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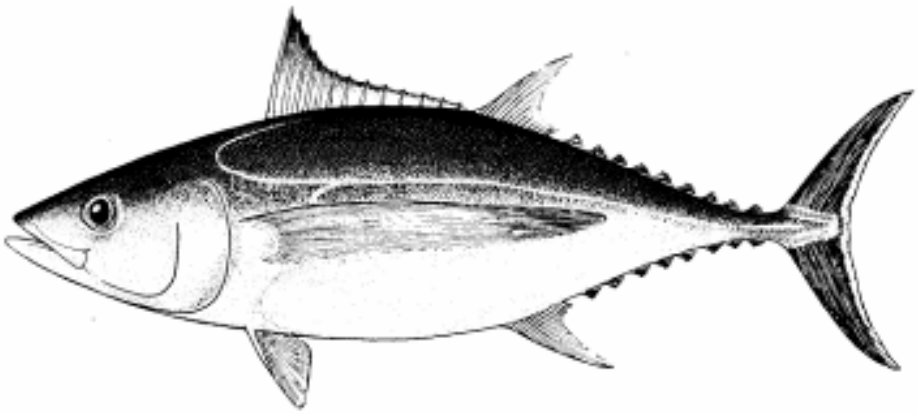
Catch monitoring of the New Zealand albacore troll fishery



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Abstract

Albacore tuna caught by trolling in New Zealand waters during the 2004–05 fishing season were sampled in fish sheds to determine the length frequency composition and length-weight relationship. This season albacore were sampled from two ports, Auckland and Greymouth. New Plymouth was not sampled as landings into this port were low this year.

Albacore sampled in the 2004–05 fishing year had a mean fork length of 66.5 cm, and ranged in size from 45–94 cm, with nearly all fish (99%) in the 52–80 cm range. Length:weight relationships were determined. Log of fork length plotted against log of green weight produced a significant linear relationship (R^2=0.96).

Nearly all of the albacore sampled in the troll fishery over an nine year period from 1996–97 to 2004–05 were in the 47–81 cm size range (99%), with a mean fork length of 63.7 cm. There is considerable variability in the size composition from year to year.

Size frequency of the troll catch is compared with the New Zealand observed longline catch of albacore. Longline caught albacore are larger, with an average fork length of 79.8 cm, and most fish (99%) in the 56–104 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.

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 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 mostly 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 (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. 39–41º S, 1000 n. miles east of New Zealand eastward to waters off South America. Landings from these vessels has fluctuated from 1986–87 to 1994–95 between 603 t and 2916 t, with no real trend (Childers and Coan 1996). From 1996–97 to 2000–01, U.S.A. catches in this region have ranged from 1241–2562 t (Ito *et al*. 2002). Canadian landings in this fishery from its inception in 1987–88 to 2000–01 are estimated to have ranged from 134 to 351 mt per season (Shaw & Stocker 2002). It has previously been noted (Labelle 1993) that STCZ albacore tend to be larger than those around New Zealand.

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, Griggs 2002a, 2002b, 2003a, 2003b, 2004a, 2004b). Fish sampled in the 2003–04 season, mostly juveniles, ranged in size from 40–94 cm fork length, with nearly all of the fish in the 47–76 cm range, and a mean of 64.3 cm (Griggs 2004a, 2004b). A significant linear relationship was found between albacore fork length and greenweight. Griggs and Murray (2000) previously found that the sex ratio was not statistically different from a 1:1 ratio.

The objective of the present study was to conduct sampling in fish sheds and determine and report the length composition and length-weight relationships of albacore tuna during the 2004/2005 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 sampling of albacore caught by troll vessels in New Zealand waters. This work is an extension to the sampling funded in 1996–97 and 1997–98 by the SPC, and 1998–99 to 2003–04 by the Ministry of Fisheries.

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: Auckland (port Onehunga, on the west coast) and Greymouth, from December/January to April/May. Fish were sampled from at least 5 vessel unloadings and 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 length and weight. New Plymouth was to be sampled as well but landings were low this year in this port.

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. Otoliths were collected from fish of fork length 50 cm or less.

Results

During the 2004–05 fishing season, a total of 5502 fish were sampled, 2431 landed in Auckland, and 3071 in Greymouth. In Auckland, fish were sampled from 5 boats in January 2004, 5 boats in February and 2 boats in March. The season ended in the northern region in mid March and this was the latest the season had run in this area in the nine years of sampling. In Greymouth, fish were sampled from 4 boats in late January when the season started, 6 boats in February, and 7 boats in March. The season ended in Greymouth in early April but no vessels could be sampled in April.

The area fished out of Greymouth extended from Pillar Point (near Cape Farewell) (40°30 S, 172°42 E) to the Waiho River mouth (43°17 S, 170°03 E) on the west coast of the South Island, while the area fished in the north was concentrated around the Auckland/Manukau area, but extended from North Cape (34°25′ S, 172°15′ E) to stat area 035, west of Kahurangi Point (approximately 41°15′ S, 171°00′ E) near the top of the South Island.

Weights were recorded for 400 fish, 100 from Auckland and 300 from Greymouth. Otoliths were collected from 58 fish, 50 from Auckland and 8 from Greymouth.

Size composition

Figures 1 and 2 show the length frequency distribution of fork length, by month, for albacore sampled from troll vessels in the 2004–05 season, in Auckland and Greymouth respectively. Fish sampled ranged in size from 45–94 cm, with nearly all fish (99%) in the 52–80 cm range. The overall mean fork length was 66.5 cm. The distributions of the fish sampled in the two ports and their mean lengths were different: 65.0 cm in Auckland, and 67.7 cm in Greymouth. There were very more small fish of less than 50 cm fork length this year than in the previous fishing season.

Table 1 shows mean length, standard deviation, minimum and maximum lengths and percentiles for each month for each port sampled in the 2004–05 season, and Table 2 shows the data for each port combined and for 2004–05 combined.

Table 3 summarises the length frequency statistics for the fishing years sampled from 1996–97 to 2004–05, while Figure 3 shows length frequency distributions for each of these years. In this 9 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 63.7 cm (Table 3). 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 is considerable variability in the distributions from year to year. In 1998–99 there was a large proportion of small fish (46–56 cm). There was one dominant mode centered around 60 cm in the fish sampled in the 1999–00 season. The greatest proportion of large fish (68–78 cm) were seen in the 2000–01 sample. In 2001–02, there were more small fish with the peak of the largest mode at 62 cm, and there were also a significant number of large fish (> 75 cm). The peak of the largest mode was at 61 cm in 2002–03, and there were few fish over 75 cm, more smaller fish (< 55 cm), and the lowest mean (60.9 cm) in the nine years sampled. In 2003–04 there were 2 prominent modes with peaks at 62 cm and 70 cm, few small fish (< 55 cm) and a large proportion of bigger fish, but few over 75cm. A large proportion of bigger fish were seen again in 2004–05. The distribution shows three modes with peaks at 53 cm, 62cm and the largest one at 70 cm, and the presence of both small fish (< 55 cm) and large fish (> 75 cm) (Figure 3).

Figure 4 shows length distributions of troll and longline caught albacore. Troll caught albacore are from 9 years sampling combined (1996–97 to 2004–05). The longline data (extracted from the *l_line* database), were collected by Ministry of Fisheries Observer Programme observers on New Zealand domestic and Japanese longliners, from 1987–2004. Albacore caught in New Zealand by longline are larger (mean fork length 79.8 cm) than troll caught fish, and are caught over a wider geographic area and in more months of the year (all year round). 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 3.

Length:weight relationship

Figure 5 shows the length:weight relationship for albacore sampled during January to March 2005. Data are plotted as ln(greenweight) vs. ln(fork length).

Figure 6 shows the length:weight relationship for albacore sampled over 7 fishing years, 1998–99 to 2004–05. Length:weight relationships for albacore caught by troll and longline are shown in Figure 7. Longline caught fish are measured by observers to the nearest kg, which is less precise than the troll caught fish (measured to the nearest 0.1 kg).

Table 4 summarises the linear regression parameters and their standard errors, for the following equation:

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

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:

Auckland, January 22.0%
Auckland, February 25.7%
Auckland, March 36.0% (n=400)
Greymouth, January 28.4%
Greymouth, February 21.8%
Greymouth, March 27.7%
Pooled 12.4%

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 for the March sample collected in Auckland at the end of the season where only 400 fish were measured.

Discussion and Conclusions

Troll caught albacore sampled in the 2004–05 fishing year from the landings of New Zealand troll vessels ranged in size from 45–94 cm fork length, with nearly all of the fish in the 52–80 cm range, and the mean length was 66.5 cm. As albacore reach sexual maturity at about 85 cm (Bailey 1991), almost all of these fish are juveniles.

Albacore sampled over a 9 year period from 1996–97 to 2004–05 are mostly in the 47–81 cm size range, with an average fork length of 63.7 cm. The size distribution varies over the 8 year period. There was a large proportion of small fish (46–56 cm) in 1998–99, one dominant mode centered around 60 cm in 1999–00, the greatest proportion of large fish (68–78 cm) in 2000–01, and more smaller fish (< 55 cm) in the 2002–03 season than in any of the other years. Few small fish and more larger fish are seen in the 2003–04 sample, while in 2004–05 there is a big proportion of large fish, and more small fish than seen the previous year.

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 79.8 cm, mostly in the 56–104 cm size range, as shown by data in this report, and reported by Murray *et al.* (1999) and Griggs and Murray (2000, 2001a, 2001b) and Griggs (2004a, 2004b).

A significant linear relationship was found between albacore fork length and greenweight for troll caught fish sampled in 2004–05 (R^2=0.96). The length:weight relationships showed similar slopes and intercepts for fish sampled over a 7 year period, and for troll and longline caught 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.

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 Secretariat of the Pacific Community. The longline data were collected by observers from the Ministry of Fisheries Observer Programme, and extracted from the *l_line* database. This work was funded by Ministry of Fisheries project ALB2003/01.

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Table 1: Summary of mean fork length, standard deviation, median and percentiles for albacore sampled each month during the 2004–05 season.

	Auckland Jan 2005	Auckland Feb 2005	Auckland Mar 2005	Greymouth Jan 2005	Greymouth Feb 2005	Greymouth Mar 2005
n	1000	1031	400	623	1200	1248
mean	66.7	64.2	62.8	68.9	68.7	66.1
std.dev.	5.3	7.2	7.3	5.9	5.9	8.6
min	45	45	46	51	48	48
1%	57	48	49	60	58	52
5%	60	53	50	61	61	53
median	68	67	63	70	70	69
95%	74	72	73	77	76	77
99%	78	79	75	82	80	82
max	82	92	77	93	85	94

Table 2: Summary of mean fork length, standard deviation, median and percentiles for albacore sampled during the 2004–05 season, summarized by area.

	Auckland data combined	Greymouth data combined	All 2004-05 data combined
n	2431	3071	5502
mean	65.0	67.7	66.5
std.dev	6.7	7.2	7.1
min	45	48	45
1%	50	52	52
5%	56	55	55
median	67	70	68
95%	73	76	76
99%	78	81	80
max	92	94	94

Table 3: Summary of length frequency statistics for albacore sampled during eight years of troll sampling, and albacore caught by longline.

	1996 -97	1997 -98	1998 -99	1999 -00	2000 -01	2001 -02	2002 -03	2003 -04	2004 -05	Troll data 1997-2005	Longline data 1987-2004
n	4217	3978	3431	3962	5192	5170	7606	5485	5502	44543	69165
mean	65.0	66.0	61.4	61.1	65.2	63.6	60.9	64.3	66.5	63.7	79.8
std.dev	6.9	6.7	8.7	5.6	8.5	8.6	6.4	5.1	7.1	7.4	11.5
min	40	45	38	39	40	42	42	40	45	38	37
1%	49	51	47	49	46	47	47	52	52	47	56
5%	51	59	48	55	49	51	50	58	55	50	63
median	66	64	62	60	68	62	61	63	68	63	79
95%	76	78	74	74	75	80	71	73	76	76	99
99%	81	81	81	81	78	83	76	76	80	81	104
max	92	91	91	94	99	89	92	94	94	99	135

Table 4: Linear regression parameters for troll and longline length-weight relationships

		n	b_0	SE_{b0}	b_1	SE_{b1}	R^2
troll	1998-99	317	-10.61	0.13	2.95	0.03	0.97
troll	1999-00	397	-9.46	0.16	2.67	0.04	0.93
troll	2000-01	599	-9.86	0.12	2.77	0.03	0.94
troll	2000-02	606	-9.69	0.10	2.73	0.02	0.95
troll	2002-03	709	-9.82	0.16	2.76	0.04	0.87
troll	2003-04	598	-10.33	0.14	2.89	0.03	0.92
troll	2004-05	400	-10.36	0.13	2.90	0.03	0.96
troll	1999-2005	3626	-10.03	0.05	2.81	0.01	0.94
longline	1999-2004	31273	-10.23	0.02	2.86	0.00	0.91

Figure 1: Albacore length frequency distributions, Auckland 2004–2005

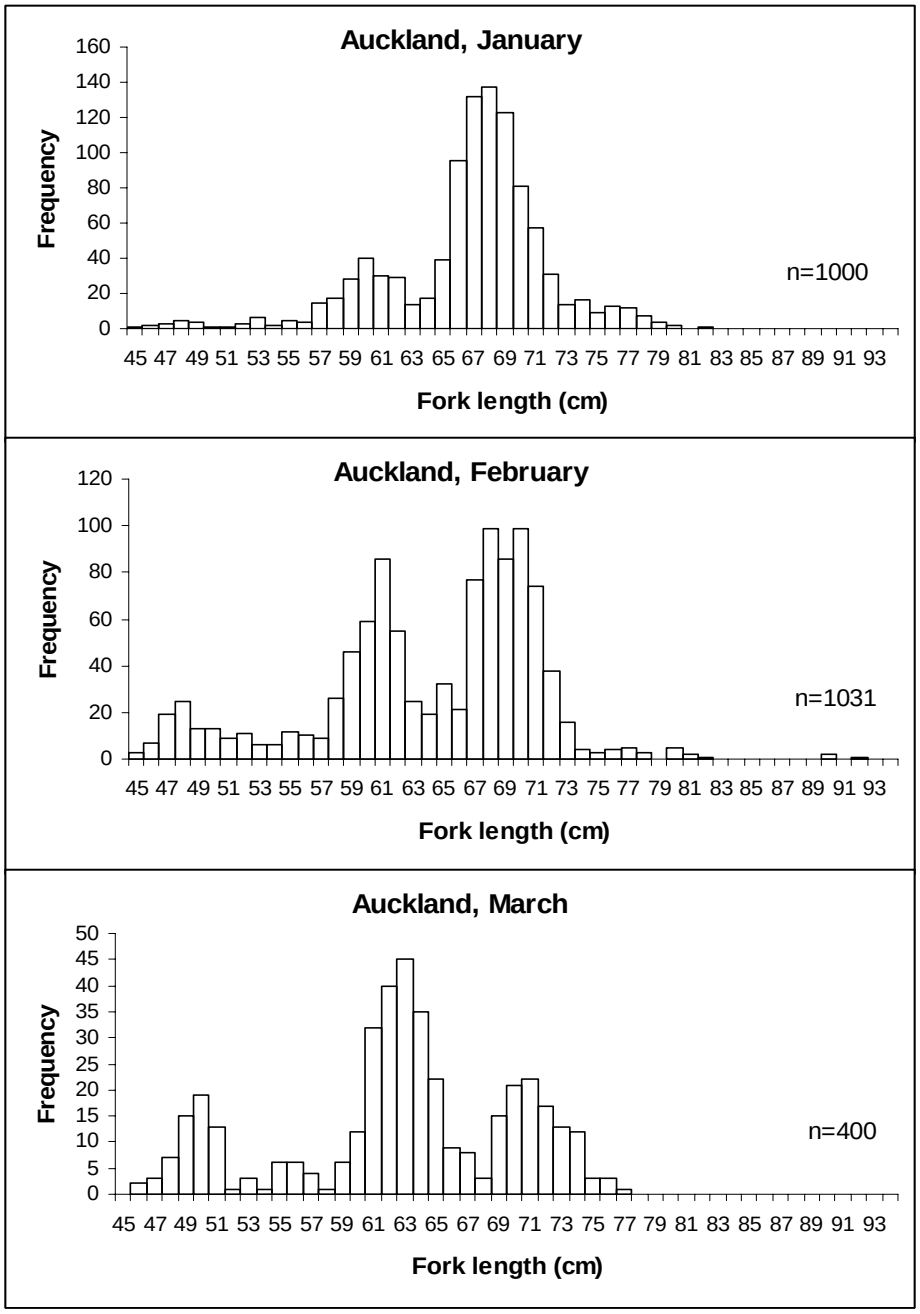


Figure 2: Albacore length frequency distributions, Greymouth 2004–2005

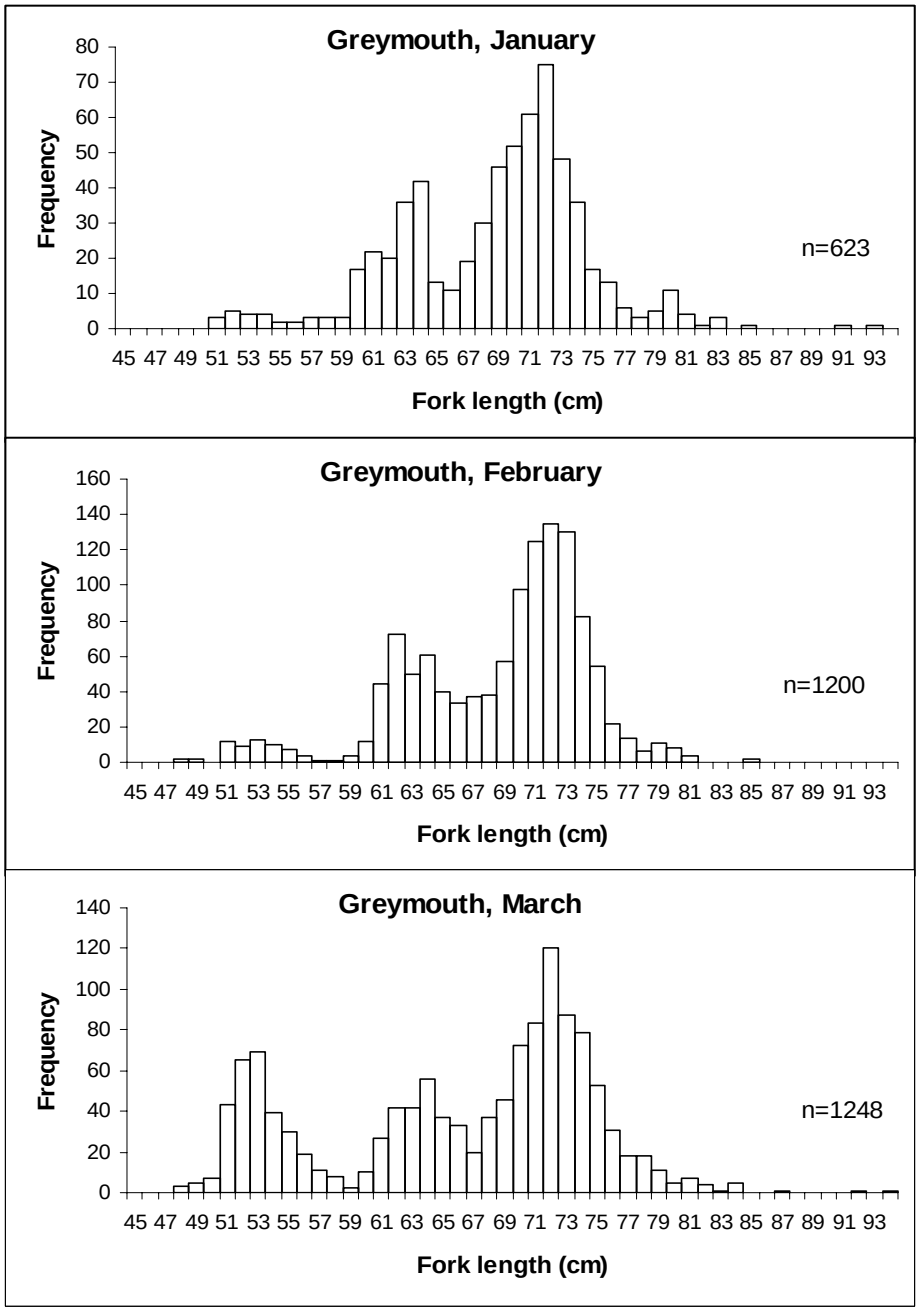
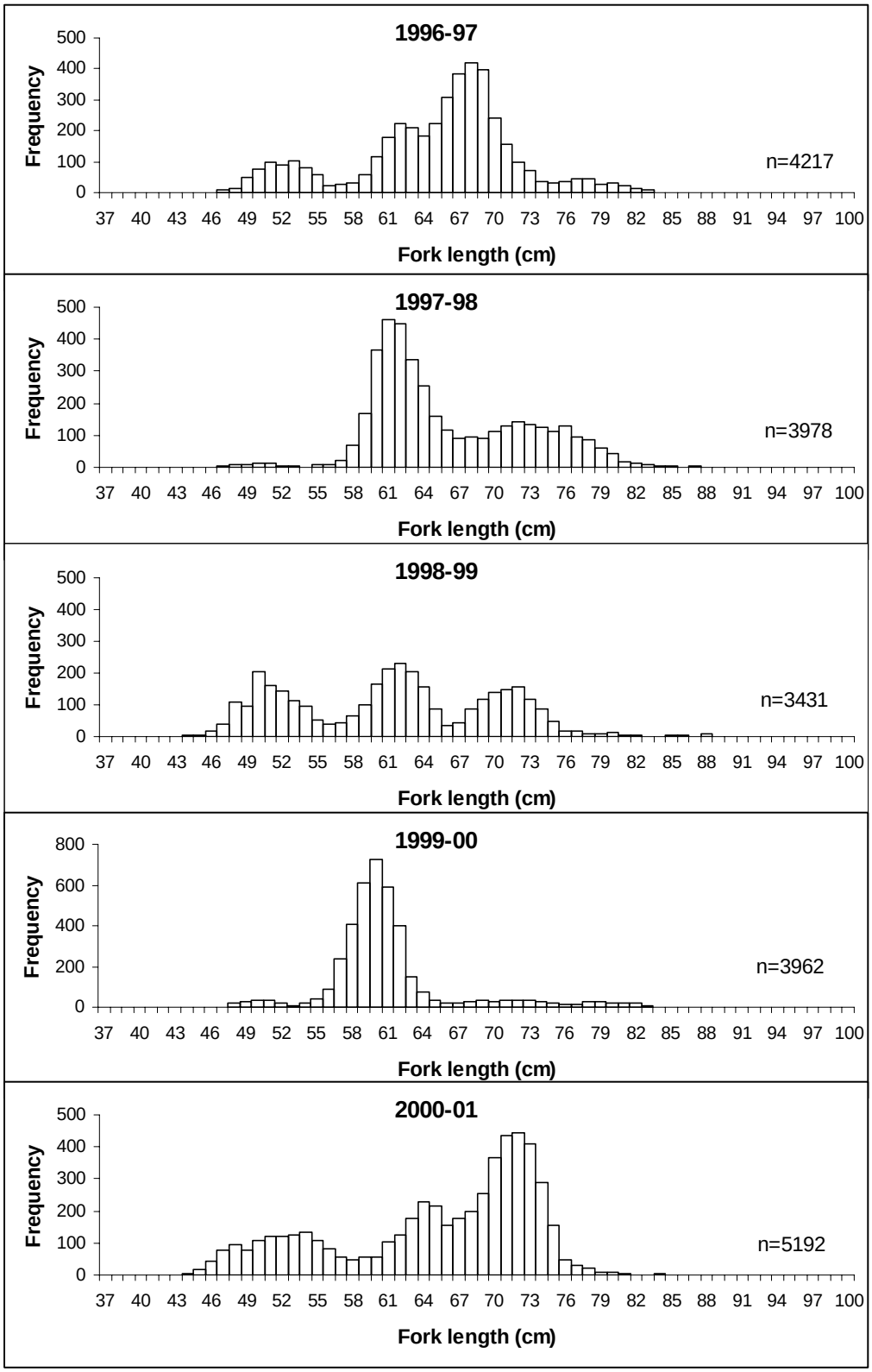


Figure 3: Length frequency distributions for 8 years of troll sampling from 1996–1997 to 2004–2005



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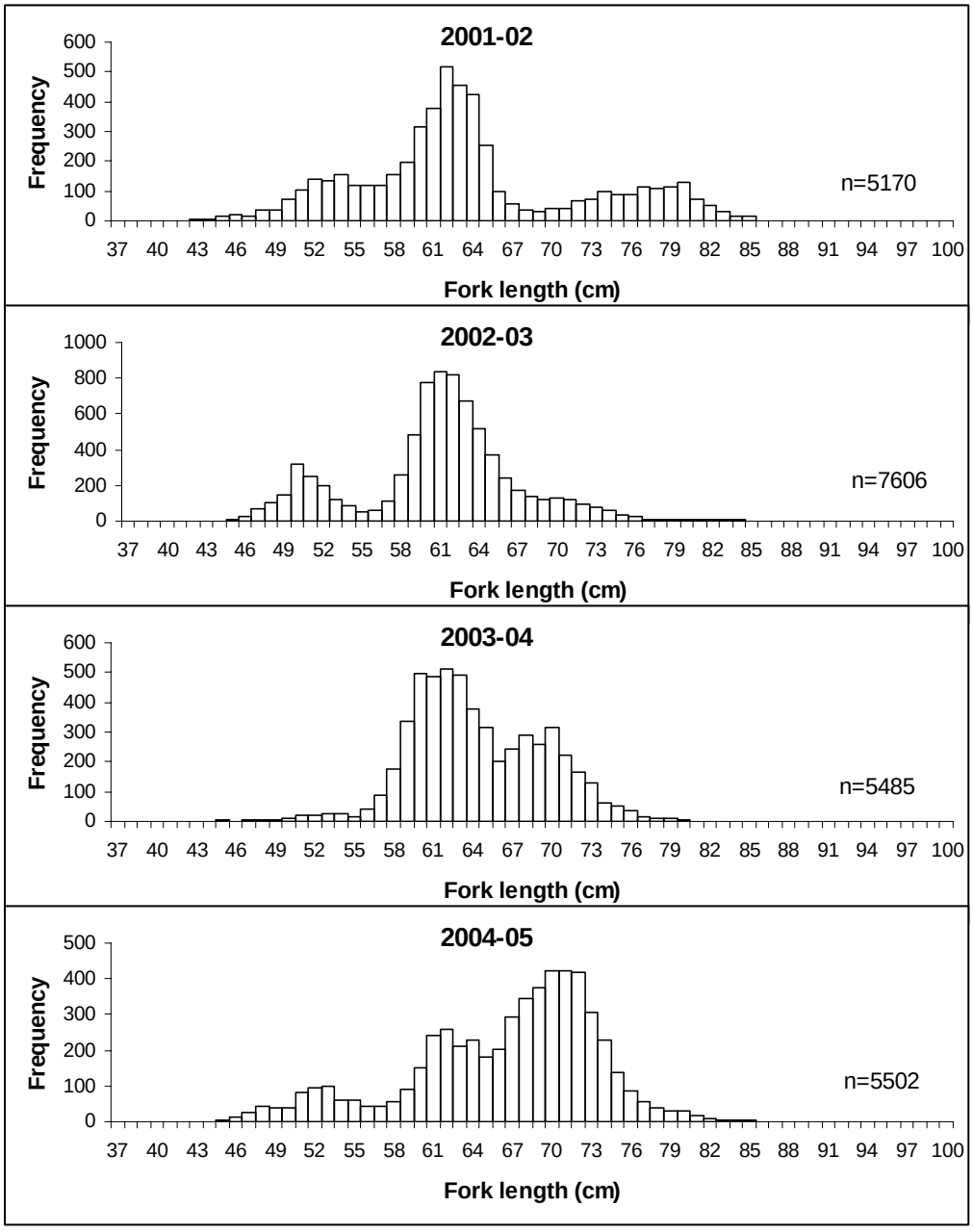

Figure 4: Length frequency distribution for troll and longline caught albacore

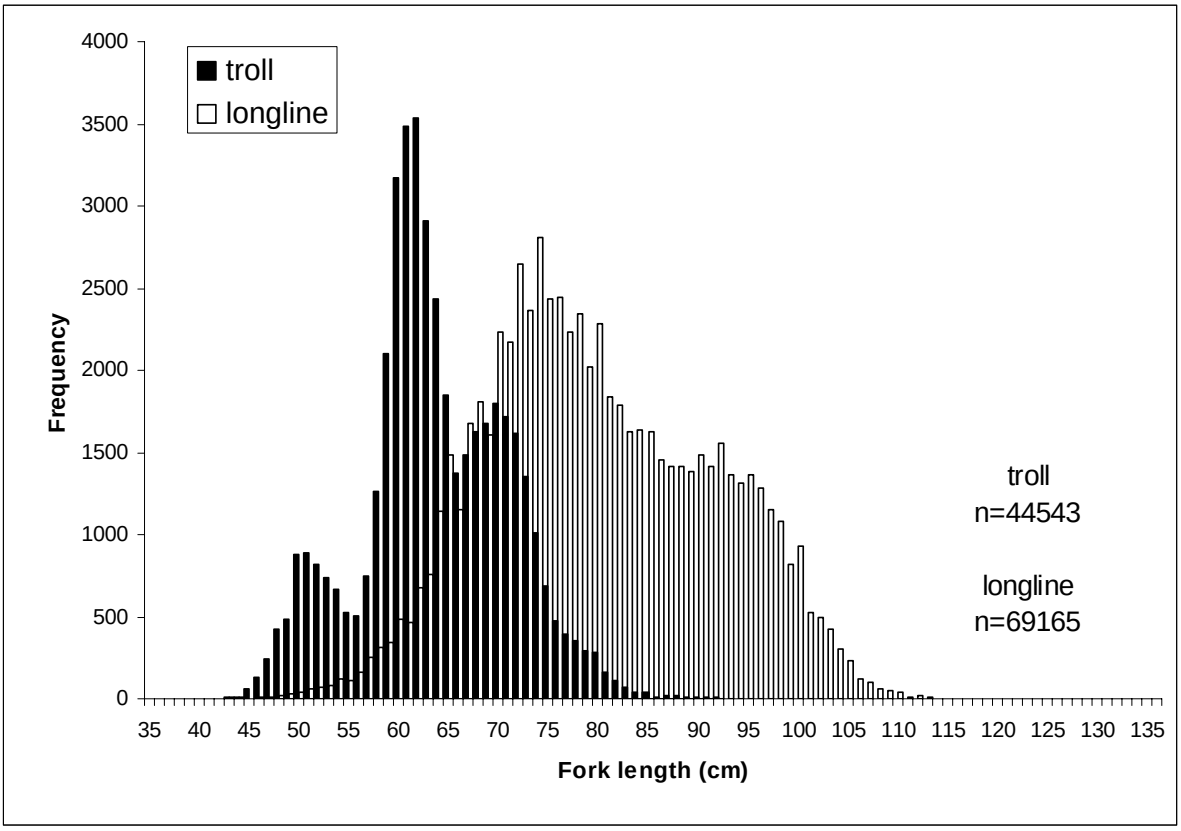

Figure 5: Length:weight relationship for troll caught albacore sampled in 2004–05

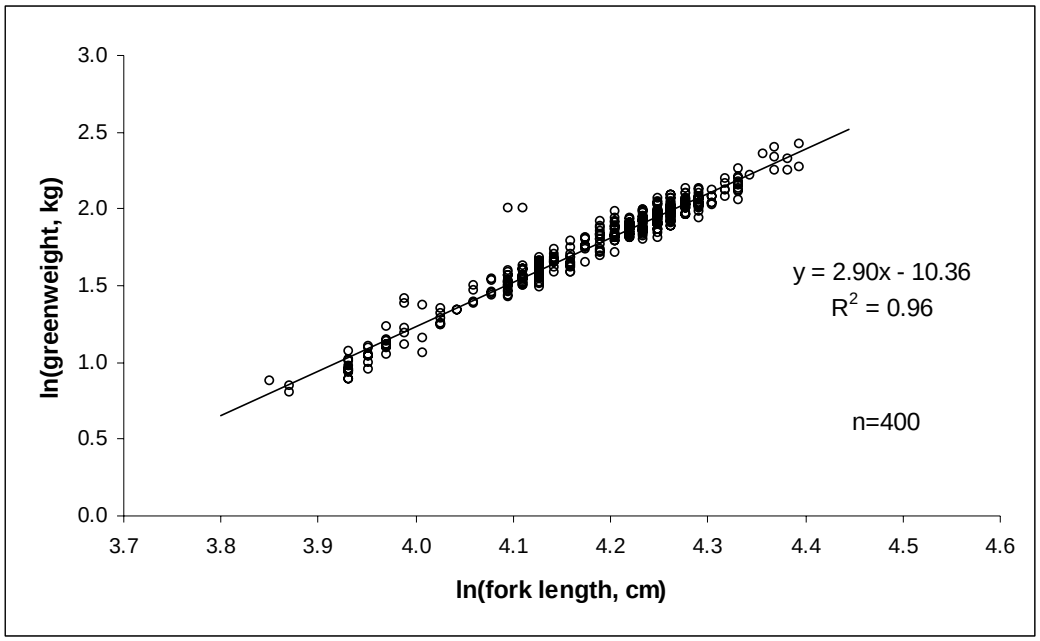

Figure 6: Length:weight relationship for troll caught albacore sampled in 1999–2003

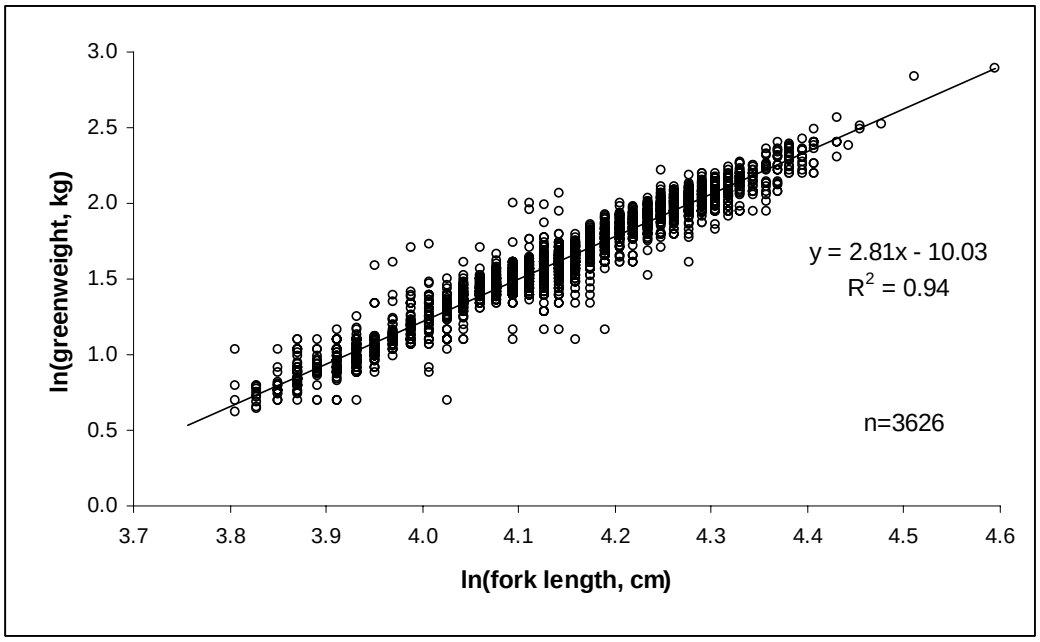

Figure 7: Length:weight relationship for troll and longline caught albacore