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Tini a Tangaroa

Age composition of commercial snapper landings in SNA 1, 2017–18

New Zealand Fisheries Assessment Report 2019/45

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This report presents the results of Objective 2 of Fisheries New Zealand project "Estimation of snapper year class strength in SNA 1, 2017–18" (SNA2017/02). The general objective was to determine by market sampling for use in stock assessment models the age structure of commercial landings from the three snapper stocks that constitute SNA 1.

The random age frequency sampling approach was employed over four seasons from spring 2017 to winter 2018 to estimate catch-at-age for snapper from the three bottom longline fisheries in SNA 1: East Northland, Hauraki Gulf, and Bay of Plenty. Target sample sizes were achieved for numbers of landings (120) and exceeded for otoliths by 14.5% (Hauraki Gulf) to 26.9% (Bay of Plenty) due primarily to an increase in average landing size in the fishery compared to previous years. Overall, spatio-temporal comparisons revealed good sample representativeness despite minor disproportionality in the number of sampled landings in some months and in relation to vessel selection and landing size.

Catch-at-age distributions for the SNA 1 bottom longline fisheries in 2017–18 have remained broad since the previous sampling year in 2012–13, with good representation across almost all year classes up to 20 years, resulting in high estimates of mean age: East Northland (9.9 years), Hauraki Gulf (10 years), and Bay of Plenty (8.7 years). East Northland remains the only stock with a high proportion of snapper 20 years or older. Hauraki Gulf landings were largely dominated by the 2013–2006 year classes (5- to 12-year-olds), most of similar relative strength, whereas Bay of Plenty landings displayed much higher variability across the same year classes. The East Northland longline fishery was dominated by a very strong 2011 year class (7-years-old) that accounted for one in every four snapper landed in 2017–18, one of the strongest year classes seen in over a decade.

With perpetuating slow growth rates in SNA 1 for many fish, mean size in the bottom longline fisheries has continued to remain low and now ranges between 32 cm (about 0.7 kg) for Hauraki Gulf, the lowest ever recorded estimate, to 35 cm (about 0.9 kg) for East Northland.

Mean weighted coefficients of variation (MWCV from bootstrap estimates) for the age compositions of SNA 1 ranged between 19 and 21%, close to the target of 20%. To achieve the same target catch-at-age precision for SNA 1 stocks in future years, otolith sample size targets may need to be higher, should age compositions continue to broaden and bottom longline average landing size remain high.

1. INTRODUCTION

Snapper (*Chrysophrys auratus*) is New Zealand's most important commercial inshore fish species. In 2017–18, 70% of the national Total Allowable Commercial Catch (TACC) of 6397 t was apportioned to SNA 1 (4500 t), encompassing the northeast coast of the North Island (Figure 1). In most recent years the greatest proportion (over 95%) of the SNA 1 commercial catch has been taken by three methods (bottom longline (about 38%), bottom trawl (about 34%) and Danish seine (about 25%)) mostly targeting snapper, but also as a bycatch when targeting other species, particularly trevally (*Pseudocaranx dentex)*, John dory (*Zeus faber*) and red gurnard (*Chelidonichthys kumu*). The annual SNA 1 catch over the past two decades has, on average, been closely aligned to the TACC (Figure 2, Fisheries New Zealand 2018).

SNA 1 has been one of the most researched inshore finfish fisheries in New Zealand. Staff of the National Institute of Water and Atmospheric Research (NIWA), and formerly MAF Fisheries, have sampled the length and age compositions of snapper 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 dominant fishing methods in SNA 1 and SNA 8. Because of heterogeneity in snapper biology and fishing patterns, SNA 1 is often further subdivided into three substocks (referred to herein as stocks): East Northland, Hauraki Gulf, and Bay of Plenty. The time series of length and age information from the SNA 1 fishery continued uninterrupted for a period of 21 years up until 2009–10 and has been summarised in a number of reports. Triennial sampling was adopted after 2009–10 based on research investigating the optimum frequency for market sampling (Bian et al. 2009), the last sampling programme being undertaken in 2012–13 (Walsh et al. 2014b).

In 2003–04 the approach for sampling SNA 1 commercial bottom longline landings for length and age data was modified from a spring and summer sampling programme to one that encompassed the entire year (see Walsh et al. 2006). This change was largely introduced so that sampling reflected the seasonal characteristics of the longline fleet and its fishing operations in recent years, in which the snapper catch is landed year-round, rather than just over spring and summer. The sampling undertaken in 2017–18 continued with the year-round approach with landings sampled randomly for age only. Davies et al. (1993) investigated the relative benefit of catch-at-age precision associated with particular length frequency and otolith sample sizes in snapper landings so as to optimise sampling resources. They concluded that there was no great benefit from collecting large length frequency samples. The aim of the present study was to estimate the age and length compositions of snapper longline catches from each of the snapper stocks in SNA 1 during the 2017–18 fishing year. The age composition of longline catches is an important input to SNA 1 stock assessments, where it is used to estimate selectivity and relative year class strength. .

This report presents the results of market sampling between October 2017 and August 2018 (Fisheries New Zealand project SNA2017/02).

The specific objectives of this project for 2017–18 were:

1. To characterise the SNA 1 fishery by analysing existing commercial catch and effort data to the end of 2015/16 fishing year.

2. To carry out sampling and estimate the relative proportion at age and length of recruited snapper sampled from the commercial catch in SNA 1 throughout the fishing year 2017/18. The target coefficient of variation (CV) for the catch-at-age will be 20 % (mean weighted CV across all age classes).

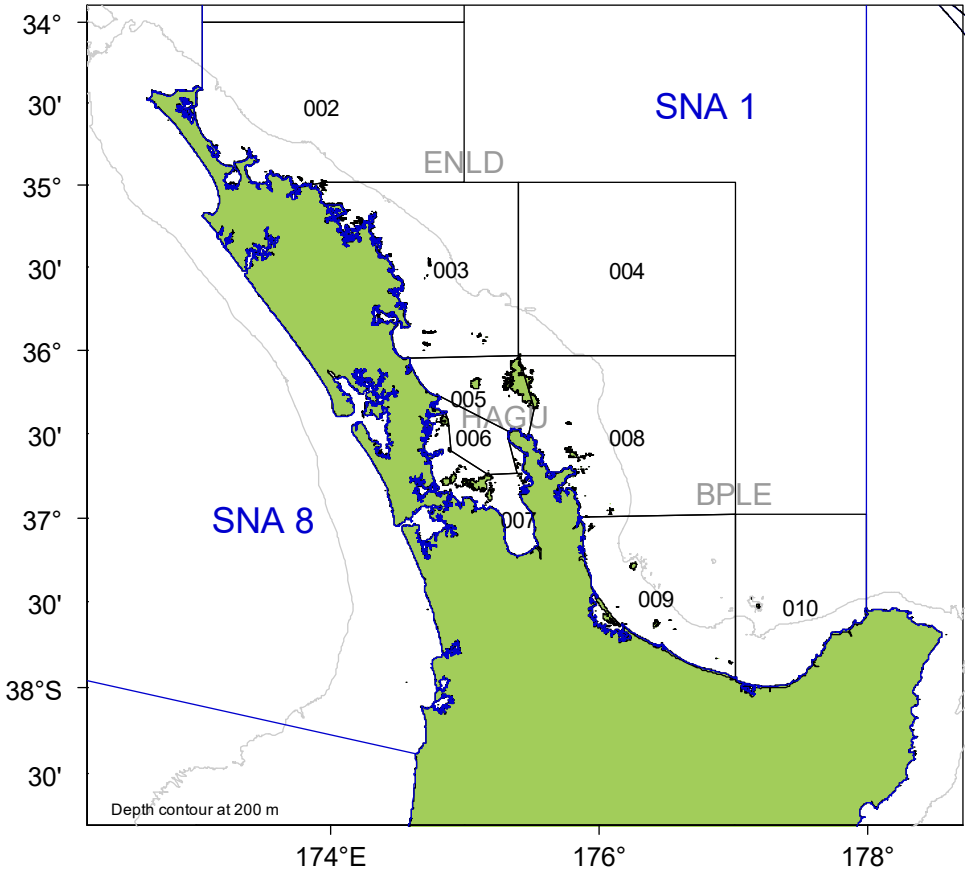

Figure 1: Quota management area for the north east North Island snapper stock, SNA 1, and the spatial dimensions of the three SNA 1 substocks: East Northland (Statistical Areas 002 and 003), Hauraki Gulf (Statistical Areas 005 to 007), and Bay of Plenty (Statistical Areas 008 to 010).

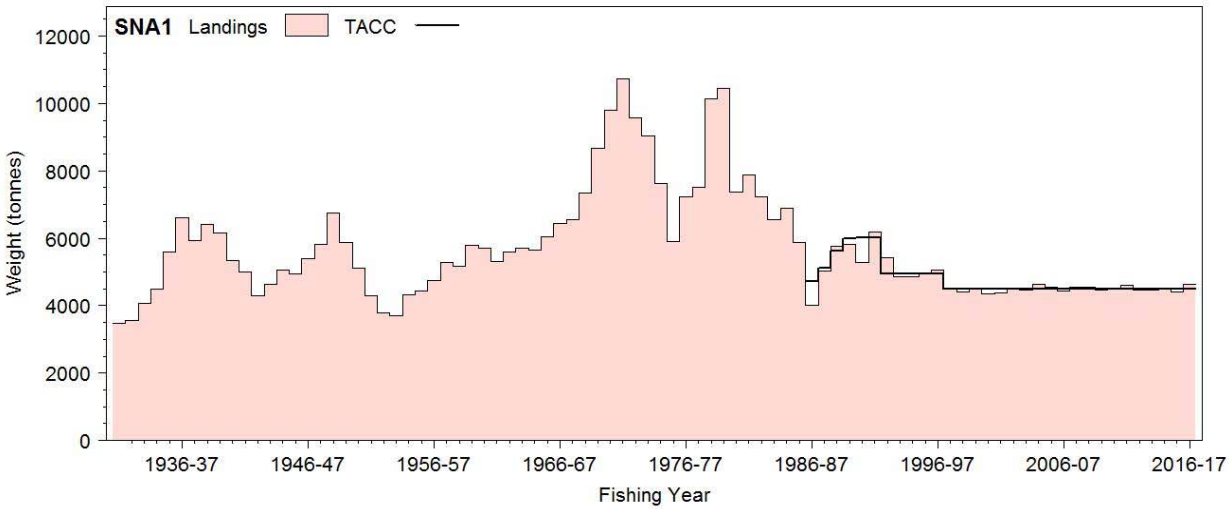

Figure 2: Reported landings of snapper in SNA 1 and TACCs to 2016–17 (Fisheries New Zealand 2018).

2. METHODS

2.1 Characterisation of recent fishery profile data for SNA 1, 2011–12 to 2015–16

A characterisation of the spatial, temporal and operational patterns in the SNA 1 fishery over the period October 2011 through to September 2016 (spanning five fishing years) was undertaken using data extracted from the Fisheries New Zealand commercial catch reporting system, to inform the design of a catch sampling programme in 2017–18.

All effort details and associated catch weights (all species including snapper) from all trips landing from SNA 1 were extracted. Data obtained from Fisheries New Zealand were groomed and checked for typical reporting errors. The data used to inform the characterisation were compiled in two tables:

1. Landed catch weight: A file containing the verified green (unprocessed) landed weight of all SNA 1 trips.
2. Trip specific data: A file containing demographic information (location, method, target species, estimated catch etc.).

Although the trip effort data table provided information on catch, these weights were based on fisher estimates rather than measured weights. The process followed was to prorate the actual trip landed weight totals across the effort information (location, method, target species) on the basis of the estimated catch ratios. The link between the two data tables was the common trip number field (trip_key).

Operational aspects such as fishery timing, gear type, target species, statistical area, fine scale spatial distribution, port of landing, and annual number of vessels and landings were summarised.

2.2 Design of SNA 1 sampling in 2017–18

The SNA 1 stock encompasses the northeast coast of New Zealand's North Island (North Cape to Cape Runaway) and for sampling purposes is divided into three stocks: East Northland, Hauraki Gulf, and Bay of Plenty (Figure 1). Although three fishing methods (bottom longline, bottom trawl and Danish seine) are important in SNA 1, to be consistent with sampling over the past three decades, only bottom longline was sampled in 2017–18. Bottom longline operates year-round with few spatial restrictions and has logistic selectivity, providing a better indication of the recruited population age structure than other methods, and most often catches proportionally more snapper overall.

Bottom longline landings from SNA 1 were stratified by stock and season (e.g., Bay of Plenty–spring). Seasonal splits were: spring (October–November), summer (December–February), autumn (March–May), and winter (June–August). September was not included in the seasonal stratification. As limited fishing occurs in September (the last month of the fishing year) its absence from the spring sampling stratum was deemed to have a minimal effect on the final results.

2.3 Sampling SNA 1 bottom longline landings

Age frequency samples were collected from the SNA 1 bottom longline fisheries using a two-stage sampling procedure, similar to that described for length sampling (West 1978). The random selection of landings and a random sample of bins within landings represent the first and second stages respectively. In previous years the sampling procedure needed to account for the grading of fish according to length and quality (within-landing strata) by taking a stratified random sample of bins within a landing (Davies et al. 1993), but this was not required in 2017–18.

The random age frequency sampling method was used for collecting otoliths from each landing by taking random otolith samples using a systematic selection interval. This involved taking a random sample of bins from each landing that was roughly proportional to the total number of bins in a landing, hence large samples were taken from large landings and small samples from small landings. A systematic selection of every tenth fish was taken from the sampled bins by counting in a continuous sequence. Unlike most other species, longline caught snapper are "soldier packed" (upright on their abdomen) in "iki" bins making the selection of exactly every 10th fish an unequivocal process. The optimum selection interval was determined from simulations using data from historical length and age samples that achieved a desired level of catch-at-age precision, a mean weighted coefficient of variation (MWCV) over all age classes of less than or equal to 20%. This range took account of the expected mean number of fish in a bin and the total number of bins in landings. Sample sizes typically ranged from 20 fish being collected from landings having a total of 15 bins, to 40 fish from landings of over 100 bins.

A total sample size of 800 otoliths was targeted from each of the East Northland and Bay of Plenty bottom longline fisheries over the entire year, with about 200 otoliths collected per season (Table 1). The East Northland stock was sub-stratified by the Statistical Areas 002 and 003 (Figure 1) to improve the precision on catch-at-age estimates (Davies & Walsh 2003). One thousand otoliths were targeted from the Hauraki Gulf bottom longline fishery with about 250 otoliths collected per season.

Sampling in 2017–18 was conducted by the fishing industry research company Trident Systems. The Trident Systems sampling approach relied predominantly on the use of Licenced Fish Receiver staff to measure fish and collect otolith samples. All fish 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.

Table 1: Level of sampling proposed to describe the SNA 1 bottom longline fishery in 2017–18 based on historical sampling for catch-at-age data that derived MWCVs below 0.20.

Stock area	Annual target number of landings (per season)	Annual target number of otoliths (per season)
East Northland (002)	20 (5)	400 (100)
East Northland (003)	20 (5)	400 (100)
Hauraki Gulf	40 (10)	1000 (250)
Bay of Plenty	40 (10)	800 (200)

2.4 Quality assurance of sampling processes

To ensure that sampling standards were maintained throughout the project, NIWA staff undertook routine random visits to Licensed Fish Receiver premises to audit the Trident Systems sampling processes. A three stage non-conformity definition (critical, major, minor) was used to review sampling and identify specific issues that might arise.

2.5 Age determination

All snapper otoliths were prepared using the break and burn technique (Chugunova 1963) and a standardised procedure for reading otoliths was followed, outlined in the age determination protocol for snapper (Walsh et al. 2014a). Four readers were used in ageing SNA 1 otolith samples in 2017–18, with reader 1 ageing all three fishery collections and readers 2 to 4 each ageing one. Each reader had no prior knowledge of each other's zone count obtained or of the fish length. For otoliths from each fishery where both readers agreed on the zone count, the age was determined from this count. When readers disagreed, the otolith was re-read together to determine the likely source of error and the count agreed upon. The forced margin method was implemented to anticipate the otolith margin type (wide, line,

narrow) *a priori* in 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 were increased by 1 year (e.g., 3W is aged as a 4 year old) and '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. 2014a).

Otolith reading precision was quantified by carrying out 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 mean coefficient of variation (CV) (Chang 1982), were calculated for each test.

2.6 Catch-at-age analysis

NIWA's catch-at-length and -age analysis software tool CALA (catch-at-length and -age, Francis & Bian 2011) was used in the calculation of proportion-at-age and variance (bootstrap) estimates for the SNA 1 bottom longline fisheries from the random age frequency samples collected from each landing. Proportions at age across all landings within a season were estimated from sample proportions, weighted by the estimated number of fish in each landing. The weighted mean proportion-at-age and variance across temporal (seasons) and spatial (East Northland only) strata for each fishery was calculated following Blackwell et al. (1999).

Calculation of mean weight-at-age was based on the following length-weight relationship: $w\,(g) = 0.04467l^{2.793}(cm)$ (Paul 1976). Mean weight-at-age estimates were calculated as a weighted mean with respect to the total number of fish estimated within each landing sampled (Walsh et al. 2006) and is directly analogous to estimating proportion catch-at-age (Davies et al. 2003). Landing-specific weight-at-age was scaled up to the season-fishery stratum and combined over all seasons (and spatial strata in East Northland). The calculation of estimates of mean length-at-age followed those procedures for estimating weight-at-age outlined in Davies et al. (2003).

Proportions-at-age, mean length-at-age, and derived mean weight-at-age were calculated for the range of fishing year age classes (herein referred to as "age classes"). The maximum age was a plus group, being an aggregate of all age classes over 29 years, which were assigned an age of 30.

Random age frequency data were collected primarily to derive catch-at-age estimates. However, it can be assumed that fish sampled randomly for age were also random observations from within each length interval. Consequently, age-length keys could be derived from the random age frequency otolith samples. However, fish in the larger length classes, collected by the random age frequency method, were infrequently sampled and are likely to be poorly described in the age-length key. Age-length keys are assumed to be representative of the seasonal strata of the samples, that being the entire year, and may not be directly comparable to collections in years when only spring and summer were usually sampled. The main assumption that must 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). Age-length keys are included to give the reader an appreciation of the age-at-length differences between the stocks.

Snapper age data were stored on the Fisheries New Zealand *age* database, and landing details on the *market* database, administered by NIWA.

3. RESULTS

3.1 Updated fishery characterisation 2013–14 to 2017–18

An updated characterisation of the SNA 1 fisheries (East Northland, Hauraki Gulf, Bay of Plenty) spanning the 2013–14 to 2017–18 fishing years was conducted to provide a comparison of the recent catch with that of the catch sampling programme in 2017–18 (Figures 3a–c). In 2017–18, Bay of Plenty contributed 40% (1759 t) of the overall SNA 1 catch, East Northland 35% (1502 t) and Hauraki Gulf 25% (1072 t). The most significant spatial change in the SNA 1 catch over the last five years occurred for the Hauraki Gulf and Bay of Plenty stocks which represented 38% (1682 t) and 35% (1542 t) of the annual catch respectively in 2013–14.

The bottom longline catch from East Northland increased significantly in 2017–18 to 881 t and was by far the most dominant method, accounting for 59% of the catch (Figure 3a). A new trawl method (Modular Harvest System, MHS) recently became operational in the SNA 1 fishery (replacing fishing effort of conventional bottom trawl) and in 2017–18 accounted for the second largest method catch (334 t) in East Northland.

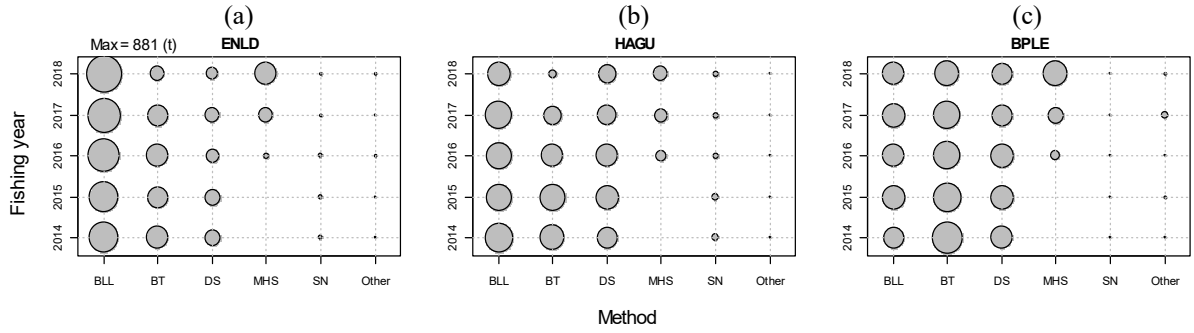

Figure 3: Catch of snapper in SNA 1 stocks by gear type from fishing years 2013–14 to 2017–18. ((a) ENLD, East Northland; (b) HAGU, Hauraki Gulf; (c) BPLE, Bay of Plenty; BLL, Bottom longline; BT, Bottom trawl; DS, Danish seine; MHS, Modular Harvest System; SN, Set net).

Despite a significant decline in the bottom longline catch of snapper from the Hauraki Gulf in 2017–18, longline remained the most dominant method with a 43% share (462 t) of the total fishing year catch, with Danish seine second largest, landing 315 t (Figure 3b). The catch by bottom trawl has declined to its lowest estimate (72 t) in decades, partially substituted by the recent inclusion of Modular Harvest System which caught 189 t.

In 2017–18, four main methods were used in the Bay of Plenty snapper fishery, the catches from Modular Harvest System (501 t) and bottom trawl (479 t), slightly larger than those from bottom longline (404 t) and Danish seine (354 t) (Figure 3c). Aside from the recent introduction of Modular Harvest System, all other methods showed a consistent annual pattern in the volume of snapper taken in the Bay of Plenty over the past five years.

3.2 Relative SNA 1 catch by bottom longline

From 2013–14 to 2017–18, bottom longline operated across seven main statistical areas (002–003 and 005–009) (Figures 4a–c). The catch from Statistical Area 003 in East Northland has consistently been the largest over the five fishing years, with the 2017–18 estimate the largest overall at 481 t followed closely by Statistical Area 002 at 396 t, also in East Northland (Figure 4a).

A significant decline in the bottom longline catch over time was apparent in central Hauraki Gulf (Statistical Area 006) with the 2017–18 estimate (123 t) the lowest across all three Statistical Areas within the Gulf, and less than half of that caught in 2013–14 (Figure 4b). In contrast, the catch of

snapper from central Bay of Plenty (Statistical Area 009) in 2017–18 increased twofold over the same period (Figure 4c).

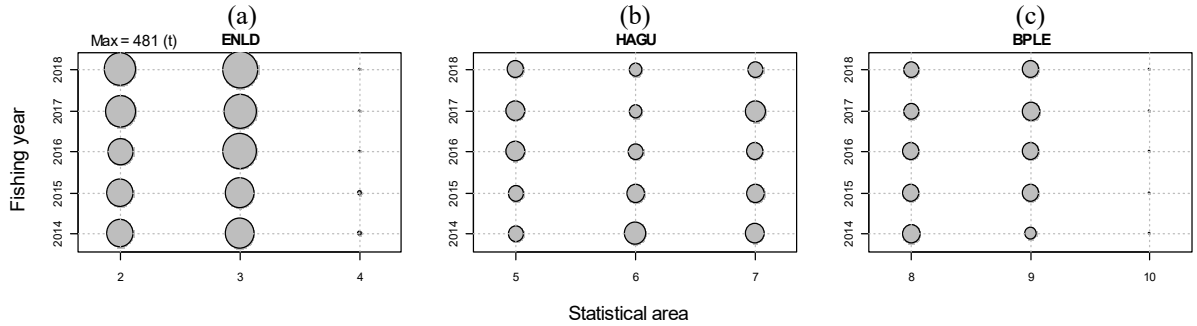

Figure 4: Bottom longline catch of snapper in SNA 1 stocks by statistical area from fishing years 2013–14 to 2017–18 ((a) ENLD, East Northland; (b) HAGU, Hauraki Gulf; (c) BPLE, Bay of Plenty).

The monthly pattern of bottom longline catches was generally consistent over the 5 year period within each stock (Figures 5a–c). Bottom longline from East Northland tends to operate year round with fairly uniform monthly catches throughout, while the largest volumes in the Hauraki Gulf fishery occur during October to January, and the smallest in the Bay of Plenty, around December through to January (Figures 5a–c).

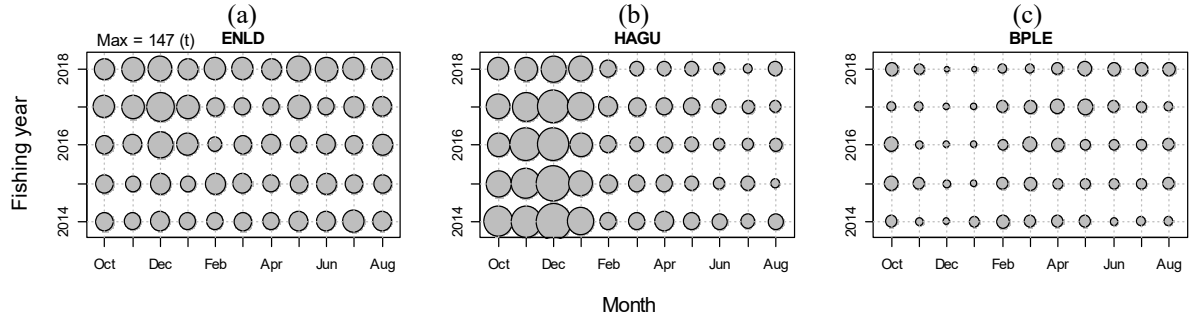

Figure 5: Bottom longline catch of snapper in SNA 1 stocks by month from fishing years 2013–14 to 2017–18 ((a) ENLD, East Northland; (b) HAGU, Hauraki Gulf; (c) BPLE, Bay of Plenty).

3.3 Sampling the SNA 1 bottom longline fishery in 2017–18

Quality assurance of sampling processes

In 2017–18, 21 auditing events were conducted across four separate Licenced Fish Receivers with over 62 individual roles audited. Although there were only four outright audit fails, the frequency of inconsistencies and non-conformities identified during audits did not substantively diminish during the course of the programme, which is in part due to a high turn-over of samplers in some Licenced Fish Receivers. All audit-identified issues were appropriately dealt with by Trident Systems, however, the degree to which sampling irregularities affected the integrity of the data, prior to being identified by audit, is unknown, but is unlikely to be a significant source of variability or bias.

Sample collections

Summaries of the bottom longline sample sizes for stock-season strata are given in Table 2, and summaries of the otolith sample collections, in Table 3. A total of 120 bottom longline landings were sampled from SNA 1 in 2017–18, with 3157 snapper selected randomly for age information. In all, 26 vessels from a fleet of about 37 were sampled and collectively contributed to 92% of the total longline catch. Proportional sampling across the fleet relative to catch was, however, at times sub-optimal. For example, one bottom longline vessel operating in the Hauraki Gulf and another in the Bay of Plenty, accounted for 33% of sampled landings by number (13 of 40 each), and 67% and 42% respectively of the sampled landings by weight. These vessels contributed to less than half these percentages of both the catches and numbers of landings from these areas.

While sample sizes for targeted number of landings were achieved across the SNA 1 stocks, otolith sample sizes exceeded the annual targets by as much 14.5% (Hauraki Gulf) to 26.9% (Bay of Plenty), mainly due to an increase in the average landing size of snapper across SNA 1.

Table 2: Summary of the catch (total number and weight of landings) and samples (number of landings and weight sampled, and number of fish sampled for otoliths) in stock–season strata for the SNA 1 bottom longline fisheries from spring 2017 to winter 2018. ENLD data presented for Statistical Areas 002, 003 and combined.

		Number of landings			No. of fish	Weight of landings (t)		
Substock*	Season	Total	Sampled	% of total	sampled	Total	Sampled	% of total
ENLD	Spring	169	5	3.0	107	80	2	2.5
(002)	Summer	200	5	2.5	130	98	3	3.1
	Autumn	210	5	2.4	125	103	4	3.9
	Winter	194	5	2.6	116	93	3	3.2
ENLD	Spring	109	5	4.6	129	62	3	4.8
(003)	Summer	162	5	3.1	130	121	3	2.5
	Autumn	195	5	2.6	141	126	4	3.2
	Winter	218	5	2.3	116	139	3	2.2
ENLD	Spring	274	10	3.6	234	142	5	3.5
(comb.)	Summer	357	10	2.8	259	219	7	3.2
	Autumn	396	10	2.5	265	229	8	3.5
	Winter	402	10	2.5	232	232	6	2.6
HAGU	Spring	157	10	6.4	282	123	17	13.8
	Summer	199	10	5.0	280	188	10	5.3
	Autumn	92	10	10.9	269	74	9	12.2
	Winter	70	10	14.3	315	56	16	28.6
BPLE	Spring	134	10	7.5	250	76	7	9.2
	Summer	93	9	9.7	221	47	4	8.5
	Autumn	179	11	6.1	306	127	9	7.1
	Winter	236	10	4.2	240	136	5	3.7

* ENLD, East Northland; HAGU, Hauraki Gulf; BPLE, Bay of Plenty.

Table 3: Details of snapper otolith samples collected in 2017–18 from the stock areas of SNA 1 (Note: ENLD data presented for Statistical Areas 002, 003, and both combined).

Substock*	Method†	Sampling period	Sampling method††	Length range (cm)	Otoliths
ENLD (002)	BLL	Spring-winter	R	25–84	478
ENLD (003)	BLL	Spring-winter	R	25–66	516
ENLD (comb.)	BLL	Spring-winter	R	25–84	994
HAGU	BLL	Spring-winter	R	24–68	1 146
BPLE	BLL	Spring-winter	R	25–65	1 017

* ENLD, East Northland; HAGU, Hauraki Gulf; BPLE, Bay of Plenty.

† BLL, bottom longline.

†† R, random sample.

Representativeness

The weight and number of landings sampled throughout the 2017–18 fishing year was relatively representative of temporal catch trends of each stock (Figures 6–8).

East Northland accounted for half (50%) the 2017–18 SNA 1 longline catch. The operation of the East Northland fishery was relatively consistent over the sampling period with slightly more weight of snapper caught from late spring to early summer and late autumn to early winter (Figure 6). The temporal spread of sampled landings was generally evenly distributed and proportional to the fishery over all months with the exception of December, the month with the second largest catch, but represented by only one sampled landing. The sampled catch accounted for 3% by weight and 3% by number of landings of the total bottom longline catch in East Northland. The average landing size selected for sampling (623 kg) was marginally larger than the average landing in the fishery (575 kg).

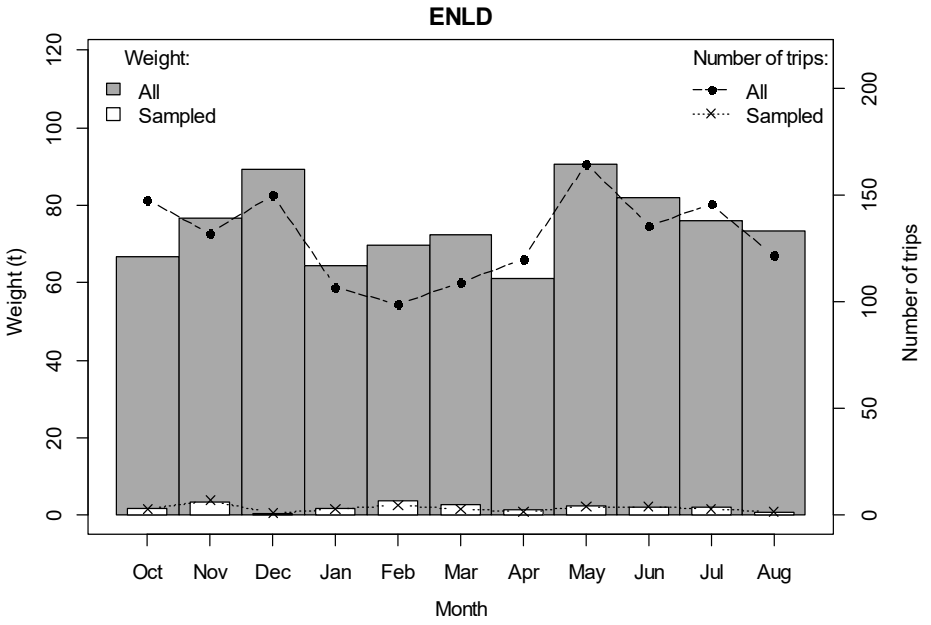

Figure 6: Comparison of the monthly distribution of landed weight (grey bars) and numbers of landings (dashed line) of snapper in the East Northland bottom longline fishery for all landings where snapper was caught for the period October to August 2017–18. Included are corresponding estimates for all sampled landings (white bars and dotted line) to show representativeness of collections.

Hauraki Gulf landings accounted for 27% of the overall SNA 1 bottom longline catch in 2017–18. A higher proportion of the Hauraki Gulf catch was taken during the first four months of the fishing year than during the remaining 7 months (Figure 7). Although the temporal spread of sampled landings in the Hauraki Gulf showed some disproportionality, all months of the sampling period were represented (Figure 7). The sampled catch accounted for 12% by weight and 8% by number of landings of the total bottom longline catch in the Hauraki Gulf. The average landing size selected for sampling (1304 kg) was considerably larger than the average landing in the fishery (851 kg).

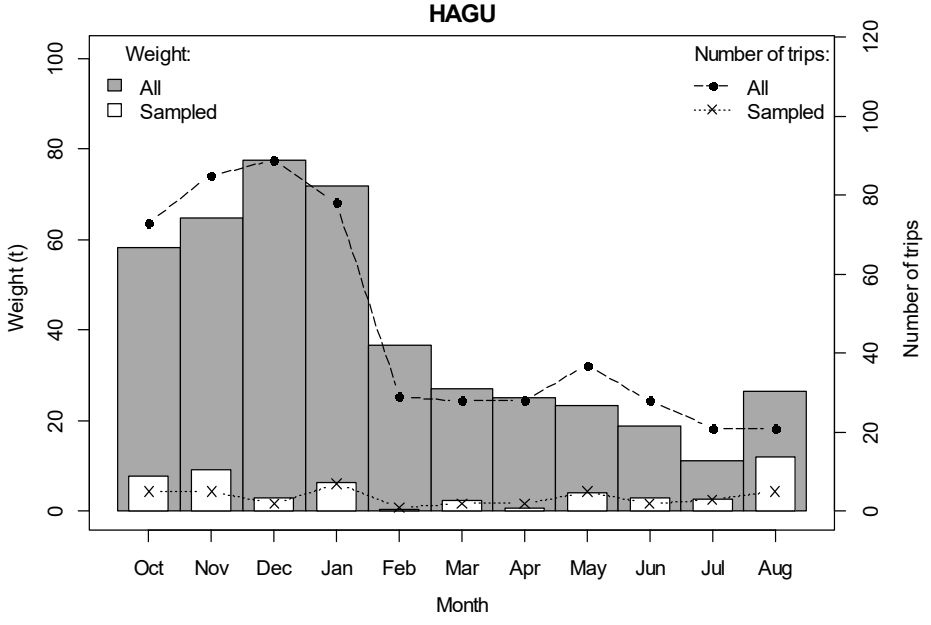

Figure 7: Comparison of the monthly distribution of landed weight (grey bars) and numbers of landings (dashed line) of snapper in the Hauraki Gulf bottom longline fishery for all landings where snapper was caught for the period October to August 2017–18. Included are corresponding estimates for all sampled landings (white bars and dotted line) to show representativeness of collections.

Bay of Plenty landings accounted for 23% of the overall SNA 1 bottom longline catch in 2017–18. Bottom longline volumes were lowest in summer and highest during late autumn and winter (Figure 8). Although the temporal spread of sampled landings in the fishery appears disproportionate to the fishery, each month is represented by at least two or more landings (Figure 8). The sampled catch accounted for 6% by weight and 6% by number of landings of the total bottom longline catch in the Bay of Plenty. The average landing size selected for sampling (621 kg) was marginally larger than the average landing in the fishery (601 kg).

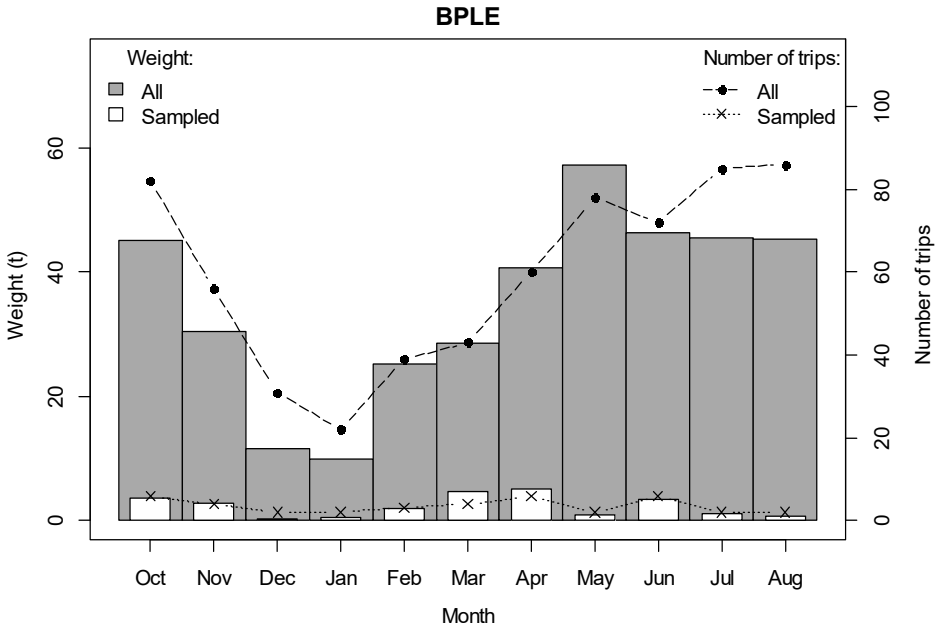

Figure 8: Comparison of the monthly distribution of landed weight (grey bars) and numbers of landings (dashed line) of snapper in the Bay of Plenty bottom longline fishery for all landings where snapper was caught for the period October to August 2017–18. Included are corresponding estimates for all sampled landings (white bars and dotted line) to show representativeness of collections.

The sampling performance relative to the cumulative proportion of the total number (left) and catch weight (right) of landings throughout the sampling period is illustrated in Figure 9. Sampling appears well distributed in proportion to, and representative of, the bottom longline fisheries in SNA 1.

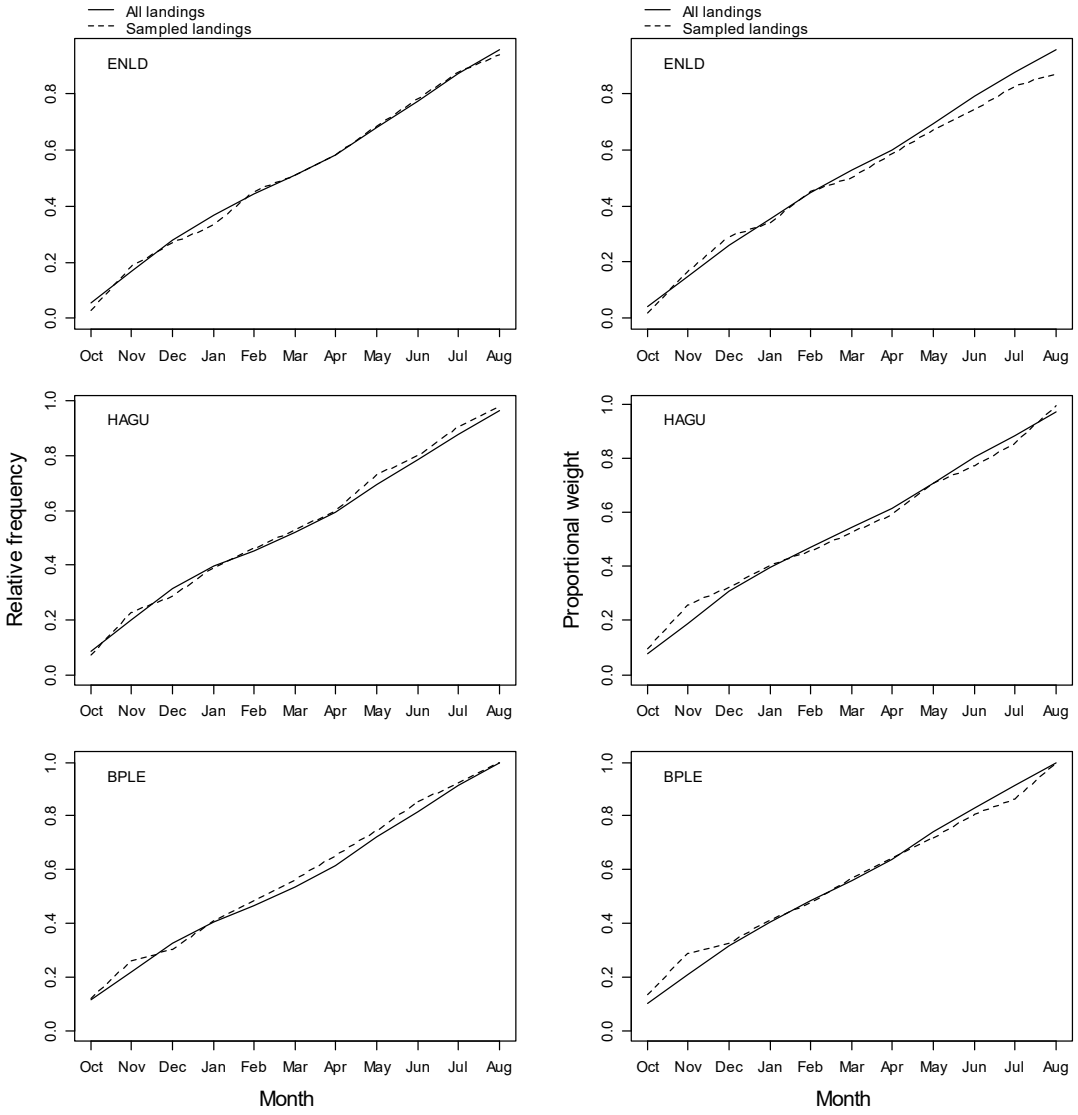

Figure 9: Comparison of the cumulative proportion of the number of landings (left column) and catch weight of landings (right column) with cumulative proportions of samples taken from the SNA 1 stock bottom longline fisheries in 2017–18. ENLD, East Northland; HAGU, Hauraki Gulf; BPLE, Bay of Plenty.

Spatial comparisons (0.1 degree blocks) of the SNA 1 bottom longline fishery catch and sampled catch for 2017–18 are presented in Figure 10 and by Statistical Area in Figure 11.

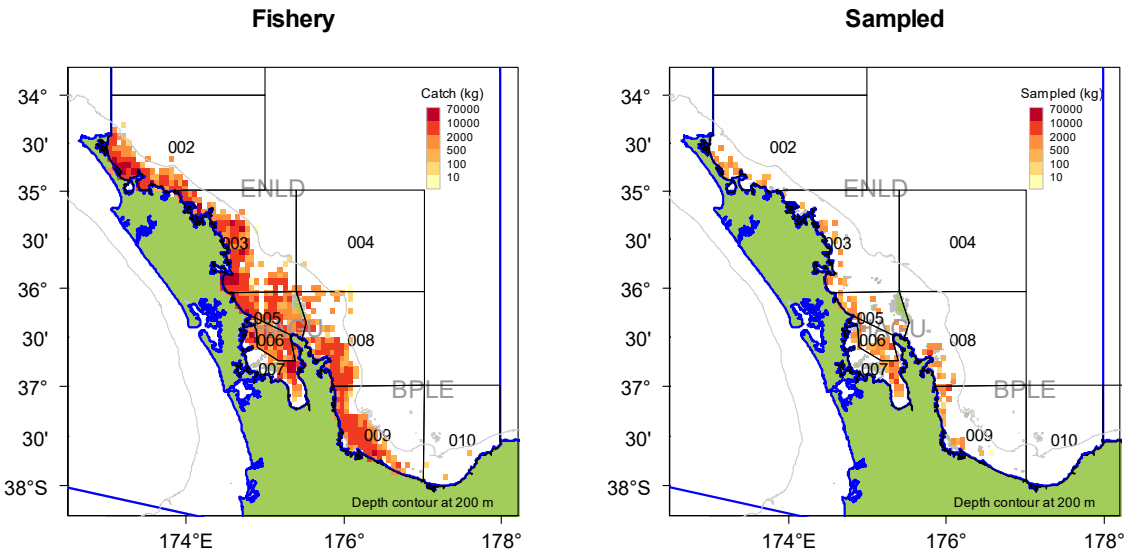

Figure 10: Comparison of the spatial distribution of the bottom longline catch and the sampled component for the SNA 1 stocks in 2017–18.

Almost the entire bottom longline catch (99.6%) in 2017–18 was taken from the coastal regions between North Cape and the Tarawera river entrance, west of Whakatane (Statistical Areas 002–003 and 005–009; Figures 10 and 11). Sampling was broadly representative of SNA 1 Statistical Area catch (Figure 11).

Although the SNA 1 longline catch in 2017–18 was taken targeting five species, snapper targeting accounted for 97% of the total catch (Figure 11). Sampling in relation to target species was representative.

Aside from slight under and over sampling issues within the Hauraki Gulf and Bay of Plenty statistical areas, the proportionality of the sampled component to that of the fishery suggests that the sampled landings, by and large, were representative of the operation of the SNA 1 bottom longline fleet as a whole (Figure 11).

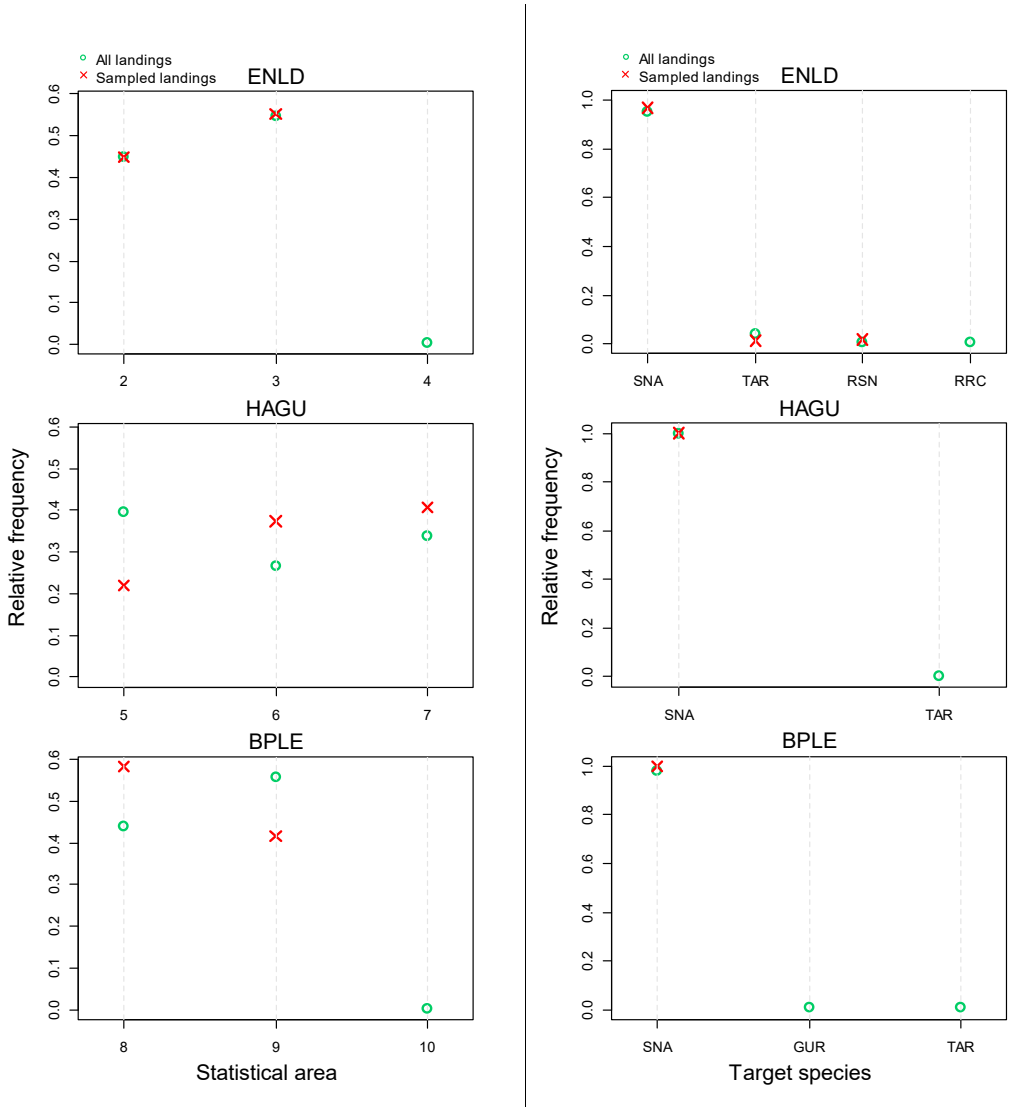

Figure 11: Comparison of the proportional distribution of the estimated bottom longline catch and the sampled component by statistical area (left column) and target species (right column) over the sampling period for the SNA 1 stocks in 2017–18.

3.4 Snapper otolith readings: reader comparison tests for reference readings

To assess reader competency in ageing snapper otoliths in 2017–18, each of the four 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. 2014a). All readers achieved CV and IAPE scores below the targets (Table 4).

Table 4: **Reader comparison scores determined from ageing 50 randomly selected snapper reference otolith samples ranging in age from 2 to 47 years.**

	IAPE	CV	Agreed age	Pass/Fail
Target	1.50%	2.12%	–	–
Reader 1	0.39%	0.55%	86%	Pass (1st attempt)
Reader 2	0.97%	1.37%	76%	Pass (1st attempt)
Reader 3	1.09%	1.54%	81%	Pass (3rd attempt)
Reader 4	1.31%	1.85%	64%	Pass (2nd attempt)

3.5 Reader comparison tests for SNA 1 readings

Of the total 3157 otolith samples collected from the SNA 1 stocks in 2017–18, all but 7 samples (due to incorrect length, no length or no otoliths) were successfully aged by four readers, reader 1 reading all stock samples and readers 2 to 4, each reading a single stock sample. Between-reader tests, based on graphical comparisons, are given in Figures 12–14, and depict a reasonable level of consistency between readers. The overall percentage agreement between readers was 88% for East Northland, 84% for Hauraki Gulf and 80% for the Bay of Plenty, with only minor systematic differences (bias) in first counts of snapper otoliths between the readers. The slight positive weighting of the histograms, the relative clustering of plotted points about the zero lines, and the slight deviation from the one-to-one line on the age-bias plots (Figures 12 to 14(a–c)) indicate that readers 2, 3 and 4, at times, underestimated age, particularly for older fish. On a handful of occasions, the age for three year old snapper was overestimated by readers 3 and 4. The between-reader CVs ranged from 0.91 to 1.96% and IAPE ranged from 0.64 to 1.39% (Figures 12–14(c)) and the profiles show that precision varied across age classes in all stock collections, being lowest for East Northland and highest for the Bay of Plenty (Figures 12–14(d)). Comparisons of the age-bias plots for all four readers with the agreed age indicate that reader 1 showed a high level of precision and consistency in estimating age with CV and IAPE estimates less than 0.09% (Figures 12–14(e)). For readers 2 to 4, precision was slightly lower, with CVs and IAPEs almost identical to the between-reader estimates (Figures 12–14(c)), ranging from 0.81 to 1.96% (CV) and 0.57 to 1.39% (IAPE) (Figures 12–14(f)).

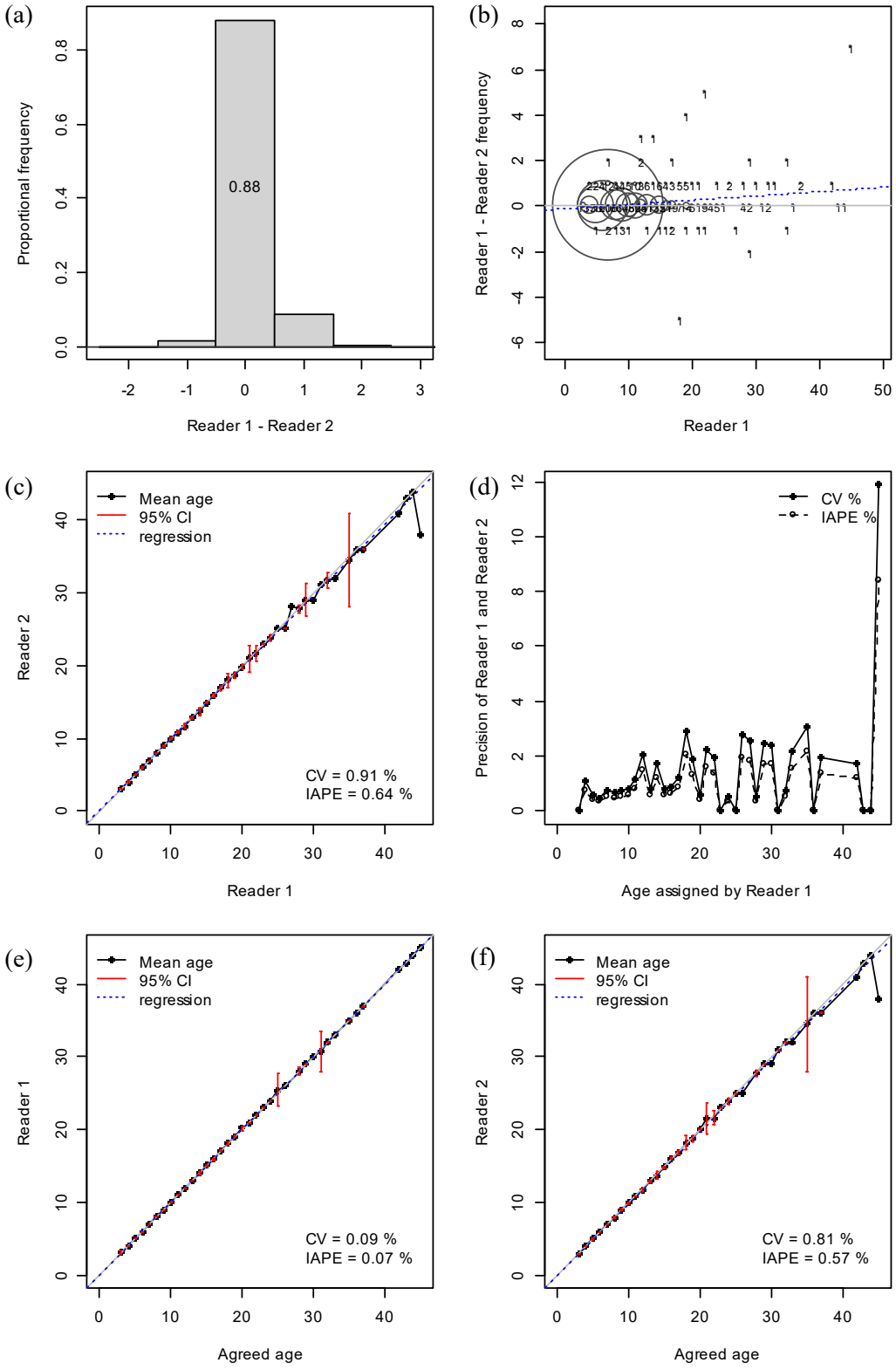

Figure 12: Results of between-reader comparison test (reader 1 and 2) for East Northland otoliths collected in 2017–18 (n = 990): (a) histogram of differences between readings for the same otolith; (b) differences between readers for a given age assigned by reader 1; (c) bias plot between readers; (d) CV and IAPE profiles (precision) relative to the age assigned by reader 1; (e) bias plot between reader 1 ((f) reader 2) and agreed age. The expected one-to-one (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).

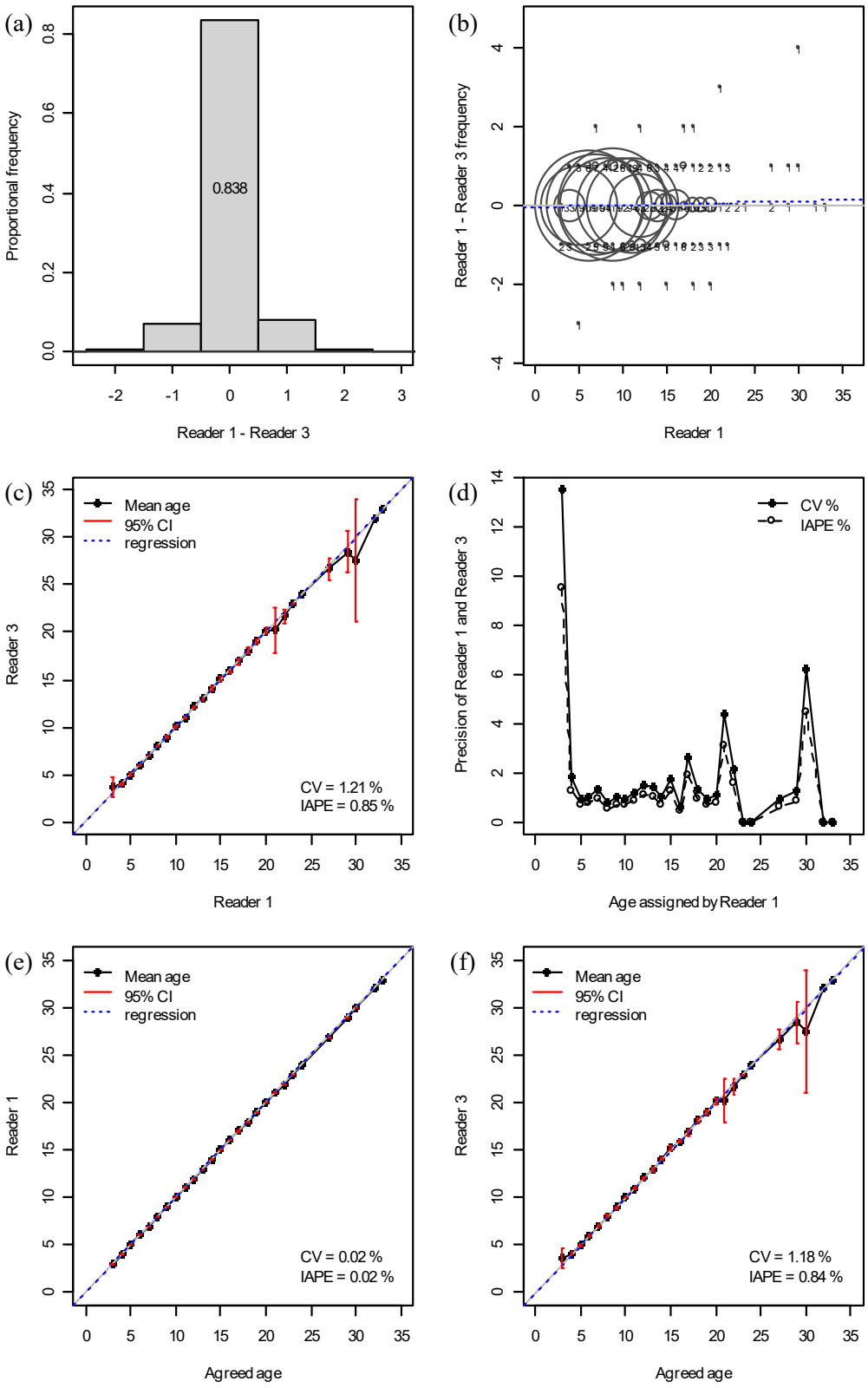

Figure 13: Results of between-reader comparison test (reader 1 and 3) for Hauraki Gulf otoliths collected in 2017–18 (*n* = 1145): (a) histogram of differences between readings for the same otolith; (b) differences between readers for a given age assigned by reader 1; (c) bias plot between readers; (d) CV and IAPE profiles (precision) relative to the age assigned by reader 1; (e) bias plot between reader 1 ((f) reader 3) and agreed age. The expected one-to-one (solid line) and actual relationship (dashed line) between readers are overlaid on (b) and (c), and between reader 1 and 3 and the agreed age on (e) and (f).

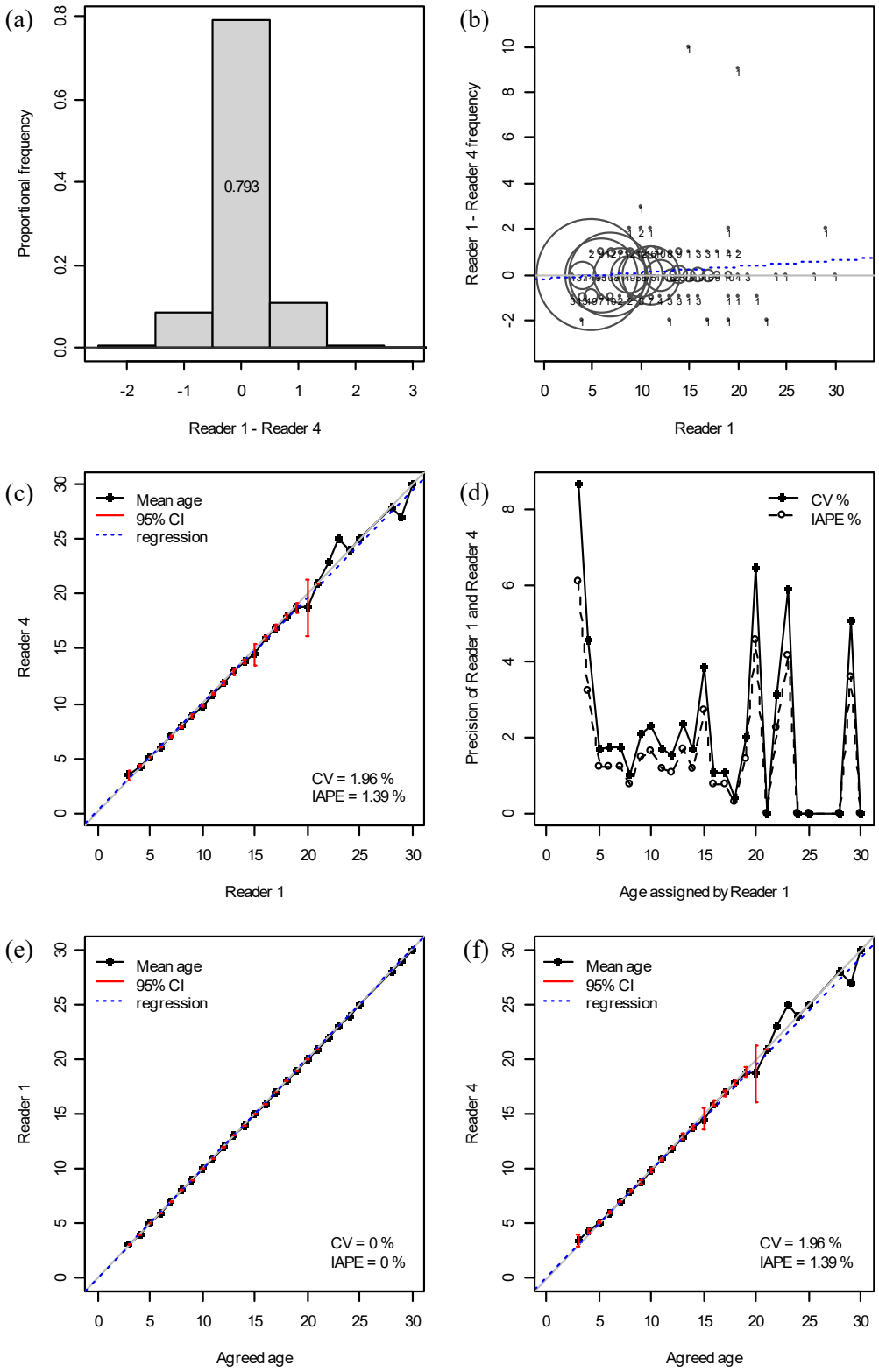

Figure 14: Results of between-reader comparison test (reader 1 and 4) for Bay of Plenty otoliths collected in 2017–18 (*n* = 1015): (a) histogram of differences between readings for the same otolith; (b) differences between readers for a given age assigned by reader 1; (c) bias plot between readers; (d) CV and IAPE profiles (precision) relative to the age assigned by reader 1; (e) bias plot between reader 1 ((f) reader 4) and agreed age. The expected one-to-one (solid line) and actual relationship (dashed line) between readers are overlaid on (b) and (c), and between reader 1 and 4 and the agreed age on (e) and (f).

3.6 SNA 1 bottom longline catch-at-age estimates

Catch-at-age compositions (sampled using the random age frequency sampling approach) with bootstrap variance estimates were derived for each stock and season, and then combined over all seasons (spring to winter) to produce annual compositions (Figure 15). Age distributions are used to compare differences in the age structure of each stock and season stratum and to gauge relative year class strengths (Figures 15 and 16, Appendix 1).

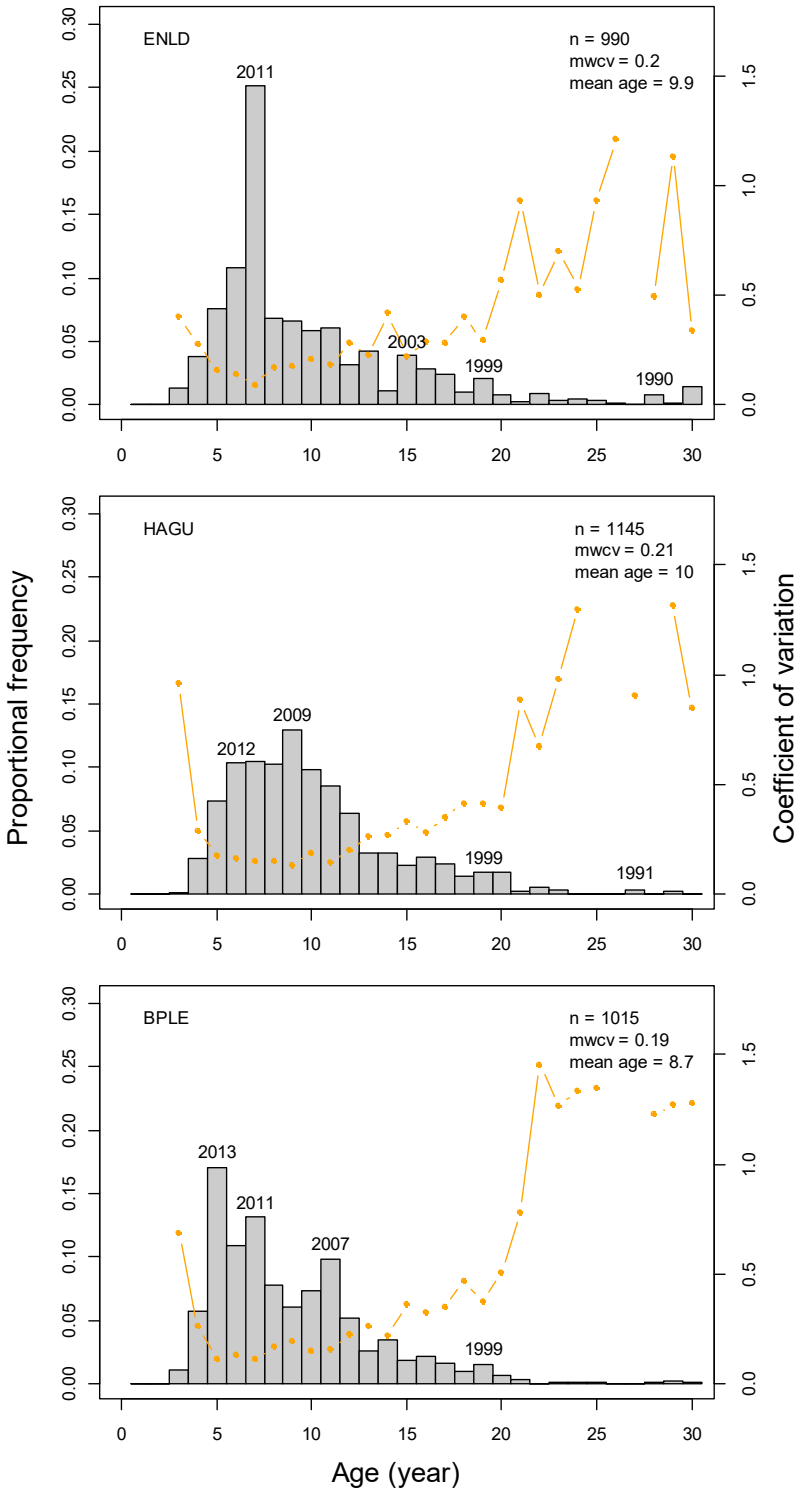

Figure 15: Proportion at age distributions (histograms) and CVs (lines) determined from snapper landings sampled from the three SNA 1 stock bottom longline fisheries in 2017–18 (ENLD, East Northland; HAGU, Hauraki Gulf; BPLE, Bay of Plenty; *n*, sample size; MWCV, mean weighted CV).

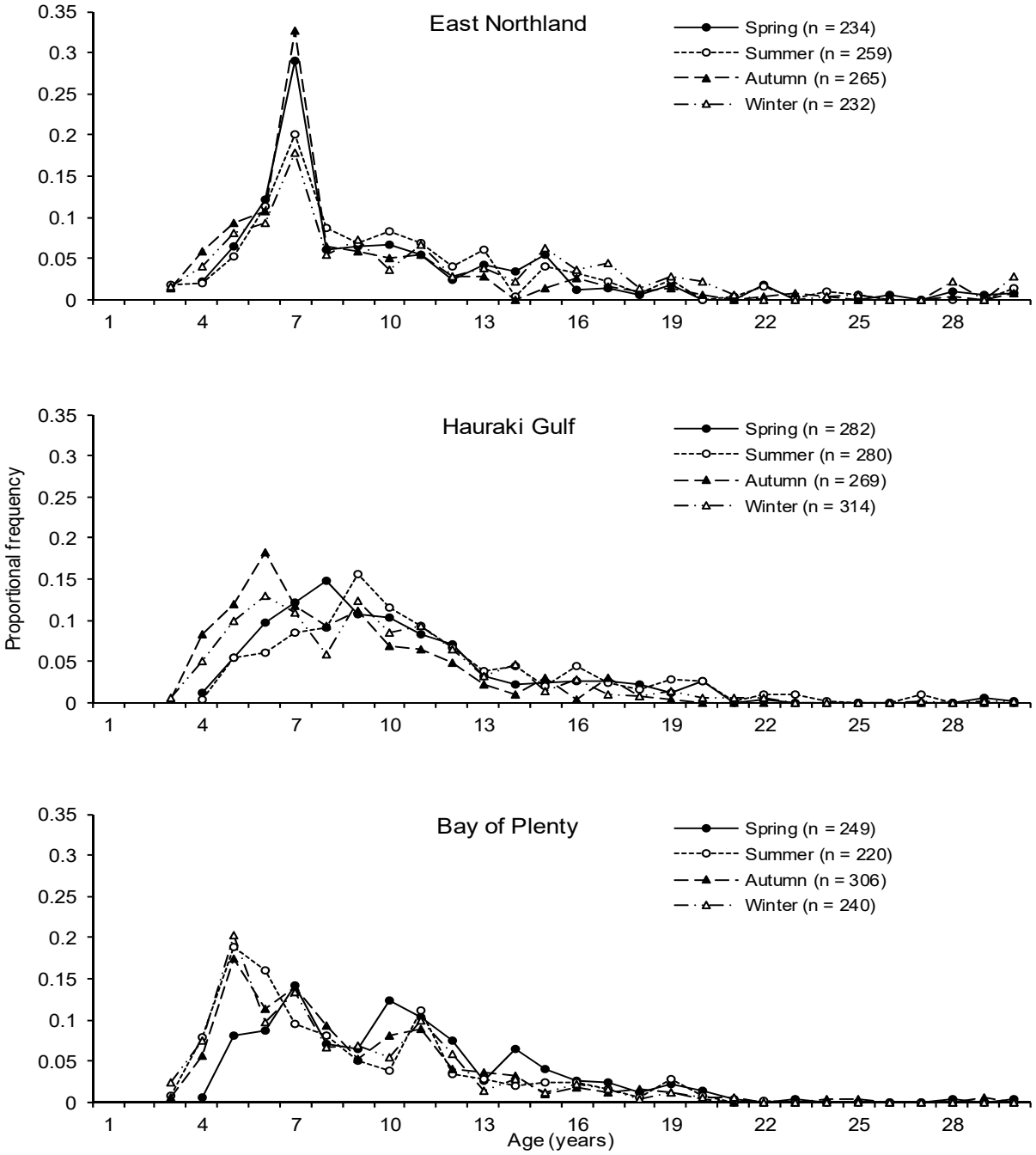

Figure 16: Proportion-at-age by season for SNA 1 bottom longline landings in 2017–18 (*n*, sample size).

Relative proportions-at-age for the spring-summer combined season are compared with those from the year-round sampling in Figure 17. Results of the catch-at-age for each stock are described below (Sections 3.7 to 3.9).

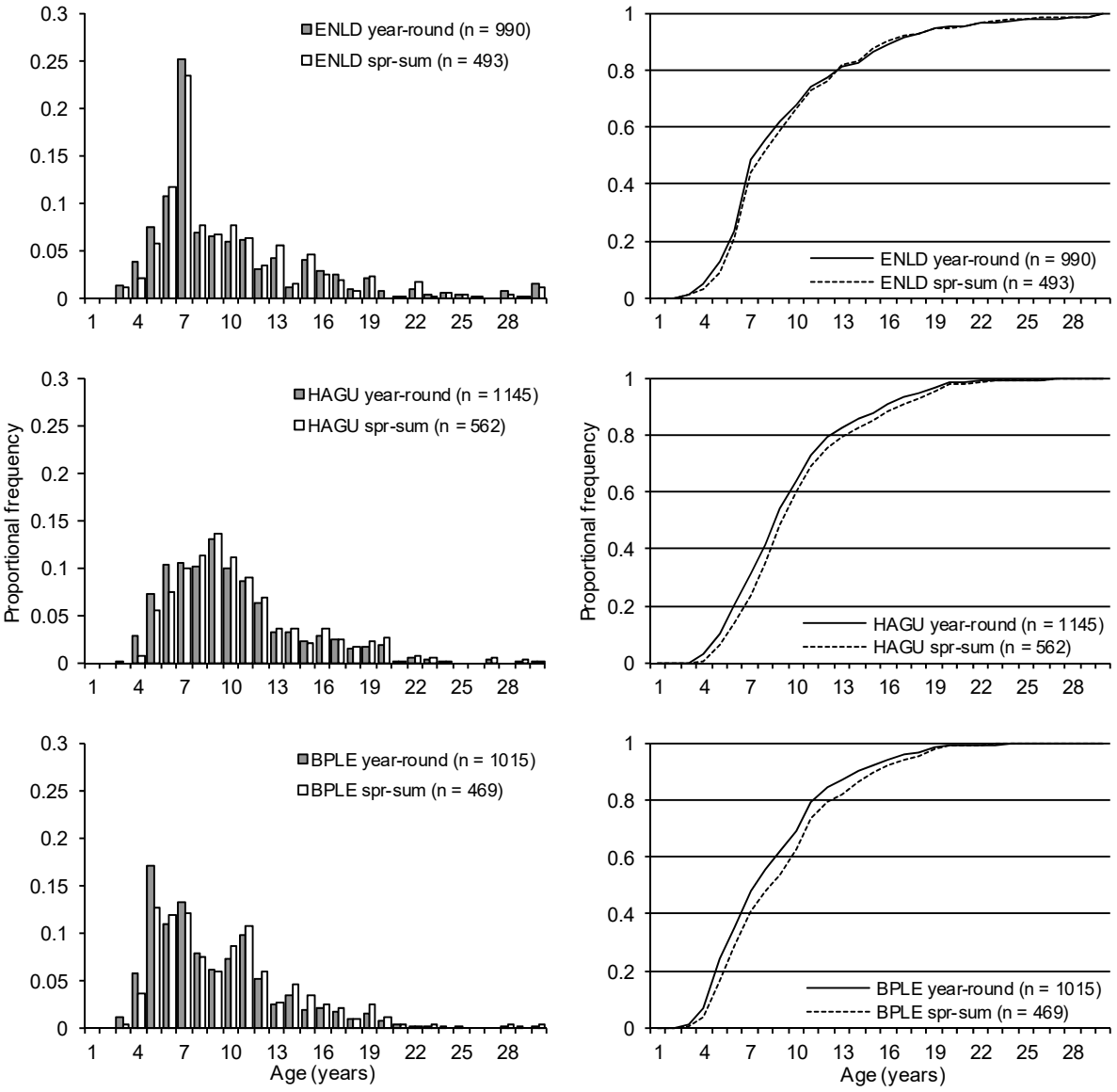

Figure 17: Comparison of the proportion and cumulative proportion at age distributions determined from snapper landings sampled over the spring and summer combined, and year-round seasons from the three SNA 1 stock bottom longline fisheries in 2017–18 (ENLD, East Northland; HAGU, Hauraki Gulf; BPLE, Bay of Plenty; *n*, sample size).

3.7 East Northland

The East Northland bottom longline age distribution in 2017–18 consisted mainly of young to moderate aged fish: those 3 to 13 years of age collectively made up over 80% of the landed catch by number (Figure 15, see Appendix 1). Nevertheless, there was representation across almost all recruited age classes up to 30 or more years, those fish 20 years and older accounting for 5% of the landed catch, the highest proportion in SNA 1. The oldest fish sampled from the fishery during 2017–18 was 45 years (Appendix 2). The 2011 year class (7-year-olds) was dominant, accounting for 25% of all snapper in East Northland landings in 2017–18, and was at least twice that of all other year classes present. Other year classes that stood out in the right-limb of the distribution were 2003, 1999, and 1990 (15-, 19- and 28-year-olds). Only those age classes over 8 years of age in East Northland are considered fully recruited (here we consider fish > 27 cm as fully recruited), because fish in the 25–27 cm length interval were infrequent in the catch (see age-length key, Appendix 3). The mean age of the East Northland distribution was 9.9 years and the MWCV was 0.20.

In 2017–18, East Northland longline catch-at-age samples showed reasonable seasonal consistency in the relative strengths of the common age classes (Figures 16 and 17). Winter samples contained proportionally more old fish (over 10 years) than other seasons and spring and autumn the highest numbers from the dominant age class, 7-year-olds. The seasonal differences seen in the relative year class strengths for the 2014 and 2013 year classes (4- to 5-year-olds) between spring and summer, and autumn and winter, is likely to be due to the recruitment of these small young fish into the fishery later in the year (Figures 16 and 17).

3.8 Hauraki Gulf

The Hauraki Gulf bottom longline age distribution in 2017–18 consisted mainly of young to moderate aged fish with reasonable representation in age classes up to 20 years (Figure 15, see Appendix 1). The oldest fish sampled during 2017–18 was 33 years (Appendix 2). Collectively, the 2013–2006 year classes (5- to 12-year-olds) made up over 75% of the landed catch by number in 2017–18, the 2009 year class (9-year-olds) marginally the most prominent at 13%, while those fish over 20 years contributed to only 2%. Only those age classes over 13 years of age can be considered fully recruited to the fishery as they no longer contain a noticeable proportion of fish in the 25–27 cm length intervals (see age-length key, Appendix 3). The mean age of snapper in the Hauraki Gulf fishery was 10.0 years, the second highest ever recorded estimate for the stock, and the MWCV was 0.21.

The 2017–18 Hauraki Gulf longline catch-at-age samples showed some seasonal consistency in the relative strengths of some common age classes, while variations in proportions were evident for others i.e., 5-, 6-, 8-, 14- and 16-year-olds (Figures 16 and 17). Summer samples contained proportionally more old fish (over 10 years) than all other seasons, and autumn and winter were the only seasons to include 3-year-olds. The seasonal differences seen in the relative year class strengths for the 2014 to 2012 year classes (4- to 6-year-olds) between spring and summer, and autumn and winter, is likely to be due to the recruitment of these small young fish into the fishery later in the year (Figures 16 and 17).

3.9 Bay of Plenty

The Bay of Plenty bottom longline age distribution in 2017–18 consisted mainly of young to moderate aged fish between 4 and 12 years, collectively making up 83% of the number of snapper landed (Figure 15, see Appendix 1). The oldest fish sampled during 2017–18 was 30 years (Appendix 2). The 2013 year class (5-year-olds) was the most dominant year class in the fishery accounting for 17% of the longline catch by number, followed closely by the 2011 year class (7-year-olds) with 13%. Collectively, those fish 7 years of age and younger made up almost half (48%) the Bay of Plenty catch in 2017–18, the highest proportion of young fish in SNA 1. Although representation in the age distribution up to 19 years of age was reasonable, the combined total for fish over 20 years made up less than 1% of the landed catch, the lowest estimate in SNA 1. Only age classes greater than 7 years of age appear fully recruited to the fishery, as they no longer contain a proportion of fish in the 25–27 cm length intervals (see age-length key, Appendix 3). The mean age of snapper in the Bay of Plenty fishery was 8.7 years, marginally the highest ever recorded estimate for the stock, and the MWCV was 0.19.

Spring samples from the Bay of Plenty contained proportionally more old fish than other seasons (Figures 16 and 17). The seasonal differences seen in the relative year class strengths for the 2014 to 2013 year classes (4- and 5-year-olds) between spring the other seasons is likely to be due to the recruitment of these small young fish into the fishery later in the year (Figures 16 and 17).

3.10 SNA 1 stock comparisons

Marked differences in year class strength were evident between the three regions in the 2017–18 SNA 1 bottom longline catch-at-age data. For example, the 2011 year class was strong in East Northland, 2009 strong in Hauraki Gulf and 2007 strong in the Bay of Plenty, but were not as evident in the other two stocks (Figures 15 to 17).

3.11 Mean length-at-age and mean weight-at-age estimates

A trend of increasing mean length-at-age and mean weight-at-age over successive age classes up to around 20 years of age was generally evident in year-round data collected from the East Northland and Bay of Plenty snapper longline fisheries in 2017–18, while that for Hauraki Gulf tended to fluctuate for fish over 12 years of age (Figure 18, Appendices 4 and 5). Few differences were apparent between East Northland and Bay of Plenty stocks for age classes 3–20 years, both sharing the highest estimates in SNA 1, on average about 20% heavier and 8% longer than Hauraki Gulf snapper (Figure 18, Appendices 4 and 5).

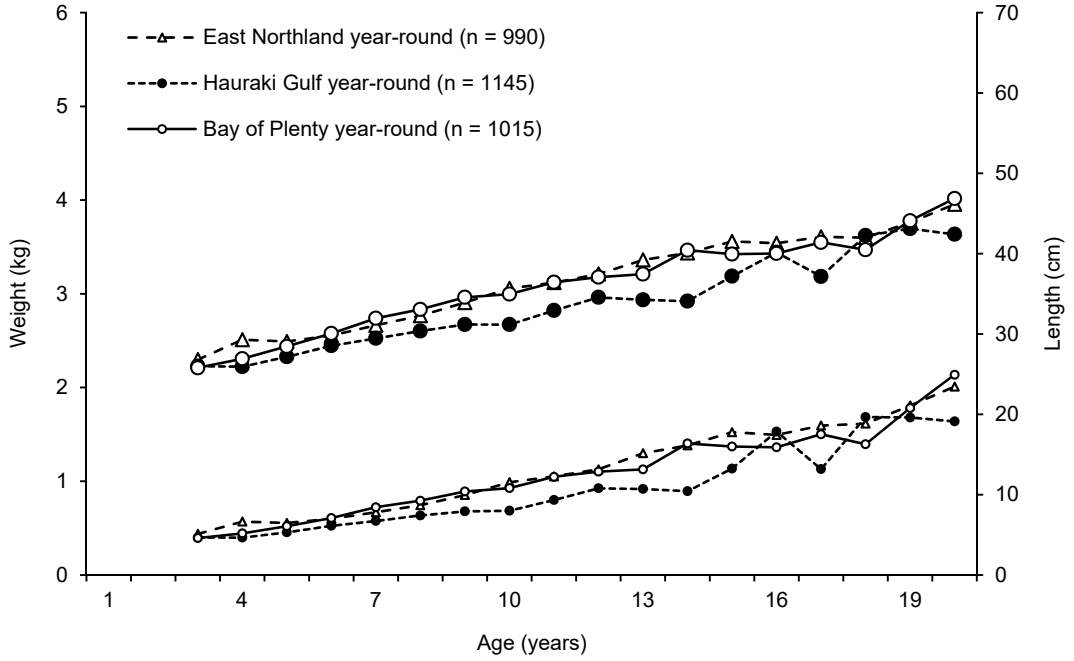

Figure 18: Observed mean length-at-age (large symbols) and mean weight-at-age (small symbols) estimates from snapper landings sampled from the three SNA 1 stock bottom longline fisheries in 2017–18 (*n*, sample size). Note: data presented for ages 3–20 years only.

3.12 Mean weight-at-age time series comparisons

Time series comparisons of spring-summer mean weight-at-age estimates derived from sampling the SNA 1 bottom longline fisheries over the past three decades show a gradual long-term decrease in the mean weight-at-age for snapper for most of the common age classes, particularly in the Hauraki Gulf and Bay of Plenty stocks, these being indicative of a temporal decline in growth rates (Figures 19–21). Note, annual mean weight-at-age estimates for many of the older age classes (i.e., over 13 years of age) appear highly variable from year to year and unlikely to provide realistic estimates due to the low number of individuals present.

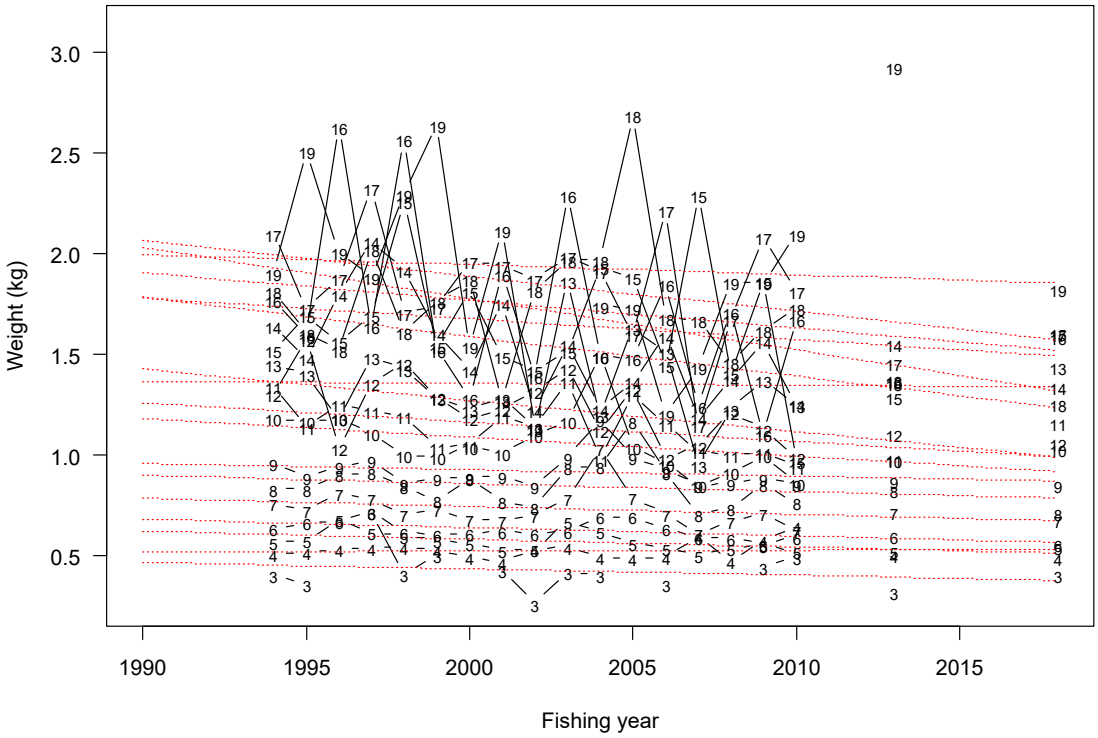

Figure 19: Mean weight-at-age estimates for 3- to 19-year-old snapper sampled from the East Northland bottom longline fishery (during spring–summer) between 1993–94 and 2017–18 with fitted trend lines (dotted) for each age class depicting long-term changes in growth rates over the 25 year period.

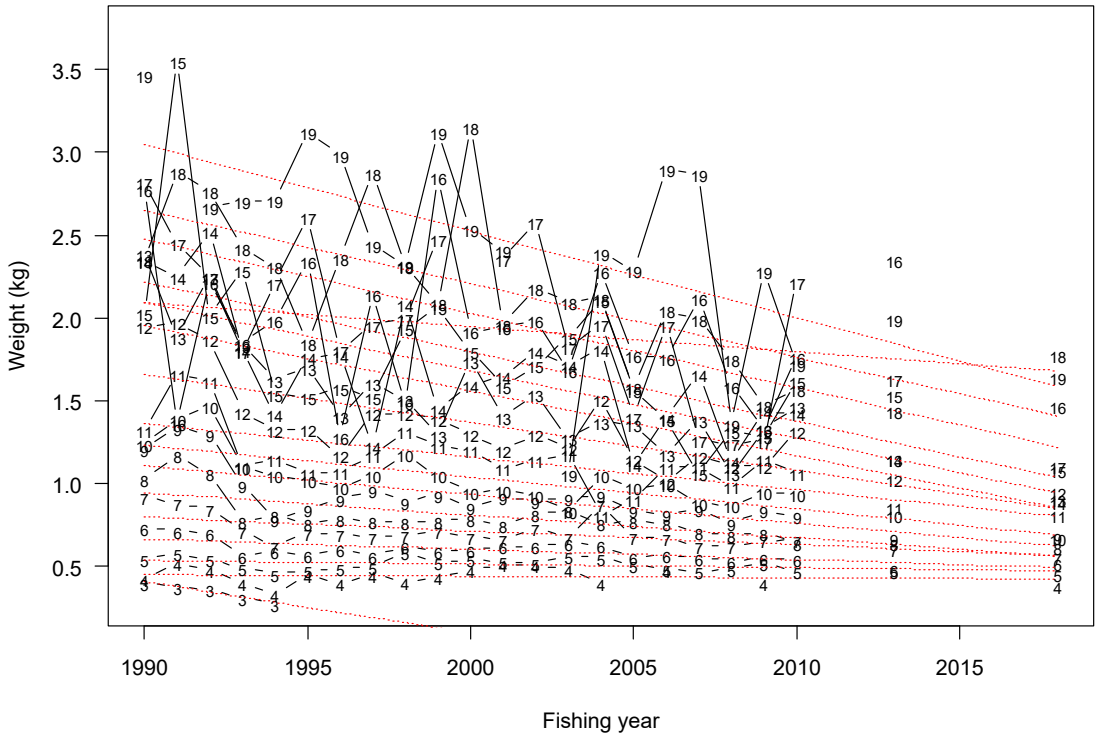

Figure 20: Mean weight-at-age estimates for 3- to 19-year-old snapper sampled from the Hauraki Gulf bottom longline fishery (during spring–summer) between 1989–90 and 2017–18 with fitted trend lines (dotted) for each age class depicting long-term changes in growth rates over the 29 year period.

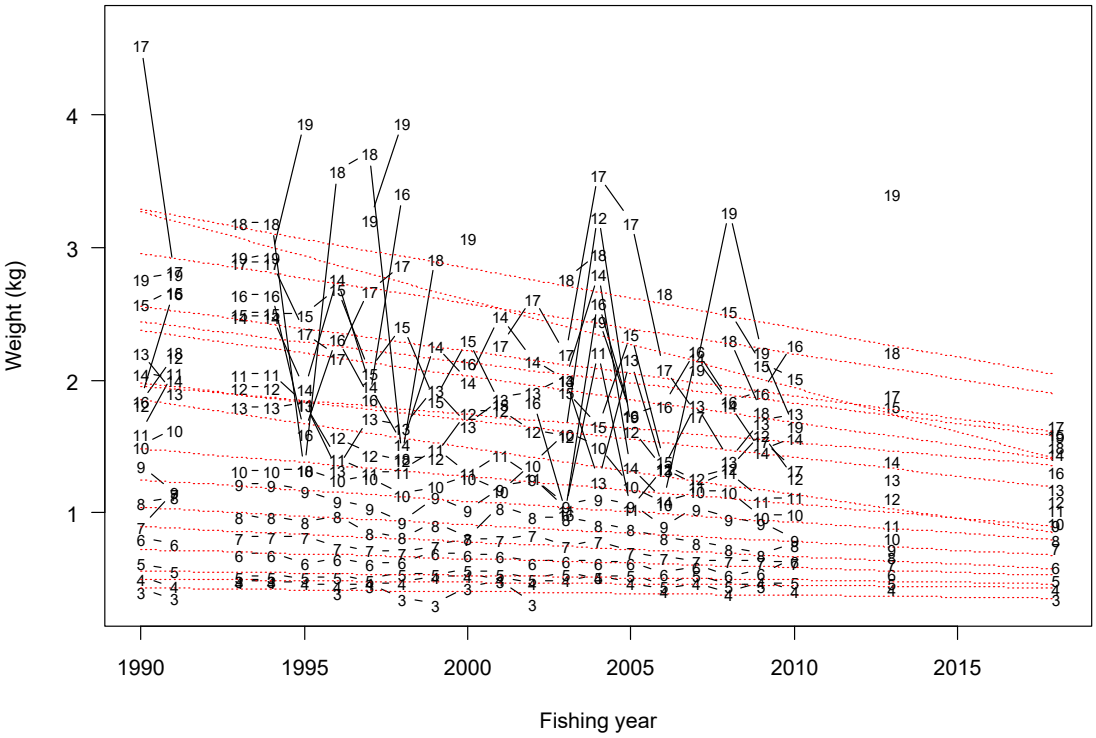

Figure 21: Mean weight-at-age estimates for 3- to 19-year-old snapper sampled from the Bay of Plenty bottom longline fishery (during spring–summer) between 1989–90 and 2017–18 with fitted trend lines (dotted) for each age class depicting long-term changes in growth rates over the 29 year period.

Comparisons of stock mean weight-at-age (spring-summer) estimates for snapper from the two most recent sampling years (2012–13 and 2017–18) to a time series comprising the average of two decadal collections (1990s and 2000s) of mean weight-at-age are presented in Figure 22.

The mean weight-at-age of the common age classes for East Northland snapper has remained relatively stable over time, the Bay of Plenty showing some recent improvement for young age classes, while estimates for the Hauraki Gulf fishery have most often remained much lower than those of earlier decades (Figure 22). Hauraki Gulf mean weight-at-age up to about 9 years from 2017–18 closely mirrored those samples from 2012–13, but for older age classes, further weight loss was evident. A recent increase in mean weight-at-age for Bay of Plenty snapper below 12 years of age was apparent in the 2017–18 data, while those fish greater than 14 years have diverged negatively, similar to that observed in the Hauraki Gulf (Figure 22).

The difference in mean weight-at-age between the first decade (1990s) and 2017–18 indicates the overall net weight loss/gain to the respective fisheries, estimated conservatively at around -34% for most of the common age classes (i.e., 5- to 15-year-olds) in the Hauraki Gulf, -24% for the Bay of Plenty, and -10% for East Northland. Only 13-year-old snapper from East Northland demonstrated a positive gain (Figure 22).

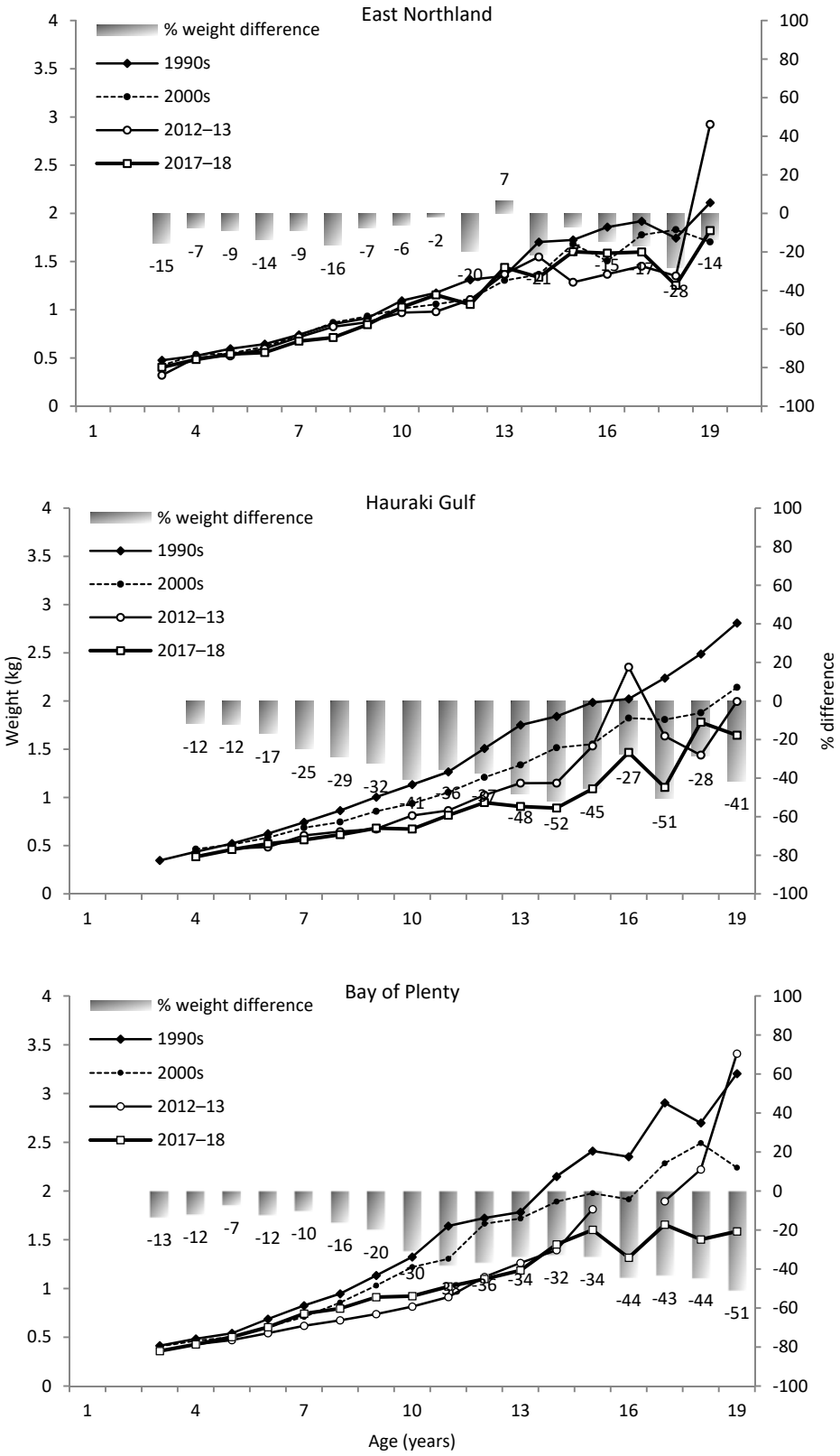

Figure 22: Mean weight-at-age estimates for snapper sampled from the three SNA 1 stock bottom longline fisheries from two distinct decadal time periods and from the two most recent sampling years 2012–13 and 2017–18, and where each period reflects the average mean weight-at-age for those years. The percentage weight difference for each age class (positive or negative) is the difference between the first decade (1990s) and 2017–18, and indicative of a net weight gain or loss in mean weight-at-age through time. Note: For comparative purposes over time, only spring-summer samples have been presented.

4. DISCUSSION

The random age frequency sampling approach was employed over four seasons from spring 2017 to winter 2018 to estimate catch-at-age for snapper from the three bottom longline fisheries in SNA 1: East Northland, Hauraki Gulf and Bay of Plenty. A total of 120 landings and 3157 otoliths were selected for age information from 26 vessels that collectively contributed over 90% of the total SNA 1 longline catch.

The collection of otolith samples in 2017–18 followed the same design as that first implemented in 2003–04 (Walsh et al. 2006), spanning the entire year, whereas collections before 2003–04 (and in 2005–06) were made only in the spring and summer seasons. The change was made largely so that sampling better reflected the seasonal characteristics of the bottom longline fleet and its fishing operations, as more of the snapper catch in recent years has been landed year-round.

Although considerable developments within the fishing industry have occurred over the past two decades, with downsizing and rationalisation of the commercial inshore fleet, the SNA 1 bottom longline fishery has remained relatively consistent. Most bottom longline fishers operate year-round. In recent years, bottom longline has been the dominant method in the fishery, catching more snapper than bottom trawl and Modular Harvest System combined. Unlike other methods, longlining operates extensively in most spatial strata of SNA 1 (with the exception of the eastern Bay of Plenty), across a wide range of habitats (soft and hard substrates), and has few fine-scale management (area and effort) restrictions imposed on its use. Importantly, catch-at-age data from the longline fishery provide a particularly useful tool for stock monitoring, believed to be the most uniform of all the fishing methods in its selection of fish across both size and age.

East Northland

The East Northland year-round catch-at-age distribution in 2017–18 appears to have broadened slightly from that seen in 2012–13 (see Appendices 6 and 7), with good representation across almost all recruited age classes resulting in a high mean age of 9.9 years (Appendix 8). The 2011 year class (7-year-olds), singularly the most dominant in the fishery, accounted for 25% of all snapper in East Northland landings in 2017–18, by far the highest estimate for any year class across all SNA 1 stocks. A modelled relationship between sea surface temperature and snapper recruitment (Francis 1993) predicted the 2011 year class to be the third strongest year class to recruit into the Hauraki Gulf in the past two decades, but in 2017–18 was most apparent in the East Northland fishery, a likely recruitment response to common broad climatic trends (Francis & McKenzie 2015). With an average size at 31 cm (about 0.650 kg), but still comprising a portion of fish at the minimum legal size (MLS) of 25 cm (see Appendix 3), the 2011 year class is unlikely to be fully recruited, and is likely to be significant to the fishery for many years to come, not just by number, but by its contribution by weight.

Although not as large as the Hauraki Gulf stock (Francis & McKenzie 2015), East Northland has remained in a healthy state, comprising a reasonable number (about 5%) of fish 20 years of age and older, more than any other New Zealand snapper stock. However, the average size of fish in East Northland remains comparatively small at about 35 cm (about 0.9 kg).

Hauraki Gulf

The age composition of the Hauraki Gulf bottom longline catch in 2017–18 comprised mainly young to moderate aged snapper with good representation across all year classes up to, and including, 20 years of age, with proportionally fewer fish occupying the right hand limb compared to samples from 2012–13 (see Appendices 6 and 7). The 2013–2006 year classes (5- to 12-year-olds), most of similar relative strength, collectively made up three-quarters of the landed catch by number in 2017–18. The mean age of Hauraki Gulf snapper from year-round sampling remains high at 10.0 years, equally the second highest estimate for more than two decades. However, due to very slow growth rates, the average size of fish landed by bottom longline remains small at 32 cm (about 0.7 kg), the lowest ever recorded estimate for this stock.

In the past, the Hauraki Gulf has been regarded as the mainstay of the SNA 1 fishery, comprising the largest biomass and most often producing the largest commercial and recreational harvest (Walsh et al. 2014b, Francis & McKenzie 2015). More recently however, commercial fishing in the Hauraki Gulf has declined with landings between 2013–14 and 2017–18 dropping by more than 30%, and now contributing the lowest catch in SNA 1. Significant fishing effort has instead been directed toward the East Northland and Bay of Plenty stocks where snapper are of larger average size and better quality (colour and condition[1]) than in the Gulf, and (anecdotally) valuable bycatch species more readily available.

Bay of Plenty

From sampling conducted in 2012–13, Walsh et al. (2014b) reported a noticeable and consistent broadening in the Bay of Plenty age distribution over successive years coupled with an increasing trend of catch per unit effort (CPUE) for bottom longline (McKenzie & Parsons 2012). It was suggested that the biomass of snapper in the Bay of Plenty may be rebuilding to a size not seen for over three decades, should fishing pressure remain stable, and recruitment, average or better. Five years later in the current study, 2017–18, the same effects were again evident – broadening age composition, increasing (and highest recorded) mean age (8.7 year), and slow growth rates (see Appendices 6 and 7), providing further evidence that a slow but consistent rebuild of the Bay of Plenty stock may be underway. Nevertheless, the most recent SNA 1 assessment suggests that the Bay of Plenty is likely to be below the hard limit of 10% B_0 (Francis & McKenzie 2015), the lowest biomass level of all three stocks.

Although reasonable numbers of moderate aged snapper were present in Bay of Plenty bottom longline samples in 2017–18, landings also comprised a relatively high proportion of young fish, those 7 years of age and younger making up almost half the catch by number, the 2013 year class (5-year-olds) the most dominant, accounting for almost one in every five fish. Those fish greater than 12 years of age collectively make up 16% of the total Bay of Plenty catch, similar to that seen in the Hauraki Gulf ten years ago, with representation across all age classes up to 20 years, indicating improvement in the numbers of moderate aged fish. In contrast, during the 1990s and early 2000s, a period when the Bay of Plenty experienced high exploitation relative to the larger East Northland and Hauraki Gulf stocks, catches comprised only a handful of young age classes, with few fish attaining an age of 10 or more years (see Appendices 6 and 7).

Similar to the Hauraki Gulf, recruitment into the Bay of Plenty snapper fishery in recent years has been delayed by a slowing growth rate (Walsh et al. 2011b, 2014b), the current average size landed by bottom longline in 2017–18 being comparatively small at about 33 cm (about 0.8 kg).

Variability in catch-at-age between stocks

Since 1989–90, broad similarities in relative year class strengths and recruitment patterns have been evident between the SNA 1 stocks, particularly for extremely strong and weak year classes. Variability in relative year class proportions between the SNA 1 stocks has mostly been associated with the variable recruitment (a reflection of unique environmental conditions), growth differences, and fishing mortality differences (Walsh et al. 2003). Unlike previous years, few obvious consistencies in relative year class strengths were evident between stock bottom longline catch-at-age compositions from 2017–18.

As mentioned beforehand, the 2011 year class (currently 7-year-olds) was predicted to be the third strongest year class in over two decades to recruit into the Hauraki Gulf fishery based on a modelled relationship between sea surface temperature and snapper recruitment (Francis 1993). However, the 2011 year class overwhelmingly dominated East Northland bottom longline landings in 2017–18 and was the second strongest year class in the Bay of Plenty, but appeared equal to that of adjacent recruiting year classes in the Hauraki Gulf. In 2012–13, Walsh et al. (2014b) reported that similarities in year class strengths were more evident between East Northland and the Bay of Plenty and that

[1] See image of poor conditioned snapper from the Hauraki Gulf fishery (Appendix 9).

minor differences such as that seen for year classes in the Hauraki Gulf fishery were thought to be due to slower growth and delayed recruitment. It was acknowledged that a trend in declining growth was obvious since 2008–09 (Walsh et al. 2011a) particularly in the Hauraki Gulf, less so in the Bay of Plenty, but not at all apparent in East Northland, and that those same trends more or less continued until 2017–18 (Walsh et al. 2011b, 2014b). Due to very slow growth rates for some snapper, the rate of recruitment into the Hauraki Gulf fishery is now significantly different to that of the other two SNA 1 stocks, with full recruitment of a year class, potentially taking as long as 10 years. Essentially this means that a portion of a year class may be exposed to fishing mortality from a range of methods (above and below the MLS of 25 cm) annually for many years prior to full recruitment, and the relative strength is likely to diminish such that it eventually recruits proportionally similar to adjacent year classes with much less definition.

Seasonal differences in catch-at-age

Older and larger fish were found to be more common during spring in the Bay of Plenty, summer in the Hauraki Gulf and winter in East Northland, the latter area influenced in part by the higher seasonal proportions of the strong 2011 year class (7-year-olds) during spring and autumn. High numbers of small young snapper were most common during autumn, reflecting a time of strong seasonal recruitment into the commercial longline fishery.

Precision in catch-at-age

The bootstrap MWCV estimates for the age distributions sampled from the SNA 1 fisheries in 2017–18 ranged between 0.19 and 0.21, slightly lower than estimates determined in 2012–13. Although approximating the target MWCVs of 20%, precision in 2017–18 catch-at-age estimates was aided by the substantial increase in otolith sample size which exceeded the annual targets. In future, to maintain a target catch-at-age precision (MWCV) of 20% for the respective SNA 1 stocks, given that the respective fisheries may continue to populate and likely broaden, year-round otolith sample sizes will need to be increased to a level similar to that collected in 2017–18: from 800 to 1000 otoliths for East Northland and Bay of Plenty stocks and from 1000 to 1200 otoliths for the Hauraki Gulf.

In the two decades preceding 2009–10, sampling of the SNA 1 longline fishery was largely conducted over successive years, and comparisons of inter-annual catch-at-age estimates indicated a high level of consistency in relative year class strength, where cohorts were easily tracked from one year to the next (see Appendices 6 and 7). However, relative year class strength estimates from 2017–18 were less consistent with previous estimates. This was especially evident in the Hauraki Gulf.

Recent change in snapper growth rates

Using the time series of catch sampling data available from SNA 1, Walsh et al. (2011a, 2011b, 2014b) documented temporal trends in the growth rates of snapper by comparing changes in mean weight-at-age over time. They found that growth rates for Hauraki Gulf and Bay of Plenty snapper were fastest during the 1990s and steadily declined throughout the 2000s, the trend correlating with a perceived increase in stock size, supported by broadening age distributions. By 2012–13, the decline in growth rates had continued and was deemed to be more likely due to compensatory density dependence (Rose et al. 2001) as the recent Hauraki Gulf and Bay of Plenty assessments suggest biomass had increased through this period (Francis & McKenzie 2015), rather than temperature related effects or bias in the sampling design or fishing method selectivity. In 2017–18, mean weight-at-age estimates for the common age classes in the Hauraki Gulf were found to be close to, if not the lowest ever recorded in almost three decades of catch sampling and indicative of a continuing negative trend. Conversely, Bay of Plenty snapper showed a recent increase in mean weight-at-age for fish below 12 years compared to samples from 2012–13. No obvious temporal trends in growth rates were evident for East Northland snapper.

The reduced growth rate observed in the Hauraki Gulf fishery in recent years and the resulting drop in yield-per-recruit compared to the 1990s and the impact on productivity of the stock has been reported a number of times (Walsh et al. 2007, 2008, 2009, 2011a,b, 2014b) and means that the fishery will now land considerably more snapper than it did 10–30 years ago to achieve the same harvest weight.

Similar density-dependent growth trends in relation to changes in biomass have recently been documented for SNA 8 (Walsh et al. 2014c, 2017).

Snapper were on average about 30% heavier (and 10% longer) in East Northland and Bay of Plenty than in the Hauraki Gulf in 2017–18.

5. MANAGEMENT IMPLICATIONS

Reliable estimates of year class strength are critical for SNA 1 stock management, not only for assessing current stock status but also for determining rebuild rates under alternative future Total Allowable Catches. Results from the most recent 2013 SNA 1 stock assessment suggest that recent estimates of year class strength are required to inform meaningful projections of the fishable stock biomass, which are used to set catch limits in future years (Francis & McKenzie 2015). Model projections of stock biomass based on empirical resampling of year class strengths from a full 40 year time series predicted increasing biomass in future years, but the stock biomass was predicted to decrease when year classes were drawn from the last 10 years of this time series only (i.e., year classes with 1 or more sampling observations: 1995–2004).

Year class strength can be derived from catch-at-age sampling data, with sampling across multiple years providing many "looks" at a year class as it passes through the fishery. It follows that less frequent catch-at-age sampling reduces the statistical power of an assessment model to estimate the relative strength of any given year class strength. Sample sizes of 3 to 5 are generally considered to be the absolute minimum number of observations required to derive any "meaningful" statistical estimate from a population (Sokal & Rohlf 1995), i.e., 3–5 separate annual catch-at-age sampling events.

Over the 30 year period from 1989–90 through 2018–19, sampling of the Hauraki Gulf snapper longline fishery occurred in 23 of those years. However, between 2009–10 and 2018–19, including this current programme, there were only two annual Hauraki Gulf snapper longline fishery sampling events, largely due to the adoption of a one year in every three SNA 1 sampling strategy post 2009–10.

Coefficient of variation estimates on Hauraki Gulf snapper longline age frequencies over the last 23 years (Appendix 6) suggest that the effective age range for determining year class strength is from 5 to 20 years (i.e., a 16 year observation window), as our ability to distinguish year class strength in the data after age 20 is markedly reduced as denoted by relatively high CVs. The youngest Hauraki Gulf 5+ snapper year class having 3 or more looks using the available catch sampling series is the 2005 year class (Table 5). Relative to a 5–20 year old age window as of 2018–19, the number of Hauraki Gulf estimable age classes from the post 1989–90 longline catch series is 35 (1972–2005 year classes; Table 5). As expected, the year class estimation power of the current SNA 1 sampling strategy of "one-in-every-three" is markedly lower than an annual strategy (Table 5). A consecutive "two-in-every-five" year sampling strategy would achieve slightly higher precision (i.e., higher observational frequency average) than the current "one-year-in-three" year strategy but does not reduce the year class estimation time-lag (i.e., 13 years; Table 5).

Table 5: Frequency of Hauraki Gulf snapper year classes having 3 or more observations within a 5 through 20 age range over a 30 year annual sampling period for alternative sample frequency strategies.

		Alternative sample frequency strategies		
	Actual Hauraki Gulf data series (as of 2018–19)	Annual	1-in-3 years	2-in-5 years
Number of annual sampling events	23	30	10	12
YC† estimation time lag (yrs)	14 (2005 YC)	7	13	13
Number estimable YCs above 3 looks	34 (1972–2005 YCs)	41	31	32
Max. number individual YC looks	16	16	6	7
Mean number 3+ YC looks	10.4	11.6	4.6	5.5

† Year class

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8. APPENDICES

Appendix 1: Estimated seasonal proportion at age and coefficients of variation (CVs) for snapper bottom longline fisheries in SNA 1 in 2017–18.

Estimates of proportion at age with coefficients of variation for snapper from the East Northland bottom longline fishery in 2017–18.

	Random age frequency Longline									
Age	Spring		Summer		Autumn		Winter		Spr-win	
(years)	*P.j.*	CV	*P.j.*	CV	*P.j.*	CV	*P.j.*	CV	*P.j.*	CV
1	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
3	0.0000	0.00	0.0190	0.70	0.0131	0.65	0.0161	0.73	0.0133	0.40
4	0.0229	0.59	0.0196	0.77	0.0585	0.41	0.0400	0.47	0.0378	0.28
5	0.0651	0.35	0.0530	0.33	0.0940	0.23	0.0814	0.35	0.0753	0.16
6	0.1222	0.34	0.1143	0.30	0.1067	0.23	0.0925	0.25	0.1079	0.14
7	0.2892	0.22	0.2009	0.17	0.3273	0.14	0.1783	0.21	0.2517	0.09
8	0.0612	0.31	0.0871	0.27	0.0657	0.35	0.0551	0.41	0.0682	0.17
9	0.0653	0.32	0.0681	0.34	0.0583	0.35	0.0731	0.35	0.0656	0.17
10	0.0670	0.46	0.0832	0.36	0.0508	0.33	0.0368	0.53	0.0589	0.21
11	0.0547	0.43	0.0679	0.32	0.0549	0.37	0.0664	0.36	0.0611	0.18
12	0.0249	0.54	0.0412	0.41	0.0283	0.63	0.0275	0.50	0.0311	0.28
13	0.0426	0.43	0.0617	0.33	0.0290	0.56	0.0378	0.48	0.0421	0.23
14	0.0333	0.55	0.0030	1.49	0.0000	0.00	0.0216	0.66	0.0114	0.42
15	0.0545	0.37	0.0396	0.40	0.0138	0.72	0.0627	0.41	0.0390	0.22
16	0.0117	0.94	0.0326	0.46	0.0265	0.60	0.0354	0.47	0.0278	0.29
17	0.0150	0.66	0.0218	0.60	0.0151	0.66	0.0449	0.39	0.0240	0.28
18	0.0057	1.25	0.0089	0.74	0.0103	0.85	0.0137	0.62	0.0100	0.40
19	0.0178	0.63	0.0241	0.49	0.0134	0.72	0.0293	0.53	0.0208	0.30
20	0.0000	0.00	0.0000	0.00	0.0061	0.94	0.0225	0.72	0.0074	0.57
21	0.0000	0.00	0.0038	1.32	0.0000	0.00	0.0057	1.26	0.0024	0.93
22	0.0182	0.85	0.0169	0.69	0.0033	1.26	0.0000	0.00	0.0086	0.50
23	0.0000	0.00	0.0025	1.46	0.0083	0.80	0.0000	0.00	0.0034	0.70
24	0.0000	0.00	0.0096	0.77	0.0047	0.96	0.0040	1.28	0.0051	0.53
25	0.0000	0.00	0.0069	1.24	0.0000	0.00	0.0057	1.43	0.0032	0.93
26	0.0054	1.23	0.0000	0.00	0.0000	0.00	0.0000	0.00	0.0009	1.21
27	0.0000	0.00	0.0000	0.00	0.0000	0.00	0.0000	0.00	0.0000	0.00
28	0.0102	0.89	0.0000	0.00	0.0030	1.32	0.0222	0.65	0.0079	0.49
29	0.0052	1.16	0.0000	0.00	0.0000	0.00	0.0000	0.00	0.0009	1.13
>29	0.0076	0.94	0.0142	0.58	0.0086	0.77	0.0275	0.56	0.0144	0.34
n	234		259		265		232		990	

Appendix 1 – continued:
Estimates of proportion at age with coefficients of variation for snapper from the East Northland bottom longline fishery (statistical area 002) in 2017–18.

	Random age frequency Longline									
Age	Spring		Summer		Autumn		Winter		Spr-win	
(years)	*P.j.*	CV	*P.j.*	CV	*P.j.*	CV	*P.j.*	CV	*P.j.*	CV
1	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
3	0.0000	0.00	0.0111	1.33	0.0170	0.93	0.0296	0.83	0.0148	0.54
4	0.0175	0.92	0.0107	1.32	0.0902	0.45	0.0813	0.49	0.0528	0.34
5	0.0457	0.64	0.0505	0.60	0.1107	0.34	0.1190	0.40	0.0838	0.22
6	0.1551	0.43	0.1299	0.46	0.1079	0.39	0.1323	0.30	0.1290	0.20
7	0.3547	0.27	0.1925	0.28	0.3622	0.25	0.1835	0.36	0.2766	0.15
8	0.0534	0.47	0.0809	0.34	0.0443	0.56	0.0360	0.60	0.0535	0.24
9	0.0439	0.51	0.0652	0.50	0.0471	0.50	0.0651	0.55	0.0551	0.26
10	0.0351	0.76	0.0757	0.56	0.0401	0.54	0.0346	0.74	0.0467	0.31
11	0.0365	0.81	0.0623	0.41	0.0148	1.18	0.0411	0.54	0.0374	0.31
12	0.0095	1.29	0.0468	0.52	0.0259	1.02	0.0101	1.28	0.0241	0.44
13	0.0322	0.85	0.0705	0.45	0.0456	0.76	0.0591	0.61	0.0522	0.33
14	0.0336	0.82	0.0000	0.00	0.0000	0.00	0.0000	0.00	0.0071	0.80
15	0.0563	0.55	0.0365	0.68	0.0197	0.87	0.0607	0.41	0.0411	0.32
16	0.0121	1.31	0.0360	0.58	0.0000	0.00	0.0267	0.68	0.0178	0.40
17	0.0221	0.75	0.0201	0.74	0.0117	1.06	0.0404	0.62	0.0226	0.39
18	0.0000	0.00	0.0217	0.73	0.0000	0.00	0.0259	0.67	0.0114	0.49
19	0.0262	0.69	0.0254	0.69	0.0123	1.19	0.0187	0.87	0.0200	0.43
20	0.0000	0.00	0.0000	0.00	0.0000	0.00	0.0000	0.00	0.0000	0.00
21	0.0000	0.00	0.0000	0.00	0.0000	0.00	0.0000	0.00	0.0000	0.00
22	0.0287	0.92	0.0170	0.96	0.0080	1.28	0.0000	0.00	0.0128	0.59
23	0.0000	0.00	0.0061	1.49	0.0102	1.04	0.0000	0.00	0.0046	0.84
24	0.0000	0.00	0.0159	0.89	0.0114	0.99	0.0094	1.29	0.0097	0.61
25	0.0000	0.00	0.0000	0.00	0.0000	0.00	0.0000	0.00	0.0000	0.00
26	0.0095	1.26	0.0000	0.00	0.0000	0.00	0.0000	0.00	0.0020	1.22
27	0.0000	0.00	0.0000	0.00	0.0000	0.00	0.0000	0.00	0.0000	0.00
28	0.0095	1.21	0.0000	0.00	0.0074	1.34	0.0072	1.43	0.0059	0.76
29	0.0091	1.21	0.0000	0.00	0.0000	0.00	0.0000	0.00	0.0019	1.19
>29	0.0091	1.26	0.0254	0.69	0.0136	0.90	0.0195	0.86	0.0170	0.44
n	106		129		125		115		475	

Appendix 1 – continued:
Estimates of proportion at age with coefficients of variation for snapper from the East Northland bottom longline fishery (statistical area 003) in 2017–18.

	Random age frequency Longline									
Age	Spring		Summer		Autumn		Winter		Spr-win	
(years)	*P.j.*	CV	*P.j.*	CV	*P.j.*	CV	*P.j.*	CV	*P.j.*	CV
1	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
3	0.0000	0.00	0.0246	0.81	0.0104	0.95	0.0058	1.51	0.0120	0.57
4	0.0300	0.74	0.0259	0.91	0.0365	0.77	0.0089	1.31	0.0260	0.47
5	0.0910	0.36	0.0547	0.38	0.0824	0.32	0.0531	0.64	0.0685	0.23
6	0.0784	0.38	0.1034	0.39	0.1059	0.27	0.0625	0.43	0.0913	0.18
7	0.2020	0.29	0.2069	0.22	0.3031	0.16	0.1743	0.22	0.2320	0.11
8	0.0717	0.40	0.0915	0.38	0.0806	0.44	0.0694	0.50	0.0799	0.22
9	0.0937	0.42	0.0701	0.46	0.0660	0.45	0.0792	0.45	0.0738	0.22
10	0.1095	0.53	0.0885	0.47	0.0583	0.42	0.0384	0.74	0.0685	0.26
11	0.0789	0.43	0.0718	0.45	0.0827	0.38	0.0855	0.44	0.0798	0.22
12	0.0455	0.56	0.0374	0.61	0.0300	0.79	0.0405	0.54	0.0366	0.33
13	0.0564	0.41	0.0555	0.48	0.0176	0.82	0.0217	0.86	0.0342	0.31
14	0.0329	0.67	0.0051	1.50	0.0000	0.00	0.0379	0.66	0.0147	0.46
15	0.0522	0.42	0.0417	0.49	0.0098	1.32	0.0642	0.64	0.0373	0.34
16	0.0112	1.29	0.0301	0.77	0.0449	0.60	0.0420	0.62	0.0358	0.36
17	0.0056	1.50	0.0231	0.86	0.0174	0.85	0.0483	0.49	0.0250	0.38
18	0.0134	1.23	0.0000	0.00	0.0174	0.87	0.0045	1.51	0.0088	0.63
19	0.0067	1.36	0.0233	0.70	0.0142	0.89	0.0372	0.67	0.0214	0.39
20	0.0000	0.00	0.0000	0.00	0.0104	0.95	0.0395	0.71	0.0132	0.60
21	0.0000	0.00	0.0064	1.33	0.0000	0.00	0.0100	1.25	0.0042	0.94
22	0.0042	1.48	0.0169	0.93	0.0000	0.00	0.0000	0.00	0.0053	0.81
23	0.0000	0.00	0.0000	0.00	0.0070	1.31	0.0000	0.00	0.0025	1.30
24	0.0000	0.00	0.0051	1.39	0.0000	0.00	0.0000	0.00	0.0015	1.33
25	0.0000	0.00	0.0118	1.24	0.0000	0.00	0.0100	1.43	0.0057	0.88
26	0.0000	0.00	0.0000	0.00	0.0000	0.00	0.0000	0.00	0.0000	0.00
27	0.0000	0.00	0.0000	0.00	0.0000	0.00	0.0000	0.00	0.0000	0.00
28	0.0112	1.25	0.0000	0.00	0.0000	0.00	0.0335	0.73	0.0095	0.63
29	0.0000	0.00	0.0000	0.00	0.0000	0.00	0.0000	0.00	0.0000	0.00
>29	0.0056	1.33	0.0064	1.33	0.0052	1.41	0.0335	0.73	0.0124	0.58
n	128		130		141		116		515	

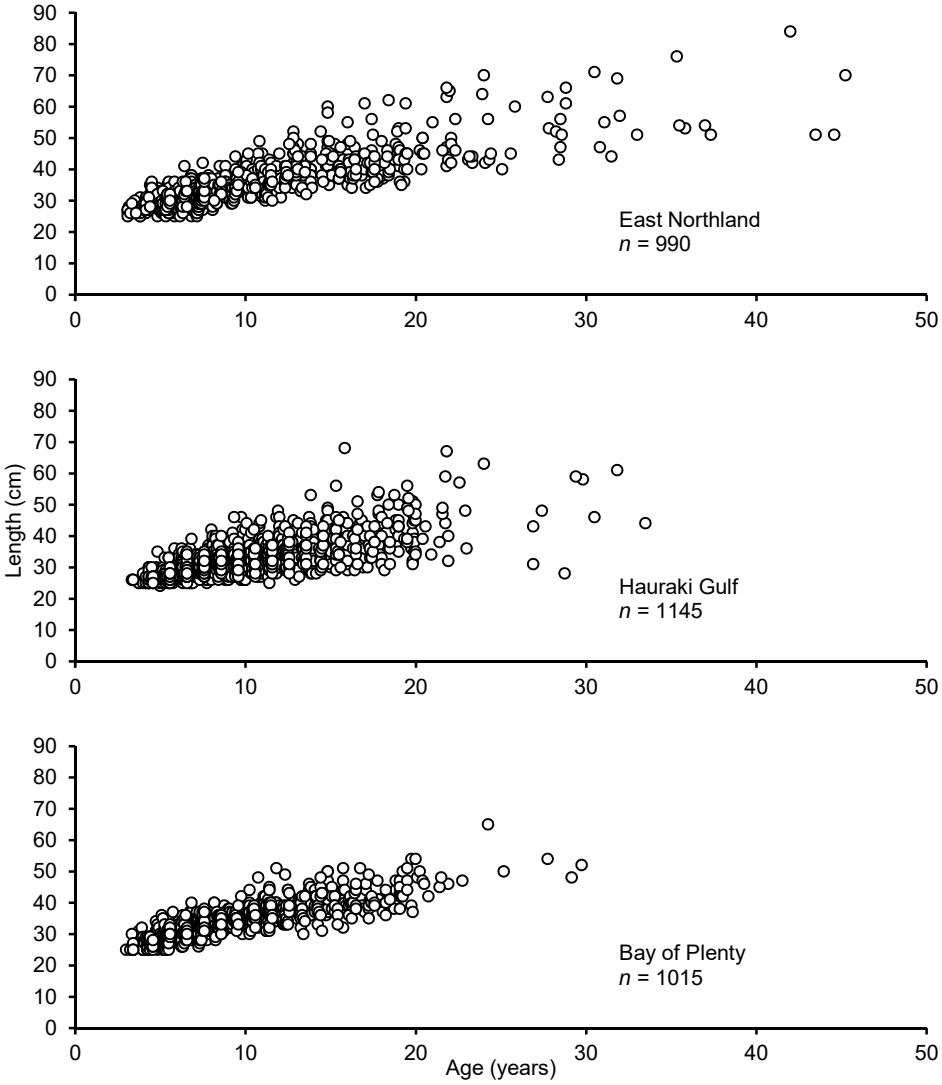
Appendix 1 – continued:
Estimates of proportion at age with coefficients of variation for snapper from the Hauraki Gulf bottom longline fishery in 2017–18.

	Random age frequency Longline									
Age	Spring		Summer		Autumn		Winter		Spr-win	
(years)	*P.j.*	CV	*P.j.*	CV	*P.j.*	CV	*P.j.*	CV	*P.j.*	CV
1	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
3	0.0000	0.00	0.0000	0.00	0.0033	1.39	0.0062	1.33	0.0015	0.96
4	0.0128	1.18	0.0048	1.03	0.0823	0.37	0.0515	0.49	0.0284	0.29
5	0.0552	0.55	0.0538	0.35	0.1205	0.23	0.0999	0.35	0.0734	0.18
6	0.0964	0.43	0.0615	0.39	0.1822	0.20	0.1294	0.25	0.1035	0.16
7	0.1210	0.32	0.0861	0.27	0.1171	0.25	0.1091	0.29	0.1046	0.15
8	0.1481	0.25	0.0910	0.28	0.0926	0.26	0.0597	0.30	0.1023	0.15
9	0.1084	0.33	0.1555	0.22	0.1113	0.27	0.1242	0.20	0.1301	0.13
10	0.1033	0.32	0.1149	0.32	0.0689	0.30	0.0843	0.30	0.0987	0.19
11	0.0837	0.28	0.0935	0.24	0.0638	0.45	0.0942	0.21	0.0852	0.15
12	0.0707	0.46	0.0664	0.29	0.0494	0.33	0.0642	0.36	0.0639	0.20
13	0.0314	0.45	0.0385	0.46	0.0221	0.61	0.0327	0.36	0.0326	0.27
14	0.0229	0.77	0.0444	0.38	0.0095	0.96	0.0470	0.38	0.0322	0.27
15	0.0233	0.66	0.0201	0.60	0.0309	0.55	0.0145	0.71	0.0223	0.33
16	0.0258	0.66	0.0441	0.38	0.0042	1.07	0.0285	0.39	0.0293	0.28
17	0.0267	0.87	0.0246	0.55	0.0294	0.46	0.0110	0.69	0.0242	0.35
18	0.0214	0.77	0.0154	0.66	0.0081	1.03	0.0089	0.94	0.0147	0.41
19	0.0125	0.78	0.0280	0.55	0.0046	1.45	0.0138	0.69	0.0174	0.41
20	0.0254	0.61	0.0258	0.56	0.0000	0.00	0.0050	1.11	0.0178	0.39
21	0.0000	0.00	0.0027	1.38	0.0000	0.00	0.0067	0.92	0.0020	0.88
22	0.0032	1.17	0.0090	0.92	0.0000	0.00	0.0052	1.26	0.0052	0.67
23	0.0000	0.00	0.0091	0.98	0.0000	0.00	0.0000	0.00	0.0037	0.98
24	0.0000	0.00	0.0016	1.32	0.0000	0.00	0.0000	0.00	0.0006	1.30
25	0.0000	0.00	0.0000	0.00	0.0000	0.00	0.0000	0.00	0.0000	0.00
26	0.0000	0.00	0.0000	0.00	0.0000	0.00	0.0000	0.00	0.0000	0.00
27	0.0000	0.00	0.0090	0.94	0.0000	0.00	0.0011	1.41	0.0038	0.91
28	0.0000	0.00	0.0000	0.00	0.0000	0.00	0.0000	0.00	0.0000	0.00
29	0.0064	1.39	0.0000	0.00	0.0000	0.00	0.0011	1.45	0.0018	1.32
>29	0.0014	1.14	0.0000	0.00	0.0000	0.00	0.0019	1.29	0.0006	0.85
n	282		280		269		314		1 145	

Appendix 1 – continued:
Estimates of proportion at age with coefficients of variation for snapper from the Bay of Plenty bottom longline fishery in 2017–18.

	Random age frequency Longline									
Age	Spring		Summer		Autumn		Winter		Spr-win	
(years)	*P.j.*	CV	*P.j.*	CV	*P.j.*	CV	*P.j.*	CV	*P.j.*	CV
1	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
3	0.0000	0.00	0.0070	1.39	0.0054	0.98	0.0233	0.85	0.0111	0.69
4	0.0053	1.02	0.0781	0.65	0.0576	0.33	0.0751	0.41	0.0577	0.26
5	0.0815	0.34	0.1882	0.23	0.1741	0.21	0.2027	0.16	0.1707	0.11
6	0.0865	0.39	0.1607	0.22	0.1127	0.22	0.0978	0.26	0.1090	0.13
7	0.1412	0.20	0.0953	0.26	0.1397	0.21	0.1336	0.20	0.1322	0.11
8	0.0709	0.32	0.0801	0.30	0.0934	0.29	0.0662	0.31	0.0782	0.17
9	0.0650	0.31	0.0497	0.38	0.0535	0.37	0.0693	0.34	0.0606	0.19
10	0.1233	0.29	0.0388	0.42	0.0814	0.25	0.0542	0.32	0.0733	0.15
11	0.1028	0.28	0.1117	0.25	0.0900	0.31	0.0986	0.27	0.0980	0.15
12	0.0759	0.32	0.0350	0.44	0.0395	0.48	0.0593	0.37	0.0521	0.22
13	0.0263	0.53	0.0273	0.54	0.0363	0.40	0.0139	0.74	0.0255	0.26
14	0.0652	0.36	0.0195	0.58	0.0330	0.35	0.0277	0.50	0.0348	0.22
15	0.0409	0.51	0.0235	0.70	0.0109	0.76	0.0129	0.85	0.0182	0.36
16	0.0256	0.62	0.0242	0.75	0.0182	0.52	0.0221	0.65	0.0216	0.32
17	0.0236	0.55	0.0165	0.64	0.0126	0.75	0.0160	0.64	0.0161	0.35
18	0.0128	0.73	0.0053	1.47	0.0157	0.69	0.0031	1.36	0.0094	0.47
19	0.0213	0.56	0.0289	0.80	0.0117	0.73	0.0113	0.88	0.0153	0.37
20	0.0146	0.72	0.0076	1.05	0.0029	1.34	0.0067	0.95	0.0068	0.51
21	0.0044	1.32	0.0000	0.00	0.0000	0.00	0.0062	0.94	0.0030	0.78
22	0.0000	0.00	0.0025	1.47	0.0000	0.00	0.0000	0.00	0.0003	1.45
23	0.0044	1.28	0.0000	0.00	0.0000	0.00	0.0000	0.00	0.0007	1.27
24	0.0000	0.00	0.0000	0.00	0.0029	1.36	0.0000	0.00	0.0010	1.34
25	0.0000	0.00	0.0000	0.00	0.0034	1.35	0.0000	0.00	0.0012	1.35
26	0.0000	0.00	0.0000	0.00	0.0000	0.00	0.0000	0.00	0.0000	0.00
27	0.0000	0.00	0.0000	0.00	0.0000	0.00	0.0000	0.00	0.0000	0.00
28	0.0044	1.24	0.0000	0.00	0.0000	0.00	0.0000	0.00	0.0007	1.23
29	0.0000	0.00	0.0000	0.00	0.0050	1.27	0.0000	0.00	0.0017	1.27
>29	0.0044	1.30	0.0000	0.00	0.0000	0.00	0.0000	0.00	0.0007	1.28
n	249		220		306		240		1 015	

Appendix 2: Scatterplot of age-at-length data for snapper sampled from the SNA 1 bottom longline fisheries in 2017–18 (*n*, sample size). Age is decimalised as of the month of collection relative to an assumed January 1 "birthdate".



Appendix 3: Age-length keys derived from otolith samples collected from snapper fisheries in SNA 1 in 2017–18.

Estimates of proportion of length at age for snapper sampled from East Northland (statistical areas 002 and 003 combined), spring-winter 2017–18. (Note: Aged to 01/01/18)

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	0.11	0.22	0.22	0.22	0.22	0	0	0	0	0	0	0	0	0	0	0	0	0	9
26	0	0	0.23	0.08	0.27	0.31	0.12	0	0	0	0	0	0	0	0	0	0	0	0	0	26
27	0	0	0.05	0.17	0.32	0.27	0.17	0.02	0	0	0	0	0	0	0	0	0	0	0	0	41
28	0	0	0.02	0.15	0.13	0.29	0.40	0.02	0	0	0	0	0	0	0	0	0	0	0	0	55
29	0	0	0.02	0.05	0.25	0.20	0.36	0.10	0.03	0	0	0	0	0	0	0	0	0	0	0	61
30	0	0	0.01	0.04	0.13	0.25	0.43	0.10	0.02	0	0.02	0	0	0	0	0	0	0	0	0	84
31	0	0	0	0.05	0.06	0.10	0.51	0.13	0.04	0.06	0.04	0.01	0	0	0	0	0	0	0	0	80
32	0	0	0	0.01	0.10	0.11	0.37	0.16	0.16	0.02	0.06	0	0.01	0	0	0	0	0	0	0	83
33	0	0	0	0.03	0.06	0.09	0.46	0.12	0.12	0.06	0.03	0	0.03	0	0	0	0	0	0	0	67
34	0	0	0	0.02	0.04	0.04	0.16	0.08	0.25	0.20	0.06	0.04	0.06	0.02	0	0.02	0.02	0	0	0	51
35	0	0	0	0.04	0.02	0.09	0.17	0.11	0.20	0.09	0.09	0.06	0.06	0	0.02	0.02	0.02	0	0.02	0	54
36	0	0	0	0.02	0.02	0.06	0.17	0.04	0.15	0.09	0.19	0.09	0.06	0.04	0	0	0.02	0.02	0.04	0	53
37	0	0	0	0	0	0	0.15	0.13	0.13	0.15	0.09	0.13	0.06	0	0.09	0.04	0	0.04	0	0	47
38	0	0	0	0	0	0	0.05	0.03	0.08	0.11	0.11	0.11	0.16	0.08	0.11	0.08	0.03	0.05	0	0	37
39	0	0	0	0	0	0	0	0	0.03	0.13	0.17	0.13	0.17	0	0.20	0.07	0.07	0.03	0	0	30
40	0	0	0	0	0	0	0	0	0.03	0.10	0.20	0.03	0.07	0.07	0.17	0.07	0.10	0.03	0.07	0.07	30
41	0	0	0	0	0	0.04	0	0.04	0.04	0.11	0.07	0.11	0.30	0	0.11	0.04	0.07	0	0.04	0.04	27
42	0	0	0	0	0	0	0	0	0	0.05	0.20	0	0.10	0	0.05	0.10	0.25	0.05	0	0.15	20
43	0	0	0	0	0	0	0	0	0	0.05	0.05	0	0	0.05	0.23	0.23	0.09	0	0.14	0.18	22
44	0	0	0	0	0	0	0	0	0.05	0	0	0	0.11	0.11	0.21	0.05	0.21	0.05	0.05	0.16	19
45	0	0	0	0	0	0	0	0	0	0.06	0.12	0.06	0.12	0.06	0.12	0	0.06	0	0.18	0.24	17
46	0	0	0	0	0	0	0	0	0	0	0	0	0.22	0	0	0	0.11	0.11	0.22	0.33	9
47	0	0	0	0	0	0	0	0	0	0	0	0	0.11	0	0.33	0.11	0	0	0.11	0.33	9
48	0	0	0	0	0	0	0	0	0	0	0	0.14	0.14	0.14	0.14	0.14	0	0	0.14	0.14	7
49	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.40	0.20	0	0.20	0	0	5
50	0	0	0	0	0	0	0	0	0	0	0	0	0.25	0	0	0	0	0	0	0.75	4
51	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.17	0	0	0.83	6
52	0	0	0	0	0	0	0	0	0	0	0	0	0.25	0.25	0	0	0	0	0.25	0.25	4
53	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.50	0.50	4
54	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.00	2
55	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.33	0	0	0	0.67	3
56	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.25	0	0	0.75	4
57	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.00	1
58	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.00	0	0	0	0	0	1
59	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.50	0	0	0	0	0.50	2
61	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.33	0	0.33	0.33	3
62	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.00	0	0	1
63	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.00	2
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	0	1.00	2
67	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
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	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	2
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	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	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
81	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
82	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
83	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
84	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.00	1
85	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total																					990

Appendix 3 – continued:
Estimates of proportion of length at age for snapper sampled from East Northland (statistical area 002), spring-winter 2017–18. (Note: Aged to 01/01/18)

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	0	0.50	0.25	0.25	0	0	0	0	0	0	0	0	0	0	0	0	0	4
26	0	0	0.16	0.05	0.37	0.37	0.05	0	0	0	0	0	0	0	0	0	0	0	0	0	19
27	0	0	0.04	0.13	0.22	0.35	0.22	0.04	0	0	0	0	0	0	0	0	0	0	0	0	23
28	0	0	0.03	0.13	0.16	0.22	0.47	0	0	0	0	0	0	0	0	0	0	0	0	0	32
29	0	0	0	0.04	0.12	0.28	0.44	0.12	0	0	0	0	0	0	0	0	0	0	0	0	25
30	0	0	0.02	0.07	0.14	0.26	0.47	0.05	0	0	0	0	0	0	0	0	0	0	0	0	43
31	0	0	0	0.09	0	0.15	0.48	0.18	0.03	0.03	0	0.03	0	0	0	0	0	0	0	0	33
32	0	0	0	0.04	0.11	0.18	0.50	0.11	0.07	0	0	0	0	0	0	0	0	0	0	0	28
33	0	0	0	0.06	0.10	0.06	0.52	0.10	0.13	0.03	0	0	0	0	0	0	0	0	0	0	31
34	0	0	0	0.05	0.11	0.05	0.21	0.11	0.16	0.21	0	0	0.05	0	0	0	0.05	0	0	0	19
35	0	0	0	0.08	0.04	0.21	0.13	0.08	0.29	0	0	0.04	0.08	0	0	0.04	0	0	0	0	24
36	0	0	0	0.05	0.05	0	0.29	0.05	0.14	0.05	0.14	0.05	0.14	0	0	0	0	0	0.05	0	21
37	0	0	0	0	0	0	0.15	0.10	0.25	0.10	0.05	0.15	0.10	0	0.05	0	0	0.05	0	0	20
38	0	0	0	0	0	0	0.10	0.05	0.10	0.10	0.10	0.10	0.20	0.10	0.05	0	0	0.10	0	0	20
39	0	0	0	0	0	0	0	0	0	0.18	0.24	0.06	0.18	0	0.24	0.06	0	0.06	0	0	17
40	0	0	0	0	0	0	0	0	0.06	0.19	0.13	0.06	0	0.13	0.19	0.06	0.06	0.06	0.06	0	16
41	0	0	0	0	0	0	0	0.06	0	0.18	0.06	0	0.35	0	0.06	0.06	0.12	0	0.06	0.06	17
42	0	0	0	0	0	0	0.08	0	0	0.08	0.25	0	0.17	0	0.08	0.08	0.08	0	0	0.17	12
43	0	0	0	0	0	0	0	0	0	0.09	0.09	0	0	0	0.27	0.09	0.18	0	0	0.27	11
44	0	0	0	0	0	0	0	0	0.09	0	0	0	0.09	0	0.27	0.09	0.18	0	0.09	0.18	11
45	0	0	0	0	0	0	0	0	0	0	0.14	0.14	0.14	0	0.14	0	0	0	0.29	0.14	7
46	0	0	0	0	0	0	0	0	0	0	0	0	0.20	0	0	0	0.20	0	0.40	0.20	5
47	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.33	0.17	0	0	0.17	0.33	6
48	0	0	0	0	0	0	0	0	0	0	0	0	0.20	0	0.20	0.20	0	0	0.20	0.20	5
49	0	0	0	0	0	0	0	0	0	0	0.50	0	0	0	0	0	0	0.50	0	0	2
50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.00	1
51	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.50	0	0	0.50	2
52	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.00	1
53	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.50	0.50	2
54	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.00	1
55	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.50	0	0	0	0.50	2
56	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.33	0	0	0.67	3
57	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
58	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
59	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.00	1
61	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.50	0	0	0.50	2
62	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
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	0	0
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	0	1.00	1
67	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
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	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	2
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	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	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
81	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
82	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
83	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
84	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.00	1
85	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total																					475

Appendix 3 – continued:
Estimates of proportion of length at age for snapper sampled from East Northland (statistical area 003), spring-winter 2017–18. (Note: Aged to 01/01/18)

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	0.20	0.40	0	0.20	0.20	0	0	0	0	0	0	0	0	0	0	0	0	0	5
26	0	0	0.43	0.14	0	0.14	0.29	0	0	0	0	0	0	0	0	0	0	0	0	0	7
27	0	0	0.06	0.22	0.44	0.17	0.11	0	0	0	0	0	0	0	0	0	0	0	0	0	18
28	0	0	0	0.17	0.09	0.39	0.30	0.04	0	0	0	0	0	0	0	0	0	0	0	0	23
29	0	0	0.03	0.06	0.33	0.14	0.31	0.08	0.06	0	0	0	0	0	0	0	0	0	0	0	36
30	0	0	0	0	0.12	0.24	0.39	0.15	0.05	0	0.05	0	0	0	0	0	0	0	0	0	41
31	0	0	0	0.02	0.11	0.06	0.53	0.09	0.04	0.09	0.06	0	0	0	0	0	0	0	0	0	47
32	0	0	0	0	0.09	0.07	0.31	0.18	0.20	0.04	0.09	0	0.02	0	0	0	0	0	0	0	55
33	0	0	0	0	0.03	0.11	0.42	0.14	0.11	0.08	0.06	0	0.06	0	0	0	0	0	0	0	36
34	0	0	0	0	0	0.03	0.13	0.06	0.31	0.19	0.09	0.06	0.06	0.03	0	0.03	0	0	0	0	32
35	0	0	0	0	0	0	0.20	0.13	0.13	0.17	0.17	0.07	0.03	0	0.03	0	0.03	0	0.03	0	30
36	0	0	0	0	0	0.09	0.09	0.03	0.16	0.13	0.22	0.13	0	0.06	0	0	0.03	0.03	0.03	0	32
37	0	0	0	0	0	0	0.15	0.15	0.04	0.19	0.11	0.11	0.04	0	0.11	0.07	0	0.04	0	0	27
38	0	0	0	0	0	0	0	0	0.06	0.12	0.12	0.12	0.12	0.06	0.18	0.18	0.06	0	0	0	17
39	0	0	0	0	0	0	0	0	0.08	0.08	0.08	0.23	0.15	0	0.15	0.08	0.15	0	0	0	13
40	0	0	0	0	0	0	0	0	0	0	0.29	0	0.14	0	0.14	0.07	0.14	0	0.07	0.14	14
41	0	0	0	0	0	0.10	0	0	0.10	0	0.10	0.30	0.20	0	0.20	0	0	0	0	0	10
42	0	0	0	0	0	0	0	0	0	0	0.13	0	0	0	0	0.13	0.50	0.13	0	0.13	8
43	0	0	0	0	0	0	0	0	0	0	0	0	0	0.09	0.18	0.36	0	0	0.27	0.09	11
44	0	0	0	0	0	0	0	0	0	0	0	0	0.13	0.25	0.13	0	0.25	0.13	0	0.13	8
45	0	0	0	0	0	0	0	0	0	0.10	0.10	0	0.10	0.10	0.10	0	0.10	0	0.10	0.30	10
46	0	0	0	0	0	0	0	0	0	0	0	0	0.25	0	0	0	0	0.25	0	0.50	4
47	0	0	0	0	0	0	0	0	0	0	0	0	0.33	0	0.33	0	0	0	0	0.33	3
48	0	0	0	0	0	0	0	0	0	0	0	0.50	0	0.50	0	0	0	0	0	0	2
49	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.67	0.33	0	0	0	0	3
50	0	0	0	0	0	0	0	0	0	0	0	0	0.33	0	0	0	0	0	0	0.67	3
51	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.00	4
52	0	0	0	0	0	0	0	0	0	0	0	0	0.33	0.33	0	0	0	0	0.33	0	3
53	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.50	0.50	2
54	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.00	1
55	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.00	1
56	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.00	1
57	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.00	1
58	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.00	0	0	0	0	0	1
59	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.00	0	0	0	0	0	1
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	1.00	0	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	0	0
66	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.00	1
67	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
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	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	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	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																					515

Appendix 3 – continued:
Estimates of proportion of length at age for snapper sampled from the Hauraki Gulf, spring-winter 2017–18.
(Note: Aged to 01/01/18)

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	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
25	0	0	0	0.38	0.34	0.09	0.13	0.03	0	0	0.03	0	0	0	0	0	0	0	0	0	32
26	0	0	0.06	0.22	0.26	0.17	0.02	0.09	0.07	0.09	0	0	0.02	0	0	0	0	0	0	0	54
27	0	0	0	0.10	0.24	0.24	0.10	0.10	0.10	0.04	0.05	0	0.01	0	0	0	0	0	0	0	78
28	0	0	0	0.01	0.19	0.24	0.21	0.08	0.08	0.11	0.03	0.02	0.01	0.03	0	0	0	0	0	0.01	106
29	0	0	0	0.01	0.10	0.19	0.16	0.12	0.11	0.12	0.09	0.04	0.01	0.02	0.01	0.02	0	0.01	0	0	101
30	0	0	0	0.03	0.04	0.18	0.16	0.07	0.17	0.09	0.08	0.08	0.01	0.03	0.02	0	0.02	0	0	0	95
31	0	0	0	0	0	0.07	0.17	0.14	0.16	0.14	0.08	0.08	0.03	0.02	0.03	0.03	0	0.02	0	0.02	92
32	0	0	0	0	0	0.10	0.16	0.13	0.18	0.09	0.16	0.03	0.03	0.05	0.01	0.02	0	0	0	0.02	97
33	0	0	0	0	0.03	0.05	0.05	0.11	0.18	0.10	0.11	0.15	0.08	0.03	0.02	0.01	0.05	0.01	0	0	87
34	0	0	0	0	0	0.06	0.08	0.10	0.10	0.15	0.22	0.13	0.03	0	0.06	0.03	0.01	0.01	0	0.03	72
35	0	0	0	0	0.02	0.04	0.04	0.07	0.18	0.11	0.23	0.05	0.04	0.05	0.05	0.04	0.04	0.02	0.02	0.04	57
36	0	0	0	0	0	0.04	0.02	0.09	0.09	0.04	0.15	0.16	0.07	0.11	0.04	0.05	0.07	0.02	0.02	0.04	55
37	0	0	0	0	0	0	0	0.13	0.03	0.09	0.25	0.22	0.06	0.06	0.03	0.03	0.03	0.03	0.03	0	32
38	0	0	0	0	0	0	0	0	0.07	0.04	0.15	0.15	0.07	0.04	0.04	0.19	0.07	0.04	0.04	0.11	27
39	0	0	0	0	0	0	0.03	0.07	0.14	0.03	0.14	0.07	0	0.03	0.17	0.10	0.03	0.03	0.07	0.07	29
40	0	0	0	0	0	0	0	0.14	0	0.10	0.05	0.10	0.05	0.14	0	0.14	0.10	0.05	0.10	0.05	21
41	0	0	0	0	0	0	0	0	0.13	0.13	0	0.25	0.38	0	0	0	0	0	0	0.13	8
42	0	0	0	0	0	0	0	0.06	0	0.18	0	0.06	0.12	0.06	0.18	0.18	0.12	0	0.06	0	17
43	0	0	0	0	0	0	0	0	0	0	0.07	0.14	0.07	0.14	0	0	0.14	0.07	0.21	0.14	14
44	0	0	0	0	0	0	0	0	0	0.08	0.08	0	0.08	0.08	0.08	0.15	0.08	0.15	0	0.23	13
45	0	0	0	0	0	0	0	0	0	0	0.09	0	0.09	0	0.36	0	0.09	0	0.18	0.18	11
46	0	0	0	0	0	0	0	0	0.11	0.11	0	0.22	0	0.11	0.11	0.11	0	0.11	0	0.11	9
47	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.20	0	0.20	0	0.60	5
48	0	0	0	0	0	0	0	0	0	0	0	0.14	0	0	0.14	0	0	0.14	0.14	0.43	7
49	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.33	0	0	0	0.33	0.33	3
50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.33	0.33	0.33	3
51	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.25	0	0	0	0.75	4
52	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.00	0	1
53	0	0	0	0	0	0	0	0	0	0	0	0	0	0.33	0	0	0	0.33	0.33	0	3
54	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.00	0	0	1
55	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
56	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.50	0	0	0	0.50	0	2
57	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.00	1
58	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.00	1
59	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.00	2
60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
61	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.00	1
62	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
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	0	0
65	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
66	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
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	1.00	0	0	0	0	1
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	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	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	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																					1145

Appendix 3 – continued:
Estimates of proportion of length at age for snapper sampled from the Bay of Plenty, spring-winter 2017–18.
(Note: Aged to 01/01/18)

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	0.20	0.52	0.28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	25
26	0	0	0	0.34	0.51	0.11	0.03	0	0	0	0	0	0	0	0	0	0	0	0	0	35
27	0	0	0.02	0.20	0.56	0.16	0.07	0	0	0	0	0	0	0	0	0	0	0	0	0	45
28	0	0	0	0.10	0.61	0.19	0.07	0.03	0	0	0	0	0	0	0	0	0	0	0	0	70
29	0	0	0	0.11	0.40	0.31	0.13	0.05	0	0	0	0	0	0	0	0	0	0	0	0	75
30	0	0	0.02	0	0.37	0.30	0.18	0.09	0	0.04	0	0	0.02	0	0	0	0	0	0	0	57
31	0	0	0	0.01	0.12	0.30	0.28	0.13	0.03	0.06	0.06	0	0	0.01	0	0	0	0	0	0	69
32	0	0	0	0.01	0.06	0.14	0.37	0.18	0.10	0.07	0.04	0	0.01	0	0	0.01	0	0	0	0	71
33	0	0	0	0	0.04	0.13	0.27	0.18	0.12	0.08	0.11	0.05	0	0.01	0.01	0	0	0	0	0	83
34	0	0	0	0	0.02	0.02	0.16	0.16	0.13	0.30	0.11	0.08	0.02	0	0	0	0	0	0	0	61
35	0	0	0	0	0.01	0.01	0.15	0.09	0.26	0.18	0.15	0.08	0.04	0	0	0.01	0.01	0	0	0	74
36	0	0	0	0	0.01	0.03	0.06	0.13	0.10	0.16	0.25	0.14	0.04	0.04	0.03	0.01	0	0.01	0	0	80
37	0	0	0	0	0	0.02	0.10	0.05	0.10	0.11	0.21	0.18	0.10	0.05	0.03	0	0.02	0.02	0	0.02	61
38	0	0	0	0	0	0	0.03	0	0.05	0.08	0.26	0.13	0.11	0.05	0.08	0.11	0.05	0	0.05	0	38
39	0	0	0	0	0	0	0	0	0.05	0.08	0.28	0.13	0.05	0.15	0.05	0.13	0.08	0	0	0.03	40
40	0	0	0	0	0	0	0.04	0.07	0	0.04	0.11	0.11	0.07	0.11	0	0.14	0.14	0.11	0.07	0	28
41	0	0	0	0	0	0	0	0	0	0	0.13	0	0.31	0.13	0.06	0.06	0.06	0.19	0.06	0	16
42	0	0	0	0	0	0	0	0	0	0.05	0.10	0	0.10	0.25	0.15	0.05	0.10	0	0.15	0.05	20
43	0	0	0	0	0	0	0	0	0	0	0	0.13	0	0.50	0.13	0.13	0	0	0.13	0	8
44	0	0	0	0	0	0	0	0	0	0.06	0.12	0.12	0	0.18	0.12	0.18	0.06	0.06	0.12	0	17
45	0	0	0	0	0	0	0	0	0	0	0.13	0	0	0.25	0.13	0	0.25	0	0.13	0.13	8
46	0	0	0	0	0	0	0	0	0	0	0	0	0	0.20	0	0.20	0.20	0	0	0.40	5
47	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.13	0.13	0	0.13	0.38	0.25	8
48	0	0	0	0	0	0	0	0	0	0	0.20	0	0	0.20	0	0	0	0	0	0.60	5
49	0	0	0	0	0	0	0	0	0	0	0	0.50	0	0	0	0	0.50	0	0	0	2
50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.40	0	0	0	0.20	0.40	5
51	0	0	0	0	0	0	0	0	0	0	0	0.25	0	0	0	0.25	0.25	0	0.25	0	4
52	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.00	1
53	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
54	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.00	3
55	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
56	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
57	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
58	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
59	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
61	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
62	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
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	0	0	0	0	0	0	0
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	0	0	0
67	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
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	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	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	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																					1015

Appendix 4: Estimated mean weight-at-age (kg) and coefficents of variation (CVs) for snapper bottom longline fisheries in SNA 1 in 2017–18.

Estimates of mean weight-at-age (kg) with coefficients of variation for snapper from the East Northland bottom longline fishery in 2017–18.

Age	Spring		Summer		Autumn		Winter		Spr-win	
(years)	Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV
1	–	–	–	–	–	–	–	–	–	–
2	–	–	–	–	–	–	–	–	–	–
3	–	–	0.40	0.33	0.47	0.23	0.45	0.36	0.44	0.07
4	0.49	0.23	0.48	0.27	0.52	0.08	0.76	0.11	0.57	0.07
5	0.60	0.10	0.49	0.05	0.53	0.05	0.62	0.08	0.56	0.04
6	0.52	0.10	0.58	0.07	0.59	0.05	0.72	0.11	0.60	0.04
7	0.69	0.09	0.65	0.05	0.63	0.03	0.78	0.06	0.67	0.03
8	0.81	0.11	0.67	0.08	0.71	0.06	0.90	0.09	0.75	0.04
9	0.89	0.06	0.82	0.05	0.76	0.06	0.97	0.09	0.85	0.04
10	1.14	0.08	0.98	0.10	0.88	0.13	1.04	0.13	0.99	0.05
11	1.32	0.12	1.08	0.09	0.86	0.12	1.09	0.09	1.05	0.06
12	1.15	0.16	1.02	0.11	1.08	0.23	1.37	0.18	1.13	0.06
13	1.52	0.16	1.40	0.09	1.03	0.17	1.24	0.13	1.30	0.06
14	1.40	0.16	0.85	0.98	–	–	1.45	0.42	1.38	0.14
15	1.88	0.14	1.34	0.12	1.70	0.34	1.39	0.08	1.52	0.06
16	1.63	0.59	1.59	0.14	1.37	0.32	1.50	0.15	1.50	0.08
17	1.39	0.23	1.70	0.34	1.41	0.23	1.67	0.14	1.59	0.09
18	1.03	0.78	1.36	0.47	1.72	0.48	1.86	0.51	1.62	0.20
19	1.96	0.23	1.78	0.21	1.23	0.35	2.14	0.29	1.81	0.12
20	–	–	–	–	1.65	0.55	2.15	0.40	2.01	0.21
21	–	–	3.24	1.01	–	–	1.97	0.94	2.52	0.60
22	2.55	0.54	2.22	0.43	2.69	0.84	–	–	2.39	0.26
23	–	–	1.63	1.03	1.67	0.33	–	–	1.67	0.23
24	–	–	3.61	0.56	2.78	0.66	1.85	0.99	3.03	0.35
25	–	–	1.33	1.00	–	–	1.85	1.06	1.55	0.63
26	4.13	0.97	–	–	–	–	–	–	4.13	0.97
27	–	–	–	–	–	–	–	–	–	–
28	3.77	0.60	–	–	2.77	1.03	2.56	0.36	2.84	0.18
29	4.86	0.79	–	–	–	–	–	–	4.86	0.79
>29	3.73	0.59	4.07	0.35	5.51	0.45	3.24	0.36	3.95	0.16

Appendix 4 – continued:
Estimates of mean weight-at-age (kg) with coefficients of variation for snapper from the East Northland (statistical area 002) bottom longline fishery in 2017–18.

Age	Spring		Summer		Autumn		Winter		Spr-win	
(years)	Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV
1	–	–	–	–	–	–	–	–	–	–
2	–	–	–	–	–	–	–	–	–	–
3	–	–	0.44	1.06	0.47	0.55	0.46	0.48	0.46	0.15
4	0.60	0.56	0.49	0.99	0.52	0.09	0.79	0.12	0.62	0.09
5	0.63	0.34	0.50	0.24	0.50	0.08	0.63	0.15	0.55	0.06
6	0.49	0.15	0.58	0.13	0.61	0.05	0.64	0.11	0.58	0.06
7	0.65	0.12	0.65	0.07	0.65	0.05	0.81	0.10	0.68	0.04
8	0.78	0.21	0.64	0.11	0.73	0.08	1.14	0.25	0.77	0.08
9	0.85	0.16	0.94	0.06	0.85	0.11	1.15	0.20	0.96	0.07
10	1.38	0.37	1.20	0.13	0.88	0.23	1.21	0.41	1.14	0.07
11	1.55	0.44	1.26	0.13	1.12	0.80	1.36	0.17	1.33	0.08
12	1.07	0.98	1.05	0.22	1.15	0.79	1.33	1.01	1.11	0.11
13	1.44	0.49	1.37	0.16	1.15	0.32	1.35	0.16	1.31	0.07
14	1.24	0.41	–	–	–	–	–	–	1.24	0.45
15	1.60	0.20	1.32	0.27	1.66	0.49	1.52	0.10	1.52	0.07
16	1.63	1.03	1.71	0.23	–	–	1.68	0.35	1.69	0.13
17	1.44	0.31	1.86	0.63	1.56	0.57	2.21	0.29	1.87	0.17
18	0.00	0.00	1.36	0.47	–	–	1.25	0.29	1.30	0.19
19	2.02	0.28	2.07	0.30	1.16	0.79	1.85	0.53	1.84	0.10
20	–	–	–	–	–	–	–	–	0.00	0.00
21	–	–	–	–	–	–	–	–	0.00	0.00
22	2.23	0.66	3.16	0.59	2.69	0.84	–	–	2.63	0.30
23	–	–	1.63	1.03	1.61	0.54	–	–	1.62	0.36
24	–	–	3.00	0.83	2.78	0.66	1.85	0.99	2.67	0.43
25	–	–	–	–	–	–	–	–	–	–
26	4.13	0.97	–	–	–	–	–	–	4.13	1.00
27	–	–	–	–	–	–	–	–	–	–
28	2.92	0.94	–	–	2.77	1.03	1.63	1.10	2.50	0.41
29	4.86	0.79	–	–	–	–	–	–	4.86	0.81
>29	4.10	0.91	4.24	0.44	7.10	0.52	4.28	0.80	4.94	0.23

Appendix 4 – continued:
Estimates of mean weight-at-age (kg) with coefficients of variation for snapper from the East Northland (statistical area 003) bottom longline fishery in 2017–18.

Age	Spring		Summer		Autumn		Winter		Spr-win	
(years)	Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV
1	–	–	–	–	–	–	–	–	–	–
2	–	–	–	–	–	–	–	–	–	–
3	–	–	0.39	0.45	0.47	0.55	0.40	1.06	0.42	0.19
4	0.40	0.38	0.48	0.39	0.51	0.46	0.49	0.82	0.48	0.08
5	0.58	0.05	0.49	0.07	0.55	0.07	0.62	0.10	0.56	0.04
6	0.61	0.13	0.58	0.12	0.57	0.08	0.86	0.18	0.62	0.06
7	0.79	0.05	0.66	0.06	0.60	0.05	0.76	0.08	0.66	0.03
8	0.83	0.11	0.68	0.10	0.70	0.09	0.81	0.08	0.73	0.04
9	0.91	0.08	0.75	0.10	0.71	0.09	0.86	0.08	0.79	0.04
10	1.04	0.12	0.85	0.10	0.88	0.19	0.92	0.35	0.91	0.07
11	1.17	0.11	0.98	0.13	0.83	0.13	1.00	0.15	0.95	0.07
12	1.17	0.23	0.99	0.24	1.04	0.35	1.38	0.22	1.14	0.08
13	1.59	0.22	1.42	0.13	0.81	0.42	1.00	0.60	1.28	0.11
14	1.62	0.27	0.85	0.98	–	–	1.45	0.42	1.44	0.19
15	2.28	0.23	1.35	0.18	1.74	1.05	1.31	0.34	1.53	0.11
16	1.63	1.03	1.49	0.45	1.37	0.32	1.41	0.35	1.42	0.10
17	1.15	1.04	1.61	0.39	1.35	0.47	1.32	0.12	1.40	0.06
18	1.03	0.78	–	–	1.72	0.48	4.53	1.05	1.93	0.42
19	1.63	0.99	1.56	0.48	1.28	0.62	2.25	0.45	1.79	0.22
20	–	–	–	–	1.65	0.55	2.15	0.40	2.01	0.21
21	–	–	3.24	1.01	–	–	1.97	0.94	2.52	0.62
22	5.40	1.02	1.56	0.58	–	–	–	–	1.94	0.68
23	–	–	–	–	1.74	0.99	–	–	1.74	1.00
24	–	–	4.95	1.01	–	–	–	–	4.95	1.01
25	–	–	1.33	1.00	–	–	1.85	1.06	1.55	0.58
26	–	–	–	–	–	–	–	–	–	–
27	–	–	–	–	–	–	–	–	–	–
28	4.74	1.01	–	–	–	–	2.71	0.45	3.01	0.35
29	–	–	–	–	–	–	–	–	–	–
>29	2.92	0.99	3.58	0.99	2.63	1.02	2.79	0.43	2.89	0.17

Appendix 4 – continued:
Estimates of mean weight-at-age (kg) with coefficients of variation for snapper from the Hauraki Gulf bottom longline fishery in 2017–18.

Age	Spring		Summer		Autumn		Winter		Spr-win	
(years)	Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV
1	–	–	–	–	–	–	–	–	–	–
2	–	–	–	–	–	–	–	–	–	–
3	–	–	–	–	0.40	0.99	0.40	0.84	0.40	0.51
4	0.36	0.85	0.42	0.60	0.40	0.06	0.41	0.07	0.40	0.04
5	0.46	0.15	0.46	0.05	0.45	0.05	0.46	0.06	0.46	0.03
6	0.50	0.11	0.53	0.09	0.53	0.05	0.54	0.07	0.53	0.03
7	0.54	0.10	0.57	0.07	0.63	0.07	0.59	0.08	0.58	0.04
8	0.61	0.16	0.61	0.16	0.73	0.07	0.65	0.09	0.64	0.09
9	0.56	0.09	0.72	0.06	0.74	0.10	0.64	0.07	0.68	0.04
10	0.63	0.17	0.69	0.11	0.83	0.09	0.64	0.08	0.69	0.07
11	0.77	0.13	0.83	0.13	0.80	0.08	0.77	0.06	0.80	0.07
12	0.79	0.11	1.03	0.17	1.00	0.11	0.82	0.10	0.93	0.09
13	1.25	0.23	0.77	0.27	0.79	0.29	0.94	0.11	0.92	0.14
14	0.91	0.34	0.88	0.17	0.66	0.66	0.98	0.17	0.89	0.11
15	1.17	0.23	1.04	0.19	1.29	0.25	0.93	0.29	1.14	0.10
16	2.72	0.53	1.11	0.11	1.14	0.61	1.43	0.28	1.53	0.23
17	1.36	0.38	0.97	0.18	1.12	0.24	1.15	0.22	1.13	0.12
18	2.33	0.27	1.41	0.29	0.81	0.81	1.21	0.53	1.69	0.21
19	1.74	0.34	1.62	0.19	1.24	1.09	2.14	0.29	1.68	0.09
20	1.89	0.21	1.48	0.18	–	–	1.54	0.62	1.64	0.13
21	–	–	0.85	0.98	–	–	1.98	0.43	1.36	0.43
22	3.37	0.52	1.14	0.62	–	–	–	–	1.85	0.48
23	–	–	1.36	0.72	–	–	–	–	1.36	0.72
24	–	–	4.74	1.00	–	–	–	–	4.74	1.00
25	–	–	–	–	–	–	–	–	–	–
26	–	–	–	–	–	–	–	–	–	–
27	–	–	0.95	0.70	–	–	2.22	1.03	1.00	0.57
28	–	–	–	–	–	–	–	–	–	–
29	0.49	1.06	–	–	–	–	3.94	1.04	0.77	1.20
>29	4.05	0.58	–	–	–	–	1.85	0.83	3.16	0.45

Appendix 4 – continued:
Estimates of mean weight-at-age (kg) with coefficients of variation for snapper from the Bay of Plenty bottom longline fishery in 2017–18.

Age	Spring		Summer		Autumn		Winter		Spr-win	
(years)	Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV
1	–	–	–	–	–	–	–	–	–	–
2	–	–	–	–	–	–	–	–	–	–
3	–	–	0.36	1.01	0.47	0.64	0.38	0.46	0.39	0.19
4	0.53	0.62	0.42	0.15	0.43	0.06	0.46	0.06	0.44	0.04
5	0.50	0.08	0.51	0.04	0.49	0.05	0.55	0.03	0.52	0.02
6	0.62	0.08	0.60	0.06	0.57	0.06	0.65	0.05	0.61	0.03
7	0.75	0.06	0.73	0.05	0.67	0.07	0.76	0.06	0.72	0.04
8	0.79	0.07	0.80	0.05	0.77	0.10	0.83	0.05	0.79	0.04
9	0.90	0.06	0.92	0.06	0.85	0.04	0.91	0.04	0.89	0.02
10	0.92	0.05	0.92	0.08	0.88	0.08	1.00	0.05	0.93	0.04
11	0.98	0.07	1.07	0.06	0.97	0.07	1.14	0.08	1.05	0.04
12	1.12	0.12	1.05	0.07	1.05	0.19	1.14	0.12	1.10	0.07
13	1.22	0.13	1.15	0.18	1.15	0.09	0.98	0.39	1.13	0.06
14	1.45	0.08	1.40	0.27	1.22	0.09	1.56	0.21	1.40	0.06
15	1.62	0.17	1.55	0.44	1.29	0.34	0.95	0.51	1.37	0.11
16	1.40	0.29	1.22	0.38	1.24	0.11	1.50	0.19	1.36	0.08
17	1.66	0.18	1.65	0.30	1.44	0.42	1.39	0.20	1.50	0.09
18	1.65	0.40	1.07	1.10	1.33	0.25	1.43	1.00	1.39	0.11
19	1.51	0.18	1.65	0.48	1.76	0.40	2.15	0.50	1.78	0.09
20	1.97	0.56	2.48	0.61	2.48	1.02	2.02	0.58	2.14	0.18
21	1.53	0.98	–	–	–	–	2.04	0.55	1.91	0.38
22	–	–	1.97	1.01	–	–	–	–	1.97	1.01
23	2.09	0.95	–	–	–	–	–	–	2.09	0.95
24	–	–	–	–	5.17	1.05	–	–	5.17	1.05
25	–	–	–	–	2.48	1.05	–	–	2.48	1.05
26	–	–	–	–	–	–	–	–	–	–
27	–	–	–	–	–	–	–	–	–	–
28	3.08	0.97	–	–	–	–	–	–	3.08	0.97
29	–	–	–	–	2.22	0.98	–	–	2.22	0.98
>29	2.77	0.99	–	–	–	–	–	–	2.77	0.99

Appendix 5: Estimated mean length-at-age (cm) and coefficents of variation (CVs) for snapper bottom longline fisheries in SNA 1 in 2017–18.

Estimates of mean length-at-age (cm) with coefficients of variation for snapper from the East Northland bottom longline fishery in 2017–18.

Age	Spring		Summer		Autumn		Winter		Spr-win	
(years)	Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV
1	–	–	–	–	–	–	–	–	–	–
2	–	–	–	–	–	–	–	–	–	–
3	–	–	26.07	0.33	27.52	0.21	27.00	0.33	26.81	0.02
4	27.71	0.18	27.81	0.26	28.45	0.04	32.45	0.06	29.29	0.02
5	29.95	0.04	27.93	0.02	28.57	0.02	30.25	0.03	29.07	0.01
6	28.38	0.03	29.50	0.02	29.68	0.02	31.75	0.04	29.81	0.01
7	31.39	0.03	30.87	0.02	30.40	0.01	32.79	0.02	31.09	0.01
8	33.16	0.04	31.04	0.03	31.84	0.02	34.59	0.03	32.28	0.01
9	34.48	0.02	33.54	0.02	32.54	0.02	35.51	0.03	33.92	0.01
10	37.70	0.03	35.61	0.03	34.07	0.04	36.45	0.10	35.68	0.02
11	39.42	0.04	36.87	0.03	33.88	0.04	37.03	0.04	36.39	0.02
12	37.83	0.14	36.13	0.05	37.03	0.22	40.19	0.10	37.48	0.02
13	41.39	0.06	40.33	0.03	36.19	0.13	38.76	0.09	39.23	0.02
14	40.46	0.09	34.00	0.98	–	–	40.67	0.28	40.09	0.05
15	44.50	0.04	39.71	0.04	43.42	0.31	40.47	0.04	41.53	0.02
16	43.00	0.59	42.18	0.05	39.82	0.23	41.58	0.11	41.31	0.03
17	40.58	0.22	42.67	0.15	40.67	0.21	42.79	0.04	42.09	0.03
18	36.50	0.78	39.81	0.35	43.79	0.47	43.34	0.24	42.00	0.06
19	45.83	0.21	43.66	0.11	38.65	0.30	46.69	0.15	43.90	0.04
20	–	–	–	–	42.99	0.53	47.34	0.39	46.15	0.17
21	–	–	55.00	1.01	–	–	46.00	0.94	49.87	0.56
22	48.91	0.34	46.96	0.24	51.00	0.81	–	–	48.15	0.10
23	–	–	43.00	1.03	43.40	0.32	–	–	43.32	0.23
24	–	–	54.78	0.41	51.43	0.57	45.00	0.99	51.92	0.16
25	–	–	40.00	1.00	–	–	45.00	1.06	42.10	0.61
26	60.00	0.97	–	–	–	–	–	–	60.00	0.97
27	–	–	–	–	–	–	–	–	–	–
28	57.69	0.56	–	–	52.00	1.03	50.19	0.32	52.00	0.11
29	63.50	0.78	–	–	–	–	–	–	63.50	0.78
>29	56.44	0.51	58.35	0.19	64.98	0.35	53.89	0.21	57.48	0.05

Appendix 5 – continued:
Estimates of mean length-at-age (cm) with coefficients of variation for snapper from the East Northland (statistical area 002) bottom longline fishery in 2017–18.

Age	Spring		Summer		Autumn		Winter		Spr-win	
(years)	Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV
1	–	–	–	–	–	–	–	–	–	–
2	–	–	–	–	–	–	–	–	–	–
3	–	–	27.00	1.06	27.53	0.54	27.26	0.45	27.31	0.11
4	30.08	0.55	28.00	0.99	28.53	0.05	33.10	0.10	30.23	0.03
5	30.26	0.26	28.08	0.23	28.00	0.04	30.13	0.08	28.97	0.02
6	27.72	0.06	29.49	0.10	30.14	0.02	30.49	0.04	29.44	0.02
7	30.70	0.04	30.73	0.03	30.90	0.02	33.13	0.04	31.16	0.01
8	32.68	0.11	30.60	0.04	32.28	0.07	37.73	0.22	32.57	0.03
9	33.97	0.13	35.16	0.04	33.96	0.08	37.72	0.16	35.34	0.02
10	40.46	0.37	38.29	0.08	34.36	0.20	38.62	0.40	37.65	0.03
11	41.86	0.40	38.97	0.05	37.50	0.80	40.18	0.15	39.69	0.03
12	37.00	0.98	36.31	0.11	38.00	0.79	40.00	1.01	37.29	0.05
13	40.87	0.45	39.92	0.07	37.73	0.31	40.21	0.15	39.53	0.02
14	38.96	0.40	–	–	–	–	–	–	38.96	0.45
15	42.54	0.17	39.63	0.20	43.01	0.44	41.79	0.07	41.70	0.03
16	43.00	1.03	42.99	0.10	0	0	43.28	0.32	43.09	0.05
17	41.07	0.31	42.57	0.36	42.31	0.57	47.52	0.22	44.26	0.06
18	–	–	39.81	0.35	–	–	39.08	0.29	39.43	0.10
19	46.38	0.27	46.56	0.27	38.00	0.78	45.00	0.53	44.56	0.04
20	–	–	–	–	–	–	–	–	–	–
21	–	–	–	–	–	–	–	–	–	–
22	47.02	0.47	53.58	0.47	51.00	0.81	–	–	49.98	0.14
23	–	–	43.00	1.03	42.79	0.53	–	–	42.86	0.36
24	–	–	50.54	0.60	51.43	0.57	45.00	0.99	49.63	0.21
25	–	–	–	–	–	–	–	–	–	–
26	60.00	0.97	–	–	–	–	–	–	60.00	1.00
27	–	–	–	–	–	–	–	–	–	–
28	53.00	0.94	–	–	52.00	1.03	43.00	1.10	49.83	0.37
29	63.50	0.78	–	–	–	–	–	–	63.50	0.81
>29	58.00	0.82	58.84	0.27	72.72	0.51	58.05	0.60	61.94	0.10

Appendix 5 – continued:
Estimates of mean length-at-age (cm) with coefficients of variation for snapper from the East Northland (statistical area 003) bottom longline fishery in 2017–18.

Age	Spring		Summer		Autumn		Winter		Spr-win	
(years)	Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV
1	–	–	–	–	–	–	–	–	–	–
2	–	–	–	–	–	–	–	–	–	–
3	–	–	25.78	0.44	27.50	0.53	26.00	1.06	26.33	0.18
4	25.87	0.37	27.75	0.39	28.32	0.44	28.00	0.82	27.78	0.04
5	29.74	0.02	27.83	0.04	29.10	0.03	30.44	0.09	29.17	0.01
6	30.13	0.07	29.51	0.06	29.36	0.03	33.78	0.08	30.22	0.02
7	33.00	0.02	30.97	0.02	29.99	0.02	32.51	0.03	31.02	0.01
8	33.63	0.04	31.31	0.03	31.67	0.03	33.36	0.06	32.13	0.02
9	34.80	0.04	32.49	0.07	31.83	0.06	34.14	0.03	33.08	0.02
10	36.52	0.09	34.01	0.07	33.93	0.08	34.98	0.35	34.62	0.02
11	37.91	0.05	35.59	0.08	33.43	0.04	35.88	0.11	35.17	0.02
12	38.06	0.22	35.97	0.24	36.45	0.33	40.22	0.14	37.57	0.03
13	41.77	0.09	40.71	0.06	33.41	0.42	35.79	0.55	38.86	0.04
14	42.50	0.22	34.00	0.98	–	–	40.67	0.28	40.52	0.06
15	47.31	0.10	39.75	0.10	44.00	1.05	39.54	0.32	41.37	0.03
16	43.00	1.03	41.51	0.44	39.82	0.23	40.76	0.33	40.61	0.03
17	38.00	1.04	42.72	0.38	39.91	0.45	39.80	0.10	40.55	0.02
18	36.50	0.78	–	–	43.79	0.47	62.00	1.05	44.63	0.24
19	43.00	0.99	41.45	0.35	39.05	0.56	47.33	0.31	43.42	0.07
20	–	–	–	–	42.99	0.53	47.34	0.39	46.14	0.18
21	–	–	55.00	1.01	–	–	46.00	0.94	49.87	0.58
22	66.00	1.02	42.30	0.58	–	–	–	–	44.65	0.44
23	–	–	–	–	44.00	0.99	–	–	44.00	1.00
24	–	–	64.00	1.01	–	–	–	–	64.00	1.01
25	–	–	40.00	1.00	–	–	45.00	1.06	42.09	0.57
26	–	–	–	–	–	–	–	–	–	–
27	–	–	–	–	–	–	–	–	–	–
28	63.00	1.01	–	–	–	–	51.35	0.44	53.07	0.29
29	–	–	–	–	–	–	–	–	–	–
>29	53.00	0.99	57.00	0.99	51.00	1.02	52.05	0.43	52.68	0.16

Appendix 5 – continued:
Estimates of mean length-at-age (cm) with coefficients of variation for snapper from the Hauraki Gulf bottom longline fishery in 2017–18.

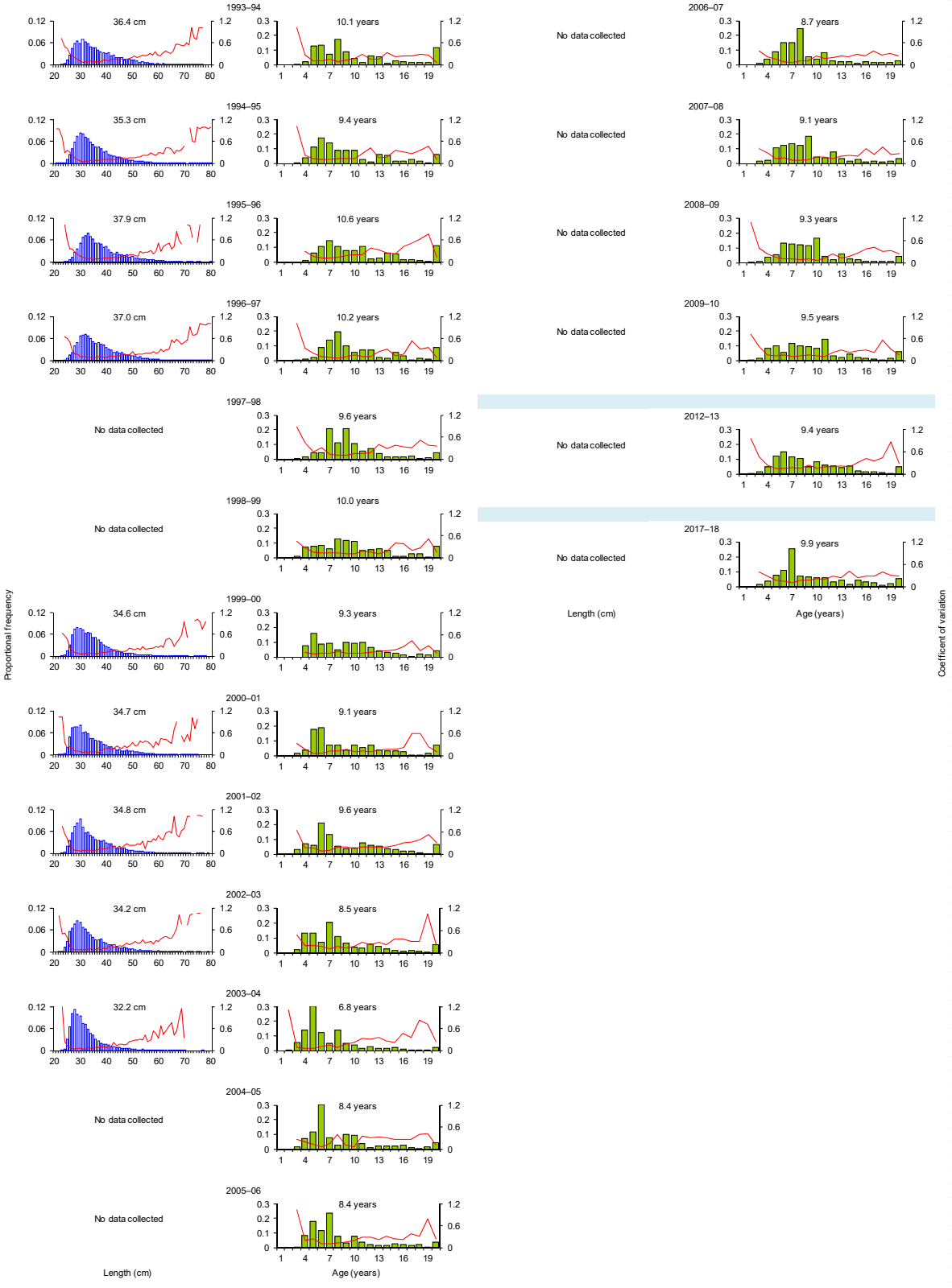
Age	Spring		Summer		Autumn		Winter		Spr-win	
(years)	Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV
1	–	–	–	–	–	–	–	–	–	–
2	–	–	–	–	–	–	–	–	–	–
3	–	–	–	–	26.00	0.99	26.00	0.84	26.00	0.51
4	25.00	0.85	26.35	0.58	26.01	0.02	26.13	0.06	25.94	0.01
5	27.26	0.08	27.24	0.02	27.03	0.02	27.19	0.02	27.17	0.01
6	28.11	0.04	28.65	0.03	28.68	0.02	28.77	0.02	28.55	0.01
7	28.65	0.03	29.47	0.03	30.38	0.03	29.80	0.03	29.46	0.01
8	29.94	0.06	29.92	0.05	32.04	0.02	30.73	0.03	30.37	0.03
9	29.23	0.03	31.89	0.02	32.20	0.03	30.62	0.02	31.19	0.01
10	30.23	0.06	31.23	0.04	33.44	0.03	30.57	0.03	31.18	0.03
11	32.38	0.05	33.34	0.05	33.04	0.03	32.59	0.02	32.93	0.03
12	32.92	0.04	35.68	0.05	35.87	0.04	33.25	0.03	34.57	0.03
13	38.42	0.09	32.22	0.11	32.74	0.18	35.03	0.04	34.26	0.05
14	33.86	0.12	34.08	0.06	30.74	0.58	35.32	0.07	34.09	0.04
15	37.56	0.08	36.29	0.13	38.80	0.09	34.81	0.19	37.19	0.03
16	48.46	0.17	37.12	0.04	37.74	0.60	39.93	0.11	40.16	0.06
17	39.72	0.31	35.31	0.08	37.04	0.11	37.85	0.17	37.16	0.05
18	48.27	0.15	40.06	0.17	32.36	0.61	38.00	0.36	42.26	0.08
19	43.60	0.22	42.70	0.15	39.00	1.09	46.73	0.19	43.12	0.03
20	44.52	0.09	41.07	0.10	–	–	42.10	0.61	42.41	0.05
21	–	–	34.00	0.98	–	–	45.89	0.37	39.37	0.28
22	54.40	0.40	37.56	0.55	–	–	57.00	0.99	43.00	0.20
23	–	–	39.60	0.62	–	–	–	–	39.60	0.62
24	–	–	63.00	1.00	–	–	–	–	63.00	1.00
25	–	–	–	–	–	–	–	–	–	–
26	–	–	–	–	–	–	–	–	–	–
27	–	–	34.66	0.56	–	–	48.00	1.03	35.19	0.39
28	–	–	–	–	–	–	–	–	–	–
29	28.00	1.06	–	–	–	–	59.00	1.04	30.52	0.75
>29	59.52	0.58	–	–	–	–	45.00	0.82	53.64	0.37

Appendix 5 – continued:
Estimates of mean length-at-age (cm) with coefficients of variation for snapper from the Bay of Plenty bottom longline fishery in 2017–18.

Age	Spring		Summer		Autumn		Winter		Spr-win	
(years)	Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV
1	–	–	–	–	–	–	–	–	–	–
2	–	–	–	–	–	–	–	–	–	–
3	–	–	25.00	1.01	27.34	0.59	25.52	0.46	25.79	0.15
4	28.60	0.59	26.41	0.11	26.61	0.02	27.26	0.02	26.91	0.01
5	27.92	0.03	28.20	0.01	27.92	0.02	29.10	0.01	28.46	0.01
6	30.25	0.03	29.97	0.02	29.31	0.02	30.87	0.02	30.06	0.01
7	32.40	0.02	32.22	0.02	31.07	0.02	32.58	0.02	31.96	0.01
8	32.97	0.03	33.27	0.02	32.57	0.03	33.68	0.02	33.06	0.01
9	34.63	0.02	34.97	0.02	33.93	0.01	34.90	0.02	34.56	0.01
10	34.90	0.02	34.98	0.07	34.30	0.03	36.00	0.02	34.97	0.01
11	35.67	0.02	36.90	0.02	35.46	0.02	37.50	0.03	36.44	0.02
12	37.25	0.04	36.65	0.06	36.38	0.09	37.51	0.04	37.08	0.02
13	38.66	0.10	37.87	0.17	37.72	0.03	35.43	0.31	37.45	0.02
14	41.12	0.03	40.60	0.24	38.55	0.03	41.81	0.14	40.43	0.02
15	42.43	0.09	42.14	0.43	39.48	0.32	35.27	0.49	39.95	0.05
16	39.93	0.18	38.63	0.38	38.86	0.07	41.53	0.16	40.02	0.03
17	42.97	0.10	42.90	0.24	40.39	0.33	40.58	0.19	41.41	0.03
18	43.05	0.37	37.00	1.10	39.79	0.21	41.00	1.00	40.48	0.06
19	41.68	0.13	43.00	0.47	43.97	0.35	47.32	0.48	44.10	0.03
20	44.81	0.38	49.81	0.59	50.00	1.02	46.46	0.57	46.87	0.09
21	42.00	0.98	–	–	–	–	46.51	0.55	45.40	0.37
22	–	–	46.00	1.01	–	–	–	–	46.00	1.01
23	47.00	0.95	–	–	–	–	–	–	47.00	0.95
24	–	–	–	–	65.00	1.05	–	–	65.00	1.05
25	–	–	–	–	50.00	1.05	–	–	50.00	1.05
26	–	–	–	–	–	–	–	–	–	–
27	–	–	–	–	–	–	–	–	–	–
28	54.00	0.97	–	–	–	–	–	–	54.00	0.97
29	–	–	–	–	48.00	0.98	–	–	48.00	0.98
>29	52.00	0.99	–	–	–	–	–	–	52.00	0.99

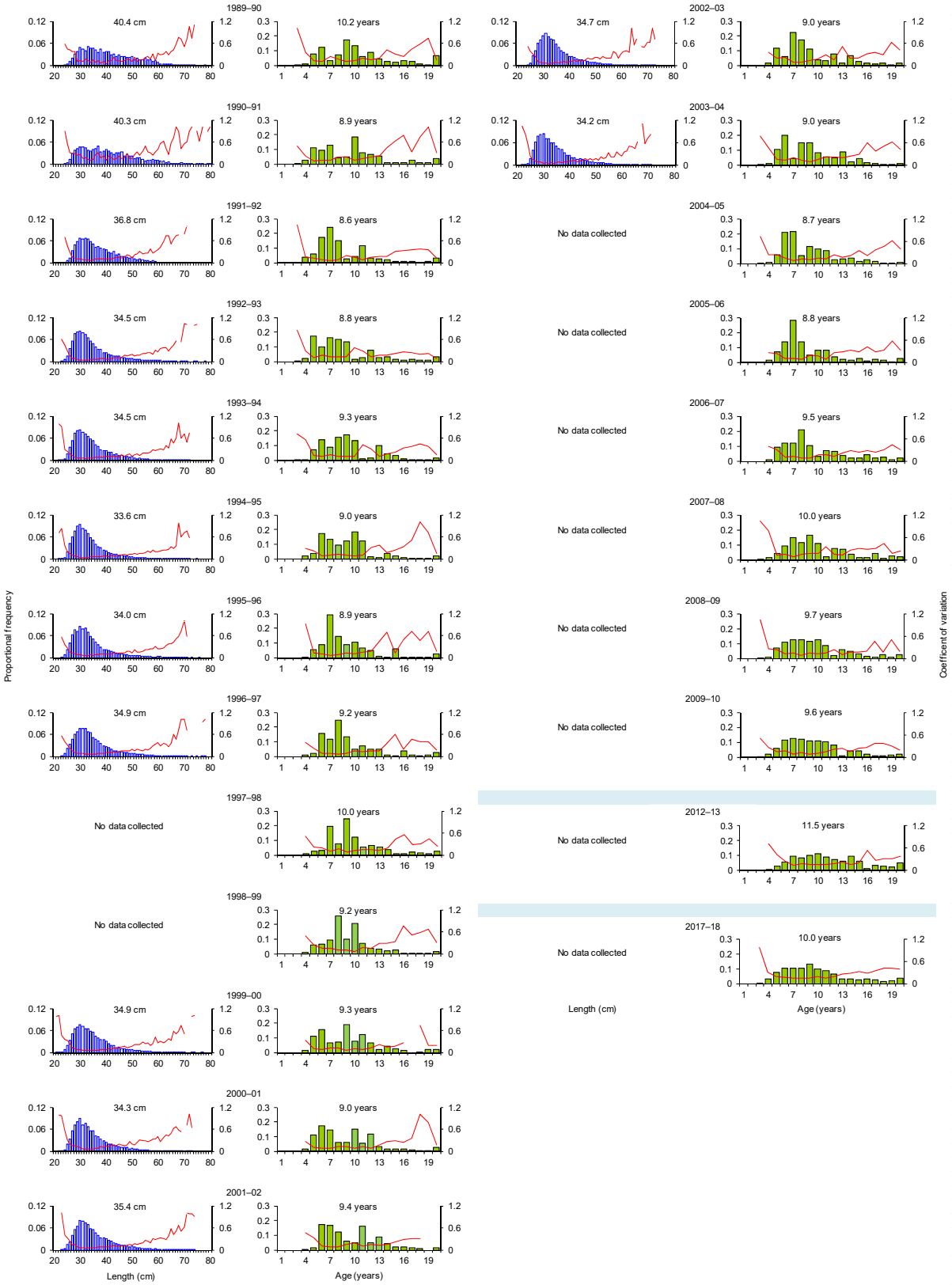
Appendix 6: Time series of proportion at length and age distributions for the snapper bottom longline fisheries in SNA 1. Length frequency sampling was not conducted after 2003–04.

Proportion at length and age distributions and CVs for snapper from the East Northland bottom longline fishery from 1993–94 to 2017–18. Data are from spring-summer up until 2002–03 and year-round thereafter. Plots are annotated with estimates of mean length and/or mean age. The blue line indicates a break in the continuous time series of data.



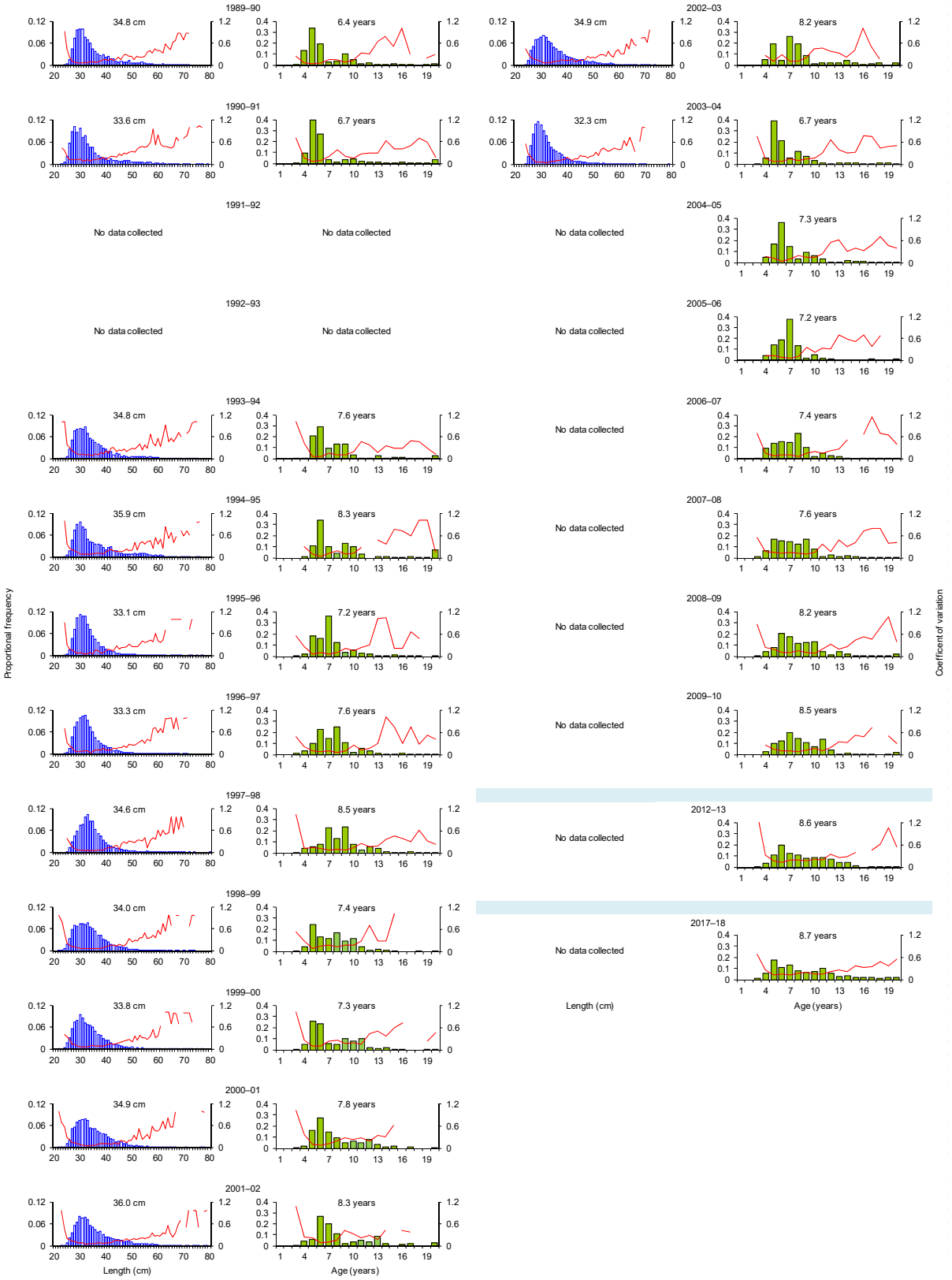
Appendix 6 – continued:

Proportion at length and age distributions and CVs for snapper from the Hauraki Gulf bottom longline fishery from 1989–90 to 2017–18. Data are from spring-summer up until 2002–03 and year-round thereafter. Plots are annotated with estimates of mean length and/or mean age. The blue line indicates a break in the continuous time series of data.



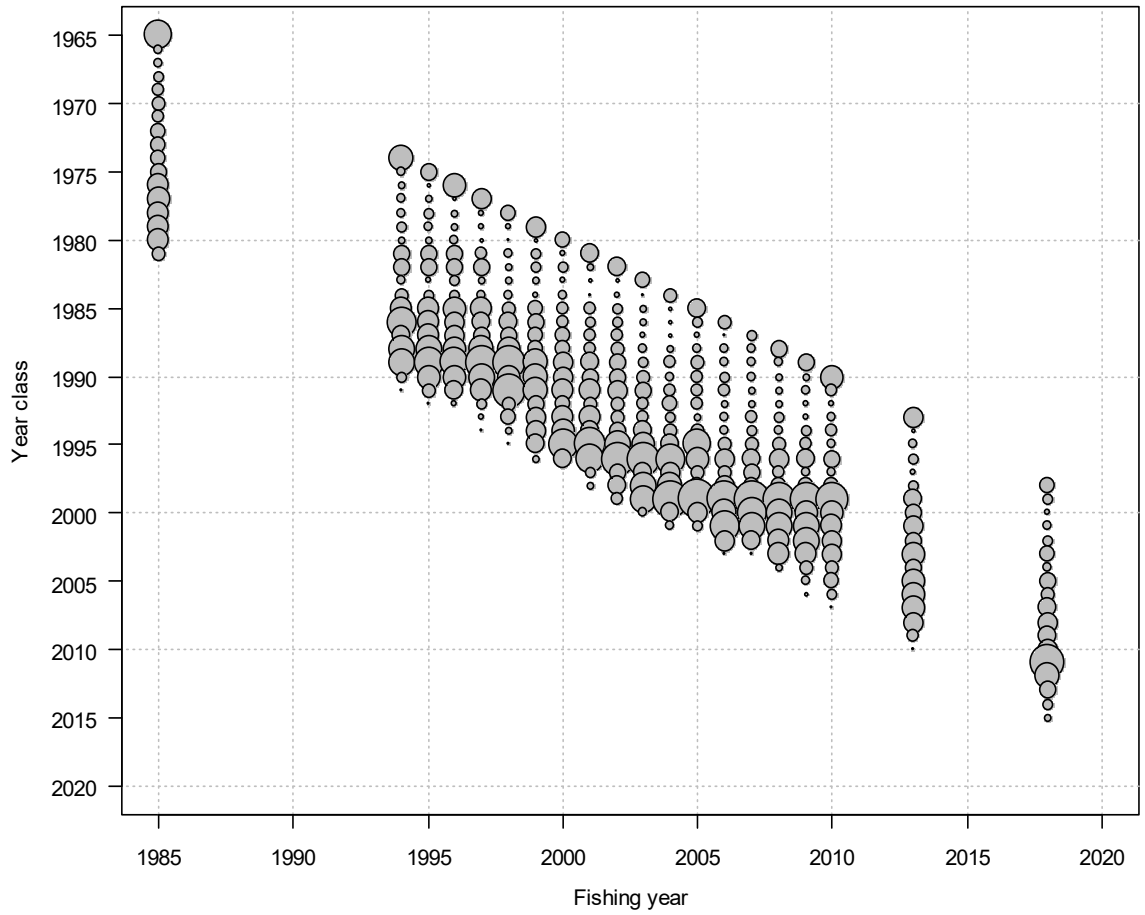
Appendix 6 – continued:

Proportion at length and age distributions and CVs for snapper from the Bay of Plenty bottom longline fishery from 1989–90 to 2017–18. Data are from spring-summer up until 2002–03 and year-round thereafter. Plots are annotated with estimates of mean length and/or mean age. The blue line indicates a break in the continuous time series of data.

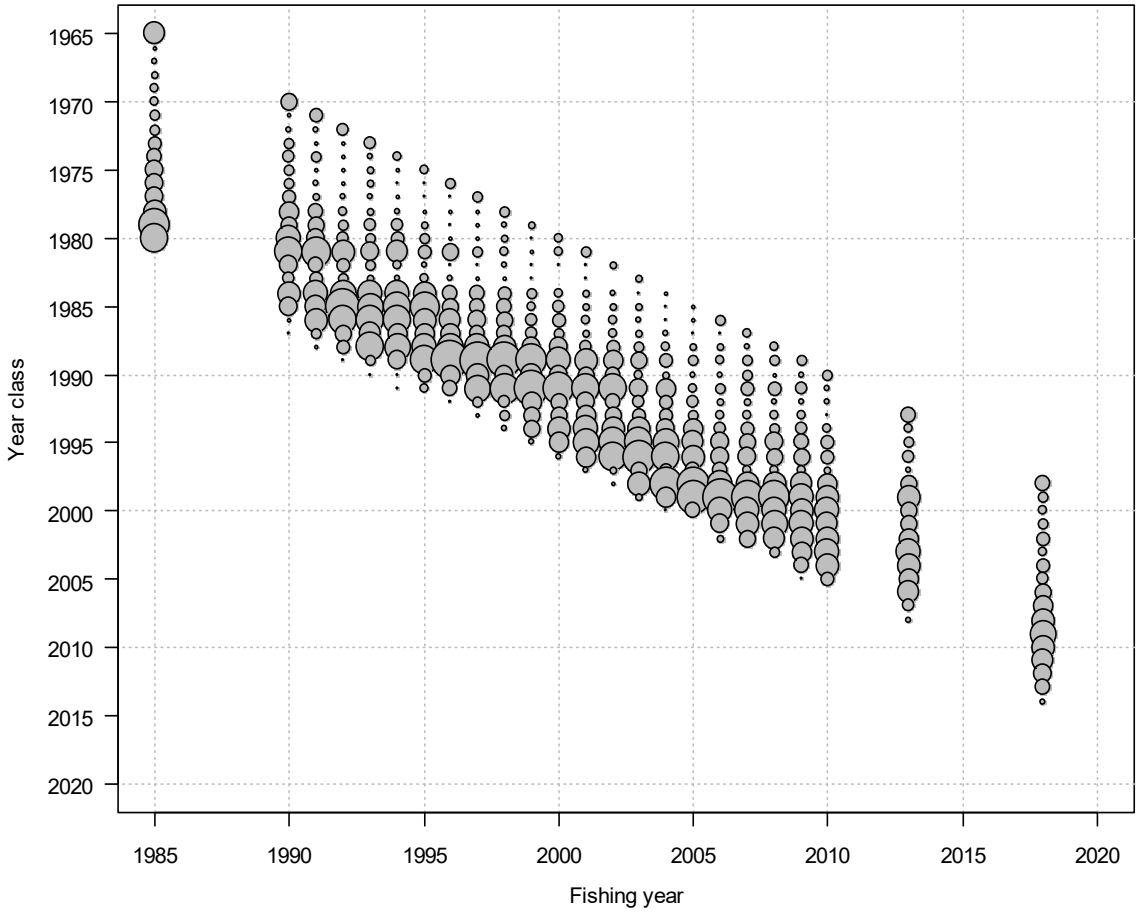


Appendix 7: Time series of age frequency distributions by year class and year from the SNA 1 bottom longline fisheries.

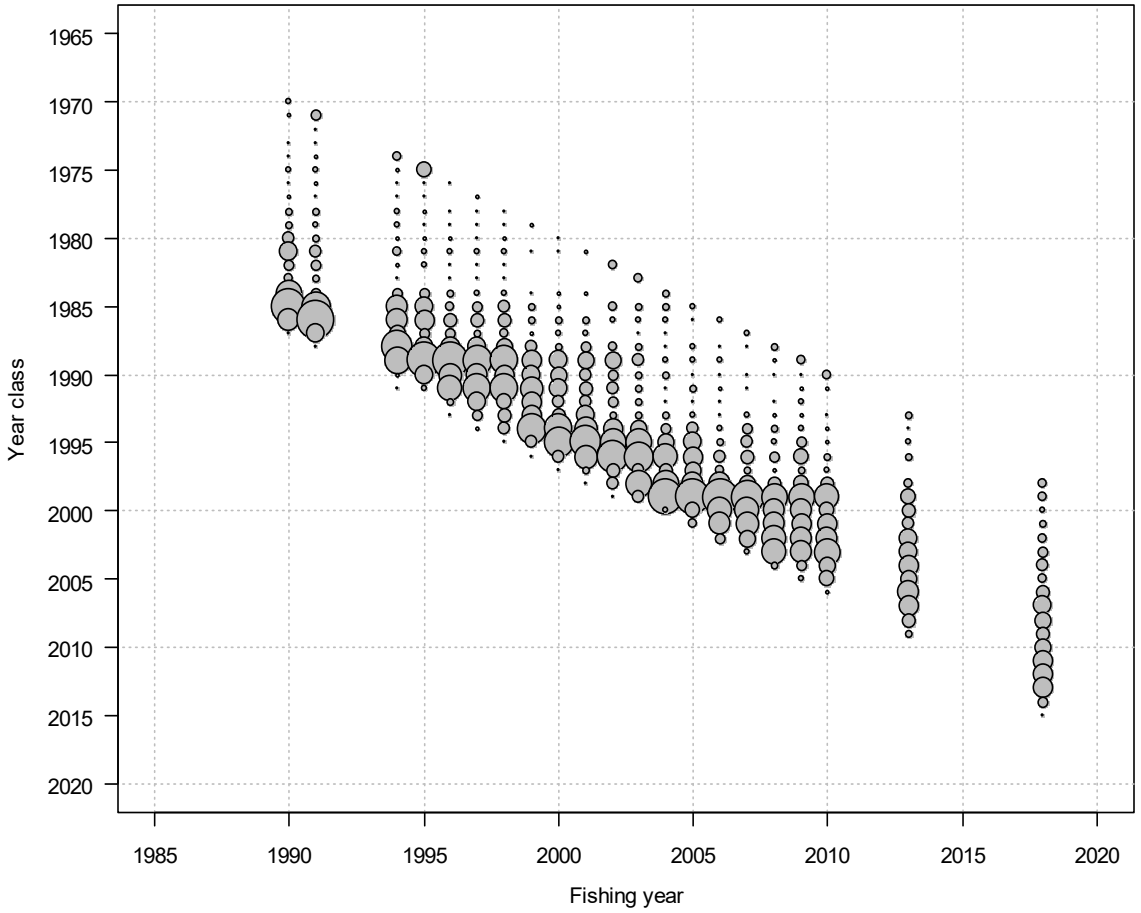
Time series of age frequency distributions by year class and year from the East Northland bottom longline spring-summer fishery from 1984–85 to 2017–18. Symbol area is proportional to the proportion at age. The proportion of the oldest year class in each year is represented by an aggregate (over 19 years) age group.



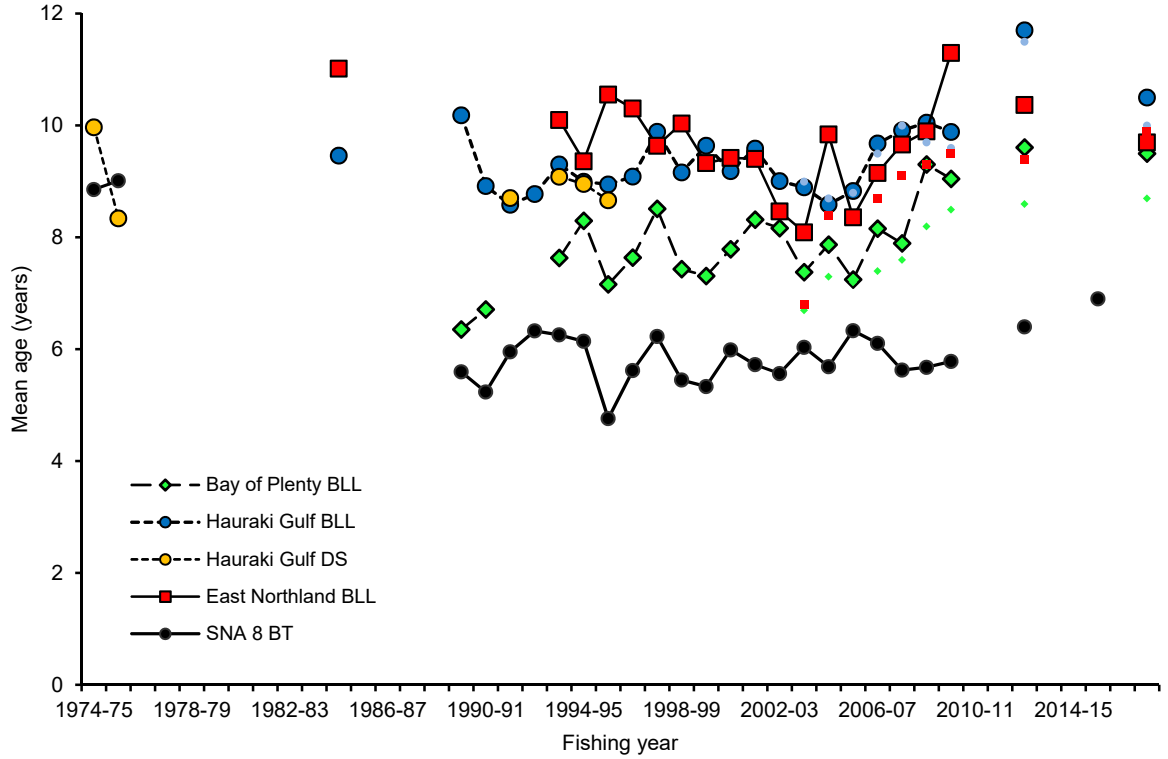
Appendix 7 – continued:
Time series of age frequency distributions by year class and year from the Hauraki Gulf bottom longline spring-summer fishery from 1984–85 to 2017–18. Symbol area is proportional to the proportion at age. The proportion of the oldest year class in each year is represented by an aggregate (over 19 years) age group.



Appendix 7 – continued:
Time series of age frequency distributions by year class and year from the Bay of Plenty bottom longline spring-summer fishery from 1989–90 to 2017–18. Symbol area is proportional to the proportion at age. The proportion of the oldest year class in each year is represented by an aggregate (over 19 years) age group.



Appendix 8: Time series of mean age estimates from the SNA 1 bottom longline (BLL) and Danish seine (DS) fisheries between 1974–75 and 2017–18, using data from spring-summer (large markers) and year-round (small markers) collections (2003–04 onwards). For comparative purposes, data collected from the SNA 8 bottom trawl (BT) fishery is also included.



Appendix 9: Depiction of poor conditioned "skinny" snapper caught from the Hauraki Gulf fishery (April 2019). Commercial fishermen state that such emaciated fish have become a more regular catch in recent years.

Comparison of a "skinny" snapper and fish of normal condition from the same catch.