) determined from snapper landings sampled from the SNA 8 single trawl fishery in 2003–04 using the age-length key approach (*n*, otolith sample size; MWCV, mean weighted c.v.).

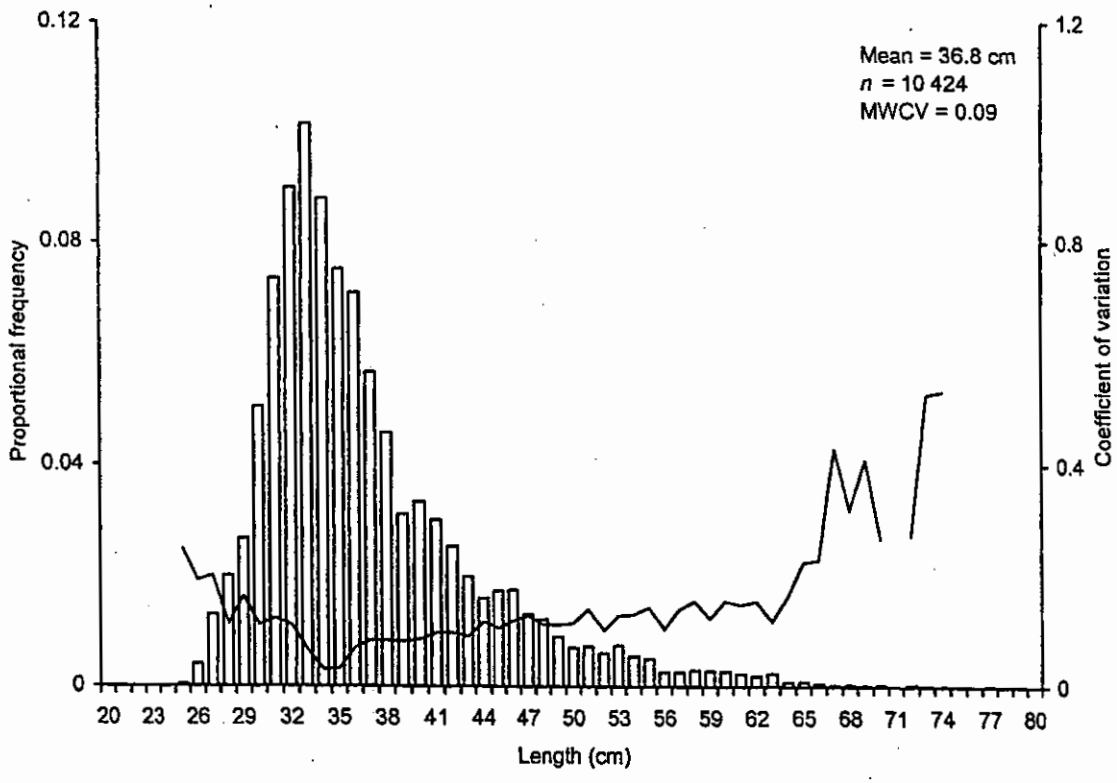

Figure 4: Proportion at length distribution (histogram) and c.v.s (solid line) determined from snapper landings sampled from the SNA 8 pair trawl fishery in 2003–04 (*n*, length sample size; MWCV, mean weighted c.v.).

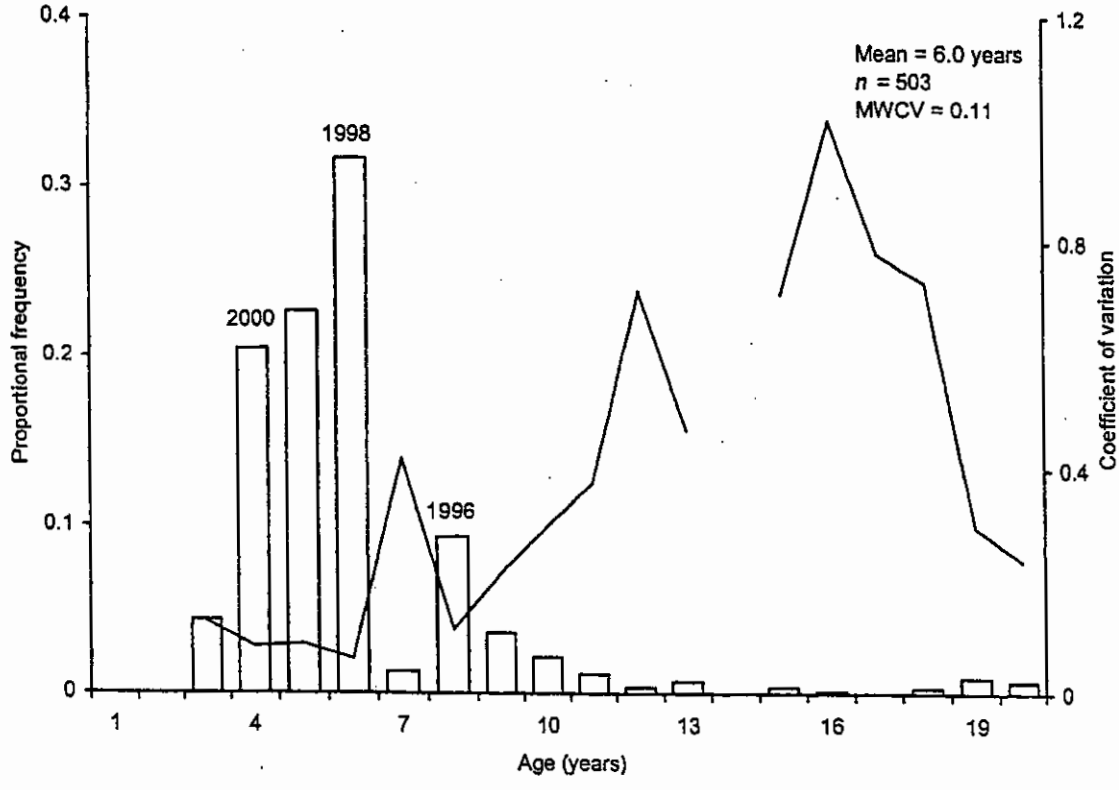

Figure 5: Proportion at age distribution (histogram) and c.v.s (solid line) determined from snapper landings sampled from the SNA 8 pair trawl fishery in 2003–04 using the age-length key approach (*n*, otolith sample size; MWCV, mean weighted c.v.).

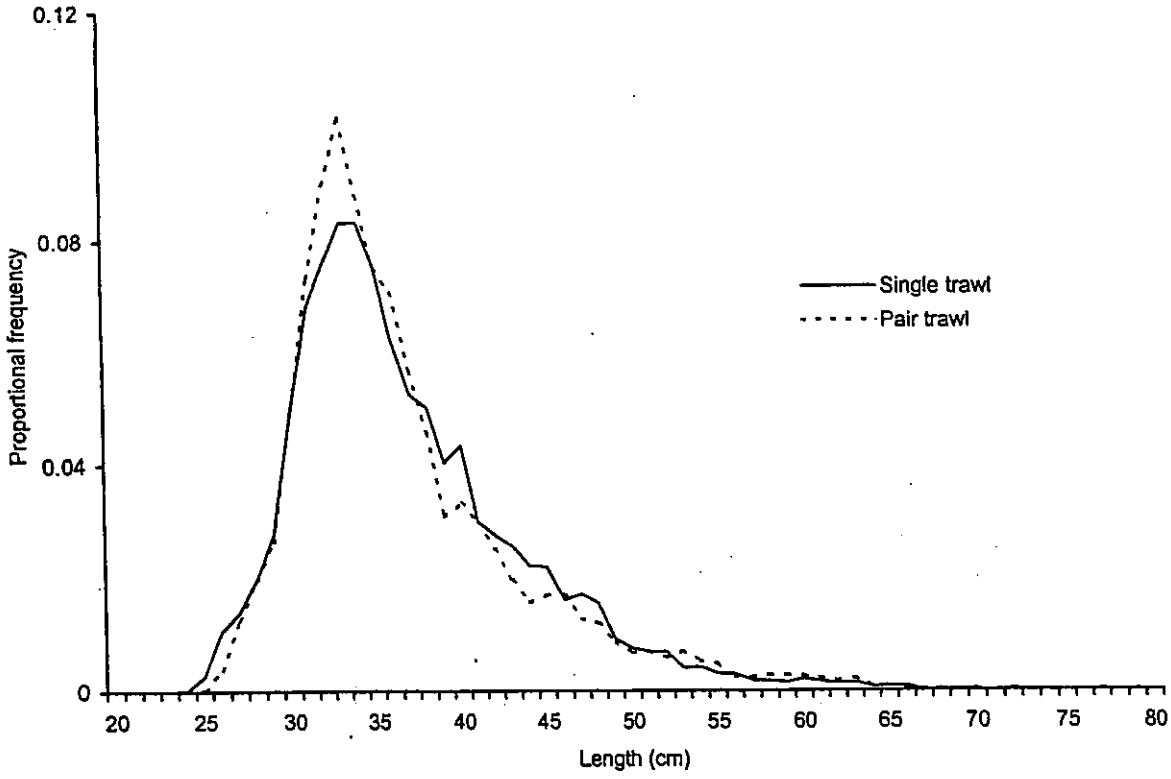

Figure 6: Proportion at length distributions determined from snapper landings sampled from the SNA 8 single trawl and pair trawl (solid and dashed lines respectively) fisheries in 2003–04.

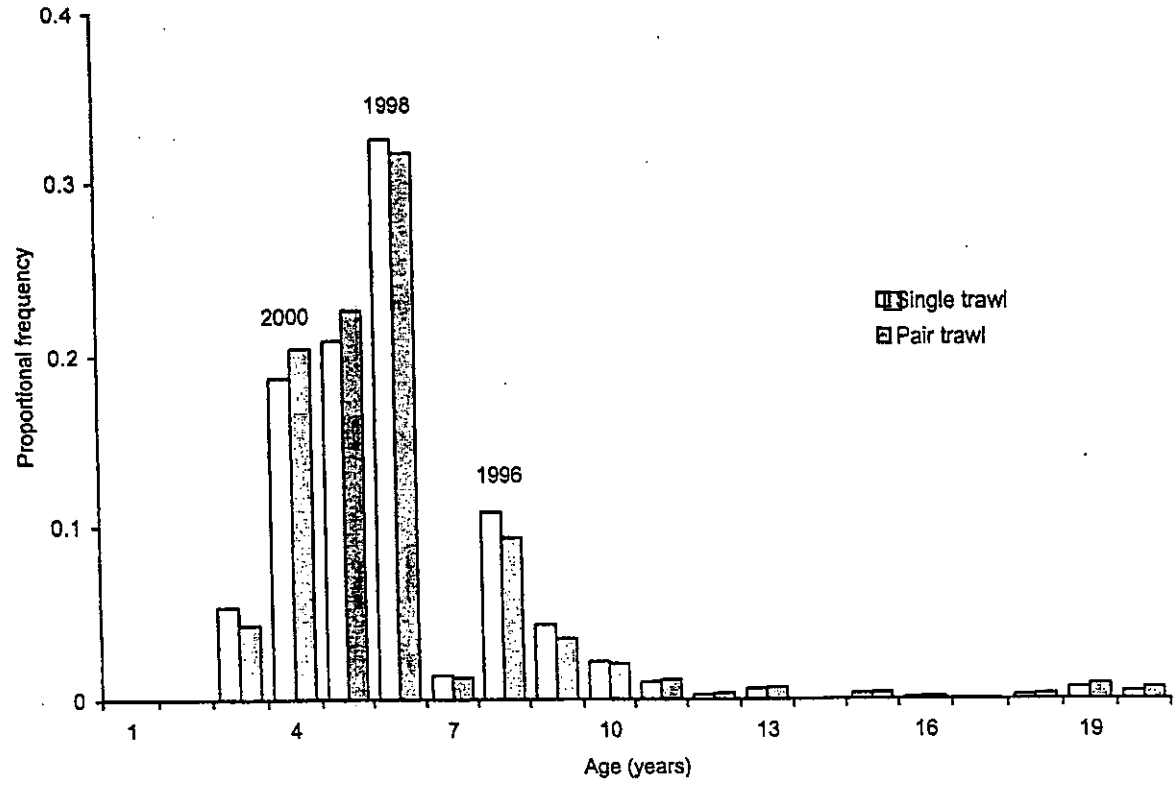

Figure 7: Proportion at age distributions determined from snapper landings sampled from the SNA 8 single trawl and pair trawl (unshaded and shaded histograms respectively) fisheries in 2003–04 using the age-length key approach.

Appendix 1: Estimates of the proportion at length of snapper from the SNA 8 single trawl and pair trawl fisheries in 2003–04 (– no estimate available because only one landing was sampled). The spr-sum estimates are based on a combined stratum, not the sum of spring and summer values.

P.i. = proportion of fish in length class. *Nt* = total number of fish caught.
c.v. = coefficient of variation. *n* = total number of fish sampled.

	Single trawl						Pair trawl					
Length	Spring		Summer		Spr-sum		Spring		Summer		Spr-sum	
(cm)	*P.i.*	c.v.	*P.i.*	c.v.	*P.i.*	c.v.	*P.i.*	c.v.	*P.i.*	c.v.	*P.i.*	c.v.
20	0.0000	0.00	0.0000	–	0.0000	0.00	0.0000	0.00	0.0000	0.00	0.0000	0.00
21	0.0000	0.00	0.0000	–	0.0000	0.00	0.0000	0.00	0.0000	0.00	0.0000	0.00
22	0.0000	0.00	0.0000	–	0.0000	0.00	0.0000	0.00	0.0000	0.00	0.0000	0.00
23	0.0000	0.00	0.0000	–	0.0000	0.00	0.0000	0.00	0.0000	0.00	0.0000	0.00
24	0.0002	0.58	0.0000	–	0.0002	0.64	0.0000	0.00	0.0000	0.00	0.0000	0.00
25	0.0029	0.25	0.0000	–	0.0028	0.27	0.0003	0.03	0.0004	0.36	0.0003	0.25
26	0.0113	0.21	0.0000	–	0.0108	0.24	0.0055	0.01	0.0024	0.15	0.0039	0.19
27	0.0147	0.20	0.0000	–	0.0141	0.22	0.0174	<0.01	0.0082	0.15	0.0128	0.20
28	0.0207	0.11	0.0053	–	0.0201	0.13	0.0230	<0.01	0.0168	0.07	0.0199	0.11
29	0.0291	0.10	0.0026	–	0.0281	0.11	0.0362	<0.01	0.0171	0.07	0.0267	0.16
30	0.0522	0.10	0.0026	–	0.0503	0.12	0.0634	<0.01	0.0376	0.05	0.0505	0.11
31	0.0703	0.08	0.0212	–	0.0684	0.09	0.0934	<0.01	0.0531	0.06	0.0733	0.12
32	0.0786	0.06	0.0212	–	0.0763	0.07	0.1054	<0.01	0.0743	0.08	0.0899	0.11
33	0.0853	0.06	0.0317	–	0.0832	0.07	0.1100	<0.01	0.0932	0.05	0.1016	0.07
34	0.0846	0.05	0.0529	–	0.0833	0.06	0.0914	<0.01	0.0845	0.03	0.0879	0.03
35	0.0753	0.03	0.0820	–	0.0755	0.04	0.0739	<0.01	0.0760	0.04	0.0750	0.03
36	0.0608	0.05	0.0952	–	0.0621	0.05	0.0540	<0.01	0.0876	0.02	0.0708	0.07
37	0.0502	0.04	0.1111	–	0.0526	0.06	0.0529	<0.01	0.0604	0.04	0.0567	0.08
38	0.0471	0.06	0.1270	–	0.0502	0.08	0.0344	<0.01	0.0571	0.03	0.0457	0.08
39	0.0396	0.06	0.0608	–	0.0405	0.07	0.0235	<0.01	0.0387	0.05	0.0311	0.08
40	0.0415	0.08	0.0899	–	0.0434	0.09	0.0318	<0.01	0.0348	0.07	0.0333	0.08
41	0.0289	0.09	0.0556	–	0.0300	0.10	0.0250	<0.01	0.0351	0.05	0.0301	0.10
42	0.0266	0.09	0.0556	–	0.0277	0.10	0.0178	<0.01	0.0327	0.05	0.0252	0.10
43	0.0254	0.09	0.0344	–	0.0258	0.09	0.0154	0.01	0.0240	0.07	0.0197	0.09
44	0.0218	0.12	0.0344	–	0.0223	0.12	0.0141	0.01	0.0176	0.11	0.0158	0.12
45	0.0222	0.13	0.0212	–	0.0221	0.14	0.0162	0.01	0.0181	0.07	0.0171	0.10
46	0.0162	0.13	0.0185	–	0.0163	0.14	0.0163	0.01	0.0182	0.10	0.0172	0.12
47	0.0176	0.14	0.0106	–	0.0173	0.15	0.0105	0.01	0.0154	0.13	0.0129	0.13
48	0.0160	0.12	0.0079	–	0.0157	0.13	0.0101	0.01	0.0140	0.08	0.0121	0.11
49	0.0095	0.17	0.0053	–	0.0093	0.18	0.0069	0.01	0.0108	0.11	0.0089	0.11
50	0.0076	0.19	0.0079	–	0.0076	0.20	0.0055	0.01	0.0083	0.11	0.0069	0.11
51	0.0069	0.17	0.0106	–	0.0070	0.18	0.0066	0.01	0.0077	0.16	0.0071	0.14
52	0.0071	0.14	0.0079	–	0.0071	0.15	0.0042	0.01	0.0077	0.06	0.0060	0.10
53	0.0040	0.18	0.0079	–	0.0042	0.19	0.0075	0.01	0.0071	0.09	0.0073	0.13
54	0.0043	0.17	0.0026	–	0.0043	0.19	0.0043	0.01	0.0066	0.14	0.0054	0.13
55	0.0033	0.24	0.0000	–	0.0032	0.27	0.0046	0.01	0.0052	0.17	0.0049	0.14
56	0.0032	0.21	0.0000	–	0.0030	0.23	0.0016	0.02	0.0035	0.13	0.0025	0.10
57	0.0020	0.23	0.0000	–	0.0019	0.25	0.0013	0.02	0.0037	0.16	0.0025	0.14
58	0.0019	0.20	0.0000	–	0.0018	0.22	0.0026	0.01	0.0031	0.23	0.0029	0.15
59	0.0015	0.25	0.0026	–	0.0016	0.26	0.0020	0.02	0.0036	0.12	0.0028	0.12
60	0.0022	0.26	0.0026	–	0.0022	0.28	0.0026	0.01	0.0029	0.22	0.0027	0.15
61	0.0017	0.31	0.0000	–	0.0016	0.34	0.0014	0.02	0.0032	0.17	0.0023	0.15
62	0.0013	0.23	0.0026	–	0.0013	0.24	0.0006	0.03	0.0030	0.08	0.0018	0.15
63	0.0016	0.38	0.0000	–	0.0015	0.42	0.0022	0.01	0.0023	0.11	0.0023	0.12
64	0.0006	0.31	0.0026	–	0.0006	0.31	0.0009	0.02	0.0006	0.32	0.0008	0.16
65	0.0009	0.28	0.0000	–	0.0008	0.31	0.0010	0.02	0.0007	0.30	0.0009	0.22
66	0.0008	0.23	0.0026	–	0.0009	0.24	0.0007	0.03	0.0003	0.40	0.0005	0.23
67	0.0000	0.00	0.0000	–	0.0000	0.00	0.0000	0.00	0.0004	0.51	0.0002	0.43
68	0.0002	0.77	0.0000	–	0.0002	0.84	0.0004	0.04	0.0003	0.44	0.0003	0.32
69	0.0002	0.55	0.0000	–	0.0002	0.61	0.0000	0.00	0.0003	0.48	0.0002	0.41
70	0.0000	0.00	0.0026	–	0.0001	0.90	0.0003	0.03	0.0004	0.43	0.0003	0.27
71	0.0000	0.00	0.0000	–	0.0000	0.00	0.0000	0.00	0.0000	0.00	0.0000	0.00
72	0.0001	0.78	0.0000	–	0.0001	0.86	0.0004	0.04	0.0004	0.34	0.0004	0.27
73	0.0000	0.00	0.0000	–	0.0000	0.00	0.0000	0.00	0.0002	0.61	0.0001	0.53
74	0.0000	0.00	0.0000	–	0.0000	0.00	0.0000	0.00	0.0001	0.62	0.0001	0.53
75	0.0000	0.00	0.0000	–	0.0000	0.00	0.0000	0.00	0.0000	0.00	0.0000	0.00
76	0.0001	0.79	0.0000	–	0.0001	0.86	0.0000	0.00	0.0000	0.00	0.0000	0.00
77	0.0000	0.00	0.0000	–	0.0000	0.00	0.0003	0.04	0.0000	0.00	0.0002	0.50
78	0.0000	0.00	0.0000	–	0.0000	0.00	0.0000	0.00	0.0000	0.00	0.0000	0.00
79	0.0000	0.00	0.0000	–	0.0000	0.00	0.0000	0.00	0.0001	0.66	<0.0001	0.55
80	0.0000	0.00	0.0000	–	0.0000	0.00	0.0000	0.00	0.0000	0.00	0.0000	0.00
Nt	541 082		289 445		868 645		70 798		118 952		192 981	
n	8 780		378		9 158		3 313		7 111		10 424	

Appendix 2: Estimates of proportion at age of snapper from the SNA 8 single trawl and pair trawl fisheries in 2003–04.

P.j., proportion of fish in age class; c.v., coefficient of variation; otolith sample size = 503

	Single trawl						Pair trawl					
Age	Spring		Summer		Spr-sum		Spring		Summer		Spr-sum	
(years)	*P.j.*	c.v.	*P.j.*	c.v.	*P.j.*	c.v.	*P.j.*	c.v.	*P.j.*	c.v.	*P.j.*	c.v.
1	0.0000	0.00	0.0000	0.00	0.0000	0.00	0.0000	0.00	0.0000	0.00	0.0000	0.00
2	0.0000	0.00	0.0000	0.00	0.0000	0.00	0.0000	0.00	0.0000	0.00	0.0000	0.00
3	0.0558	0.10	0.0056	0.47	0.0538	0.10	0.0554	0.13	0.0312	0.13	0.0433	0.13
4	0.1918	0.08	0.0622	0.17	0.1867	0.08	0.2407	0.08	0.1685	0.09	0.2046	0.08
5	0.2118	0.09	0.1498	0.12	0.2094	0.09	0.2429	0.09	0.2102	0.09	0.2266	0.09
6	0.3176	0.06	0.5033	0.06	0.3250	0.06	0.2849	0.06	0.3488	0.06	0.3168	0.06
7	0.0140	0.41	0.0180	0.43	0.0141	0.41	0.0118	0.44	0.0140	0.41	0.0129	0.42
8	0.1064	0.12	0.1521	0.15	0.1082	0.12	0.0791	0.12	0.1078	0.12	0.0934	0.11
9	0.0434	0.21	0.0524	0.26	0.0437	0.21	0.0298	0.22	0.0412	0.22	0.0355	0.21
10	0.0221	0.30	0.0210	0.41	0.0221	0.30	0.0174	0.31	0.0243	0.30	0.0209	0.30
11	0.0101	0.42	0.0109	0.54	0.0101	0.41	0.0104	0.39	0.0124	0.38	0.0114	0.38
12	0.0025	0.72	0.0009	1.41	0.0025	0.72	0.0030	0.73	0.0039	0.72	0.0035	0.71
13	0.0061	0.50	0.0040	0.90	0.0061	0.50	0.0049	0.50	0.0090	0.47	0.0069	0.47
14	0.0000	0.00	0.0000	0.00	0.0000	0.00	0.0000	0.00	0.0000	0.00	0.0000	0.00
15	0.0032	0.72	0.0044	0.86	0.0033	0.72	0.0030	0.72	0.0044	0.71	0.0037	0.71
16	0.0011	1.03	0.0013	1.41	0.0011	1.02	0.0013	1.06	0.0014	1.02	0.0014	1.02
17	0.0000	0.00	0.0000	0.00	0.0000	0.00	0.0003	0.98	0.0000	0.00	0.0002	0.78
18	0.0025	0.73	0.0009	1.41	0.0024	0.73	0.0021	0.79	0.0040	0.72	0.0031	0.73
19	0.0069	0.29	0.0066	0.63	0.0069	0.28	0.0068	0.39	0.0113	0.26	0.0090	0.30
>19	0.0044	0.23	0.0066	0.63	0.0045	0.23	0.0062	0.26	0.0072	0.28	0.0067	0.24

Appendix 3: Estimates of mean weight at age (kg) of snapper from the SNA 8 single trawl and pair trawl fisheries in 2003–04.

c.v., coefficient of variation; otolith sample size = 503

	Single trawl						Pair trawl						
Age	Spring		Summer		Spr-sum		Spring		Summer		Spr-sum		
(years)	Mean	c.v.	Mean	c.v.	Mean	c.v.	Mean	c.v.	Mean	c.v.	Mean	c.v.	*n*
1	–	–	–	–	–	–	–	–	–	–	–	–	–
2	–	–	–	–	–	–	–	–	–	–	–	–	–
3	0.49	0.02	0.54	0.05	0.49	0.02	0.51	0.03	0.51	0.02	0.51	0.02	61
4	0.70	0.01	0.78	0.03	0.70	0.01	0.69	0.01	0.71	0.02	0.70	0.01	97
5	0.81	0.02	0.93	0.02	0.81	0.02	0.79	0.02	0.83	0.02	0.81	0.02	97
6	1.10	0.01	1.16	0.01	1.10	0.01	1.05	0.02	1.09	0.01	1.07	0.01	132
7	1.40	0.12	1.48	0.07	1.41	0.12	1.32	0.15	1.37	0.12	1.34	0.13	6
8	1.78	0.03	1.63	0.03	1.77	0.03	1.76	0.03	1.76	0.03	1.76	0.03	45
9	1.94	0.04	1.82	0.07	1.94	0.04	1.96	0.05	1.95	0.05	1.95	0.05	19
10	2.33	0.05	2.27	0.10	2.33	0.06	2.44	0.06	2.38	0.06	2.40	0.06	11
11	2.64	0.06	2.70	0.04	2.64	0.06	2.72	0.04	2.70	0.05	2.71	0.05	6
12	3.15	0.02	3.08	0.01	3.15	0.02	3.16	0.02	3.15	0.02	3.16	0.02	2
13	3.31	0.07	3.16	0.15	3.31	0.07	3.45	0.07	3.43	0.07	3.44	0.07	5
14	–	–	–	–	–	–	–	–	–	–	–	–	–
15	2.16	0.27	1.76	0.26	2.14	0.27	2.22	0.27	2.25	0.26	2.24	0.26	2
16	4.13	0.01	4.13	0.01	4.13	0.01	4.13	0.01	4.13	0.01	4.13	0.01	1
17	–	–	–	–	–	–	8.30	0.02	–	–	8.30	0.02	1
18	3.29	0.05	3.08	0.01	3.28	0.05	3.24	0.05	3.31	0.05	3.28	0.05	2
19	4.21	0.04	4.80	0.07	4.23	0.04	4.06	0.06	4.14	0.04	4.11	0.04	6
>19	4.99	0.04	5.31	0.11	5.00	0.04	4.98	0.04	4.96	0.06	4.97	0.05	10

Appendix 4: Age-length key derived from otolith samples collected from snapper fisheries in SNA 8 in 2003–04.

Estimates of proportion of age at length for snapper sampled from SNA 8, spring and summer 2003–04. (Note: Aged to 01/01/2004)

Length (cm)	Age (years) 1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	>19	No. aged
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	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
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	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9
26	0	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10
27	0	0	0.73	0.20	0.07	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	15
28	0	0	0.60	0.20	0.17	0.03	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30
29	0	0	0.30	0.40	0.30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30
30	0	0	0.10	0.63	0.27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30
31	0	0	0.06	0.56	0.38	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	32
32	0	0	0	0.58	0.32	0.10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	31
33	0	0	0	0.37	0.40	0.20	0.03	0	0	0	0	0	0	0	0	0	0	0	0	0	30
34	0	0	0	0.13	0.33	0.53	0	0	0	0	0	0	0	0	0	0	0	0	0	0	30
35	0	0	0	0.10	0.45	0.45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	29
36	0	0	0	0.07	0.33	0.59	0	0	0	0	0	0	0	0	0	0	0	0	0	0	27
37	0	0	0	0	0.24	0.72	0	0.04	0	0	0	0	0	0	0	0	0	0	0	0	25
38	0	0	0	0	0	0.83	0	0.11	0.06	0	0	0	0	0	0	0	0	0	0	0	18
39	0	0	0	0	0.12	0.82	0.06	0	0	0	0	0	0	0	0	0	0	0	0	0	17
40	0	0	0	0	0	0.81	0	0.19	0	0	0	0	0	0	0	0	0	0	0	0	16
41	0	0	0	0	0	0.50	0.13	0.31	0	0	0	0	0	0	0.06	0	0	0	0	0	16
42	0	0	0	0	0	0.36	0	0.45	0.09	0.09	0	0	0	0	0	0	0	0	0	0	11
43	0	0	0	0	0	0.36	0	0.45	0.18	0	0	0	0	0	0	0	0	0	0	0	11
44	0	0	0	0	0	0.11	0.11	0.44	0.33	0	0	0	0	0	0	0	0	0	0	0	9
45	0	0	0	0	0	0	0.13	0.50	0.38	0	0	0	0	0	0	0	0	0	0	0	8
46	0	0	0	0	0	0	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	6
47	0	0	0	0	0	0	0	0.33	0.33	0.33	0	0	0	0	0	0	0	0	0	0	6
48	0	0	0	0	0	0	0	0.50	0.17	0.17	0.17	0	0	0	0	0	0	0	0	0	6
49	0	0	0	0	0	0	0	0.14	0.29	0.43	0.14	0	0	0	0	0	0	0	0	0	7
50	0	0	0	0	0	0	0	0.40	0.60	0	0	0	0	0	0	0	0	0	0	0	5
51	0	0	0	0	0	0	0	0	0.33	0.33	0.33	0	0	0	0	0	0	0	0	0	3
52	0	0	0	0	0	0	0	0.33	0	0.33	0	0	0.33	0	0	0	0	0	0	0	3
53	0	0	0	0	0	0	0	0	0	0.33	0.67	0	0	0	0	0	0	0	0	0	3
54	0	0	0	0	0	0	0	0	0	0	0	0.33	0	0	0.33	0	0	0.33	0	0	3
55	0	0	0	0	0	0	0	0	0	0.33	0	0.33	0	0	0	0	0	0	0.33	0	3
56	0	0	0	0	0	0	0	0.33	0	0	0.33	0	0.33	0	0	0	0	0	0	0	3
57	0	0	0	0	0	0	0	0	0	0	0	0	0.50	0	0	0	0	0.50	0	0	2
58	0	0	0	0	0	0	0	0	0	0	0	0	0.50	0	0	0	0	0	0.50	0	2
59	0	0	0	0	0	0	0	0	0	0	0	0	0.50	0	0	0	0	0	0	0.50	2
60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.50	0	0	0.50	0	2
61	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.00	0	1
62	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.00	0	1
63	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.00	1
64	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.00	1
65	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.00	1
66	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.00	0	1
67	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.00	1
68	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.00	1
69	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.00	1
70	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.00	1
71	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
72	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.00	1
73	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
74	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
76	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.00	1
77	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.00	0	0	0	1
78	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
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
Total																					503