Ministry for Primary Industries
Manatū Ahu Matua

Albacore catch sampling during 2013–14 and 2014–15

New Zealand Fisheries Assessment Report 2016/33

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ISSN 1179-5352 (online)
ISBN 978-1-77665-281-5 (online)

June 2016

New Zealand Government

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TABLE OF CONTENTS

EXECUTIVE SUMMARY

Griggs, L.; Large, K. (2016). Albacore catch sampling during 2013–14 and 2014–15.

***New Zealand Fisheries Assessment Report 2016/33*. 31 p.**

Albacore caught by trolling during the 2013−14 and 2014−15 fishing seasons were sampled in fish sheds to determine the length frequency composition and length-weight relationship. Albacore were sampled from two ports, Auckland and Greymouth. Targets for sampling were based on the monthly distribution of the commercial catch during recent years.

During 2013−14, 5815 albacore were sampled from 50 landings and 33 vessels, and 1071 fish were weighed. A total of 5216 fish were sampled in 2014–15 from 42 landings and 30 vessels, with 857 weights recorded. Fish were sampled from December 2013 to April 2014, then December 2014 to March 2015 and represented the fishery well both temporally and spatially.

Albacore showed a multimodal length distribution with three to four modes visible in most samples in each year, month and port. Fish sampled during 2013−14 ranged in size from 42 to 96 cm, with nearly all fish (99%) in the 46–80 cm range. The median fork length (FL) was 61 cm and the mean FL was 63.4 cm. In 2014–15 fish ranged from 29 to 86 cm with most in the range 44–78 cm. The 29 cm fish was the smallest recorded in the eighteen years of troll sampling. The 2014–15 median was 61 cm and the mean was 61.1 cm. Length-weight relationships were determined, and length composition was scaled to the total catch, for each year.

Albacore sampled over the eighteen years of the catch sampling programme ranged in size from 29 to 99 cm FL, with almost all (99%) in the 47−80 cm range. As albacore reach sexual maturity at about 85 cm almost all of these fish were juveniles. There is considerable variability in the size composition from year to year.

Data from troll caught albacore provided to the WCPFC (Western Central Pacific Fisheries Commission) are an important input in the South Pacific albacore stock assessment. Data from the shed sampling programme have been provided to WCPFC since 1996−97.

Albacore caught by trolling around New Zealand tend to be smaller than those caught by United States troll vessels fishing in the subtropical convergence zone in the eastern Pacific, the only other surface fishery for the South Pacific albacore stock. Fish caught by longline throughout the South Pacific, including those caught by longline in New Zealand waters, are mainly larger sub-adult and adult fish.

Continued monitoring of the catch composition of juvenile albacore in the New Zealand troll fishery is a critical input to the length-based regional stock assessment of the South Pacific albacore stock. The New Zealand troll fishery catches the majority of the total removals of juveniles from this stock and is one of only two target fisheries for juveniles. Failure to monitor size composition in this stock would appreciably increase the uncertainty of stock assessments.

1. INTRODUCTION

Albacore tuna (*Thunnus alalunga*) caught in the New Zealand EEZ (Exclusive Economic Zone) are part of a single South Pacific Ocean stock that ranges from the equator to about 45° S. Female albacore mature at about 85 cm FL and spawn in the austral summer from November to February in tropical and subtropical waters, between about 10° S and 20° S, west of 140° W (Murray 1994, Ramon & Bailey 1996, Murray et al. 1999).

Juvenile albacore recruit to surface fisheries in New Zealand coastal waters and in the vicinity of the subtropical convergence zone (STCZ) at about 2 years of age, at 45–50 cm FL. They then appear to gradually disperse north (Hampton & Fournier 2000) where they are caught by longline fleets. Longline fleets from Japan, Korea, China, and Taiwan, and domestic fleets of several Pacific Island countries, catch adult albacore throughout their range (OFP-SPC and the WCPFC Secretariat 2015). Fish caught by longline in the southern part of the region are smaller than those caught further north (Hampton & Fournier 2000). The New Zealand longline fishery catches adult and sub-adult albacore (Griggs et al. 2013).

There has been a troll fishery for juvenile albacore in New Zealand coastal waters since the 1960s, and in the central region of the STCZ since the mid 1980s (Murray 1994, Murray et al. 2000, Hampton & Fournier 2000). The New Zealand troll fishery is operated by domestic vessels mostly in New Zealand coastal waters, primarily off the west coasts of the North Island and South Island with Onehunga (Auckland), New Plymouth, Westport, and Greymouth being major landing ports.

The New Zealand albacore troll catch of 1796 t in 2007 was the lowest for nearly 20 years, mainly because of a reduction in active vessel numbers due to economic conditions. Catches have fluctuated since then, ranging between 1794 t and 3352 t between 2008 and 2012 (Williams & Terawasi 2012, Pilling et al. 2014). New Zealand troll catch was 2836 t in 2013 and 1937 t in 2014 (Anon 2015a).

Troll vessels from the United States have fished for albacore in the South Pacific since 1986, in the STCZ, approximately 39–41º S, from 1000 n. miles east of New Zealand to waters off South America. Landings from these vessels fluctuated between 603 t and 2916 t between 1986–87 and 2003–04 (Childers & Coan 1996, Ito et al. 2005). In recent years, the U.S. troll fisheries for albacore have experienced a significant decline in participation. Between 2007 and 2013, the United States troll fleet catches have ranged between 151 t and 471 t (Pilling et al. 2014). The US troll catch in the South Pacific was 390 t in 2013, which declined to 263 t in 2014 (Anon 2015b).

Canadian landings in this fishery from its inception in 1987–88 to 2003–04 are estimated to have ranged from 134 to 351 t per season (Stocker & Shaw 2005), but since then have declined, and there have been no Canadian troll vessels in the South Pacific since 2007 (Anon 2015c, Pilling et al. 2014). Up until 2007 there were also minor contributions from the Cook Islands and French Polynesian fleets (Williams & Terawasi 2008), but these fleets have not been active in the troll fishery since then (Pilling et al. 2014), except for a 21 t catch in 2014 by a Cook Islands vessel (Anon 2015d).

With the decline in participation of other fleets since 2007, the New Zealand troll catch has made up approximately 90% of the South Pacific troll catch between 2008 and 2014 (Anon 2015a, OFP-SPC and the WCPFC Secretariat 2015).

Labelle (1993) noted that STCZ albacore tend to be larger than those around New Zealand. Albacore sampled in the STCZ by the American fleet in 2003–04 had an average FL of 66 cm.

The size composition, sex ratio, and length-weight relationship of albacore caught by troll in New Zealand have previously been investigated by NIWA over 18 years (Griggs & Murray 2000, 2001a, b, Griggs 2002a, b, 2003a, b, 2004a, b, 2005a, b, 2008a, b, Griggs & Doonan 2010, Griggs et al. 2013,

2014). Fish sampled over these 16 years were mostly juveniles, ranging in size from 38 to 99 cm FL, with nearly all fish (99%) in the 47–80 cm range.

Albacore reach sexual maturity at about 85 cm (Bailey 1991). Maturity studies carried out by Farley et al. (2012) show 50% maturity reached at 87 cm FL and 100% maturity reached at 95 cm FL.

A significant linear relationship was found between the logs of albacore FL and greenweight (GW). Griggs & Murray (2000) found that the sex ratio was not statistically different from 1:1.

Previous comparisons of temporal and spatial coverage of the troll fishery data by the catch sampling programme and MPI observers have shown that the observer data were not representative of the fishery because the observer coverage was not able to extend to enough vessels, and that port sampling is able to offer better representation of the fishery (Griggs et al. 2013, 2014). Troll vessel coverage by observers was discontinued for this reason.

The present study updates and extends these previous analyses for two more years, thus increasing the port sampling time series to 18 years. It addresses the following objectives.

OVERALL OBJECTIVES:

1. To determine the length composition of the commercial catch of albacore (*Thunnus alalunga*) in New Zealand fisheries waters.

2. To support the stock assessment of the wider South Pacific albacore stock.

SPECIFIC OBJECTIVES:

1. To conduct representative sampling to determine the length composition of albacore tuna during the 2013/14 and 2014/15 fishing years. The target coefficient of variation (CV) for the length composition is 20 % (mean weighted CV across all length classes).

This work is an extension to the sampling funded in 1996−97 and 1997–98 by the South Pacific Commission (SPC, now Secretariat of the Pacific Community), and 1998–99 to 2012–13 by the Ministry of Fisheries, now Ministry for Primary Industries.

2. METHODS

2.1 Catch-effort data

Commercial troll catch-effort data recorded by vessel personnel are recorded on CELR (Catch Effort Landing Return) forms. These data were extracted from the *tuna* database (Wei 2007). Vessels recorded fishing positions daily on CELR forms, either as latitude and longitude or a statistical area. If a statistical area was recorded, a 'centroid' position was assigned in the *tuna* database (Wei 2007).

Fishers are required to record the number of fish caught for all tuna species reported on CELR forms, but sometimes recorded weights instead, and these records were identified when loading data to the tuna database (Wei 2007). Weights were apparently recorded for 2.5% of the 2013−14 and 2014−15 CELR troll records in which albacore catch was recorded. Where fishers recorded weight instead of fish number, the weights were divided by average weights (determined from the albacore troll sampling programme) to estimate catch numbers. Catch weights for other records were estimated from catch numbers by multiplying them by the average fish weight for each year.

The albacore troll fishery extends over the summer months, and the fishing year for albacore is from 1 July to 30 June, so 2014−15 is 1 July 2014 to 30 June 2015, with the majority of fishing in 2015.

2.2 Catch sampling

Sampling targets for 2013−14 and 2014−15 were based on a recent characterisation carried out under MPI project ALB201201 (Griggs et al. 2014). The sampling design was based on the spatial and temporal distribution of albacore during three previous years, 2009−10 to 2011−12, and was also used for sampling in the 2012−13 troll season (Griggs et al. 2014). This continued the trend for three years of sampling following each fishery characterisation (Griggs et al. 2013, 2014).

Analysis of the size composition of the fishery requires regular sampling through the season (December–April/May) and should take account of any differences among areas and boats. The original sample design, as specified by the SPC, required fish to be sampled from at least five vessel unloadings, and selected at random from each unloading. At least 1000 FLs were to be recorded in each port, each month, and at least 100 of these fish were to be subsampled for length and weight.

The sampling strategy was revised in 2009−10 by the HMS (Highly Migratory Species) Working Group to measure a number of fish each month that was proportional to the commercial catch each month, and to sample more landings, in order to increase the representativeness of the sampling data. In each landing, the aim was to sample 100 fish for length, and in each month to subsample 100 fish for length and weight. Logistically this was more difficult to achieve in Auckland, so the revised target was set at a maximum of 200 fish per landing, from fewer landings. The sample design was based on a characterisation of the fishery undertaken under ALB2012-01 (Griggs et al. 2014).

Two ports, Auckland (Port Onehunga, on the west coast) and Greymouth, were sampled during the 2013−14 and 2014−15 troll fishing seasons from December to April. At each port, sampling was carried out on the premises of the Licenced Fish Receiver (LFR) before freezing or grading of the fish. The fish were kept on ice while on the vessel and frozen once they were discharged into the fish receivers. In Greymouth, fish were sampled by NIWA staff close to the wharf when the troll vessel unloaded its catch. In Auckland, fish were subsampled at the wharf and trucked to the LFR shed. Sampling was carried out by Sanfords staff, who were trained by staff from Trident Systems. NIWA carried out audits to ensure that sampling was carried out correctly and to address any issues that arose. FL was measured to the whole centimetre, rounded down, and weight was recorded as GW to the nearest 0.1 kilogram.

2.3 Size composition and length-weight relationships

Size composition and length-weight relationships for fish sampled during the 2013−14 and 2014−15 troll season were summarised and presented. Unscaled size frequency distributions were compiled by month and area. Linear regression parameters and their standard errors were derived, for the following equation:

$$\ln(GW) = b_0 + b_1 \times \ln(FL)$$

where b_0 and b_1 are the y-axis intercept and the slope of the line respectively.

The sampled catches were scaled to the total commercial catch using data from the troll fishery. The total catches of albacore by year and month as recorded by fishers on CELR forms were extracted from the *tuna* database for the 2013−14 and 2014−15 albacore fishing years.

Estimated scaled numbers-at-length were calculated for 2013−14 and 2014−15 using the "R" software (R Development Core Team 2010) '*Catch-at-age*', developed by NIWA (Bull & Dunn 2002). Sampled landings were matched with corresponding trips recorded on CELR forms to obtain the total catch of albacore in each landing. Samples were assigned to the capture FMA. Where fishing occurred in more than one FMA, the sample was assigned to the FMA with the most catch (by fish number). Samples were stratified by month and North-South area. The North area was defined by FMA areas 1, 2, 8, 9, and 10. The other samples were assigned to the South area.

Samples were scaled up by the total catch in the month within North-South area to give an overall scaled-up length frequency (LF). Some months were not sampled and so the catches from these months were assigned to the nearest month that was sampled.

Coefficients of variation (CVs,) of the numbers-at-length were calculated (from the original data in 1 cm length classes) by bootstrapping with fish resampled within each landing and landings resampled within each month. Although the resulting CVs would be smaller if the size classes were aggregated, the finer resolution of the original data was maintained because the results are used for inferring growth rate within a length-based age-structured model, MULTIFAN-CL (Fournier et al. 1998). Mean weighted CVs (MWCVs) were calculated as the average of the CVs for the individual length classes weighted by the proportion of fish in each class, using the '*Catch.at.age*' software developed by NIWA.

2.4 Representativeness of sampling

Sample data were compared with CELR data to assess their spatial and temporal representativeness in relation to the commercial catch. Comparisons were made by month, FMA and statistical area.

3. RESULTS

3.1 Total troll catch

The total New Zealand albacore troll catches by fishing year, in fish numbers and weights, for 1999–00 to 2014–15 are shown in Table 1 and a plot of fish numbers is shown in Figure 1. Over this period, the troll fishery peaked in 2002–03 and declined to 2006–07. Thereafter catches were relatively stable.

Catches in 2013−14 and 2014−15 were lower than in the three previous years, and very similar to each other. However, the figures shown are likely to have been underestimated due to missing CELR data: some of the landings did not match to CELR data, and some that did match had no albacore catch recorded on the CELRs.

3.2 Catch sampling

The numbers of fish sampled each year and port for the 18 years of albacore troll sampling are shown in Table 2. The target number of fish and the number sampled each year and month during 2013–14 and 2014−15 are shown in Table 3 and Figure 2. A summary of the number of fish, landings and vessels sampled, in each month and port during 2012−13 and 2014−15 is shown in Table 4.

During 2013–14, a total of 5815 fish were sampled, 2041 in Auckland and 3774 in Greymouth. Of 50 landings, 11 were sampled in Auckland, and 39 in Greymouth. There were 25 vessels sampled in Greymouth and 11 in Auckland. Fish were sampled in December and January in Auckland, and from January through to April in Greymouth.

During 2014–15, a total of 5216 fish were sampled, 2279 in Auckland and 2937 in Greymouth. Of 42 landings, 12 were sampled in Auckland, and 30 in Greymouth. There were 21 vessels sampled in Greymouth and 11 in Auckland. Fish were sampled in December and January in Auckland, and from January through to March in Greymouth.

Weights were recorded for 1071 fish during 2013−14, and 857 in 2014–15. Three outliers were removed from the 2013−14 data and one from the 2014–15 data, leaving 1068 and 856 records for 2013−14 and 2014–15 respectively.

3.3 Size composition and length-weight relationships

Three length-frequency modes were visible each month during 2013−14 (Figure 3). There were three quite even modes in the December sample at 46 cm, 58 cm and 70 cm, while the 58 and 70 cm modes were more predominant in the Auckland sample from January. The fish sampled in Greymouth showed modes at 51 cm, 60–61 cm, and 70–74 cm each month with the 60–61cm mode predominant in February and March. Small fish (less than 50 cm FL) and large fish (more than 75 cm) were seen in all months.

Three to four modes were visible each month during 2014−15 (Figure 4). Two large modes were seen at 58–59 cm and 67 cm in both Auckland samples (December and January) with a small mode at 46 cm and a less distinct smaller mode at about 76 cm. A similar pattern was seen in the January sample from Greymouth although this was less distinct with fewer fish sampled. In February and March modes were at 44−46 cm, 55−56 cm and 63−65cm, with some overlap of the second and third modes. Small fish (less than 50 cm FL) were seen in all months and particularly well represented in February. Large fish (more than 75 cm) were also seen in all months.

Fish sampled during 2013−14 ranged in size from 42 to 96 cm, with nearly all fish (99%) in the 46–80 cm range. The median FL was 61 cm and the mean FL was 63.4 cm. During 2014–15 the size range was

from 29 to 86 cm, with nearly all fish (99%) in the 44–78 cm range; the median FL was 61 cm and the mean FL was 61.1 cm (Table 5). Length frequency distributions with all months combined are shown in Figure 5. During the 18 years of sampling, FL of troll-caught albacore ranged from 29 to 99 cm, with nearly all of the fish (99%) in the 47–80 cm range; the median was 62 cm and the mean was 62.9 cm (Table 5).

The 18 year time series of annual unscaled length frequency distributions is shown in Figure 6. Three modes were visible in most months of the years sampled. These modes tended to increase by about 1 cm each month during the sampling period. There was considerable variability in the distributions from year to year. The number of modes varied from two to four, with some years showing clearly defined modes and others overlapping (including 2014–15), and the proportion of fish in each mode varied from year to year. The 1999–00 sample featured a single dominant mode, while three equal sized modes were visible in 1988–89. Small fish (less than 55 cm) were well represented in some years especially 1998–99 and 2002–03, and lacking in other years, particularly 1997–98, 2003–04, and 2011−12. The greatest proportion of large fish (over 75 cm) was seen in the 2000–01 sample, while other years lacked large fish, especially 2007–08 to 2011–12. Large fish were well represented again in 2013–14.

Length and weight data have been recorded for 16 fishing years, 1998–99 to 2014–15. The length-weight relationships for troll sampled albacore are shown in Figure 7 for 2013−14 and 2014–15. A summary of the linear regression parameters and their standard errors is shown in Table 6.

The length frequencies scaled to the total catch numbers are shown in Figure 8 for 2013–14 with a comparison of scaled and unscaled distributions in Figure 9. Similarly Figure 10 shows the scaled distribution for 2014–15, with a scaled/unscaled comparison in Figure 11. The pooled MWCV for 2013–14 was 14.2% and for 2014–15 was 15.1%, both of which were below the target CV of 20%.

3.4 Representativeness of sampling

The number and percentage of days fished and sampled, by month are shown in Table 7 and Figure 12, and the number and percentage of albacore caught and sampled, by month can be seen in Table 8 and Figure 13.

Most fishing effort occurred from December to April (96.4% in 2013–14 and 98.0% in 2014–15) with the peak of the season from January to March (75.8% in 2013–14 and 79.8% in 2014–15). Catch sampling covered the same period, with similar proportions each month to those fished (Figures 12).

In 2013–14 the peak catches of the season were in January and February, with the highest catch in February, while in 2014–15 the peak effort and catch was in January and the lower February 2015 catch was closer to that of the March 2015 catch (Figure 13).

The proportion of albacore sampled quite closely followed the monthly catch distribution. In 2014–15 the monthly sampling matched the actual catch (Figure 13) better than it matched the monthly targets (Figure 2).

The number and percentage of days fished and sampled, by FMA are shown in Table 9 and Figure 14, with number and percentage of albacore caught and sampled, by FMA in Table 10 and Figure 15. Most troll fishing was in FMA 7 with some effort in west coast FMAs 8, and 9, and a small amount off the east coast in FMAs 1 and 2. Most of the catch was from FMA 7 and the majority of samples were from FMA 7.

Catch by month and FMA is shown in Figure 16. The 2013–14 and 2014–15 fishing seasons began on the East Coast of the North Island (ECNI) in FMA 1 with a small amount of albacore catch in November. December catch was predominantly off the West Coast of the North Island (WCNI), mainly from FMA 9, and there were small amounts in FMA 1, FMA 8, and FMA 7 in 2013–14. In both years, from January onwards, catches were predominantly from the West Coast of the South Island (WCSI) in

FMA 7. Catches from WCNI in FMA 9 and FMA 8 were seen in January, particularly in 2014–15. There were small amounts in FMA 8, FMA 5 and FMA 2. Catches in FMA 5 have been variable over the years and low during 2013–14 and 2014–15. Small catches in FMA 2 were seen in March and April during 2013–14, while catches in FMA 2 were seen earlier in 2014–15, from January to March, and highest in February (Figure 16).

Statistical area density plots comparing albacore caught and sampled are shown in Figure 17 for 2013–14 and Figure 18 for 2014–15. In 2013–14, 93.4% of the catch was from the west coast, and in 2014–15, 92.9% of was from the west coast. While sampling was carried out on west coast landings, one of the sampled vessels carried out some fishing in Statistical Areas 014 and 015 on the east coast. Most of the catch came from WCSI Statistical Areas 034 and 035 (Figure 19). Area 034 was predominant in the samples, but somewhat over-sampled in both years, while 035 was relatively under-represented and 045 was over-sampled in both years (Figure 19).

4. DISCUSSION

Catch sampling in landing sheds

Monthly distributions of the numbers of fish sampled during 2013−14 and 2014−15 achieved the targets and represented the temporal and spatial coverage of the fishery well, especially during the season peak months of January to March. December was over-sampled in both years, and April was under-sampled.

The fishery started later in the south than usual in 2014−15 and only a few landings were available for sampling in late January so most of the January samples were from the north. The northern region was oversampled relative to the southern region in 2014–15 because more fish were sampled in each landing in Auckland samples. This will be addressed in subsequent sampling. Otherwise the sampling split of north and south FMAs represents the fishery better in 2013−14 and 2014−15 than it did in the 2009−10 and 2012−13 periods.

The total troll catch of albacore was similar in 2013−14 and 2014−15 but relative proportions of catch among months varied particularly between January and February. The catch peaked in February in the 2013−14 season, and peaked in January in the 2014−15 season when the catch in February was significantly lower.

The proportion of albacore sampled closely followed the monthly catch distribution and matched the actual catch better than it matched the monthly targets, reflecting the ability of samplers to respond to real time fishery trends.

International use of troll data for stock assessment

Data from this albacore troll sampling programme are provided to SPC for incorporation into the stock assessment of South Pacific albacore. The most recent assessments were described by Hoyle et al. (2012) and Harley et al. (2015). Continued monitoring of the catch composition of juvenile albacore in the New Zealand troll fishery is a critical input to the length-based regional stock assessment of the South Pacific albacore stock.

The New Zealand troll data were specifically mentioned as informative data for the WCPFC South Pacific albacore stock assessment (Hoyle et al. 2012). Currently, the New Zealand troll size data provide essential information about growth rates of young fish. Hoyle et al. (2012) state “The data that provide by far the most information about growth rates is the New Zealand troll data, mostly sampled from 165–175°E, which is modelled at a monthly time step and demonstrates very clear and consistent growth modes.”

The relative strength of different size modes in the same year provides information to the model about relative year class strength, i.e. relative recruitment. This information needs to be constantly updated and missing a year means losing precision.

SPC plans to use New Zealand troll size data to improve the assessment, and understanding of the albacore fishery by investigating variability in growth and recruitment timing among years (S. Brouwer, WCPFC, pers. comm.). Annual variation is seen, with fish growing faster or recruiting earlier in some years, but the level of variation has not been assessed or linked to covariates such as oceanographic variables. The time series of good quality data is still fairly short for this, so cutting back on sampling would make this work harder to do. Also, climate change may affect growth rates, which would change the productivity of the stock. This would be important and it could be picked up sooner with more frequent sampling.

Recommendation

Accurate positional information in the troll fishery is limited by the use of CELR forms where most fishers record a statistical area rather than latitude and longitude. Fewer than 5% of forms have latitude and longitude recorded. Dependence on fishers' use of the appropriate CELR template causes confusion, especially about which species to record as weight and which to record as fish numbers. Consequently a mixture of fish number and fish weight are recorded for tuna species including albacore, when all should be recorded as fish numbers. Another limitation of CELR forms is the lack of provision for reporting bycatch and discards. Creation of a new custom troll form (similar to the TLCER form) would enable fishers to record bycatch, discards, accurate positional information, and both fish numbers and weight.

5. ACKNOWLEDGMENTS

Thanks to NIWA staff in Greymouth and Auckland staff who carried out the sampling, especially Michael O'Driscoll in Greymouth who sampled most of the fish in this project, and Helena Armiger for coordination in the northern region. Thanks also to licensed fish receiver companies who permitted us to sample fish in their sheds, and the fishers who caught the albacore and cooperated with our sampling requirements. Thanks to Sanford Limited for sampling in Auckland and to Trident Systems who managed the Auckland sampling. Thanks to Malcolm Francis (NIWA) and John Annala (MPI) for helpful comments on the manuscript.

The 1996–97 and 1997–98 troll data were sampled for the Secretariat of the Pacific Community. The troll data collected by observers from the MPI Observer Programme were extracted from the *cod* database.

This work was funded by MPI project ALB2013/01.

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Table 1: Total troll catch recorded on CELR forms.

ALB fishing year	No. of fish	Estimated weight (kg)
1999–00	566 247	2 672 202
2000–01	550 467	2 986 363
2001–02	555 510	2 826 972
2002–03	674 283	3 130 960
2003–04	568 179	3 167 817
2004–05	476 717	2 928 249
2005–06	393 427	2 183 331
2006–07	329 775	1 716 409
2007–08	436 442	2 018 381
2008–09	373 664	1 950 843
2009–10	325 928	1 720 897
2010–11	434 300	2 067 270
2011–12	435 736	2 169 966
2012–13	420 953	2 311 034
2013–14	340 183	1 598 861
2014–15	342 280	1 759 320

Table 2: Number of fish sampled for length each year by port from 1996−97 to 2014−15.

	Port			
ALB year	Auckland	Greymouth	New Plymouth	All ports
1996–97	200	4 017		4 217
1997–98	982	2 996		3 978
1998–99	400	3 031		3 431
1999–00	949	3 013		3 962
2000–01	2 000	3 192		5 192
2001–02	1 400	3 770		5 170
2002–03	2 002	2 602	3 002	7 606
2003–04	1 821	2 666	998	5 485
2004–05	2 431	3 071		5 502
2005–06	1 600	3 070		4 670
2006–07	1 600	2 600		4 200
2007–08	400	4 164		4 564
2008–09				0
2009–10	600	3 585		4 185
2010–11	0	4 783		4 783
2011–12	400	4 700		5 100
2012–13	941	4 307		5 248
2013–14	2 041	3 774		5 815
2014–15	2 279	2 937		5 216
Total	**22 046**	**62 278**	**4 000**	**88 324**

Table 3: Target number of fish to sample each month, and number sampled per month in each port and month during 2013–14 and 2014–15.

		Sampled 2013–14		
Month	Targets	Auckland	Greymouth	Total
December	400	1 122		1 122
January	1 600	919	772	1 691
February	1 600		1663	1 663
March	1 000		1137	1 137
April	400		202	202
Total	**5 000**	**2 041**	**3774**	**5 815**

		Sampled 2014–15		
Month	Targets	Auckland	Greymouth	Total
December	400	786		786
January	1 600	1 493	400	1 893
February	1 600		1 400	1 400
March	1 000		1 137	1 137
April	400			0
Total	**5 000**	**2 279**	**2 937**	**5 216**

Table 4: Number of fish, landings and vessels sampled, in each month and port during 2013–14 and 2014–15.

2013–14		**No. of fish**	**Landings**	**Vessels**
Auckland	December	1 122	6	6
	January	919	5	5
Greymouth	January	772	8	6
	February	1 663	17	15
	March	1 137	12	11
	April	202	2	2
	Total	**5 815**	**50**	**33**

2014–15		**No. of fish**	**Landings**	**Vessels**
Auckland	December	786	4	3
	January	1 493	8	8
Greymouth	January	400	4	4
	February	1 400	14	12
	March	1 137	12	9
	April	0		
	Total	**5 216**	**42**	**30**

Table 5: Summary of length frequency statistics for albacore sampled during 18 years of troll sampling, fork lengths in cm.

	n	mean	stdev	min	1%	5%	median	95%	99%	max
1996–97	4 217	65.0	6.9	40	49	51	66	76	81	92
1997–98	3 978	66.0	6.7	45	51	59	64	78	81	91
1998–99	3 431	61.4	8.7	38	47	48	62	74	81	91
1999–00	3 962	61.1	5.6	39	49	55	60	74	81	94
2000–01	5 192	65.2	8.5	40	46	49	68	75	78	99
2001–02	5 170	63.6	8.6	42	47	51	62	80	83	89
2002–03	7 606	60.9	6.4	42	47	50	61	71	76	92
2003–04	5 485	64.3	5.1	40	52	58	63	73	76	94
2004–05	5 502	66.5	7.1	45	52	55	68	76	80	94
2005–06	4 670	63.3	7.5	45	50	52	63	78	83	92
2006–07	4 200	61.4	8.1	43	49	50	61	74	80	92
2007–08	4 564	61.6	6.4	42	49	51	61	73	77	92
2008–09	0									
2009–10	4 185	61.6	5.6	41	48	51	61	61	77	87
2010–11	4 783	59.3	6.0	44	46	49	59	59	76	96
2011–12	5 100	61.8	5.4	46	54	56	60	60	77	93
2012–13	5 248	64.1	6.3	42	47	50	65	74	78	86
2013–14	5 815	63.4	8.3	42	46	49	61	77	80	96
2014–15	5 216	61.1	7.0	29	44	47	61	71	78	86
All troll	88 324	62.9	7.2	29	47	50	62	75	80	99

Table 6: Linear regression parameters for length-weight relationships.

	n	b_0	SE_{b0}	b_1	SE_{b1}	R^2
1998–99	317	-10.61	0.13	2.95	0.03	0.97
1999–00	397	-9.46	0.16	2.67	0.04	0.93
2000–01	599	-9.86	0.12	2.77	0.03	0.94
2000–02	606	-9.69	0.10	2.73	0.02	0.95
2002–03	709	-9.82	0.16	2.76	0.04	0.87
2003–04	598	-10.33	0.14	2.89	0.03	0.92
2004–05	400	-10.36	0.13	2.90	0.03	0.96
2005–06	600	-10.47	0.10	2.92	0.02	0.96
2006–07	598	-10.63	0.06	2.97	0.02	0.98
2007–08	574	-10.33	0.11	2.89	0.03	0.96
2009–10	500	-10.57	0.11	2.96	0.03	0.96
2010–11	386	-10.22	0.15	2.86	0.04	0.94
2011–12	498	-10.09	0.14	2.84	0.03	0.93
2012–13	673	-10.74	0.07	2.99	0.02	0.98
2013–14	1 068	-10.40	0.08	2.90	0.02	0.96
2014–15	856	-10.59	0.08	2.96	0.02	0.97
All troll	9 379	-10.27	0.03	2.87	0.01	0.95

Table 7: Number and percentage of days fished and sampled, by month

2013–14

		Days		% Days	
Year	Month	Fished	Sampled	Fished	Sampled
2013	July	1		<0.1	
	September	1		<0.1	
	October	2		<0.1	
	November	56		1.3	
	December	574	32	13.3	12.6
2014	January	1 175	65	27.3	25.6
	February	1 344	89	31.2	35.0
	March	746	64	17.3	25.2
	April	313	4	7.3	1.6
	May	88		2.0	
	June	7		0.2	

2014–15

		Days		% Days	
Year	Month	Fished	Sampled	Fished	Sampled
2014	November	12		0.3	
	December	307	35	7.7	14.3
2015	January	1 242	66	31.1	26.9
	February	1 078	87	27.0	35.5
	March	868	57	21.7	23.3
	April	420	0	10.5	0.0
	May	67		1.7	

Table 8: Number and percentage of albacore caught and sampled, by month

2013–14

		No. ALB		% ALB	
Year	Month	Fished	Sampled	Fished	Sampled
2013	July	29		<0.1	
	October	65		<0.1	
	November	3 783		1.1	
	December	46 107	1 122	13.6	19.3
2014	January	104 717	1 691	30.8	29.1
	February	111 965	1 663	32.9	28.6
	March	46 853	1 137	13.8	19.6
	April	21 078	202	6.2	3.5
	May	5 486		1.6	
	June	100		<0.1	

Table 8 continued

2014–15

		No. ALB		% ALB	
Year	Month	Fished	Sampled	Fished	Sampled
2014	November	1 472		0.4	
	December	22 548	786	6.6	15.1
2015					
	January	123 287	1 893	36.6	36.3
	February	86 590	1 400	25.3	26.8
	March	78 124	1 137	22.8	21.8
	April	28 550	0	8.3	0.0
	May	1 709		0.5	

Table 9: Number and percentage of days fished and sampled, by FMA, Unk, unknown

2013–14

	Days		% Days	
FMA	Fished	Sampled	Fished	Sampled
1	188	5	4.4	2.0
2	225	2	5.2	0.8
3	5		0.1	
5	19	3	0.4	1.2
7	2 946	190	68.4	74.8
8	371	10	8.6	3.9
9	542	44	12.6	17.3
Other/Unk.	11		0.3	

2014–15

	Days		% Days	
FMA	Fished	Sampled	Fished	Sampled
1	71		1.8	
2	319		8.0	
3	1		<0.1	
5	11	2	0.3	0.8
7	2 562	161	64.1	65.7
8	563	16	14.1	6.5
9	459	66	11.5	26.9
Other/Unk.	8		0.2	

Table 10: Number and percentage of albacore caught and sampled, by FMA, Unk, unknown

2013–14

	No. ALB		% ALB	
FMA	Fished	Sampled	Fished	Sampled
1	8 970		2.6	
2	13 394	130	3.9	0.7
3	56		<0.1	
5	859	219	0.3	1.1
7	242 998	13 794	71.4	71.9
8	28 118	608	8.3	3.2
9	45 624	4 441	13.4	23.1
Other/Unk.	164		<0.1	

2014–15

	No. ALB		% ALB	
FMA	Fished	Sampled	Fished	Sampled
1	4 296		1.3	
2	20 018		5.8	
3	9		<0.1	
5	447	155	0.1	0.6
7	228 425	16 535	66.7	64.0
8	46 637	1 427	13.6	5.5
9	42 373	7 711	12.4	29.9
Other/Unk.	75		<0.1	

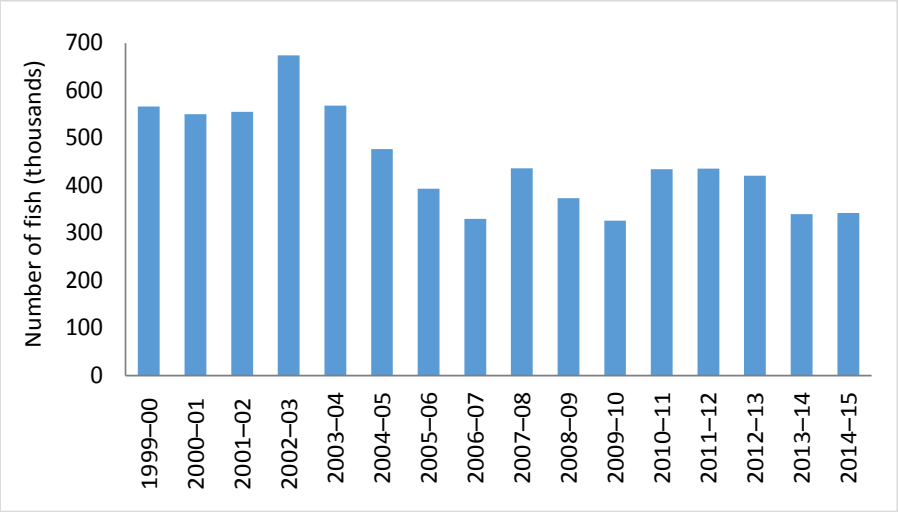

Figure 1: Total troll catch recorded on CELR forms.

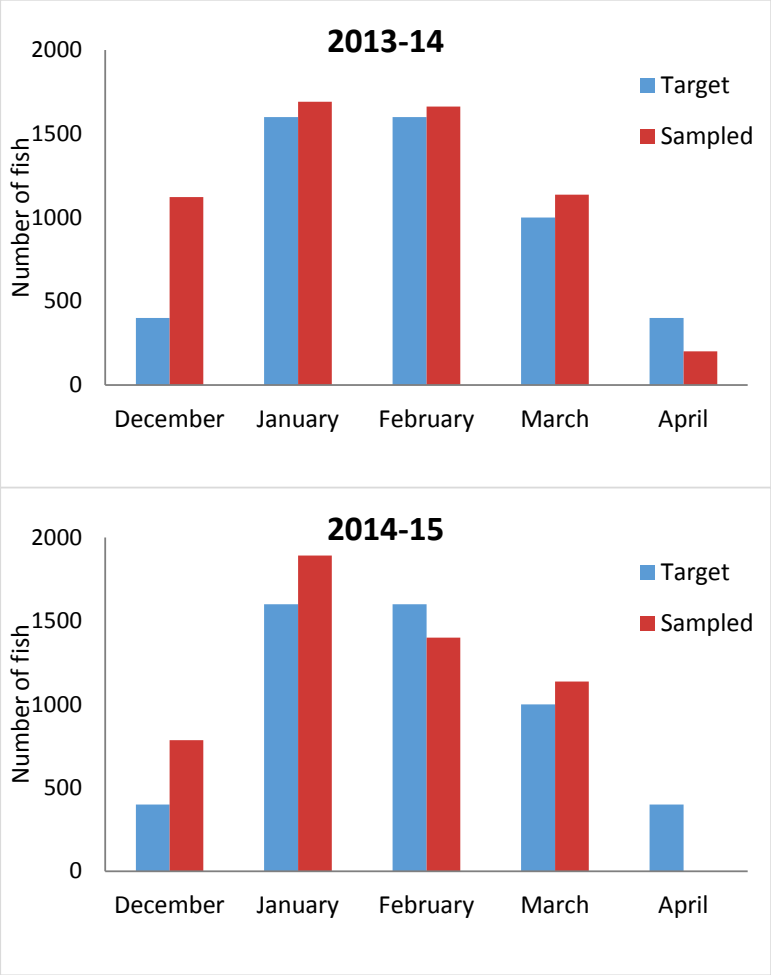

Figure 2: Target number of fish and actual number sampled each month during 2013−14 and 2014−15.

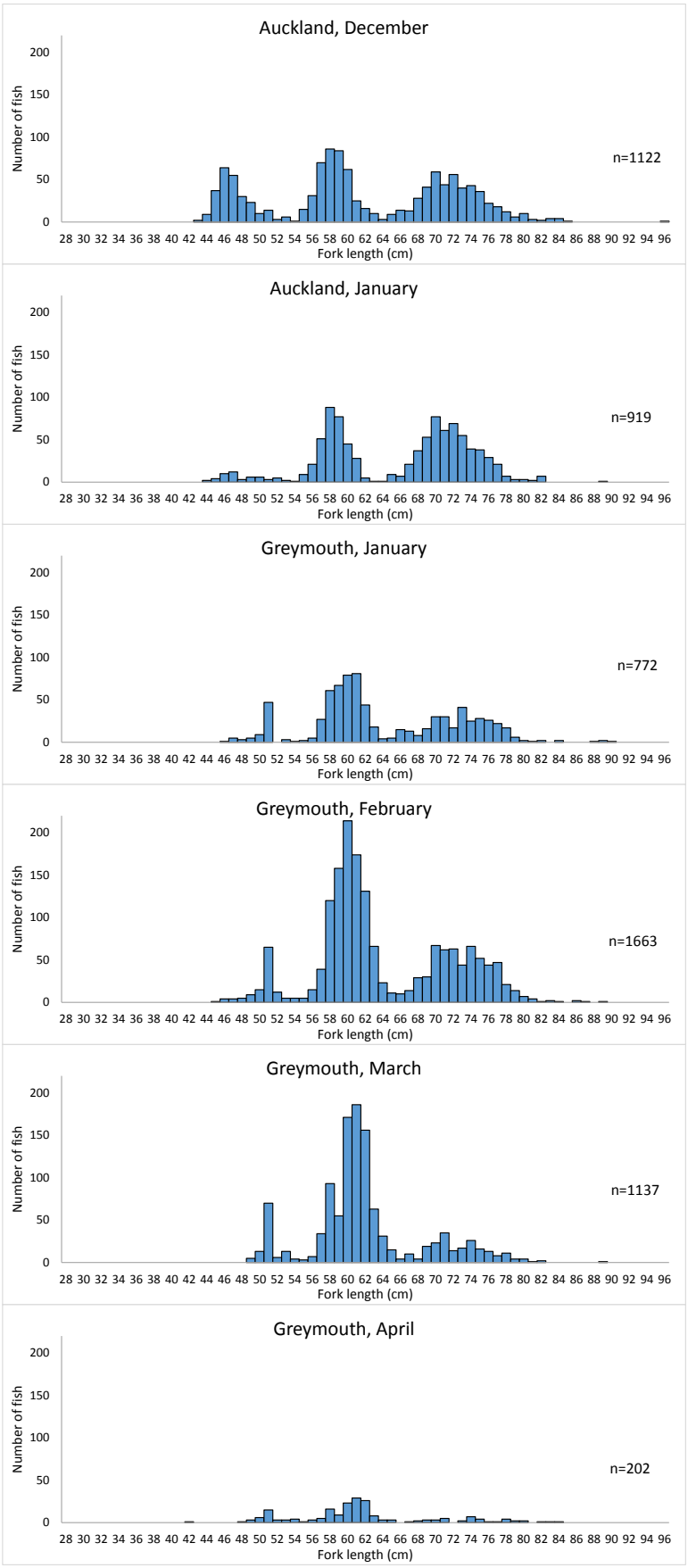

Figure 3: Albacore length frequency distributions, sampled from landings by troll vessels in Auckland and Greymouth during 2013−14.

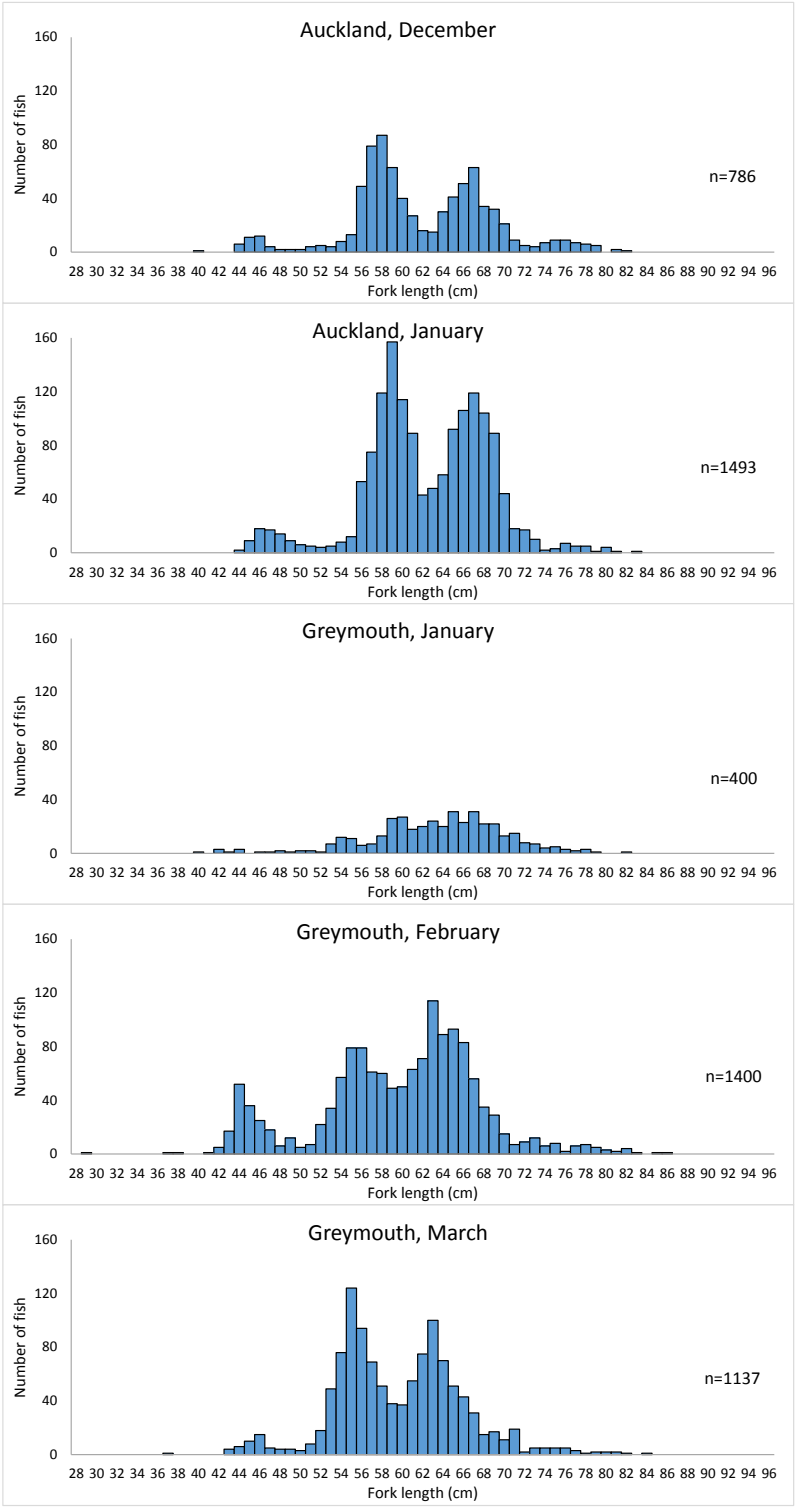

Figure 4: Albacore length frequency distributions, sampled from landings by troll vessels in Auckland and Greymouth during 2014−15.

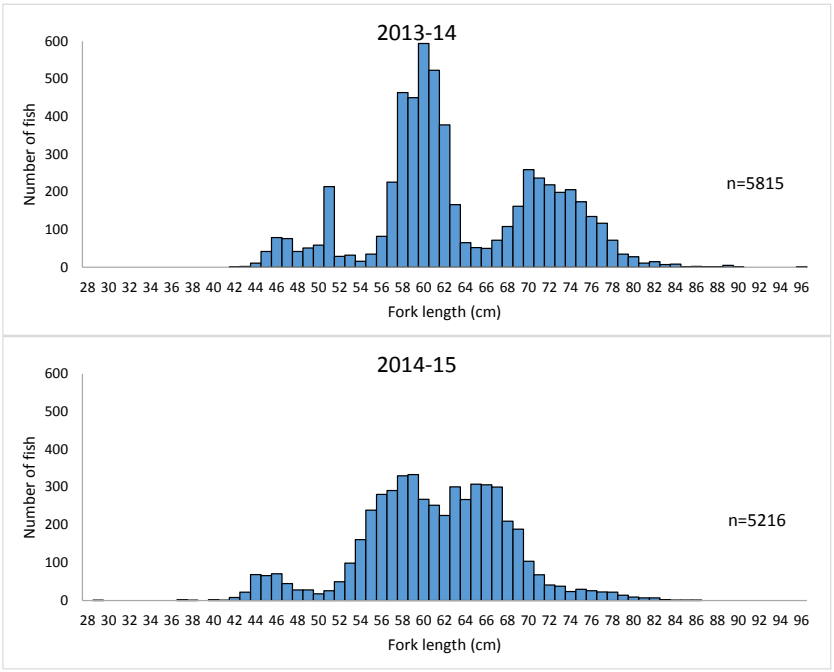

Figure 5: Albacore length frequency distributions, 2013−14 and 2014−15, all months combined.

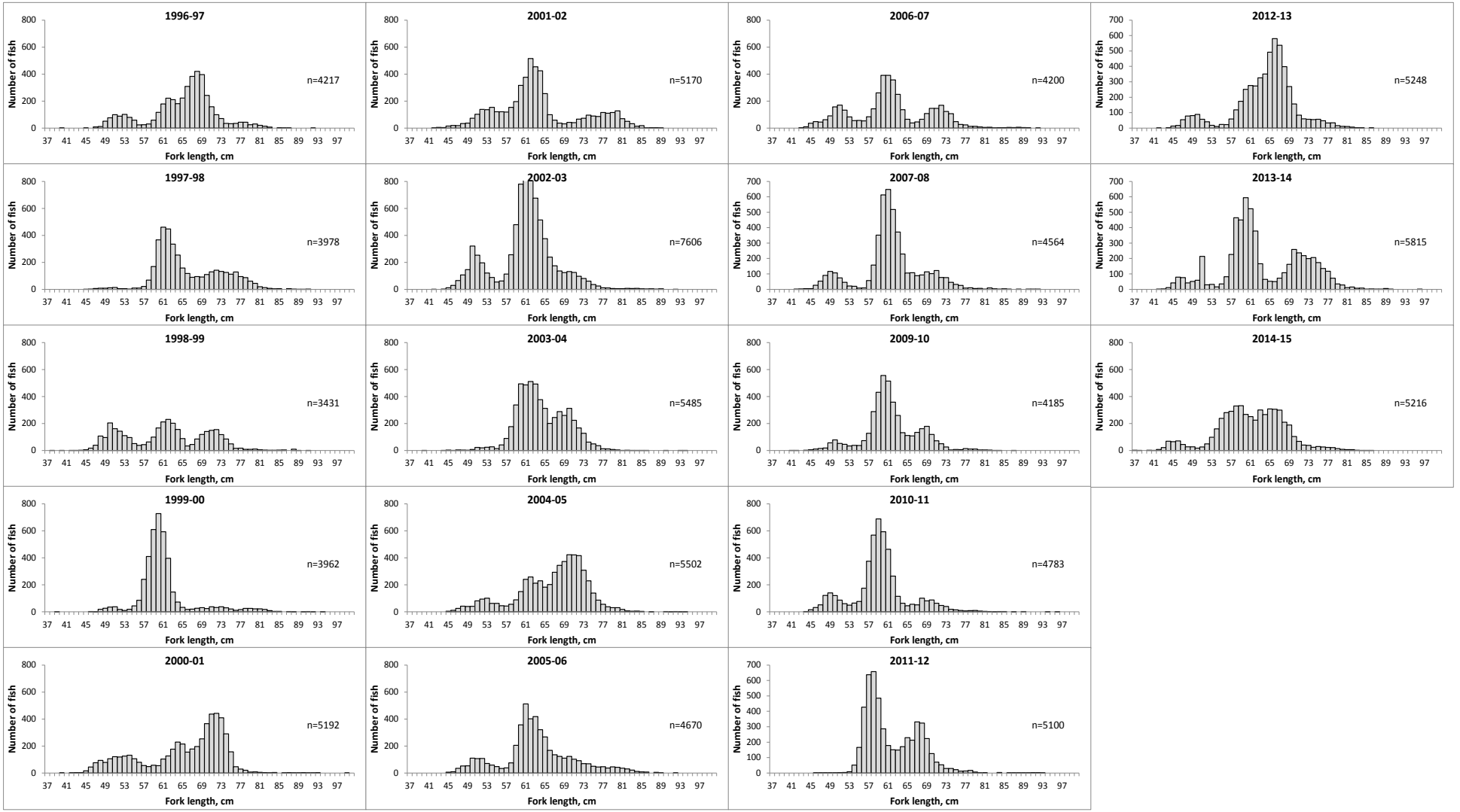

Figure 6: Albacore length frequency distributions for 18 years of sampled landings from troll vessels, 1996–97 to 2014–15.

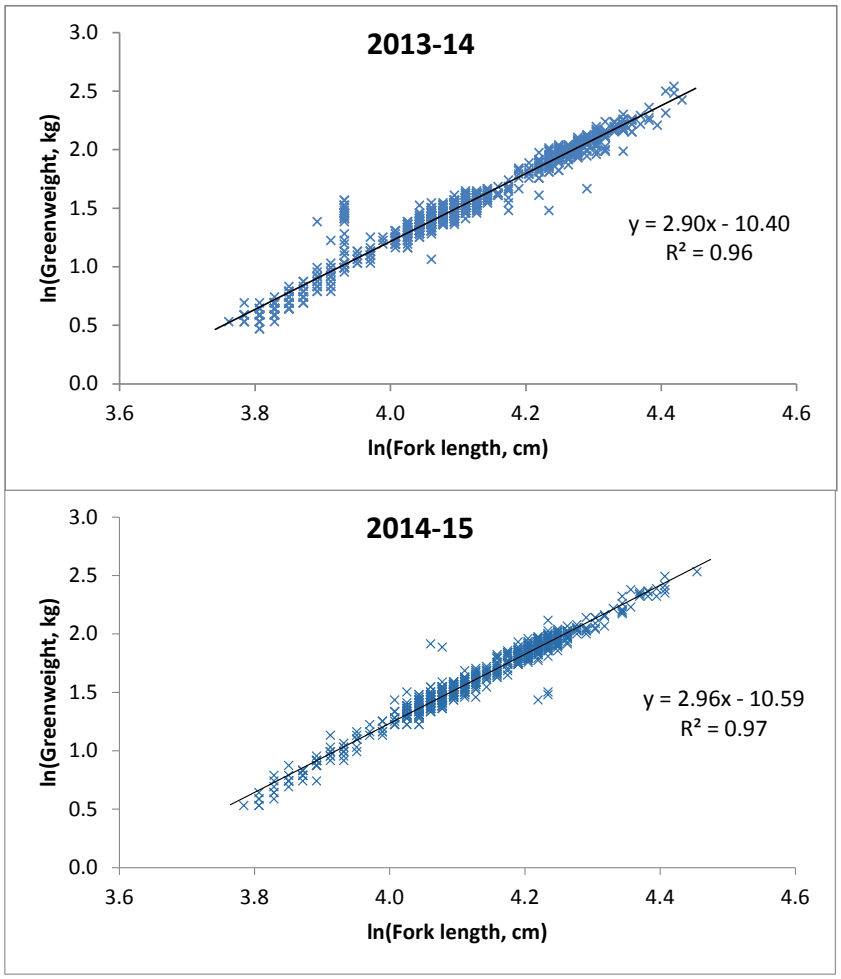

Figure 7: Length-weight relationship for troll caught albacore sampled from troll vessel landings, 2013−14 and 2014−15.

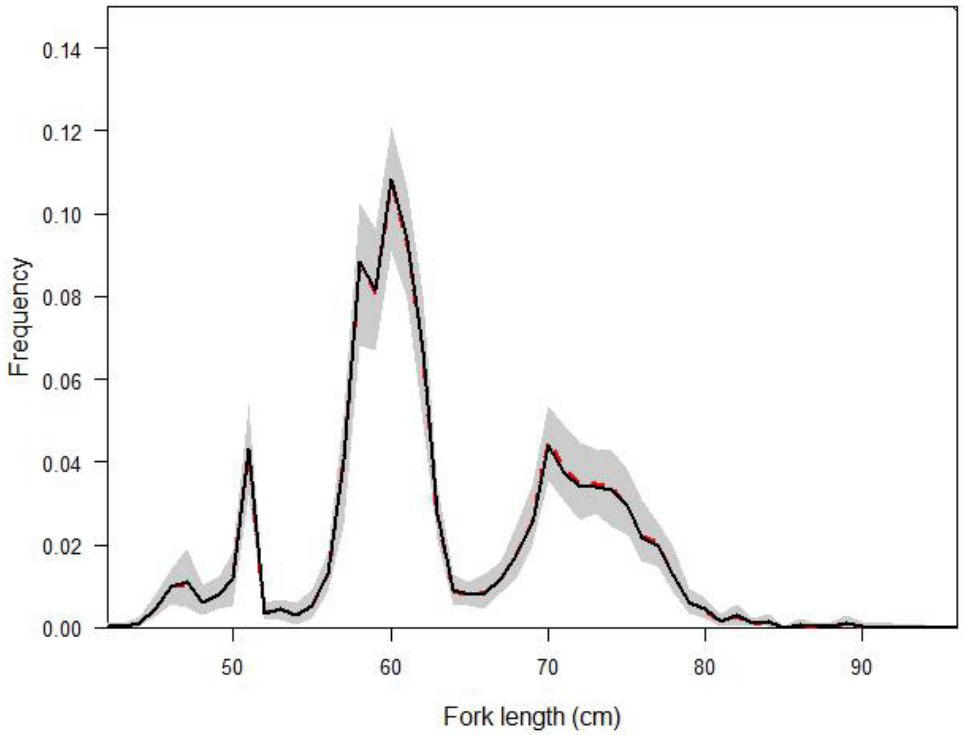

Figure 8: Albacore length frequency distributions, scaled to the total catch, 2013–14.
The scaled length frequency is shown by the solid black line, while the broken red line represents the bootstrapped median, and the grey region shows the bootstrapped 95% confidence interval.

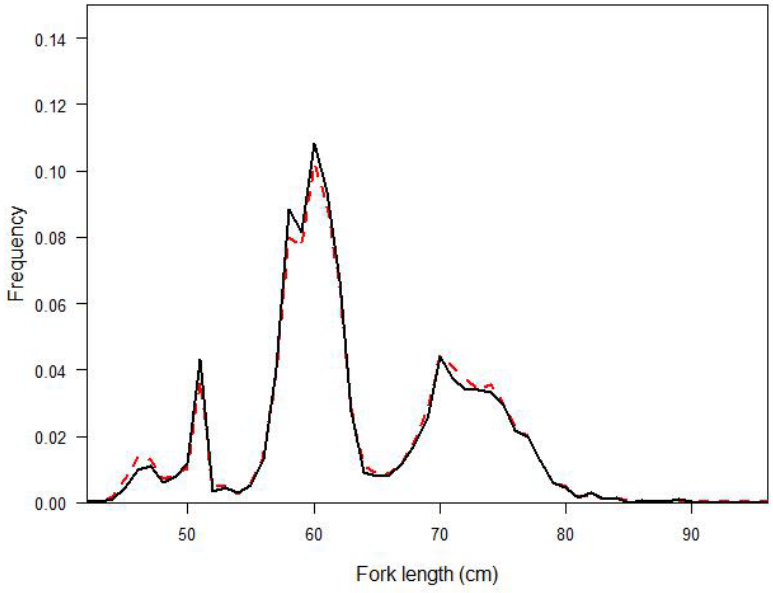

Figure 9: Comparison of scaled (solid line) and unscaled (broken line) length frequency, 2013–14.

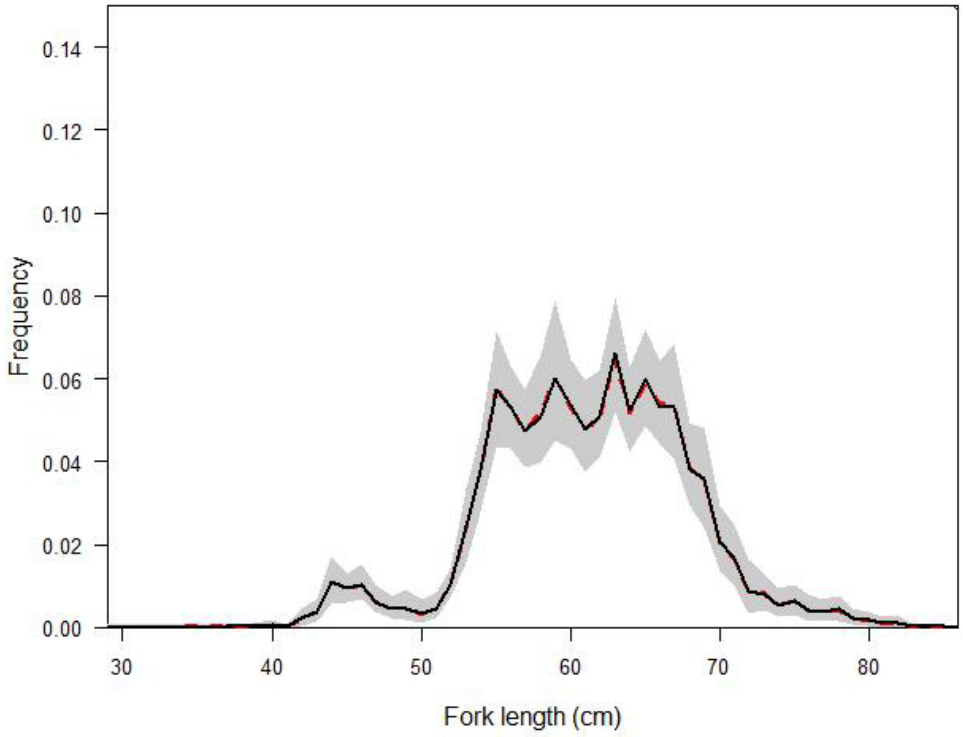

Figure 10: Albacore length frequency distributions, scaled to the total catch, 2014–15.
The scaled length frequency is shown by the solid black line, while the broken red line represents the bootstrapped median, and the grey region shows the bootstrapped 95% confidence interval.

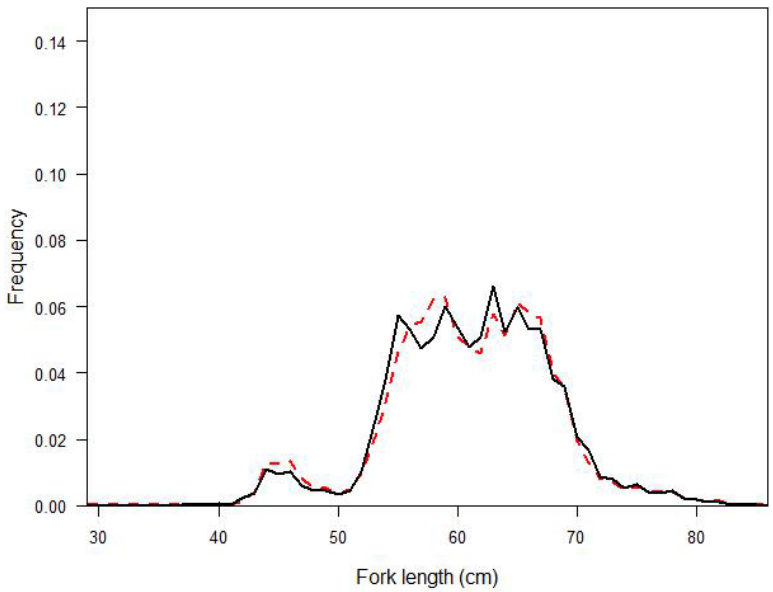

Figure 11: Comparison of scaled (solid line) and unscaled (broken line) length frequency, 2014–15.

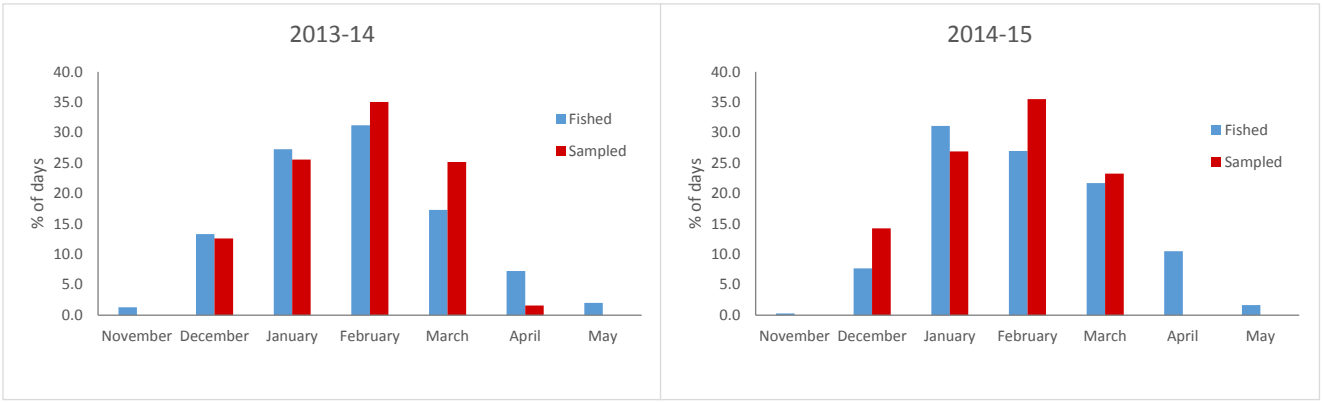

Figure 12: Number and percentage of days fished and sampled, by year and month.

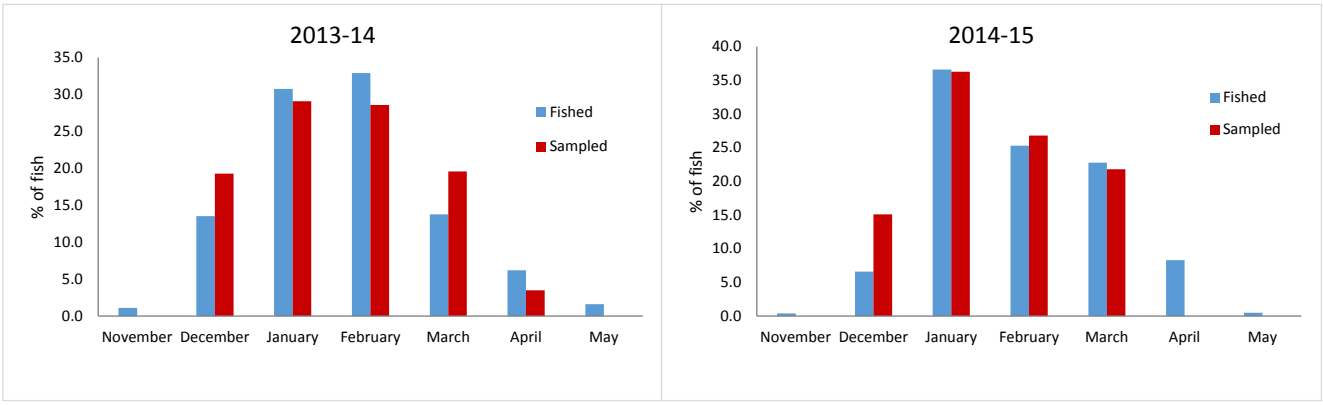

Figure 13: Number and percentage of albacore caught and sampled, by year and month.

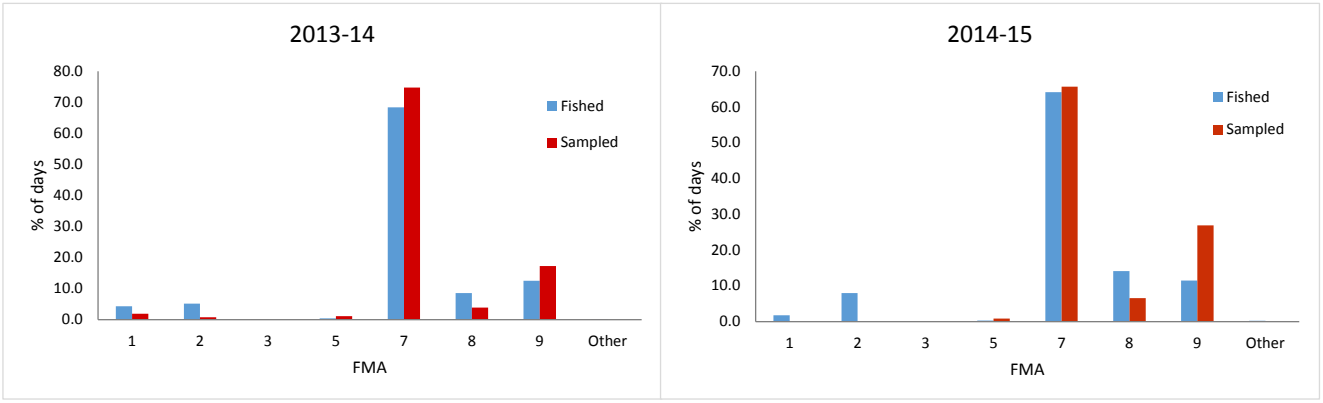

Figure 14: Number and percentage of days fished and sampled, by year and FMA, Unk, unknown.

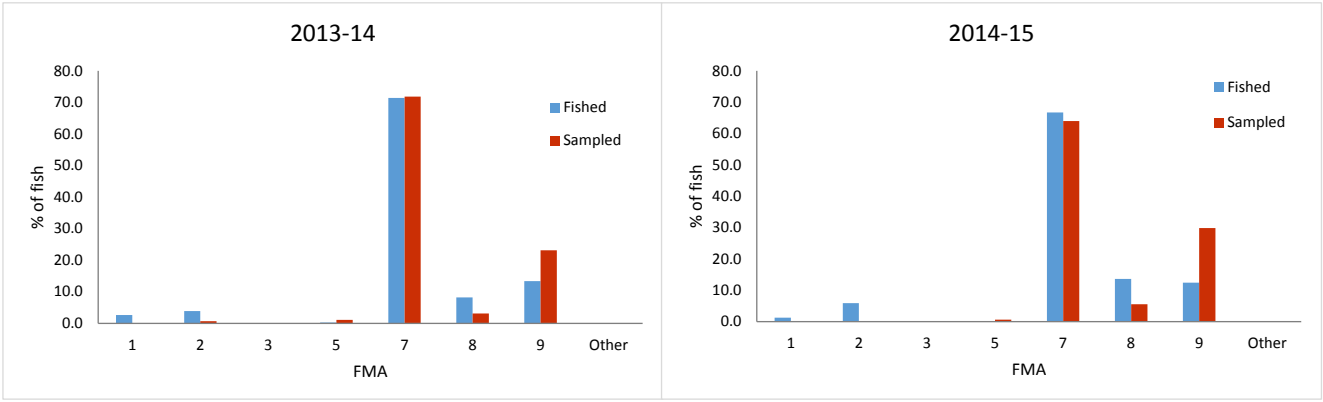

Figure 15: Number and percentage of albacore caught and sampled, by year and FMA, Unk, unknown.

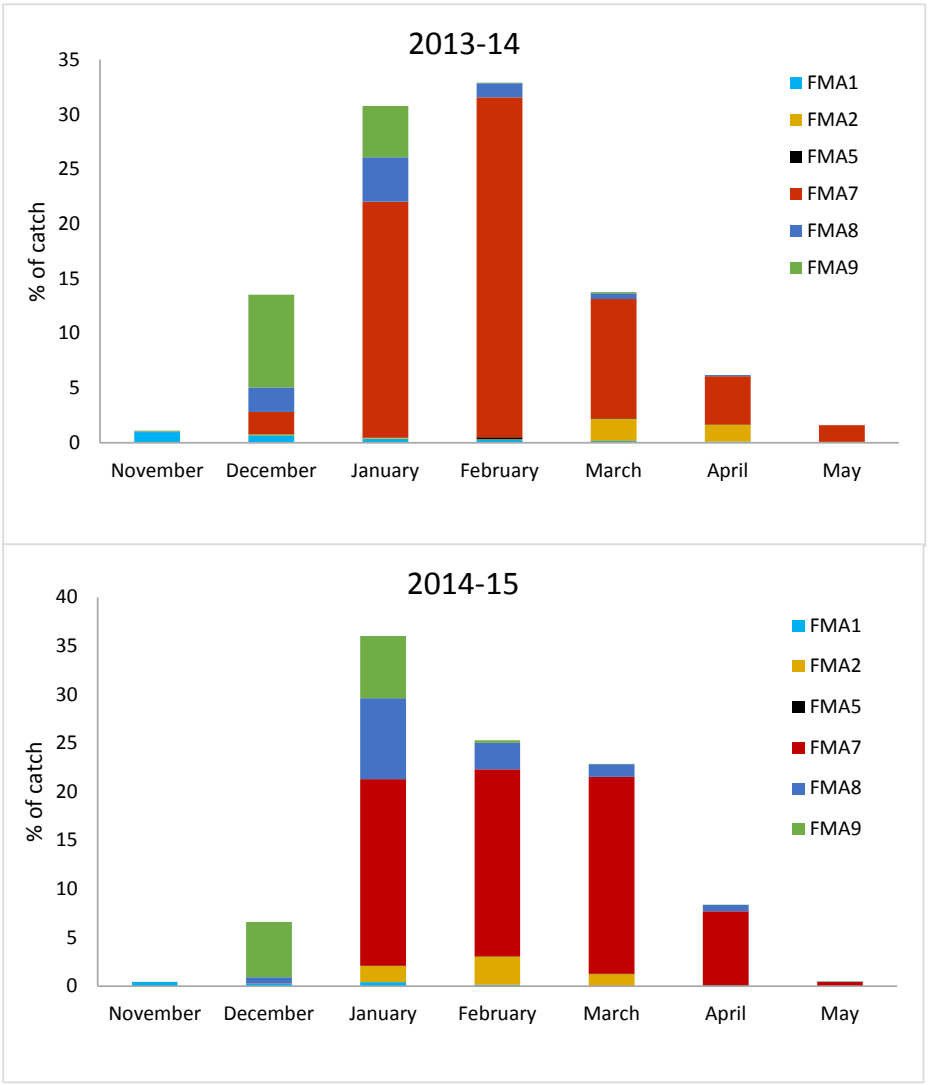

Figure 16: Proportion of catch by year, month and FMA.

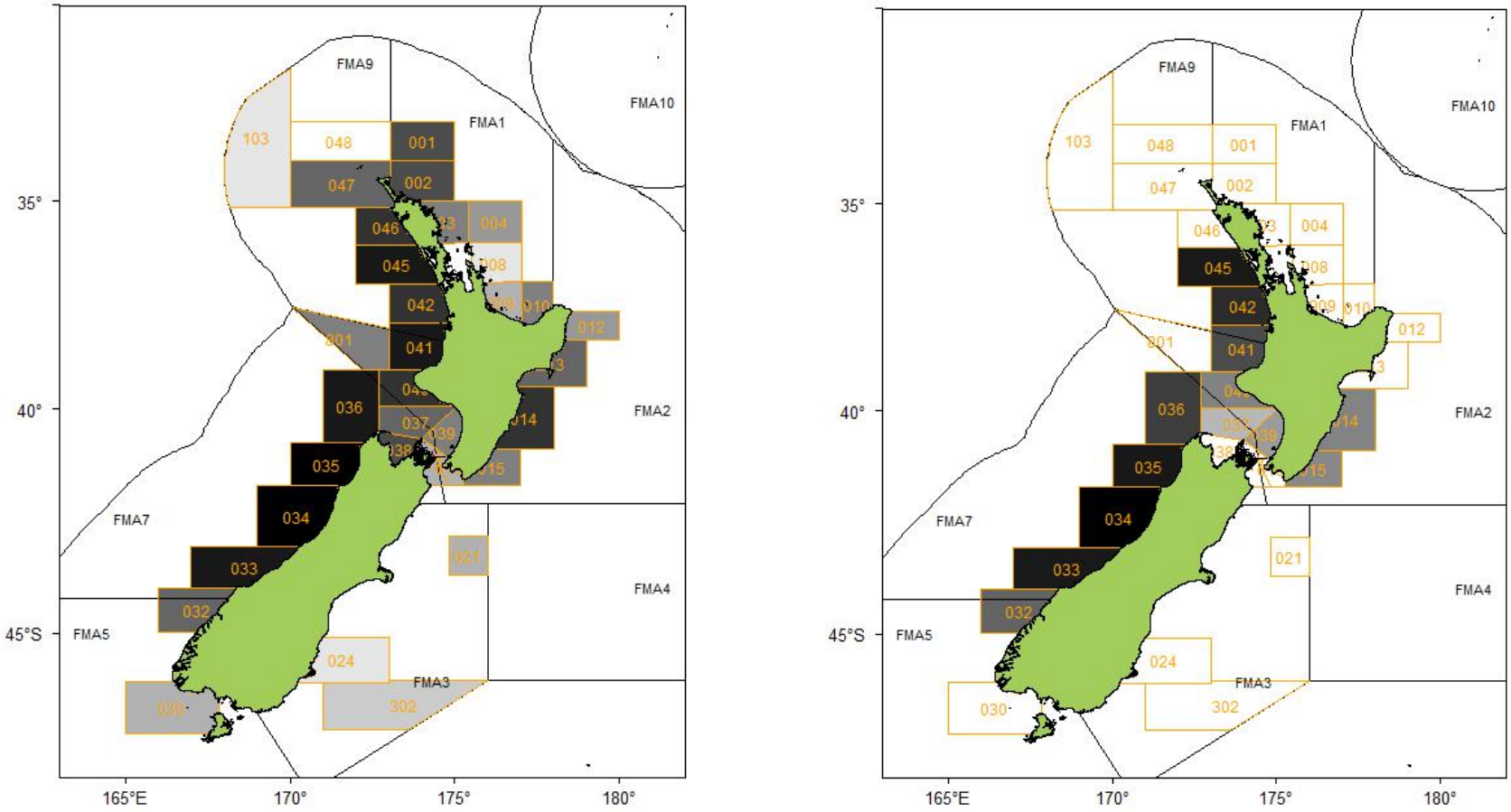

Figure 17: Statistical area density plots of albacore catch, fished (left) and sampled (right) for the 2013−14 year. A logarithmic density scale was used where 0=white and 1=black.

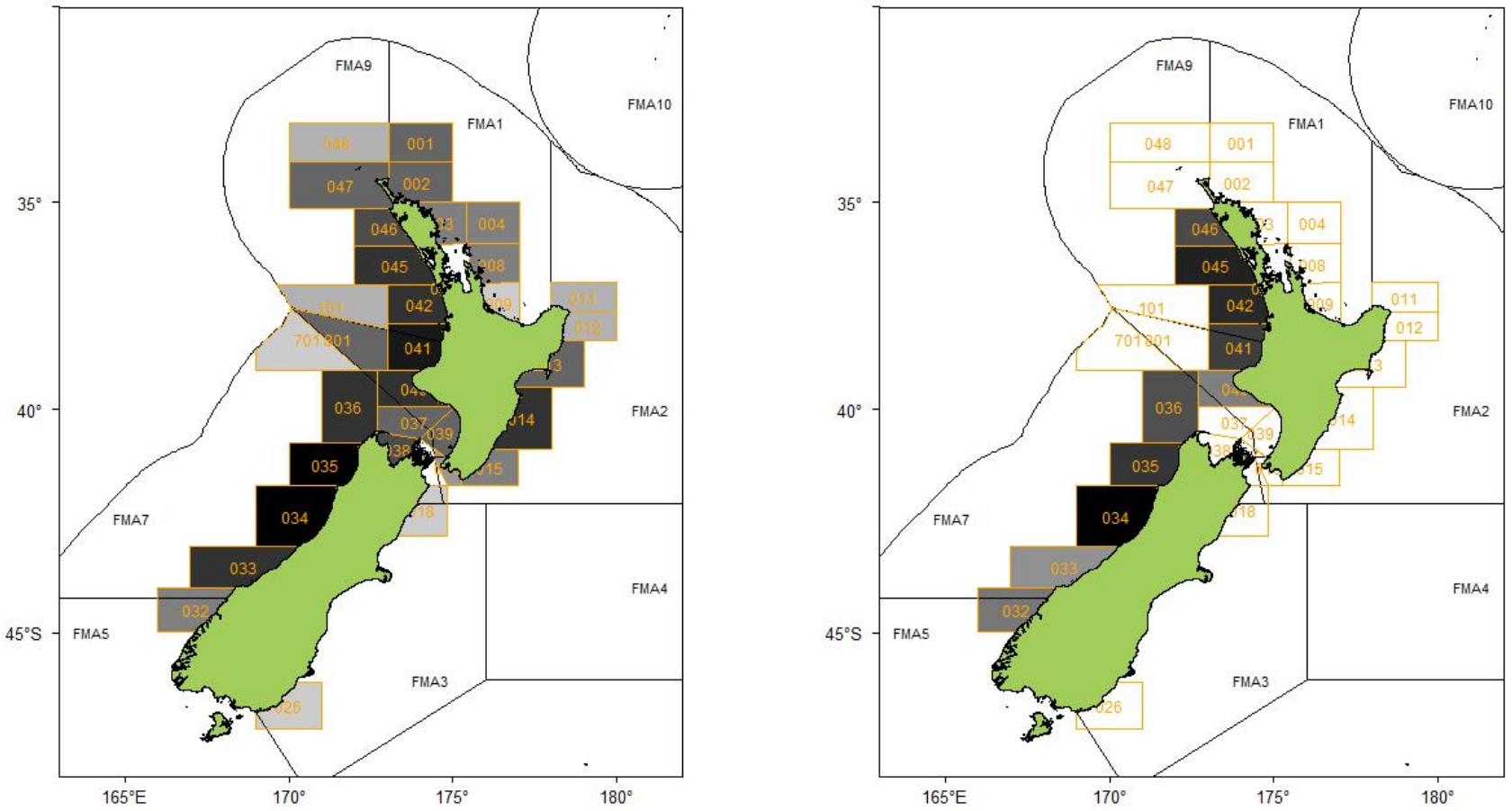

Figure 18: Statistical area density plots of albacore catch, fished (left) and sampled (right) for the 2014−15 year. A logarithmic density scale was used where 0=white and 1=black.

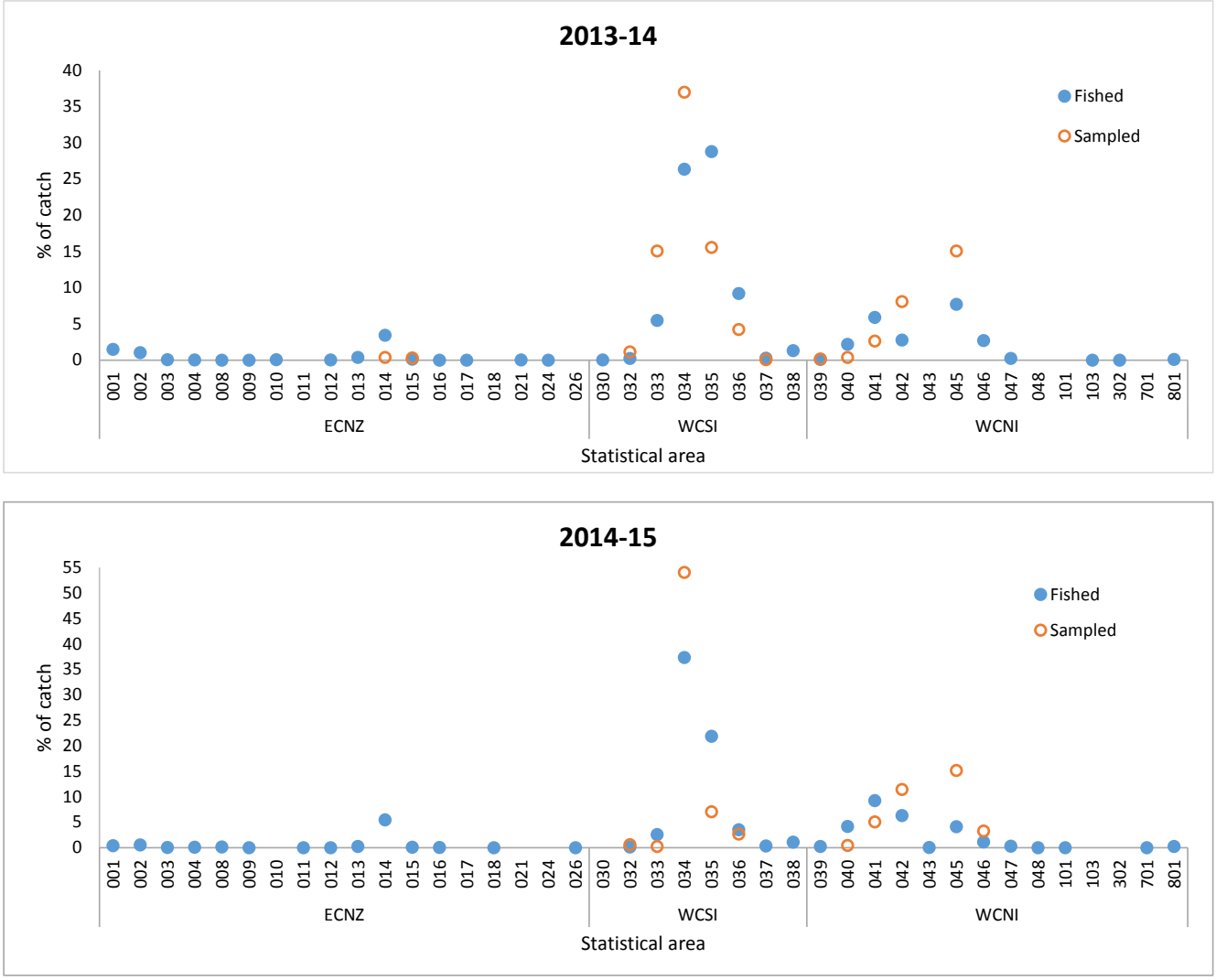

Figure 19: Albacore catch by statistical area, 2013−14 (above) and 2014−15 (below). ECNZ, East Coast with north and south combined; WCSI, West Coast South Island; WCNI, West Coast North Island.