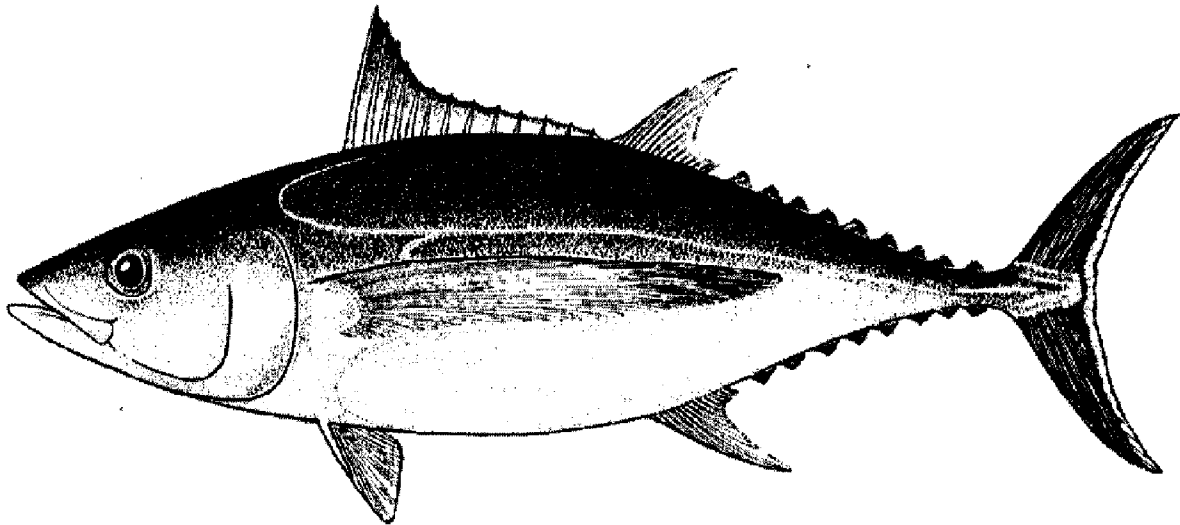




Monitoring the length structure of commercial landings of albacore tuna  
during the 2000–2001 fishing year



Griggs, L. & T. Murray

## **Monitoring the length structure of commercial landings of albacore tuna during the 2000–2001 fishing year.**

**Lynda Griggs and Talbot Murray**

### **Abstract**

Albacore tuna caught by trolling in New Zealand waters during the 2000–01 fishing season were sampled in fish sheds to determine the length composition and length-weight relationship.

Albacore sampled in the 2000–01 fishing year had a mean fork length of 65.2 cm, and ranged in size from 40–99 cm, with nearly all fish (99%) in the 46–78 cm range. Length:weight relationships are determined. Log of fork length plotted against log of green weight produced a significant linear relationship ( $R^2=0.94$ ).

Nearly all of the albacore sampled in the troll fishery over a five year period from 1996–97 to 2000–01 are in the 47–81 cm size range (99%), with a mean fork length of 63.9 cm. Data are presented for the troll catch in comparison with the New Zealand observed longline catch of albacore. Longline caught albacore are larger, with an average fork length of 83.6 cm, and most fish (99%) are in the 59–105 cm size range.

Albacore caught by trolling around the New Zealand coast tend to be smaller than those caught by troll vessels from U.S.A. fishing in the sub-tropical convergence zone, the only other surface fishery for the South Pacific albacore stock. Fish caught by longline throughout the South Pacific are all larger sub-adult and adult fish. This study reinforces the importance of continuing to monitor the catch composition of juvenile albacore stocks in New Zealand as an important input to the regional stock assessment of albacore.

## Introduction

Albacore tuna (*Thunnus alalunga*) caught in the New Zealand EEZ 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 fork length 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 (Ramon and Bailey 1996, Murray 1994, Murray *et al.* 1999).

Juveniles recruit to surface fisheries in New Zealand coastal waters and in the vicinity of the sub-tropical convergence zone (STCZ), at about 2 years of age, at 45–50 cm fork length. Albacore then appear to gradually disperse north (Hampton and Fournier 2000) where they are caught by longline fleets.

Longline fleets from Japan, Korea and Taiwan, and domestic fleets of several Pacific Island countries, catch primarily adult albacore throughout their range. Fish caught by longline in the southern part of the region are smaller than those caught further north (Hampton and Fournier 2000). The New Zealand longline fishery catches adult and sub-adult albacore (Murray *et al.* 1999).

Annual catches of South Pacific albacore have varied between 20 000 t and 52 000 t since the 1960s, mostly contributed by longlining, with a troll catch of up to 10 000 t per year (Murray *et al.* 1999, Hampton and Fournier 2000).

The troll fishery for juvenile albacore has occurred in New Zealand coastal waters since the 1960s, and in the central region of the STCZ since the mid-1980s (Murray 1994, Hampton and Fournier 2000).

The New Zealand troll fishery operated by domestic vessels in New Zealand coastal waters, catches up to 6000 t of albacore annually, over half of the total South Pacific surface fishery catch (Murray *et al.* 2000).

Troll vessels from the United States of America have fished for albacore in the South Pacific since 1986, in the STCZ, approx. 39–41° S, 1000 n. miles east of New Zealand eastward to waters off South America. Landings from these vessels increased from 751 t in 1986–87 to a peak of 5540 t in 1990–91, and then declined to 603 t in 1993–94 and rose to 2916 t in 1994–95 (Childers and Coan 1996).

Driftnet catches of juvenile albacore peaked at 27,000 t in 1989 but have since declined to zero following a United Nations moratorium on industrial-scale driftnetting (Murray 1994).

The size composition, sex ratio, and length:weight relationship of troll caught albacore sampled in the 1998-99 season were investigated for project TUN9801, objective 4 (Griggs and Murray 2000). These fish, which are mostly juveniles, ranged in size from 38–91 cm fork length, with nearly all of the fish in the 47–81 cm range, and a mean of 61.4 cm. The catch composition of albacore caught by troll and longline were compared. New Zealand longline fisheries caught adult and sub-adult albacore, mostly in the 59–105

cm size range. The sex of troll caught albacore was determined by microscopic examination. The sex ratio was found to not differ significantly from a 1:1 ratio, in both troll and longline caught fish. A linear relationship was found between albacore fork length and greenweight with  $R^2=0.95$ . The length:weight relationships showed similar slopes and intercepts for males and females, and for troll and longline caught fish (Griggs and Murray 2000).

The objective of the present study is to conduct sampling in fish sheds and determine and report the length composition and length-weight relationships of albacore tuna during the 2000/2001 fishing year from samples collected in fish sheds. The target coefficient of variation (c.v.) for the length composition is 30 % (mean weighted c.v. across all length classes).

This objective extends the time series of albacore troll vessel sampling in New Zealand. This work is an extension to the sampling funded since 1996–97 by the SPC, and by Ministry of Fisheries project TUN9801 (objective 4).

## **Methods**

Trolling for albacore occurs primarily off the west coasts of the North Island and South Island with Onehunga (in Auckland), New Plymouth, Westport and Greymouth being major landing ports. Characterisation of the size composition of the fishery requires regular sampling through the season (December–May). The sampling should take account of any differences in size composition between areas and between boats.

The following albacore sampling strategy was used, where possible:

- two ports sampled: Onehunga and Greymouth, from December/January–April/May;
- fish sampled from at least 5 vessel unloadings;
- fish selected at random from each vessel unloading;
- at least 1000 fork lengths measured) in each port, each month;
- at least 100 fish sub-sampled for length and weight in each port, each month.

At each port, sampling was carried out when the troll vessel unloaded its catch. The fish were kept on ice while on the vessel and frozen once they were discharged into the fish receivers. Fish were sampled prior to freezing. Fork length was measured to the nearest whole cm, rounded down, and weight was measured to the nearest 0.1 kg.

## **Results**

During the 2000-01 fishing season, a total of 5192 fish were sampled, 3192 landed in Greymouth and 2000 landed in the port of Onehunga in Auckland. In Greymouth, fish were sampled from 5 vessels in January 2001, 7 vessels in February, 7 vessels in March and 2 vessels in April. In Auckland, fish were sampled during January and February, from 5 boats each month.

The area fished out of Greymouth extended from New Plymouth, south to latitude 42°44' S and longitude 170°00' E on the west coast of the South Island. The area fished in the north was in latitude range 34°00' S to 37°06' S and longitude range 171°30' E to 173°28' E.

Weights were recorded for 601 fish, 401 from Greymouth and 200 from Auckland.

The fishing season was much longer in the Auckland region than it has been in previous years when sampling was carried out (Griggs and Murray 2000). Fishing in this area typically lasts about 4 weeks.

Figure 1 shows mean sea surface temperatures in New Zealand waters in January and February 2001. The sea surface temperature anomaly is also shown, which is based on the difference from the 5-year mean SST (1993–97). These data were taken from NIWA SST Archive (Climatology) at <http://www.sst.niwa.cri.nz>.

In January and February of 2001, temperatures on the west coast of the North Island were less than 20° C, in a range suitable for albacore, and this was likely to have been a major factor contributing to greater landings of albacore in the Auckland area this year. Average sea surface temperatures in January and February of 1999 were 20–21° C, up to 2° C higher than average, which is likely to account for a poorer fishing season.

Juvenile albacore spend little time in waters cooler than 15° C, and can be found in waters up to 21° C, but highest catch rates occur in a sea surface temperature range of 16° to 18° C (Murray 1994).

### **Size composition**

Figures 2 and 3 show the length frequency distribution of fork length, by month, for albacore sampled from troll vessels in the 2000–01 season, in Greymouth and in Auckland respectively. Fish sampled ranged in size from 40 cm to 99 cm, with almost all of the fish (99%) in the 46–78 cm range. The mean fork length was 65.2 cm. The fish sampled in Greymouth were larger, with a mean length of 67.3 cm, than those sampled in Auckland, with a mean length of 61.9 cm.

Table 1 shows mean length, standard deviation, minimum and maximum lengths and percentiles for each month sampled in the 2000–01 season, and for Greymouth combined and Auckland combined.

Table 2 shows these parameters for each of the fishing years sampled from 1996–97 to 2000–01, while figure 4 shows length frequency distributions for each of these years. In this five year period, fork length of troll caught albacore ranged from 38 cm to 99 cm, with nearly all of the fish (99%) in the 47–81 cm range, and the mean was 63.9 cm (Table 2). Three modes are visible in most months and these modes tended to increase by about 1 cm each month during the sampling period. There were more small fish in 1998–99 than in any of the other years. There was one predominant mode in the fish

sampled in the 1999-00 season, with a median of 60 cm. The greatest proportion of large fish were seen in the 2000-01 sample.

Figure 5 shows length distributions of troll and longline caught albacore. Troll caught albacore are from 5 years sampling combined (1996–97 to 2000–01). The longline data (extracted from the *l\_line* database), were collected by Ministry of Fisheries Scientific Observer Programme observers on New Zealand domestic and Japanese longliners, from 1987–2000. Albacore caught in New Zealand by longline are larger (mean fork length 83.6 cm) than troll caught fish, and are caught over a wider geographic area and in more months of the year (December to August). Albacore are usually caught as bycatch in longline operations targeting Southern bluefin tuna and bigeye tuna.

Mean length, standard deviation, minimum and maximum lengths and percentiles are compared for troll and longline caught fish in Table 2.

Table 1: Summary of mean fork length, standard deviation, median and percentiles for albacore sampled during the 2000–01 season.

|          | Greymouth<br>Jan 2001 | Greymouth<br>Feb 2001 | Greymouth<br>Mar 2001 | Greymouth<br>Apr 2001 | Auckland<br>Jan 2001 | Auckland<br>Feb 2001 | Greymouth<br>data<br>combined | Auckland<br>data<br>combined | All<br>2001 data<br>combined |
|----------|-----------------------|-----------------------|-----------------------|-----------------------|----------------------|----------------------|-------------------------------|------------------------------|------------------------------|
| n        | 805                   | 1243                  | 1008                  | 136                   | 1000                 | 1000                 | 3192                          | 2000                         | 5192                         |
| mean     | 69.5                  | 66.4                  | 67.4                  | 62.4                  | 61.2                 | 62.5                 | 67.3                          | 61.9                         | 65.2                         |
| std dev. | 5.8                   | 7.9                   | 7.3                   | 9.8                   | 9.5                  | 8.2                  | 7.5                           | 8.9                          | 8.5                          |
| min      | 45                    | 47                    | 40                    | 47                    | 44                   | 42                   | 40                            | 42                           | 40                           |
| 1%       | 48                    | 49                    | 50                    | 48                    | 45                   | 47                   | 49                            | 46                           | 46                           |
| 5%       | 55                    | 51                    | 53                    | 50                    | 46                   | 48                   | 52                            | 47                           | 49                           |
| median   | 71                    | 69                    | 69                    | 64                    | 63                   | 64                   | 70                            | 63                           | 68                           |
| 95%      | 75                    | 75                    | 75                    | 75                    | 74                   | 73                   | 75                            | 73                           | 75                           |
| 99%      | 77                    | 77                    | 78                    | 77                    | 80                   | 75                   | 77                            | 79                           | 78                           |
| max      | 84                    | 92                    | 93                    | 99                    | 83                   | 93                   | 99                            | 93                           | 99                           |

Table 2: Summary of mean fork length, standard deviation, median and percentiles for albacore sampled during the five years of troll sampling, and albacore caught by longline.

|          | 1997 data<br>combined | 1998 data<br>combined | 1999 data<br>combined | 2000 data<br>combined | 2001 data<br>combined | Troll data,<br>1996-97 to<br>2000-01 | Longline<br>data 1987-<br>2000 |
|----------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|--------------------------------------|--------------------------------|
| n        | 4217                  | 3978                  | 3431                  | 3962                  | 5192                  | 20780                                | 34364                          |
| mean     | 65.0                  | 66.0                  | 61.4                  | 61.1                  | 65.2                  | 63.9                                 | 83.6                           |
| std dev. | 6.9                   | 6.7                   | 8.7                   | 5.6                   | 8.5                   | 7.7                                  | 10.8                           |
| min      | 40                    | 45                    | 38                    | 39                    | 40                    | 38                                   | 40                             |
| 1%       | 49                    | 51                    | 47                    | 49                    | 46                    | 47                                   | 59                             |
| 5%       | 51                    | 59                    | 48                    | 55                    | 49                    | 50                                   | 67                             |
| median   | 66                    | 64                    | 62                    | 60                    | 68                    | 63                                   | 83                             |
| 95%      | 76                    | 78                    | 74                    | 74                    | 75                    | 76                                   | 100                            |
| 99%      | 81                    | 81                    | 81                    | 81                    | 78                    | 81                                   | 105                            |
| max      | 92                    | 91                    | 91                    | 94                    | 99                    | 99                                   | 133                            |

### Length:weight relationship

Figure 6 shows the length:weight relationship for albacore caught by troll during January-April 2001. Data are plotted as log (greenweight) vs. log (fork length).

Figure 7 shows the length:weight relationship for albacore sampled over three fishing years, 1998–99 to 2000–01. Length:weight relationships for albacore caught by troll and longline are shown in Figure 8.

Table 3 summarises the linear regression parameters and their standard errors, for the following equation:

$$\ln(\text{greenweight}) = b_0 + b_1 * \ln(\text{fork length})$$

Table 3: linear regression parameters for troll and longline length-weight relationships

|          |           | n     | $b_0$  | $SE_{b_0}$ | $b_1$ | $SE_{b_1}$ | $R^2$ |
|----------|-----------|-------|--------|------------|-------|------------|-------|
| troll    | 1999      | 320   | -10.44 | 0.16       | 2.91  | 0.03       | 0.95  |
| troll    | 2000      | 397   | -9.46  | 0.16       | 2.67  | 0.04       | 0.93  |
| troll    | 2001      | 599   | -9.86  | 0.12       | 2.77  | 0.03       | 0.94  |
| troll    | 1999-2001 | 1316  | -9.88  | 0.08       | 2.77  | 0.02       | 0.94  |
| longline | 1987-2000 | 24079 | -10.37 | 0.03       | 2.89  | 0.01       | 0.91  |

### Target coefficient of variation

The target coefficient of variation for the sampling was set at 30% as a mean weighted across all size classes. To determine whether the sampling strategy adopted by the SPC would equal or better this target CV we estimated the coefficient of variation in two ways, pooling across months and across age classes within a sampling period. The first (pooling across months) allows us to estimate the precision of sampling a given age class, the second the overall precision attained in a given month.

To estimate CVs we first analysed each month separately using MULTIFAN to decompose the length frequency distribution into age classes and to estimate the mean and standard deviation of each age class. Five age classes were identified in each of the months sampled, the summary statistics are given in Table 4.

To estimate the CV across age classes for each month we used an estimate of the pooled variance ( $\hat{\sigma}_j^2$ )

$$\hat{\sigma}_j^2 = \sum_i n_{ij}^2 \sigma_{ij}^2 / \sum_i n_{ij}^2$$

and mean length ( $\hat{X}_j$ )

$$\hat{X}_j = \sum_i n_{ij} \bar{X}_{ij} / \sum_i n_{ij}$$

where  $\bar{X}_{ij}$  = mean length in age class  $i$  in month  $j$ ;  $\sigma_{ij}$  = standard deviation in age class  $i$  in month  $j$ ; and  $n_{ij}$  = number of albacore sampled in age class  $i$  in month  $j$ .

The CV across all size classes is then:

$$CV_j = \hat{\sigma}_j / \hat{X}_j * 100$$

The mean weighted CV across months for each age class ( $CV_i$ ) was similarly estimated by summing across months  $j$ .

Table 4: summary statistics for the four age classes in 2001 and mean weighted CV's

| age                                       | Month 1<br>January 2001 |     |     | Month 2<br>February 2001 |     |     | Month 3<br>March 2001 |     |     | Month 4<br>April 2001 |     |    | Mean weighted CV<br>across months<br>CV |
|---|-------------------------|-----|-----|--------------------------|-----|-----|-----------------------|-----|-----|-----------------------|-----|----|---|
|   | mean                    | SD  | No  | mean                     | SD  | No  | mean                  | SD  | No  | mean                  | SD  | No |   |
| 1   | 50.7                    | 3.3 | 361 | 53.1                     | 3.3 | 586 | 55.3                  | 2.5 | 183 | 53.4                  | 2.6 | 58 | 6.2                                     |
| 2   | 63.6                    | 2.4 | 409 | 65.2                     | 2.5 | 740 | 66.5                  | 2.4 | 312 | 65.4                  | 2.1 | 18 | 3.8                                     |
| 3   | 71.8                    | 2.0 | 992 | 72.5                     | 2.1 | 907 | 73.0                  | 2.4 | 506 | 73.2                  | 1.9 | 60 | 2.9                                     |
| 4   | 76.9                    | 1.8 | 19  | 76.9                     | 1.9 | 7   | 76.8                  | 2.4 | 4   | 78.2                  | 1.7 | 1  | 2.4                                     |
| 5   | 80.1                    | 1.7 | 23  | 79.5                     | 1.8 | 4   | 79.0                  | 2.3 | 2   | 81.4                  | 0.0 | 0  | 2.1                                     |
| Mean weighted<br>CV across age<br>classes | 3.4                     |     |     | 3.9                      |     |     | 3.6                   |     |     | 3.5                   |     |    |   |

## Discussion and Conclusions

Troll caught albacore sampled in the 2000–01 fishing year from the landings of New Zealand troll vessels ranged in size from 40–99 cm fork length, with nearly all of the fish in the 46–78 cm range (mean 65.2 cm). As albacore reach sexual maturity at about 85 cm, almost all of these fish are juveniles.

Albacore sampled over a five year period from 1996–97 to 2000–01 are mostly in the 47–81 cm size range, with an average fork length of 63.9 cm. The size distribution varies over the five year period, with more small fish in 1998–99, one predominant mode in 1999–00, and a greater proportion of large fish in 2000–01.



Age classes tended to increase by about 1 cm each month during the sampling period, and that is similar to the growth rate seen in length-frequency analysis of South Pacific albacore carried out by Labelle *et al.* (1993).

New Zealand longline fisheries caught adult and sub-adult albacore, with a mean of 83.6 cm, mostly in the 59–105 cm size range, as shown by data in this report, and reported by Murray *et al.* (1999).

A significant linear relationship was found between albacore fork length and greenweight ( $R^2=0.94$ ). The length:weight relationships showed similar slopes and intercepts for fish sampled over a three year period, and for troll and longline caught fish.

Average fork lengths of fish sampled from the catch of troll vessels from the U.S.A. fishing in the STCZ varied from 63 cm in 1992–93 to 74 cm in 1990–91 over a nine year sampling period. In most years, most of these fish were greater than 60 cm long (Childers and Coan 1996). It has been previously noted (Labelle 1993) that STCZ albacore tend to larger than those around New Zealand, and this study further supports this, and reinforces the importance of monitoring the catch composition of juvenile albacore stocks in New Zealand, one of the major albacore fisheries, for stock assessment.

## Acknowledgments

Thanks to NIWA staff in Greymouth and Auckland who carried out the sampling, licensed fish receiver companies who permitted us to sample fish in their sheds, and to the fishers who caught the albacore and co-operated with our sampling requirements.

The 1996–97 and 1997–98 troll data were sampled for the Pacific Community. The longline data were collected by observers from the Ministry of Fisheries Scientific Observer Programme, and extracted from the *l\_line* database.

This work was funded by Ministry of Fisheries project TUN2000/01.

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Figure 2: Albacore length frequency distributions, Greymouth 2001

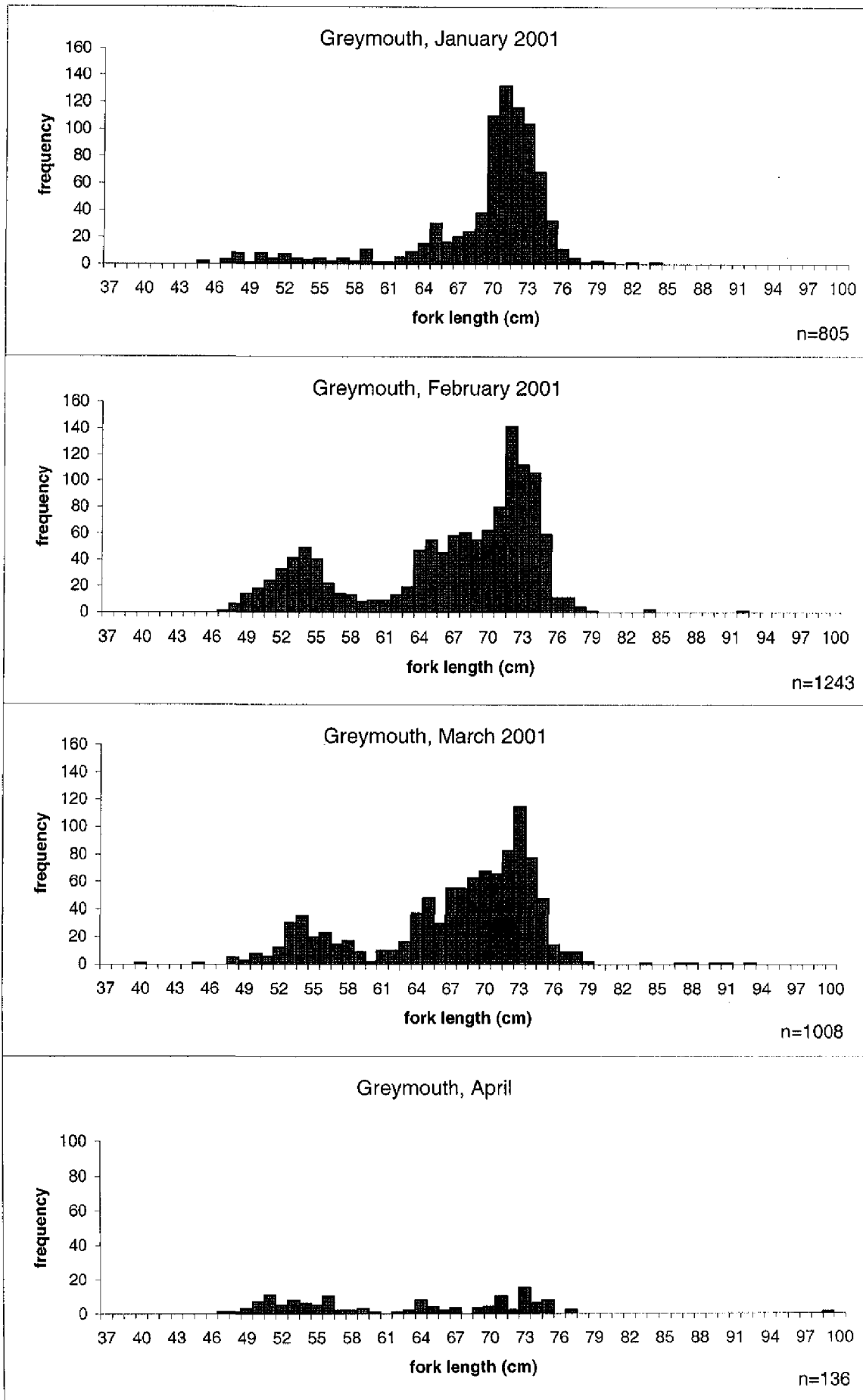


Figure 3: Albacore length frequency distributions, Auckland 2001

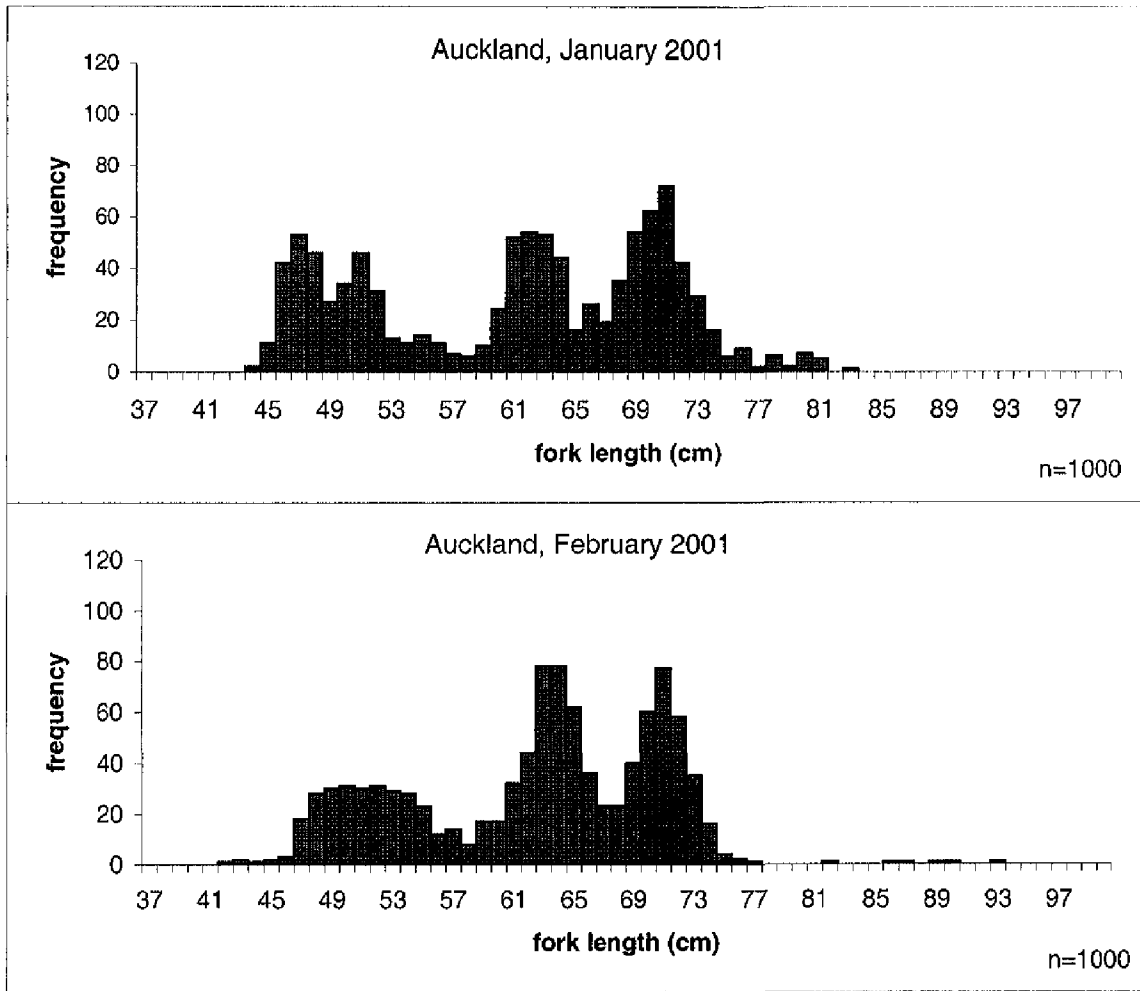


Figure 1. Length frequency distributions for five years of fish sampling from 1997 to 2001.

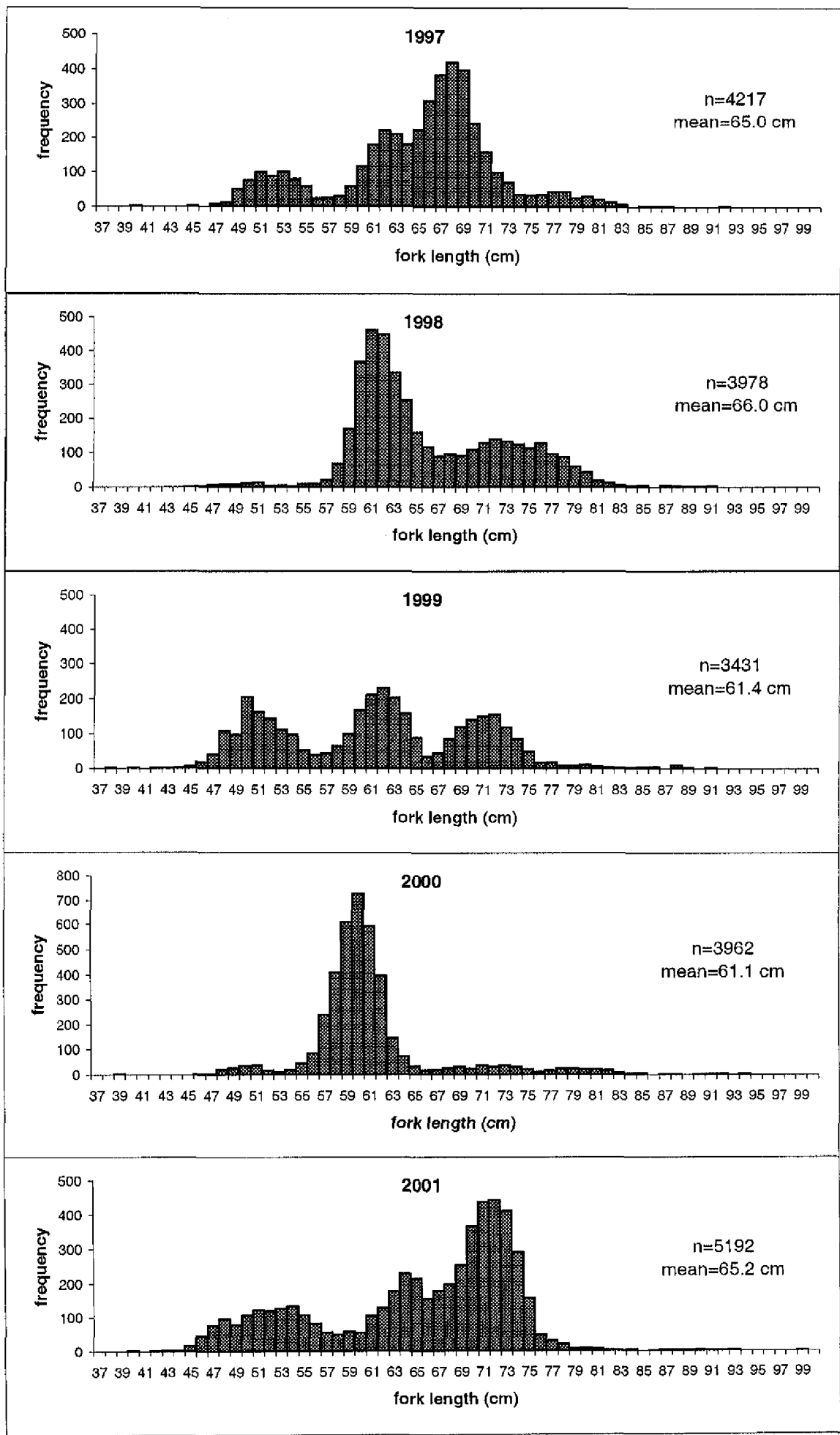


Figure 5: Length frequency distribution for troll and longline caught albacore

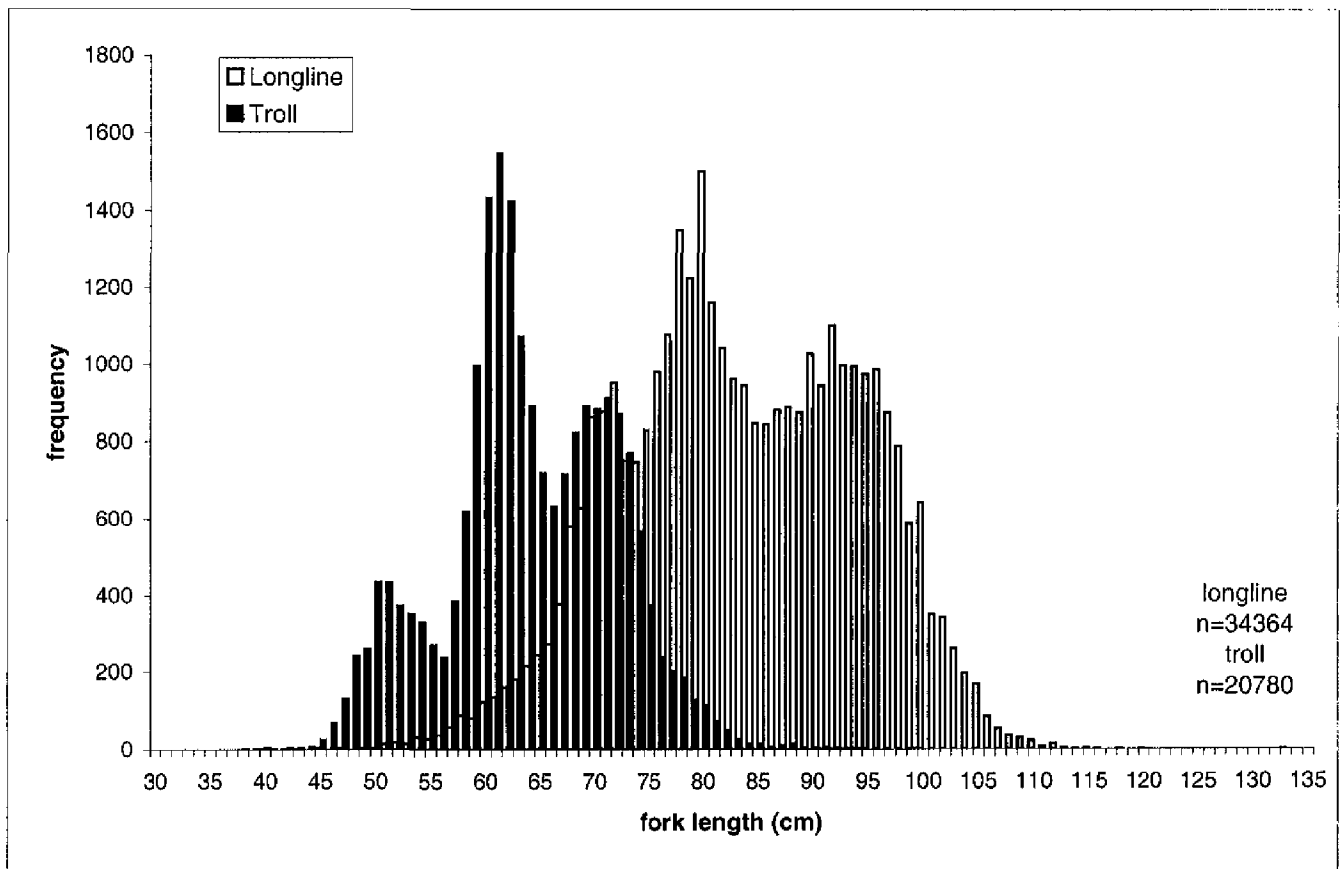


Figure 6: length:weight relationship for troll caught albacore sampled in the 2000-01 season

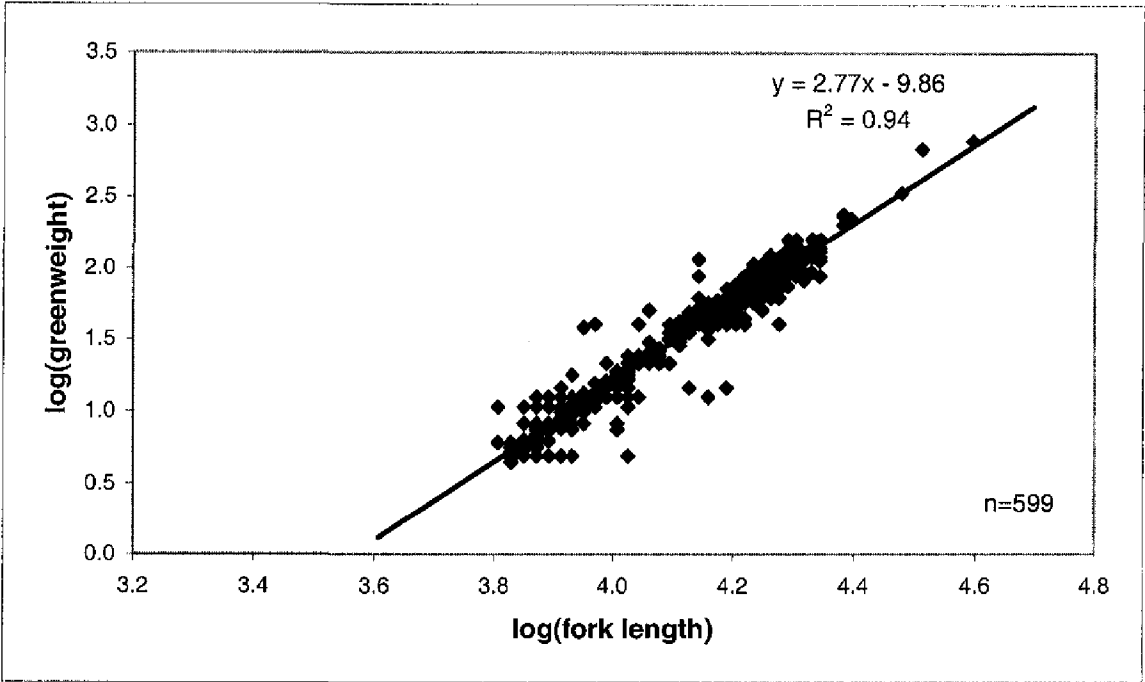


Figure 7: length:weight relationship for troll caught albacore sampled in 1999-2001

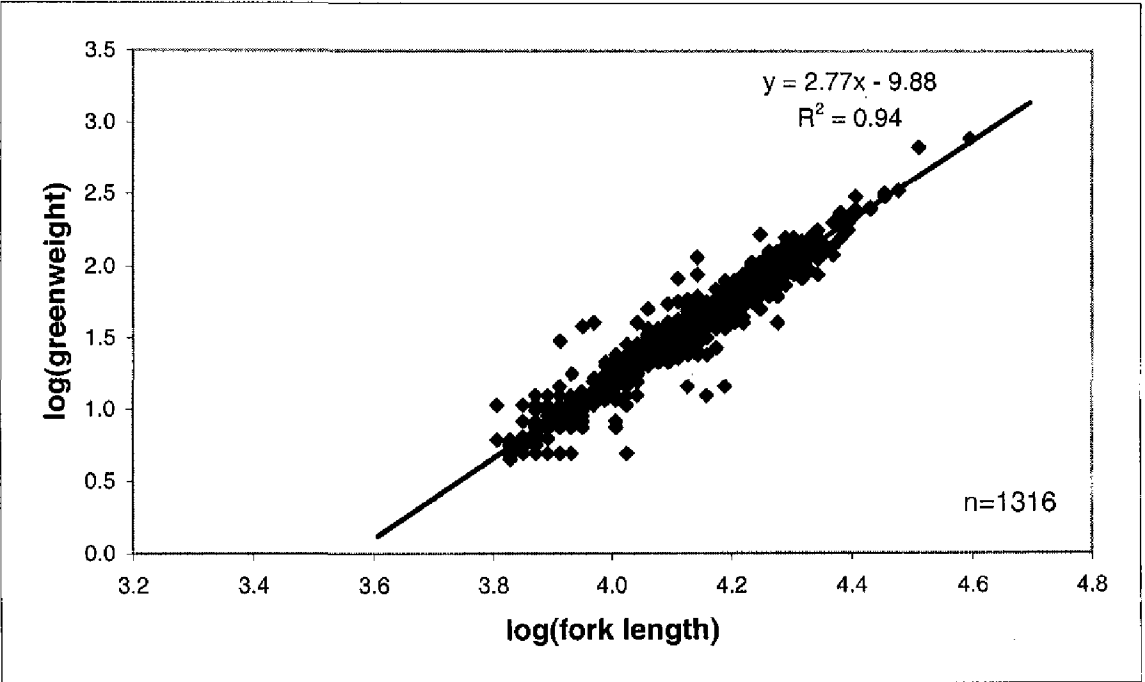
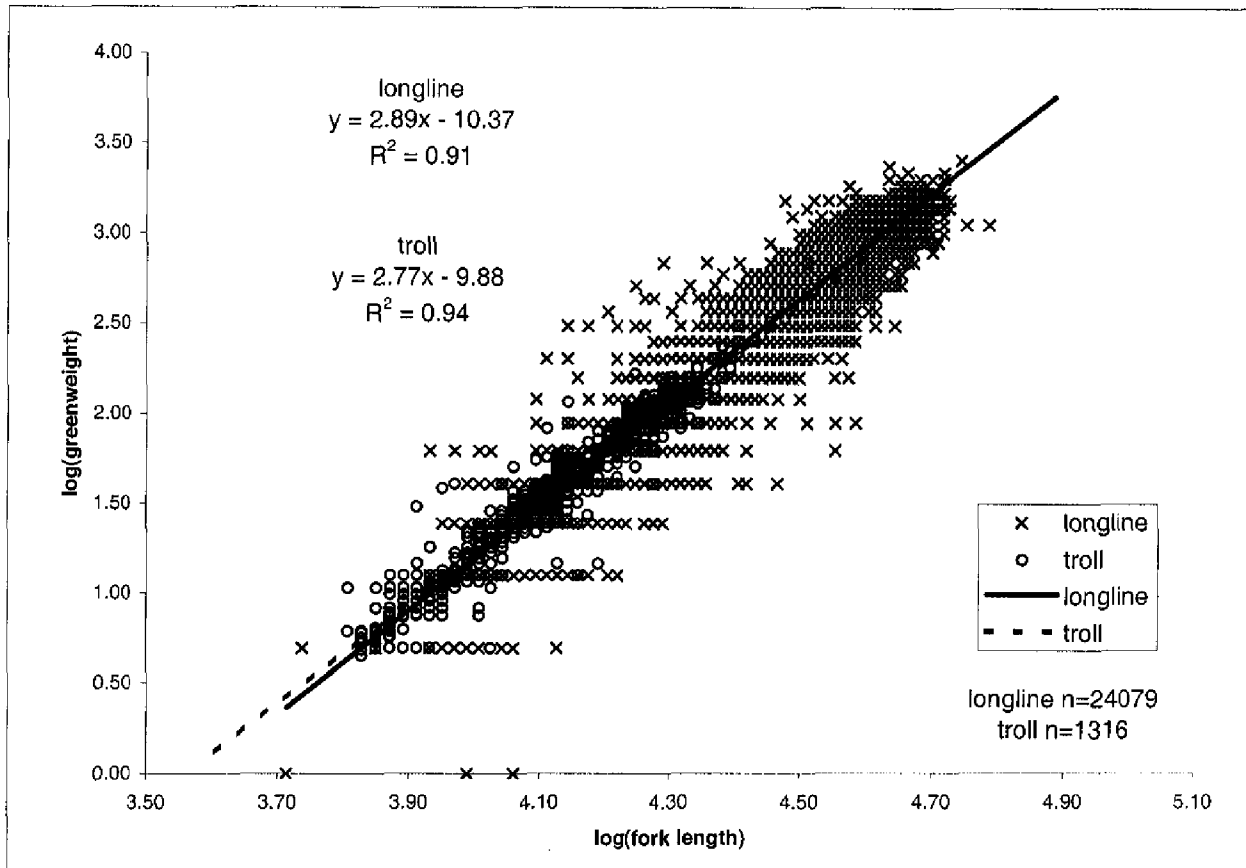


Figure 8: length:weight relationship for troll and longline caught albacore





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**Lynda Griggs and Talbot Murray**

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Albacore tuna caught by trolling in New Zealand waters during the 2000–01 fishing season were sampled in fish sheds to determine the length composition and length-weight relationship.

Albacore sampled in the 2000–01 fishing year had a mean fork length of 65.2 cm, and ranged in size from 40–99 cm, with nearly all fish (99%) in the 46–78 cm range. Length:weight relationships are determined. Log of fork length plotted against log of green weight produced a significant linear relationship ( $R^2=0.94$ ).

Nearly all of the albacore sampled in the troll fishery over a five year period from 1996–97 to 2000–01 are in the 47–81 cm size range (99%), with a mean fork length of 63.9 cm. Data are presented for the troll catch in comparison with the New Zealand observed longline catch of albacore. Longline caught albacore are larger, with an average fork length of 83.6 cm, and most fish (99%) are in the 59–105 cm size range.

Albacore caught by trolling around the New Zealand coast tend to be smaller than those caught by troll vessels from U.S.A. fishing in the sub-tropical convergence zone, the only other surface fishery for the South Pacific albacore stock. Fish caught by longline throughout the South Pacific are all larger sub-adult and adult fish. This study reinforces the importance of continuing to monitor the catch composition of juvenile albacore stocks in New Zealand as an important input to the regional stock assessment of albacore.

cm size range. The sex of troll caught albacore was determined by microscopic examination. The sex ratio was found to not differ significantly from a 1:1 ratio, in both troll and longline caught fish. A linear relationship was found between albacore fork length and greenweight with  $R^2=0.95$ . The length:weight relationships showed similar slopes and intercepts for males and females, and for troll and longline caught fish (Griggs and Murray 2000).

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Mean length, standard deviation, minimum and maximum lengths and percentiles are compared for troll and longline caught fish in Table 2.

Table 1: Summary of mean fork length, standard deviation, median and percentiles for albacore sampled during the 2000–01 season.

|          | Greymouth<br>Jan 2001 | Greymouth<br>Feb 2001 | Greymouth<br>Mar 2001 | Greymouth<br>Apr 2001 | Auckland<br>Jan 2001 | Auckland<br>Feb 2001 | Greymouth<br>data<br>combined | Auckland<br>data<br>combined | All<br>2001 data<br>combined |
|----------|-----------------------|-----------------------|-----------------------|-----------------------|----------------------|----------------------|-------------------------------|------------------------------|------------------------------|
| n        | 805                   | 1243                  | 1008                  | 136                   | 1000                 | 1000                 | 3192                          | 2000                         | 5192                         |
| mean     | 69.5                  | 66.4                  | 67.4                  | 62.4                  | 61.2                 | 62.5                 | 67.3                          | 61.9                         | 65.2                         |
| std dev. | 5.8                   | 7.9                   | 7.3                   | 9.8                   | 9.5                  | 8.2                  | 7.5                           | 8.9                          | 8.5                          |
| min      | 45                    | 47                    | 40                    | 47                    | 44                   | 42                   | 40                            | 42                           | 40                           |
| 1%       | 48                    | 49                    | 50                    | 48                    | 45                   | 47                   | 49                            | 46                           | 46                           |
| 5%       | 55                    | 51                    | 53                    | 50                    | 46                   | 48                   | 52                            | 47                           | 49                           |
| median   | 71                    | 69                    | 69                    | 64                    | 63                   | 64                   | 70                            | 63                           | 68                           |
| 95%      | 75                    | 75                    | 75                    | 75                    | 74                   | 73                   | 75                            | 73                           | 75                           |
| 99%      | 77                    | 77                    | 78                    | 77                    | 80                   | 75                   | 77                            | 79                           | 78                           |
| max      | 84                    | 92                    | 93                    | 99                    | 83                   | 93                   | 99                            | 93                           | 99                           |

Table 2: Summary of mean fork length, standard deviation, median and percentiles for albacore sampled during the five years of troll sampling, and albacore caught by longline.

|          | 1997 data<br>combined | 1998 data<br>combined | 1999 data<br>combined | 2000 data<br>combined | 2001 data<br>combined | Troll data,<br>1996-97 to<br>2000-01 | Longline<br>data 1987-<br>2000 |
|----------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|--------------------------------------|--------------------------------|
| n        | 4217                  | 3978                  | 3431                  | 3962                  | 5192                  | 20780                                | 34364                          |
| mean     | 65.0                  | 66.0                  | 61.4                  | 61.1                  | 65.2                  | 63.9                                 | 83.6                           |
| std dev. | 6.9                   | 6.7                   | 8.7                   | 5.6                   | 8.5                   | 7.7                                  | 10.8                           |
| min      | 40                    | 45                    | 38                    | 39                    | 40                    | 38                                   | 40                             |
| 1%       | 49                    | 51                    | 47                    | 49                    | 46                    | 47                                   | 59                             |
| 5%       | 51                    | 59                    | 48                    | 55                    | 49                    | 50                                   | 67                             |
| median   | 66                    | 64                    | 62                    | 60                    | 68                    | 63                                   | 83                             |
| 95%      | 76                    | 78                    | 74                    | 74                    | 75                    | 76                                   | 100                            |
| 99%      | 81                    | 81                    | 81                    | 81                    | 78                    | 81                                   | 105                            |
| max      | 92                    | 91                    | 91                    | 94                    | 99                    | 99                                   | 133                            |

and mean length ( $\hat{X}_j$ )

$$\hat{X}_j = \sum_i n_{ij} \bar{X}_{ij} / \sum_i n_{ij}$$

where  $\bar{X}_{ij}$  = mean length in age class  $i$  in month  $j$ ;  $\sigma_{ij}$  = standard deviation in age class  $i$  in month  $j$ ; and  $n_{ij}$  = number of albacore sampled in age class  $i$  in month  $j$ .

The CV across all size classes is then:

$$CV_i = \sigma_j / \hat{X}_j * 100$$

The mean weighted CV across months for each age class ( $CV_i$ ) was similarly estimated by summing across months  $j$ .

Table 4: summary statistics for the four age classes in 2001 and mean weighted CV's

| age                                       | Month 1<br>January 2001 |     |     | Month 2<br>February 2001 |     |     | Month 3<br>March 2001 |     |     | Month 4<br>April 2001 |     |    | Mean weighted CV<br>across months |
|---|-------------------------|-----|-----|--------------------------|-----|-----|-----------------------|-----|-----|-----------------------|-----|----|-----------------------------------|
|   | mean                    | SD  | No  | mean                     | SD  | No  | mean                  | SD  | No  | mean                  | SD  | No | CV                                |
| 1   | 50.7                    | 3.3 | 361 | 53.1                     | 3.3 | 586 | 55.3                  | 2.5 | 183 | 53.4                  | 2.6 | 58 | 6.2                               |
| 2   | 63.6                    | 2.4 | 409 | 65.2                     | 2.5 | 740 | 66.5                  | 2.4 | 312 | 65.4                  | 2.1 | 18 | 3.8                               |
| 3   | 71.8                    | 2.0 | 992 | 72.5                     | 2.1 | 907 | 73.0                  | 2.4 | 506 | 73.2                  | 1.9 | 60 | 2.9                               |
| 4   | 76.9                    | 1.8 | 19  | 76.9                     | 1.9 | 7   | 76.8                  | 2.4 | 4   | 78.2                  | 1.7 | 1  | 2.4                               |
| 5   | 80.1                    | 1.7 | 23  | 79.5                     | 1.8 | 4   | 79.0                  | 2.3 | 2   | 81.4                  | 0.0 | 0  | 2.1                               |
| Mean weighted<br>CV across age<br>classes | 3.4                     |     |     | 3.9                      |     |     | 3.6                   |     |     | 3.5                   |     |    |                                   |

## Discussion and Conclusions

Troll caught albacore sampled in the 2000–01 fishing year from the landings of New Zealand troll vessels ranged in size from 40–99 cm fork length, with nearly all of the fish in the 46–78 cm range (mean 65.2 cm). As albacore reach sexual maturity at about 85 cm, almost all of these fish are juveniles.

Albacore sampled over a five year period from 1996–97 to 2000–01 are mostly in the 47–81 cm size range, with an average fork length of 63.9 cm. The size distribution varies over the five year period, with more small fish in 1998–99, one predominant mode in 1999–00, and a greater proportion of large fish in 2000–01.

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Labelle, M., Hampton, J., Bailey, K., Murray, T., Fournier, D.A., & Sibert, J.R., 1993: Determination of age and growth of South Pacific albacore (*Thunnus alalunga*) using three methodologies. *Fishery Bulletin* 91: 649-663.

Murray, T., 1994: A review of the biology and fisheries for albacore *Thunnus alalunga*, in the South Pacific ocean. *In* Interactions of Pacific tuna fisheries. *Edited by* S. Shomura, J. Majkowski, and S.Langi. FAO Fisheries Technical Paper 336/2. p188–206.

Murray, T., Richardson, K., Dean, H. & Griggs, L. 1999. New Zealand tuna fisheries with reference to stock status and swordfish bycatch (Report prepared for the New Zealand Ministry of Fisheries, June 1999.) 126 p.

Murray, T., Richardson, K., Dean, H., & Griggs, L. 2000: National Tuna Fishery Report 2000 – New Zealand. SCTB13 Working Paper, 13th Meeting of the Standing Committee on Tuna and Billfish, New Caledonia, 5–12 July 2000.

Figure 3: Albacore length frequency distributions, Auckland 2001

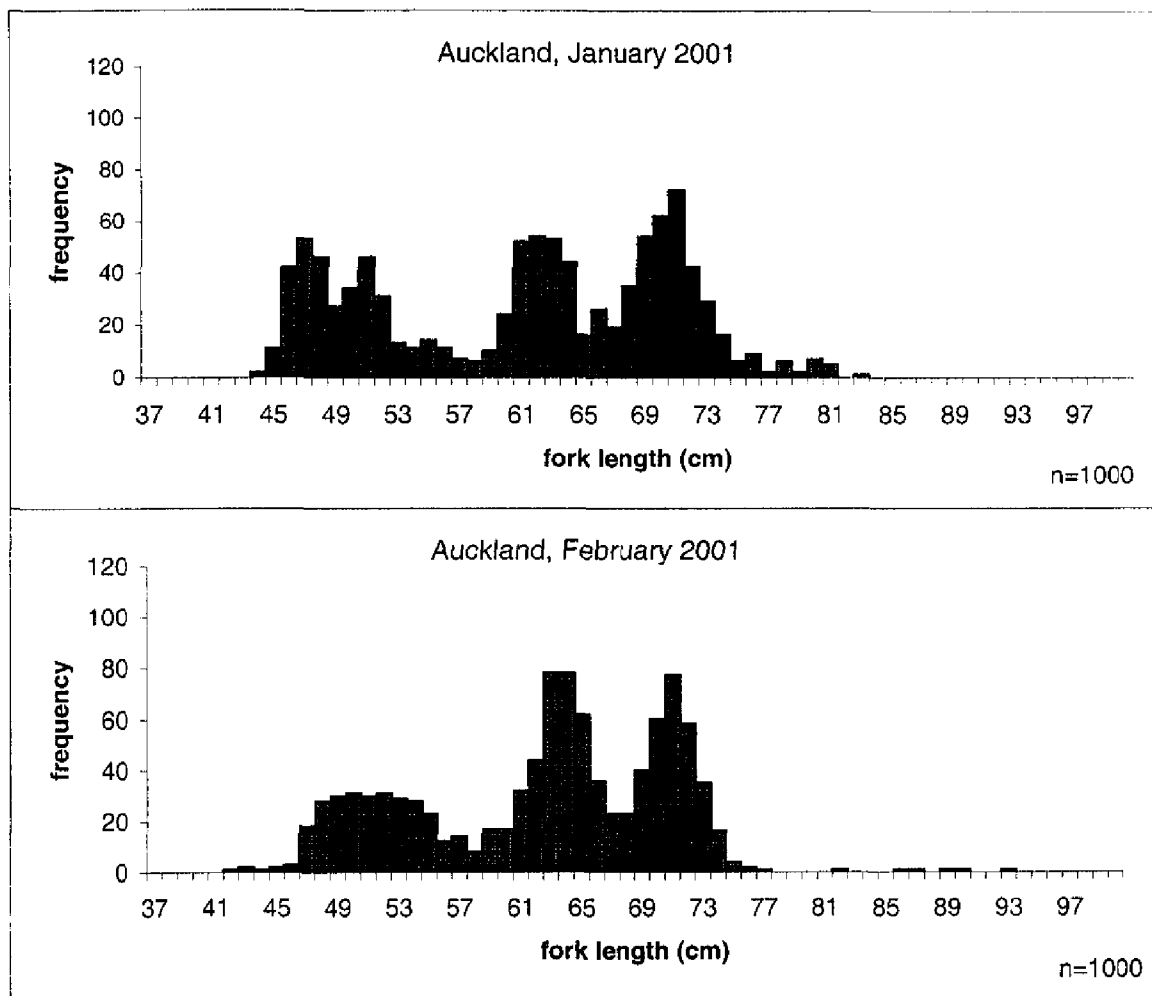


Figure 5: Length frequency distribution for troll and longline caught albacore

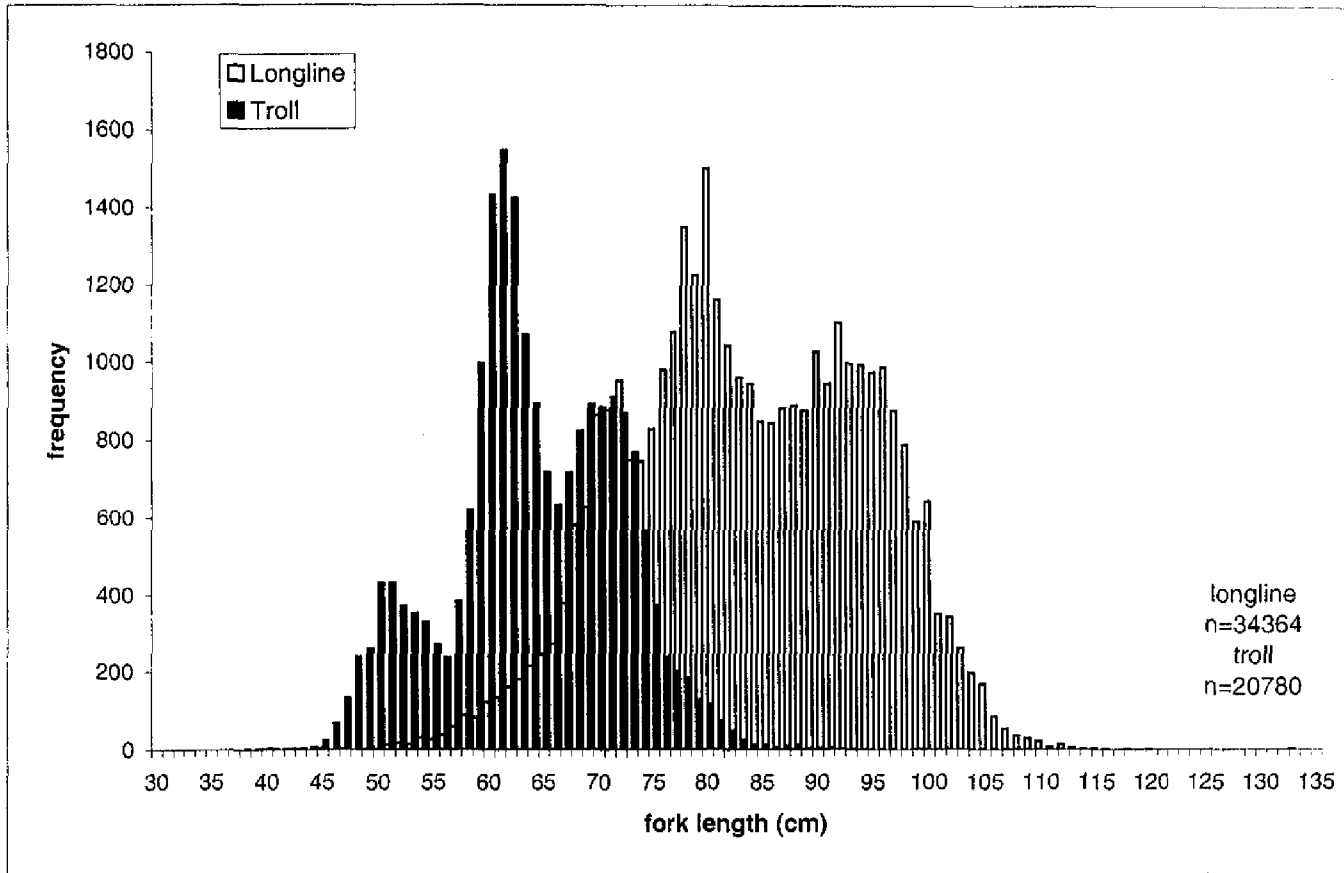


Figure 8: length:weight relationship for troll and longline caught albacore

