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Length and age composition of commercial trevally landings in TRE 7, 2009–10

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EXECUTIVE SUMMARY

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This report presents the results of Objective 1 of the Ministry of Fisheries project "Estimation of year class strength in TRE 7" (TRE200902). The general objective was to determine the length frequency and age structure of commercial landings of trevally from TRE 7 in 2009–10 (by market sampling), for use in stock assessment models.

The length frequency and age-length key sampling approach was employed during the 2009–10 fishing year to estimate catch-at-age for trevally for the main fishing method in TRE 7. Length frequency samples were collected from the TRE 7 bottom trawl fishery, and otoliths were collected randomly to form a fixed allocation age-length key, to ensure fish in all length intervals were well accounted for. No seasonal stratification was imposed on the sampling design other than it be conducted over the "peak" period, spring and summer, when most trevally is landed. A total of 37 bottom trawl landings were sampled for length frequency from the TRE 7 fishery, with 15 709 trevally measured for length and 1158 otoliths collected to construct age-length keys. Estimates of proportion at length and age for the TRE 7 fishery were calculated according to three designs: all TRE 7 data combined unstratified, subarea specific collections unstratified, or subarea specific collections stratified, the latter design using identifiable subarea data to weight proportions of length and age for each stratum according to the estimated number of fish landed in each stratum.

The length and age distributions sampled from the TRE 7 bottom trawl fishery in 2009–10 contained a broad range of fish of various sizes and ages, despite more than 80% of the landed catch, by number, being less than 13 years of age. The 2006 and 2003 year classes (4- and 7-year-olds) were the most dominant in the fishery and accounted for about one in every three trevally landed. The proportion of fish occupying the aggregate (over 19) age group was substantial, making up around 8% of the catch.

For a third year, spatial differences in length and age structure of bottom trawl landings were examined in TRE 7, with independent sample collections made from three distinct latitudinal subareas of the west coast of New Zealand; Ninety Mile Beach, combined Kaipara-Manukau and North Taranaki Bight, and South Taranaki Bight. Length and age distributions from the Ninety Mile Beach subarea comprised trevally of mainly small to moderate size and age, half the commercial catch based on fish four years of age or less. Landings from the combined Kaipara-Manukau and North Taranaki Bight subareas comprised fish of a broader size and age range, including a reasonable proportion 20 years and older. However, the most significant subarea difference evident within TRE 7 was specific to South Taranaki Bight, where an overwhelming number (42%) of fish currently occupy the aggregate (over 19 years) age group. In addition, the apparent lack of consistency in relative year class strength comparisons between estimates from the South Taranaki Bight and the two northern subareas further confirm what is already known: spatial heterogeneity exists within the TRE 7 stock, with an increasing size and age of trevally down a latitudinal cline. This heterogeneity was able to be detected because of comprehensive sampling and consistency in the fishery operation over the same spatial scale and a rigorous ageing approach, and further emphasises that trevally movement between subareas is relatively limited.

Similar to findings in 2007–08, the relative trevally year class strengths apparent in the TRE 7 proportion at age estimates in 2009–10 correlate well with snapper estimates from SNA 8 in the same year, and are likely to be temperature related recruitment effects. There are a number of consistencies, the most noticeable being the dominance of the 2006 and 2003 year classes, especially given the selectivity differences between the species and the relative exploitation status of the respective

populations. Similar correlations could not be drawn for trevally between the South Taranaki Bight subarea stratum and snapper from SNA 7.

It is expected that the derived proportional length and age estimates presented here are adequate and provide representative descriptions of the temporal and spatial spread of bottom trawl catches from the TRE 7 fishery for 2009–10. Length and age compositions for the unstratified and stratified approaches were almost identical in their relative proportional estimates, despite spatially discrete differences between subareas. Precision on the combined TRE 7 age composition was good with a mean weighted coefficient of variation (MWCV) estimate of 0.12, but this varied between the subareas, ranging from 0.20 to 0.30.

Differences in mean weight-at-age estimates were not considerable between the subareas of TRE 7 in 2009–10, although estimates from the Ninety Mile Beach were most often the lowest for the common age classes.

Current combined subarea catch samples for TRE 7 in 2009–10 comprise proportionally fewer small fish compared to samples from the late 1990s and estimates of mean length and mean age are relatively high, with good representation in the aggregate age group. It is more than likely that the current TRE 7 fishery is in a relatively healthy state and that exploitation rates in recent years have not impacted to any great extent on the stock, despite the TACC not having been achieved for the past six years. However, as proportional catch-at-age data are not a direct index of absolute abundance, inferences to changes in stock size or state are not totally reliable and should be treated with some care. Nevertheless, the most recent assessment (Langley & Maunder 2009) predicts that the stock size will remain at or above B_{MSY} to 2014.

1. INTRODUCTION

Trevally (*Pseudocaranx dentex*) is one of New Zealand's most important commercial inshore fish species. Over 50% of the national Total Allowable Commercial Catch (TACC) of 3932 t is apportioned to TRE 7 (2153 t), the largest of the trevally Quota Management Areas (QMAs), encompassing the entire west coast of the North Island and most of the north and west coasts of the South Island (Figure 1). In recent years the greatest proportion of the TRE 7 catch has been taken by bottom trawl, mainly from the northern half of the North Island's west coast. Most trevally is caught as the target species over the spring and summer months, but it can also be a bycatch when targeting other species, usually snapper (*Pagrus auratus*) and red gurnard (*Chelidonichthys kumu*). The annual TRE 7 catch has been below the Total Allowable Commercial Catch (TACC) for the last six years (Figure 2).

The first trevally length and age sample collections from the west coast fishery were from a series of bimonthly research cruises undertaken between Tasman Bay and North Cape during 1971 and 1972, with some additional intermittent samples taken up until 1979 (James 1984). Catch sampling of commercial landings for length and age compositions from the bottom pair trawl fishery first took place around the late 1970s (unpublished data) and was resumed in the 1997–98 fishing year (Walsh et al. 1999) as part of a new stock monitoring programme instigated by the Ministry of Fisheries. Annual sampling from the bottom trawl and bottom pair trawl fishing methods continued in the TRE 7 fishery until 2000–01 and the data were summarised in a series of subsequent reports (Walsh et al. 2000, Langley 2001, 2002) and in two reviews by Langley (unpublished results) and Walsh & McKenzie (2009). The programme was reinstated in 2005–06 (Langley 2009) with sampling concentrating on the bottom trawl fishery and continued until 2007–08 (Walsh et al. 2010a, 2010b), with a secondary aim of investigating patterns of spatial heterogeneity within the TRE 7 stock. A summary of the various methods and subarea strata that have been sampled from TRE 7 since 1997–98 is presented in Table 1.

This report presents the results of market sampling from the TRE 7 bottom trawl fishery for length and age data between October 2009 and September 2010, and thus continues the time series. Funding for this project, TRE2009/02, was provided by the Ministry of Fisheries.

The specific objectives of this project for 2009–10 were:

1. To characterise the TRE 7 fishery by analysing existing commercial catch and effort data to the end of 2009/10 fishing year.

2. To conduct representative sampling to determine the length, sex and age composition of the commercial catch of trevally in TRE 7 during the 2009/10 fishing year.

3. To explore the time series of catch sampling data, in particular, for any significant changes in the length and age composition of commercial catches.

2. METHODS

2.1 Characterisation of recent fishery profile data for TRE 7, 2003–04 to 2009–10

A characterisation of patterns in the TRE 7 fishery over the period October 2003 through to September 2010 was undertaken using data extracted from the Ministry of Fisheries commercial catch reporting system. All effort details and associated catch weights (all species including trevally) from all trips landing TRE 7 were requested.

Data obtained from the Ministry was groomed and checked for typical reporting errors. Information to perform the characterisation was compiled in two tables:

1. Landed catch weight: A file containing the verified green (unprocessed) landed weight of all TRE 7 trips.
2. Trip specific data: A file containing demographic information (location, method, target species, estimated catch etc).

Although the trip effort data table has information on catch, these are only fisher estimates. 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).

2.2 Design of TRE 7 sampling in 2009–10

Landings were stratified by subarea and sample collections made from the only significant commercial method that currently operates in TRE 7, single trawl. A rationalisation of the west coast trawl fleet in recent years has resulted in the bottom pair trawl method in TRE 7 being excluded from the sampling programme because the relative bottom pair trawl effort has become insignificant. There was no seasonal stratification imposed on the sampling other than it be conducted over the "peak" period when most trevally is landed by bottom trawl, usually spring and summer. For some landings the stratification of the catch by subarea was done by communication with the skipper during the fishing trip and before sampling to confirm the area fished. If vessels fished in more than one subarea during the trip, cooperative skippers would mark the bins (as stratification of ponds within the hold was not viable) indicating that a catch related to a particular subarea stratum. However, for most sampled landings it was not feasible for skippers to partition their catch based on specific spatial subarea strata. Confirmation of the subarea catch of trevally was therefore not determined until some months after sampling, based on data received from the Ministry of Fisheries catch and effort returns, some of these comprising samples from mixed subarea strata.

As part of a previous trevally catch sampling review, Walsh & McKenzie (2009) undertook an optimisation analysis for various catch sampling designs. The optimisation results for the length frequency and age-length key approach indicated that a mean weighted coefficient of variation (MWCV) of 0.20 for TRE 7 bottom trawl catch-at-age estimates could be achieved by sampling about 20 landings and through the application of a 900 otolith age-length key. For reasons of cost, it was not proposed to target a MWCV of 0.20 in each subarea stratum. Instead the goal of the programme in 2009–10 was to achieve a MWCV of at least 0.20 in the TRE 7 stock after stratum amalgamation using the subarea target sample sizes, 10 landings and 300 otoliths, outlined in Table 2.

All length frequency samples (except one from September) were collected during the "peak" season (November–April), which incorporates the period when schools of spawning trevally become more vulnerable to trawling. The peak of the season usually occurs during January–February, which is about one month after the peak of the snapper fishery. Although not consistent between years, Walsh et al. (1999) found significant spatial differences in the length composition of TRE 7 bottom trawl landings in 1997–98, as did Langley (2001) for samples collected from South Taranaki Bight in 1999–2000. Spatial differences in length composition were further investigated for samples collected from the bottom trawl fisheries in 2006–07 and 2007–08 by Walsh et al. (2010a, 2010b), with specific collections targeted from the following three subareas: Ninety Mile Beach; Kaipara and Manukau coastline and North Taranaki Bight combined (as few differences were apparent in past years between these subareas); South Taranaki Bight (see Figure 1). The aforementioned spatial stratification of the TRE 7 fishery was based on findings by James (1984) and was used in 2009–10. The sampling regime for TRE 7 specified that all bottom trawl landings were to have a minimum catch weight of trevally of at least 2 t for the northern two subareas and 1 t for the South Taranaki Bight subarea.

A two-stage sampling procedure was used to obtain length frequencies (West 1978). A random selection of landings chosen at regular intervals across the spring and summer period, and a random sample of bins within landings represent the first and second stages respectively. Sample sizes typically ranged from about 100–200 fish being collected from South Taranaki Bight landings having a total of 10–20 bins, and up to 600 fish from northern subarea landings which comprised over 1000 bins. All fish in the sampled bins were measured to the nearest centimetre below the fork length. As trevally show no differential growth between sexes (James 1984), sex was not determined. The sampling design used for snapper (Davies & Walsh 1995) was adopted for trevally.

2.3 Otolith collections and ageing of TRE 7 samples for 2009–10

Otoliths were collected as a subsample of all landings sampled for length frequency to create age-length keys (refer Davies & Walsh 1995). Samples taken from TRE 7 bottom trawl landings encompassed the period November–April and September. The purpose of the keys was to convert catch length frequency information to age frequency. It was assumed that age was distributed randomly within each sampled centimetre length class (Southward 1976). A fixed allocation sample for each length class was determined from the proportion of fish in each length class in bottom trawl length frequency samples in TRE 7 from 2000–01, but was broadened to ensure that fish in all length intervals were well accounted for (Appendix 1). Otolith sample sizes were capped at 12 for the common length class intervals (31–40 cm), and a step-wise sample size of about ten fish for length intervals greater than 40 cm, eight fish over 45 cm, five fish over 50 cm, three fish over 55 cm, two fish over 60 cm, and one fish for all length classes 66 cm and above was specified for collection. This resulted in about 300 otolith samples being targeted for collection from each of the three subareas: Ninety Mile Beach, Kaipara-Manukau and North Taranaki Bight, and South Taranaki Bight. The overall target otolith allocation for TRE 7 would therefore sum to about 900 otolith samples, the optimised target sample outlined above (see Table 2). To ensure spatial and temporal representativeness in the sample collections, a target of about 30–40 otoliths was collected from all landings sampled for length frequency (bottom trawl) within a subarea until the target sample sizes for each length class within the age-length key were achieved. Those size classes that were uncommon in landings (i.e., very small or large fish) were often targeted for otoliths when available to samplers in order to fulfil the age-length key requirements as best as possible.

All otoliths were prepared using the thin section technique as described by Stevens & Kalish (1998) and Tracey & Horn (1999) and a standardised procedure for reading otoliths was followed (Walsh et al. 1999). However, Walsh & McKenzie (2009) determined that inconsistencies observed in the relative year class strengths of trevally catch-at-age data from previous collections were most likely a result of ageing error caused by two main factors: the misinterpretation of growth zones in difficult otolith sections, and the inaccurate determination of the margin relative to the sample collection and birth dates. A revised trevally ageing protocol developed in 2006–07 adopted a more rigorous approach than in past years to improve reader accuracy and increase the level of between-reader agreements, and this was followed for 2009–10. In summary, this modified protocol focused on a few main facets: the interpretation and location of the first annulus; forcing an expected margin on the reader relative to the otolith collection date (forced margin method); and allowing the readers access to a variety of otolith images from previous collections in the hope of improving reader accuracy and precision, especially in preparations that are not easily interpreted. Two readers read the entire sets independently to determine an unbiased reading estimate. Where agreement was reached, it was deemed to be the final agreed reading. If no agreement was attained, then the otolith was reviewed again by both readers with an experienced third reader present (via remote log-ons and teleconference technology) to reach agreement, or discarded from the set as unreadable (if it was of an age less than 20 years, as samples over 19 years were combined into an aggregate age group for the analysis). It was envisaged that discarding a few unreadable otoliths from the age-length key should have minimal effect on the sample collections and was likely to improve the precision in estimates of catch-at-age.

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 (c.v.) (Chang 1982), were calculated for each test.

A forced margin 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. The forced margin method was found to be essential for ageing trevally sampled throughout the year, as some readers had difficulty correctly interpreting otolith margins in previous year-round collections (Walsh & McKenzie 2009). This has been most apparent for young fast growing trevally (e.g., 2 and 3 year olds) captured late in the year, where age is commonly overestimated. The nominal birth date of trevally is taken as 1 January.

2.4 Data analysis for TRE 7, 2009–10

Trevally length and age data are stored on the Ministry for Primary Industries *market* and *age* databases respectively, managed by NIWA.

The calculation of proportions at length and age, and variances from length frequency samples and age-length keys, followed Davies & Walsh (1995). For sample collections from the TRE 7 bottom trawl fishery in 2009–10, estimates of proportion at length and age were calculated according to three possible designs: all TRE 7 data combined unstratified, subarea specific collections unstratified, or subarea specific collections stratified. In the unstratified designs, length and age data were pooled across spatial strata (Ninety Mile Beach, Kaipara-Manukau and North Taranaki Bight, and South Taranaki Bight subareas), thus treating the fishery as a single stratum. The first design also included a mixed area stratum comprising landings where vessels fished across more than one subarea on a fishing trip. In the stratified design, where vessels only fished within a specific subarea, estimates of proportion at age and length (and coefficient of variation) were calculated for each stratum, and then combined to calculate weighted mean estimates. The stratum estimates were combined and weighted according to the estimated number of fish landed in each stratum, following Davies & Walsh (2003).

The calculation of mean weight-at-age and variances followed Quinn II et al. (1983); with a length-weight relationship of w (g) = $0.016\, l^{3.064}$ (cm) from James (1984). Proportions at age, mean weight-at-age, and mean length-at-age (with analytical estimates of coefficient of variation, c.v.) were calculated for the range of age classes recruited, with the maximum age being an aggregate of all age classes over 19 years.

Proportions-at-age, mean weight-at-age, and mean length-at-age were calculated for the range of fishing year age classes (herein referred to as “age classes” encompassing October 2009 to September 2010) recruited, with the maximum age being an aggregate of all age classes over 19 years. Estimates of mean age determined from catch-at-age estimates in each stock and subarea stratum were calculated such that all fish comprising the aggregate (over 19 years) age group were assigned an age of 20.

3. RESULTS

3.1 Characterisation of TRE 7, 2003–04 to 2009–10

3.1.1 Data grooming errors

The “true” landed catch weights derived after removing non-terminating (i.e., retained or transhipped) catch records from the landed catch data table are given in Table 3. Duplicate landing weights of the annual reported TRE 7 catch for most years in the series were generally low (below 2%), the exception being 7.1% in 2009–10. For most years, the amount of annual catch that could be linked directly to (prorated across) effort varied between 98–99%. We are therefore confident that the characterisations in this report (i.e., catch by location, season, method, target species etc) are highly representative of the “true” TRE 7 catches for the fishing years given in Table 3.

3.1.2 Annual TRE 7 catch by subarea

Between 2003–04 and 2009–10, the largest proportion of the annual TRE 7 catch was taken from the Kaipara-Manukau subarea (Figure 3). Significant catches were also made from the Ninety Mile Beach and North Taranaki Bight subareas over most years, with South Taranaki Bight consistently comprising the lowest catch in TRE 7 (Figure 3).

3.1.3 Relative catch by method for the subareas of TRE 7

Overall, bottom trawl was the dominant fishing method in all subareas of TRE 7, although significant catches of trevally have been made by bottom pair trawl operating in the Ninety Mile Beach and Kaipara-Manukau subareas in some years (Figure 4, Appendix 2). There is some evidence of a gradual shift in bottom trawl effort for trevally away from the Kaipara-Manukau subarea, with more emphasis in recent years toward the Ninety Mile Beach and North Taranaki Bight subareas.

3.1.4 Spatio-temporal distribution and target species of the bottom trawl commercial catch

The TRE 7 bottom trawl catch by statistical area for the period 2003–04 to 2009–10 shows that the most significant catches of trevally are consistently taken from the northern half of North Island’s west coast, principally statistical areas 041, 042, and 045–047 (Figure 5, Appendix 3). As bottom trawl is the dominant method in the TRE 7 fishery, the overall trend evident in subarea fishing patterns described above for all methods (Section 3.1.3) are also reflected in those seen for the bottom trawl catch by statistical area. Although catches remain significant in statistical areas 045 and 046 (Kaipara-Manukau subarea), they have steadily declined over time, with corresponding increases apparent in statistical areas 041, 042, and 047 (North Taranaki Bight and Ninety Mile Beach subareas) (Figure 5, Appendix 3). Bottom trawl catches for the statistical areas south of New Plymouth, 017 to 040, are consistently low.

The majority of the TRE 7 bottom trawl catch is taken over the spring and summer months (Figure 6). There appears to be a general trend in the temporal pattern of fishing activity especially in the northern three subareas with fishing first taking place in the Kaipara-Manukau subarea from November to January, followed by the North Taranaki Bight subarea over January to February, and the Ninety Mile Beach subarea from February to March. Although trevally is encountered in the South Taranaki Bight subarea over a range of months the largest catches appear more common in October (Figure 6).

For the three northern subareas of TRE 7 the bottom trawl catch is almost exclusively a trevally target fishery with comparatively minor amounts of trevally landed when snapper or red gurnard are the target species (Figure 7, Appendix 4). For the South Taranaki Bight subarea a number of other target species are also commonly reported when trevally is caught which include leatherjacket (*Parika scaber*), barracouta (*Thyrsites atun*), tarakihi (*Cheilodactylus macropterus*), blue warehou (*Seriolella brama*), and flatfish species with trevally reported intermittently between years and mainly from the northern bounds of the subarea such as statistical area 040 (Figure 7, Appendix 3).

3.2 Sampling of the TRE 7 bottom trawl fishery in 2009–10

3.2.1 Sample collections

Summaries of the length frequency sample sizes for bottom trawl taken from each subarea stratum within TRE 7 in 2009–10 are given in Table 4 and summaries of the otolith sample collections in Table 5. Length distributions of otolith sample collections as a comparison to that targeted for TRE 7 subarea strata are presented in Appendix 1.

Thirty seven landings of a total target of 30 (see Tables 2 and 4) were sampled from the TRE 7 bottom trawl fishery in 2009–10: six landings each from the Ninety Mile Beach and combined Kaipara-Manukau and North Taranaki Bight subareas respectively, 17 from the South Taranaki Bight subarea, and nine of mixed subarea origin (i.e., samples taken from vessels that fished across multiple subarea strata). The sampled catch accounted for 38% by weight and 7% by number of the total bottom trawl catch in TRE 7 in 2009–10 (Table 4). The average weight of the sampled landings from TRE 7 bottom trawl fishery was 15.564 t, with a broad range spanning 0.080 to 84.234 t. Trevally was the target species in 19 of the 37 landings sampled in 2009–10, all of these from the subareas north of Cape Egmont. For the other 18 sampled landings, including all 17 from the South Taranaki Bight subarea, five other target species were reported; red gurnard, snapper, leatherjacket, barracouta, blue warehou. Where trevally was the main target, the average sampled landing size was large (29.468 t) compared to the average (0.887 t) when other target species were reported. Table 4 summarises information for all bottom trawl landings containing trevally (target and bycatch) caught from TRE 7.

The relative annual catch of trevally by subarea and by method in 2009–10 is given in Figure 8. Most of the 2009–10 TRE 7 catch of 1966 t was taken from the northern three subareas, Ninety Mile Beach (28%), Kaipara-Manukau (39%) and North Taranaki Bight (21%), while the South Taranaki Bight subarea accounted for only 11% (Figure 8). Bottom trawl was the dominant method for catching trevally accounting for 78% of the TRE 7 landed catch in 2009–10.

The average bottom trawl landing size and the numbers of landings in each subarea stratum, for all landings and those greater than 1 t (minimum landing size to sample), are illustrated in Figure 9 and depict landing size and availability of bottom trawl landings for sampling. The northern three subareas comprised by far the greatest number of large landings in TRE 7 in 2009–10, with the Ninety Mile Beach subarea having the highest overall mean landing weight of over 8.452 t, followed by Kaipara-Manukau (4.948 t) and North Taranaki Bight (2.861 t). The average landed catch of trevally in the South Taranaki Bight subarea was the lowest in TRE 7 at 0.683 t. All TRE 7 subareas had a good number of landings over 1 t available for sampling, with the Ninety Mile Beach subarea having the highest mean (10.549 t) and South Taranaki Bight the lowest (3.446 t).

3.2.2 Sampling representativeness

Monthly catch comparisons

The monthly catch of trevally and of that sampled (weight and number of landings) for the bottom trawl method (all landings and those greater than 1 t) are presented in Figures 10 and 11 to display the seasonal patterns in the fisheries and the representativeness of the sample collections. Although trevally may be caught year-round, the greatest proportion of the bottom trawl catch was over the spring and summer months, and the temporal sampling coverage was well represented for this period with the exception of October (Figures 10 and 11).

Spatial catch, statistical area, and target species comparisons

A comparison of the spatial distribution of TRE 7 bottom trawl commercial catch with that sampled from the fishery in 2009–10 shows that the majority of the catch, as well as the sampled component, was taken in the northern half of the stock, mostly north of Kawhia Harbour (Figure 12). Catches and samples in the southern South Taranaki Bight subarea (South Island) in 2009–10 were relatively small, with trevally rarely encountered south of statistical area 036. The sampled component is spread throughout most areas where the commercial bottom trawl fishery operated in 2009–10 suggesting that sampled landings are likely to be spatially representative of the fishery.

A comparison of the proportional distribution of the estimated bottom trawl catch of trevally with that sampled in 2009–10 for the statistical areas that make up TRE 7 is given in Figure 13. By far the greatest proportion of trevally caught by bottom trawl was from vessels fishing in statistical areas 042, and 045–047; the highest catch and weight of samples coming from statistical 047 (Ninety Mile Beach). A similar comparison depicting the bottom trawl catch by target species is given in Figure 14, with 97% of the landed trevally catch coming from trevally targeted tows, far outweighing the catch for the 12 other target species reported, many of which were exclusive to South Taranaki Bight. The proportionality of the sampled component to that of the fishery suggests that sampled landings were representative of the operation of the TRE 7 bottom trawl fleet as a whole.

3.2.3 Otolith readings

A total of 1158 trevally otolith samples were collected from the TRE 7 bottom trawl collections in 2009–10 and all were prepared and read (Table 5). Between-reader tests with graphical comparisons of these are given in Figure 15. The relative symmetry of the histogram in Figure 15(a), that the error bars on the age-bias plot for the majority of common age classes in Figure 15(b) encompass the one-to-one line, and the relatively even distribution of plotted points about the zero line in Figure 15(c) all suggest that only slight differences in interpretation exists between readers. The between reader c.v. and IAPE were 5.31% and 3.75% and the profiles indicate that the greatest difference in precision was associated with ageing 2 year old trevally (Figure 15d). A comparison of the age-bias plots for reader 1 and 2 with the agreed age show that reader 2 had better overall agreement than reader 1 and considerably lower c.v. (0.78%) and IAPE (0.55%) estimates (Figures 15(e) and 15(f)).

The unweighted proportions at age (i.e., not scaled by length frequency data) derived from otolith samples collected from the three subarea strata (Ninety Mile Beach, Kaipara-Manukau and North Taranaki Bight, and South Taranaki Bight subareas), those from mixed subarea origin, and the combined total of all TRE 7 collections in 2009–10 are presented in Figure 16. The plots demonstrate the underlying spatial variability in year class strengths evident between the subarea collections in TRE 7 used to form the age-length keys. The South Taranaki Bight unweighted proportions at age show the least amount of similarity in year class strength to the other two northern subareas (Figure 16(c)). The samples from the mixed subarea collection were from eight landings where vessels fished in the Ninety Mile Beach, and the Kaipara-Manukau and North Taranaki Bight strata (Figure 16(d)).

3.2.4 TRE 7 length and age distributions

For the TRE 7 fisheries in 2009–10, scaled catch-at-age compositions (i.e. scaled by applying the age-length key to the length frequency distributions) were derived from the combined length distributions of subarea strata, and used to identify year class strengths. Otolith collections may not have been consistent across the entire sampling period, especially from landings sampled toward the end of the season when the age-length key collection was nearly complete or when specific subarea collections were difficult to obtain. This is unlikely to bias the age characterisations because the growth of recruited trevally (i.e., those over 25 cm long) would have been relatively low over the period when length frequency collections were made. This assumption has been accepted for other species with growth rates comparable to those of trevally (Westrheim & Ricker 1978, Davies & Walsh 1995).

Length and age distributions, and coefficients of variations (c.v.) for the TRE 7 stock and subarea bottom trawl fisheries in 2009–10 are presented as histograms and line graphs, respectively (Figures 17–20). Length and age distributions are also shown as cumulative proportions (Figures 21 and 22). Scatterplots and von Bertalanffy growth curves of unweighted age-length data collected from each subarea and for all TRE 7 age data combined for 2009–10 are given in Figure 23, and von Bertalanffy growth parameters presented in Table 6. Mean weight- and length-at-age estimates for the Ninety Mile Beach, Kaipara-Manukau and North Taranaki Bight, and South Taranaki Bight bottom trawl fisheries are presented in Figures 24 and 25. A three year time series (2006–07, 2007–08, 2009–10) of length and age distributions for the TRE 7 subarea (Ninety Mile Beach, Kaipara-Manukau and North Taranaki Bight, South Taranaki Bight) bottom trawl fisheries are presented in Figures 26 to 31. The estimated proportions at length, age, mean weight-at-age, and mean length-at-age, are tabulated in Appendices 5–8. The age-length keys for the TRE 7 stock and subarea strata are presented in Appendix 9 and a discontinuous time series of trevally length and age compositions from the TRE 7 bottom trawl fishery from 1997–98 to 2009–10 is given in Appendix 10.

The estimated total number of fish caught in each stock and subarea method stratum was calculated from the reported total weight landed and the mean fish weight derived from stratum length compositions (see Appendix 5).

3.2.5 Unstratified and stratified distributions

The unstratified and stratified length distributions of the TRE 7 bottom trawl catch in 2009–10 were very similar, and contained a broad range of fish of various sizes, the majority being of medium size, characterised by two closely aligned (albeit, not well defined) modes at 38 and 44 cm, and a tail of the distribution extending to over 50 cm (Figures 17 and 21). The mean lengths of trevally sampled from the fishery ranged between 40.1 and 41.1 cm for the unstratified and stratified approaches, and the proportion-at-length MWCVs ranged between 0.12 and 0.22.

The unstratified and stratified age distributions for the TRE 7 bottom trawl fishery in 2009–10 were relatively similar, with three in every four fish landed being between 3 and 12 years of age, and a significant proportion 20 years and older (Figures 18 and 21). The 2006 and 2003 year classes (4- and 7-year-olds) were the most dominant in the fishery and accounted for about one in every three trevally landed. Aside from the high proportion of fish in the aggregate (over 19 years) age group, the 1999, 1998, and 1995 year classes (11-, 12-, and 15-year-olds) were the most prominent year classes occupying the right hand limb of the distribution. The mean ages of trevally sampled from the fishery was high and ranged between 8.5 and 9.4 years for the unstratified and stratified approaches, and the proportion-at-age MWCVs ranged between 0.12 and 0.18 (Figure 18).

3.2.6 Subarea catch-at-length and catch-at-age

Ninety Mile Beach

Landings from the Ninety Mile Beach subarea comprised a high proportion of small to moderate sized trevally between 33 and 41 cm, characterised by one main mode centred around 37 cm, with a narrow tail extending out to over 50 cm (Figure 19a). The mean length sampled from the fishery was the lowest of the TRE 7 subareas at 37.9 cm, and the proportion-at-length MWCV was 0.17. Ninety Mile Beach catches were largely comprised of young trevally with the 2007, 2006, and 2003 year classes (3-, 4-, and 7-year-olds) by far the most dominant, making up just under two-thirds (61%) by number of the bottom trawl catch in 2009–10 (Figure 20a). There were very low proportions of fish occupying the older age classes, the combined total over 10 years of age amounting to only 9%, inclusive of the aggregate (over 19 years) age group. The mean age of trevally sampled from Ninety Mile Beach was 6.0 years, the lowest of the subarea fisheries, and the proportion-at-age MWCV was 0.20.

Kaipara-Manukau/North Taranaki Bight

The length distribution from the combined Kaipara-Manukau and North Taranaki Bight subareas was broad with low numbers of small fish present, and moderate to large fish predominating, characterised by two poorly defined modes centred at 38 and 44 cm respectively, and a tail extending to over 50 cm (Figure 19b). The mean length of trevally sampled from the fishery was 42.8 cm, and the proportion-at-length MWCV was 0.17. The age distribution from the Kaipara-Manukau and North Taranaki Bight subareas although broad was dominated by trevally from the 2003, 1999, 1998, 1995 year classes (7-, 11-, 12-, and 15-year-olds), with the aggregate (over 19 years) age group alone making up 13% of the landed catch by number, the highest equal proportion in the fishery (Figure 20b). The mean age of trevally sampled from the fishery was 11.0 years, and the proportion-at-age MWCV was 0.30 which most likely reflects a combination of the lower sample size of age samples collected and the broadness of the age distribution.

South Taranaki Bight

The South Taranaki Bight subarea contained the highest proportions of large fish for sampling undertaken in TRE 7 in 2009–10 and was characterised by a very small mode at 37 cm, and a dominant mode centred about 45 cm, and a tail extending to over 55 cm (Figure 19c). The mean length was the highest of the TRE 7 subareas at 44.6 cm, and the proportion-at-length MWCV was 0.23. The South Taranaki Bight age distribution in 2009–10 was completely dominated by a very high proportion of fish from many age classes making up the aggregate (over 19) age group, the highest estimate (42%) of all TRE 7 subareas (Figure 20c). With the 2002 year class (8-year-olds) the second most dominant in the fishery, making up just 10% of the landed catch, most other proportions at age appear relatively low, the 1997 year class (13-year-olds) having no fish at all. The mean age of trevally sampled from the subarea was the highest in TRE 7 at 14.1 years, and the proportion-at-age MWCV was 0.26.

3.2.7 Growth curves, mean weight-at-age, and mean length-at-age estimates

Trevally growth

Scatterplots of age-length data and generated von Bertalanffy growth curves (using decimalised ages and not fishing year ages) for the 2009–10 otolith collections from TRE 7 showed only minor growth variability between subareas (Figure 23). Brody growth coefficient (k) values for the subareas ranged between 0.093 and 0.104, with trevally from the Ninety Mile Beach having the fastest initial growth (Table 6). The otolith collection from the South Taranaki Bight subarea comprised fish with the greatest age range and good representation in most age classes up to 40 years, while collections from the Ninety Mile Beach subarea had relatively lower numbers of fish over 20 years of age (Figure 23).

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

Mean weight-at-age for the TRE 7 subarea bottom trawl fisheries in 2009–10 varied slightly between subareas. Mean weight-at-age from Ninety Mile Beach were the lowest for the common age classes, while South Taranaki Bight most often comprised the highest estimates for trevally up to 11 years of age, and Kaipara-Manukau and North Taranaki Bight for ages greater than 11 years (Figure 24). The mean weight-at-age estimates for some of the young age classes (2- to 5-year-olds) may be positively biased because of the minimum legal size (MLS) restriction of 25 cm in commercial catches, and also because fish of this age range may not yet be fully recruited to the fishery (Davies et al. 2003).

Observed mean length-at-age estimates in the TRE 7 subarea bottom trawl fisheries closely resemble those patterns seen in mean weight-at-age estimates (Figure 25).

3.2.8 TRE 7 subarea time series comparisons (2006–07, 2007–08, 2009–10)

Ninety Mile Beach

The length and age distributions sampled from bottom trawl landings from the Ninety Mile Beach subarea in 2006–07, 2007–08, and 2009–10 most often comprised a relatively high proportion of small and young trevally (Figures 26 and 27). Estimates of mean length ranged from 37.2 to 40.6 cm and mean age from 6.0 to 8.2 years, consistently the lowest age estimates sampled from the TRE 7 subarea fisheries in each respective sampling year. Despite variability in length and age structure between years, some continuity in year class strength was evident in the progression of some year classes over successive years, most noticeably the strong 2003 year class (Figure 27). Sample sizes for both length and age collections in the 2006–07 and 2007–08 fishing years were well below targets (Figures 26 and 27 (a and b)).

Kaipara-Manukau/North Taranaki Bight

Sampled bottom trawl length and age distributions from the combined Kaipara-Manukau and North Taranaki Bight subareas in 2006–07 and 2007–08 were generally more similar than in 2009–10. These samples were based on comprehensive collections and achieved adequate levels of precision (MWCVs ranging from 0.12 to 0.21; Figures 28 and 29). Length and age distributions were relatively broad comprising a wide range of fish of various sizes and ages, with mean length ranging from 38.2 to 42.8 cm and mean age from 7.9 to 11.0 years. Some continuity in year class strength progression was evident over successive years (Figure 29), although sample sizes for length and age collections for the 2009–10 fishing year were below the allocated target, resulting in the proportion at age estimate having the highest MWCV (0.30) of the time series (Figures 28(c) and 29(c)).

South Taranaki Bight

The length and age distributions sampled from bottom trawl landings from the South Taranaki Bight subarea in 2006–07, 2007–08, and 2009–10 most often comprised a relatively high proportion of moderate to large sized and old trevally (Figures 30 and 31). Estimates of mean length ranged from 42.2 to 44.6 cm and mean age from 9.4 to 14.1 years, and were consistently the highest estimates sampled from the TRE 7 subarea fisheries in each respective year. Despite some variability in length and age structure between years, good continuity in year class strength was evident in the progression of year classes over successive years, most noticeably the 2002 to 1999 year classes and the aggregate (over 19 years) age group (Figure 31). Sample sizes for both length and age collections for the 2007–08 fishing year were low, with the age distribution having the highest MWCV estimate (0.30) in the time series (Figures 30b and 31b).

4. DISCUSSION

Ageing error

This is the eleventh report to summarise the length and age compositions of trevally landings from the main fishing methods operating in TRE 1 and/or TRE 7 since 1997–98. In a review of the trevally catch sampling data collected between 1997–98 and 2002–03 from both stocks, Walsh & McKenzie (2009) concluded that difficulty tracking strong and weak year classes across time was a direct result of ageing error, where the misinterpretation of growth zones in difficult otolith sections, and the inaccurate determination of the margin relative to the sample collection and birth dates, were the main contributing factors. A new ageing protocol was implemented in 2006–07 which adopted a more rigorous approach with the aim of improving reader accuracy and increasing the level of between-reader agreements. However, trevally otoliths can be inherently difficult to age, and as such, some level of ageing error is always likely to be present in catch-at-age results.

Sampling landings

Walsh et al. (2010a) suggested that inadequate sample sizes from trevally catch sampling in 2006–07, may have adversely affected results, warning that in order to fully determine whether spatial variability in length and age composition exists for trevally, future sampling would require full industry cooperation to improve on previous results. The cooperation of the fishing industry (company managers and fishermen) is vital to minimise bias (spatial, temporal, and size/age selective). Cooperation was forthcoming in 2009–10 in relation to sampling the TRE 7 stock as a whole, with 16 of the contracted samples (of a target of 20) all coming from vessels fishing the northern half of the North Island’s west coast. However, no directed effort was made by the contractor to sample specific subareas in TRE 7 in 2009–10 (i.e., Ninety Mile Beach, Kaipara-Manukau and North Taranaki Bight), as it was deemed logistically too difficult as fishing regularly occurred over more than one subarea on a trip and separating catches by subarea was considered unfeasible. Nevertheless, a total of 12 subarea specific landings were successfully sampled, six from each of the aforementioned subareas, eight in total by the contractor, these being chance happenings where the vessel fished only within the subarea for that trip.

Length and age distributions

Few noticeable differences were observed between the unstratified and stratified length and age compositions for the TRE 7 bottom trawl fishery in 2009–10, the first analysis of its kind for the stock. The two unstratified designs are a reflection of where data are pooled across spatial strata (1. using all TRE 7 data; 2. using identifiable subarea data), thus treating the fishery as a single stratum. The stratified design (using identifiable subarea data) weights proportions of length and age for each stratum according to the estimated number of fish landed in that stratum, when calculating TRE 7 proportions at length and age. As the total tonnage (and the estimated number of trevally) landed by bottom trawl was relatively similar for the Ninety Mile Beach, and the combined Kaipara-Manukau and North Taranaki Bight subareas in 2009–10, their combined total is far greater (eight times by number) than that for the South Taranaki Bight subarea, and the results for both the stratified length and age compositions for the TRE 7 bottom trawl fishery more closely resemble the combination of estimates derived for the northern two subareas (see Figures 17 and 18).

The TRE 7 length composition in 2009–10 was relatively broad comprising mainly medium sized fish and proportionally fewer small fish compared to samples from the late 1990s. The current estimate of mean age (8.5 years) in the fishery reflects a high proportion of young fish in the catch (71% ten years or younger) coupled with a good proportion (8%) 20 or more years of age.

Spatial patterns in length and age

Similar to findings in 2006–07 and 2007–08 (Walsh et al. 2010a, Walsh et al. 2010b), the length and age distributions for the TRE 7 subarea fisheries in 2009–10 further confirm that heterogeneous patterns exist within TRE 7 on a moderate spatial scale along a latitudinal cline from the north to the south. The three year subarea time series of proportion at age data provides sufficient evidence to conclude that relative year class strengths vary among subareas. Further, there is sufficient continuity from one year to the next within each subarea, which indicates that spatial heterogeneity in age is a persistent feature within TRE 7.

The spatial heterogeneity seen in the TRE 7 three year time series is also consistent with what is known from tagging studies in that trevally movement between areas is limited with most fish (88%) captured within 30 nautical miles of release sites (James 1980), and that the vast majority of fish probably reside within the same spatial strata from year to year indicative of low levels of stock and subarea mixing (Walsh et al. 2010b). The continuation of a trawl-based sampling programme with some regularity should continue to provide better information on the mortality and recruitment variation of the TRE 7 stock required for stock assessments, as long as spatially specific sample collections can be maintained and industry participation and cooperation is forthcoming.

Any variability in relative year class proportions between the TRE 7 subareas may also be due to the variable recruitment specific to a stock (a reflection of unique environmental conditions), growth differences, and fishing mortality differences. The positioning of subarea boundaries and internal spatial patterns of fishing effort, which may occur within any subarea (i.e., South Taranaki Bight) are also likely to contribute to the apparent inter-annual proportion at age variability.

Despite clear heterogeneous patterns showing that inconsistencies in relative year class strengths exist between subareas in the three year time series of catch-at-age collections from TRE 7, there were also some similarities. These were most apparent in the north, between the adjacent Ninety Mile Beach, and Kaipara-Manukau and North Taranaki Bight subareas, particularly for some of the very young trevally i.e., those fish occupying the 2002 to 2006 year classes. Such patterns may be hypothesised as a southern movement of fish associated with increasing age, but only information from a tagging programme would clarify the level of connectivity between the subareas of TRE 7, and any linkage with TRE 1. As there were few visible similarities in year class strengths between the northern subareas and South Taranaki Bight over the three year time series, correlations are probably coincidental. It is recommended that the stock structure be fully investigated prior to the next assessment of TRE 7.

Ninety Mile Beach

Sample collections from the Ninety Mile Beach subarea have consistently been dominated by a high proportion of small young trevally (Walsh et al. 2010a, 2010b), with generally few large and old fish present, especially in the two most recent collections, 2007–08 and 2009–10. However, some of the largest fast growing trevally have been known from Ninety Mile Beach subarea samples in previous years (James 1984, Walsh et al. 1999, 2000, 2010b), but are absent in others (Langley 2001, 2002), so heterogeneous patterns in length and age may also exist within the subarea. The catch-at-age collection in 2009–10 appears the most robust of the three year time series, exceeding the otolith targets (n = 332) and with high precision (MWCV = 0.20). There is visible progression of weak and strong year classes in this fishery over the past three year time series especially for many of the younger fish, the most apparent being the 2004–2002 years classes. Nevertheless, inconsistencies in sample collections from this subarea do hinder results. In 2009–10, statistical area 047 encompassing the Ninety Mile Beach subarea, received by far the greatest fishing pressure of all statistical areas making up the TRE 7 stock.

Kaipara-Manukau and North Taranaki Bight

The three year time series of length and age samples from the combined Kaipara-Manukau and North Taranaki Bight subareas have, by and large, comprised trevally of small to moderate size and age, often with good precision, where only moderate levels of heterogeneity between landings was thought to occur (Walsh et al. 2010b). Proportion at age estimates have generally been broad, often comprising numbers of fish across many age classes, including the aggregate (over 19 years) age group. Although normally the mainstay of the TRE 7 fishery and receiving the greatest fishing pressure, sampling from this subarea in 2009–10 was unusually poor (n = 217 ages) and catch-at-age precision on estimates were the lowest recorded (MWCV = 0.30), resulting in some lack of continuity in the time series. Despite this, reasonable progression of weak and strong year classes remains apparent in the time series, especially over the range of the 2004–1997 year classes.

South Taranaki Bight

South Taranaki Bight length and age samples are known to be the most different to all other areas in TRE 7 (James 1984, Walsh et al. 1999, Langley 2001, Walsh et al. 2010a, Walsh & McKenzie 2009), the recent three year time series providing the most evidence of this (see Figures 30 and 31). Landings from the South Taranaki Bight have more often had the highest proportions of large fish, and there have always been low numbers of small fish in the fishery. In 2006–07, the first year of directed age sampling from the subarea, there was an overwhelming dominance of old fish, although there was a paucity of data for specific age ranges, including a relative absence of very young fish, possibly reflecting periodic or delayed recruitment to the fishery (Walsh et al. 2010a, b). Unique patterns in year class strength, broad length and age compositions, and the presence of a very high proportion of old fish occupying the aggregate (over 19 years) age group are all significant and specific differences particular to the South Taranaki Bight subarea. The three year time series of catch-at-age estimates from the South Taranaki Bight, generally display the most clearly visible progression of weak and strong year classes for any of the TRE 7 subareas. The 2002–1999 year classes can be easily tracked from 2006–07 to 2009–10, and the increase in proportion of the aggregate (over 19 years) age group over this time (from 20 to 42%), and the decreasing proportion of young age classes, can easily be explained by the strong 1990–1988 year classes (17- to 19-year-olds) making up 18% by number in 2006–07, merging into the aggregate age group by 2009–10. However, as sample collections from 2007–08 are well below the targeted estimates (3 landings and 133 otoliths sampled), there are inconsistencies in the results, especially relating to the proportion of fish in the aggregate age group for this year.

Comparison of relative year class strengths in TRE 7 and TRE 1

In the early 1990s, only minor similarities in relative year class strengths in bottom trawl catches from the TRE 1 and TRE 7 stocks were apparent when sampling was conducted concurrently in both fisheries (Walsh et al. 1999, 2000). However, in 2006–07 and 2007–08, when specific subarea samples were concurrently collected from TRE 1 and TRE 7, some similarities in year class strength between East Northland and Ninety Mile Beach were noted (Walsh et al. 2010a, 2010b). Although no concurrent sampling was undertaken for TRE 1 in 2009–10, proportion at age estimates from the East Northland bottom trawl fishery in the previous year (2008–09; Walsh et al. 2012) showed some similarity in year class strengths with the Ninety Mile Beach estimates presented here. Although trevally movement is known to be limited (James 1980), the similarities in year class strengths between the northern boundaries of TRE 1 and TRE 7 (principally East Northland and Ninety Mile Beach), and the presence, at times, of very large fast growing fish (James 1984, Walsh et al. 1999, 2000, 2010b), may indicate some linkage between these adjacent subareas.

Comparison of relative year class strengths in TRE 7 and SNA 8

Walsh et al. (2010b) found some similarities in relative year class strengths for trevally from the combined Kaipara-Manukau and North Taranaki Bight subareas in 2007–08 that correlated well with those for snapper from SNA 8 (Walsh et al. 2009) for the same year, with consistency especially evident for both the 2003 and 1997 year classes. Despite some anomalies, comparisons made between TRE 7 and SNA 8 catch-at-age estimates for 2009–10 were more apparent, with considerable similarities in the overall relative year class strengths (Appendix 11), given selectivity differences between the species and the relative exploitation status of the respective populations.

It seems likely that recruitment strength variability in TRE 7 and SNA 8 is largely driven by water temperature, similar to the relationship modelled for snapper in the Hauraki Gulf (Francis 1993). However, this is likely to vary over the geographic range of the stocks due to the different hydrodynamic and recruitment processes, where peak spawning for snapper usually occurs in early to mid December, about one to two months earlier than trevally. Walsh et al. (2010b) were unable to find a similar correlation between the relative year class strength estimates for trevally from the South Taranaki Bight subarea stratum, which encompasses both South Taranaki Bight and Tasman

Bay/Golden Bay areas, and snapper from SNA 7 (Blackwell & Gilbert 2008), a discrete stock with localised spawning and recruitment.

Precision and representativeness in catch-at-age

Similar to previous years, the TRE 7 combined bottom trawl sample collections in 2009–10 were based on comprehensive length (15 700 measurements) and age (1158 otoliths) samples, and where the temporal and spatial fishing and sampling effort suggested a good level of representativeness. The combined length and age distributions had high levels of precision, with MWCVs of 0.13 and 0.12 respectively, reflective of the rigorous sampling and ageing methodologies in place. Precision on subarea bottom trawl length and age distributions in 2009–10 was lower, with MWCVs ranging from 0.17 to 0.30, reflective of lower sample sizes and heterogeneity between sample collections within a subarea. The highest MWCV estimates for catch-at-age were determined for the Kaipara-Manukau and North Taranaki Bight (0.30), and South Taranaki Bight (0.26) subareas, and may be indicative of the broader distributions and high proportions of old fish present. However, both subareas fell short of meeting the required otolith targets in 2009–10, and the derived estimate of catch-at-age, at least for the Kaipara-Manukau and North Taranaki Bight subarea, may have only marginal utility. If otolith samples had been more complete, then the precision on catch-at-age would undoubtedly have been better.

The potential for differences in the subarea length and age compositions highlights the importance of ensuring that the sampling coverage is representative of the areal distribution of the entire fishery to ensure the collection of an unbiased sample of the length (Langley 2002) and age (Walsh et al. 2010b) composition of the catch. This may be dependent on changes in spatial fishing pattern if the relative catch by subarea varies from year to year, as it has done in 2009–10, with considerably more fishing effort directed toward the Ninety Mile Beach subarea. As comprehensive length and age samples from the South Taranaki Bight subarea were only included in TRE 7 collections in recent years (2006–07, 2007–08, and 2009–10), previous collections may not be comparable because of the level of spatial heterogeneity that is now known to be present within the stock.

It is fundamental that future sampling in TRE 7 should ensure that all length and age data are representative of the areal distribution of the entire fishery, and that the optimised targets of numbers of landings and otolith samples in the catch sampling design are firmly adhered to.

Mean weight-at-age

Length stratification of otolith samples, such as was used in the fixed allocation for TRE 7 subarea otolith collections in 2009–10, has been known to introduce bias in estimates of mean weight- and length-at-age, and consequently in growth parameters (Goodyear 1995). To estimate catch-at-age, the otolith samples presented here have been adjusted to reflect the length composition of the fishery and are therefore unbiased. Consequently, the estimates of mean weight- and length-at-age may be suitable for gross comparisons in growth variability between the subareas of TRE 7 in 2009–10; differences possibly related to spatial and genetic factors within the TRE 7 stock.

In 2009–10, as in 2007–08 (Walsh et al. 2010b), the mean weight-at-age estimates for the younger age classes were generally highest from the South Taranaki Bight subarea. Mean weight-at-age estimates for the for the older age classes were often highest from the combined Kaipara-Manukau and North Taranaki Bight subareas, while estimates for the Ninety Mile Beach were regularly the lowest in TRE 7. Spatial and temporal variability in mean weight-at-age estimates have also been found in snapper and are thought to be due to differences in regional exploitation levels, recruitment rates, and different rates of somatic growth (Davies et al. 2003, Walsh et al. 2006a, 2006b, 2006c, 2011). If spatial and/or temporal variation in growth exist within the TRE 7 stock or subarea strata, then it is likely that the predicted estimates presented here will not be suitable descriptions of the stock. Observed mean length-at-age estimates for the TRE 7 subarea fisheries follow the same patterns seen in mean weight-at-age estimates.

Some of the very largest trevally are often found in catches from the Far North, especially off the Ninety Mile Beach to North Cape area (James 1984, Walsh et al. 1999, 2000), but were absent from samples in 2009–10. It was postulated that these fish may be part of a separate substock, as they appear to grow faster, attaining a size and weight of up to 10 cm longer and 2.5 kg heavier than trevally from areas to the south (Walsh et al. 1999, 2000). Preliminary research into whether two species of trevally exist within New Zealand waters is currently under way (Clive Roberts, Te Papa, pers comm.), and may explain the reason for the observed size differences in trevally from the Far North.

The oldest trevally sampled from the TRE 7 fishery in 2009–10 was 43 years old, and samples aged by James (1984) from collections undertaken in the 1970s determined maximum age estimates of 47 years.

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Table 1: TRE 7 catch sampling summary from 1997–98 to 2009–10 (Note: all collections made using the length frequency and age-length key sampling approach, and all ageing undertaken by NIWA).

TRE 7

Catch sampling report	Research Provider	Fishing year	Fishing method	No. of landings sampled for LF	Season[††]	Comments*	Otolith sample size	Otolith prep[n†]	Season[††]
Walsh et al. (1999)	NIWA	1997–98	Bottom trawl	55	Spr–Aut, Win	9 NMB, 15 K-M, 10 NTB, 1 STB, 20 Mixed (47 Peak, 8 Off-peak)	375	B&E	Sum
			Bottom pair trawl	7	Spr–Sum	Unknown			
Walsh et al. (2000)	NIWA	1998–99	Bottom trawl	26	Spr–Aut	3 NMB, 10 K-M, 2 NTB, 11 Mixed	225	TS	Sum–Aut
			Bottom pair trawl	14	Sum–Aut	6 NMB, 2 K-M, 2 NTB, 4 Mixed	156	TS	Sum–Aut
Langley (2001)	Sanford Ltd	1999–2000	Bottom trawl	39	Sum–Aut	6 NMB, 7 K-M, 5 NTB, 2 STB, 19 Mixed	505	TS	Sum–Aut
Langley (2002)	Sanford Ltd	2000–01	Bottom trawl	49	Spr–Aut	5 NMB, 16 K-M, 3 NTB, 25 Mixed	496	TS	Spr–Sum
			Bottom pair trawl	13	Spr–Sum	2 NMB, 7 K-M, 4 Mixed			
Langley (2009)	GANZL	2005–06	Bottom trawl	11	Spr–Aut	3 K-M, 2 NTB, 3 STB, 3 Mixed	328	TS	Spr–Sum
Walsh et al. (2010a)	NIWA	2006–07	Bottom trawl	33	Spr–Win	2 NMB, 14 K-M/NTB, 11 STB, 6 Mixed	920	TS	Spr–Win
Walsh et al. (2010b)	NIWA	2007–08	Bottom trawl	21	Spr–Aut	2 NMB, 12 K-M/NTB, 3 STB, 4 Mixed	848	TS	Spr–Aut
This report	NIWA	2009–10	Bottom trawl	37	Spr–Win	6 NMB, 6 K-M/NTB, 17 STB, 8 Mixed	1158	TS	Spr–Win

* NMB = Ninety Mile Beach; K-M = Kaipara-Manukau; NTB = North Taranaki Bight; STB = South Taranaki Bight.
[†] B&E = Bake and embed; TS = Thin section.
[††] Spr (Oct–Nov), Sum (Dec–Feb), Aut (Mar–May), Win (Jun–Sep).
NIWA, National Institute of Water and Atmospheric Research; GANZL, Golder Associates (NZ) Ltd.

Table 2: Level of sampling proposed to describe the TRE 7 subarea bottom trawl fisheries in 2009–10.

	Subarea	Method	Number of landings	Number of otoliths in age-length-key
TRE 7	Ninety Mile Beach	Bottom trawl	10	~300
	Kaipara-Manukau/North Taranaki Bight	Bottom trawl	10	~300
	South Taranaki Bight	Bottom trawl	10	~300

Table 3: Breakdown of total TRE 7 LFR reported landed catch (t) showing total duplicate (retained not landed), "true" landed weights, and the amount of catch that could be included in the characterisation (linked to effort).

Fishing Year	LFR total	Retained	% retained	True	Effort link	% effort link
2003–04	2 174	8	0.4	2 166	2 143	98.9
2004–05	1 963	16	0.8	1 947	1 910	98.1
2005–06	1 972	21	1.1	1 951	1 934	99.1
2006–07	1 770	29	1.7	1 741	1 700	97.7
2007–08	1 813	29	1.6	1 784	1 767	99.0
2008–09	2 034	30	1.5	2 005	1 977	98.6
2009–10	2 113	150	7.1	1 962	1 934	98.6

Table 4: Summary of the catch (total number and weight of landings) and samples (number of landings and weight sampled, and number of fish measured) in subarea strata for the TRE 7 bottom trawl fishery for the 2009–10 fishing year.*

		Number of landings			No. of fish	Weight of landings (t)		
Method*	Area**	Total	Sampled	% of total	measured	Total	Sampled	% of total
BT	NMB	53	6	11.3	3 725	448	122	27.2
	K-M/NTB	226	6	2.7	2 735	852	183	21.5
	STB	306	17	5.6	3 424	209	16	7.7
	TRE 7†	501	37	7.4	15 709	1 509	576	38.2

*BT, bottom trawl.

**NMB, Ninety Mile Beach; K-M/NTB, Kaipara-Manukau & North Taranaki Bight; STB, South Taranaki Bight.

†The TRE 7 total number of landings does not equal combined subareas total as some vessels fished over more than one subarea per trip.

Table 5: Details of trevally otolith samples collected from TRE 7 subareas in 2009–10 for age-length key collections.

Method*	Area**	Sampling period	Sample method †	Length range (cm)	No. aged††
BT	NMB	9 Feb 10–7 Apr 10	SR	27–62	332
	K-M/NTB	30 Nov 09–15 Apr 10	SR	28–61	217
	STB	18 Nov 09–13 Sep 10	SR	30–62	261
	TRE 7	12 Nov 09–13 Sep 10	SR	27–67	1 158

*BT, bottom trawl.

**NMB, Ninety Mile Beach; K-M/NTB, Kaipara-Manukau & North Taranaki Bight; STB, South Taranaki Bight.

†Stratified random sample.

††The TRE 7 total number of otoliths does not equal combined subareas total as some vessels fished over more than one subarea per trip.

Table 6: Von Bertalanffy parameters calculated from unweighted trevally otolith data collected from the TRE 7 subareas in 2009–10.

Stock/substock	L_{inf}	k	t_o	n
Ninety Mile Beach	53.6	0.104	-6.13	332
Kaipara-Manukau/North Taranaki Bight	54.2	0.094	-6.62	217
South Taranaki Bight	52.0	0.093	-8.06	261
All TRE 7 data combined	53.2	0.105	-6.04	1 158

L_{inf} = length-at-age infinity; k = Brody's growth coefficient; t_o = hypothetical age at zero length.

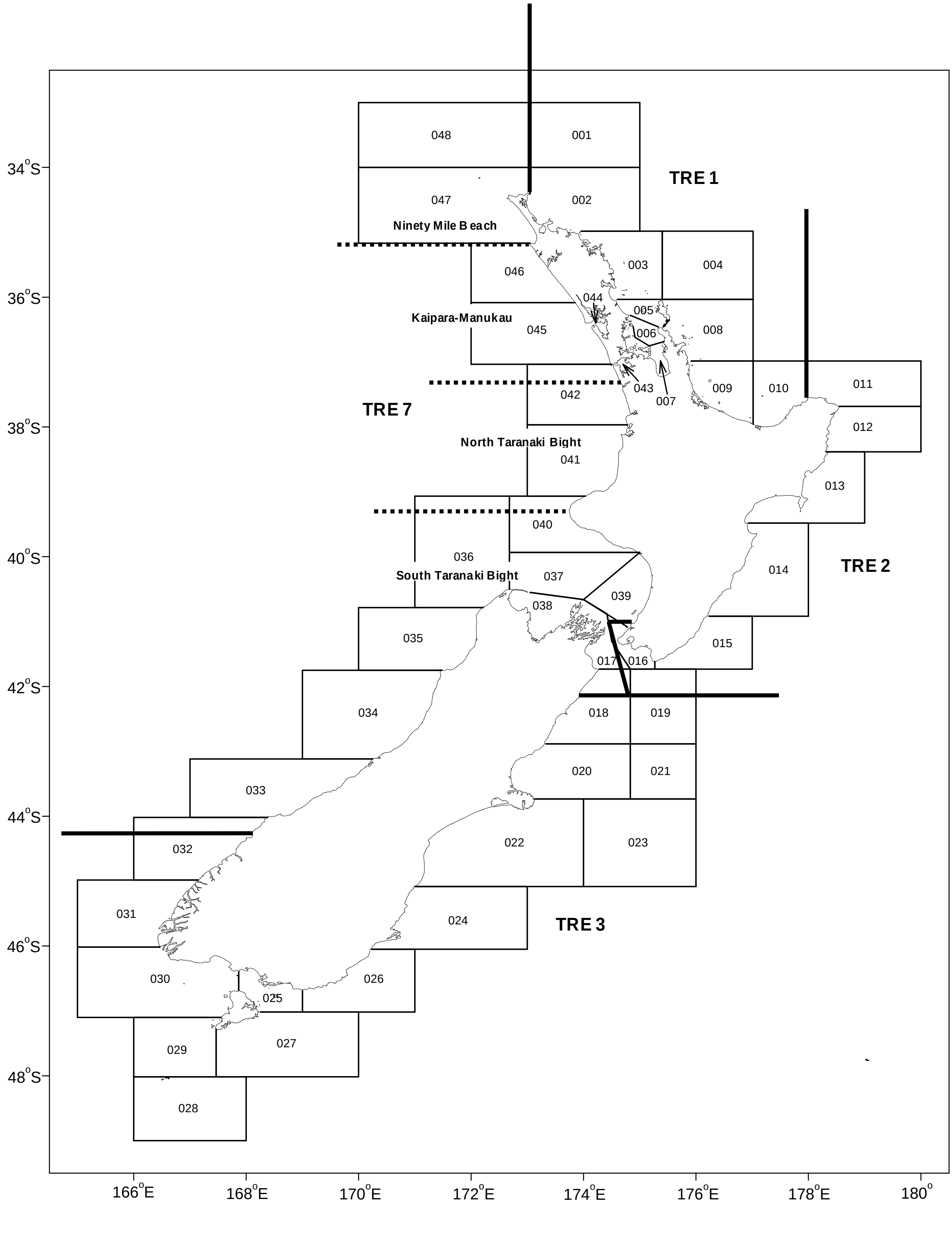


Figure 1: Trevally Quota Management Areas, statistical areas, and locations referred to in the text. Dashed lines represent the boundaries separating the subareas that make up the TRE 7 stock.

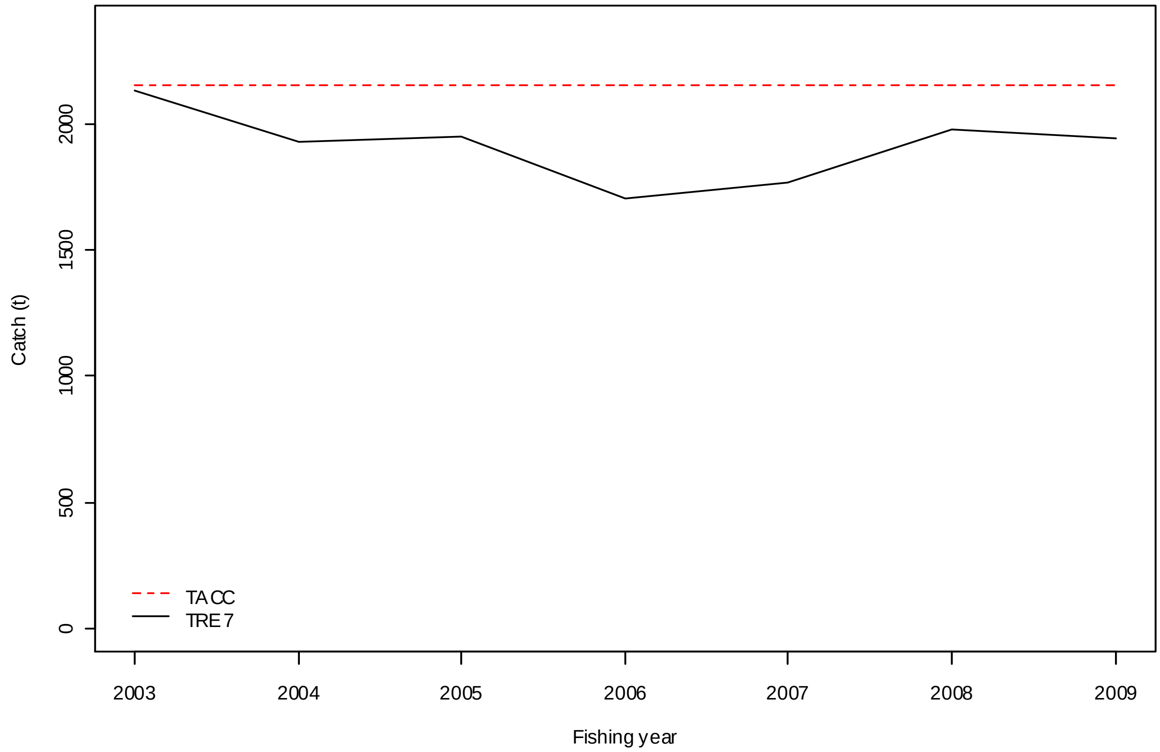


Figure 2: Reported landings of trevally (t) in TRE 7 and TACCs (t) for 2003–04 to 2009–10 (QMS data from Ministry of Fisheries, 2011).

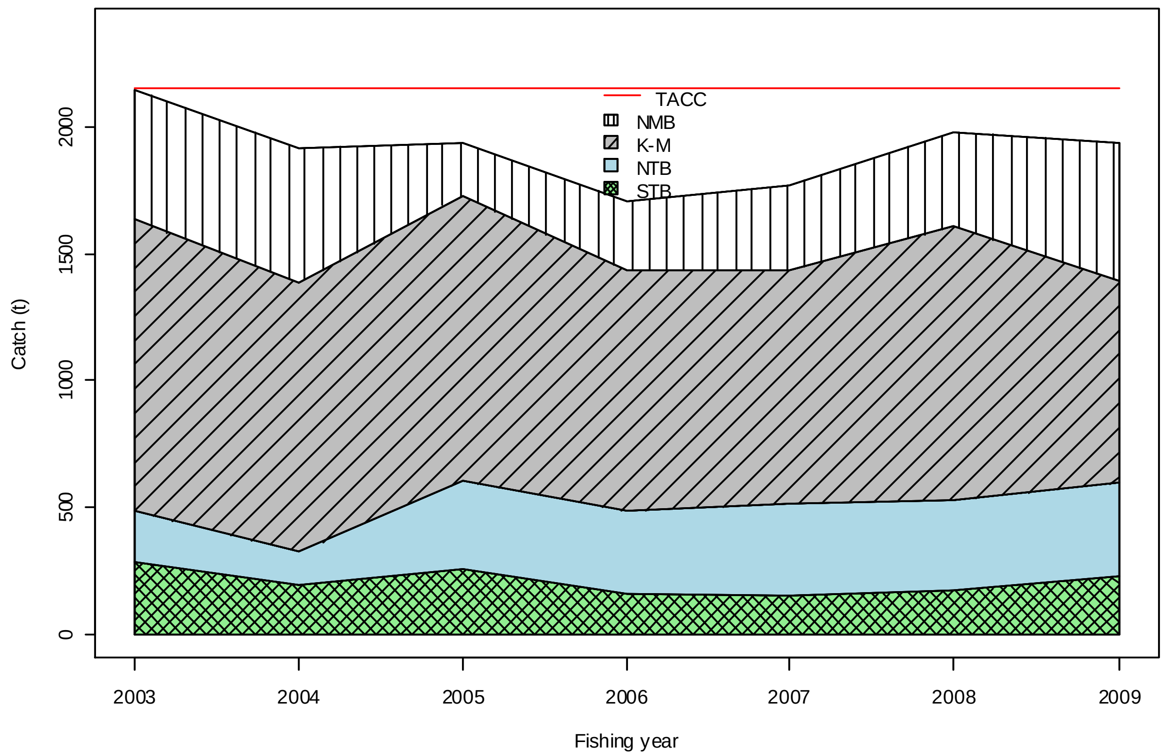


Figure 3: Annual TRE 7 catch by subarea (NMB, Ninety Mile Beach; K-M, Kaipara/Manukau; NTB, North Taranaki Bight; STB, South Taranaki Bight).

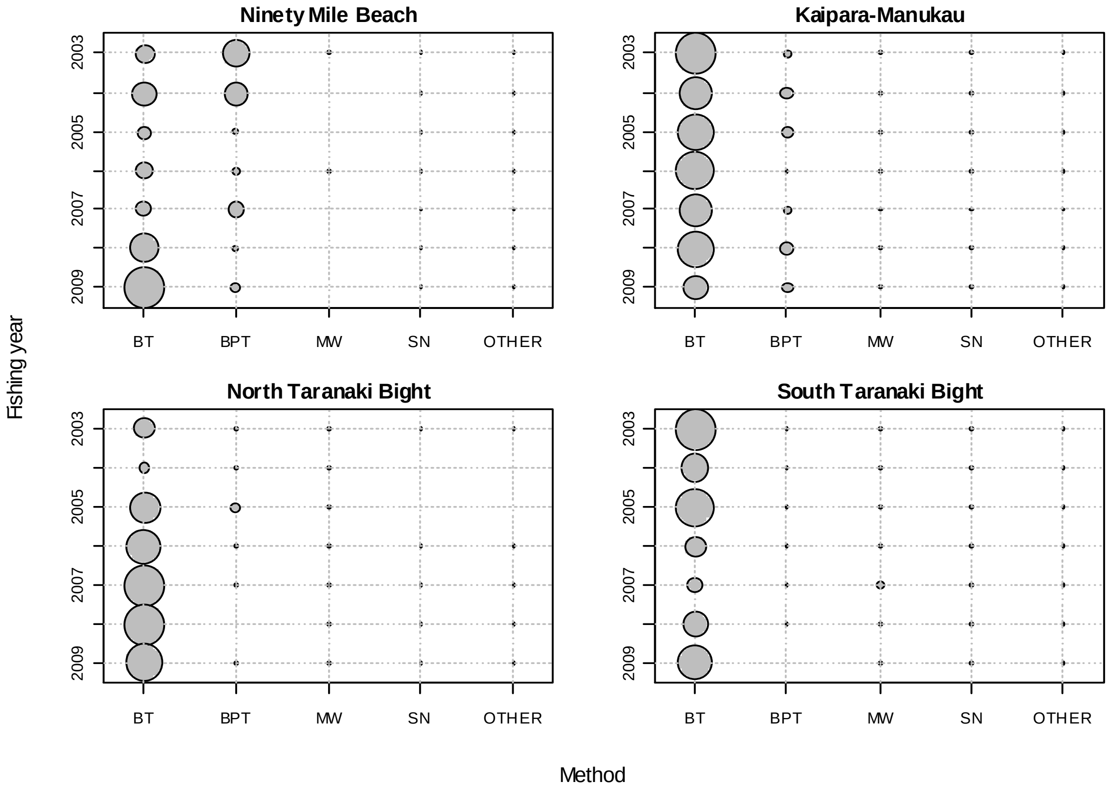


Figure 4: Relative annual catch by method for the subareas of TRE 7, 2003–04 to 2009–10 (BT, bottom trawl; BPT, bottom pair trawl; MW, midwater trawl; SN, set net).

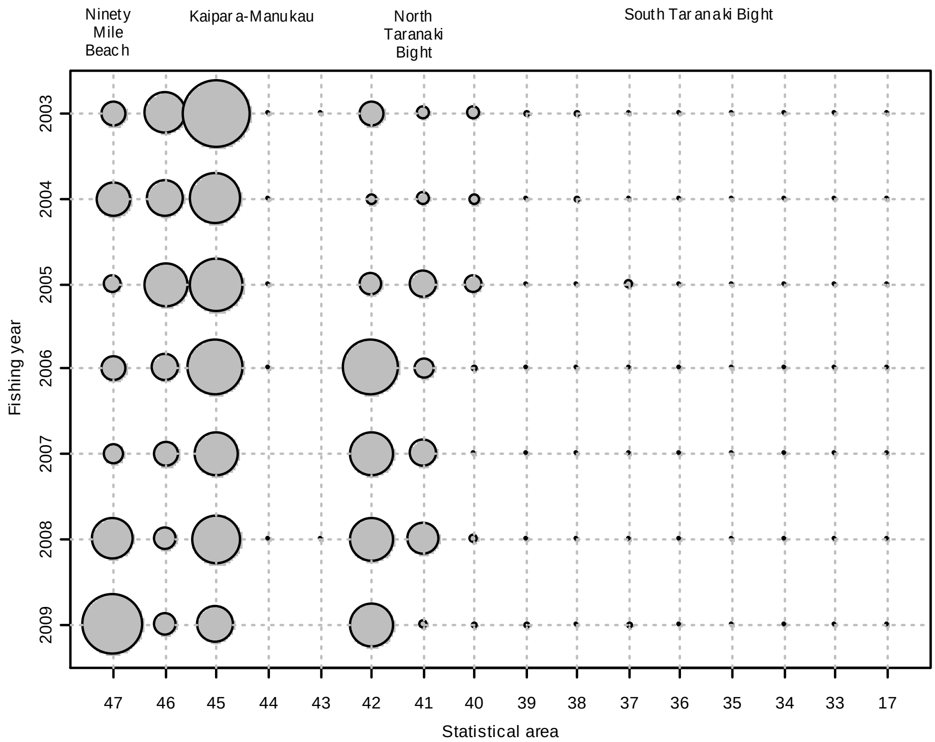


Figure 5: Relative annual bottom trawl catch by the statistical reporting areas within the TRE 7 stock, 2003–04 to 2009–10.

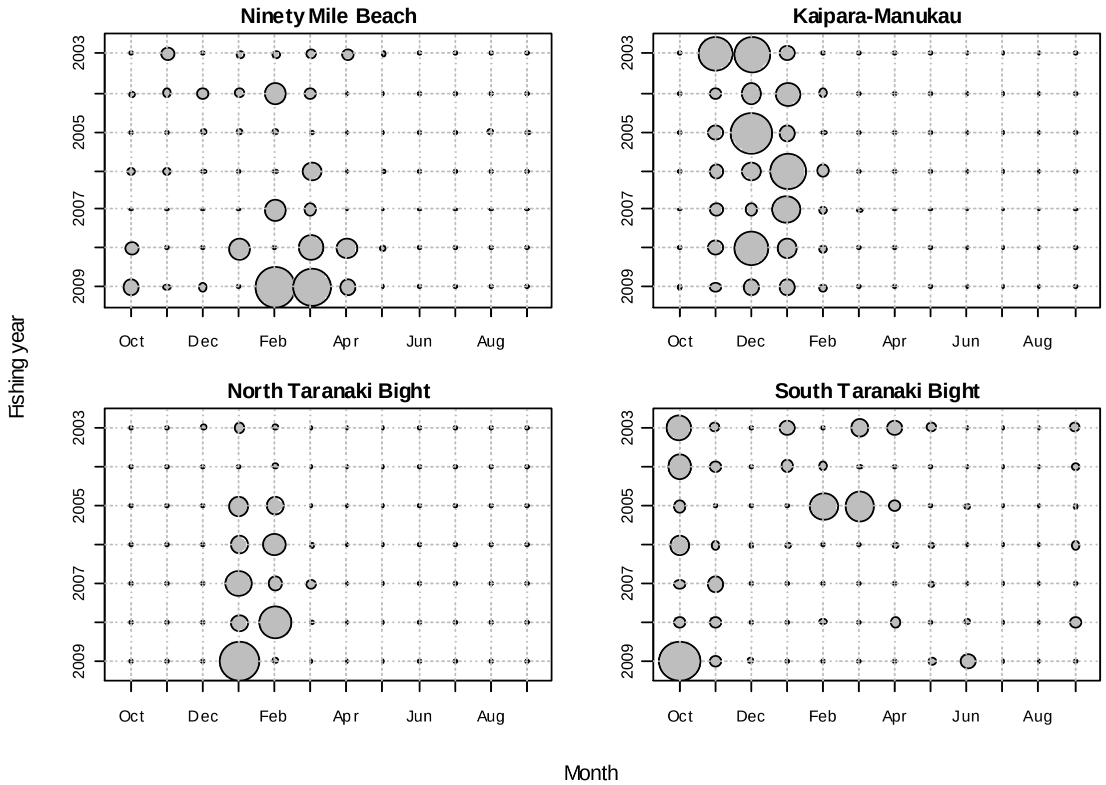


Figure 6: Relative annual bottom trawl catch by month for the subareas of TRE 7, 2003–04 to 2009–10.

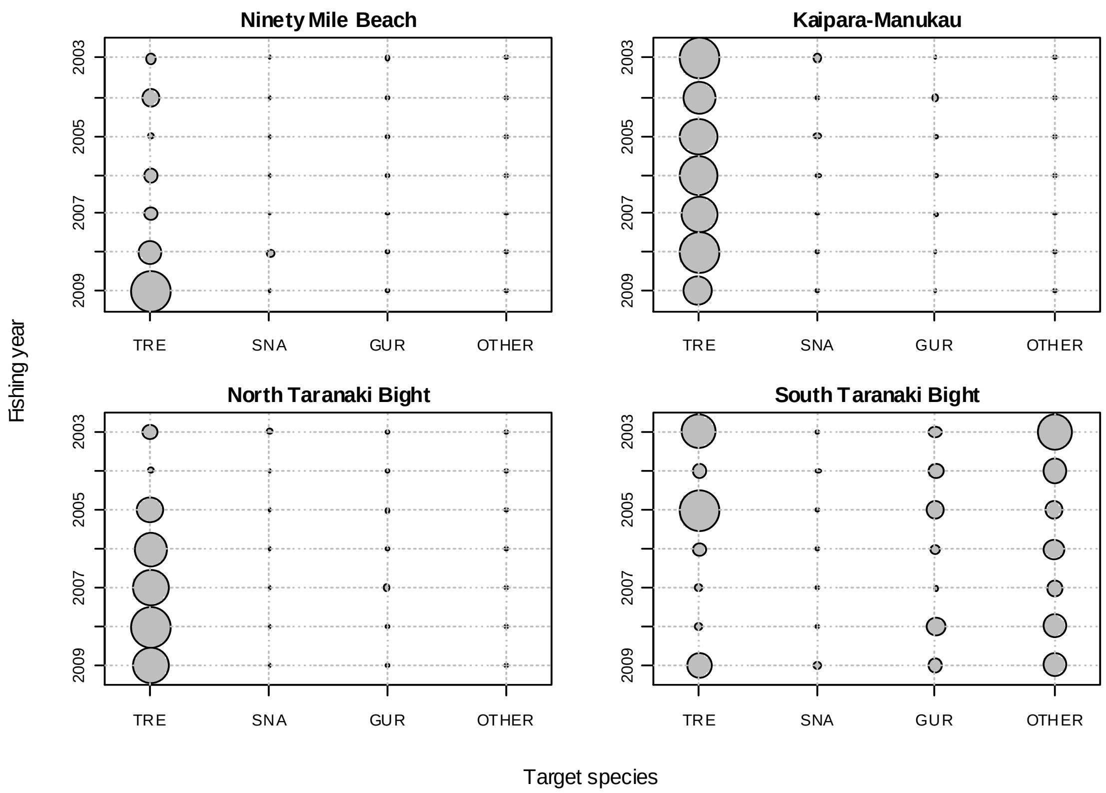


Figure 7: Relative annual bottom trawl catch by target species for the subareas of TRE 7, 2003–04 to 2009–10 (TRE, trevally; SNA, snapper; GUR, red gurnard).

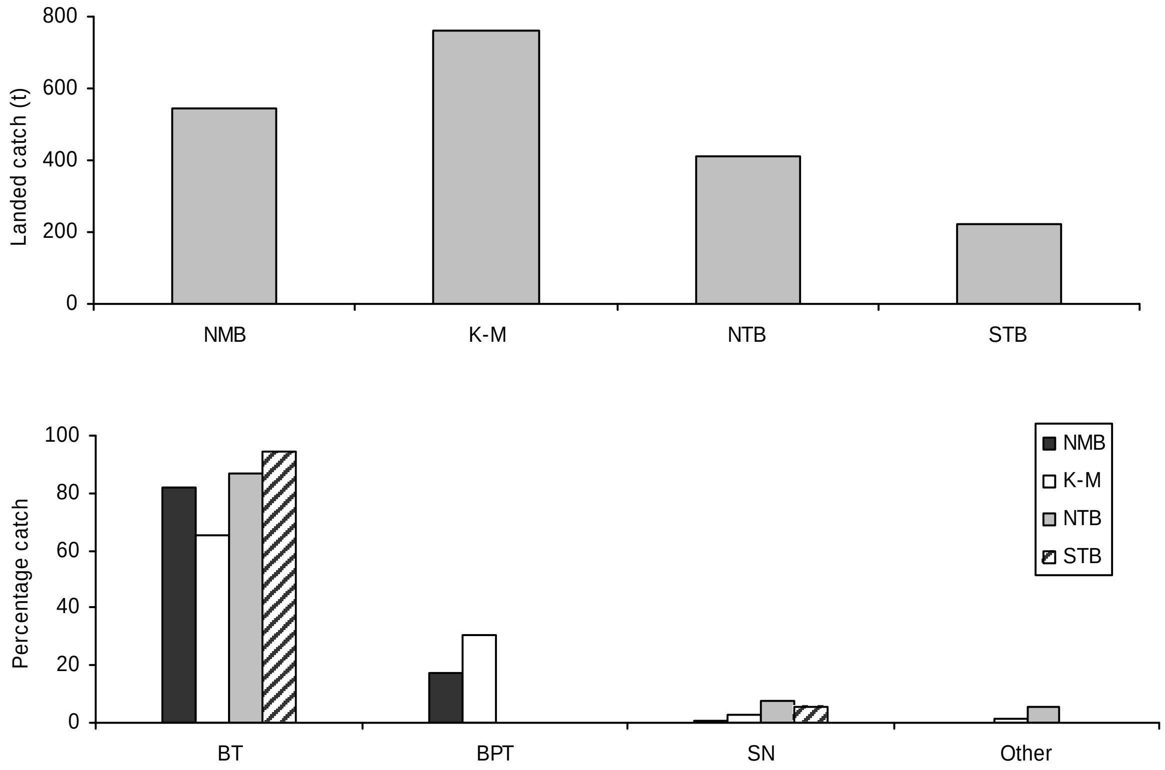


Figure 8: The landed catch (t) and percentage catch by method of trevally for the subareas of TRE 7 in 2009–10 NMB, Ninety Mile Beach; K-M, Kaipara-Manukau; NTB, North Taranaki Bight; STB, South Taranaki Bight; BT, bottom trawl; BPT, bottom pair trawl; SN, set net).

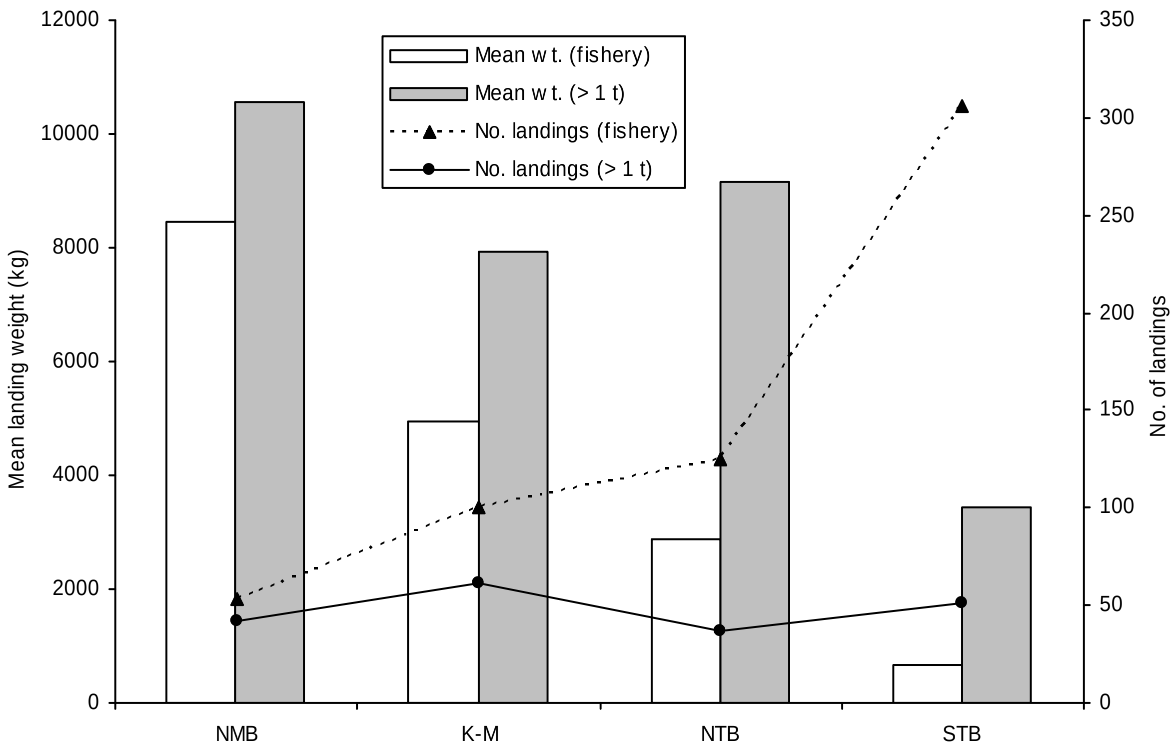


Figure 9: Mean bottom trawl landing size and number of landings of trevally for all landings in the fishery and for those landings > 1 tonne in 2009–10 (NMB, Ninety Mile Beach; K-M, Kaipara-Manukau; NTB, North Taranaki Bight; STB, South Taranaki Bight).

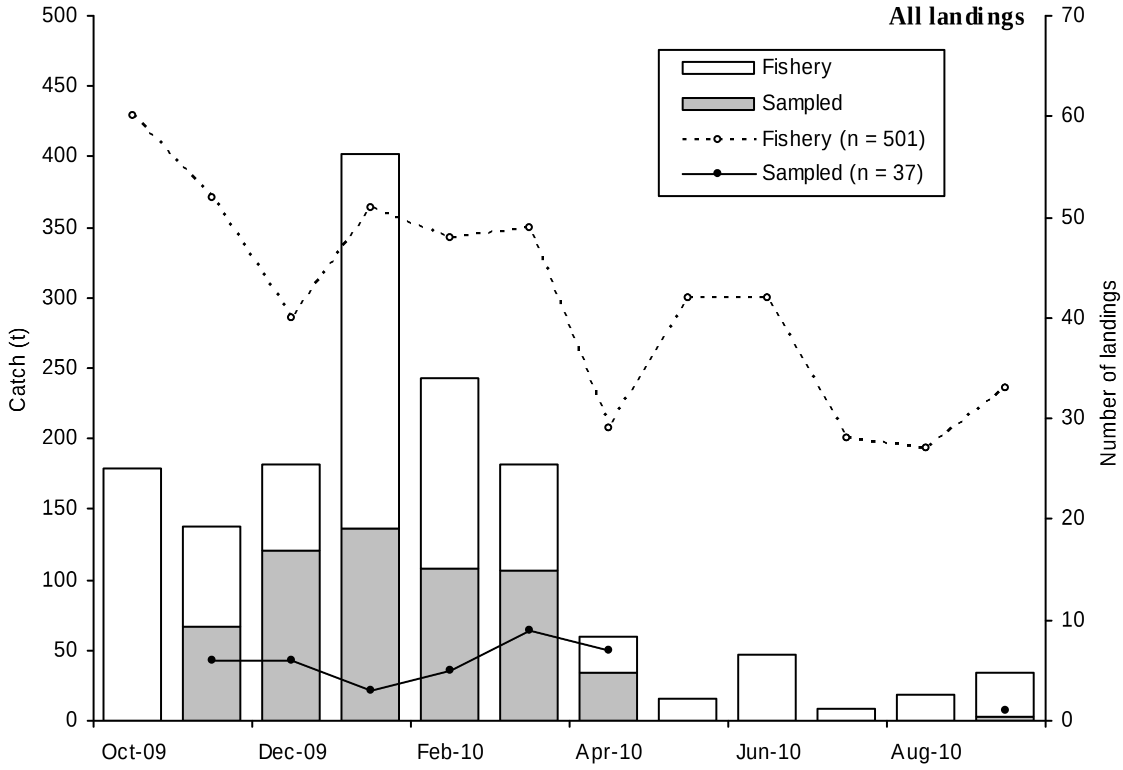


Figure 10: Comparison of the monthly distribution of landed weight (white bars) and numbers of landings (dashed line) of trevally in the TRE 7 bottom trawl fishery for all landings where trevally was caught in 2009–10. Included are corresponding estimates for all sampled landings (grey bars and solid line) to show representiveness of collections. Note: bars and lines are overlaid.

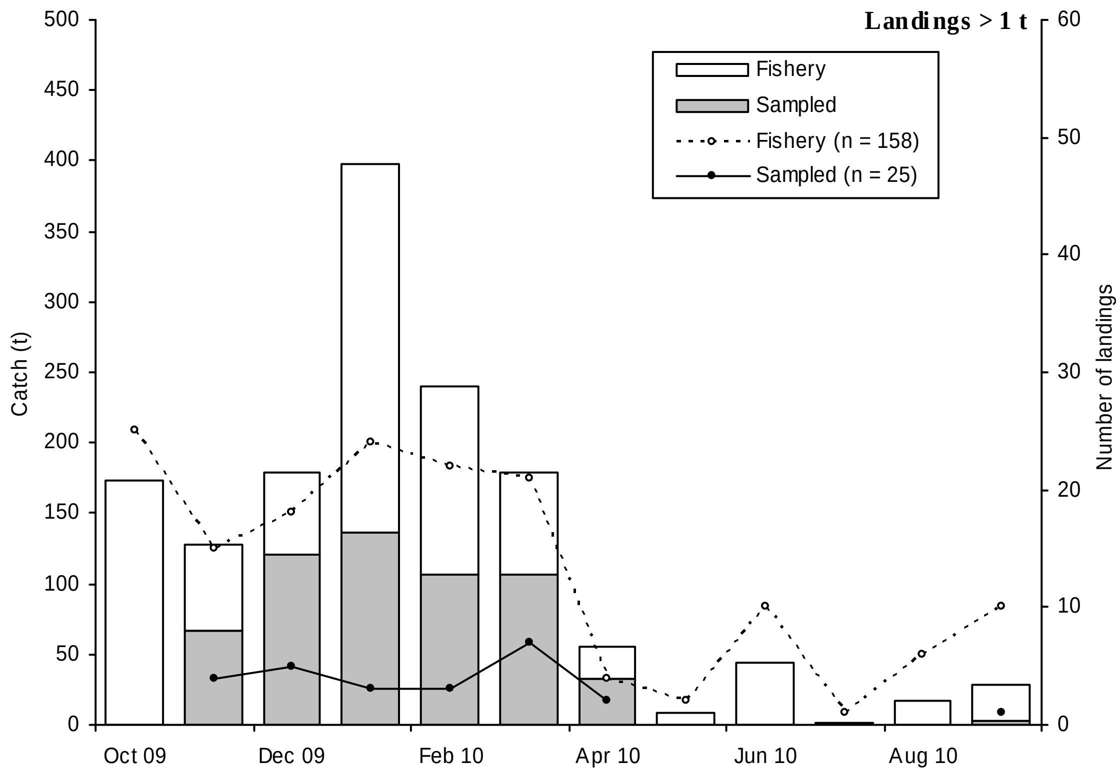


Figure 11: Comparison of the monthly distribution of landed weight (white bars) and numbers of landings (dashed line) of trevally in the TRE 7 bottom trawl fishery for all landings > 1 tonne in 2009–10. Included are corresponding estimates for all sampled landings (grey bars and solid line) to show representiveness of collections. Note: bars and lines are overlaid.

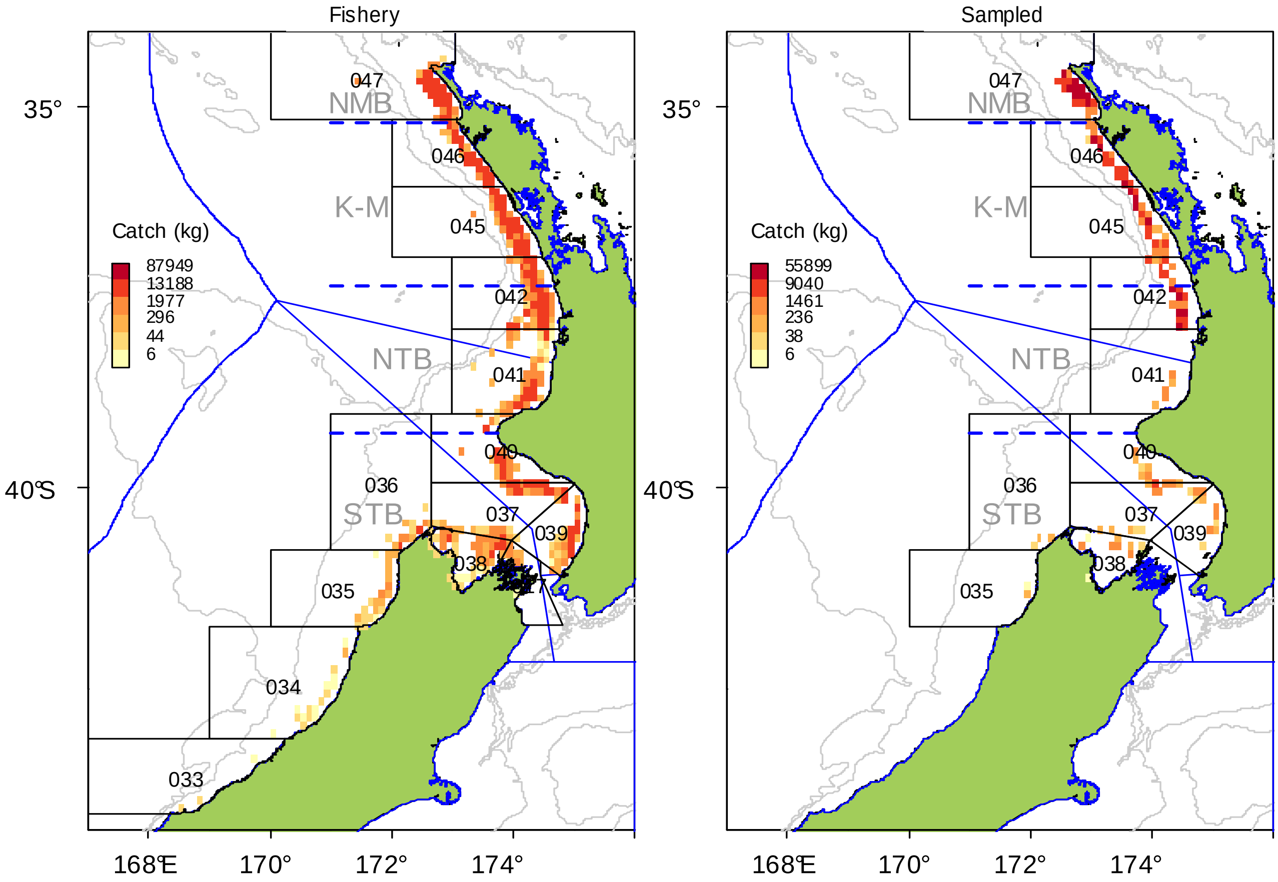


Figure 12: Comparison of the spatial distribution of the bottom trawl catch and the sampled component for the TRE 7 stock in 2009–10 (NMB, Ninety Mile Beach; K-M, Kaipara-Manukau; NTB, North Taranaki Bight; STB, South Taranaki Bight).

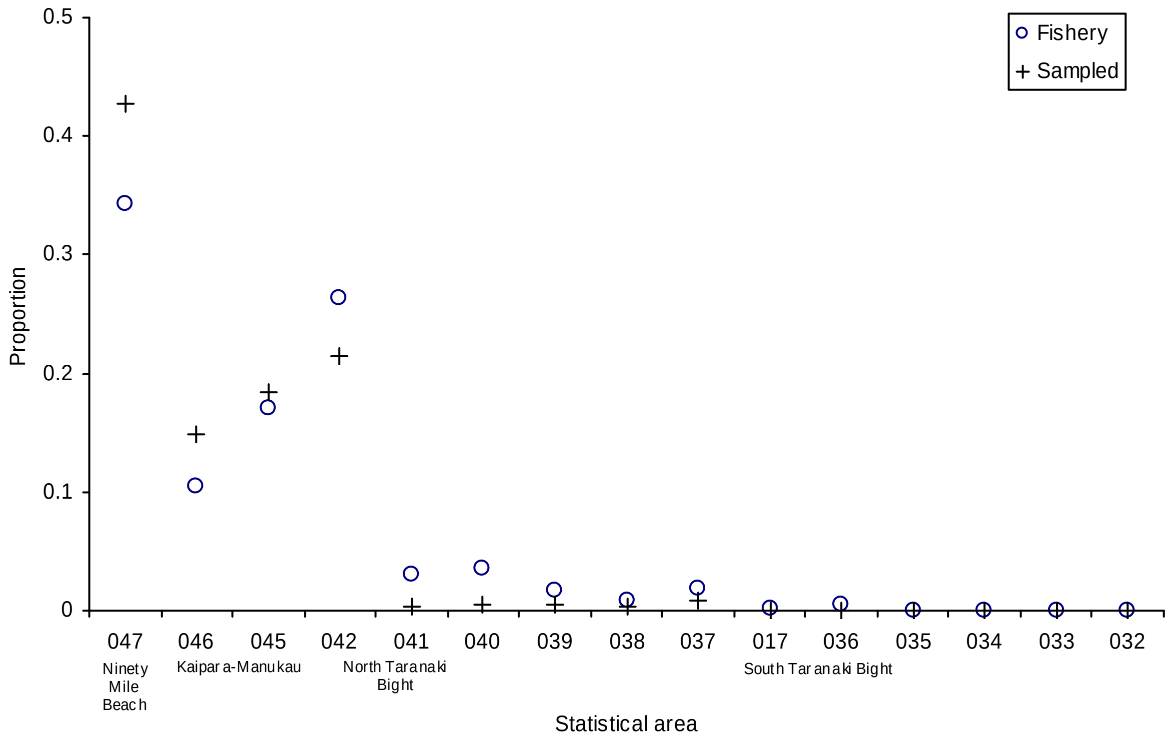


Figure 13: Comparison of the proportional distribution of the estimated bottom trawl catch and the sampled component by statistical area (with annotated spatial subarea strata) over the sampling period for the TRE 7 stock in 2009–10.

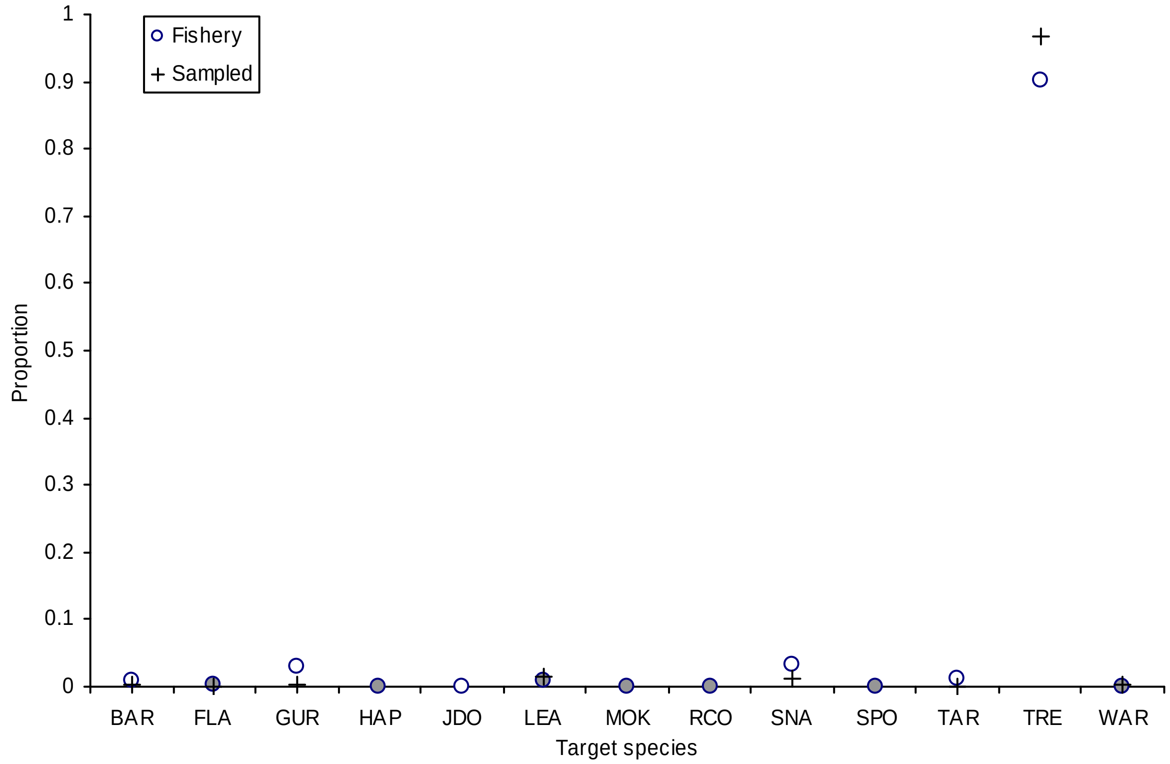


Figure 14: Comparison of the proportional distribution of the estimated bottom trawl catch and the sampled component by target species over the sampling period for the TRE 7 stock in 2009–10. Shaded circles designate target species exclusively used in the South Taranaki Bight subarea.

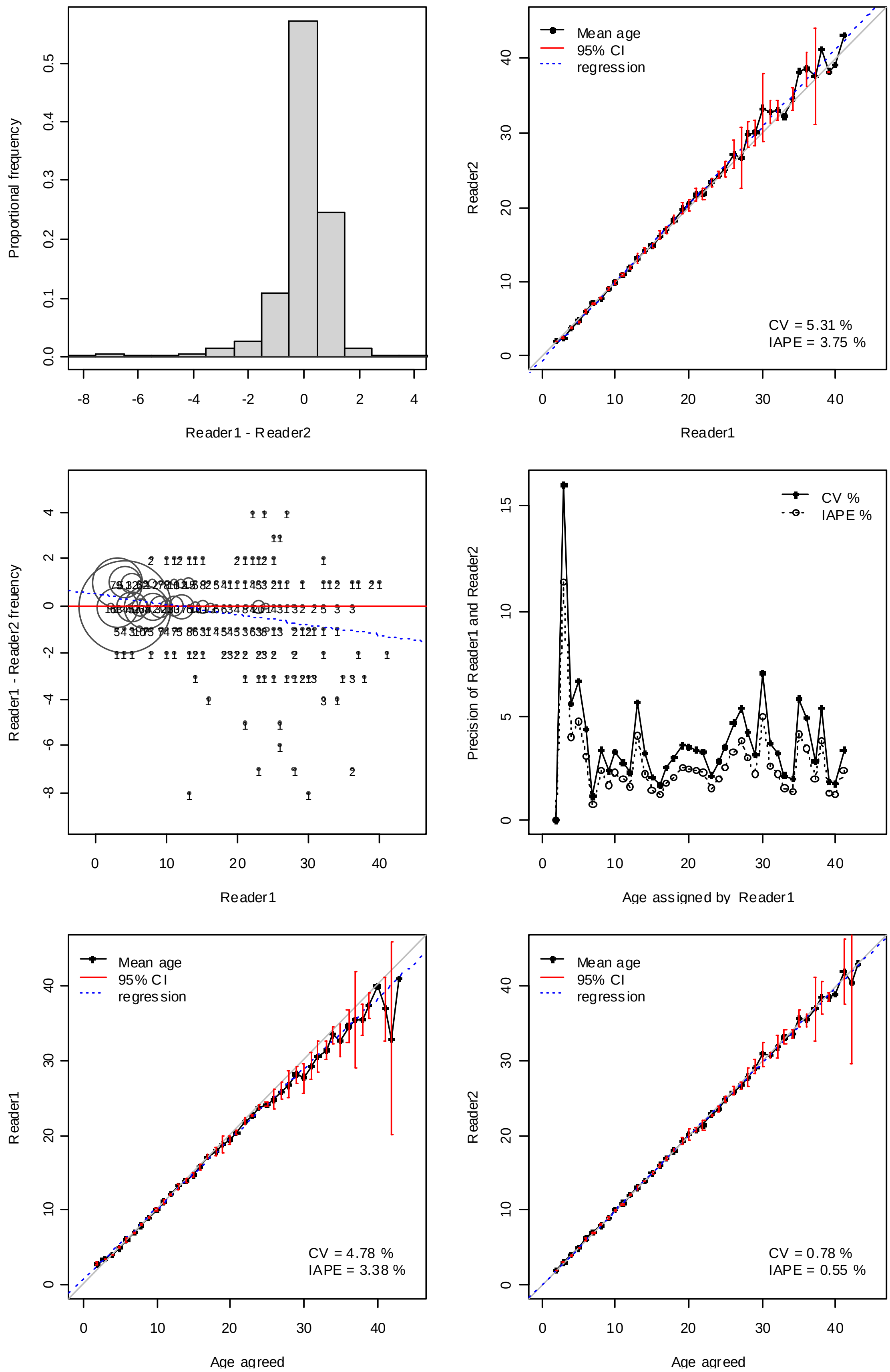


Figure 15: Results of between-reader comparison test (reader 1 and 2): (a) histogram of differences between readings for the same otolith; (b) bias plot between readers; (c) differences between readers for a given age assigned by reader 1 (d) c.v. and IAPE profiles (precision) relative to the age assigned 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).

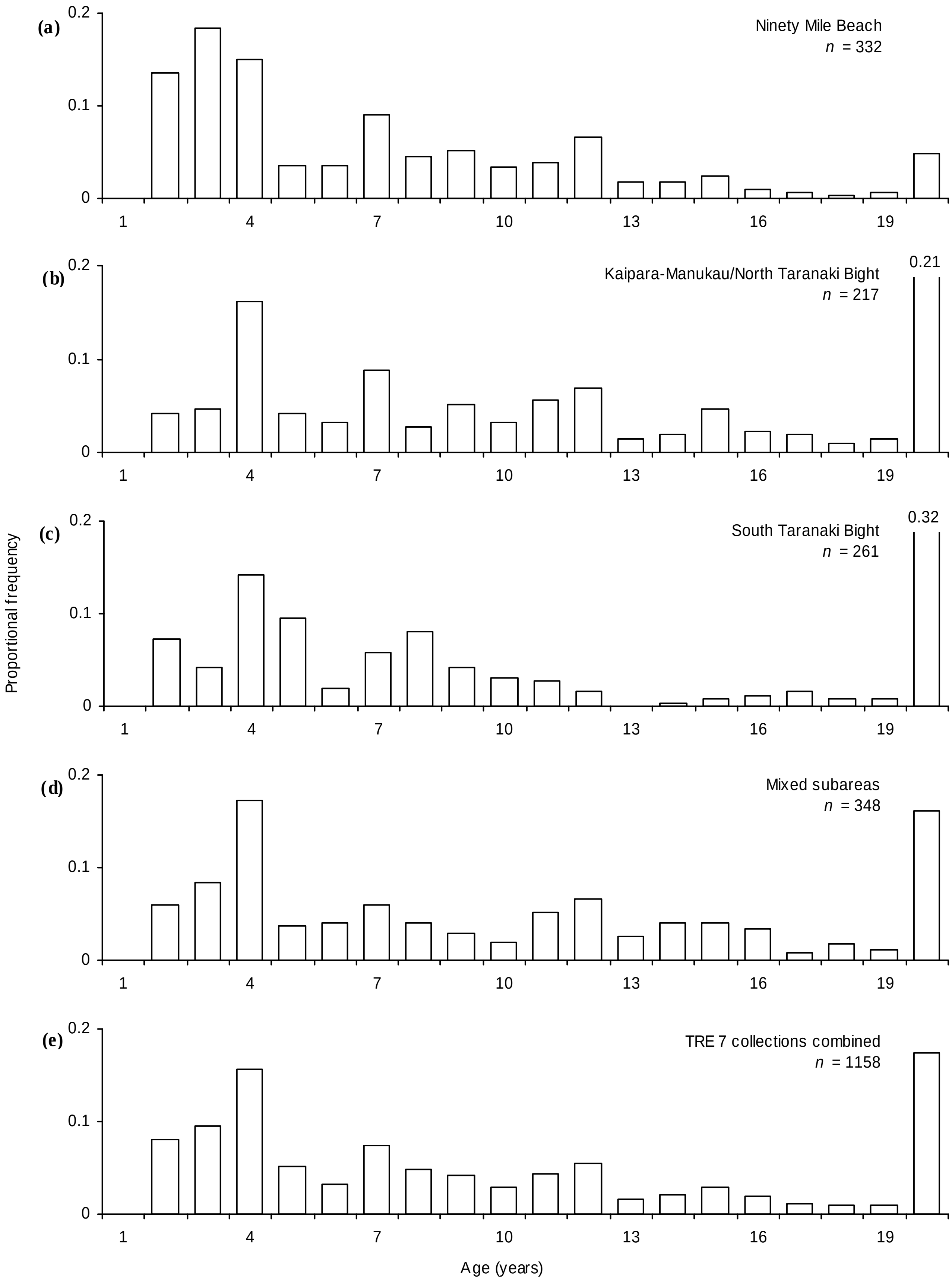


Figure 16: Comparison of the unweighted proportions at age determined from trevally landings sampled from the three subarea fisheries (a–c), those of mixed subarea origin (d), and the overall combined collection for TRE 7 (e), in 2009–10 (*n*, otolith sample size).

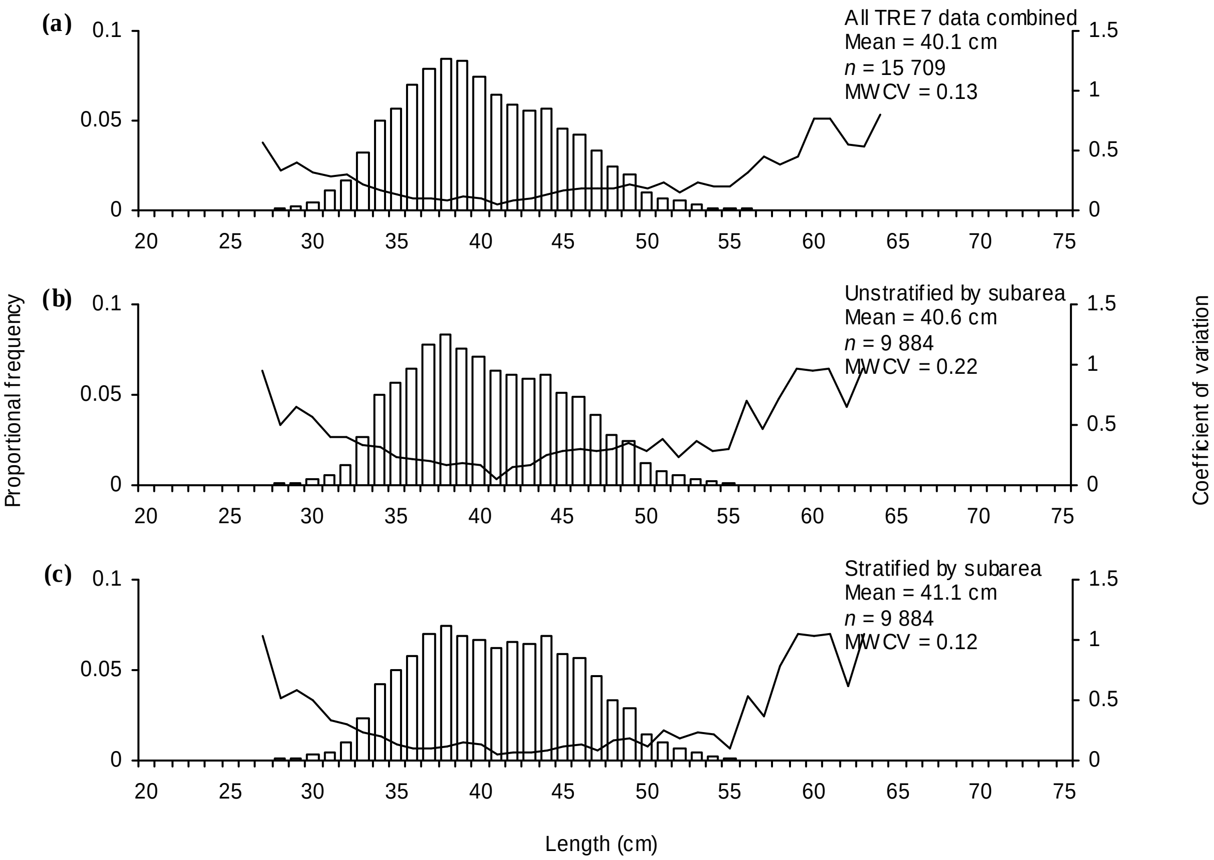


Figure 17: All data combined (a), unstratified (b), and stratified (c) proportion at length distributions (histogram) and analytical c.v.s (solid line) determined from trevally landings sampled from the TRE 7 bottom trawl fishery in 2009–10 (*n*, length sample size; MWCV, mean weighted c.v.).

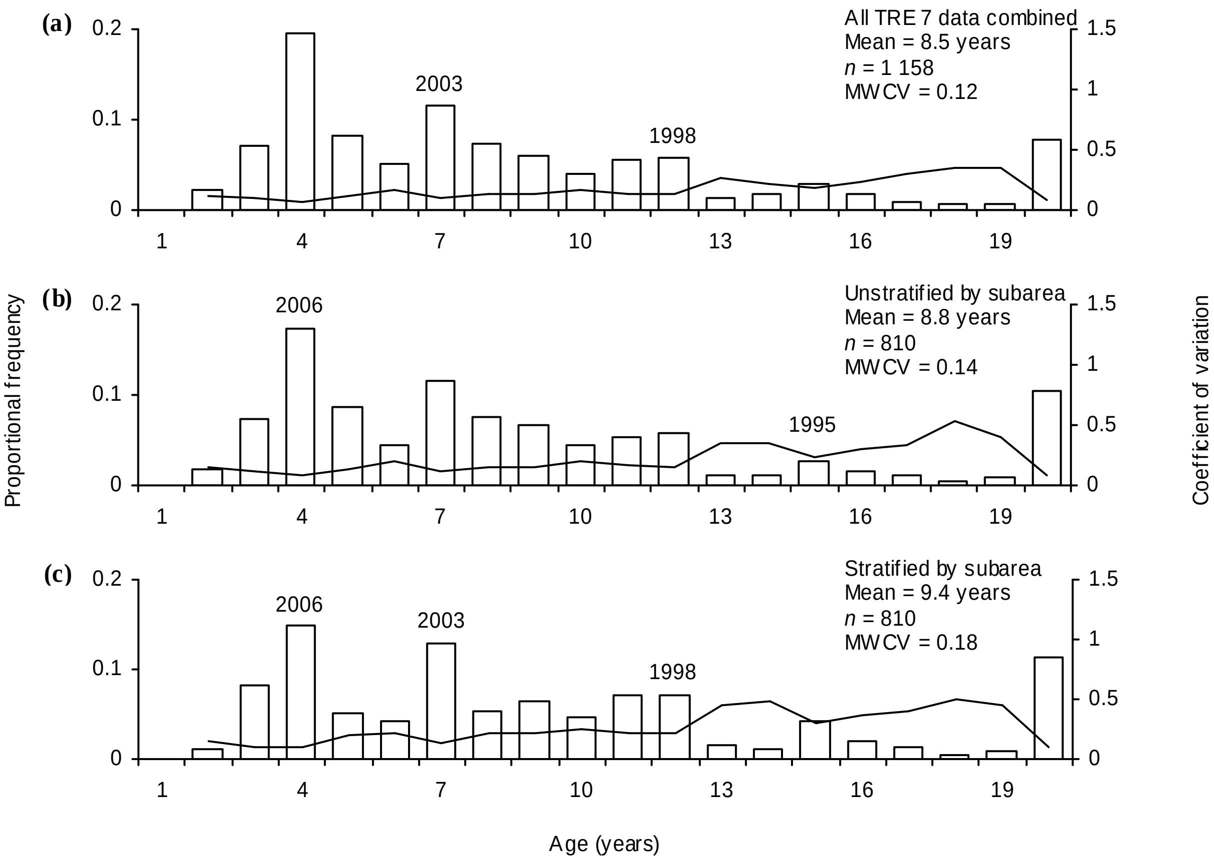


Figure 18: All data combined (a), unstratified (b), and stratified (c) proportion at age distributions (histogram) and analytical c.v.s (solid line) determined from trevally landings sampled from the TRE 7 bottom trawl fishery in 2009–10 (*n*, otolith sample size; MWCV, mean weighted c.v.).

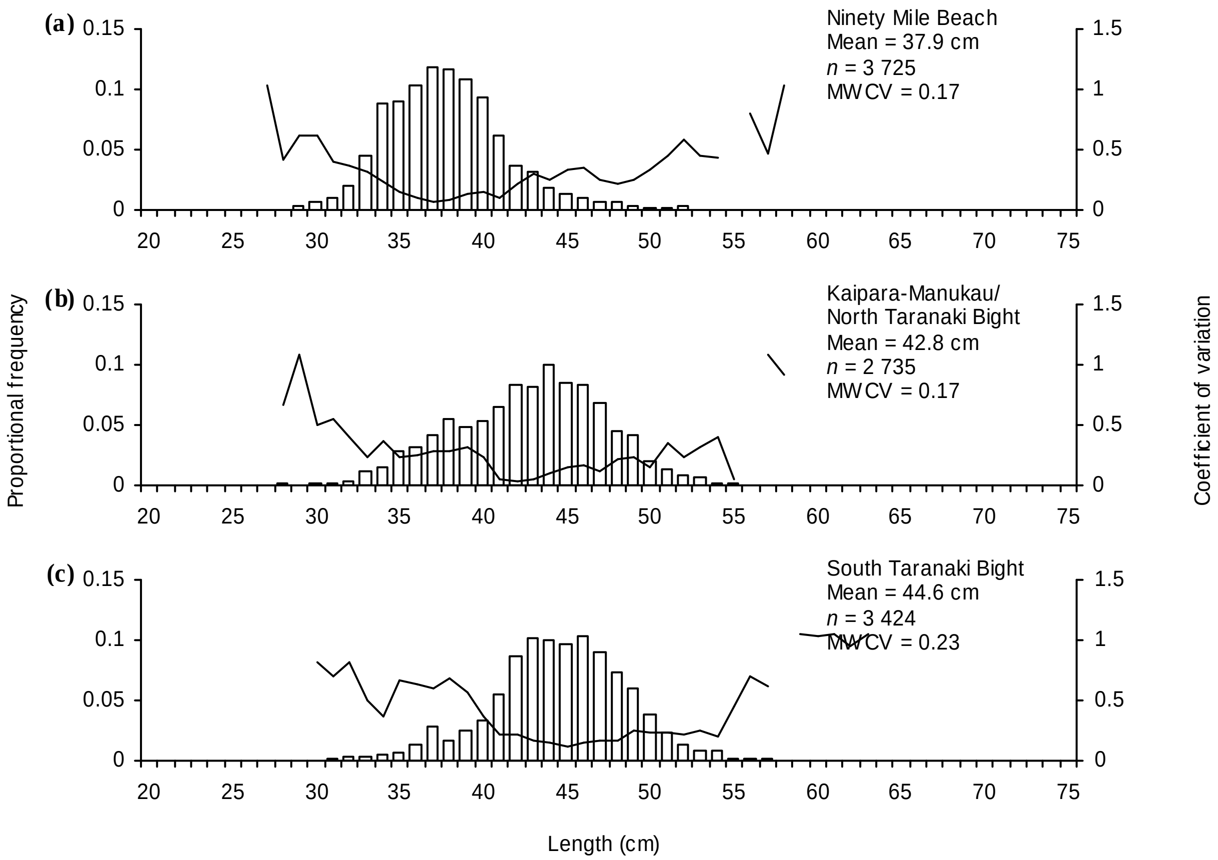


Figure 19: Proportion at length distributions (histogram) and analytical c.v.s (solid line) determined from trevally landings sampled from the (a) Ninety Mile Beach, (b) Kaipara-Manukau/North Taranaki Bight, and (c) South Taranaki Bight subarea bottom trawl fisheries in 2009–10 (*n*, length sample size; MWCV, mean weighted c.v.).

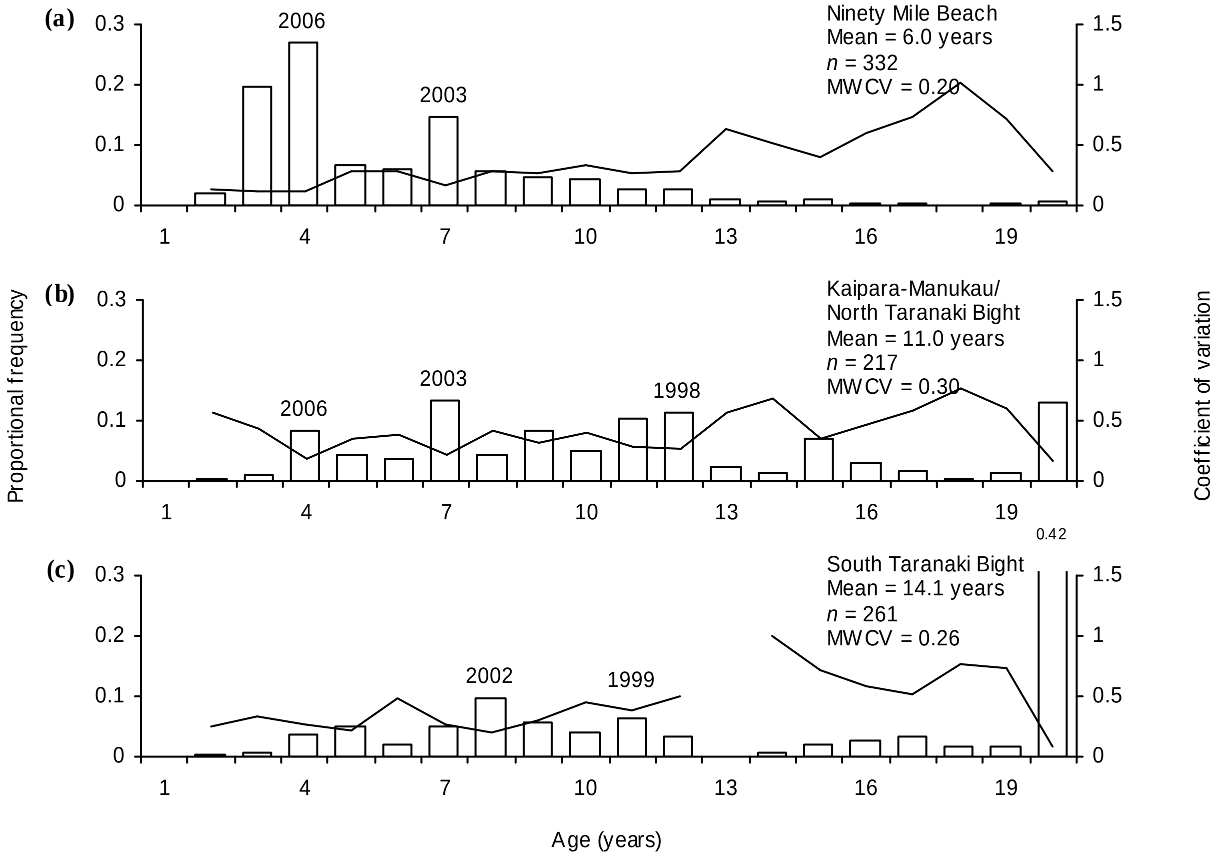


Figure 20: Proportion at age distributions (histogram) and analytical c.v.s (solid line) determined from trevally landings sampled from the (a) Ninety Mile Beach, (b) Kaipara-Manukau/North Taranaki Bight, and (c) South Taranaki Bight subarea bottom trawl fisheries in 2009–10 (*n*, otolith sample size; MWCV, mean weighted c.v.).

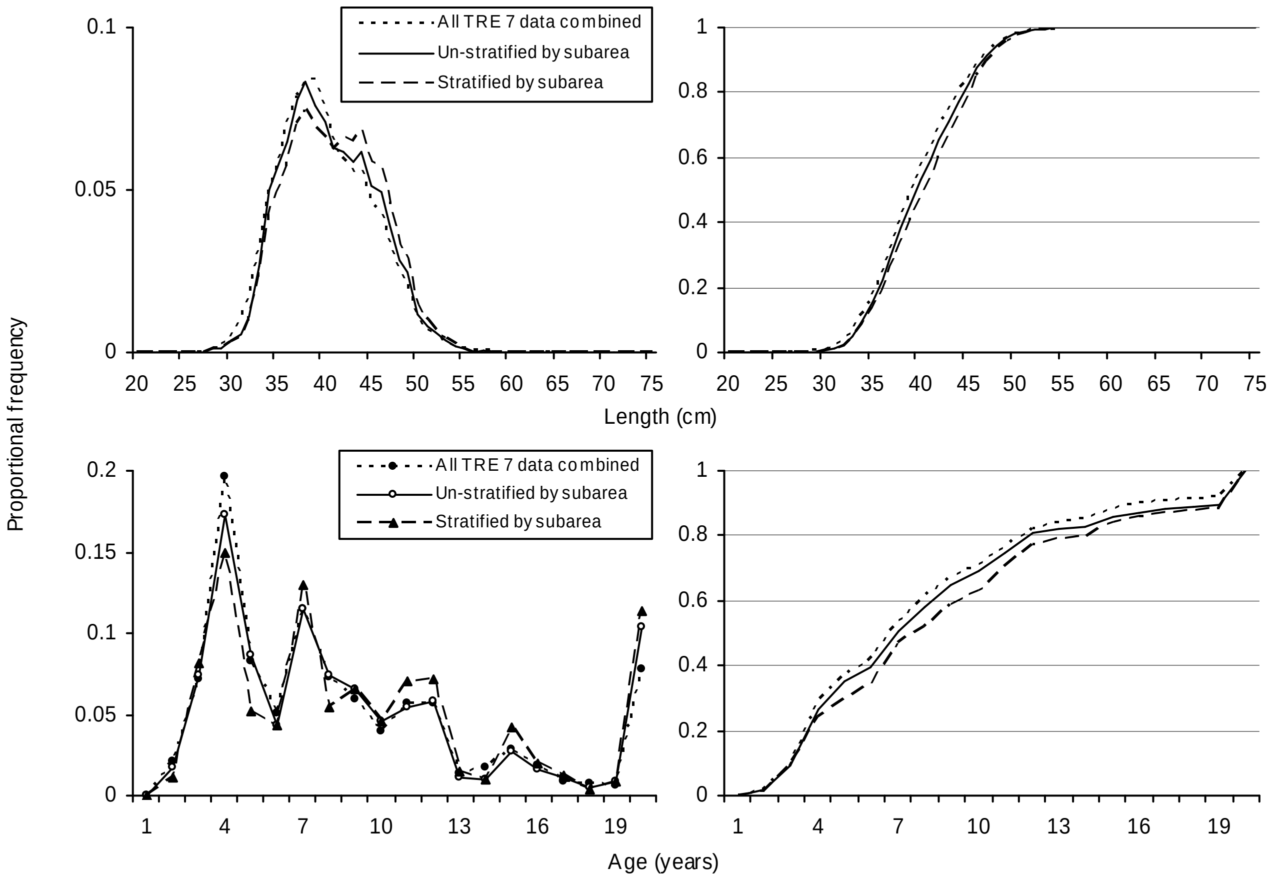


Figure 21: Comparison of the proportion and cumulative proportion at length and age distributions (all data combined, unstratified, and stratified) determined from trevally landings sampled from the TRE 7 bottom trawl fishery in 2009–10.

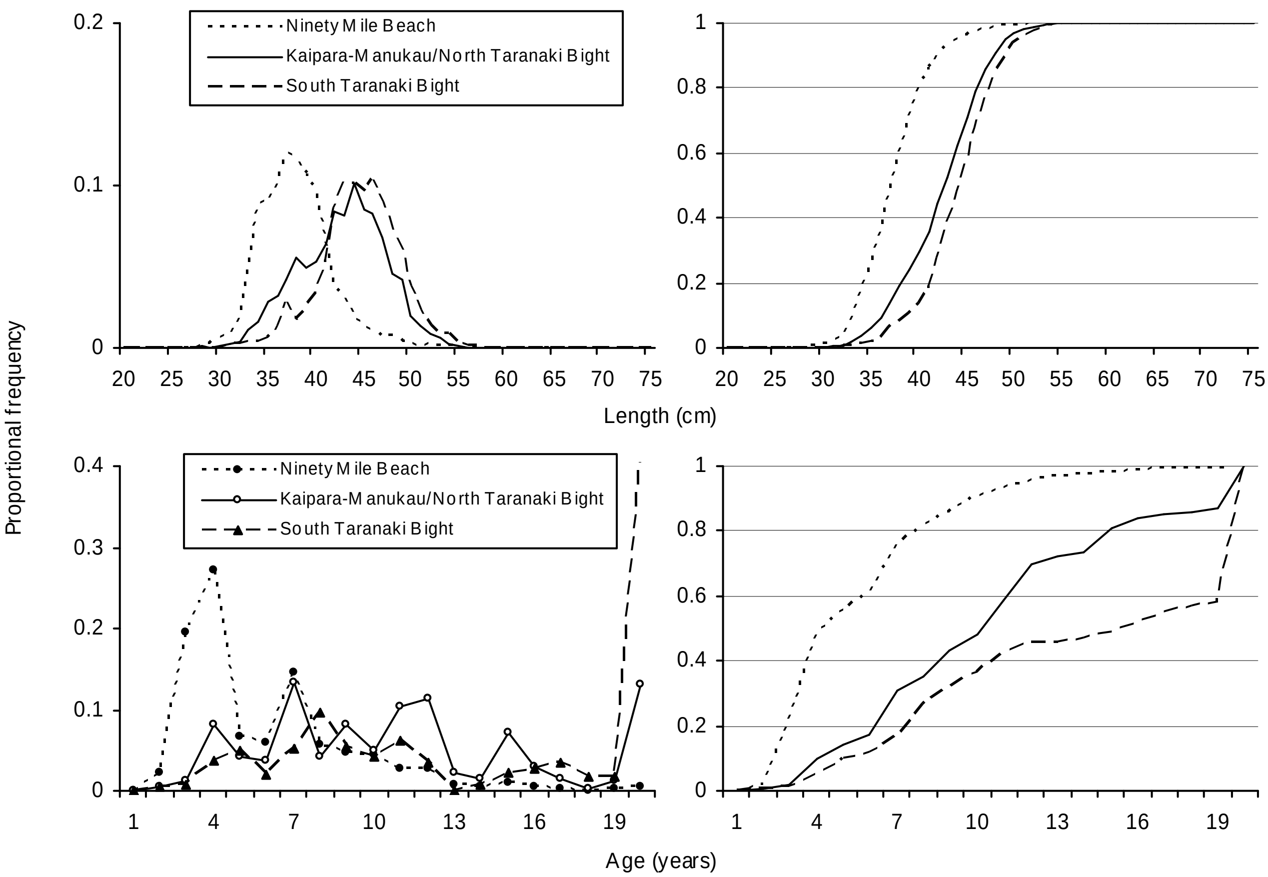


Figure 22: Comparison of the proportion and cumulative proportion at length and age distributions determined from trevally landings sampled from the Ninety Mile Beach, Kaipara-Manukau/North Taranaki Bight, and South Taranaki Bight subarea bottom trawl fisheries of TRE 7 in 2009–10.

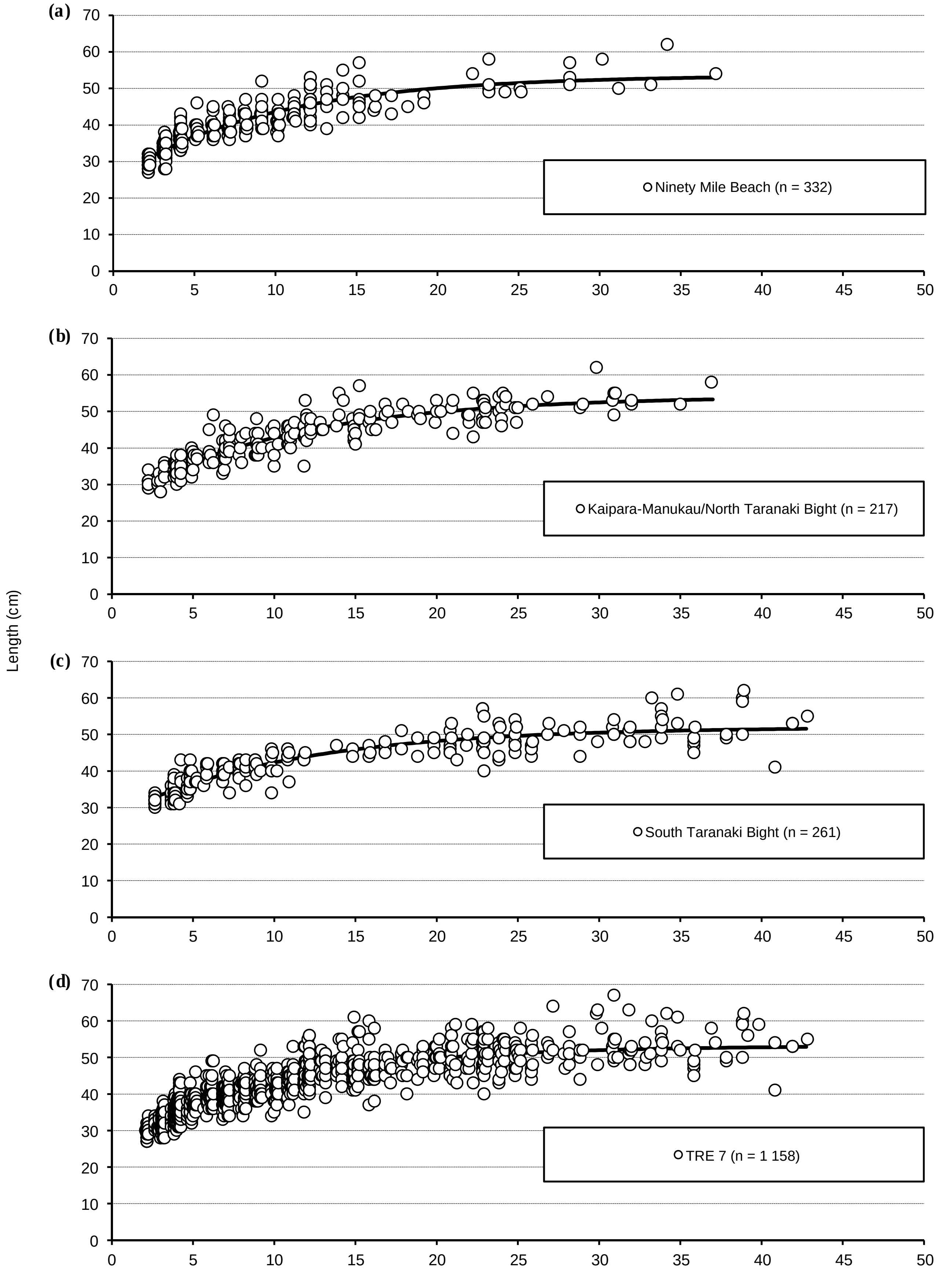


Figure 23: von Bertalanffy growth curves and scatterplots of unweighted age-length data for trevally sampled in 2009–10 from the (a) Ninety Mile Beach, (b) Kaipara-Manukau/North Taranaki Bight, (c) South Taranaki Bight subareas, and (d) all TRE 7 data combined (Note: *n*, sample size). Age is decimalised as of the month of collection relative to an assumed January 1 "birthdate".

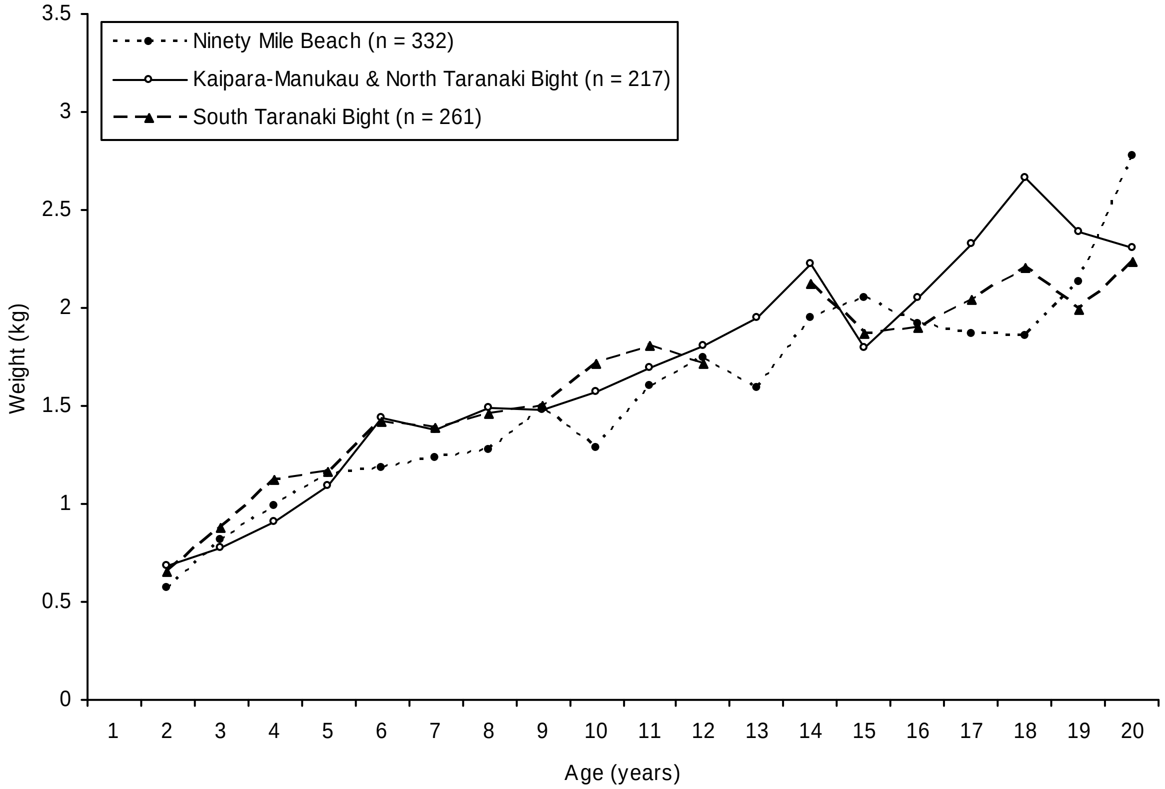


Figure 24: Observed mean weight-at-age estimates from trevally landings sampled from the Ninety Mile Beach, Kaipara-Manukau/North Taranaki Bight, and South Taranaki Bight subarea bottom trawl fisheries of TRE 7 in 2009–10 (*n*, sample size).

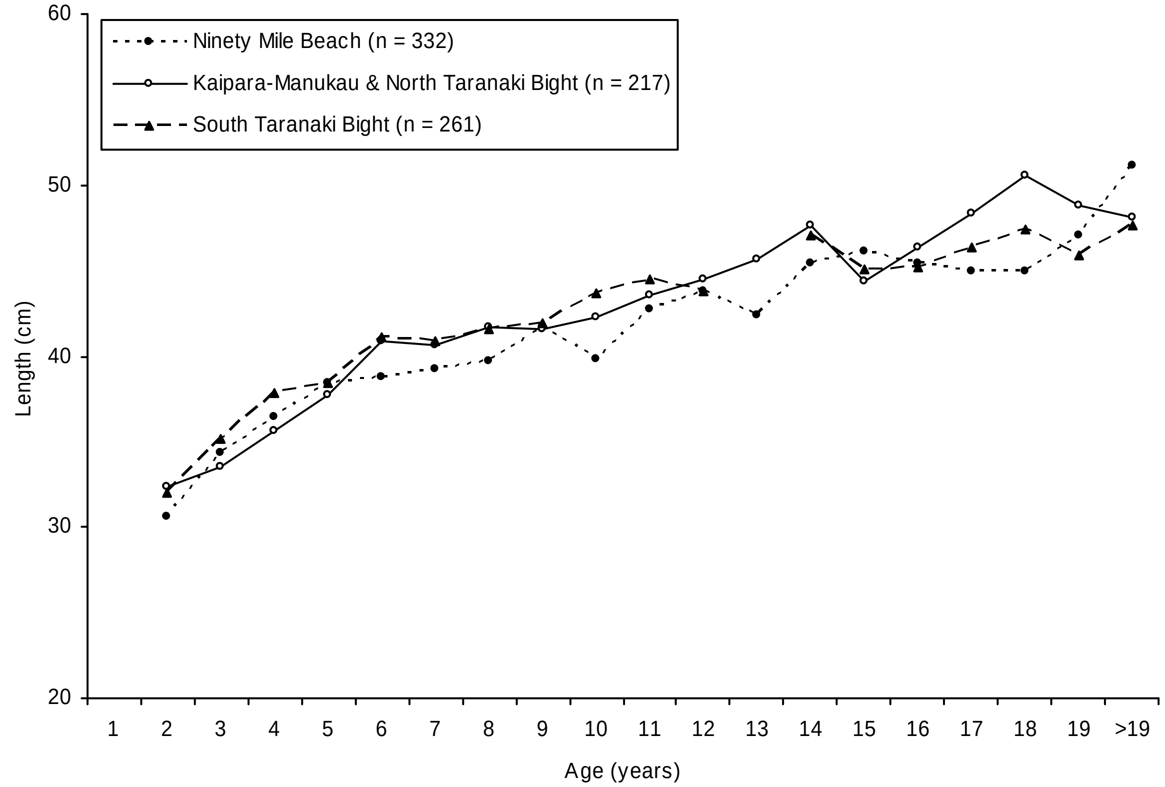


Figure 25: Observed mean length-at-age estimates from trevally landings sampled from the Ninety Mile Beach, Kaipara-Manukau/North Taranaki Bight, and South Taranaki Bight subarea bottom trawl fisheries of TRE 7 in 2009–10 (*n*, sample size).

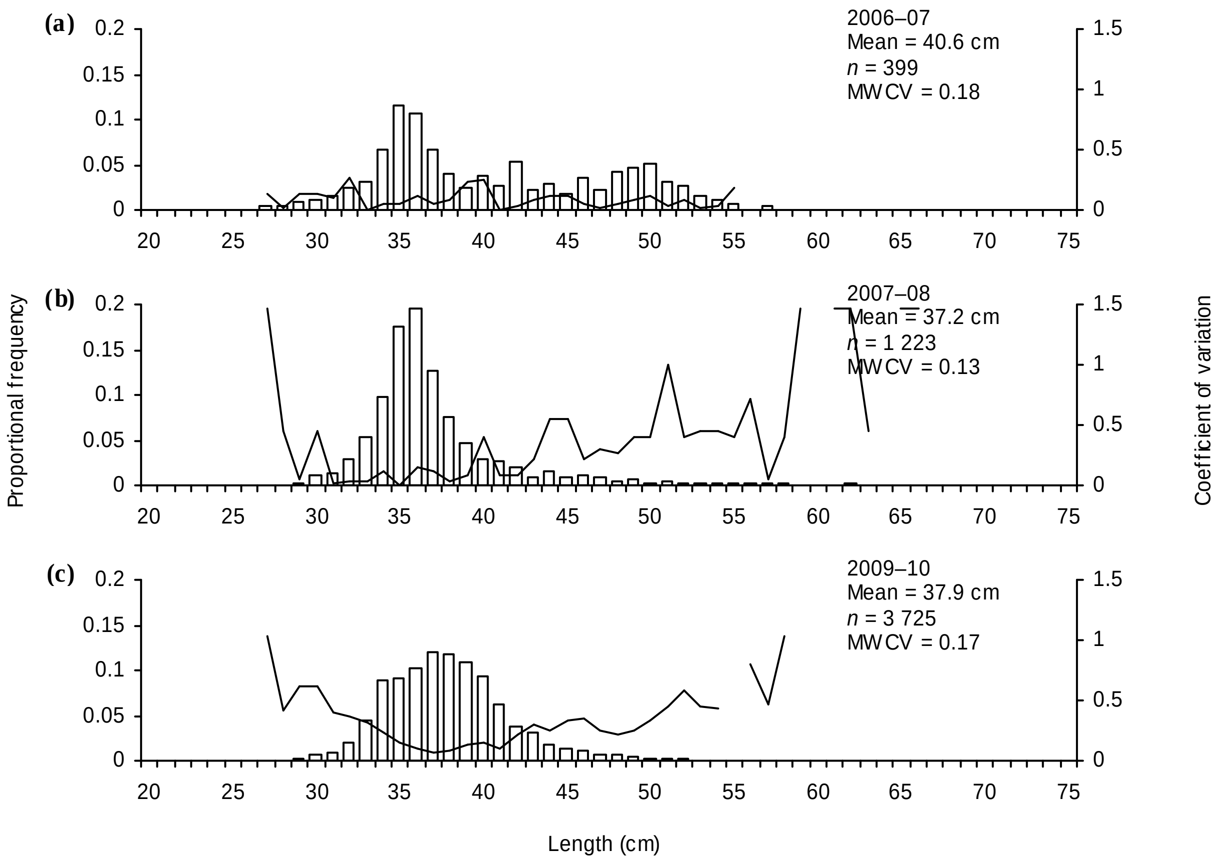


Figure 26: Time series of proportion at length distributions (histogram) and analytical c.v.s (solid line) determined from trevally landings sampled from the Ninety Mile Beach subarea bottom trawl fishery in (a) 2006–07, (b) 2007–08, and (c) 2009–10 (*n*, length sample size; MWCV, mean weighted c.v.).

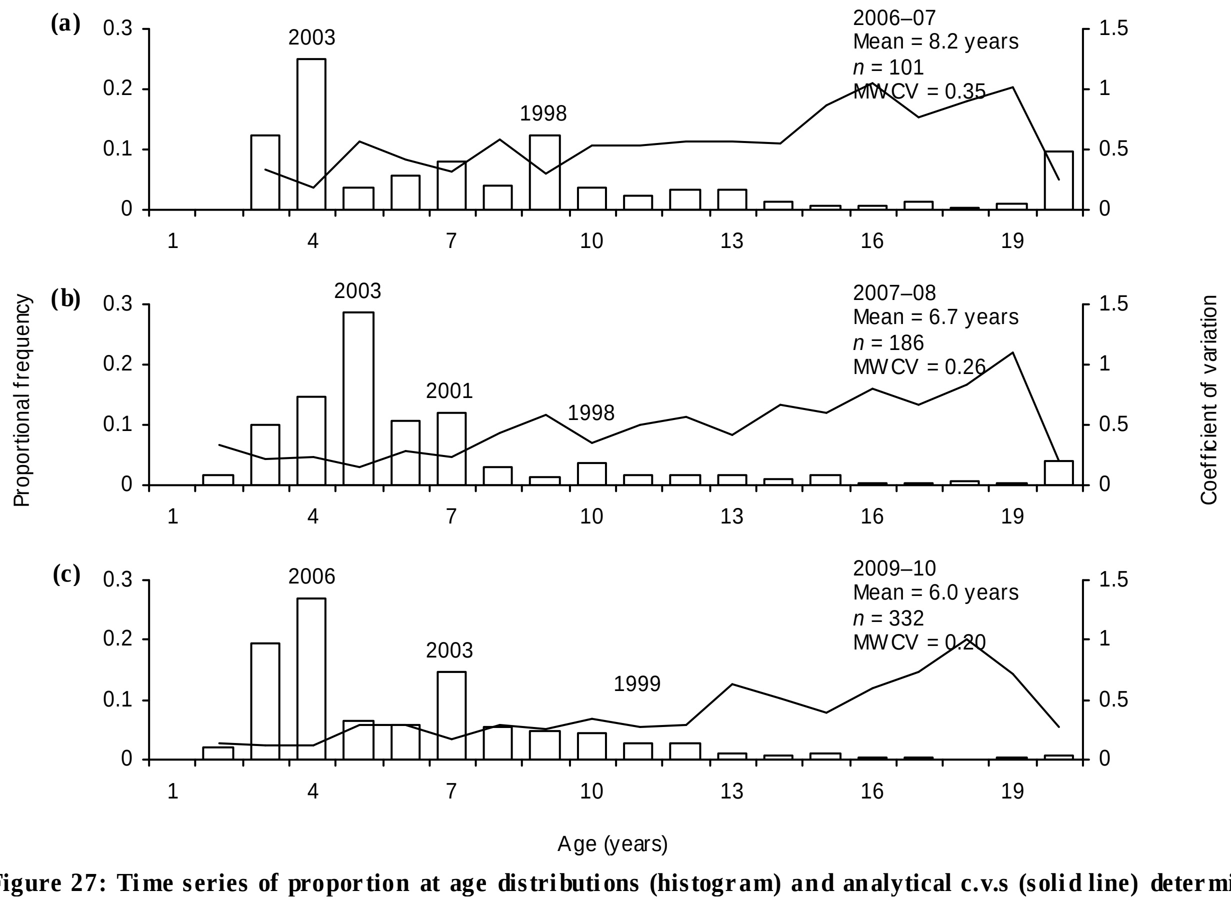


Figure 27: Time series of proportion at age distributions (histogram) and analytical c.v.s (solid line) determined from trevally landings sampled from the Ninety Mile Beach subarea bottom trawl fishery in (a) 2006–07, (b) 2007–08, and (c) 2009–10 (*n*, otolith sample size; MWCV, mean weighted c.v.).

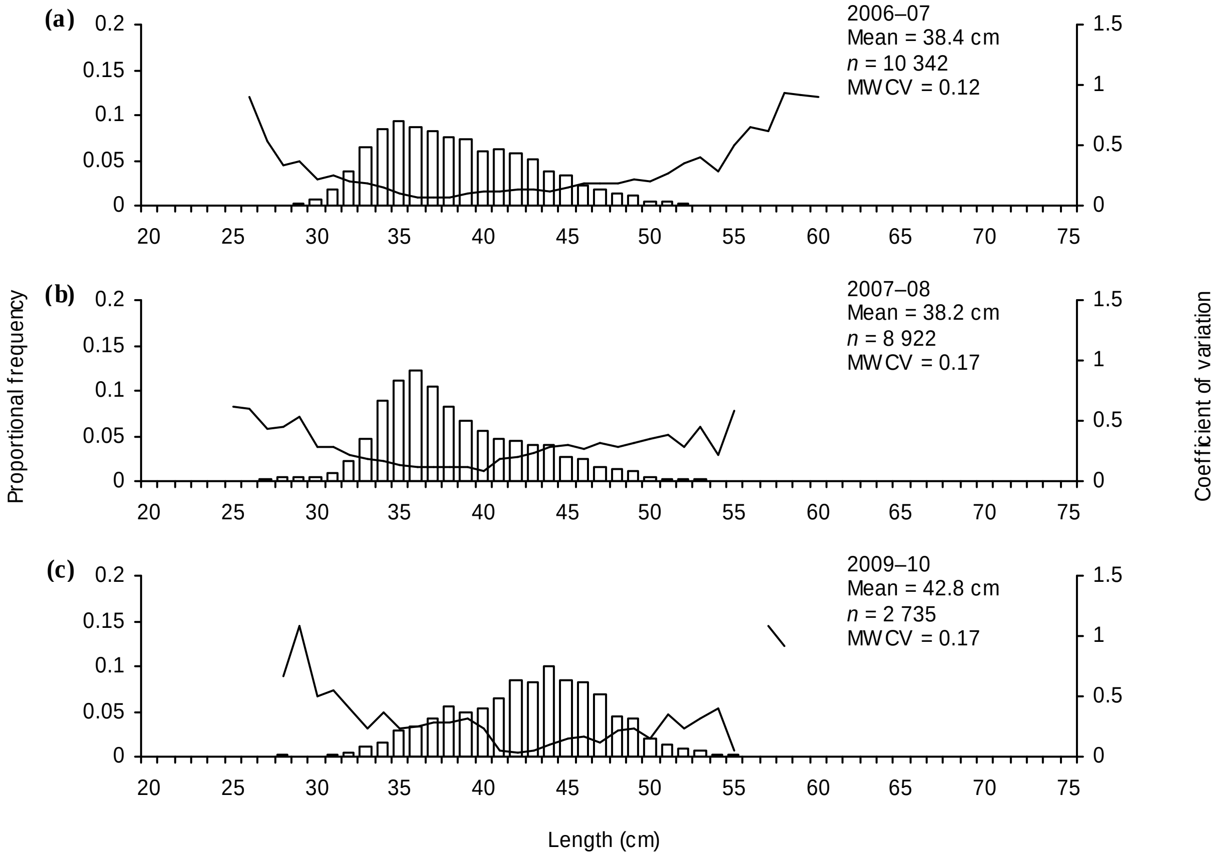


Figure 28: Time series of proportion at length distributions (histogram) and analytical c.v.s (solid line) determined from trevally landings sampled from the Kaipara-Manukau/North Taranaki Bight subarea bottom trawl fishery in (a) 2006–07, (b) 2007–08, and (c) 2009–10 (*n*, length sample size; MWCV, mean weighted c.v.).

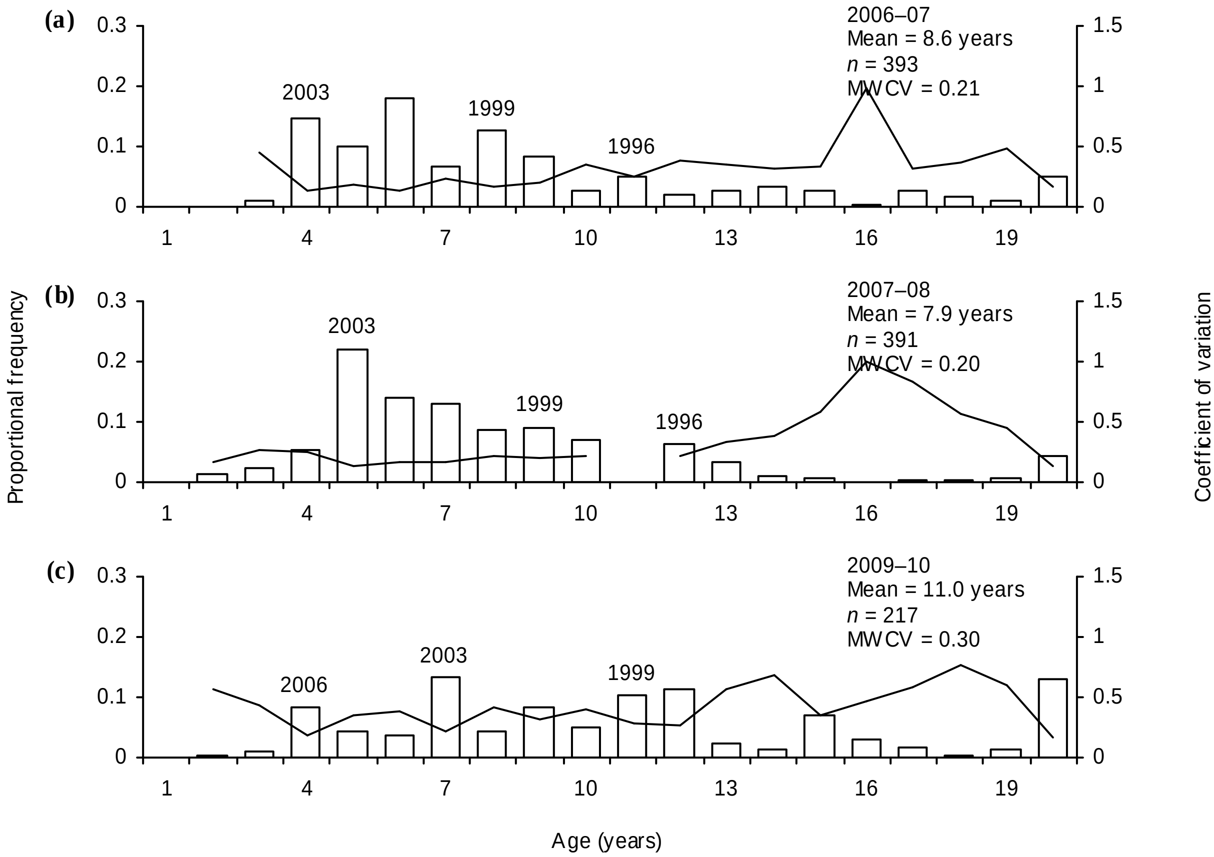


Figure 29: Time series of proportion at age distributions (histogram) and analytical c.v.s (solid line) determined from trevally landings sampled from the Kaipara-Manukau/North Taranaki Bight subarea bottom trawl fishery in (a) 2006–07, (b) 2007–08, and (c) 2009–10 (*n*, otolith sample size; MWCV, mean weighted c.v.).

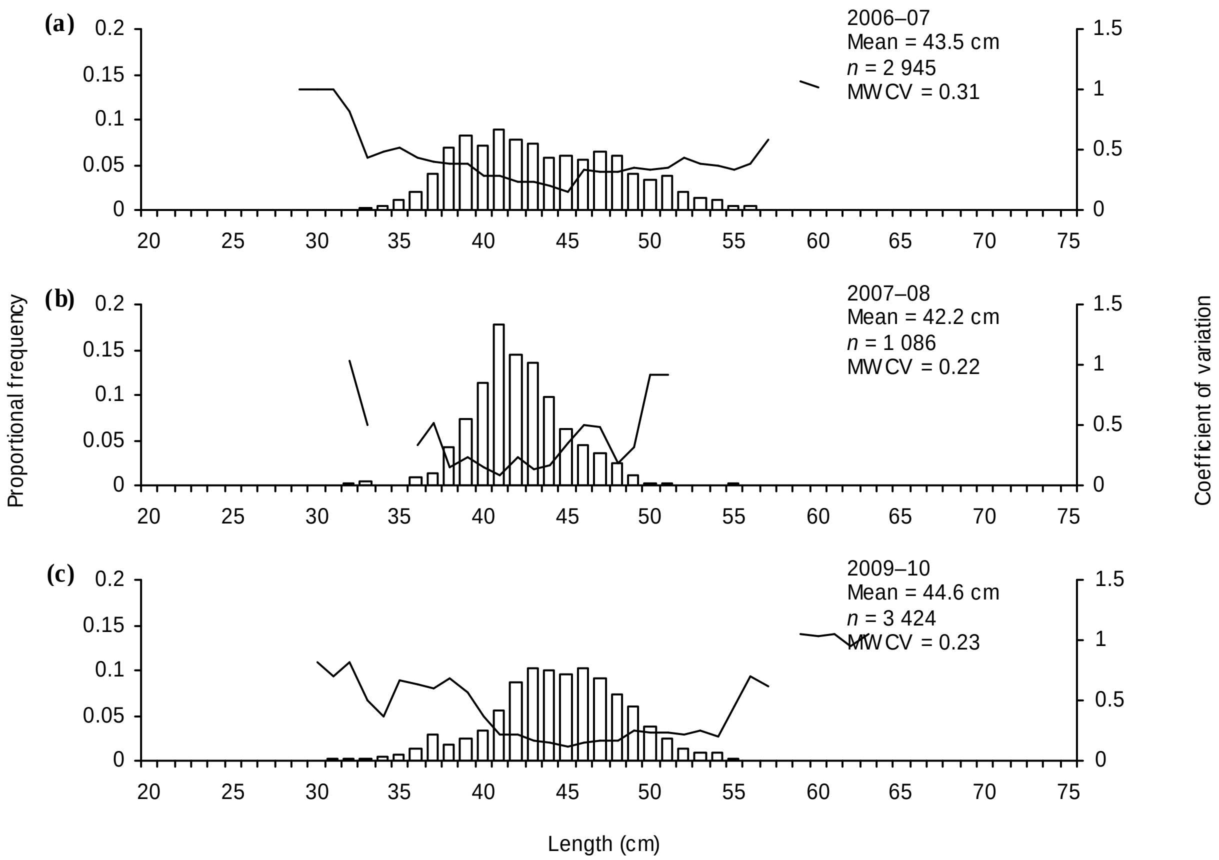


Figure 30: Time series of proportion at length distributions (histogram) and analytical c.v.s (solid line) determined from trevally landings sampled from the South Taranaki Bight subarea bottom trawl fishery in (a) 2006–07, (b) 2007–08, and (c) 2009–10 (*n*, length sample size; MWCV, mean weighted c.v.).

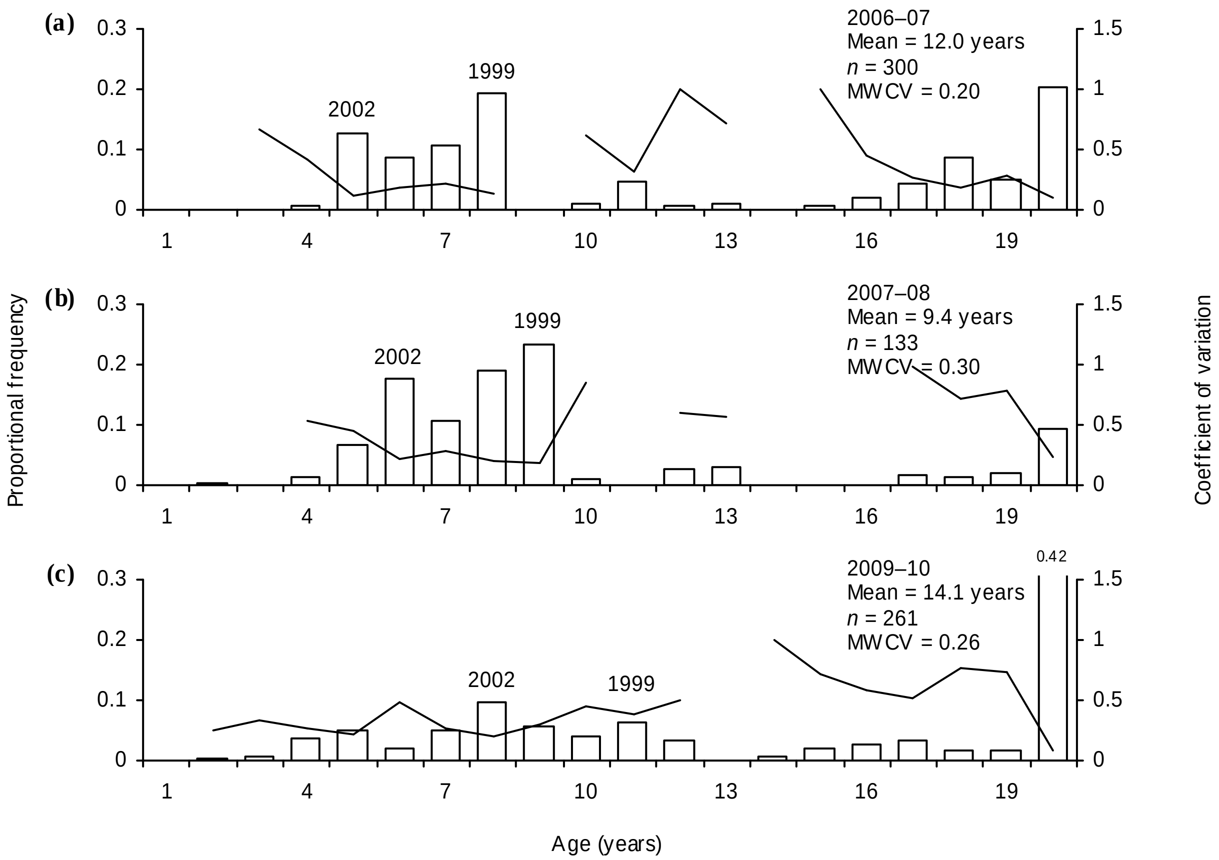
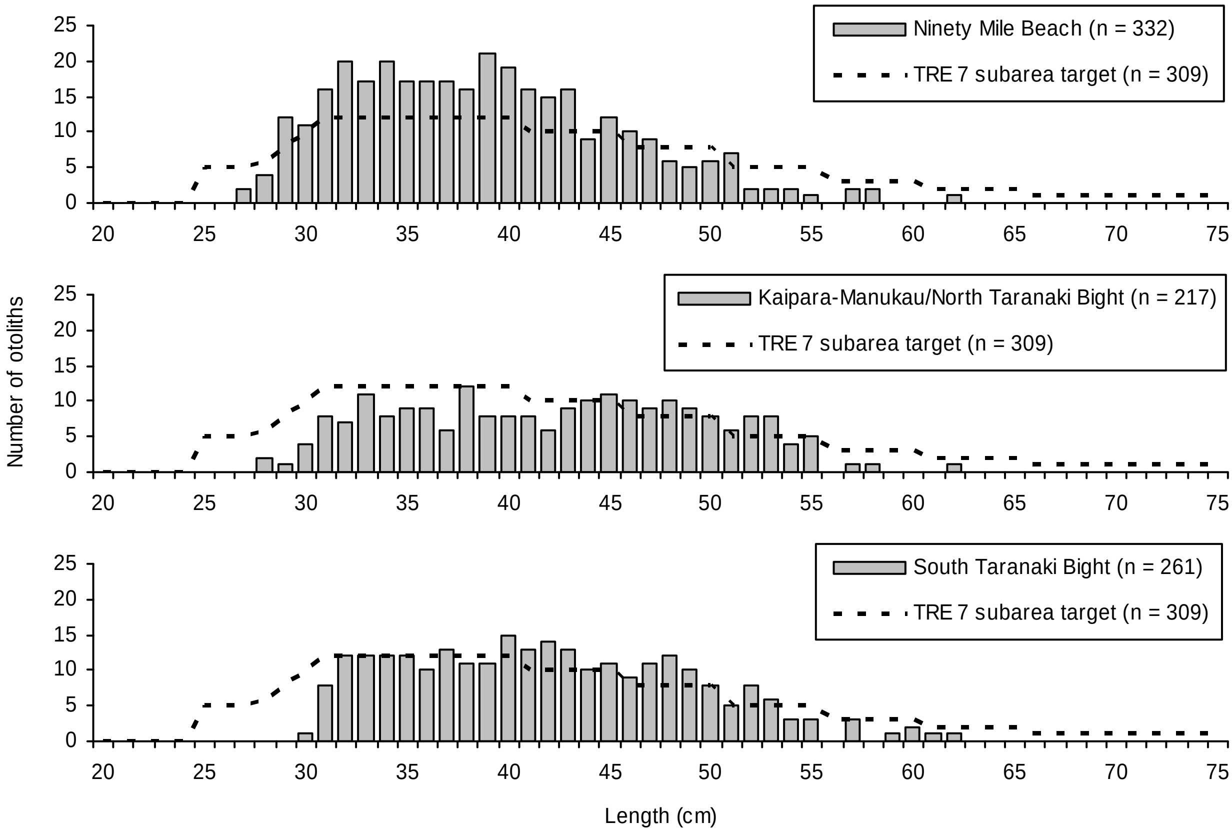


Figure 31: Time series of proportion at age distributions (histogram) and analytical c.v.s (solid line) determined from trevally landings sampled from the South Taranaki Bight subarea bottom trawl fishery in (a) 2006–07, (b) 2007–08, and (c) 2009–10 (*n*, otolith sample size; MWCV, mean weighted c.v.).

Appendix 1: Length distributions of the target fixed allocation otolith samples (dashed lines) and the achieved otolith collections (histograms) for the subarea strata of the TRE 7 stock in 2009–10.



Appendix 2: Annual commercial catch (t) by method for the subareas of TRE 7, 2003–04 to 2009–10 (BT = bottom trawl; BPT = bottom pair trawl; MW = mid water trawl SN = set net).

	Ninety Mile Beach					Kaipara-Manukau				
Fishing year	BT	BPT	MW	SN	Other	BT	BPT	MW	SN	Other
2003–04	193	290	0	5	20	955	153	13	20	13
2004–05	257	260	0	7	1	773	261	0	24	8
2005–06	134	68	0	4	1	860	235	0	16	12
2006–07	190	71	0	4	1	906	11	0	24	13
2007–08	156	170	0	2	3	734	159	0	21	10
2008–09	308	55	0	1	4	803	254	0	13	12
2009–10	448	94	0	2	2	535	234	0	20	10

	North Taranaki Bight					South Taranaki Bight				
Fishing year	BT	BPT	MW	SN	Other	BT	BPT	MW	SN	Other
2003–04	175	23	5	0	0	267	7	0	6	0
2004–05	92	38	0	0	0	183	0	0	7	0
2005–06	269	79	1	0	0	248	1	2	2	0
2006–07	315	2	0	12	0	140	0	0	13	0
2007–08	350	4	0	15	0	92	0	43	8	1
2008–09	347	0	0	16	0	152	0	0	11	1
2009–10	317	1	24	30	0	209	0	0	13	0

Appendix 3: Annual bottom trawl catch (t) by statistical reporting areas within the TRE 7 stock, 2003–04 to 2009–10.

	Statistical area																
Fishing year	048	047	046	045	044	043	042	041	040	039	038	037	036	035	034	033	017
2003–04	0	193	305	493	0	0	187	92	87	50	60	37	8	3	1	0	13
2004–05	0	255	281	383	0	0	81	67	74	21	48	16	1	11	0	0	2
2005–06	0	134	333	387	1	0	152	169	118	22	10	63	15	1	1	1	0
2006–07	0	190	202	405	0	0	406	111	40	18	24	25	13	8	0	0	1
2007–08	0	156	190	338	0	0	335	214	36	6	4	7	35	3	1	0	1
2008–09	0	308	180	371	0	0	338	251	67	31	18	31	5	2	0	4	0
2009–10	0	448	173	280	0	0	333	64	51	52	28	59	16	3	0	0	2

Appendix 4: Annual bottom trawl catch (t) by target species for the subareas of TRE 7, 2003–04 to 2009–10 (TRE, trevally; SNA, snapper; GUR, red gurnard).

	Ninety Mile Beach				Kaipara-Manukau			
Fishing year	TRE	SNA	GUR	Other	TRE	SNA	GUR	Other
2003–04	104	36	48	5	740	164	40	11
2004–05	172	33	31	22	593	65	108	6
2005–06	66	8	39	22	682	94	81	3
2006–07	139	7	41	4	746	70	83	6
2007–08	127	6	22	2	627	35	63	9
2008–09	231	71	4	2	713	39	43	9
2009–10	431	16	0	1	487	35	8	5

	North Taranaki Bight				South Taranaki Bight			
Fishing year	TRE	SNA	GUR	Other	TRE	SNA	GUR	Other
2003–04	115	41	14	5	106	9	38	114
2004–05	44	25	20	3	40	12	52	80
2005–06	215	11	41	3	134	3	56	54
2006–07	277	9	27	1	44	4	26	65
2007–08	289	12	48	1	25	7	14	46
2008–09	316	4	21	6	21	4	57	69
2009–10	276	1	28	12	74	23	43	68

Appendix 5: Estimates of the proportion at length of trevally from the TRE 7 single trawl fishery in 2009–10. The proportion at length for each subarea is also presented (Area codes: NMB, Ninety Mile Beach; K-M & NTB, Kaipara-Manukau & North Taranaki Bight; STB, South Taranaki Bight).

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

Length	TRE 7		NMB		K-M & NTB		STB	
(cm)	*P.i.*	c.v.	*P.i.*	c.v.	*P.i.*	c.v.	*P.i.*	c.v.
20	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
22	0.0000	0.00	0.0000	0.00	0.0000	0.00	0.0000	0.00
23	0.0000	0.00	0.0000	0.00	0.0000	0.00	0.0000	0.00
24	0.0000	0.00	0.0000	0.00	0.0000	0.00	0.0000	0.00
25	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
27	0.0003	0.57	0.0001	1.03	0.0000	0.00	0.0000	0.00
28	0.0011	0.34	0.0007	0.42	0.0016	0.66	0.0000	0.00
29	0.0023	0.39	0.0027	0.61	0.0001	1.08	0.0000	0.00
30	0.0047	0.31	0.0065	0.61	0.0011	0.50	0.0003	0.82
31	0.0107	0.28	0.0092	0.41	0.0019	0.55	0.0020	0.70
32	0.0170	0.29	0.0198	0.37	0.0036	0.40	0.0026	0.82
33	0.0320	0.22	0.0445	0.32	0.0113	0.23	0.0033	0.51
34	0.0496	0.17	0.0886	0.23	0.0156	0.37	0.0043	0.36
35	0.0569	0.13	0.0903	0.16	0.0279	0.24	0.0067	0.67
36	0.0704	0.10	0.1026	0.10	0.0323	0.25	0.0135	0.64
37	0.0790	0.10	0.1192	0.07	0.0420	0.28	0.0278	0.60
38	0.0843	0.09	0.1169	0.09	0.0554	0.28	0.0173	0.69
39	0.0838	0.11	0.1080	0.13	0.0488	0.32	0.0247	0.56
40	0.0748	0.10	0.0932	0.15	0.0526	0.24	0.0338	0.36
41	0.0641	0.06	0.0620	0.10	0.0646	0.04	0.0547	0.22
42	0.0593	0.08	0.0367	0.22	0.0837	0.04	0.0870	0.21
43	0.0555	0.10	0.0309	0.30	0.0820	0.06	0.1024	0.17
44	0.0564	0.14	0.0180	0.25	0.1006	0.11	0.1008	0.16
45	0.0457	0.16	0.0136	0.33	0.0849	0.16	0.0959	0.12
46	0.0427	0.18	0.0107	0.36	0.0825	0.17	0.1031	0.15
47	0.0335	0.18	0.0060	0.25	0.0678	0.11	0.0900	0.17
48	0.0248	0.18	0.0072	0.22	0.0451	0.22	0.0725	0.17
49	0.0203	0.22	0.0035	0.25	0.0423	0.23	0.0599	0.25
50	0.0105	0.18	0.0019	0.34	0.0197	0.15	0.0383	0.23
51	0.0071	0.23	0.0016	0.44	0.0137	0.35	0.0237	0.24
52	0.0056	0.15	0.0030	0.59	0.0082	0.23	0.0130	0.21
53	0.0031	0.23	0.0007	0.45	0.0061	0.32	0.0085	0.25
54	0.0015	0.21	0.0007	0.44	0.0023	0.40	0.0087	0.21
55	0.0011	0.20	0.0000	0.00	0.0019	0.04	0.0025	0.46
56	0.0006	0.32	0.0003	0.80	0.0000	0.00	0.0009	0.70
57	0.0005	0.45	0.0006	0.47	0.0001	1.08	0.0009	0.62
58	0.0004	0.38	0.0001	1.03	0.0004	0.92	0.0000	0.00
59	0.0001	0.45	0.0000	0.00	0.0000	0.00	0.0001	1.04
60	0.0000	0.76	0.0000	0.00	0.0000	0.00	0.0001	1.03
61	0.0001	0.77	0.0000	0.00	0.0000	0.00	0.0001	1.04
62	0.0000	0.54	0.0001	1.03	0.0001	1.08	0.0002	0.94
63	0.0001	0.53	0.0000	0.00	0.0000	0.00	0.0001	1.04
64	0.0000	0.80	0.0000	0.00	0.0000	0.00	0.0000	0.00
65	0.0000	0.00	0.0000	0.00	0.0000	0.00	0.0000	0.00
66	0.0000	0.00	0.0000	0.00	0.0000	0.00	0.0000	0.00
67	0.0001	0.74	0.0000	0.00	0.0000	0.00	0.0000	0.00
68	0.0000	0.00	0.0000	0.00	0.0000	0.00	0.0000	0.00
69	0.0001	0.77	0.0003	0.79	0.0000	0.00	0.0000	0.00
70	0.0000	0.00	0.0000	0.00	0.0000	0.00	0.0000	0.00
71	0.0000	0.00	0.0000	0.00	0.0000	0.00	0.0000	0.00
72	0.0000	0.00	0.0000	0.00	0.0000	0.00	0.0000	0.00
73	0.0000	0.00	0.0000	0.00	0.0000	0.00	0.0000	0.00
74	0.0000	0.00	0.0000	0.00	0.0000	0.00	0.0000	0.00
75	0.0000	0.00	0.0000	0.00	0.0000	0.00	0.0000	0.00
Nt	1 098 966		393 967		516 230		112 665	
n	15 709		3 725		2 735		3 424	

Appendix 6: Estimates of proportion at age of trevally from the TRE 7 bottom trawl fishery in 2009–10. The proportion at age for each subarea is also presented (Area codes: NMB, Ninety Mile Beach; K-M & NTB, Kaipara-Manukau & North Taranaki Bight; STB, South Taranaki Bight).
P.j. = proportion of fish in age class; c.v. = coefficient of variation; *n* = number of fish aged.

Age	TRE 7		NMB		K-M & NTB		STB	
(years)	*P.j.*	c.v.	*P.j.*	c.v.	*P.j.*	c.v.	*P.j.*	c.v.
1	0.0000	0.00	0.0000	0.00	0.0000	0.00	0.0000	0.00
2	0.0212	0.11	0.0216	0.13	0.0038	0.56	0.0047	0.25
3	0.0718	0.10	0.1954	0.11	0.0116	0.44	0.0075	0.33
4	0.1961	0.06	0.2707	0.11	0.0818	0.18	0.0359	0.27
5	0.0826	0.12	0.0659	0.29	0.0420	0.35	0.0494	0.22
6	0.0509	0.16	0.0588	0.29	0.0364	0.38	0.0205	0.48
7	0.1150	0.10	0.1458	0.17	0.1344	0.22	0.0515	0.26
8	0.0729	0.13	0.0562	0.29	0.0431	0.42	0.0961	0.20
9	0.0596	0.14	0.0467	0.26	0.0817	0.31	0.0554	0.31
10	0.0400	0.17	0.0436	0.34	0.0484	0.40	0.0416	0.44
11	0.0563	0.14	0.0273	0.27	0.1044	0.28	0.0618	0.38
12	0.0568	0.13	0.0277	0.28	0.1124	0.26	0.0346	0.49
13	0.0135	0.26	0.0086	0.63	0.0230	0.56	0.0000	0.00
14	0.0170	0.22	0.0058	0.52	0.0141	0.68	0.0082	1.00
15	0.0278	0.18	0.0093	0.40	0.0710	0.35	0.0215	0.71
16	0.0188	0.23	0.0043	0.60	0.0299	0.46	0.0270	0.58
17	0.0090	0.30	0.0031	0.73	0.0157	0.59	0.0344	0.51
18	0.0068	0.35	0.0011	1.01	0.0035	0.77	0.0162	0.77
19	0.0059	0.35	0.0023	0.72	0.0117	0.60	0.0161	0.73
>19	0.0779	0.08	0.0052	0.28	0.1311	0.17	0.4165	0.08
n	1 158		332		217		261	

Appendix 7: Estimates of mean weight-at-age (kg) of trevally from the TRE 7 bottom trawl fishery in 2009–10. The mean weight-at-age for each subarea is also presented (Area codes: NMB, Ninety Mile Beach; K-M & NTB, Kaipara-Manukau & North Taranaki Bight; STB, South Taranaki Bight).

Age	TRE 7		NMB		K-M & NTB		STB	
(years)	Mean	c.v.	Mean	c.v.	Mean	c.v.	Mean	c.v.
1	–	–	–	–	–	–	–	–
2	0.61	0.02	0.57	0.01	0.68	0.09	0.66	0.03
3	0.80	0.02	0.82	0.02	0.77	0.08	0.88	0.03
4	0.97	0.01	0.99	0.02	0.91	0.02	1.12	0.10
5	1.09	0.02	1.15	0.03	1.09	0.04	1.16	0.06
6	1.26	0.03	1.19	0.04	1.43	0.13	1.42	0.04
7	1.26	0.02	1.23	0.02	1.38	0.04	1.39	0.02
8	1.35	0.02	1.28	0.05	1.49	0.07	1.46	0.02
9	1.48	0.02	1.49	0.05	1.48	0.05	1.50	0.02
10	1.48	0.04	1.29	0.05	1.57	0.08	1.72	0.06
11	1.64	0.02	1.60	0.03	1.69	0.04	1.81	0.03
12	1.81	0.02	1.74	0.06	1.81	0.04	1.71	0.03
13	1.97	0.05	1.60	0.16	1.95	0.04	–	–
14	2.10	0.03	1.95	0.11	2.23	0.07	2.13	–
15	1.90	0.03	2.05	0.11	1.80	0.06	1.87	0.05
16	1.82	0.06	1.92	0.07	2.05	0.04	1.89	0.05
17	2.08	0.04	1.87	0.12	2.33	0.05	2.04	0.03
18	2.02	0.08	1.86	–	2.67	0.04	2.21	0.10
19	2.22	0.06	2.14	0.05	2.39	0.03	1.99	0.11
>19	2.30	0.02	2.78	0.05	2.30	0.03	2.23	0.01

Appendix 8: Estimates of mean length-at-age (cm) of trevally from the TRE 7 bottom trawl fishery in 2009–10. The mean length-at-age for each subarea is also presented (Area codes: NMB, Ninety Mile Beach; K-M & NTB, Kaipara-Manukau & North Taranaki Bight; STB, South Taranaki Bight).

Age	TRE 7		NMB		K-M & NTB		STB	
(years)	Mean	c.v.	Mean	c.v.	Mean	c.v.	Mean	c.v.
1	–	–	–	–	–	–	–	–
2	31.2	0.007	30.6	0.005	32.4	0.029	32.0	0.008
3	34.1	0.005	34.4	0.006	33.6	0.028	35.2	0.010
4	36.2	0.004	36.5	0.006	35.6	0.008	37.8	0.031
5	37.7	0.006	38.4	0.010	37.7	0.013	38.5	0.020
6	39.4	0.010	38.7	0.014	40.8	0.039	41.2	0.012
7	39.5	0.005	39.3	0.007	40.6	0.014	40.8	0.008
8	40.4	0.008	39.7	0.015	41.7	0.023	41.6	0.006
9	41.6	0.007	41.6	0.014	41.6	0.016	41.9	0.008
10	41.5	0.013	39.8	0.016	42.3	0.026	43.7	0.019
11	43.0	0.008	42.8	0.010	43.5	0.013	44.5	0.011
12	44.4	0.007	43.8	0.020	44.4	0.012	43.8	0.009
13	45.6	0.019	42.4	0.052	45.7	0.012	–	–
14	46.7	0.010	45.5	0.036	47.6	0.024	47.0	–
15	45.1	0.010	46.1	0.033	44.3	0.018	45.1	0.016
16	44.4	0.021	45.4	0.022	46.4	0.014	45.2	0.016
17	46.6	0.012	44.9	0.038	48.4	0.016	46.3	0.011
18	45.9	0.028	45.0	–	50.6	0.012	47.5	0.031
19	47.5	0.019	47.1	0.015	48.8	0.008	45.9	0.036
>19	48.0	0.006	51.1	0.015	48.1	0.011	47.6	0.005

Appendix 9: Age-length key derived from otolith samples collected from trevally fisheries in TRE 7 in 2009–10.

Estimates of proportion of age at length for trevally sampled from all TRE 7 subareas combined, 2009–10. (Note: Aged to 01/01/2010)

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	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5
28	0	0.60	0.40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10
29	0	0.86	0.10	0.05	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	21
30	0	0.70	0.22	0.07	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	27
31	0	0.60	0.24	0.16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	45
32	0	0.26	0.46	0.24	0.04	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	50
33	0	0.08	0.44	0.44	0.02	0	0.02	0	0	0	0	0	0	0	0	0	0	0	0	0	52
34	0	0.04	0.34	0.48	0.04	0.02	0.05	0.02	0	0.02	0	0	0	0	0	0	0	0	0	0	56
35	0	0	0.25	0.56	0.10	0	0.06	0	0	0.02	0	0.02	0	0	0	0	0	0	0	0	52
36	0	0	0.13	0.56	0.12	0.08	0.04	0.08	0	0	0	0	0	0	0	0	0	0	0	0	52
37	0	0	0.04	0.31	0.31	0.10	0.13	0.04	0	0.02	0.02	0	0	0	0	0.02	0	0	0	0	48
38	0	0	0.02	0.38	0.21	0.08	0.12	0.06	0.06	0.04	0.02	0	0	0	0	0.02	0	0	0	0	52
39	0	0	0	0.15	0.13	0.11	0.35	0.15	0.06	0.02	0.02	0	0.02	0	0	0	0	0	0	0	54
40	0	0	0	0.07	0.14	0.09	0.28	0.11	0.11	0.11	0.04	0.04	0	0	0	0	0	0.02	0	0.02	57
41	0	0	0	0.02	0	0.06	0.29	0.20	0.16	0.08	0.08	0.04	0	0	0.04	0	0	0	0	0.02	49
42	0	0	0	0.02	0	0.08	0.18	0.18	0.22	0.04	0.14	0.06	0	0.02	0.04	0	0	0	0	0	49
43	0	0	0	0.04	0.02	0	0.04	0.18	0.18	0.06	0.20	0.16	0.02	0	0.04	0	0.02	0	0	0.06	51
44	0	0	0	0.02	0	0.02	0.02	0.05	0.09	0.09	0.16	0.21	0.02	0.02	0.07	0.09	0	0	0.02	0.09	43
45	0	0	0	0	0	0.06	0.04	0.02	0.02	0.06	0.13	0.19	0.06	0.02	0.09	0.09	0.04	0.04	0	0.13	47
46	0	0	0	0	0.02	0	0.02	0	0	0.07	0.17	0.24	0.02	0.10	0.14	0	0.02	0.02	0.02	0.14	42
47	0	0	0	0	0	0	0	0.02	0.05	0.05	0.02	0.07	0.07	0.10	0.05	0.10	0.07	0	0	0.40	42
48	0	0	0	0	0	0	0	0	0.02	0	0.05	0.05	0	0.12	0.12	0.10	0.05	0.02	0.05	0.41	41
49	0	0	0	0	0	0.05	0	0	0	0	0	0.08	0.11	0.13	0.08	0	0.03	0.03	0.05	0.45	38
50	0	0	0	0	0	0	0	0	0	0	0	0.06	0.03	0.03	0	0.06	0.06	0.09	0.09	0.59	34
51	0	0	0	0	0	0	0	0	0	0	0	0.12	0.08	0	0	0	0	0.04	0	0.77	26
52	0	0	0	0	0	0	0	0	0.04	0	0	0	0.04	0	0.04	0	0.04	0.04	0.04	0.75	24
53	0	0	0	0	0	0	0	0	0	0	0.04	0.17	0	0.04	0	0	0	0	0.04	0.71	24
54	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.06	0	0	0	0	0.94	17
55	0	0	0	0	0	0	0	0	0	0	0	0.07	0	0.13	0	0.07	0	0	0	0.73	15
56	0	0	0	0	0	0	0	0	0	0	0	0.33	0	0	0	0	0	0	0	0.67	6
57	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.29	0	0	0	0	0.71	7
58	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.17	0	0	0	0.83	6
59	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.00	4
60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.33	0	0	0	0.67	3
61	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.50	0	0	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	1.00	3
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	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	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
Total																					1 158

Appendix 9 – continued:
Estimates of proportion of age at length for trevally sampled from the Ninety Mile Beach subarea of TRE 7, 2009–10.
(Note: Aged to 01/01/2010)

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	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
28	0	0.50	0.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
29	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12
30	0	0.91	0.09	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11
31	0	0.94	0.06	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16
32	0	0.20	0.80	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20
33	0	0	0.76	0.24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	17
34	0	0	0.65	0.35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	20
35	0	0	0.59	0.41	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	17
36	0	0	0.12	0.71	0.06	0.06	0.06	0	0	0	0	0	0	0	0	0	0	0	0	0	17
37	0	0	0.12	0.35	0.12	0.18	0.06	0.12	0	0	0	0	0	0	0	0	0	0	0	0	17
38	0	0	0.06	0.38	0.13	0	0.31	0.06	0	0	0	0	0	0	0	0	0	0	0	0	16
39	0	0	0	0.19	0.14	0.05	0.33	0.10	0.10	0.05	0	0	0.05	0	0	0	0	0	0	0	21
40	0	0	0	0.05	0.16	0.21	0.32	0.05	0.05	0.11	0	0.05	0	0	0	0	0	0	0	0	19
41	0	0	0	0.06	0	0.06	0.38	0.06	0.19	0.13	0.06	0.06	0	0	0	0	0	0	0	0	16
42	0	0	0	0.07	0	0	0.07	0.20	0.13	0	0.33	0.07	0	0.07	0.07	0	0	0	0	0	15
43	0	0	0	0.06	0	0	0.06	0.19	0.31	0.13	0.19	0	0	0	0	0	0.06	0	0	0	16
44	0	0	0	0	0	0.11	0.11	0.11	0.11	0.11	0.11	0.22	0	0	0	0.11	0	0	0	0	9
45	0	0	0	0	0	0.08	0.08	0	0.08	0	0.08	0.25	0.08	0	0.17	0.08	0	0.08	0	0	12
46	0	0	0	0	0.10	0	0	0	0	0	0.10	0.50	0	0	0.20	0	0	0	0.10	0	10
47	0	0	0	0	0	0	0	0.11	0.11	0.11	0	0.33	0.11	0.11	0.11	0	0	0	0	0	9
48	0	0	0	0	0	0	0	0	0	0	0.17	0	0	0.33	0	0.17	0.17	0	0.17	0	6
49	0	0	0	0	0	0	0	0	0	0	0	0	0.40	0	0	0	0	0	0	0.60	5
50	0	0	0	0	0	0	0	0	0	0	0	0.33	0	0.17	0	0	0	0	0	0.50	6
51	0	0	0	0	0	0	0	0	0	0	0	0.43	0.14	0	0	0	0	0	0	0.43	7
52	0	0	0	0	0	0	0	0	0.50	0	0	0	0	0	0.50	0	0	0	0	0	2
53	0	0	0	0	0	0	0	0	0	0	0	0.50	0	0	0	0	0	0	0	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	2
55	0	0	0	0	0	0	0	0	0	0	0	0	0	1.00	0	0	0	0	0	0	1
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	0.50	0	0	0	0	0.50	2
58	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.00	2
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	1.00	1
63	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
64	0	0	0	0	0	0	0	0	0	0	0	0	0	0	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	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
Total																					332

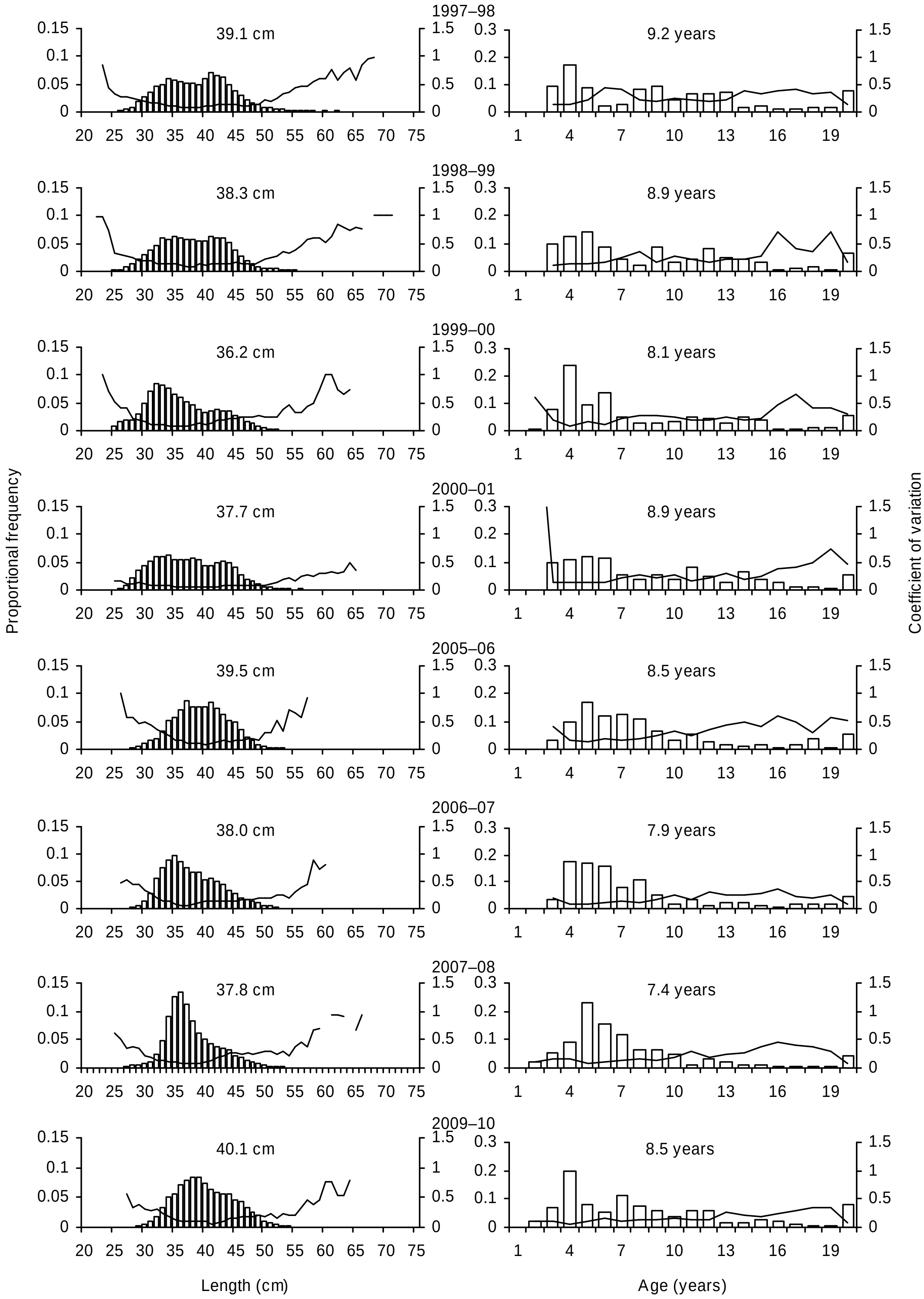
Appendix 9 – continued:
Estimates of proportion of age at length for trevally sampled from the combined Kaipara-Manukau and North Taranaki Bight subareas of TRE 7, 2009–10 (Note: Aged to 01/01/2010).

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	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28	0	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
29	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
30	0	0.50	0.25	0.25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4
31	0	0.63	0.25	0.13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
32	0	0	0.14	0.71	0.14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7
33	0	0	0.18	0.73	0	0	0.09	0	0	0	0	0	0	0	0	0	0	0	0	0	11
34	0	0.13	0	0.63	0.13	0	0.13	0	0	0	0	0	0	0	0	0	0	0	0	0	8
35	0	0	0.11	0.67	0	0	0	0	0	0.11	0	0.11	0	0	0	0	0	0	0	0	9
36	0	0	0.11	0.44	0.11	0.22	0	0.11	0	0	0	0	0	0	0	0	0	0	0	0	9
37	0	0	0	0.33	0.33	0	0.33	0	0	0	0	0	0	0	0	0	0	0	0	0	6
38	0	0	0	0.25	0.17	0.08	0.08	0.08	0.25	0.08	0	0	0	0	0	0	0	0	0	0	12
39	0	0	0	0	0.13	0.25	0.63	0	0	0	0	0	0	0	0	0	0	0	0	0	8
40	0	0	0	0	0.13	0	0.25	0.13	0.25	0.13	0.13	0	0	0	0	0	0	0	0	0	8
41	0	0	0	0	0	0	0.25	0	0.25	0.13	0.25	0	0	0	0.13	0	0	0	0	0	8
42	0	0	0	0	0	0	0.33	0	0.17	0	0.17	0.17	0	0	0.17	0	0	0	0	0	6
43	0	0	0	0	0	0	0.11	0.22	0	0	0.22	0.22	0	0	0.11	0	0	0	0	0.11	9
44	0	0	0	0	0	0	0	0.10	0.20	0.10	0.10	0.30	0	0	0.10	0	0	0	0	0.10	10
45	0	0	0	0	0	0.09	0.09	0	0	0.09	0.18	0.09	0.18	0	0.09	0.18	0	0	0	0	11
46	0	0	0	0	0	0	0.10	0	0	0.10	0.20	0.30	0	0.10	0.10	0	0	0	0	0.10	10
47	0	0	0	0	0	0	0	0	0	0	0.11	0	0.11	0	0	0.11	0.11	0	0	0.56	9
48	0	0	0	0	0	0	0	0	0.10	0	0	0.20	0	0	0.20	0.10	0	0	0.10	0.30	10
49	0	0	0	0	0	0.11	0	0	0	0	0	0.11	0	0.11	0.11	0	0.11	0	0.11	0.33	9
50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.13	0.13	0.13	0.13	0.50	8
51	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.00	6
52	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.13	0.13	0	0.75	8
53	0	0	0	0	0	0	0	0	0	0	0	0.13	0	0.13	0	0	0	0	0	0.75	8
54	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.00	4
55	0	0	0	0	0	0	0	0	0	0	0	0	0	0.20	0	0	0	0	0	0.80	5
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	1.00	0	0	0	0	0	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	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	1.00	1
63	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
64	0	0	0	0	0	0	0	0	0	0	0	0	0	0	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	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
Total																					217

Appendix 9 – continued:
Estimates of proportion of age at length for trevally sampled from the South Taranaki Bight subarea of TRE 7, 2009–10. (Note: Aged to 01/01/2010)

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	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	0	1.00	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
31	0	0.63	0.13	0.25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
32	0	0.67	0.08	0.25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12
33	0	0.33	0.17	0.50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12
34	0	0.08	0.25	0.50	0	0	0.08	0	0	0.08	0	0	0	0	0	0	0	0	0	0	12
35	0	0	0	0.67	0.33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12
36	0	0	0.40	0.20	0.30	0	0	0.10	0	0	0	0	0	0	0	0	0	0	0	0	10
37	0	0	0	0.15	0.69	0	0.08	0	0	0	0.08	0	0	0	0	0	0	0	0	0	13
38	0	0	0	0.55	0.27	0.09	0	0.09	0	0	0	0	0	0	0	0	0	0	0	0	11
39	0	0	0	0.09	0.18	0.09	0.27	0.27	0.09	0	0	0	0	0	0	0	0	0	0	0	11
40	0	0	0	0	0.20	0	0.27	0.13	0.13	0.20	0	0	0	0	0	0	0	0	0	0.07	15
41	0	0	0	0	0	0.08	0.15	0.38	0.23	0.08	0	0	0	0	0	0	0	0	0	0.08	13
42	0	0	0	0	0	0.14	0.29	0.43	0.14	0	0	0	0	0	0	0	0	0	0	0	14
43	0	0	0	0	0.08	0	0	0.23	0.23	0	0.08	0.15	0	0	0	0	0	0	0	0.15	13
44	0	0	0	0	0	0	0	0	0	0.10	0.20	0.10	0	0	0.10	0.10	0	0	0.10	0.30	10
45	0	0	0	0	0	0	0	0	0	0.09	0.09	0.09	0	0	0	0.09	0.09	0	0	0.55	11
46	0	0	0	0	0	0	0	0	0	0.11	0.22	0	0	0	0.11	0	0.11	0.11	0	0.33	9
47	0	0	0	0	0	0	0	0	0	0	0	0	0	0.09	0	0.09	0.09	0	0	0.73	11
48	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.08	0	0	0.92	12
49	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.90	10
50	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.00	8
51	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.20	0	0.80	5
52	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.00	8
53	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.00	6
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	1.00	3
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	1.00	3
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	1.00	1
60	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1.00	2
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	1.00	1
63	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
64	0	0	0	0	0	0	0	0	0	0	0	0	0	0	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	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
Total																					261

Appendix 10: A discontinuous time series of proportion at length and age distributions and c.v.s for trevally from the TRE 7 bottom trawl fishery from 1997–98 to 2009–10. Average length and age are also given. Note: all figures depict unstratified estimates (see results section).



Appendix 11: A comparison of the proportion at age distributions for TRE 7 (histogram) and SNA 8 (line) sampled from the bottom trawl fisheries in 2009–10.