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C. Walsh
N. M. Davies
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N. M. Davies
N. Rush
D. Buckthought
M. Smith

NIWA
P O Box 109695
Newmarket
Auckland

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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" (SNA2004/03). 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 during spring and summer 2004–05 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. Total sample sizes of 15 and 11 landings were sampled for length frequency from the single trawl and pair trawl fisheries respectively, with an age-length key collection of 520 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 distribution for the single trawl fishery, making up about one in every four fish landed. Although pair trawl landings were dominated by the 2001 year class (making up about one in every three fish landed), it appeared to be of average to below average strength. Together with the 1998 and 2000 year classes, these cohorts accounted for about 70% of the catch by both methods. Apart from the 1996 year class, and perhaps the 1999 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 2004–05 were slightly different. Method-specific differences most likely reflect spatial heterogeneity in stock length composition rather than differences in method selectivity. Mean weighted coefficients of variation (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, Walsh & Davies 2004). This report presents the results of market sampling from the SNA 8 stock between October 2004 and February 2005, thus continuing the time series. Funding for this project, SNA2004/03, was provided by the Ministry of Fisheries.

The specific objective of this project for 2004–05 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 2004–05. 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) over 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 single trawl proportion at length distribution as estimated for the previous year. The west coast single trawl length distribution was used (as opposed to that for the pair trawl method) because it was slightly broader and was thought to better represent the recruited population. To allow for annual variability in the abundance of fish in the 25–27 cm size range, a fixed sample size of 10 otoliths was collected from each of these length intervals. Similarly, a minimum sample size of at least one fish for size classes greater than 60 cm was specified to ensure the right hand limb of the catch length frequency was adequately represented. Otolith samples for fish greater than 70 cm were difficult to obtain because of their rarity in landings. The otolith sample size for the west coast collection (n = 520) 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 2004–05, the 1998 year class was 7 years old, whether sampled in December 2004 or February 2005.

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 and variances followed Quinn II et al. (1983), with a length-weight relationship: w (g) = $0.04467 l^{2.793}$(cm) (Paul 1976). 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 2004 to summer 2004–05 are provided in Table 1, displaying seasonal patterns in the fisheries, with both the single trawl and pair trawl fisheries operating mainly over spring and summer. The relative catch by method for the SNA 8 stock over the sampling period (October 2004–February 2005) was similar to that of the previous year, with single trawl and pair trawl making up 66% and 26% 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 most pair trawl landings, where trevally (*Pseudocaranx dentex*) was the main target 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 2004–05, with 15 and 11 landings being sampled for length frequency from each of the fisheries respectively. The cumulative proportion of the total number of landings and those sampled from the respective SNA 8 fisheries from October 2004 to February 2005 are given in Appendix 1.

3.2 Length and age distributions

For all fisheries sampled in 2004–05, 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 2004–05 are presented as histograms and line graphs (Figures 2–7). The estimated proportions at length, age, and mean weight-at-age, are tabulated in Appendices 2–4. The age-length key is presented in Appendix 5.

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 2). 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 2004–05 was characterised by one main mode centred around 36 cm, and minor modes at about 33 and 41 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 38.2 cm, and the proportion-at-length MWCV was 0.09. The pair trawl length distribution was different to that of single trawl, with a higher proportion of smaller fish (Figures 4 and 6). The main mode of the pair trawl length distribution was centred around 32 cm, with a minor mode evident at about 41 cm. The distribution had a tail extending to over 65 cm, a mean length of 35.4 cm, and the proportion-at-length MWCV was 0.13.

The age distribution for the single trawl fishery in 2004–05 was dominated by the 1998 year class (7 year olds; Figure 3), while that of the pair trawl catch was dominated by the 2001 year class (4 year olds; Figure 5). The second and third strongest year classes in the single trawl fishery were the 2000 and 2001 year classes (5 and 4 year olds; Figure 3) and in the pair trawl were the 2000 and 1998 year classes (5 and 7 year olds; Figure 5). Combined, all three year classes (1998, 2000, 2001) make up about two of every three fish landed by either method in SNA 8. Most fish landed by either method were between 3 and 10 years old, with less than 7% of fish being 11 years old or more (Figure 7). Some older age classes have a very low proportion or were absent, and the aggregate (over 19) age class makes up under 1% of the overall catch in either method. The 2001 year class appears to be of about average strength and is likely to be almost fully recruited as it contains few fish under 27 cm (see Appendix 5). The once strong 1996 and 1995 year classes (9 and 10 year olds) combined make up about 10% and 6% of fish by number in single trawl and pair trawl catches respectively (Figures 3, 5, and 7). The mean age of snapper from the single trawl and pair trawl fisheries was 6.5 and 5.7 years respectively, and the catch-at-age MWCVs were 0.12 and 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 2004–05 are generally consistent with trends observed in recent years (Walsh et al. 2001, 2002, 2003, 2004, Walsh & Davies 2004).

Unlike most recent years, where the west coast single trawl and pair trawl age distributions have been dominated by only one or two very strong year classes, the 2004–05 distributions were largely dominated by fish from three year classes; 2001, 2000, and 1998. Combined, these account for more than two in every three fish landed by both the single trawl and pair trawl methods in SNA 8. Consequently, most other year classes, with the exception of those from 1996 and 1995, appear to be of low to very low abundance. The relative proportion of fish 11 years old or more is particularly low at between 4–7%, indicating, as it has in recent years, that few older fish exist in the fishery. As in the last 16 years, the aggregate (over 19) age class was less than 1% of the overall catch, the lowest proportion for any New Zealand snapper stock, and is unlikely to increase substantially for at least another 10 years. Using the 1998 and 1996 year classes as a guide to adjacent year class strengths, the 2001, 2000, and 1999 year classes are most likely of average to below average strength. The 1997 year class continues to be very weak, as it has done over the last 5 years in catch-at-age summaries, currently made up of only a handful of fish in the age-length key collection (see Appendix 5).

The 1998 year class has been the most dominant year class in the SNA 8 fishery for the past three years accounting for, on average, about one in every three fish (30–40%) in single trawl and pair trawl landings. This dominance has now reduced slightly in 2004–05 whereby about one in every four to five fish landed by single trawl and pair trawl (respectively) can be attributed to this strong year. However, of more importance is the relative weight this year class now contributes to the fishery. The 1998 year class average fish size is about 40 cm and the average weight is about 1.3 kg (see Appendixes 4 and 5) and scaled up to an estimated overall contribution in terms of the TACC (accounting for the relative method catch) is about equal to or greater than that of the 2000 and 2001 year classes combined. Snapper from the west coast are known to grow much faster than fish in most other New Zealand stocks (Davies et al. 2003), and the relative weight increase from one year to the next, especially in fish from a strong year class as 1998, is enormously important in the sustainability of the fishery. A recent assessment of the SNA 8 stock has estimated the 1998 year class to be the strongest year class recruited into the fishery over the last 15 years, second strongest (behind the 1985 year class) in the last 25 years, with a relative strength almost twice that of the mean (Davies et al. unpublished results).

Walsh et al. (2004) predicted the 1998 year class would continue to dominate single trawl and pair trawl landings in 2004–05, the fourth consecutive year. The main reason for this was recently recruited year classes (i.e. 1999, 2000, 2001) were predicted to be of average to below average strength and therefore be unlikely to greatly influence the relative strength of the 1998 year class. These predictions have held true for the single trawl fishery, but not for the pair trawl fishery, and can be largely explained by the different areas that the respective methods fished in, and is outlined in a following paragraph on the differences observed in the length structure between the methods. Should the single trawl fishery operate in the same general area, as it normally does from year to year, and recruitment be of an average or below average strength, then the 1998 year class could conceivably dominate the SNA 8 fishery as the strongest year class for a fifth year in a row. In all years that catch sampling has occurred in SNA 8, no other year class has been the single most dominant year class for more than 3 years duration, except the 1998 year class.

The 1996 year class dominated the SNA 8 commercial fishery for 2 years before the 1998 year class fully recruited in 2001–02, and from six trawl surveys undertaken in SNA 8 between 1987 and 1999, it was estimated as the second highest year class strength observed over that period (Morrison & Parkinson 2001). At present, the 1996 year class, together with the 1995 year class, constitute a high proportion of larger and moderately aged fish in the stock and have broadened the tail of the current catch-at-age distributions. Snapper from these year classes in 2004–05 are mostly between 45 and 53 cm in length and weigh on average between 2 and 2.3 kg (see Appendixes 4 and 5). Snapper landed from the single trawl fishery, where it is the primary target species, show both the 1995 and 1996 year classes contribute about 10% of the catch by number and considerably more by weight. Because of their relative strengths, these year classes should continue to broaden the tail of the SNA 8 catch-at-age distributions and will be important to the future rebuilding of the fishery.

The 2002 year class is not yet fully recruited to the fishery, as it still contains an appreciable proportion of fish in the 25 cm size class. It appears to be of about average strength. Those year classes that recruit at well above average strength as three year olds (i.e., more than 10%) into the fishery (e.g. 1996 and 1998 year classes in 1998–99 and 2000–01 respectively) most often appear in the length frequency distribution, either by broadening the distribution below 30 cm or appearing independently as a strong length mode dominating the 25–30 cm size classes (see Walsh et al. 2000, 2002). This is not apparent for the 2002 year class in 2004–05, and a comparison of a fully recruited 2002 year class (as 4 year olds) relative to other year classes in 2005–06 will further confirm this.

Although only a single sample was collected from the pair trawl fishery in spring, and a single sample from the single trawl fishery in summer, the seasonal length distributions for the SNA 8 fisheries were more similar within seasons than between seasons. Thus, the single trawl spring length sample closely resembled that of the pair trawl sample in the same season, as did the distributions for both methods in summer. The similarity in the distributions within a season is almost certainly related to the area that the vessels fished rather than a reflection of any seasonal or bycatch aspect of the fishery. Most of the vessels operating in spring targeted snapper in an area between the Kaipara Harbour and Waikato River entrance, concentrating effort in a region mainly around the Manukau Harbour (source: TCEPR reports). Snapper sampled from commercial landings from these areas of SNA 8 have been found to be of a larger average size (Reid 1969, Walsh et al. 2006), and greater average age than areas to the north or south (Walsh et al. 2006), a similar finding to that presented here for 2004–05. Length summaries from those vessels operating in summer were made up of smaller average sized fish (and hence a younger average age) than those of spring and were largely from vessels fishing in areas from Ninety Mile Beach south to the North Taranaki Bight, targeting mainly trevally. Although differences in the length compositions of snapper landed from single trawl and pair trawl vessels seem apparent between seasons, and possibly related to the target species sought, the main reason is likely to be related to the spatial origin of the catches. The sampling effort for each method was allocated disproportionately between the seasons. Single trawl landings were sampled mostly in spring and pair trawl landings mostly in summer. Given the season-spatial differences in catch length composition, this allocation of sampling effort resulted in combined season-method distributions that were considerably different (see Appendix 1), and may not accurately reflect the true overall spatial effort of each method in the fishery.

Similarities in the length composition of single trawl and pair trawl landings from SNA 8 between 1999–2000 and 2002–03 (Walsh et al. 2001, 2002, 2003, 2004, Walsh & Davies 2004) were thought to show that the selectivity characteristics of the methods were very similar. This was because the greatest proportion of fish in the SNA 8 population were of a size that would be equally vulnerable to either method and that differences were likely to become apparent when fish from a strong year class grew to lengths that exceeded the optimum selectivity of the single trawl method yet remained vulnerable to pair trawl (Walsh et al. 2004). This was evident in SNA 8 catches from the 1970s when larger and older snapper were more abundant (Sullivan & Gilbert 1978). However, the length frequency summaries presented for single trawl and pair trawl in 2004–05 are contradictory to that expected from the methods, where pair trawl would normally catch fish of a larger average size than single trawl. As mentioned above, it may be that the differences in the length compositions of single trawl and pair trawl from year to year reflect spatial variation in population length composition depending on the location of fishing operations (Walsh et al. 2006). As current catch sampling practises by and large do not take into account the spatial differences within SNA 8, annual catch-at-age estimates may not accurately reflect the true mortality and recruitment processes acting over the entire stock (Walsh et al. 2006).

The MWCV (analytical estimates only) for the length and age distributions sampled from the SNA 8 fisheries in 2004–05 ranged between 0.09 and 0.13. There were no c.v. estimates for the single trawl summer and pair trawl spring length frequency data because only one landing was sampled from these fisheries (Appendix 2).

5. CONCLUSIONS

1. The length and age distributions sampled from the SNA 8 fisheries in 2004–05 were generally consistent with trends observed in recent years, especially in the single trawl estimates. However, between methods, differences were more pronounced and most likely reflect area of collection than method selectivity, season, or target species sought.

2. The 1998 year class continues to dominate the age distribution in the single trawl fishery in SNA 8 in 2004–05, making up about one in every four fish landed. Pair trawl landings were dominated by the 2001 year class, making up about one in every three fish landed.

3. Apart from the 2001, 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 2004 to summer 2004–05.*

		Number of landings			No. of fish	Weight of landings (t)		
Method	Season	Total	Sampled	% of total	measured	Total	Sampled	% of total
BPT	Autumn	3	0	0	0	4	0	0
	Winter	2	0	0	0	2	0	0
	Spring	14	1	7.1	689	103	19	18.4
	Summer	31	10	32.3	8 467	160	66	41.3
BT	Autumn	145	0	0	0	183	0	0
	Winter	78	0	0	0	64	0	0
	Spring	106	14	13.2	9 598	393	216	55.0
	Summer	115	1	0.9	968	282	12	4.3

* BPT, pair trawl; BT, single trawl.

Table 2: Details of snapper otolith samples collected in 2004–05 from SNA 8.

Area	Fishing method †	Sampling period	Sample method ††	Length range (cm)	No. aged
SNA 8	BPT, BT	Spring, summer	SR	25–75	520

† BPT, pair trawl; BT, single trawl.

†† SR, stratified random sample.

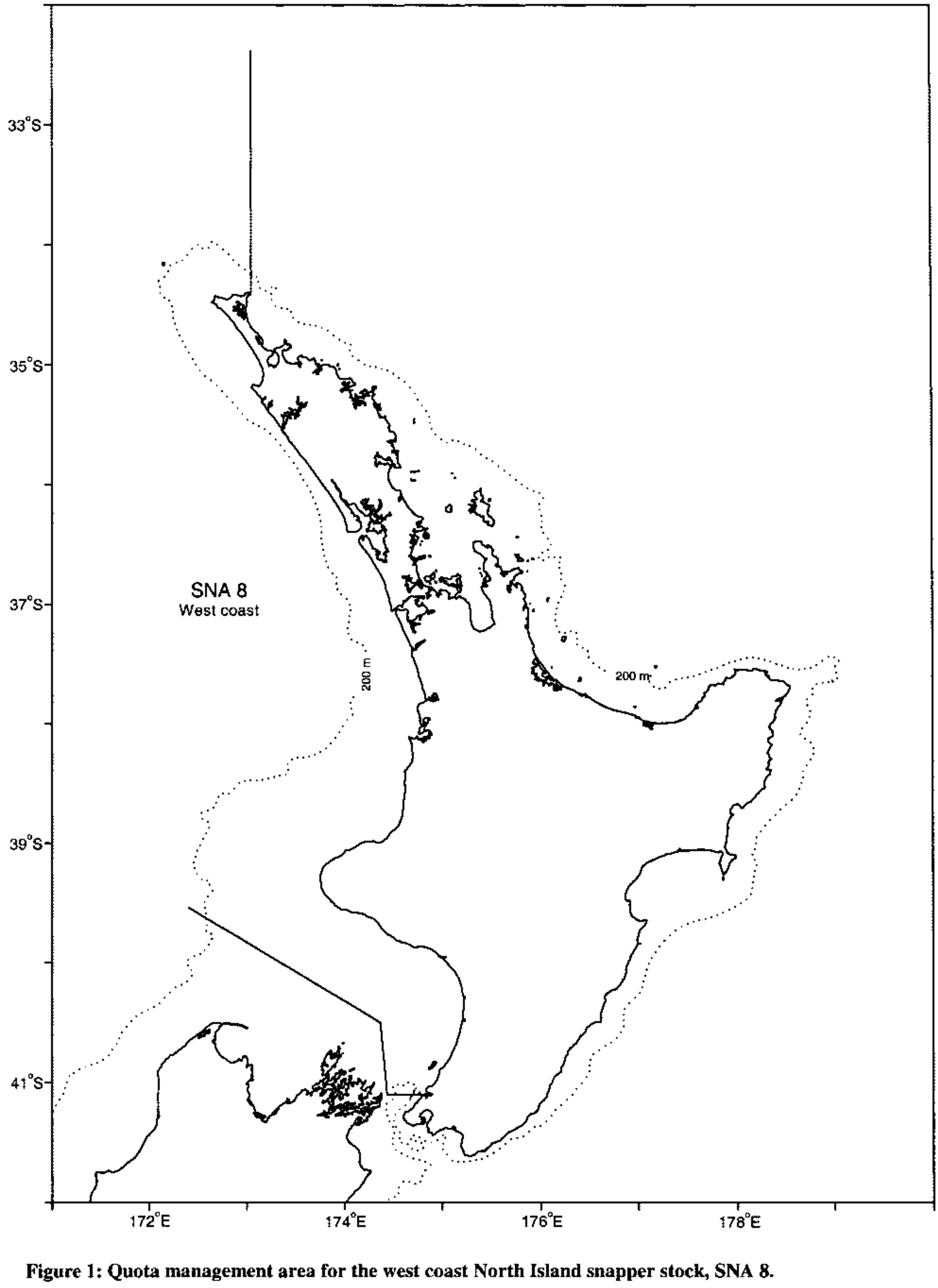


Figure 1: Quota management area for the west coast North Island snapper stock, SNA 8.

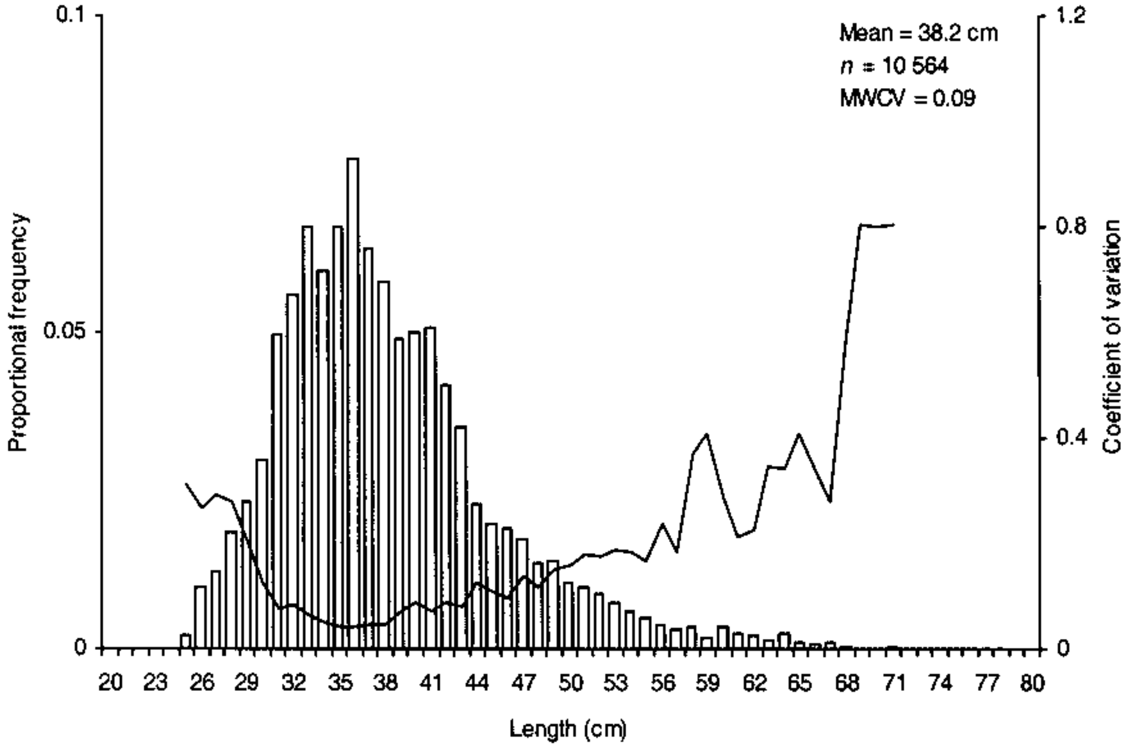


Figure 2: Proportion at length distribution (histogram) and c.v.s (solid line) determined from snapper landings sampled from the SNA 8 single trawl fishery in 2004–05 (*n*, length sample size; MWCV, mean weighted c.v.).

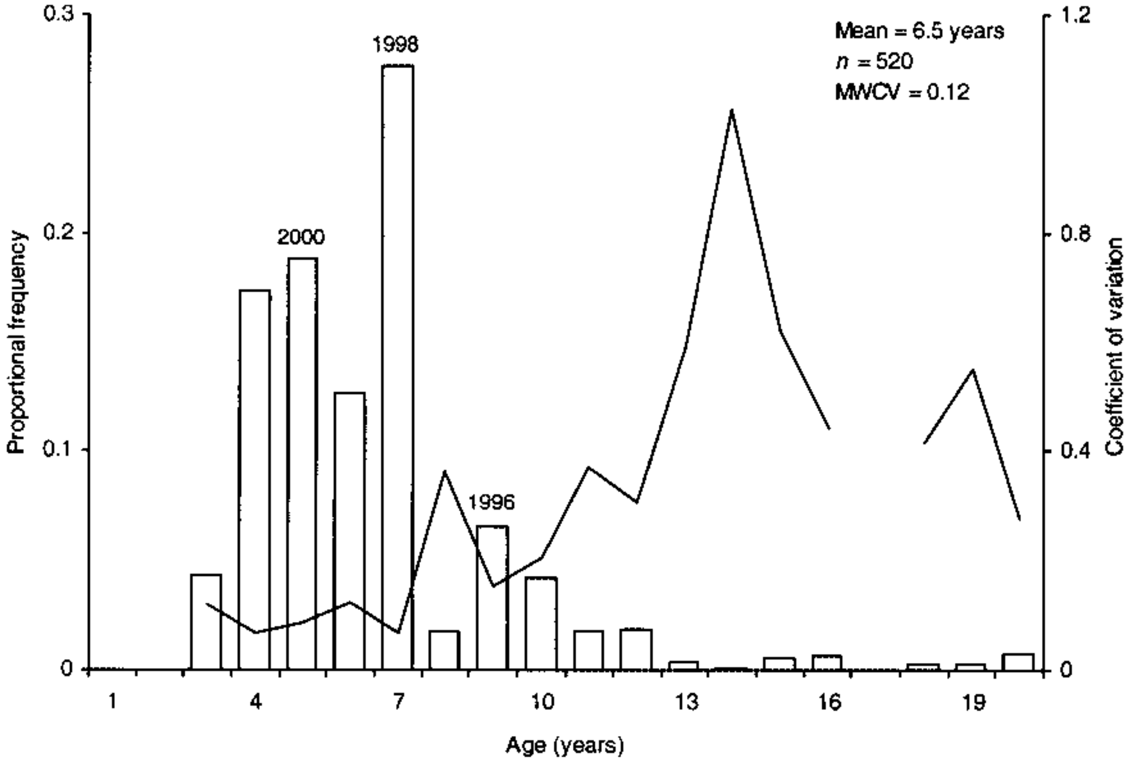


Figure 3: Proportion at age distribution (histogram) and c.v.s (solid line) determined from snapper landings sampled from the SNA 8 single trawl fishery in 2004–05 using the age-length key approach (*n*, otolith sample size; MWCV, mean weighted c.v.).

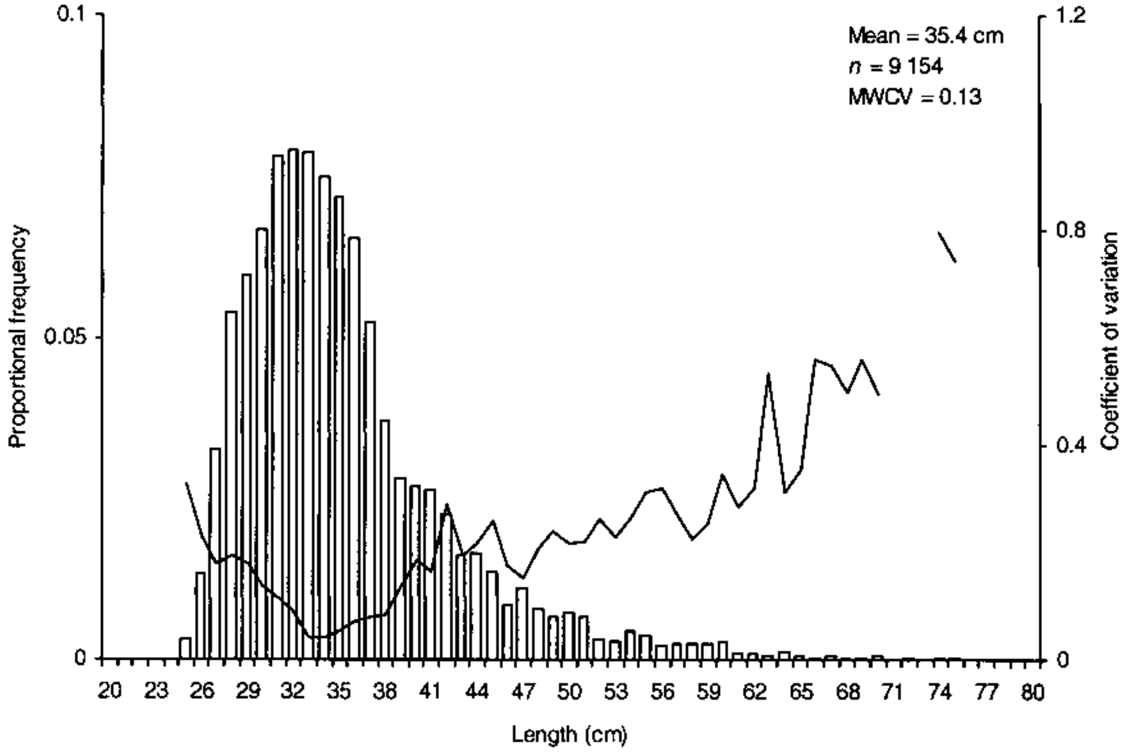


Figure 4: Proportion at length distribution (histogram) and c.v.s (solid line) determined from snapper landings sampled from the SNA 8 pair trawl fishery in 2004–05 (*n*, length sample size; MWCV, mean weighted c.v.).

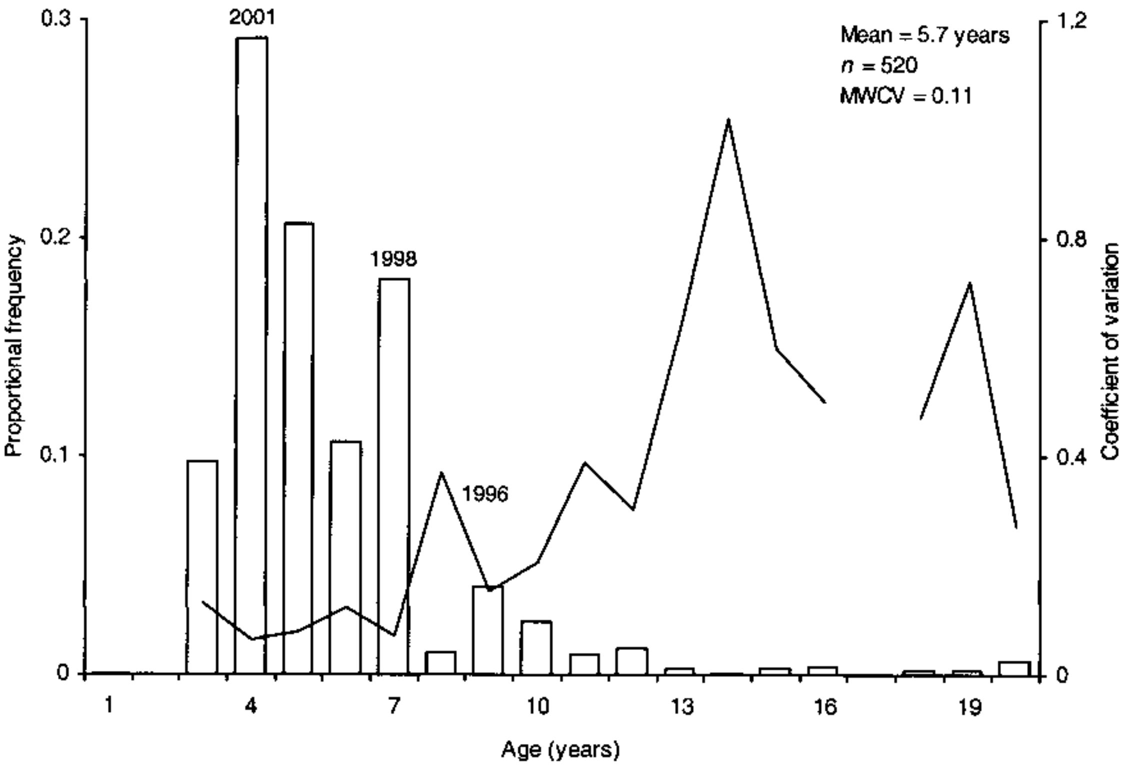


Figure 5: Proportion at age distribution (histogram) and c.v.s (solid line) determined from snapper landings sampled from the SNA 8 pair trawl fishery in 2004–05 using the age-length key approach (*n*, otolith sample size; MWCV, mean weighted c.v.).

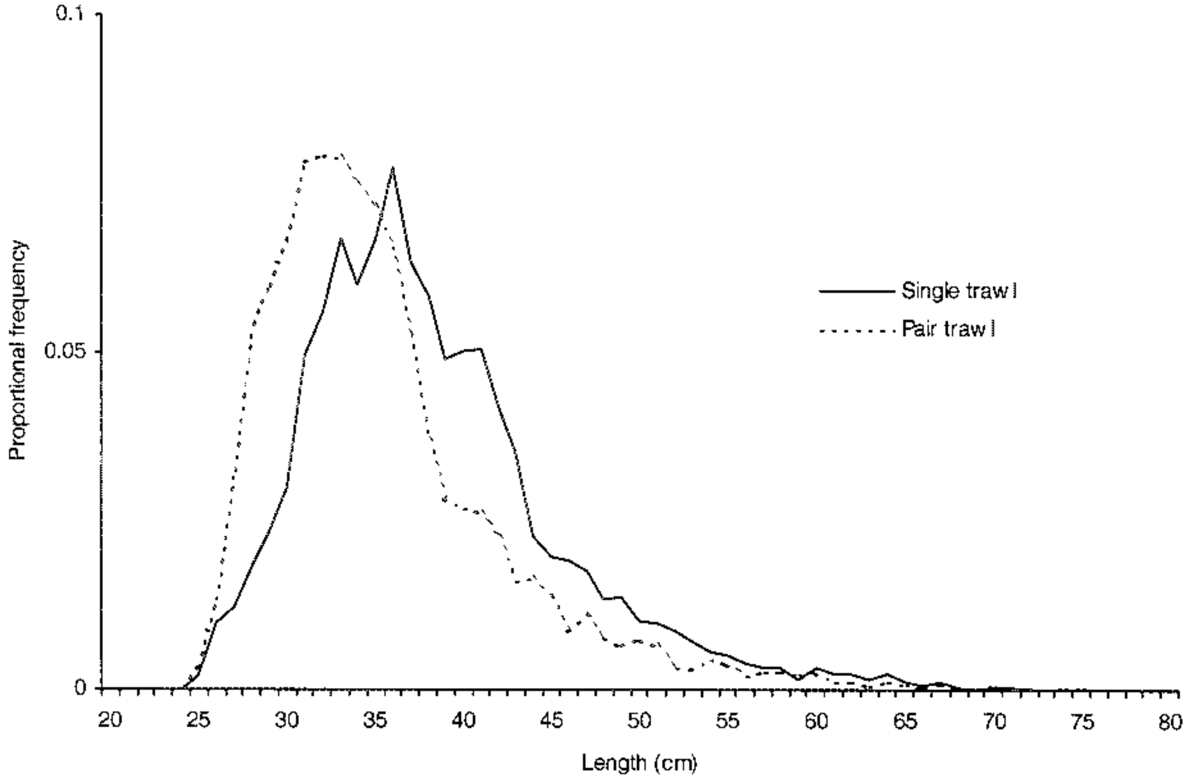


Figure 6: Proportion at length distributions determined from snapper landings sampled from the SNA 8 single trawl and pair trawl (solid and dashed lines respectively) fisheries in 2004–05.

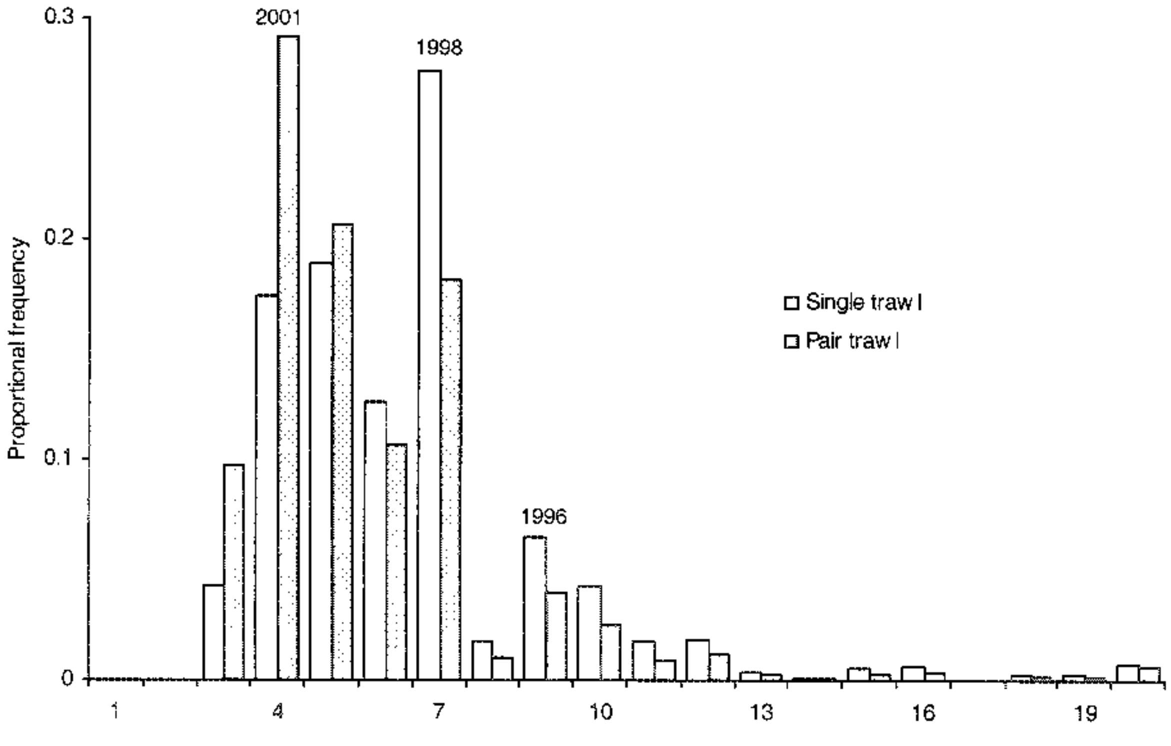
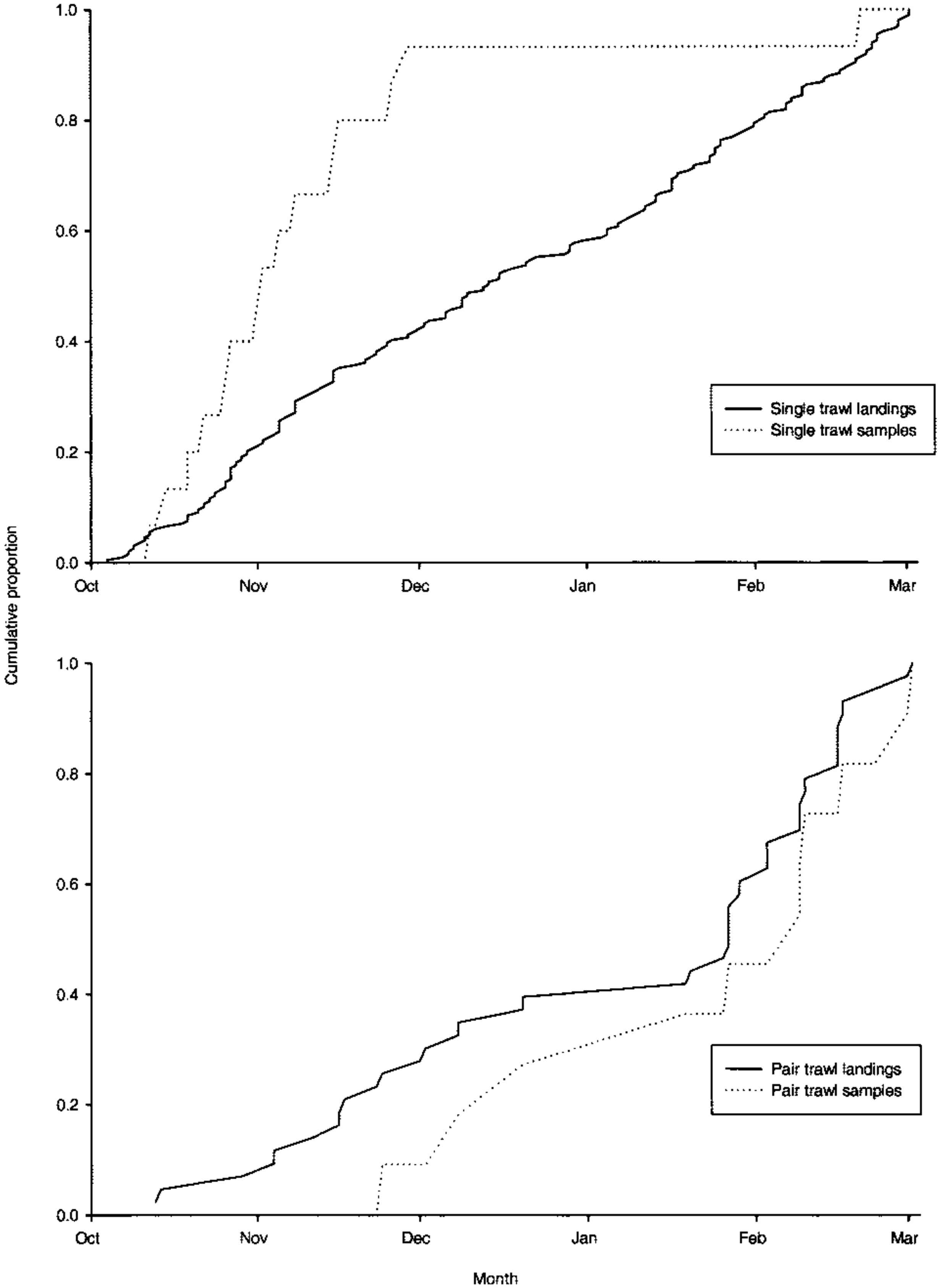


Figure 7: Proportion at age distributions determined from snapper landings sampled from the SNA 8 single trawl and pair trawl (unshaded and shaded histograms respectively) fisheries in 2004–05 using the age-length key approach.

Appendix 1: The cumulative proportion of the number of landings and samples taken from the SNA 8 single trawl and pair trawl fisheries in 2004–05.



Appendix 2: Estimates of the proportion at length of snapper from the SNA 8 single trawl and pair trawl fisheries in 2004–05 (– 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	–	0.0000	0.00	0.0000	0.00
21	0.0000	0.00	0.0000	–	0.0000	0.00	0.0000	–	0.0000	0.00	0.0000	0.00
22	0.0000	0.00	0.0000	–	0.0000	0.00	0.0000	–	0.0000	0.00	0.0000	0.00
23	0.0000	0.00	0.0000	–	0.0000	0.00	0.0000	–	0.0000	0.00	0.0000	0.00
24	0.0000	0.00	0.0000	–	0.0000	0.00	0.0000	–	0.0000	0.00	0.0000	0.00
25	0.0016	0.29	0.0083	–	0.0022	0.31	0.0000	–	0.0038	0.27	0.0031	0.33
26	0.0079	0.23	0.0320	–	0.0098	0.27	0.0000	–	0.0164	0.15	0.0134	0.23
27	0.0083	0.18	0.0579	–	0.0123	0.29	0.0058	–	0.0385	0.11	0.0326	0.18
28	0.0128	0.16	0.0837	–	0.0186	0.28	0.0087	–	0.0641	0.13	0.0540	0.19
29	0.0178	0.11	0.0857	–	0.0234	0.21	0.0131	–	0.0699	0.12	0.0596	0.18
30	0.0264	0.09	0.0682	–	0.0298	0.12	0.0334	–	0.0740	0.11	0.0666	0.14
31	0.0474	0.06	0.0754	–	0.0497	0.08	0.0392	–	0.0867	0.08	0.0781	0.11
32	0.0519	0.06	0.0992	–	0.0558	0.09	0.0522	–	0.0850	0.08	0.0791	0.09
33	0.0659	0.05	0.0775	–	0.0668	0.06	0.0639	–	0.0821	0.03	0.0788	0.04
34	0.0594	0.04	0.0651	–	0.0599	0.05	0.0697	–	0.0761	0.05	0.0749	0.04
35	0.0667	0.04	0.0651	–	0.0665	0.04	0.0769	–	0.0705	0.06	0.0717	0.05
36	0.0795	0.03	0.0537	–	0.0774	0.04	0.0842	–	0.0611	0.07	0.0653	0.07
37	0.0646	0.04	0.0475	–	0.0632	0.05	0.0668	–	0.0493	0.08	0.0525	0.08
38	0.0596	0.04	0.0413	–	0.0581	0.05	0.0435	–	0.0356	0.09	0.0370	0.08
39	0.0506	0.06	0.0289	–	0.0488	0.07	0.0493	–	0.0236	0.09	0.0283	0.14
40	0.0524	0.07	0.0248	–	0.0501	0.09	0.0552	–	0.0206	0.10	0.0269	0.19
41	0.0528	0.05	0.0248	–	0.0505	0.07	0.0479	–	0.0215	0.13	0.0263	0.16
42	0.0440	0.06	0.0134	–	0.0415	0.09	0.0610	–	0.0140	0.12	0.0225	0.29
43	0.0376	0.05	0.0083	–	0.0352	0.08	0.0305	–	0.0128	0.18	0.0161	0.19
44	0.0243	0.09	0.0052	–	0.0228	0.12	0.0348	–	0.0124	0.17	0.0165	0.22
45	0.0209	0.08	0.0072	–	0.0198	0.11	0.0319	–	0.0096	0.20	0.0136	0.26
46	0.0205	0.06	0.0021	–	0.0190	0.09	0.0131	–	0.0076	0.20	0.0086	0.18
47	0.0189	0.10	0.0021	–	0.0175	0.14	0.0174	–	0.0097	0.16	0.0111	0.15
48	0.0143	0.09	0.0031	–	0.0134	0.12	0.0145	–	0.0064	0.21	0.0079	0.21
49	0.0147	0.12	0.0031	–	0.0137	0.15	0.0087	–	0.0061	0.29	0.0066	0.24
50	0.0110	0.13	0.0021	–	0.0103	0.16	0.0145	–	0.0059	0.22	0.0074	0.22
51	0.0106	0.13	0.0000	–	0.0097	0.18	0.0131	–	0.0052	0.22	0.0067	0.22
52	0.0091	0.14	0.0031	–	0.0086	0.18	0.0073	–	0.0023	0.24	0.0032	0.26
53	0.0076	0.15	0.0021	–	0.0072	0.19	0.0044	–	0.0027	0.27	0.0030	0.23
54	0.0062	0.14	0.0010	–	0.0058	0.18	0.0044	–	0.0043	0.31	0.0043	0.27
55	0.0052	0.14	0.0021	–	0.0049	0.16	0.0058	–	0.0035	0.38	0.0039	0.31
56	0.0042	0.19	0.0000	–	0.0038	0.24	0.0044	–	0.0016	0.40	0.0021	0.32
57	0.0033	0.16	0.0031	–	0.0032	0.19	0.0044	–	0.0022	0.33	0.0026	0.28
58	0.0037	0.30	0.0000	–	0.0034	0.37	0.0058	–	0.0020	0.18	0.0027	0.23
59	0.0017	0.33	0.0000	–	0.0016	0.41	0.0044	–	0.0021	0.31	0.0025	0.26
60	0.0036	0.24	0.0010	–	0.0034	0.29	0.0058	–	0.0021	0.44	0.0028	0.35
61	0.0026	0.18	0.0010	–	0.0025	0.21	0.0015	–	0.0010	0.34	0.0011	0.28
62	0.0023	0.19	0.0010	–	0.0022	0.23	0.0000	–	0.0013	0.26	0.0011	0.32
63	0.0016	0.28	0.0000	–	0.0015	0.35	0.0000	–	0.0007	0.48	0.0006	0.53
64	0.0025	0.27	0.0000	–	0.0023	0.34	0.0015	–	0.0011	0.38	0.0011	0.31
65	0.0012	0.33	0.0000	–	0.0011	0.41	0.0000	–	0.0009	0.30	0.0008	0.35
66	0.0007	0.27	0.0000	–	0.0007	0.34	0.0000	–	0.0004	0.50	0.0003	0.56
67	0.0013	0.22	0.0000	–	0.0012	0.28	0.0000	–	0.0009	0.49	0.0008	0.55
68	0.0002	0.49	0.0000	–	0.0002	0.59	0.0000	–	0.0004	0.44	0.0003	0.50
69	0.0001	0.66	0.0000	–	0.0001	0.81	0.0000	–	0.0004	0.50	0.0003	0.56
70	0.0002	0.65	0.0000	–	0.0002	0.80	0.0000	–	0.0007	0.43	0.0006	0.49
71	0.0002	0.66	0.0000	–	0.0002	0.81	0.0000	–	0.0000	0.00	0.0000	0.00
72	0.0000	0.00	0.0000	–	0.0000	0.00	0.0000	–	0.0002	0.73	0.0002	0.79
73	0.0000	0.00	0.0000	–	0.0000	0.00	0.0000	–	0.0000	0.00	0.0000	0.00
74	0.0001	0.69	0.0000	–	0.0001	0.84	0.0000	–	0.0002	0.73	0.0002	0.79
75	0.0000	0.00	0.0000	–	0.0000	0.00	0.0015	–	0.0000	0.00	0.0003	0.74
76	0.0000	0.00	0.0000	–	0.0000	0.00	0.0000	–	0.0000	0.00	0.0000	0.00
77	0.0000	0.00	0.0000	–	0.0000	0.00	0.0000	–	0.0001	0.78	0.0001	0.84
78	0.0000	0.00	0.0000	–	0.0000	0.00	0.0000	–	0.0000	0.00	0.0000	0.00
79	0.0000	0.00	0.0000	–	0.0000	0.00	0.0000	–	0.0000	0.00	0.0000	0.00
80	0.0000	0.00	0.0000	–	0.0000	0.00	0.0000	–	0.0000	0.00	0.0000	0.00
Nt	299 168		330 512		529 111		78 320		161 820		251 024	
n	9 596		968		10 564		689		8 465		9 154	

Appendix 3: Estimates of proportion at age of snapper from the SNA 8 single trawl and pair trawl fisheries in 2004–05.
P.j., proportion of fish in age class; c.v., coefficient of variation; otolith sample size = 520

Age	Single trawl						Pair trawl					
	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	0.0317	0.13	0.1682	0.12	0.0428	0.12	0.0162	0.28	0.1154	0.13	0.0973	0.13
4	0.1596	0.07	0.3324	0.08	0.1737	0.07	0.1571	0.09	0.3213	0.06	0.2914	0.06
5	0.1876	0.09	0.2001	0.08	0.1886	0.08	0.1967	0.09	0.2086	0.08	0.2065	0.08
6	0.1287	0.12	0.0969	0.13	0.1261	0.12	0.1327	0.13	0.1003	0.13	0.1062	0.12
7	0.2872	0.07	0.1519	0.09	0.2761	0.07	0.2950	0.07	0.1564	0.08	0.1816	0.07
8	0.0190	0.36	0.0072	0.41	0.0180	0.36	0.0189	0.37	0.0085	0.38	0.0104	0.37
9	0.0694	0.15	0.0177	0.23	0.0652	0.15	0.0744	0.17	0.0323	0.16	0.0399	0.15
10	0.0450	0.21	0.0107	0.33	0.0422	0.21	0.0453	0.23	0.0200	0.21	0.0246	0.21
11	0.0186	0.37	0.0042	0.53	0.0175	0.37	0.0172	0.41	0.0079	0.39	0.0096	0.39
12	0.0199	0.31	0.0053	0.48	0.0187	0.31	0.0174	0.36	0.0113	0.30	0.0124	0.30
13	0.0044	0.59	0.0011	0.88	0.0041	0.59	0.0044	0.67	0.0020	0.67	0.0024	0.65
14	0.0009	1.03	0.0000	0.00	0.0008	1.03	0.0022	1.15	0.0011	1.03	0.0013	1.02
15	0.0057	0.62	0.0010	0.85	0.0054	0.62	0.0053	0.63	0.0026	0.61	0.0031	0.60
16	0.0069	0.44	0.0021	0.64	0.0065	0.44	0.0055	0.56	0.0029	0.52	0.0033	0.50
17	0.0000	0.00	0.0000	0.00	0.0000	0.00	0.0000	0.00	0.0000	0.00	0.0000	0.00
18	0.0032	0.42	0.0000	0.00	0.0029	0.41	0.0039	0.70	0.0017	0.45	0.0021	0.47
19	0.0034	0.55	0.0005	1.41	0.0032	0.55	0.0029	1.12	0.0018	0.63	0.0020	0.72
>19	0.0084	0.28	0.0016	0.82	0.0078	0.28	0.0051	0.73	0.0064	0.22	0.0062	0.27

Appendix 4: Estimates of mean weight at age (kg) of snapper from the SNA 8 single trawl and pair trawl fisheries in 2004–05.
c.v., coefficient of variation; otolith sample size = 520

Age	Single trawl						Pair trawl						
	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	0.48	0.04	0.47	0.02	0.48	0.03	0.52	0.06	0.48	0.02	0.48	0.02	39
4	0.70	0.02	0.64	0.02	0.69	0.02	0.71	0.02	0.65	0.01	0.66	0.01	111
5	0.91	0.02	0.85	0.02	0.91	0.02	0.91	0.02	0.85	0.02	0.86	0.02	100
6	1.10	0.03	1.00	0.03	1.10	0.03	1.10	0.03	0.99	0.03	1.02	0.03	57
7	1.32	0.01	1.21	0.02	1.31	0.01	1.33	0.02	1.23	0.02	1.26	0.02	107
8	1.55	0.08	1.39	0.09	1.54	0.08	1.53	0.09	1.49	0.10	1.50	0.10	8
9	1.93	0.04	1.77	0.06	1.93	0.04	1.91	0.03	1.95	0.04	1.93	0.04	32
10	2.31	0.06	2.15	0.15	2.31	0.06	2.32	0.06	2.32	0.06	2.32	0.06	21
11	2.28	0.09	2.11	0.17	2.28	0.09	2.26	0.09	2.24	0.09	2.25	0.09	8
12	2.89	0.07	3.17	0.08	2.90	0.07	2.99	0.08	2.98	0.07	2.98	0.07	10
13	3.16	0.05	3.06	0.06	3.16	0.05	3.19	0.04	3.21	0.03	3.20	0.03	3
14	3.94	0.01	–	–	3.94	0.01	3.94	0.01	3.94	0.01	3.94	0.01	1
15	2.61	0.12	2.30	0.02	2.61	0.12	2.82	0.16	2.67	0.13	2.72	0.14	3
16	3.57	0.10	3.31	0.12	3.57	0.10	3.43	0.11	3.64	0.10	3.58	0.10	5
17	–	–	–	–	–	–	–	–	–	–	–	–	0
18	4.13	0.05	–	–	4.13	0.05	3.76	0.01	4.10	0.05	3.99	0.04	3
19	4.42	0.04	4.13	0.01	4.42	0.04	4.13	0.01	4.38	0.04	4.32	0.03	2
>19	4.89	0.04	4.40	0.04	4.88	0.04	5.27	0.19	5.22	0.04	5.23	0.05	10

Appendix 5: Age-length key derived from otolith samples collected from snapper fisheries in SNA 8 in 2004–05.

Estimates of proportion of age at length for snapper sampled from SNA 8, spring and summer 2004–05. (Note: Aged to 01/01/2005)

Length	Age (years)																				No.
(cm)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	>19	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	0.90	0.10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10
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	0.90	0.10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10
28	0	0	0.55	0.45	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11
29	0	0	0.33	0.67	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12
30	0	0	0	0.92	0.04	0.04	0	0	0	0	0	0	0	0	0	0	0	0	0	0	24
31	0	0	0	0.72	0.25	0.03	0	0	0	0	0	0	0	0	0	0	0	0	0	0	32
32	0	0	0	0.56	0.42	0.03	0	0	0	0	0	0	0	0	0	0	0	0	0	0	36
33	0	0	0.03	0.41	0.38	0.15	0.03	0	0	0	0	0	0	0	0	0	0	0	0	0	39
34	0	0	0	0.26	0.49	0.21	0.05	0	0	0	0	0	0	0	0	0	0	0	0	0	39
35	0	0	0	0.09	0.54	0.20	0.17	0	0	0	0	0	0	0	0	0	0	0	0	0	35
36	0	0	0	0	0.34	0.28	0.34	0.03	0	0	0	0	0	0	0	0	0	0	0	0	29
37	0	0	0	0.04	0.25	0.13	0.58	0	0	0	0	0	0	0	0	0	0	0	0	0	24
38	0	0	0	0.04	0.04	0.21	0.63	0	0.04	0.04	0	0	0	0	0	0	0	0	0	0	24
39	0	0	0	0	0.09	0.22	0.52	0.04	0.09	0.04	0	0	0	0	0	0	0	0	0	0	23
40	0	0	0	0	0.10	0.35	0.40	0.10	0.05	0	0	0	0	0	0	0	0	0	0	0	20
41	0	0	0	0	0.14	0.14	0.64	0	0	0	0.07	0	0	0	0	0	0	0	0	0	14
42	0	0	0	0	0	0.08	0.85	0	0	0.08	0	0	0	0	0	0	0	0	0	0	13
43	0	0	0	0	0	0.08	0.75	0.08	0.08	0	0	0	0	0	0	0	0	0	0	0	12
44	0	0	0	0	0	0.10	0.50	0	0.40	0	0	0	0	0	0	0	0	0	0	0	10
45	0	0	0	0	0	0	0.20	0.10	0.60	0.10	0	0	0	0	0	0	0	0	0	0	10
46	0	0	0	0	0	0	0.13	0.13	0.50	0.25	0	0	0	0	0	0	0	0	0	0	8
47	0	0	0	0	0	0	0	0	0.50	0	0.25	0.25	0	0	0	0	0	0	0	0	8
48	0	0	0	0	0	0	0.22	0.11	0.22	0.22	0.11	0	0	0	0.11	0	0	0	0	0	9
49	0	0	0	0	0	0	0	0	0.20	0.40	0	0.20	0	0	0.20	0	0	0	0	0	5
50	0	0	0	0	0	0	0	0	0.50	0.50	0	0	0	0	0	0	0	0	0	0	8
51	0	0	0	0	0	0	0	0	0	0.67	0.33	0	0	0	0	0	0	0	0	0	3
52	0	0	0	0	0	0	0	0	0.14	0.14	0.29	0	0.14	0	0	0.29	0	0	0	0	7
53	0	0	0	0	0	0	0	0	0	0.33	0.33	0.33	0	0	0	0	0	0	0	0	3
54	0	0	0	0	0	0	0	0	0.33	0	0	0.67	0	0	0	0	0	0	0	0	3
55	0	0	0	0	0	0	0	0	0	0	0	0.33	0.33	0	0	0.33	0	0	0	0	3
56	0	0	0	0	0	0	0	0	0	0.67	0	0	0.33	0	0	0	0	0	0	0	3
57	0	0	0	0	0	0	0	0	0	0.50	0	0.50	0	0	0	0	0	0	0	0	2
58	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.33	0	0	0.67	0	0	3
59	0	0	0	0	0	0	0	0	0	0	0	0.50	0	0.50	0	0	0	0	0	0	2
60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.50	0.50	2
61	0	0	0	0	0	0	0	0	0	0	0	0.50	0	0	0	0.50	0	0	0	0	2
62	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.00	1
63	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.00	0	1
64	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.50	0	0	0	0.50	2
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	1.00	0	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	0	0
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	1.00	1
75	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.00	1
76	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
77	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
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																					520