Col.Vol.Sci.Pap. ICCAT, 36: 280-288 (1991)

LENGTH-WEIGHT RELATIONSHIPS FOR WESTERN NORTH ATLANTIC YELLOWFIN TUNA

by

Kevin S. Davis[1]

SUMMARY

Data collected from the western North Atlantic, primarily from the United States east coast and Gulf of Mexico were used to develop length-weight relationships for yellowfin tuna (Thunnus albacares). Linear regression based on the principle of least squares was used to develop relationships for straight fork length-round weight, straight fork length-dressed weight, and round weight-dressed weight.

RESUME

Les données recueillies dans l'Atlantique nord-ouest, surtout sur la côte est des Etats-Unis et dans le golfe du Mexique, ont servi à élaborer des rapports longueur-poids pour l'albacore (Thunnus albacares). Une régression linéaire basée sur le principe des moindres carrés a été utilisée pour calculer les rapports longueur fourche-poids vif, longueur-fourche-poids manipulé et poids vif-poids manipulé.

RESUMEN

Se emplearon datos recogidos en el Atlántico noroeste, en especial en la costa este de Estados Unidos y en el golfo de México, para establecer relaciones entre la talla y el peso del rabil (Thunnus albacares). Se aplicó la regresión lineal basada en el principio de mínimos cuadrados para establecer relaciones entre longitud a la horquilla en línea recta-peso en vivo, longitud a la horquilla en línea recta-peso eviscerado y peso en vivo-peso eviscerado.

[1]U.S. Department of Commerce, NOAA, SEFC, Miami Laboratory, Miami, Florida 33149-1099, U.S.A.

INTRODUCTION

Yellowfin tuna are found in tropical and sub-tropical seas worldwide with the exception of the Mediterranean Sea. Size is common to 150 centimeters (cm) fork length, but may exceed 200 cm. There are many important fisheries for yellowfin throughout their geographical range. Purse seine, longline, and pole-and-line are among the most common fishing techniques employed (Collette 1983).

Length-weight relationships are necessary for converting data of one type of measurement to another for various types of fisheries analyses. The purpose of this paper is to develop equations for the following relationships: round weight (whole fish) to dressed weight (head, viscera, and tail removed), dressed weight to round weight, straight fork length to round weight, round weight to straight fork length, straight fork length to dressed weight, and dressed weight to straight fork length.

METHODS AND MATERIALS

Yellowfin tuna length and weight measurements were obtained from a recreational fishery dockside sampling program that covers the western North Atlantic from the Gulf of Mexico to the Gulf of Maine, including the Bahamas and the Caribbean Sea from 1978 through 1988. Additional length and weight measurements were obtained from U.S. longline vessels fishing in the Gulf of Mexico in 1987 and 1988. Straight fork length measurements were recorded in millimeters and weights to the nearest tenth of a pound.

Plots of straight fork length on round and dressed weight, and round weight on dressed weight were visually examined so that extreme outliers could be isolated and removed prior to regression analyses. The plots revealed that very few data points had to be removed. Several of the data points were considered errors after tracing their source, and individual data points at the extremes on the *x*-axis were removed so that they would not contribute a leveraged influence on the regression line. The plots also indicated that the round weight-dressed weight relationship appeared to be linear, whereas the length-weight relationship appeared curvilinear (Figures 1a through 2a). Therefore, length and weight were logged for the length-weight regression analyses.

All length-weight and weight-weight relationships were derived using linear regression based on the principle of least squares (Zar 1974). Plots of the standardized residuals (observed value minus the predicted value divided by the standard error) plotted against the predicted values were examined to ensure that underlying assumptions were met and to identify, for removal, outliers which exceeded three standard deviations.

Preliminary length-weight analysis of the two data sources revealed that there were no significant differences between the length-weight regression slopes or intercepts, therefore the two data sources were combined for final analyses.

RESULTS

Analyses were initiated on the round weight-dressed weight relationship. Linear regression through the origin was applied with the equation $Y = bX$, where Y is the dependent variable, X is an independent variable, b is the slope, and the intercept is forced through the origin. Subsequent testing after the removal of an outlier revealed an acceptable standardized residual distribution, thus the round weight to dressed weight and dressed weight to round weight equations were accepted (Table 1, Figures 2b and 3a).

Straight fork length to dressed weight and dressed weight to straight fork length analyses were initiated with the equation $\ln(Y) = a + b(\ln(X))$, where a is the intercept, b is the slope, and Y and X are logged values of length and weight. Subsequent testing after the removal of an outlier revealed that the distribution of standardized residuals appeared quite reasonable, thus the equations were accepted (Table 1, Figures 3b and 4a).

Straight fork length to round weight and round weight to straight fork length analyses were initiated with the equation $\ln(Y) = a + b(\ln(X))$ as with the previous regression. Testing revealed a distribution of standardized residuals that appeared quite reasonable and the models explained 96% of the variation, thus the equations were accepted (Table 1, Figures 4b and 5).

DISCUSSION

The equations for dressed weight-round weight and dressed weight-straight fork length relationships were developed with less than 300 data points. There is a fairly significant amount of variation incorporated in these data due to factors such as the skill of the individuals dressing the fish and adverse conditions for taking measurements. The amount of variation explained by the straight fork length-dressed weight equations (82%) is adequate, but could possibly be improved upon in the future if more data become available. The amount of variation explained by the dressed weight-round weight equations (99%) may be artificially high due to the fact that the R^2 was redefined because the regression was forced through the origin. The equations for straight fork length-round weight relationships explain 96% of the total variation for the models and cover a size range of 560 to 1803 millimeters leaving little room for improvement, however, investigation of differences among months or seasons may warrant further analyses.

LITERATURE CITED

Collette, B. B. and C. E. Nauen, 1983. FAO Species Catalogue, Vol. 2. Scombrids of the World. An Annotated and Illustrated Catalogue of the Tunas, Mackerels, Bonitos and Related Species Known to Date. FAO Fish. Synop. (125) Vol. 2, 137p.

Zar, J. H., 1974. Biostatistical Analysis. Prentice-Hall, Inc., Engelwood Cliffs, N.J., 620p.

Table 1. Final equations for yellowfin tuna weight-weight and length-weight relationships (RWT = round weight, DWT = dressed weight, and FKLG = straight fork length). Length is in millimeters and weight in pounds.

Equation	R^2	*Number of Fish*	*Size Range*
RWT = 1.24 (DWT)	99	289	34-135 lbs
DWT = 0.805 (RWT)	99	289	42-170 lbs
DWT = 4.3×10^{-6} $(FKLG)^{2.3}$	82	288	880-1640 mm
FKLG = 278.7 $(DWT)^{.35}$	82	288	34-135 lbs
FKLG = 292.5 $(RWT)^{.33}$	96	2,768	560-1803 mm
RWT = 8.9×10^{-8} $(FKLG)^{2.88}$	96	2,768	8-222 lbs

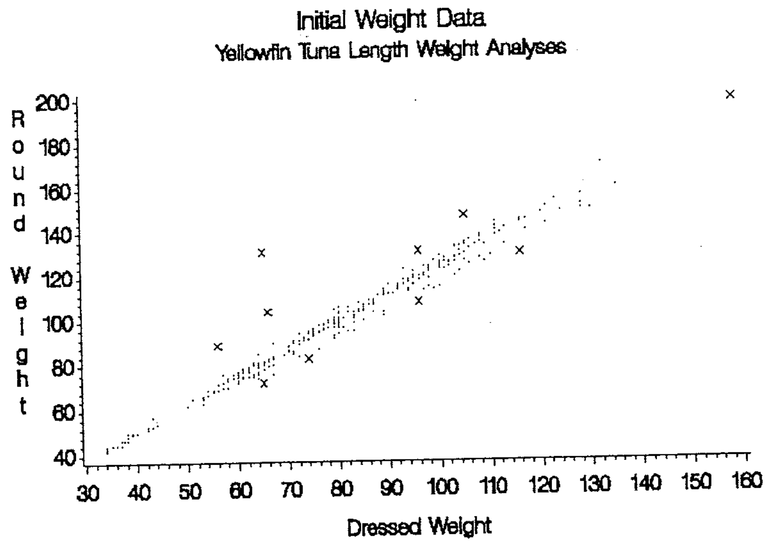

Figure 1a.

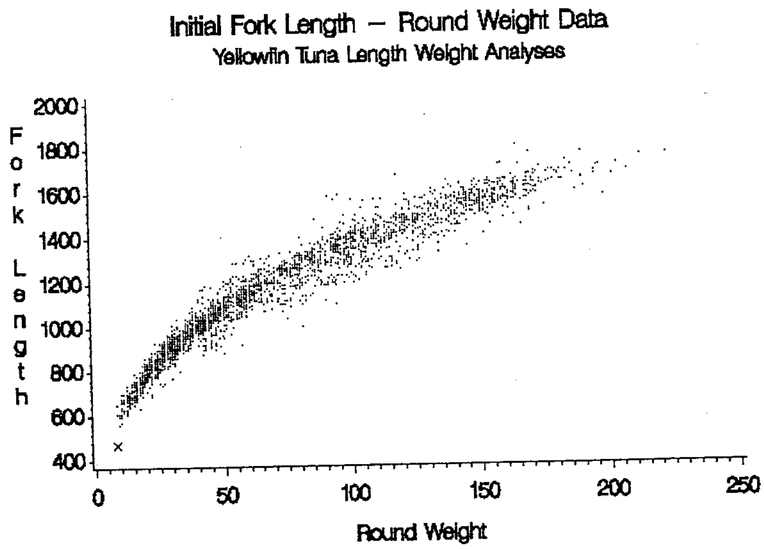

Figure 1b.

Figure 1a) Initial round weight(pounds)-dressed weight(headed, gutted, tailed, measured in pounds) data used for yellowfin tuna length-weight analyses. 1b) Initial straight fork length (millimeters) - round weight data used for yellowfin tuna length-weight analyses (x represents potential outliers inspected for removal, points may represent multiple observations).

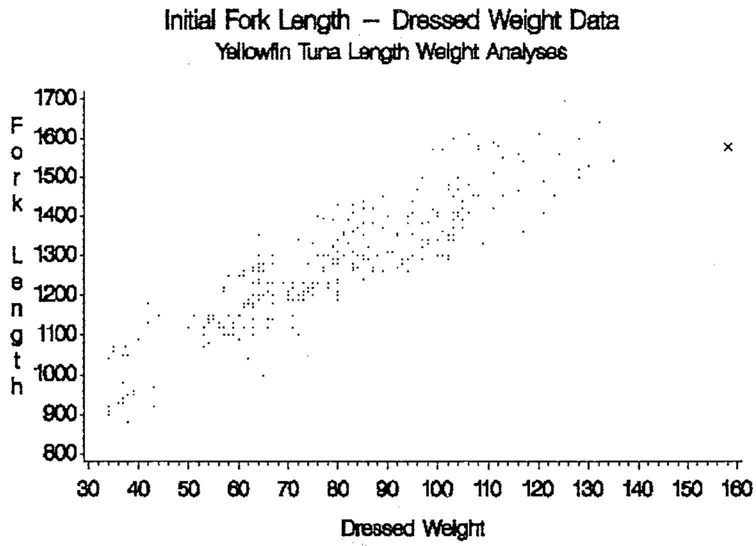

Figure 2a.

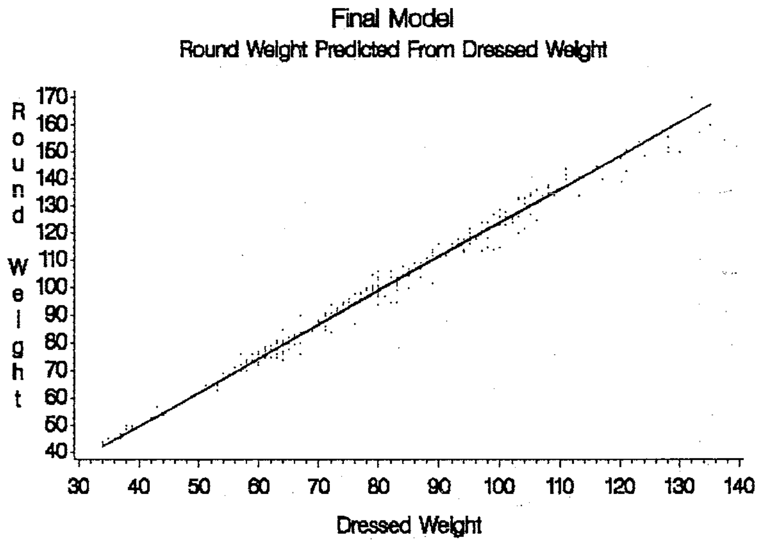

Figure 2b.

Figure 2a) Initial straight fork length (millimeters) -dressed weight (headed, gutted, tailed, measured in pounds) data used for yellowfin tuna length-weight analyses (x represents potential outliers inspected for removal, points may represent multiple observations). 2b) Final model for predicting yellowfin tuna round weight from dressed weight.

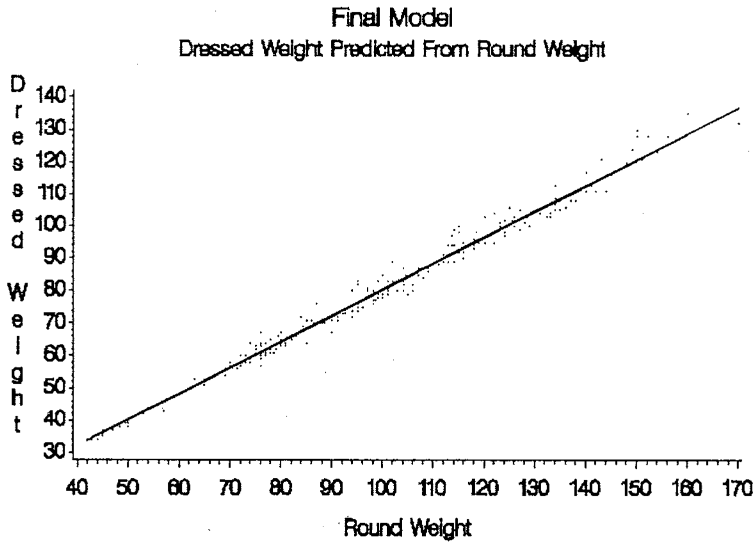

Figure 3a.

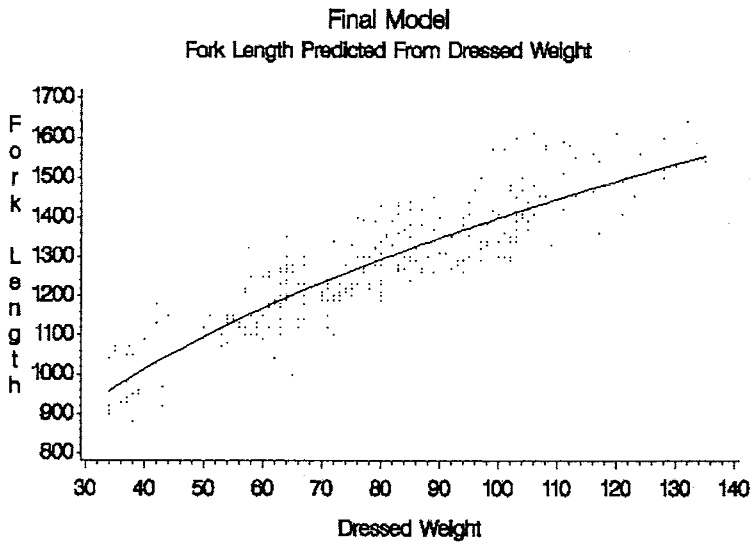

Figure 3b.

Figure 3a) Final model for predicting yellowfin tuna dressed weight (headed, gutted, tailed, measured in pounds) from round weight (pounds). 3b) Final model for predicting yellowfin tuna straight fork length (millimeters) from dressed weight (points may represent multiple observations).

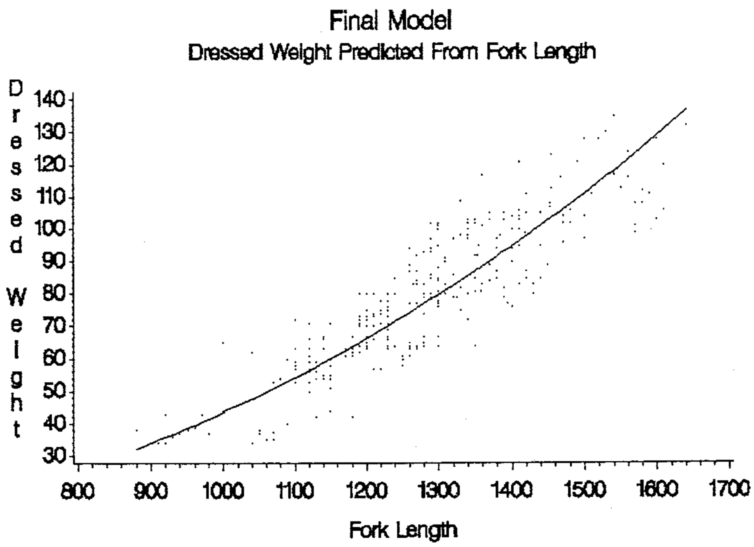

Figure 4a.

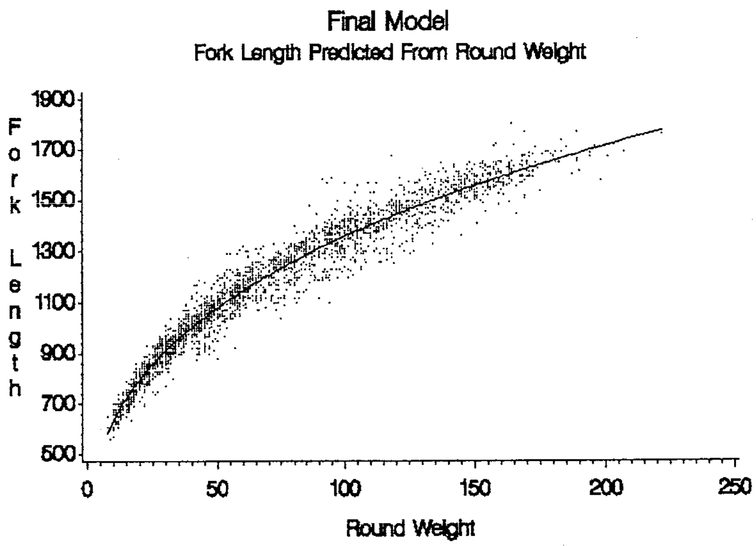

Figure 4b.

Figure 4a) Final model for predicting yellowfin tuna dressed weight (headed, gutted, tailed, measured in pounds) from straight fork length (millimeters). 4b) Final model for predicting yellowfin tuna straight fork length (millimeters) from round weight (pounds) (points may represent multiple observations).

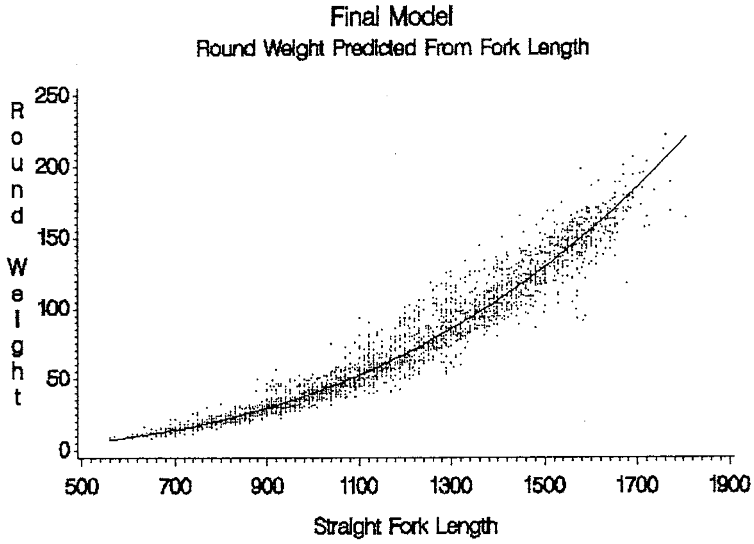

Figure 5. Final model for predicting yellowfin tuna round weight (pounds) from straight fork length (millimeters) (points may represent multiple observations).