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Catch-at-age of snapper in SNA 7 in the 2016–17 fishing year

New Zealand Fisheries Assessment Report 2018/3

D.M. Parsons,
S.J. Parker,
M. Stevenson,
C. Sutton,
D. Buckthought,
R. Bian,
J. McKenzie,
C. Walsh

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A programme to estimate the age composition of snapper (SNA) caught by bottom trawl fisheries targeting snapper (SNA 7) and flatfish (FLA 7) was conducted during the 2016–17 fishing year. The sampling design called for targeted weekly sampling (estimated at 30 landings each greater than 300 kg) from SNA 7 and FLA 7 target landings, from Statistical Areas 037/038 (Tasman Bay / Golden Bay) between October 2016 and March 2017 and landed at Talley's Seafoods in Nelson and Motueka.

A total of 27 landings were sampled from November 2016 through to early March 2017 with otoliths collected from a total of 1440 snapper. Data collected were entered into the Ministry for Primary Industries (MPI) *Market* database and the otoliths stored at National Institute of Water and Atmospheric Research (NIWA) for age determination.

A subsample of 1000 otoliths was selected for ageing from 1440 random age frequency samples across twenty-four qualifying SNA 7 landings. Bottom trawl landings in 2016–17 were dominated by the 2011 and 2008 year classes (6- and 9-year-olds), which together represented two in every three (66%) fish landed. In addition, the 2013 year class (4 year olds), which was of moderate strength, was also fully recruited to the fishery. Together these year classes are likely to be significant to the fishery for a number of years, although evidence of high inter–annual recruitment variability, is also present. The mean weighted coefficient of variation for the SNA 7 age composition was 19%, within the target of 20%.

1. INTRODUCTION

The purpose of this project was to estimate the relative year class strengths of snapper (*Chrysophrys auratus*) in the SNA 7 commercial catch by sampling landings at the major SNA 7 licenced fish receiver (LFR) during the 2016/17 fishing year. Sampling involved the collection of length and age composition samples and data from commercial landings before fish were sorted or processed. This provides relative catch-at-age information that may be combined with estimates of selectivity-at-age within an age-structured population model to estimate stock age composition and to determine year class strengths of cohorts recruited to the stock. Snapper stocks characteristically show large inter-annual variability in year class strength (Francis 1993, Walsh et al. 2011), therefore catch-at-age information is an important input into models used for their assessment.

SNA 7 currently supports a modest but important shared fishery in Tasman and Golden Bays, with a TACC of 200 t and a non-commercial allowance of 106 t. Reported annual commercial landings from SNA 7 declined from 2720 t in 1978 to 142 t in 1997–98. The TACC was set at 330 t when it was introduced into the QMS in 1986–87, but was reduced to 160 t in 1989–90 and then increased to 200 t in 1997–98. The fishery was unable to catch the 200 t TACC from 1997–98 to 2002–03, but has generally exceeded 200 t since 2010 (Ministry for Primary Industries 2017).

A 2014 stock assessment of SNA 7 based on an age-structured population model suggested that biomass had increased rapidly since 2009, due to the recruitment of one or possibly two large year classes (Langley 2015). As a result, the TACC was increased to 250 t, while the non-commercial allowance was increased to 270 t. The year classes responsible for the increase in biomass within SNA 7, however, had been sampled only once (i.e. in 2013–14). On reviewing the stock assessment, the Ministry for Primary Industries (MPI) Plenary (MPI 2017) made the following recommendation regarding additional research:

"The current and projected stock status is sensitive to the reliability of the estimate of the strength of the 2007 year class and the strength of subsequent recruitment, especially the 2010 year class. Further sampling of the age composition of the commercial catch would provide information regarding the relative strength of these year classes. Ideally, sampling would be undertaken once the 2010 year class is fully recruited to the commercial fishery (2015–16 or 2016–17)." For consistency, the two years with high recruitment strength mentioned in this extract from the plenary are here after referred to as the 2008 and 2011 year classes, respectively.

The objectives of the project, as described in the MPI tender document, were:

1. To characterise the SNA 7 fishery.
2. To conduct representative sampling to determine the length and age structure of the commercial catch of snapper in SNA 7 during the 2016/17 fishing year. The target coefficient of variation (CV) for the catch-at-age is 20% (mean weighted CV across all age classes).

2. METHODS

2.1 Fishery characterisation

The spatial, temporal and operational details of the SNA 7 fishery were summarised for the period 2012–2017 (2011–12 to 2016–17 fishing years). The characterisation was based on an extract from the MPI Catch and Effort Database and analysed using procedures developed for this purpose by NIWA (NIWA 2011). Operational aspects such as fishery timing, gear type, target species, statistical area, and fine scale spatial distribution were summarised. This characterisation was conducted after all sampling had been conducted, with the design of the sampling conducted in 2016–17 following that of the previous sampling programme (see below).

2.2 Catch-at-age sample design

The purpose of developing an age composition for the SNA 7 fishery is to add to the previous age composition data informing the stock assessment model. Therefore, it is important for the sampling design to be consistent with the previous sampling programmes and data generated for the purpose of age composition of the catch. The catch sampling design implemented for the 2016–17 fishing year was based on operational details from the fishery as characterised for the previous catch sampling programme (Parker et al. 2015), those being:

- Bottom trawl only
- Statistical Areas 037 + 038
- Target species of SNA or FLA
- Landings in October through to March
- Landed into Talley's (Nelson or Motueka)
- Minimum landing size of 300 kg

Identification of the actual target species can be difficult to attain at the time of sampling. Therefore, we ignored target species at the time of landing (i.e. we obtained a sample regardless of the target species that was communicated to us).

The target of a 20% Mean Weighted Coefficient of Variation (MWCV) was lower than the 30% target specified in previous SNA 7 catch sampling programmes. In the last programme (2013–14), a MWCV of 24% was achieved with a sample size of 22 qualifying landing samples, 848 otoliths aged, and a single strong year class present in the data (Parker et al. 2015). In addition, greater variation was expected for sampling conducted in 2016–17 as two strong year classes were anticipated. As a result, a higher target sample size of 30 sampled landings was implemented.

We used the random age frequency approach, where fish were selected at random from the catch for sampling, and subsequently otoliths selected for ageing in proportion to the relative weight of the landings (Davies & Walsh 2003). Under this approach, more otoliths are collected for each stratum and a smaller number chosen from that set to age.

The agreed catch sampling programme design was implemented from October 2016 – March 2017, with the intention that the catch sampling should match the actual seasonal pattern in landings by sampling weekly instead of developing monthly targets based on the landing patterns from previous years. It was expected that minor adjustments in the numbers of samples and their timing would be needed in order to match the fishery operations in a given year.

All sampling was designed, conducted and analysed following recommended practices documented in "Guidelines to the design, implementation and reporting of catch sampling" (Ministry of Fisheries 2008).

Fish were sampled using the following procedure:

1. Details for each trip were obtained from each processor to complete the landing record: i.e., the vessel, landing weight (all fish), landed weight of SNA, landing date, statistical area relating to the capture of fish in a landing.
2. The sample was assigned a Ministry for Primary Industries *market* database landing number. This is typically based on the calendar year, the code for the sampling programme, and a two-digit sample sequence.
3. Approximately 12 bins of fish were chosen from which 60 individuals were selected by removing the 5 fish with their heads closest to the corner nearest to the sampler of each bin.

4. Length (FL), sex, and gonad stage (5 stage method, see Beentjes et al. 2012) were recorded, and both otoliths were removed, cleaned of adhering tissue, dried, and placed in otolith envelopes.
5. The landing number, species, fish number, date, length, sex and sampler initials were recorded on the otolith envelope.
6. Data were recorded on a waterproof otolith inventory form
7. A landing record form was completed at the end of the sampling.

2.3 Snapper age determination

A standardised procedure for reading otoliths was followed, outlined in the age determination protocol for snapper (Walsh et al. 2014). Two readers aged SNA 7 otolith samples in 2013–14, with neither reader having any prior knowledge of the other's zone count obtained, or of the fish length. For otoliths where both readers agreed on the zone count, the age was determined from this count. When readers disagreed, the otolith was re-examined to determine the likely source of disagreement, and a final count agreed upon. The forced margin method was implemented to anticipate the otolith margin type (wide, line, narrow) *a priori* based on the month in which the fish was sampled, to provide guidance in determining age. To determine the "fishing year age class" of fish using the forced margin, 'wide' readings are increased by 1 year (e.g., 3W is aged as a 4 year old) while 'line' and 'narrow' readings remain the same as the zone count (e.g., 4L or 4N are aged as a 4 year old), meaning that regardless of whether the fish was caught before or after the nominal birth date of 1 January, age remains the same throughout, unlike that which would be used for age groups/age classes or in growth rate estimation (see Walsh et al. 2014).

Otolith reading precision was quantified by carrying out with between-reader comparison tests after Campana et al. (1995), including those between each reader and the agreed age. The Index of Average Percentage Error, IAPE (Beamish & Fournier 1981), and MWCV (Chang 1982), were calculated for each test.

2.4 Snapper catch-at-age analysis

NIWA's catch-at-length and at-age analysis software tool CALA (catch-at-length and at-age, Francis & Bian (2011) was used in the calculation of proportion-at-age and variance (bootstrap) estimates for the SNA 7 bottom trawl fishery from the random age frequency samples collected from each landing. Proportions-at-age across all landings within the sampling period were estimated from sample proportions, weighted by the estimated number of fish in each landing. Proportions-at-age were calculated for the range of fishing year age classes (herein referred to as "age classes" encompassing October 2016 to March 2017) recruited, with the maximum age being an aggregate of all age classes over 29 years. Estimates of mean age were calculated such that all fish comprising the aggregate (over 29 years) age group were assigned a 30+ age group (Appendix 1).

3. RESULTS

3.1 Fishery characterisation

As stated above, a fishery characterisation was not conducted prior to sampling, as the SNA 7 fishery had been recently characterised (Parker et al. 2015), and the main components of the fishery that the sample design was based on were expected to be stable.

The SNA 7 fishery has landed in excess of 200 t of snapper annually since 2010–11, although landings were slightly lower in the last full fishing year (the 2015–16 SNA 7 catch was 189 t; MPI 2017). Catches were dominated by bottom trawl (91% in 2015–16; Figure 1). Bottom pair trawl landings used to comprise about 17% of the landings up to 2012 (Parker et al. 2015), but this method

has not been used in recent years. Please note, that fishing years straddle calendar years (e.g. 2011–12), and where we use single year denotation we refer to the most recent part of the fishing year (i.e. 2012 = 2011–12).

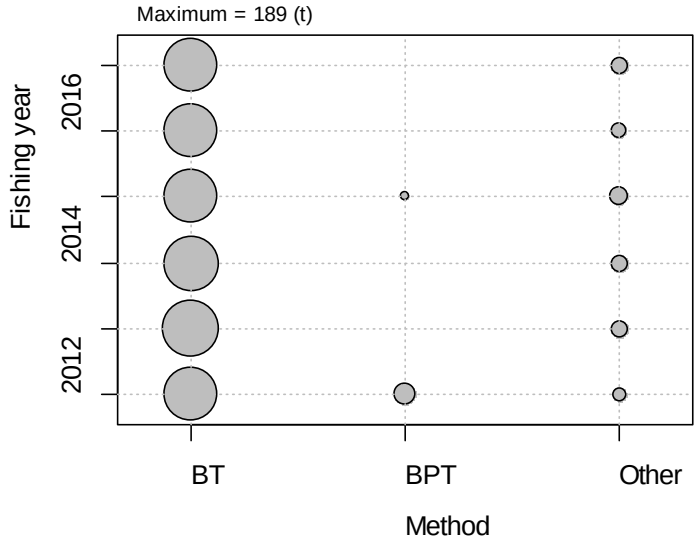

Figure 1: Snapper catch by gear type from the SNA 7 fishery between 2012 and 2017 (2017 includes data up to March only).

The majority of bottom trawl catch occurred in Statistical Area 038 (Tasman Bay/ Golden Bay), with minor landings from Statistical Areas 017, 035–037 and 039 (Figure 2 and
Figure 3). Many trips straddled Statistical Areas 037 and 038. No major annual differences in the spatial location of fishing effort or catch was noted.

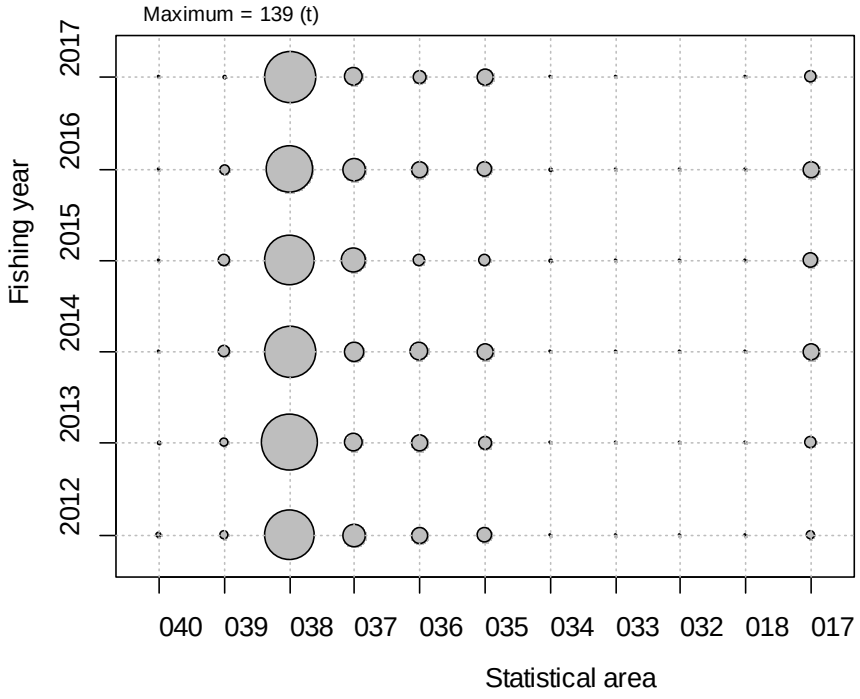

Figure 2: Snapper catch by statistical area from the SNA 7 bottom trawl fishery between 2012 and 2017 (2017 includes data up to March only).

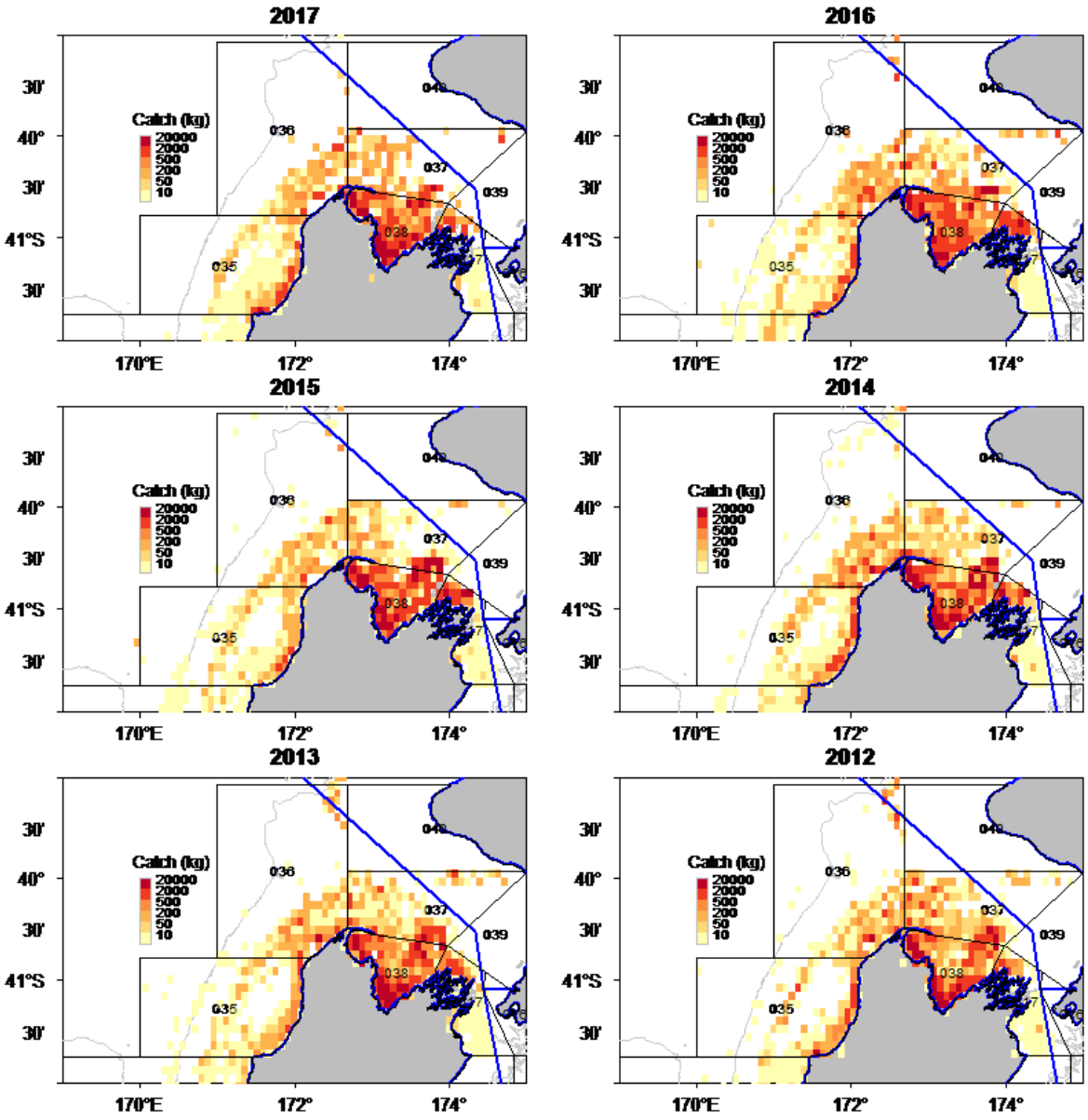

Figure 3: Spatial distribution of reported SNA 7 catch around the northern South Island, 2012–2017 (the 2017 plot includes data up to March only). Black lines delineate statistical areas and blue lines indicate boundaries of Quota Management Areas.

The majority of catch between 2012 and 2017 occurred in October through to December, significant catch continuing monthly through to April, and a diminishing trend for the remainder of the fishing year (Figure 4). An average of 79% of the bottom trawl landings occurred between October and March between 2012 and 2016. The entire 2017 fishing year was not able to be included in this characterisation due to the timing of when the data extract was conducted. However, by the end of March 2017 bottom trawl alone had already caught 165 t of the 250 t total allowable commercial catch (66%) for SNA 7.

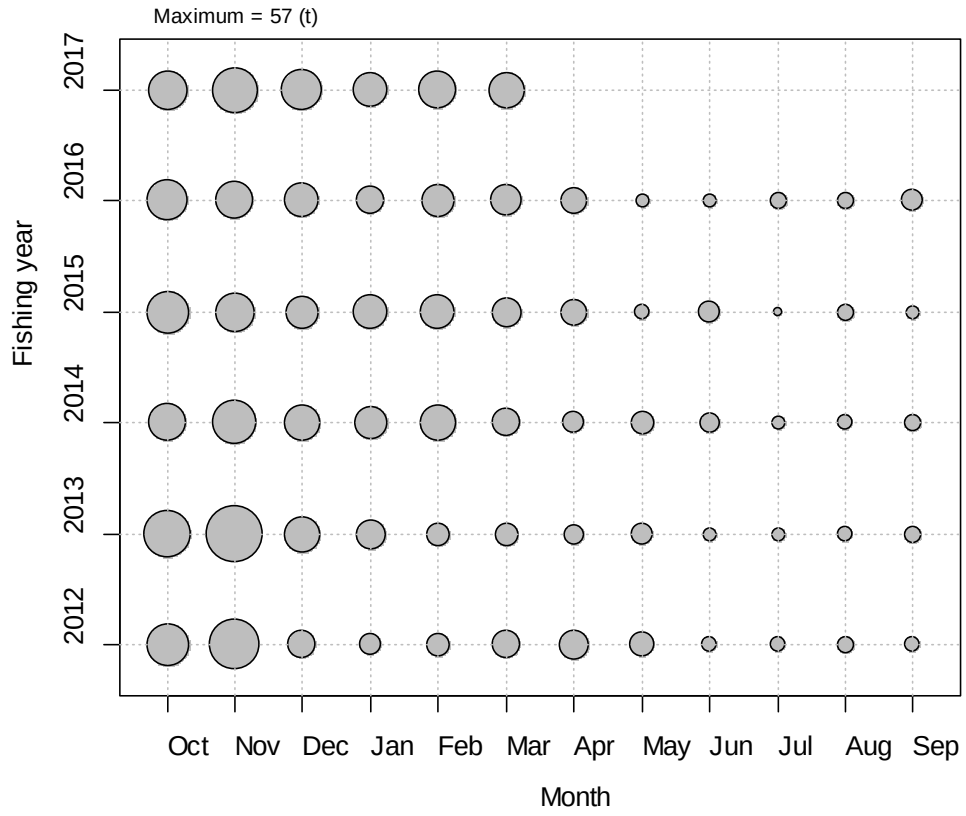

Figure 4: Monthly pattern of snapper catch from the SNA 7 bottom trawl fishery between 2012 and 2017 (2017 includes data up to March only).

The majority of snapper landed by bottom trawl was taken while targeting FLA, SNA, GUR and to some extent TAR and WAR (Figure 5). This pattern was relatively consistent between 2012 and 2017, with the importance of GUR as a target developing prior to 2012 (see Parker et al. 2015).

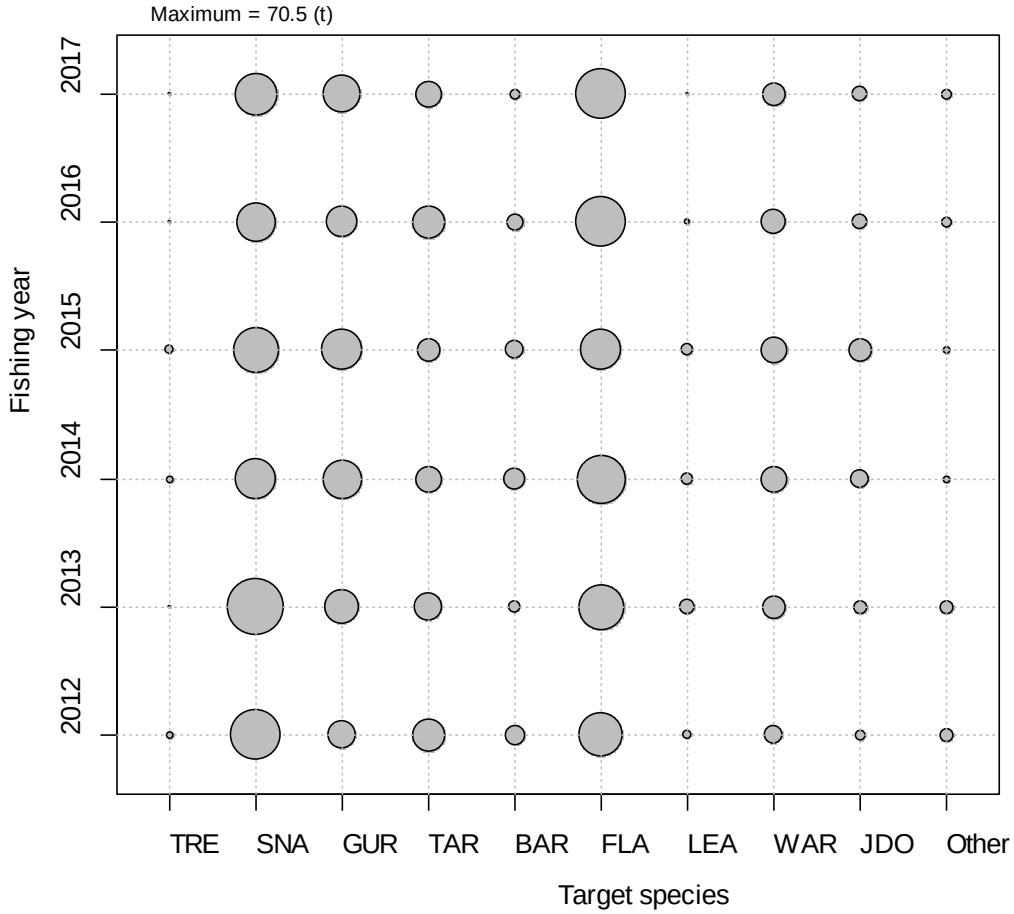

Figure 5: Target species associated with snapper catch from the SNA 7 bottom trawl fishery between 2012 and 2017 (2017 includes data up to March only).

3.2 Sample representativeness

A total of 27 landings were sampled between November 2016 and March 2017. Three of these landings were subsequently excluded because some of the associated fishing effort (and snapper catch) occurred outside of Statistical Areas 037 and 038 and targeted other species. Another two landings included some fishing events outside of Statistical Areas 037 and 038 and/or had a mixture of target species, but were retained in the final dataset as the catch from outside of Statistical Areas 037 or 038 was insignificant (less than 6 kg). The age composition of these two landings was consistent with the other landings (where pure SNA or FLA target and pure Statistical Area 037 or 038 effort was listed) (Appendices 2 and 3).

Overall the temporal pattern of landings sampled was similar to that of all landings (Figure 6). The obvious exception was the absence of sampling in October 2016, which was due to the sampling project not being initiated at that time. In general, however, our approach of opportunistically sampling as landings became available matched temporal patterns in the fishery, potentially better than the targeted approach implemented in the previous sampling programme (Parker et al. 2017).

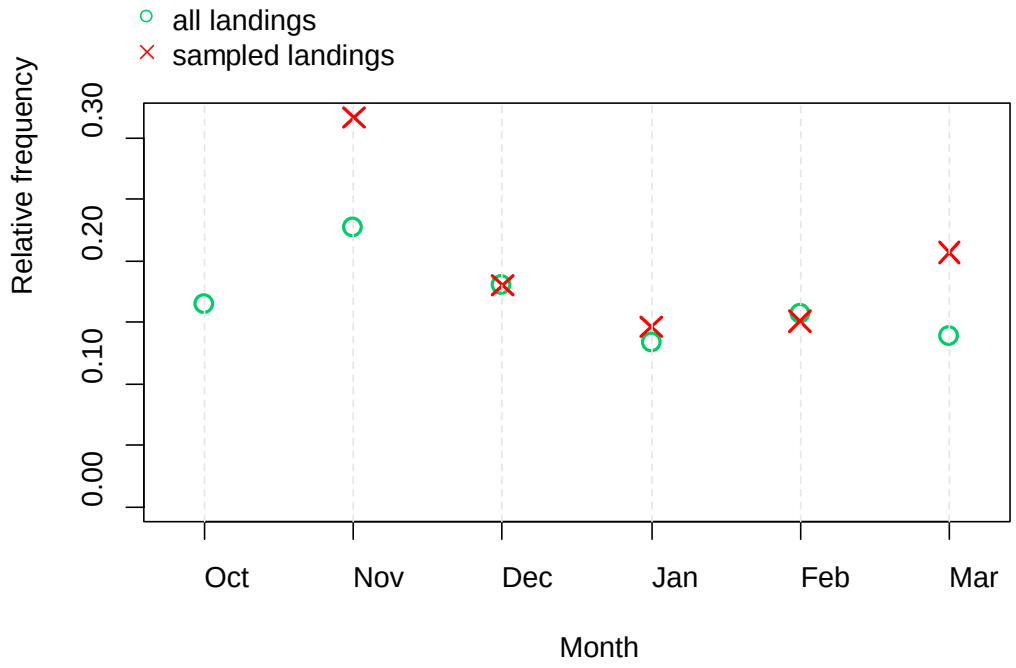

Figure 6: Relative proportions of landings sampled by the catch sampling programme compared with the relative frequency of landings of SNA 7 in the 2016–17 fishing year.

Spatially, sampled landings were constrained to Statistical Areas 037 and 038, as designated by the sampling design. Within these areas, the pattern of overall fishery catch compared to that of the sampled landings was not obviously dissimilar (Figure 7).

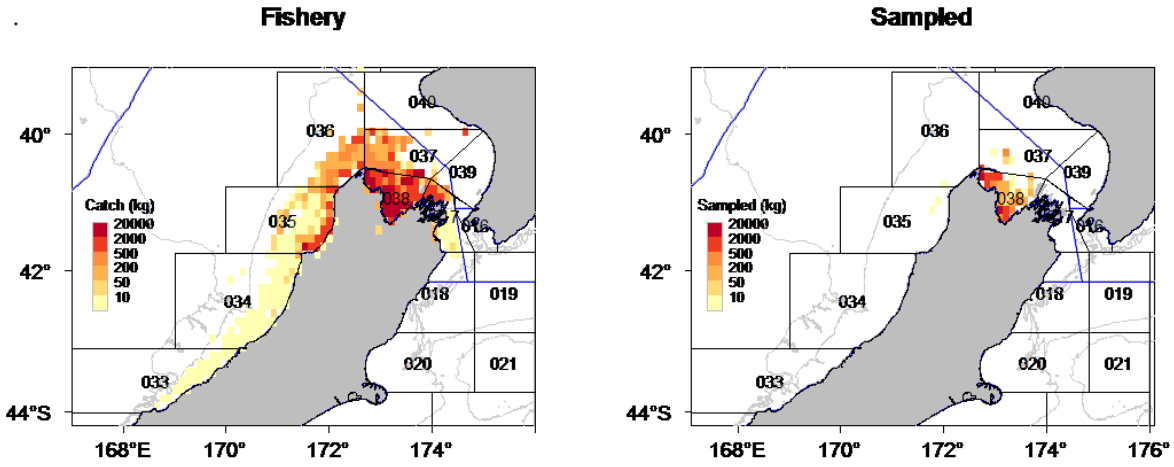

Figure 7: Spatial distribution of bottom trawl catch of snapper in 2017 (to March) for the whole SNA 7 fishery (left panel) compared to just the sampled landings (right panel). Black lines delineate statistical areas and blue lines indicate boundaries of Quota Management Areas.

3.3 Snapper otolith readings: reader comparison tests for reference readings

To assess reader competency in ageing snapper otoliths in 2016–17, each of the two selected readers aged a subsample of 50 reference otolith preparations with the aim of achieving a score for Index of Average Percentage Error, IAPE (Beamish & Fournier 1981), and mean coefficient of variation (CV) (Chang 1982), of below 1.50% and 2.12% respectively (Walsh et al. 2014). Both readers 1 and 2 achieved pass CV and IAPE (Table 1).

Table 1: **Reader comparison scores determined from ageing 50 randomly selected snapper reference otolith samples ranging in age from 2 to 47 years.**

	CV	IAPE	Agreed age	Pass/Fail
Target	2.12%	1.50%	–	–
Reader 1	0.55%	0.39%	86%	Pass
Reader 2	1.37%	0.97%	76%	Pass

3.4 Ageing SNA 7 otolith samples from 2016–17

A subsample of 1000 otoliths was randomly selected for ageing (with the number of otoliths within each landing based on weight of the landing) from the 1440 otoliths collected across twenty-four SNA 7 landings. The length distribution of the subsampled fish was representative of the larger random age frequency sample (Figure 8 and Figure 9).

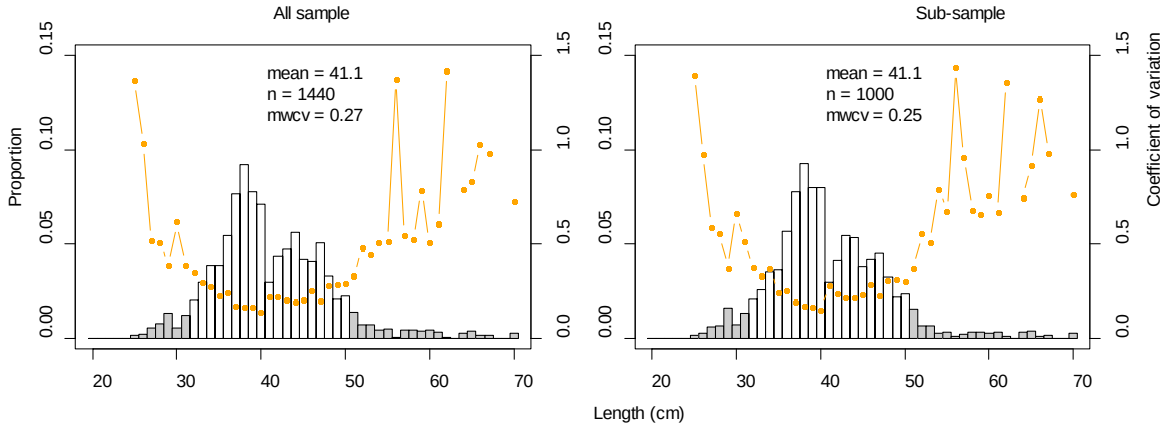

Figure 8: Proportion-at-length distributions (histograms) and CVs (lines) of the random age frequency sample (and subsample) determined from snapper landings sampled from the SNA 7 bottom trawl fishery in 2016–17 over November–March (n, sample size; MWCV, mean weighted CV).

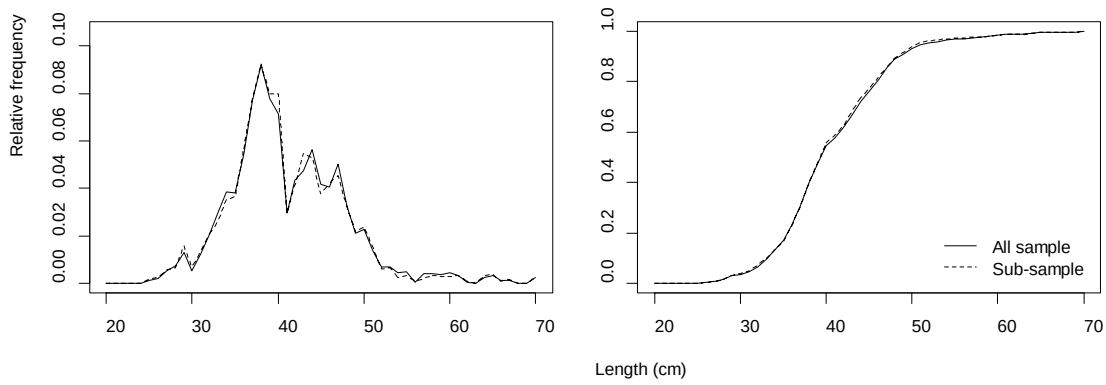

Figure 9: Comparison of the proportion and cumulative proportion-at-length distributions of the random age frequency sample (solid line), and subsample (dashed line) determined from snapper landings sampled from the SNA 7 bottom trawl fishery in 2016–17 over November–March.

3.5 Reader comparison tests for SNA 7 readings

Of the total subsample of 1000 otoliths selected for ageing, all were successfully aged. Between-reader tests from reading these 1000 otoliths showed a high level of consistency between readers (Figure 10). Overall there was a high level of agreement (98.1%) between the readers and only very minor systematic differences (bias) in the first counts of snapper otoliths (Figure 10a–c). Between-reader CV and IAPE scores were less than 0.2% (Figure 10c) and the analyses show that precision was high across almost all age classes (Figure 10d). Comparisons of age-bias plots for readers 1 and 2 with the agreed age show that overall agreement was very high (99.7% and 98.4%) and precision was high, with CV and IAPE estimates less than 0.2% (Figure 10e and f).

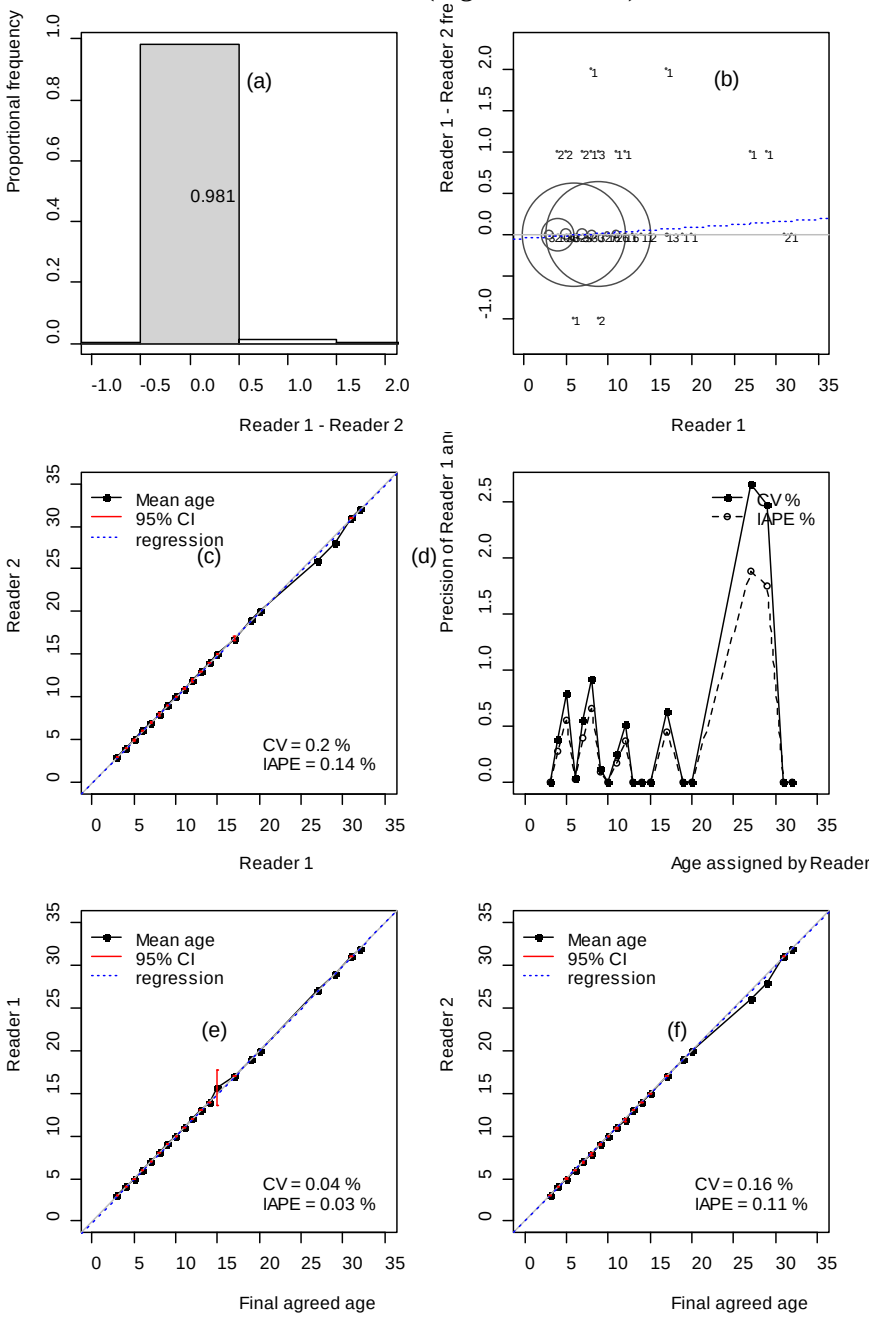

Figure 10: **Results of between-reader comparison tests (Reader 1 and 2) for SNA 7 otoliths collected in 2016–17 (n = 1000): (a) histogram of differences between readings for the same otolith; (b) differences between readers for a given age assigned by Reader 1; (c) bias plot between readers; (d) CV and IAPE profiles (precision) relative to the age assigned by Reader 1; (e, f) bias plot between Reader 1 and Reader 2 and agreed age. The expected perfect agreement (solid line) and actual relationship (dashed line) between readers are overlaid on (b) and (c), and between reader 1 and 2 and the agreed age on (e) and (f).**

3.6 SNA 7 bottom trawl catch-at-age estimates

Catch-at-age compositions with bootstrapped variance estimates were derived for the November to March sampling period (Figure 11, Appendices 1 and 4). Cumulative proportion-at-age comparisons are also given in Figure 12.

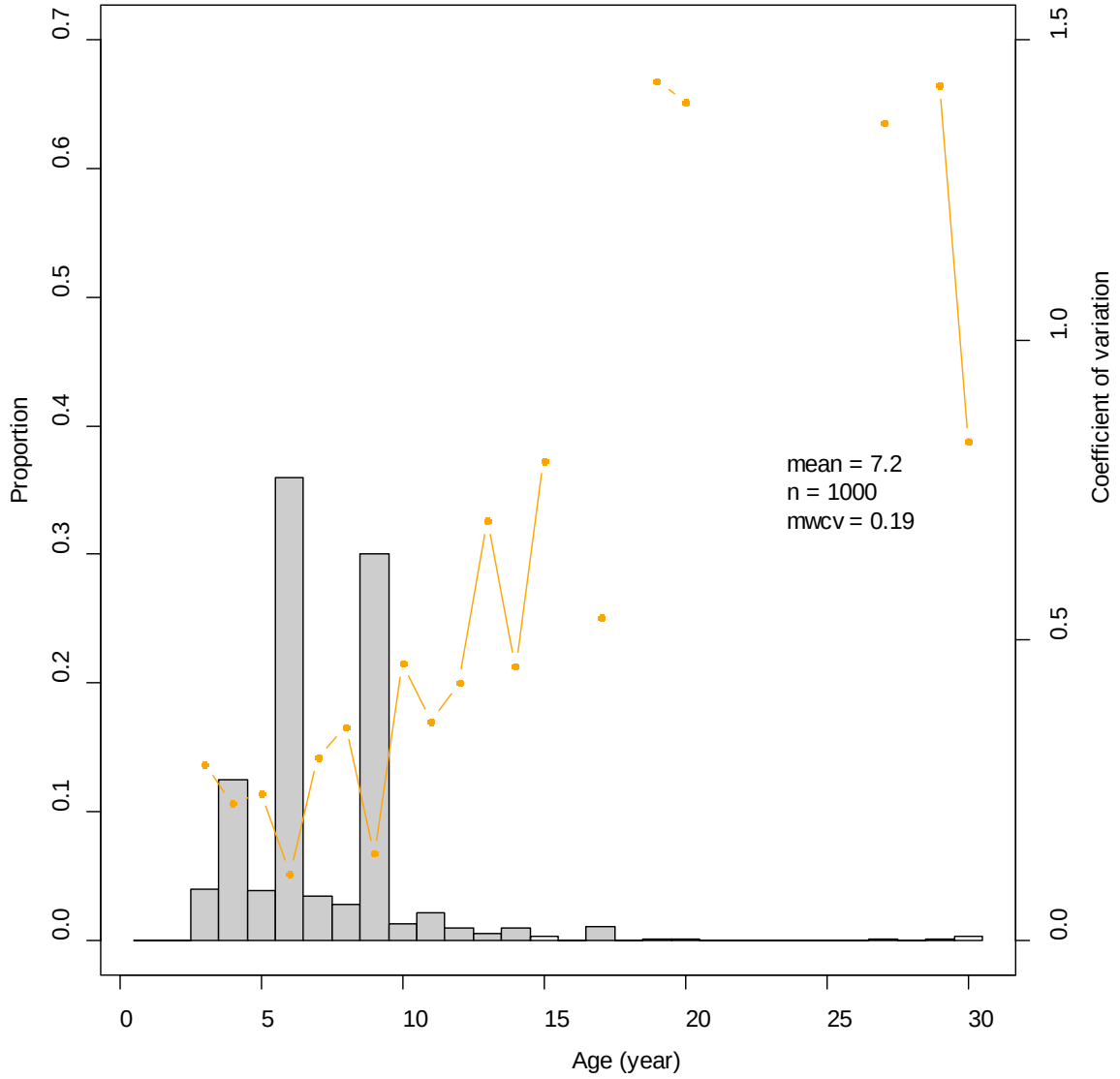

Figure 11: Proportion-at-age distributions (histogram) and CVs (line) determined from snapper landings sampled from the SNA 7 bottom trawl fishery in 2016–17 over November–March (n, sample size; MWCV, mean weighted CV).

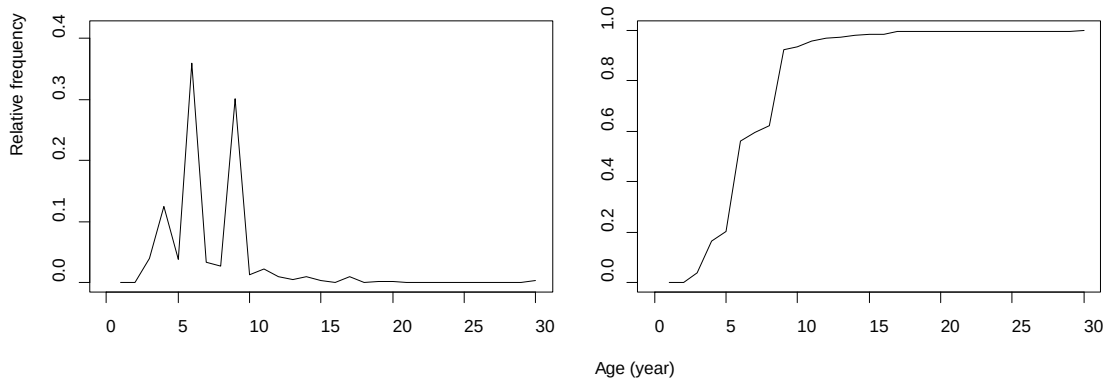

Figure 12: The proportion and cumulative proportion-at-age distributions determined from snapper landings sampled from the SNA 7 bottom trawl fishery in 2016–17 over November–March.

The SNA 7 bottom trawl catch in 2016–17 was dominated by two year classes; the 2008 year class (9 year olds, 30%) and the 2011 year class (6 year olds, 36%). The 2013 year class (4 year olds), which was the only other prominent year class in the fishery, made up 13% of the catch, and is likely to have been fully recruited to the fishery as this year class consisted of individuals between 29 and 39 cm in length (Appendices 1 and 4). The 2008 and 2011 year classes combined accounted for two out of every three (66%) snapper landed, largely comprising the two main modes in the length composition at 44 and 38 cm, respectively (see Figure 6). All other year classes comprised relatively low numbers of fish and appear weak in comparison. The oldest fish sampled from the fishery in 2016–17 was 42 years old, with six fish over 20 years of age in the subsample of 1000 fish that were aged (Figure 11). The mean age of snapper in the SNA 7 fishery over October to March was 7.2 years and the MWCV was 19%, the precision indicative of relatively low between-landing variability.

Inspection of the time series of proportion-at-age distributions available for the SNA 7 bottom trawl fishery demonstrates that the fishery is still comprised of a relatively narrow age distribution with few contributing year classes and a distinct lack of accumulation of older aged fish compared to the age distributions of the late 1990s (Figure 13). With the presence of two dominant age classes, and another of somewhat lower strength, however, the SNA 7 bottom trawl fishery contains more strong year classes than in recent years and the mean age at 7.1 years represents the highest estimate achieved from sampling in more than a decade.

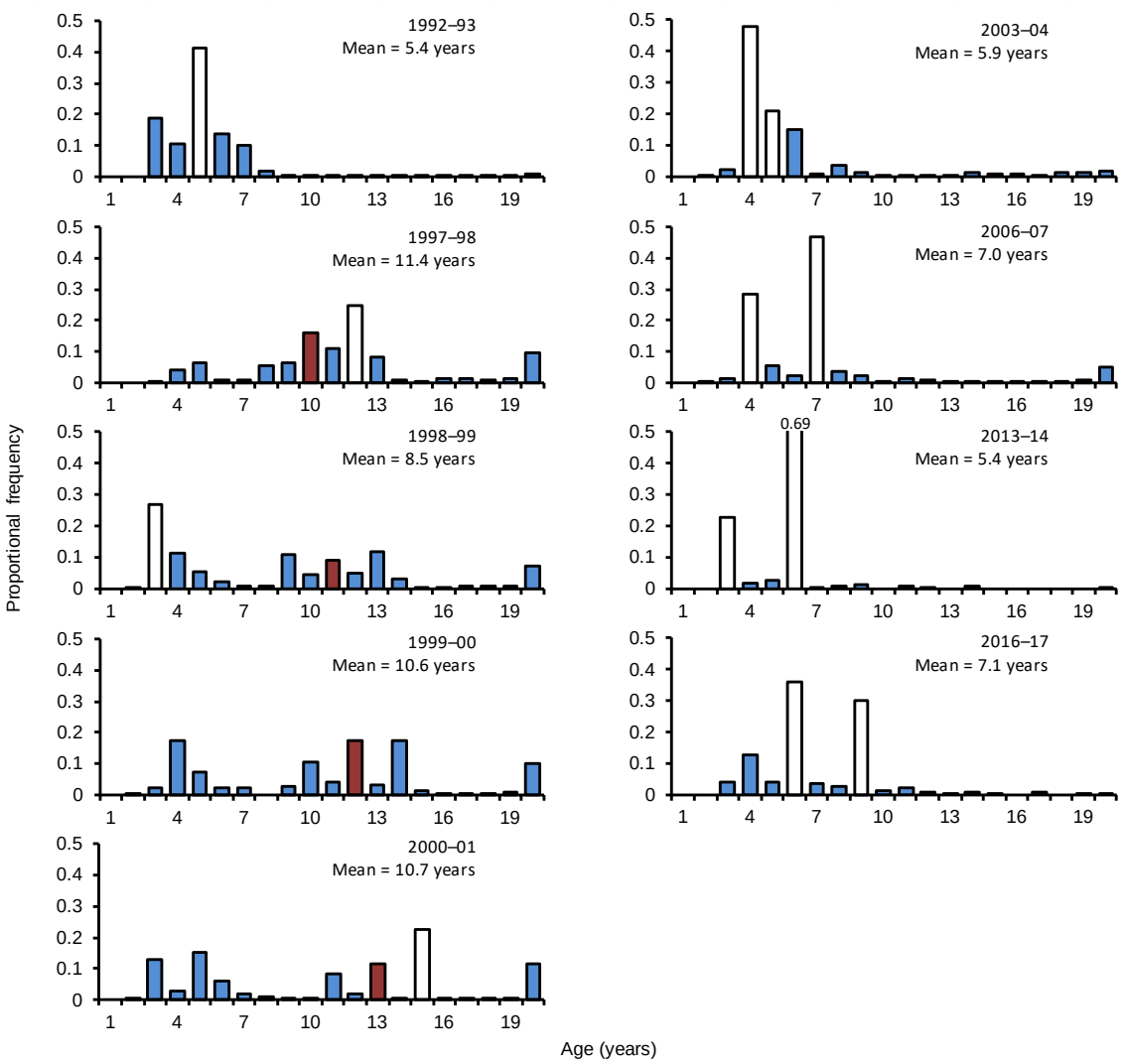

Figure 13: Intermittent time series of SNA 7 proportion-at-age distributions, 1992–93 to 2016–17. The 1988 year class is coloured maroon, 2000 year class green, 2008 year class yellow, 2011 year class coloured grey. Age distributions for all years contain a 20+ group. The 2013–14 and 2016–17 age distributions comprise sample data from only Statistical Areas 037 and 038, whereas previous age distributions may have sampled vessels that fished across all statistical areas of SNA 7.

4. DISCUSSION

The SNA 7 bottom trawl fishery targeting SNA and FLA in Statistical Areas 037 and 038 was sampled for length and otoliths during the first half of the 2016–17 fishing year. A total of 27 landings were sampled, with 24 qualifying to represent the core SNA 7 fishery, with 1440 pairs of otoliths collected from those landings.

We adopted a flexible approach to the sampling conducted for this project, opportunistically sampling landings as they became available rather than attempting to meet fixed monthly targets as has been conducted for previous sampling projects in SNA 7. Aside from October 2016 (where no sampling took place due to delays in the contracting process) this approach was highly successful, with sampled landings closely matching both temporal and spatial patterns in the SNA 7 fishery. Furthermore, the *post hoc* characterisation that we conducted confirmed that the patterns in the SNA 7 fishery (i.e. gear type, target species, monthly trends in catch) were all generally stable over the last few years that the

fishery has operated. In terms of the length composition of snapper that were aged relative to all snapper that were measured, the two distributions were virtually identical, suggesting that our otolith selection process was representative. Otolith reader comparison tests demonstrated a high level of agreement, indicating precise ageing. Furthermore, the MWCV of 0.19 was below the target of 20%, which suggests that the target of 30 landings and 1000 otoliths was sufficient to describe the age composition of the fishery.

The age composition for 2016–17 was dominated by the strong 2011 and 2008 year classes (6 and 9 year olds) that were present when sampling was last conducted in 2013–14 (Parker et al. 2015). These year classes together accounted for two-thirds (66%) of fish landed by bottom trawl, significant in the contribution they make by weight to the total catch with individual mean lengths of about 38 and 45 cm and weights of about 1.2 and 1.9 kg. In addition to these year classes, a moderately strong 2013 year class (4–year-olds) was also present and accounted for about 13% of the catch by number. As the 2013 year class has an approximate mean size of 34 cm (0.8 kg) and is considered fully recruited, its relative importance to the fishery will only increase as individual fish in this year class grow in size and the abundance of the older 2008 and 2011 year classes are reduced. As was the case in 2013–14, there were few older age classes present in the SNA 7 fishery (Parker et al. 2015), and this has remained largely unchanged in 2016–17 with 92.4% of landings comprised of individuals that were less than 10 years old.

Part of the age composition presented includes two landings (of 24 total landings), where a small amount of snapper catch was taken outside of Statistical Areas 037 or 038 (less than 6 kg), or where catch included fishing effort where species other than SNA or FLA were targeted. We assessed the effect of target species on age composition and the overall distributions as insignificant, with the strong 2008 and 2011 year classes dominating regardless of target species (Appendix 2). The relative importance of these year classes, however, were somewhat different between SNA and FLA target effort, with a higher proportion of younger (smaller) fish present for SNA target fishing effort.

When considering the entire age composition time series that is now available for SNA 7, the most obvious aspect (other than the decline in old fish currently present within the fishery) is the high level of inter-annual variability in year class strengths (i.e. variable recruitment) characteristic of SNA 7 recruitment processes. As snapper recruitment is known to be strongly positively correlated with sea surface temperature just after the time of spawning (Francis 1993), it is likely that high recruitment variability within SNA 7 is because this area is approaching the southern limit of the snapper distribution (Blackwell et al. 1999, 2000, Blackwell & Gilbert 2001, 2002, 2005, 2008, Walsh et al. 2012). Given this historic context, while the recovery of biomass (Langley 2015) associated with the strong 2008 and 2011 year classes will undoubtedly support the SNA 7 fishery for some time, it will also be important to consider the potential for consecutive years of low recruitment and how this may change with environmental conditions.

5. MANAGEMENT IMPLICATIONS

The bottom trawl catch-at-age composition of SNA 7 in 2016–17 was largely dominated by the strong 2011 and 2008 year classes (6- and 9-year-olds) with large old fish scarce in the catch. The presence of two strong year classes, the high level of inter-annual recruitment variability, and the absence of old fish in the catch may have implications for future stock status, resulting from the combination of growth, maturation, and fishing mortality.

Given the recent increased catch in SNA 7 by both the commercial and recreational sectors, we recommend that the SNA 7 bottom trawl catch be sampled in 2018–19 to closely monitor the strength of new year classes entering the fishery and the status of those year classes currently supporting the fishery.

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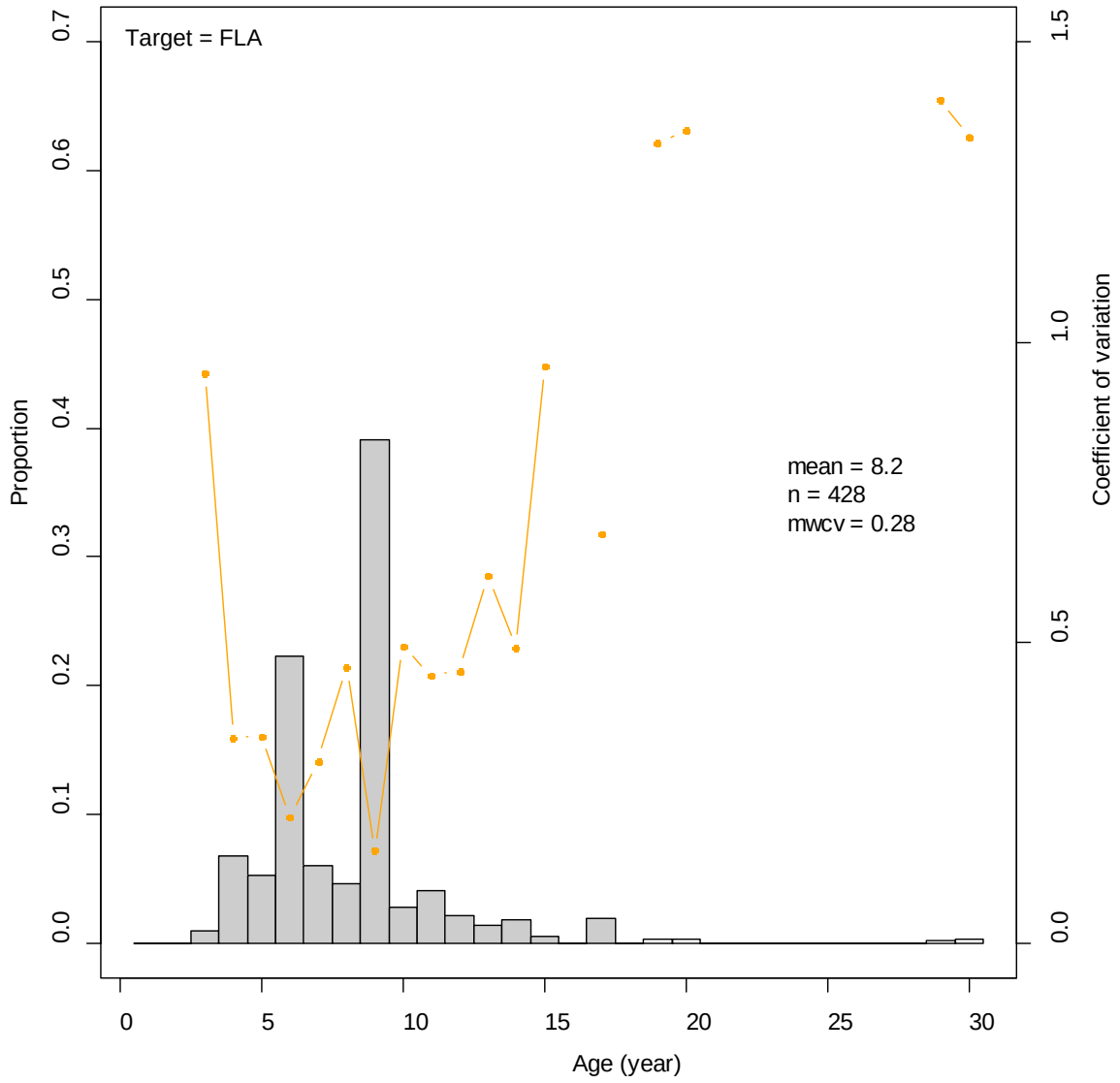
APPENDIX 1

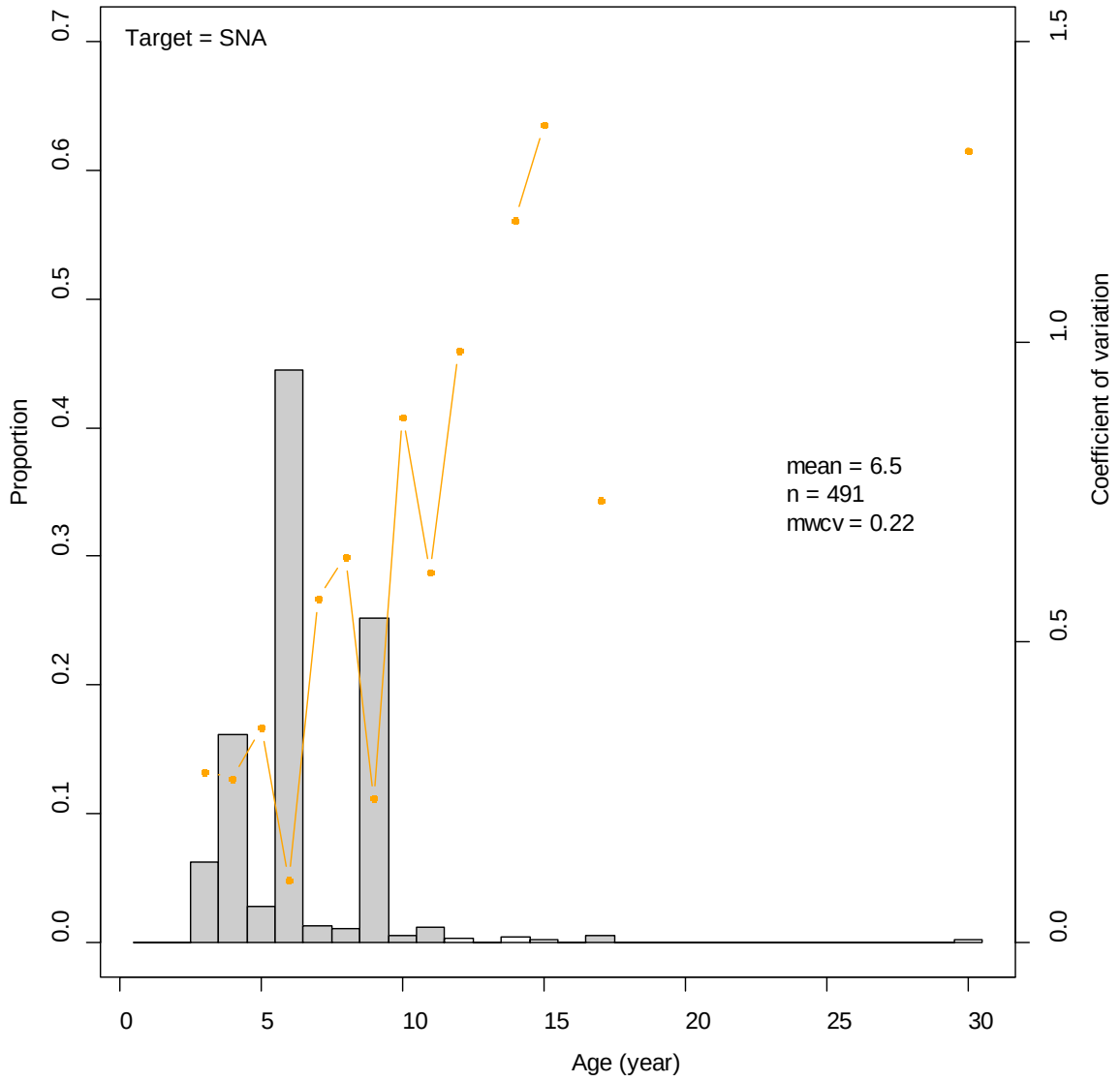
Estimates of proportion of length at-age for snapper sampled from the Tasman Bay/Golden Bay subarea of SNA 7, spring- summer 2016-17. (Note: Aged to 01/01/17).

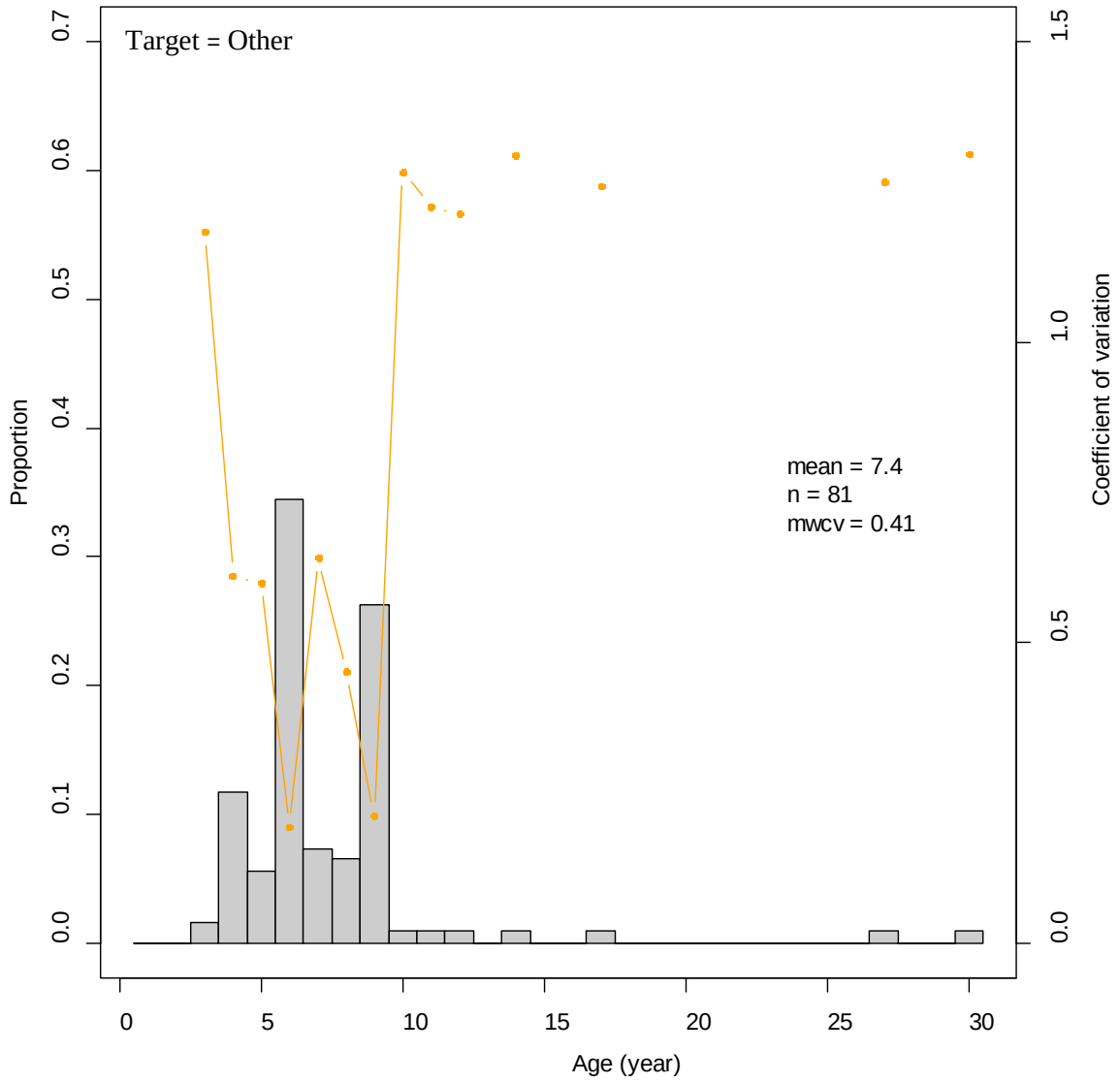
Length	Age (years)																				No.
(cm)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	>19	aged
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	0	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
26	0	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
27	0	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
28	0	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6
29	0	0	0.77	0.23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	13
30	0	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
31	0	0	0.40	0.60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10
32	0	0	0	0.88	0.06	0.06	0	0	0	0	0	0	0	0	0	0	0	0	0	0	17
33	0	0	0	0.77	0.14	0.09	0	0	0	0	0	0	0	0	0	0	0	0	0	0	22
34	0	0	0	0.83	0.07	0.07	0.03	0	0	0	0	0	0	0	0	0	0	0	0	0	29
35	0	0	0	0.50	0.06	0.41	0	0.03	0	0	0	0	0	0	0	0	0	0	0	0	34
36	0	0	0	0.24	0.16	0.56	0.04	0	0	0	0	0	0	0	0	0	0	0	0	0	50
37	0	0	0	0.07	0.16	0.72	0.01	0.01	0.01	0	0	0	0	0	0	0	0	0	0	0	69
38	0	0	0	0.06	0.10	0.78	0.04	0.02	0	0	0	0	0	0	0	0	0	0	0	0	83
39	0	0	0	0.01	0.03	0.86	0.04	0.01	0.04	0	0	0	0	0	0	0	0	0	0	0	74
40	0	0	0	0	0.03	0.72	0.09	0.01	0.13	0.01	0	0	0	0	0	0	0	0	0	0	76
41	0	0	0	0	0.03	0.59	0.13	0	0.25	0	0	0	0	0	0	0	0	0	0	0	32
42	0	0	0	0	0	0.24	0.17	0.13	0.46	0	0	0	0	0	0	0	0	0	0	0	46
43	0	0	0	0	0	0.14	0.12	0.12	0.61	0.02	0	0	0	0	0	0	0	0	0	0	59
44	0	0	0	0	0	0.05	0.04	0.09	0.78	0.04	0	0	0	0	0	0	0	0	0	0	55
45	0	0	0	0	0	0.02	0.05	0.05	0.86	0	0	0.02	0	0	0	0	0	0	0	0	43
46	0	0	0	0	0	0	0	0.08	0.82	0	0.08	0.02	0	0	0	0	0	0	0	0	49
47	0	0	0	0	0	0	0	0.04	0.80	0.08	0.06	0.02	0	0	0	0	0	0	0	0	51
48	0	0	0	0	0	0	0	0	0.87	0.05	0.05	0	0	0.03	0	0	0	0	0	0	39
49	0	0	0	0	0	0	0	0	0.69	0.08	0.19	0.04	0	0	0	0	0	0	0	0	26
50	0	0	0	0	0	0	0	0	0.59	0	0.21	0.07	0.03	0.10	0	0	0	0	0	0	29
51	0	0	0	0	0	0	0	0	0.78	0.17	0	0	0.06	0	0	0	0	0	0	0	18
52	0	0	0	0	0	0	0	0	0.38	0	0.25	0.13	0.13	0.13	0	0	0	0	0	0	8
53	0	0	0	0	0	0	0	0	0.50	0	0.25	0.13	0	0	0.13	0	0	0	0	0	8
54	0	0	0	0	0	0	0	0	0.33	0	0	0.33	0.33	0	0	0	0	0	0	0	3
55	0	0	0	0	0	0	0	0	0.25	0.25	0.25	0	0	0	0.25	0	0	0	0	0	4
56	0	0	0	0	0	0	0	0	0	0	0	1.00	0	0	0	0	0	0	0	0	1
57	0	0	0	0	0	0	0	0	0	0	1.00	0	0	0	0	0	0	0	0	0	2
58	0	0	0	0	0	0	0	0	0	0	0	0.25	0	0.25	0.25	0	0.25	0	0	0	4
59	0	0	0	0	0	0	0	0	0	0	0	0.00	0.50	0.25	0	0	0.25	0	0	0	4
60	0	0	0	0	0	0	0	0	0	0	0	0	0	0.33	0	0	0.67	0	0	0	3
61	0	0	0	0	0	0	0	0	0	0	0	0.25	0	0.25	0	0	0	0	0.25	0.25	4
62	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.00	0	0	0	1
63	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
64	0	0	0	0	0	0	0	0	0	0	0	0	0	0.50	0	0	0.25	0	0	0.25	4
65	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.00	0	0	0	5
66	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.00	0	0	0	1
67	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.50	0	0	0.50	2
68	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
69	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
70	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
71	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.00	1
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	1.00	1
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	0	0
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																					1000

APPENDIX 2

Proportion-at-age distributions (histograms) and CVs (lines) separated by landings that targeted FLA, SNA and a mixture of Other species.




Target = SNA
mean = 6.5
n = 491
mwcv = 0.22
Proportion
Coefficient of variation
Age (year)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.5
1.0
1.5
0
5
10
15
20
25
30


Target = Other
mean = 7.4
n = 81
mwcv = 0.41
Proportion
Coefficient of variation
Age (year)
0.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.5
1.0
1.5
0
5
10
15
20
25
30

APPENDIX 3

Sampled landings that were used for SNA 7 age composition under project SNA201601. Note that target species is that recorded in the logbook, not reported at the time of sampling.

Sample number	Date sampled	Target species	Landing weight (kg)	Sample weight (kg)	Statistical area	Number of otoliths
20161301	4/11/2016	FLA	534.0	83.0	038	60
20161302	4/11/2016	FLA	457.0	107.5	038	60
20161304	8/11/2016	FLA	688.0	137.0	038	60
20161305	17/11/2016	FLA	491.5	116.5	038	60
20161306	22/11/2016	SNA	1195.0	94.0	038	60
20161307	22/11/2016	SNA	787.0	104.0	038	60
20161308	30/11/2016	SNA	469.0	87.0	038	60
20161309	30/11/2016	SNA	662.0	67.5	038	60
20161310	6/12/2016	GUR, SNA, TAR, WAR	704.0	103.5	035, 036, 037, 038	60
20161311	6/12/2016	FLA	893.5	149.0	038	60
20161312	7/12/2016	LEA, GUR, JDO	653.0	85.0	038	60
20161313	14/12/2016	SNA	758.0	63.5	038	60
20171301	5/01/2017	FLA	610.0	113.5	038	60
20171302	9/01/2017	SNA	320.5	98.0	037 and 038	60
20171304	17/01/2017	FLA	529.0	132.5	038	60
20171305	18/01/2017	SNA	988.0	72.5	038	60
20171306	2/02/2017	FLA	422.0	112.5	038	60
20171307	9/02/2017	SNA	673.5	64.5	038	60
20171308	14/02/2017	FLA	843.0	127.0	038	60
20171309	24/02/2017	FLA	582.5	126.0	038	60
20171310	3/03/2017	SNA	822.0	107.0	038	60
20171311	8/03/2017	SNA	661.0	116.0	038	60
20171312	17/03/2017	SNA	1128.0	137.0	038	60
20171313	20/03/2017	FLA	847.5	130.0	038	60

APPENDIX 4

Estimated proportion-at-age and CVs for snapper sampled from the SNA 7 bottom trawl fishery, November–March 2016–17.

	Random age frequency from bottom trawl	
Age (years)	*P.j.*	CV
1	0.0000	0.0000
2	0.0000	0.0000
3	0.0398	0.2917
4	0.1250	0.2271
5	0.0383	0.2441
6	0.3595	0.1104
7	0.0336	0.3030
8	0.0272	0.3554
9	0.3007	0.1434
10	0.0130	0.4607
11	0.0215	0.3636
12	0.0094	0.4297
13	0.0048	0.6981
14	0.0089	0.4576
15	0.0026	0.7996
16	0.0000	0.0000
17	0.0101	0.5379
18	0.0000	0.0000
19	0.0009	1.4307
20	0.0008	1.3966
21	0.0000	0.0000
22	0.0000	0.0000
23	0.0000	0.0000
24	0.0000	0.0000
25	0.0000	0.0000
26	0.0000	0.0000
27	0.0008	1.3623
28	0.0000	0.0000
29	0.0007	1.4250
>29	0.0026	0.8299
n	1000	