



**Monitoring the length structure of commercial
landings of albacore tuna during the 2001–2002
fishing year**

Lynda Griggs

**Final Research Report for
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Objective 1**

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- Author:** Lynda Griggs
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 - 5. Project Leader** Lynda Griggs
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 - 7. Executive summary**

Albacore tuna caught by trolling in New Zealand waters during the 2001–02 fishing season were sampled in fish sheds to determine the length composition and length-weight relationship. Albacore had a mean fork length of 63.6 cm, and ranged in size from 42–89 cm, with nearly all fish (99%) in the 47–83 cm range. Length:weight relationships are determined. Log of fork length plotted against log of green weight produced a significant linear relationship ($R^2=0.95$).

Nearly all of the albacore sampled in the troll fishery over a six-year period from 1996–97 to 2001–02 are in the 47–82 cm size range (99%), with a mean fork length of 63.8 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 82.6 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 the 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. 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 fishery catches up to half of the total removals of juveniles from this stock and is one of only a few target fisheries for this stock. Failure to monitor size composition in this stock would appreciably increase uncertainty of stock assessments.

8. Objectives

OVERALL OBJECTIVE:

To determine the length composition of the commercial catch of albacore (*Thunnus alalunga*) in the New Zealand EEZ to support the stock assessment of the wider south Pacific stock.

SPECIFIC OBJECTIVES:

1. To conduct sampling in fish sheds and determine and report the length composition and length-weight relationships of albacore tuna during the 2001/2002 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).
2. To conduct sampling in fish sheds and determine and report the length composition and length-weight relationships of albacore tuna during the 2002/2003 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).

9. Methods

See attached report.

10. Results

See attached report.

11. Discussion and Conclusions

See attached report.

12. Publications

Nil.

13. Data Storage

Data used for the 2001–02 fishing year are stored in the Empress *l_line* database maintained by NIWA.

Introduction

Albacore tuna (*Thunnus alalunga*) caught in the New Zealand exclusive economic zone (EEZ) are part of a single South Pacific Ocean stock that ranges from the equator to about 45° S (Murray 1994). 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).

A 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). 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.

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).

The size composition, sex ratio, and length:weight relationship of albacore caught by troll in New Zealand have previously been investigated (Griggs and Murray 2000, 2001a, 2001b). Fish sampled in the 2000–01 season, mostly juveniles, ranged in size from 40–99 cm fork length, with nearly all of the fish in the 46–78 cm range, and a mean of 65.2 cm. A log–linear relationship was found between albacore fork length and greenweight. Griggs and Murray (2000) previously found that the sex ratio was not different from a 1:1 ratio.

The objectives of the present study are as follows:

OVERALL OBJECTIVE:

To determine the length composition of the commercial catch of albacore (*Thunnus alalunga*) in the New Zealand EEZ to support the stock assessment of the wider south Pacific stock.

SPECIFIC OBJECTIVES:

1. To conduct sampling in fish sheds and determine and report the length composition and length-weight relationships of albacore tuna during the 2001/2002 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).
2. To conduct sampling in fish sheds and determine and report the length composition and length-weight relationships of albacore tuna during the 2002/2003 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 Projects TUN9801 (Objective 4) and TUN2000/01.

Methods

Characterisation of the size composition of the fishery requires regular sampling through the season (December–May) and should take account of any differences in size composition between areas and between boats.

Two ports were sampled: Onehunga (in Auckland) and Greymouth, from December 2001/ January 2002 to April/May 2002. Where possible, fish were sampled from at least 5 vessel unloadings per month and fish were selected at random from each unloading. At least 1000 fork lengths were measured in each port, each month, and at least 100 of these fish were sub-sampled for weight.

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 recorded to the nearest 0.1 kg.

Results

During the 2001–02 fishing season, a total of 5170 fish were sampled, 3770 landed in Greymouth and 1400 landed in Auckland. In Auckland, fish were sampled during January and February, from 5 boats in January and two separate landings from one boat in February. The season ended in the northern region by the end of February. In Greymouth, fish were sampled from 6 boats each month in January, February, March and April. The season ended in this region by the end of April.

The area fished out of Greymouth extended from New Plymouth, south to latitude $43^{\circ}57' S$ and longitude $168^{\circ}37' E$ on the west coast of the South Island. The area fished in the north was from $36^{\circ}05' S$ and longitude $172^{\circ}40' E$, south to New Plymouth.

Weights were recorded for 606 fish, 406 from Greymouth and 200 from Auckland.

Size composition

Figures 1 and 2 show the length frequency distribution by month, for albacore sampled from troll vessels in the 2001–02 season, in Greymouth and in Auckland respectively. Fish sampled ranged in size from 42 cm to 89 cm, with almost all of the fish (99%) in the 47–83 cm range. The overall mean fork length was 63.6 cm. The distributions of the fish sampled in Greymouth were different from those sampled in Auckland, but the mean lengths were the same in both areas, 63.6 cm.

Table 1 shows mean length, standard deviation, minimum and maximum lengths and percentiles for each month sampled in the 2001–02 season, and for Greymouth combined and Auckland combined.

Table 2 shows these parameters for each of the fishing years sampled from 1996–97 to 2001–02, while figure 3 shows length frequency distributions for each of these years, with all months and both areas combined. In this six-year period, fork length of troll caught albacore ranged from 38 cm to 99 cm, with nearly all of the fish (99%) in the 47–82 cm range, and the mean was 63.8 cm (Table 2). Three modes are visible in most months of the years sampled. These modes tended to increase by about 1 cm each month during the sampling period. There were more smaller fish (< 55 cm) in 1998–99 than in any of the other years. There was one dominant 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. More smaller fish are seen again in 2001–02, with the peak of the largest mode at 62 cm, and the mean for this year (63.6) is close to the overall mean for the six years (63.8 cm).

Figure 4 shows length distributions of troll and longline caught albacore. Troll caught albacore are from 6 years sampling combined (1996–97 to 2001–02). 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 1987–2001. The length distribution of fish caught over the same time period as the troll data (i.e., 1997–2001) was very similar to that of the 1987–2001 data, so the larger data set was used. Albacore caught in New Zealand by longline are

larger (mean fork length 82.6 cm) than troll caught fish (Table 2), 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 2001–02 season.

	Greymouth Jan 2002	Greymouth Feb 2002	Greymouth Mar 2002	Greymouth Apr 2002	Auckland Jan 2002	Auckland Feb 2002	Greymouth data combined	Auckland data combined	All 2002 data combined
n	1112	1015	1059	584	1000	400	3770	1400	5170
mean	63.80	64.60	63.06	62.51	65.67	58.50	63.61	63.62	63.61
std dev.	7.99	9.12	7.48	7.12	10.21	6.05	8.08	9.76	8.57
min	48	43	49	42	43	47	42	43	42
1%	49	49	51	51	45	48	50	45	47
5%	51	51	53	52	47	49	52	48	51
median	62	63	63	63	62	59	63	61	62
95%	80	81	79	77	80	71	80	79	80
99%	84	85	83	82	81	79	83	81	83
max	88	87	88	89	83	82	89	83	89

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

	1997 data combined	1998 data combined	1999 data combined	2000 data combined	2001 data combined	2002 data combined	Troll data, 1996–97 to 2001–02	Longline data 1987–2001
n	4217	3978	3431	3962	5192	5170	25950	42792
mean	65.0	66.0	61.4	61.1	65.2	63.6	63.8	82.6
std dev.	6.9	6.7	8.7	5.6	8.5	8.6	7.9	10.8
min	40	45	38	39	40	42	38	38
1%	49	51	47	49	46	47	47	59
5%	51	59	48	55	49	51	50	67
median	66	64	62	60	68	62	63	82
95%	76	78	74	74	75	80	77	100
99%	81	81	81	81	78	83	82	105
max	92	91	91	94	99	89	99	133

Length:weight relationship

Figure 5 shows the length:weight relationship for albacore caught by troll during January-April 2002. Data are plotted as $\ln(\text{greenweight})$ versus $\ln(\text{fork length})$.

Figure 6 shows the length:weight relationship for albacore sampled over four fishing years, 1998–99 to 2001–02. Length:weight relationships for albacore caught by troll and longline are shown in Figure 7.

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_{b0}	b_1	SE_{b1}	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	2002	606	-9.69	0.10	2.73	0.02	0.95
troll	1999–2002	1922	-9.83	0.06	2.76	0.02	0.94
longline	1987–2001	31125	-10.32	0.02	2.88	0.00	0.92

Target coefficient of variation

This project specified that “The target coefficient of variation (CV) for the length composition is 30 % (mean weighted CV across all length classes).”

Mean weighted CVs of length frequency estimates were calculated with the original port sampling data analysed in 1 cm length classes. The mean weighted CV was calculated as the average of the CVs for the individual length classes weighted by the proportion of fish in each class. CVs are calculated by bootstrapping with fish re-sampled within each landing and landings re-sampled within each month. While the resulting CVs would be smaller if the size classes were aggregated, we have maintained the finer resolution of the original data because the purpose of the data is for inferring growth rate within a length-based age-structured model, MULTIFAN-CL (Fournier et al. 1998). The following mean weighted CVs were calculated using the ‘catch.at.age’ software developed by NIWA for the analysis of mean weighted CVs across length classes.

January	28.5%
February	21.6%
March	26.4%
April	66.1% (n=584 for this month)
All months pooled	15.5%

The target CV for this port sampling project of 30 % as a mean weighted CV across all length classes was realised in each month except April where the sample size was substantially less than 1000 fish.

Discussion and Conclusions

Troll caught albacore sampled in the 2001–02 fishing year from the landings of New Zealand troll vessels ranged in size from 42–89 cm fork length, with nearly all of the fish in the 47–83 cm range (mean 63.6 cm). As albacore reach sexual maturity at about 85 cm, almost all of these fish are juveniles.

Albacore sampled over a six-year period from 1996–97 to 2001–02 were mostly in the 47–82 cm size range, with an average fork length of 63.8 cm. The size distribution varied over the six-year period, with smaller fish in 1998–99, one dominant mode in 1999–00, and a greater proportion of large fish in 2000–01. There were more smaller fish in 2001–02 compared with 2000–01.

The modal length of 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 length of 82.6 cm, mostly in the 59–105 cm size range, as shown by data in this report, and reported by Murray et al. (1999) and Griggs and Murray (2000, 2001a, 2001b).

A significant log-linear relationship was found between albacore fork length and greenweight for troll caught fish sampled in 2001–02 ($R^2=0.95$). The length:weight relationships showed similar slopes and intercepts for fish sampled over a four-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 longer 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.

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 fishery catches up to half of the total removals of juveniles from this stock and is one of only a few target fisheries for this stock. Failure to monitor size composition in this stock would appreciably increase uncertainty of stock assessments.

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.

Thanks to Neville Phillips for assistance with catch-at-age software, and to Talbot Murray and Malcolm Francis for helpful comments on the manuscript.

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Figure 1: Albacore length frequency distributions, Greymouth 2002.

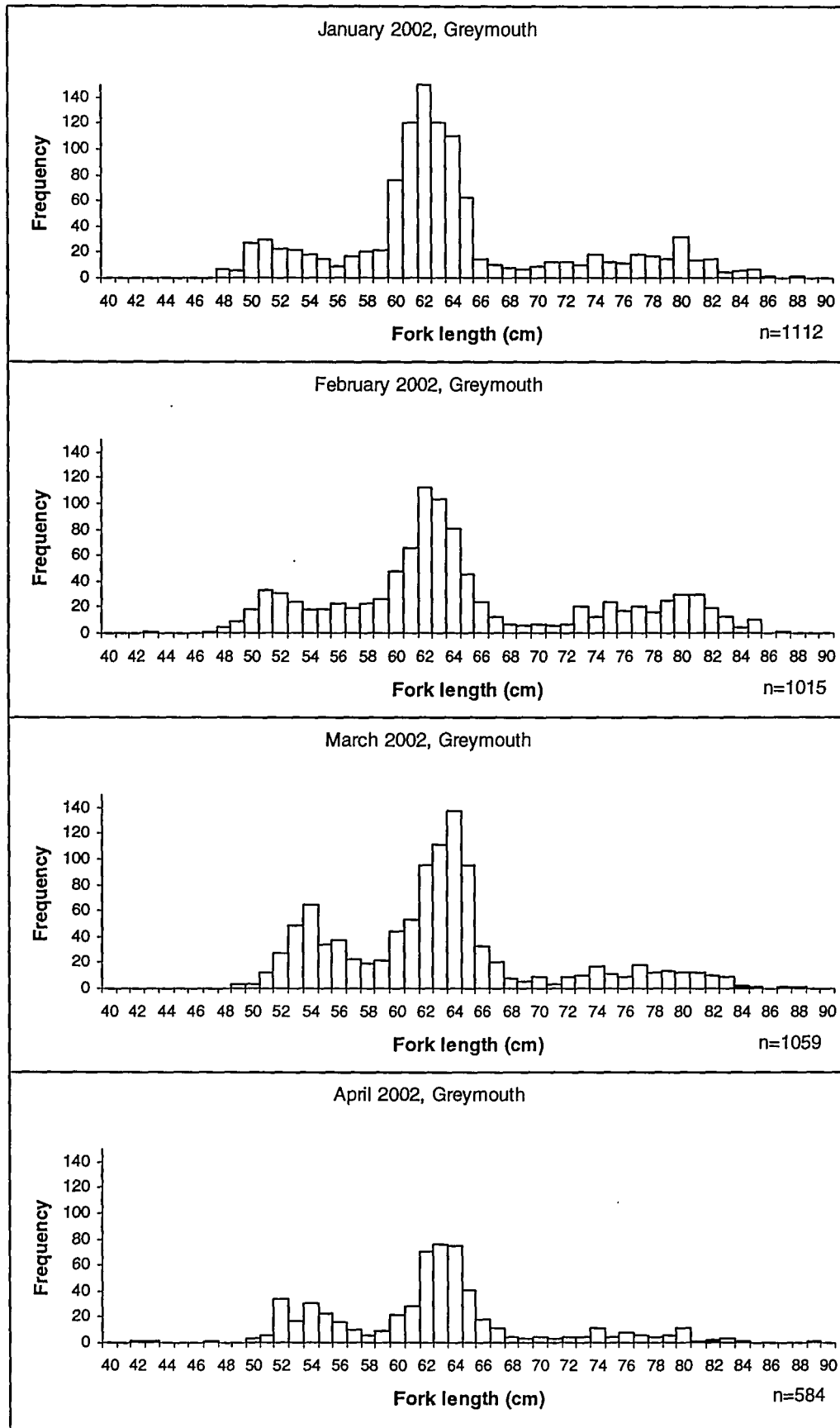


Figure 2: Albacore length frequency distributions, Auckland 2002.

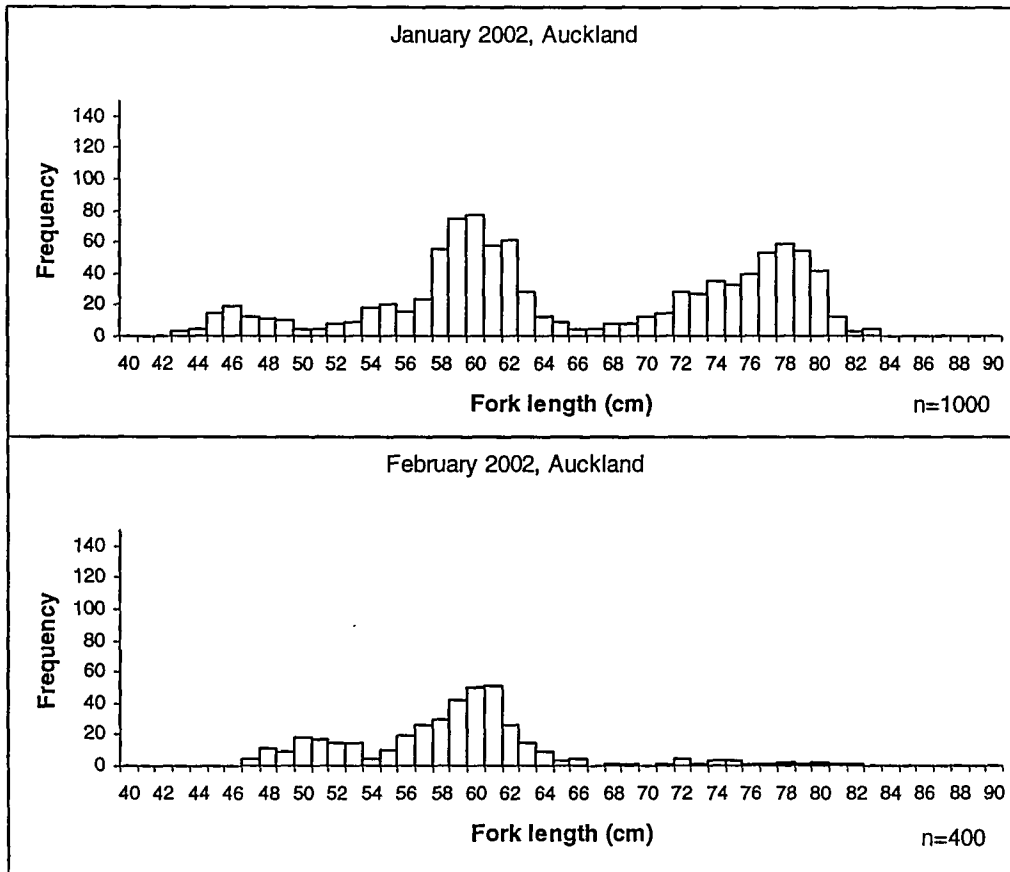


Figure 3: Length frequency distributions for six years of albacore troll sampling, 1996–97 to 2001–02, Greymouth and Auckland combined.

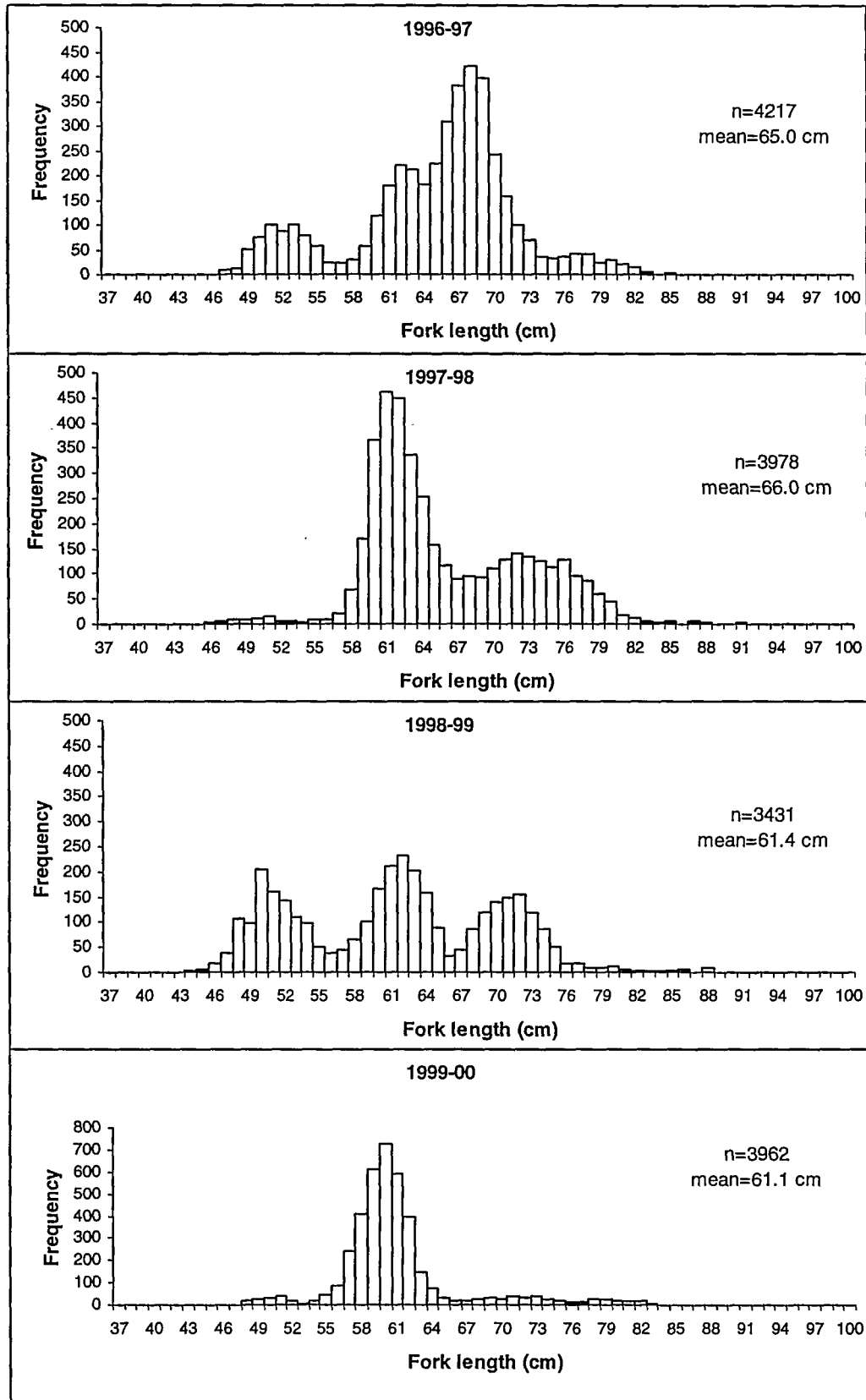


Figure 3: (continued)

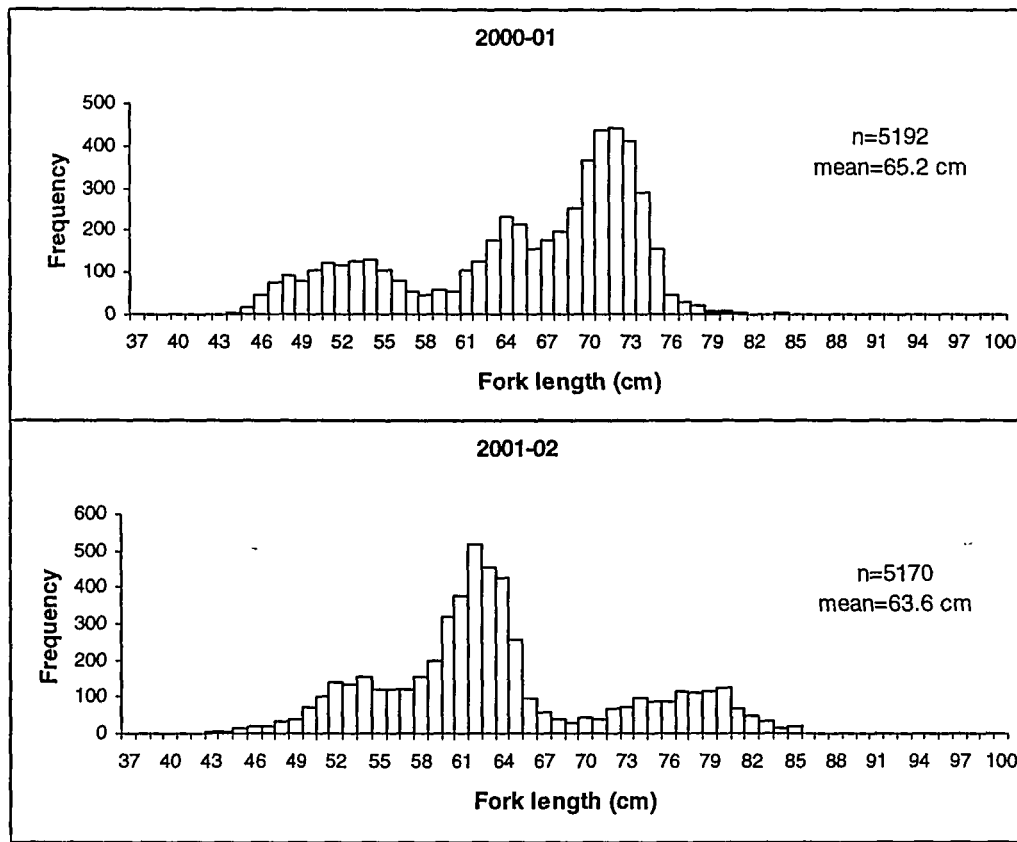


Figure 4: Length frequency distributions for troll and longline caught albacore.

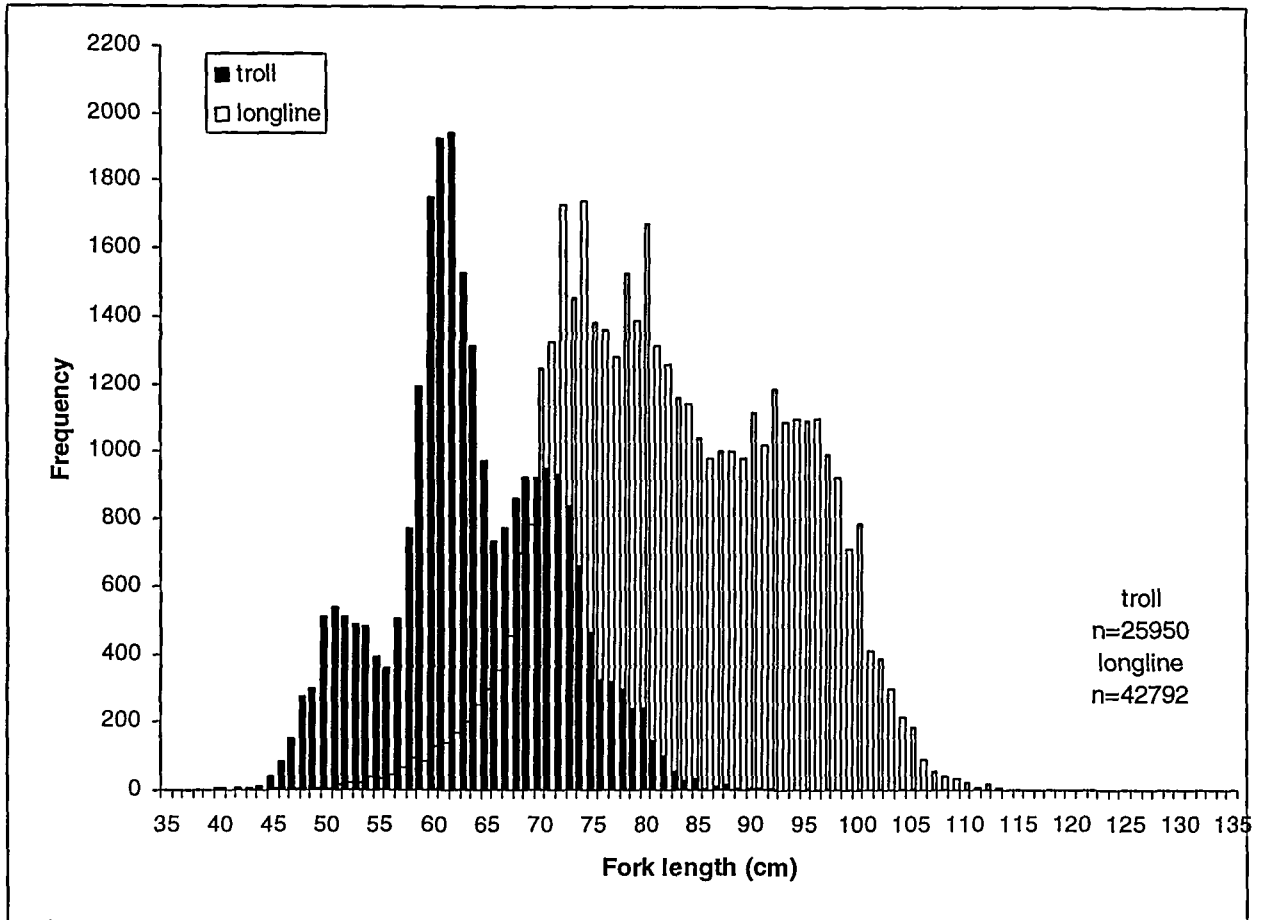


Figure 5: length:weight relationship for troll caught albacore sampled in the 2001–02 season.

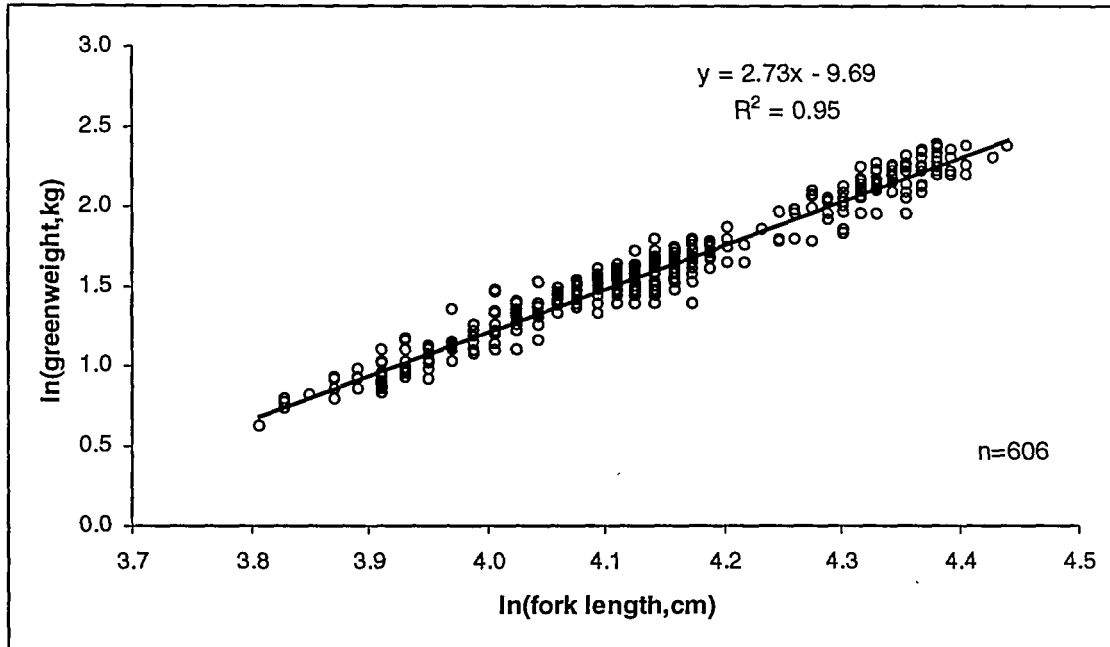


Figure 6: length:weight relationship for troll caught albacore sampled in 1998–99 to 2001–02.

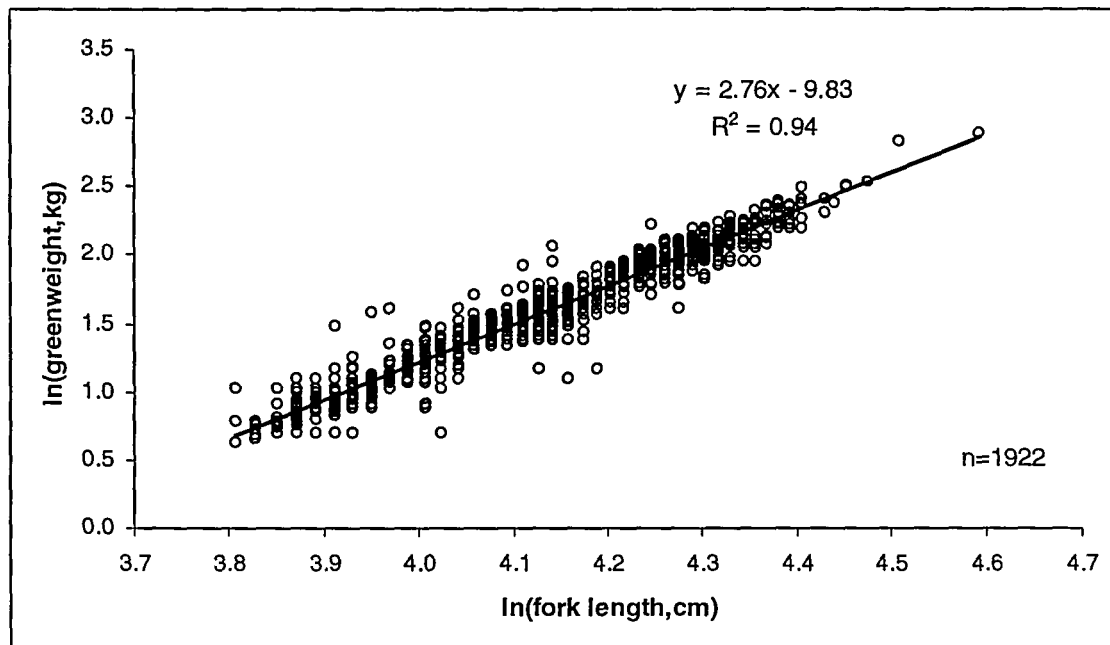


Figure 7: Length:weight relationship for troll and longline caught albacore.

