LENGTH CONVERSION EQUATIONS

FOR SOCKEYE, CHINOOK, AND COHO SALMON IN SOUTHEAST ALASKA

By

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Regional Information Report[1] No. 1J88-03

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Division of Commercial Fisheries, Southeast Region
P.O. Box 20
Douglas, Alaska 99824

February 1988

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[1] The Regional Information Report Series was established in 1987 to provide an information access system for all unpublished divisional reports. These reports frequently serve diverse ad hoc informational purposes or archive basic uninterpreted data. To accommodate needs for up-to-date information, reports in this series may contain preliminary data.

Introduction

Management of the salmon fisheries of Southeast Alaska requires the exchange of data between a number of research agencies, management agencies, and governments. One of the most basic data sets collected by these agencies is the length of the fish in the catches and escapements of salmon. Accurate length measurements are used in estimation of age, weight, maturity and forecasting. Unfortunately this data is collected in a variety of ways and there is a need for a method to convert one measurement to another.

The Alaska Department of Fish and Game (ADF&G) generally measures salmon from mideye to fork of the tail (MEF), while the Canadian Department of Fisheries and Oceans measures from the postorbit of the eye to the hypural plate (POH). ADF&G minimum size regulations for chinook salmon (*Oncorhynchus tshawytscha* Walbaum) refer to the total length (TOT), or snout to tip of the tail. The ADF&G coded wire tag (CWT) sampling program collects snout to fork (SNF) lengths. Another measurement used in fishery biology is mideye to hypural plate (MEH). Conversion formulas are necessary in order to convert one measurement to another. Duncan (1956) determined the MEF to MEH relationship for sockeye salmon in Bristol Bay. In Southeast Alaska, Gray et al (1981) reported the SNF to MEF equation for coho salmon and Dangel et al (1977) the MEH to MEF for chum salmon *(O. keta* Walbaum). Some length conversions for spawning chum salmon in Prince William Sound were determined by Helle (1979). ADF&G is continuing analysis of chum and pink salmon (*O. gorbuscha* Walbaum) measurements (J.D.Jones, Alaska Department of Fish and Game, Juneau, personal communication). This report presents the equations for sockeye (*O. nerka* Walbaum), coho (*O. kisutch* Walbaum), and chinook salmon in Southeast Alaska (Tables 1-5).

Methods

Sockeye salmon were sampled from commercial gill net and seine fisheries throughout Southeast Alaska in 1985. Coho and chinook salmon were sampled from gill net, seine and troll fisheries in 1987. In addition sport caught chinook were sampled in Juneau and spawning chinook were sampled at the Crystal Lake Hatchery near Petersburg. Each fish was laid out flat on a measuring board and measured to the nearest millimeter with a flexible measuring tape stretched taut. Sockeye salmon were sampled for MEF, MEH, and POH lengths, chinook and coho were sampled for MEF, MEH, POH, and in some cases TOT and SNF. The sex of the fish was determined only for the chinook sport fish sample.

The measurements were entered into a Lotus 123 file and sorted and edited. Predictive linear regression equations, correlation coefficients, and standard errors were computed for all possible conversions of length measurements.

Results and Discussion

As would be expected the correlation coefficients between the different length measurements were high with r^2 values of greater than 0.94 in all cases except the spawning chinook sample. The length conversion equations were determined by use of simple linear regression rather than Geometric Mean (GM) regression preferred by Ricker (1973). Since these equations are intended to be used to predict one measurement from another the linear regression was used (H.J. Geiger, Alaska Department of Fish and Game, Juneau. personal communication). Caution should be used in predicting lengths outside of the range of lengths used to derive the equations. For values of X above or below this range the function may not be the same, indeed the relationship may not even be linear in such ranges, even thought it is linear within the observed range (Zar 1974).

Sockeye

The MEF to MEH equation for sockeye falls on the end of a range of equations determined in an extensive study done on Bristol Bay sockeye salmon (Duncan 1956). He found the between year differences in Bristol Bay sockeye salmon to be statistically different but felt that in practical applications of the data the differences were unimportant. The conversion table that he generated from the 1953 data is used by the Fisheries Research Institute of the University of Washington in a field manual (Koo 1964). Duncan concluded that the MEH vs MEF relationship was linear throughout the range of sizes of adult sockeye salmon in Bristol Bay and that there was no sexual dimorphism in this relationship. Predicted measurements for Southeast Alaska sockeye salmon are within 10 mm of measurements predicted for Bristol Bay sockeye.

Chinook

Chinook salmon were the only species in this report which were sampled both in ocean fisheries and in spawning condition. There were small differences between the resulting conversion equations for the two samples and the lowest correlation coefficients involved converting TOT length measurements of spawning chinook salmon. The differences between samples result from the morphometric changes in maturing salmon, while the lower correlation coefficients are due to the small sample size, shorter range of lengths sampled and the difficulty of accurately measuring the tip of the tail.

The sex of 190 sport caught chinook was determined and predictive regression equations were computed for each sex. The differences in predicted lengths were less than 7 mm of each other which, for practical purposes is probably negligible. This is fortunate as the majority of chinook landings are dressed fish which can not be sexed accurately.

Coho

The SNF to MEF equation for coho predicts lengths similar to one determined by Gray et al (1981) for Southeast Alaska coho. Gray et al (1981) sampled 6,431 coho salmon during the commercial fishing seasons of 1969 and 1970 in Southeast Alaska and the Yakutat District. They found the snout to fork length to be up to 2 cm longer on fish sampled late in the season and increasing faster in males as they matured. The fish sampled in this report were sampled over a one month period and pooled into one sample.

Chum

Chum and pink salmon were not measured in this study, however Dangel et al. (1977) reported the MEF to MEH equation. They used the geometric mean (GM) of the functional regression (Ricker 1973). Based on 1,582 samples collected in Southeast Alaska in 1975 the equation was: MEH = 0.94355(MEF) + 36.3687. Conversion formulas for predicting MEF, SNF and POH from MEH measurements of spawning chum salmon in Prince William Sound were determined by Helle (1979) (Table 5).

LITERATURE CITED

Dangel, J. R., J.H. Helle, C.R. Mattson, and H.S. Sears. 1977. Summary of age-weight-length data for Southeastern Alaska chum salmon, 1958-1976. Alaska Department of Fish and Game, Division of Commercial Fisheries, Technical Data Report 34, Juneau.

Duncan, R. E. 1956. Two measures of the length of red salmon, *Oncorhynchus nerka* (Walbaum), their relation and application in the study of the catch and escapement in Bristol Bay, Alaska. Masters. University Washington. 1956.

Gray, P.L., J.F. Koerner, and R.A. Marriott. 1981. The age structure and length-weight relationship of Southeastern Alaska coho salmon *Oncorhynchus kisutch*, 1969-1970. Alaska Department of Fish and Game, Division of Commercial Fisheries, Informational Leaflet 195, Juneau.

Helle, J.H. 1979. Influence of Marine Environment on Age and Size at Maturity, Growth, and Abundance of Chum Salmon, *Oncorhynchus keta* (Walbaum), from Olsen Creek, Prince William Sound, Alaska. PhD Thesis, Oregon State University, Corvallis.

Koo, T.S.Y. 1964. F.R.I. Field Manual. Circular No. 143 (Revised edition) Fisheries Research Institute, College Fisheries, University Washington, Seattle.

Ricker, W.E. 1973. Linear regressions in fishery research. Journal of the Fisheries Research Board Canada. 30:409-434.

Zar, J.H. 1974. Biostatistical Analysis. Prentice-Hall, Inc. Englewood Cliffs, New Jersey.

Table 1. Linear regression equations for converting length measurements (mm) of ocean caught sockeye salmon in Southeast Alaska.

Regression Equation	N	r squared	SE Y.X	SE (b)
MEH = 0.901(MEF) - 6.714	820	0.9733	6.982416	0.005222
MEF = 1.080(MEH) + 22.652	820	0.9733	7.641730	0.006254
POH = 0.891(MEF) - 9.064	820	0.9773	6.349520	0.004748
MEF = 1.097(POH) + 23.039	820	0.9773	7.046329	0.005848
POH = 0.979(MEH) + 2.449	820	0.9849	5.180350	0.004240
MEH = 1.006(POH) + 5.292	820	0.9849	5.252852	0.004359
MEF = 1.09894(MEH) + 5.36371	Bristol Bay, from Duncan (1956).			

Where Y = bX + a
b = slope of regression line
a = Y intercept of regression
SE (b) = Standard Error of slope
SE Y.X = Standard Error of Y given X
Sample sources: various Southeast Alaska fisheries, August 1985.
Range of lengths (MEF) 324-682 mm.
MEF = Mideye to Fork of tail
MEH = Mideye to Hypural plate
POH = Postorbit of eye to Hypural plate
SNF = Snout to Fork of tail
TOT = Total length; snout to tip of tail

Table 2. Linear regression equations for converting length measurements (mm) of ocean caught chinook salmon in Southeast Alaska.

Regression Equation	N	r squared	SE Y.X	SE (b)
MEH = 0.914(MEF) - 0.116	91	0.9961	6.498167	0.006054
MEF = 1.090(MEH) + 2.688	91	0.9961	7.097985	0.007223
POH = 0.848(MEF) + 26.386	449	0.9803	9.644018	0.005682
MEF = 1.155(POH) - 16.302	449	0.9803	11.25467	0.007739
SNF = 1.101(MEF) - 15.878	449	0.9916	8.111752	0.004779
MEF = 0.900(SNF) + 20.321	449	0.9916	7.334365	0.003907
TOT = 1.120(MEF) + 21.328	449	0.9766	13.90473	0.008192
MEF = 0.872(TOT) - 1.743	449	0.9766	12.26682	0.006376
POH = 0.976(MEH) + 4.485	91	0.9960	6.406890	0.006519
MEH = 1.021(POH) - 2.198	91	0.9960	6.551643	0.006818
SNF = 1.181(MEH) - 5.061	91	0.9883	13.36876	0.013604
MEH = 0.837(SNF) + 11.262	91	0.9883	11.25745	0.009647
TOT = 1.218(MEH) + 28.176	91	0.9912	11.93114	0.012141
MEH = 0.814(TOT) - 17.660	91	0.9912	9.75438	0.008115
SNF = 1.269(POH) - 31.812	449	0.9673	16.04688	0.011034
POH = 0.762(SNF) + 45.106	449	0.9673	12.43264	0.006623
TOT = 1.291(POH) + 5.172	449	0.9525	19.81493	0.013625
POH = 0.738(TOT) + 26.471	449	0.9525	14.97914	0.007786
TOT = 1.015(SNF) + 39.020	449	0.9810	12.52947	0.006675
SNF = 0.966(TOT) - 22.940	449	0.9810	12.22515	0.006354

Where Y = bX + a
b = slope of regression line
a = Y intercept of regression
SE (b) = Standard Error of slope
SE Y.X = Standard Error of Y given X
Sample sources: for N = 91 - 32 fish from District 104 seine and 59 from District 115 gill net. For N = 449 those 91 were combined with 359 Juneau sport caught fish; all fish sampled August 1987.
Range of lengths (MEF) sampled: 470 - 1,025 mm.
MEF = Mideye to Fork of tail
MEH = Mideye to Hypural plate
POH = Postorbit of eye to Hypural plate
SNF = Snout to Fork of tail
TOT = Total length; snout to tip of tail

Table 3. Linear regression equations for converting length measurements (mm) of spawning chinook salmon in Southeast Alaska.

Regression Equation	N	r squared	SE Y.X	SE (b)
MEH = 0.907(MEF) - 21.874	38	0.9841	7.691757	0.019185
MEF = 1.085(MEH) + 36.340	38	0.9841	8.415663	0.022966
POH = 0.912(MEF) - 34.381	38	0.9848	7.576385	0.018897
MEF = 1.080(POH) + 49.228	38	0.9848	8.245917	0.022385
SNF = 1.124(MEF) - 5.625	38	0.9504	17.14589	0.042766
MEF = 0.846(SNF) + 44.126	38	0.9504	14.87662	0.032195
TOT = 1.091(MEF) + 48.677	38	0.9215	21.27932	0.053076
MEF = 0.845(TOT) + 21.242	38	0.9215	18.72268	0.041088
POH = 1.004(MEH) - 11.598	38	0.9984	2.453942	0.006697
MEH = 0.994(POH) + 12.643	38	0.9984	2.441060	0.006626
SNF = 1.217(MEH) + 36.912	38	0.9316	20.13917	0.054960
MEH = 0.765(SNF) + 19.497	38	0.9316	15.97067	0.034562
TOT = 1.179(MEH) + 92.028	38	0.8988	24.16289	0.065941
MEH = 0.762(TOT) + 0.524	38	0.8988	19.43105	0.042643
SNF = 1.211(POH) + 51.177	38	0.9326	19.98870	0.054263
POH = 0.770(SNF) + 7.068	38	0.9326	15.93499	0.034485
TOT = 1.173(POH) +106.137	38	0.8991	24.12320	0.065487
POH = 0.766(TOT) - 11.761	38	0.8991	19.50151	0.042797
TOT = 0.974(SNF) + 51.699	38	0.9751	11.99554	0.025960
SNF = 1.001(TOT) - 29.644	38	0.9751	12.16426	0.026695

Where Y = bX + a
b = slope of regression line
a = Y intercept of regression
SE (b) = Standard Error of slope
SE Y.X = Standard Error of Y given X
Sample sources: Crystal Lake Hatchery, August 1987
Range in length (MEF) 666-924 mm.
MEF = Mideye to Fork of tail
MEH = Mideye to Hypural plate
POH = Postorbit of eye to Hypural plate
SNF = Snout to Fork of tail
TOT = Total length; snout to tip of tail

Table 4. Linear regression equations for converting length measurements (mm) of ocean caught coho salmon in Southeast Alaska.

Regression Equation	N	r squared	SE Y.X	SE (b)
MEH = 0.942(MEF) - 30.245	350	0.9648	9.267920	0.009641
MEF = 1.024(MEH) + 51.824	350	0.9648	9.663889	0.010482
POH = 0.936(MEF) - 35.751	350	0.9620	9.586673	0.009972
MEF = 1.027(POH) + 59.230	350	0.9620	10.04057	0.010939
SNF = 1.076(MEF) + 5.938	350	0.9833	7.215494	0.007506
MEF = 0.914(SNF) + 4.448	350	0.9833	6.651859	0.006379
TOT = 1.147(MEF) - 1.300	100	0.9745	8.305105	0.018738
MEF = 0.849(TOT) + 16.899	100	0.9745	7.143684	0.013863
POH = 0.993(MEH) - 5.392	350	0.9960	3.112690	0.003376
MEH = 1.002(POH) + 7.520	350	0.9960	3.126490	0.003406
SNF = 1.098(MEH) + 63.721	350	0.9421	13.44827	0.014587
MEH = 0.858(SNF) - 24.112	350	0.9421	11.88977	0.011402
TOT = 1.267(MEH) - 0.476	100	0.9636	9.934275	0.024883
MEH = 0.761(TOT) + 20.812	100	0.9636	7.697166	0.014937
SNF = 1.102(POH) + 71.364	350	0.9404	13.65097	0.014873
POH = 0.854(SNF) - 29.939	350	0.9404	12.01572	0.011523
TOT = 1.260(POH) + 15.023	100	0.9592	10.51686	0.026254
POH = 0.761(TOT) + 11.108	100	0.9592	8.175743	0.015866
TOT = 1.055(SNF) + 4.918	100	0.9940	4.034130	0.008281
SNF = 0.942(TOT) - 0.615	100	0.9940	3.813664	0.007401

Where Y = bX + a
b = slope of regression line
a = Y intercept of regression
SE (b) = Standard Error of slope
SE Y.X = Standard Error of Y given X
Sample sources: for N = 100 - fish from District 105 troll.
For N = 350 - those 100 were combined with 50 fish from District 115 gill net, and 200 fish from Dist. 104 seine. Sampled 7/24 - 8/23/87.
Range of lengths (MEF) 421-704 mm.
MEF = Mideye to Fork of tail
MEH = Mideye to Hypural plate
POH = Postorbit of eye to Hypural plate
SNF = Snout to Fork of tail
TOT = Total length; snout to tip of tail