

A NEW LENGTH-WEIGHT RELATIONSHIP FOR THE NORTH ATLANTIC ALBACORE*Santiago, J.**AZTI-SIO, Txatxaramendi Irla, Sukarrieta, Vizcaya, Spain***SUMMARY**

A new length-weight relationship for north Atlantic albacore is proposed. It has been developed from data collected stratified by length class, sex and quarter. Statistical analysis demonstrates that most of the variance is explained by the variable length (99.45 percent), and the introduction in the model of factors for sex and quarter does not significantly affect the estimate of weight from length.

RESUME

Une nouvelle relation taille-poids est proposée pour le thon blanc de l'Atlantique nord. Elle a été obtenue à partir de données recueillies de façon stratifiée par classe de taille, sexe et trimestre. La plus grande partie de la variance est expliquée par la variable taille (99,45%); l'introduction de nouveaux facteurs dans le modèle (sexe et trimestre) ne modifie pas l'estimation du poids à partir de la taille de façon significative.

RESUMEN

Se propone una nueva relación talla-peso para el atún blanco del Atlántico norte. Se ha obtenido a partir de datos recogidos estratificadamente por clase de talla, sexo y trimestre. La mayor parte de la varianza es explicada por la variable talla (99,45%), y la introducción de nuevos factores en el modelo -sexo y trimestre, no afecta significativamente la estima del peso a partir de la talla.

INTRODUCTION

There are bulks of papers dealing with the relationship between length and weight in fish. This is probably because of two reasons: data are easy to collect, and allow the construction of one of the few relationships in fisheries that look attractive statistically. It is used to transform catch data from length to weight to perform some basic fisheries analysis.

The length-weight relationship adopted by ICCAT and currently used for the North Atlantic albacore was estimated by Beardsley (1971). However the 1989 Albacore Workshop (ANON., 1990) showed that this relationship might be biased for larger fish. Therefore the Workshop recommended *...to carry out scientific sampling to collect length-weight data for all size ranges caught...*

This paper proposes a new length-weight relationship for the North Atlantic albacore, developed from data collected stratified by length class, sex and quarter. Statistical analysis demonstrated that most of the variance is explained by the variable length (99.45%), and that the introduction of the factors sex and quarter into the model do not affect significantly the estimate of weight from length.

MATERIALS AND METHODS

During the 1990 albacore fishing season (July to December) in the Bay of Biscay, adjacent waters and Azores, a systematic sampling was carried out in order to collect length and weight data. The goal of the sampling was to measure and weigh five individuals per length class (1 cm), sex (for individuals bigger than 80 cm) and quarter (3rd and 4th).

A total of 714 albacores were measured (fork length) to the nearest centimetre and weighted to the nearest 100 g. Length ranged between 42-96 cm for the 3rd quarter, between 46-117 cm for the 4th quarter, 80-107 cm for females and 80-117 cm for males.

After taking logarithms, GLM analysis were conducted to evaluate the possible influence of quarter and sex in the relationship between length and weight. In order to be strict with the methodology and to make the data comparable, different ranges were selected to perform such an analysis: 45-96 cm for the evaluation of the effect 'quarter', and 80-107 cm for the effect 'sex'. These were the ranges that comprised observations for both quarters and both sexes respectively.

Standard linear regression methodology was used to fit the logarithmized data to the model.

RESULTS

Figure 1 shows the scatter diagram of the 714 pairs of North Atlantic albacore length-weight data collected in 1990. Table 1 summarizes the results of the linear regression analysis carried out after grouping the data into different sets: males, females, 3rd quarter and 4th quarter.

Before conducting a regression analysis with the complete data set, the influence of the factors 'sex' and 'quarter' on the length-weight relationship was tested. Tables 2a,b give the results of two types of hypothesis tested in GLM, Type I and Type III. Type I SS (sum of squares) measure incremental SS for the model as each variable is added; and type III SS is the SS that results when that variable is added last to the model. These tests indicated that both sources of variation (sex and quarter) did not affect significantly (at the 0.01 level) to the relationship between length and weight.

Table 3 shows the regression parameters obtained analysing the complete set of data (n=714; range: 42-117 cm). The model explains 99.45% of the variation, and it is defined as:

$$W=1.339 \cdot 10^{-5} \cdot L^{3.1066}$$

DISCUSSION

The 1989 ICCAT Albacore Workshop (ANON., 1990) reviewed several length-weight relationships for the North Atlantic albacore (Table 4), and recommended continuing the use of the Beardsley relationship.

The length-weight relationship presented in this paper estimates weights smaller than the Beardsley's (Figure 2), up to 3.3 kg difference for a 117 cm albacore. It has not been possible to test whether these differences are statistically significant or not because this relationship currently used by ICCAT is poorly documented. Considering the length range on which both regressions are strictly applicable, weight estimates obtained with the equation of Beardsley fall within the 95% confidence limits for an individual predicted value of the new regression, as is shown in Figure 2.

However, for large fish (>100cm), 95% confidence limits for a mean value, calculated taking into account only the variation in the parameter estimates (not the variation in the error term) do not contain the weight at length estimates of Beardsley's, suggesting significant differences between both equations.

According to the 1989 Workshop, the advantages of the Beardsley's equation are: fish were taken throughout the North Atlantic, the range of the fork lengths was the broadest of the available relationships (60-115 cm), and the sample size was larger than most others.

However, it has the deficiency of not being properly documented, as regards to both area and time of data collection and specially to the statistical analysis.

The new relation proposed in this paper has been derived from data collected in a limited area (Azores, Bay of Biscay and adjacent waters) in a limited time period (second half of the year). In any case, it is in this area at this time of the year when historically most of the international albacore catches are taken in the North Atlantic. Therefore the new equation probably represents more adequately the length-weight relationship than the Beardsley's equation. Moreover considering that Beardsley's was derived from data collected throughout the Atlantic Ocean, both from the northern and southern albacore stocks.

As regards to the other qualities of the relationship currently used by ICCAT, range of the data and sample size, the new regression proposed in this paper is based on data homogeneous distributed within a range wider or at least comparable to the old regression, with an also comparable sample size of 714 pairs of observations.

Possible differences in the length-weight relationship between quarters and sexes were analyzed, demonstrating that both factors did not affect significantly the dependence. Nevertheless, it has to be considered that only two quarters were compared, together with the fact that all the individuals sampled were immature or in resting condition.

REFERENCES

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Data set	Number of fish	Lg a	b	R ²	Range
Males	215	-11.357	3.137	97.76	80-117
Females	104	-11.294	3.125	96.50	80-107
3rd quarter	322	-11.161	3.091	99.25	42-96
4th quarter	392	-11.200	3.103	99.48	46-117

Table 1. Results of linear regression of log weight (kg) on log length (cm) of North Atlantic albacore, by sex (male, female) and quarter (3rd, 4th).

a n=569							
Source	DF	Type I SS	F	Pr>F	Type III SS	F	Pr>F
Lg(Length)	1	200.36	71429.7	0.00	4.07	1450.9	0.00
Quarter	1	0.01	4.7	0.03	0.00	0.1	0.80
Lg(Length)*Quarter	1	0.00	0.0	0.87	0.00	0.0	0.87
b n=252							
Source	DF	Type I SS	F	Pr>F	Type III SS	F	Pr>F
Lg(Length)	1	19.80	6561.8	0.00	18.61	6166.3	0.00
Sex	1	0.00	1.3	0.25	0.00	0.4	0.53
Lg(Length)*Sex	1	0.00	0.4	0.55	0.00	0.4	0.55

Tables 2a,b. Results of the GLM analysis to the log length-weight data, performed to estimate the influence of the class variables quarter (a) and sex (b).

	DF	Sum of Squares	Mean Square	F	Pr>F
Regression	1	362.314	362.314	127873	0.00
Error	712	2.017	0.003		
Total	713	364.332			

	Parameter estimate	Standard error	Type II SS	F	Pr>F
Intercept	-11.2208	0.038	246.813	87108.7	0.00
Slope	3.1066	0.009	362.314	127873	0.00

R²=0.9945

Table 3. Results of the regression analysis of log weight (kg) on log length (cm) for North Atlantic albacore, sexes and quarters combined.

Author	Year	Range	Sex	Months	b	Lg a	N	r
Bard (1981)	1952	49-67	-	6-7	2.907	-10.495	111	0.964
Bard (1981)	1952	46-67	-	8-9	2.873	-10.281	115	0.969
Bard (1981)	1952	68-90	-	6-7	2.997	-10.907	87	0.969
Bard (1981)	1952	68-90	-	8-9	2.902	-10.411	68	0.918
Bard (1981)	1961	52-75	-	6	2.924	-10.660	110	0.981
Bard (1981)	1969	50-75	-	8	2.891	-10.248	159	0.980
Bard (1981)	1977	68-103	-	9	3.193	-11.728	85	0.973
Bard (1981)	1977	68-86	-	9	3.159	-11.555	71	0.971
Bard (1981)	1977	50-67	-	9	3.032	-11.018	74	0.976
Bard (1981)	1970	85-115	♂	1-12	3.163	-11.444	202	0.976
Bard (1981)	1970	85-105	♀	1-12	3.522	-13.036	148	0.947
Bard (1981)	1952	90-110	-	8	3.524	-13.267	92	0.928
Beardsley (1971)	1969	60-115	-	1-12	3.283	-11.974	>350	?
Mejuto & Garcés(1985)	1984	49-92	-	7-8	2.919	-10.374	1203	0.989
Anon. (1990)	1989	68-104	-	5-11	3.507	-13.005	197	?

Table 4. Length-weight relationships for albacore in the North Atlantic according to several authors (after Anon., 1990).

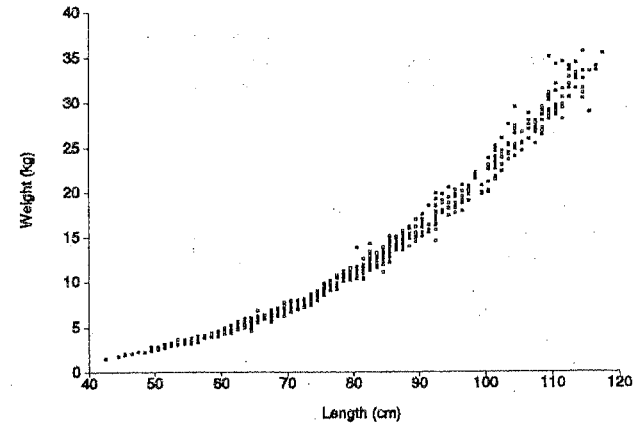


Figure 1. Scatter diagram of the length-weight data of North Atlantic albacore sampled in 1990.

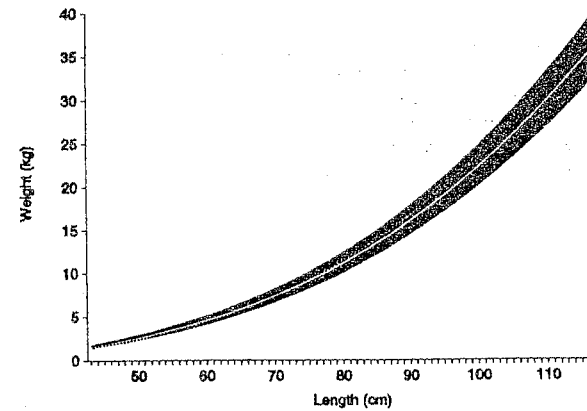


Figure 2. Comparison between the new length-weight relationship (continuous line) and the Beardsley's (1971) (broken line). The 95% confidence area of the former relation to single observations is also shown.