

Determination of the von Bertalanffy Growth Equation  
for the Southern New England-Middle Atlantic, Georges  
Bank and Gulf of Maine stocks of Silver Hake

by

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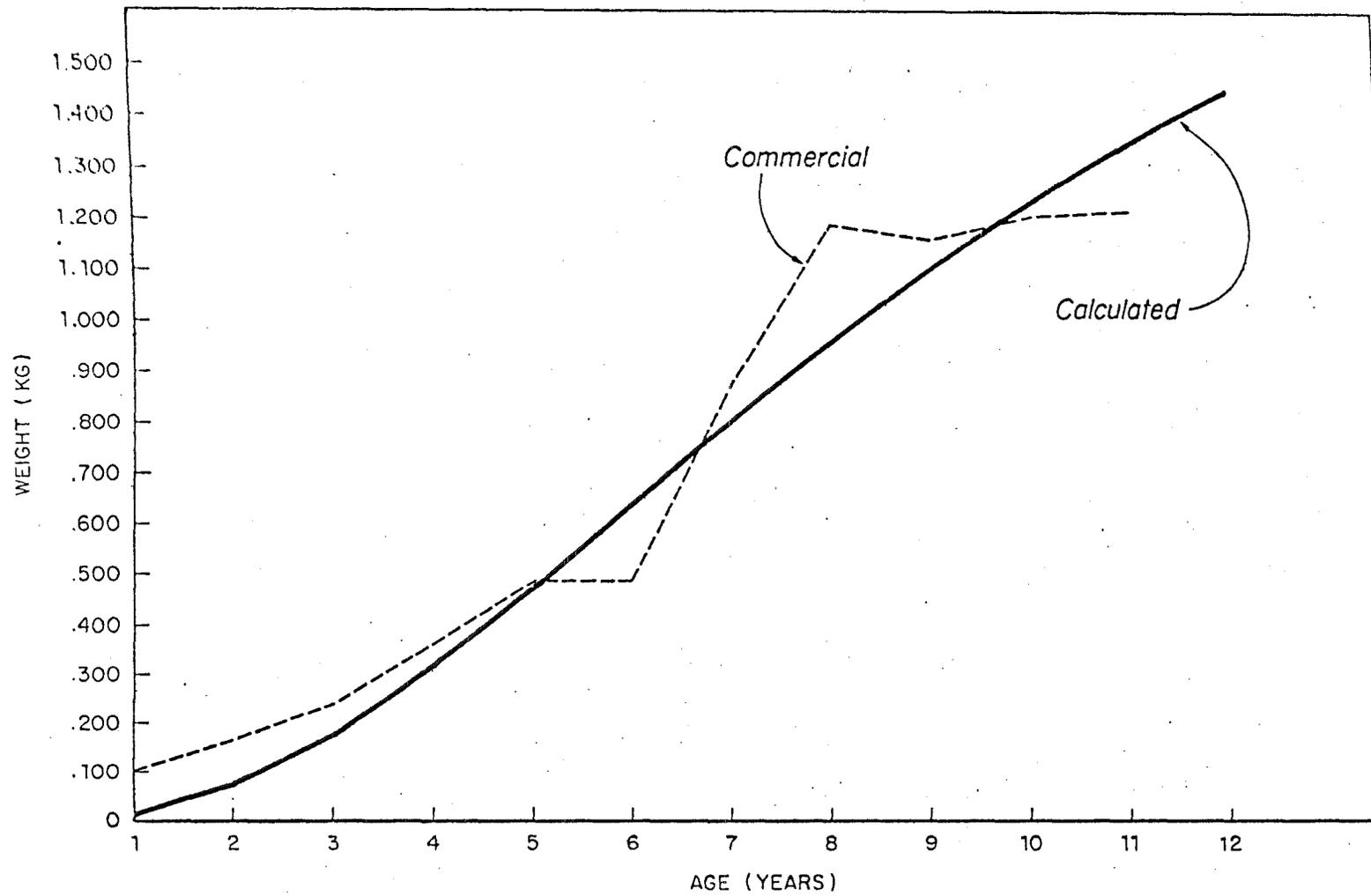


Figure 6. Weights-at-age of Silver Hake from the Gulf of Maine stock.

## INTRODUCTION

Parameters for the von Bertalanffy (1938) growth equation were calculated for three silver hake stocks using data obtained from USA spring and autumn bottom trawl surveys during 1973-1976. Calculated lengths-at-age obtained from the growth equations and calculated weights-at-age obtained by applying a length-weight equation to the calculated lengths were compared to actual commercial length and weight data from the three stocks. Growth equations were also calculated for the three stocks by sex to illustrate the sexual dimorphism in growth exhibited by this species.

## METHODS

Silver hake age-length data for the Southern New England-Middle Atlantic, Georges Bank, and Gulf of Maine stocks were obtained from samples collected during USA spring and autumn bottom trawl surveys during 1973-1976, excluding the autumn 1974 survey (not aged). Ages were adjusted to reflect the time of year the samples were obtained (i.e., an age 2 fish from a spring survey was assigned an age of 2.3 years and an age 2 fish collected during an autumn survey was given an age of 2.8 years). The data were then fitted to the von Bertalanffy (1938) growth equation:

$$l_t = L_\infty (1 - e^{-K(t-t_0)})$$

using the procedure for unequal sample sizes and age intervals devised by Tomlinson and used in his program TCPC1 (Psaropoulos, personal communication). Calculated lengths at age estimates were obtained as of the beginning of the year.

Age-length data, separated by sex, for the three stocks were also obtained from samples collected during USA spring and autumn bottom trawl surveys during 1973-1976, excluding the spring 1973 survey (not sexed) and the autumn 1974 survey (not aged).

The age-length composition of the commercial catches determined using commercial length samples obtained from the USA and USSR fisheries and age-length keys from the survey samples was examined for 1973-1976. The mean length-at-age from the commercial catches were plotted and compared to the calculated von Bertalanffy estimates.

Weight-at-age estimates were determined by applying a length-weight equation to the calculated length-at-age values. The length-weight relationship used was derived previously from survey catch data (Grosslein, unpublished data) from all areas:

$$W = 5.93229 \times 10^{-6} L^{3.04990}$$

where  $W$  = weight (kg) and  $L$  = length (cm). Mean weights-at-age determined for the commercial catches for 1973-1976 were compared to the calculated estimates.

### RESULTS

For silver hake populating the Southern New England- Middle Atlantic region, 3,344 fish were aged (sexes combined) from 1973-1976 samples, and the von Bertalanffy growth equation obtained was:

$$l_t = 46.08 (1 - e^{-.4156(t-.2730)})$$

with  $l$  = length (cm) and  $t$  = age (years). From Georges Bank 1,681 fish were aged, and the resultant equation was:

$$l_t = 50.72 (1 - e^{-.2462(t+.6208)})$$

and from the Gulf of Maine, 3,858 fish were aged, and the equation obtained was:

$$l_t = 65.41 (1 - 3^{-.1818(t+.2746)})$$

Calculated lengths-at-age for each of these stocks and the mean lengths-at-age from the commercial catches are listed in Tables 1 and 3 and plotted in Figures 1-3 for the Southern New England-Middle Atlantic, Georges Bank, and Gulf of Maine stocks, respectively.

Calculated weights-at-age and the commercial catch mean weights-at-age are listed in Tables 2 and 4 and plotted in Figures 4-6 for the Southern New England-Middle Atlantic, Georges Bank, and Gulf of Maine stocks.

#### DISCUSSION

Examination of the length-at-age data (Tables 1 and 3, Figures 1-3) shows relatively close agreement between the calculated von Bertalanffy and mean commercial catch values during 1973-1976, although the commercial lengths-at-age are almost consistently larger than the calculated von Bertalanffy values. That is expected because the commercial values represent catches taken over the entire year and reflect the growth of fish during that year, whereas the von Bertalanffy values indicate the length-at-age of fish at the beginning of each calendar year. Another explanation for the difference in lengths-at-age is the difference in mesh size between the survey and commercial nets. Commercial nets with larger mesh (38-114 mm) will tend to catch the largest individuals of the younger age groups not fully recruited to the gear. The smaller mesh survey net with a 13 mm stretched mesh cod end liner samples a greater proportion of small fish than the larger mesh commercial nets.

The weight-at-age data (Tables 2 and 4, Figures 4-6) reflect the same sampling differences as with the lengths-at-age data. There is relatively close agreement in the calculated versus commercial mean weight-at-age, for those ages most prevalent in the catch (ages 3-8) but at the older ages the data appear to lack consistency. This is probably due to the lack of older age fish in both the commercial and survey samples. The calculated values show no severe increases or declines at the older ages, but the commercial values are generally very erratic, especially in the Southern New England-Middle Atlantic and Georges Bank stocks.

Examination of both the calculated lengths-at-age and the observed means from the commercial catch data indicates that silver hake in the Gulf of Maine grow faster and attain greater lengths than fish inhabiting waters further south. Schaefer (1960) examining fish collected in the New York Bight area indicated that growth is sexually dimorphic in silver hake with females growing faster and attaining greater lengths than males. The growth equations calculated using USA spring and autumn bottom trawl survey data support this conclusion and show that the maximum length reached by an individual was 66 cm and the maximum age was 15 years. Both of these fish were female, and were captured in the Gulf of Maine. The survey data also shows that males live to a maximum age of 9 years and a maximum length of 41 cm.

References

- von Bertalanffy, L. 1938. A quantitative theory of organic growth.  
Hum. Biol. 10: 181-213.
- Schaefer, R. H. 1960. A study of the growth and feeding habits of  
the whiting or silver hake in the New York Bight. N.Y. Fish  
Game J. 7(2): 85-98.

Table 1. Estimated lengths (cm)-at-age of silver hake (sexes combined) calculated using the derived von Bertalanffy growth equation versus mean lengths-at-age from commercial catches (1973-1976).

Age	Southern New England- Middle Atlantic		Georges Bank		Gulf of Maine	
	von Bertalanffy	Commercial data	von Bertalanffy	Commercial data	von Bertalanffy	Commercial data
1	12.0	22.9	16.7	23.6	13.5	24.8
2	23.6	28.8	24.1	28.5	22.2	29.1
3	31.3	32.0	29.9	31.0	29.3	32.8
4	36.3	36.2	34.5	34.0	35.3	37.3
5	39.6	39.3	38.0	36.4	40.3	41.4
6	41.8	41.5	40.8	39.6	44.5	41.0
7	43.3	43.8	43.0	41.0	48.0	49.8
8	44.2	53.4	44.6	51.7	50.9	55.4
9	44.9	46.2	46.0	50.0	53.3	55.7
10	45.3	56.5	47.0	57.0	55.3	55.0
11	45.6	-	47.8	56.5	57.0	57.4
12	45.7	-	48.5	50.5	58.4	-

Table 2. Estimated weights (kg)-at-age of silver hake (sexes combined) calculated using length-weight relationship derived from research vessel survey data versus mean weights (kg)-at-age from commercial catches (1973-1976).

Age	Southern New England- Middle Atlantic		Georges Bank		Gulf of Maine	
	Calculated	Commercial data	Calculated	Commercial data	Calculated	Commercial data
1	.012	.086	.032	.092	.017	.108
2	.091	.169	.097	.161	.076	.168
3	.216	.235	.188	.212	.177	.242
4	.339	.349	.291	.284	.312	.361
5	.443	.464	.390	.360	.467	.486
6	.522	.557	.485	.471	.632	.484
7	.581	.635	.569	.533	.796	.875
8	.619	1.132	.636	.989	.952	1.182
9	.649	.739	.699	.931	1.095	1.152
10	.667	1.446	.746	1.193	1.226	1.200
11	.681	-	.786	1.305	1.344	1.216
12	.685	-	.821	.800	1.447	-

Table 3. Mean lengths (cm)-at-age of silver hake from commercial catches (1973-1976) including the percentage of fish greater than the calculated  $L_{\infty}$  caught in each year.

Year	AGE												%> $L_{\infty}$
	1	2	3	4	5	6	7	8	9	10	11	12	
Southern New England-Middle Atlantic													
1976	20.5	29.1	31.6	35.0	39.8	40.3	48.0	-	-	-	-	-	.56
1975	24.8	27.7	30.9	36.0	39.3	41.1	43.6	-	-	-	-	-	1.18
1974	22.1	29.5	32.4	36.7	39.0	42.8	43.6	54.3	49.9	56.5	-	-	1.18
1973	24.0	28.9	32.9	37.1	38.9	41.9	39.8	52.5	42.5	56.5	-	-	.14
Mean	22.9	28.8	32.0	36.2	39.3	41.5	43.8	53.4	46.2	56.5	-	-	.77
Georges Bank													
1976	24.2	28.5	29.8	31.1	31.6	44.5	44.5	-	-	60.5	-	-	.08
1975	23.8	28.1	31.2	34.6	36.7	39.0	36.6	53.8	43.7	59.0	-	-	.14
1974	20.2	29.1	32.1	34.5	38.1	34.9	39.0	50.8	53.1	55.0	56.5	50.5	.18
1973	26.2	38.2	30.9	35.8	39.3	40.0	43.8	50.5	53.2	53.3	-	50.5	.08
Mean	23.6	28.5	31.0	34.0	36.4	39.6	41.0	51.7	50.0	57.0	56.5	50.5	.12
Gulf of Maine													
1976	24.4	28.4	32.8	35.4	40.7	39.6	52.9	60.5	-	-	-	-	0
1975	23.2	27.4	31.3	36.4	41.8	44.1	45.9	55.7	58.5	-	-	-	0
1974	25.0	30.7	34.1	38.3	40.4	39.6	49.8	52.8	54.9	55.8	56.5	-	0
1973	26.5	29.8	33.1	38.9	42.6	40.5	50.7	52.4	53.6	54.2	58.3	-	0
Mean	24.8	29.1	32.8	37.3	41.4	41.0	49.8	55.4	55.7	55.0	57.4	-	0

Table 4. Mean weights (kg)-at-age of silver hake from commercial catches (1973-1976).

Year	AGE											
	1	2	3	4	5	6	7	8	9	10	11	12
Southern New England-Middle Atlantic												
1976	.064	.169	.218	.306	.479	.511	.823	-	-	-	-	-
1975	.114	.150	.207	.336	.458	.534	.593	-	-	-	-	-
1974	.076	.178	.241	.362	.460	.599	.638	1.144	.929	1.297	-	-
1973	.091	.179	.272	.390	.459	.584	.485	1.119	.548	1.595	-	-
Mean	.086	.169	.235	.349	.464	.557	.635	1.132	.739	1.446	-	-
Georges Bank												
1976	.099	.159	.188	.217	.236	.649	.689	-	-	1.272	-	-
1975	.091	.151	.207	.288	.349	.420	.343	1.085	.621	1.236	-	-
1974	.061	.176	.239	.298	.407	.323	.457	.942	1.075	1.191	1.305	.791
1973	.118	.157	.215	.234	.447	.492	.643	.939	1.096	1.073	-	.808
Mean	.092	.161	.212	.284	.360	.471	.533	.989	.931	1.193	1.305	.800
Gulf of Maine												
1976	.104	.151	.235	.294	.436	.431	.982	1.654	-	-	-	-
1975	.081	.135	.204	.319	.503	.622	.797	1.139	1.219	-	-	-
1974	.103	.187	.256	.372	.418	.390	.778	.909	1.118	1.218	1.057	-
1973	.142	.197	.272	.459	.585	.491	.943	1.026	1.119	1.182	1.375	-
Mean	.108	.168	.242	.361	.486	.484	.875	1.182	1.152	1.200	1.216	-

Table 5. von Bertalanffy parameters calculated for separate sexes.

	$L_{\infty}$	K	$t_0$	Number of fish aged
Southern New England-Middle Atlantic				
Males	34.80	.5545	-.2940	1031
Females	66.39	.1794	-.6682	1482
Georges Bank				
Males	35.15	.5525	-.1320	463
Females	91.13	.0818	-2.1216	596
Gulf of Maine				
Males	40.47	.3140	-.7253	778
Females	92.03	.0993	-1.0229	1269

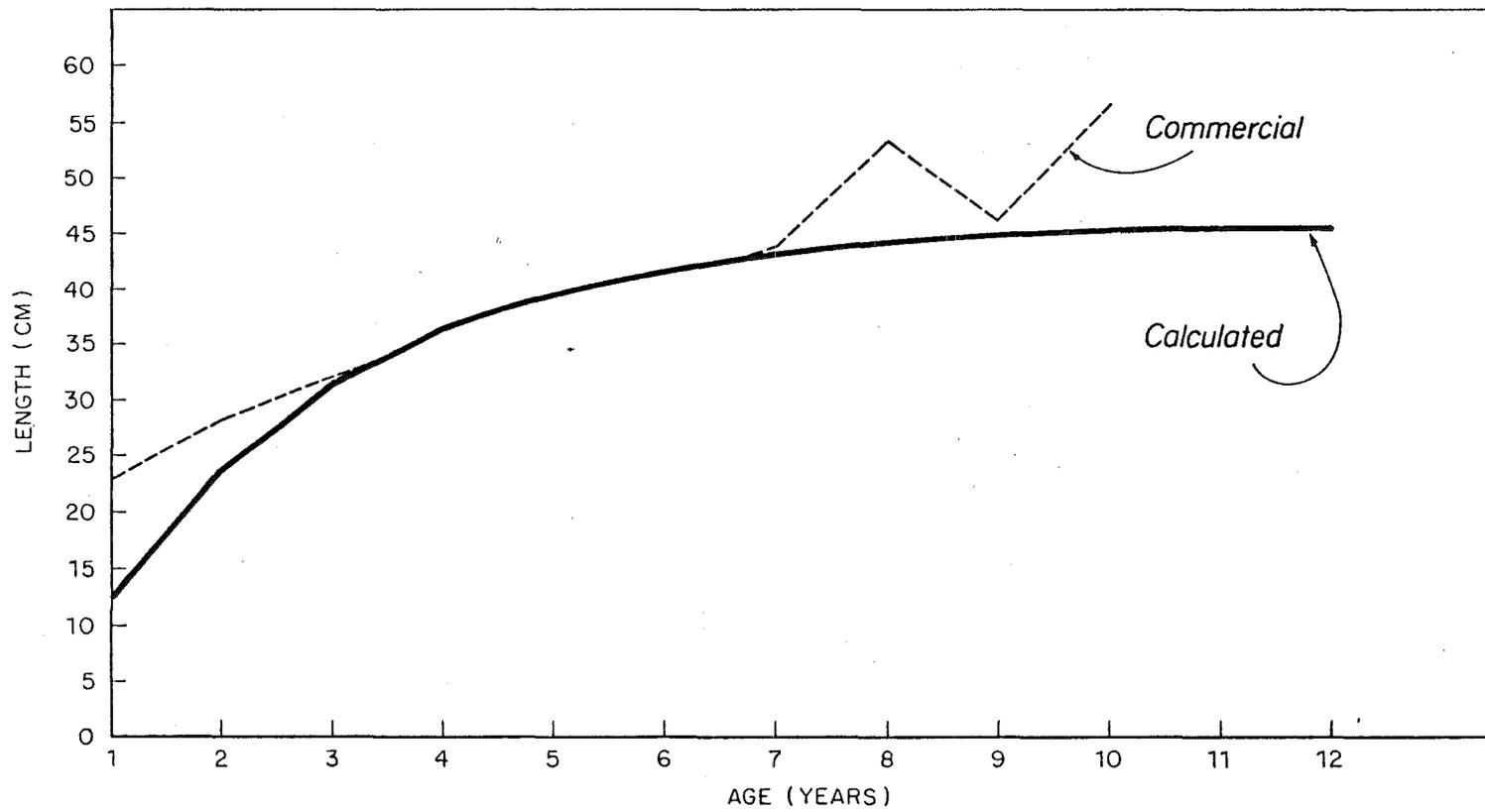


Figure 1. Lengths-at-age of Silver Hake from the Southern New England - Middle Atlantic stock.

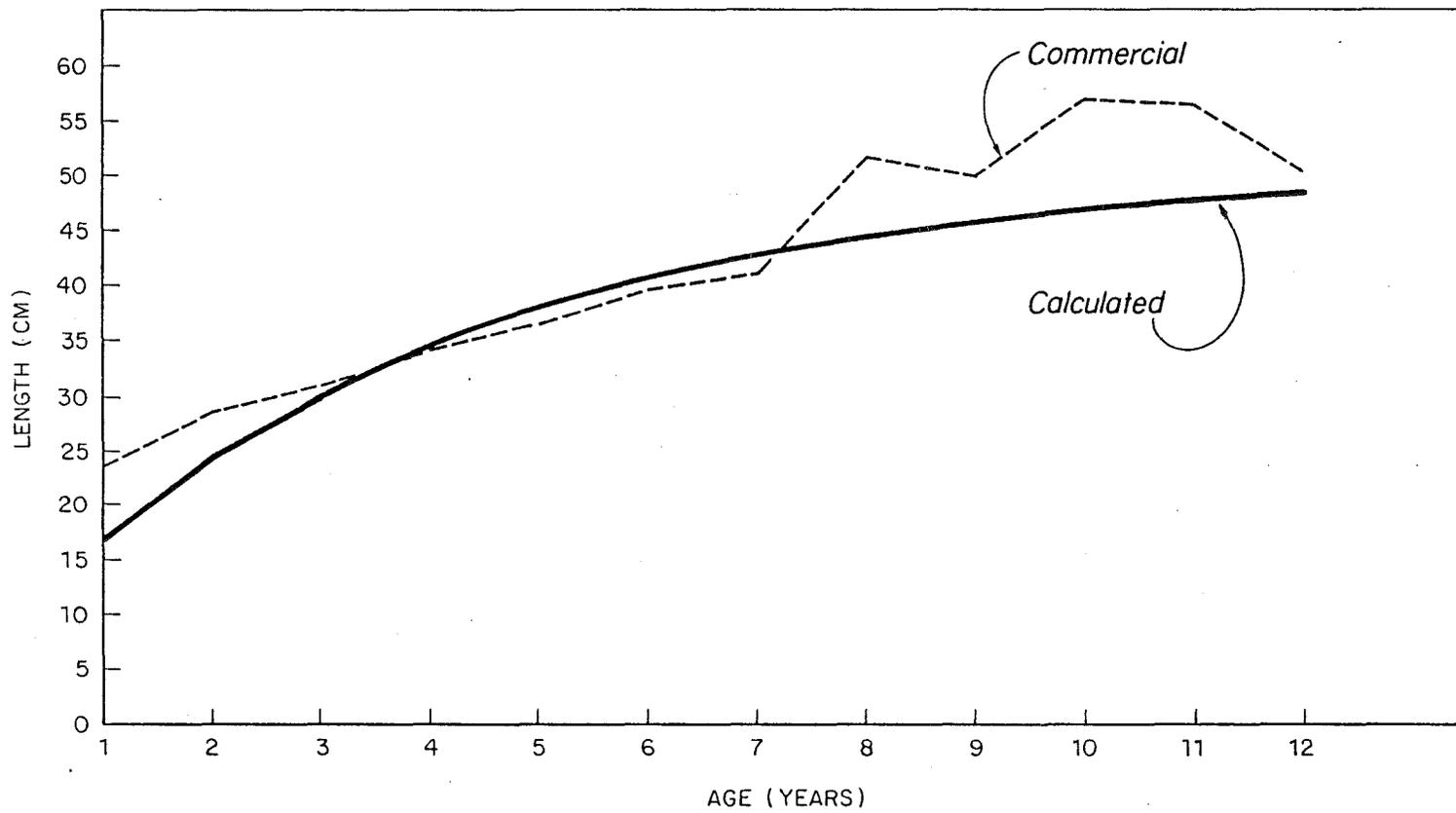


Figure 2. Lengths-at-age of Silver Hake from the Georges Bank stock.

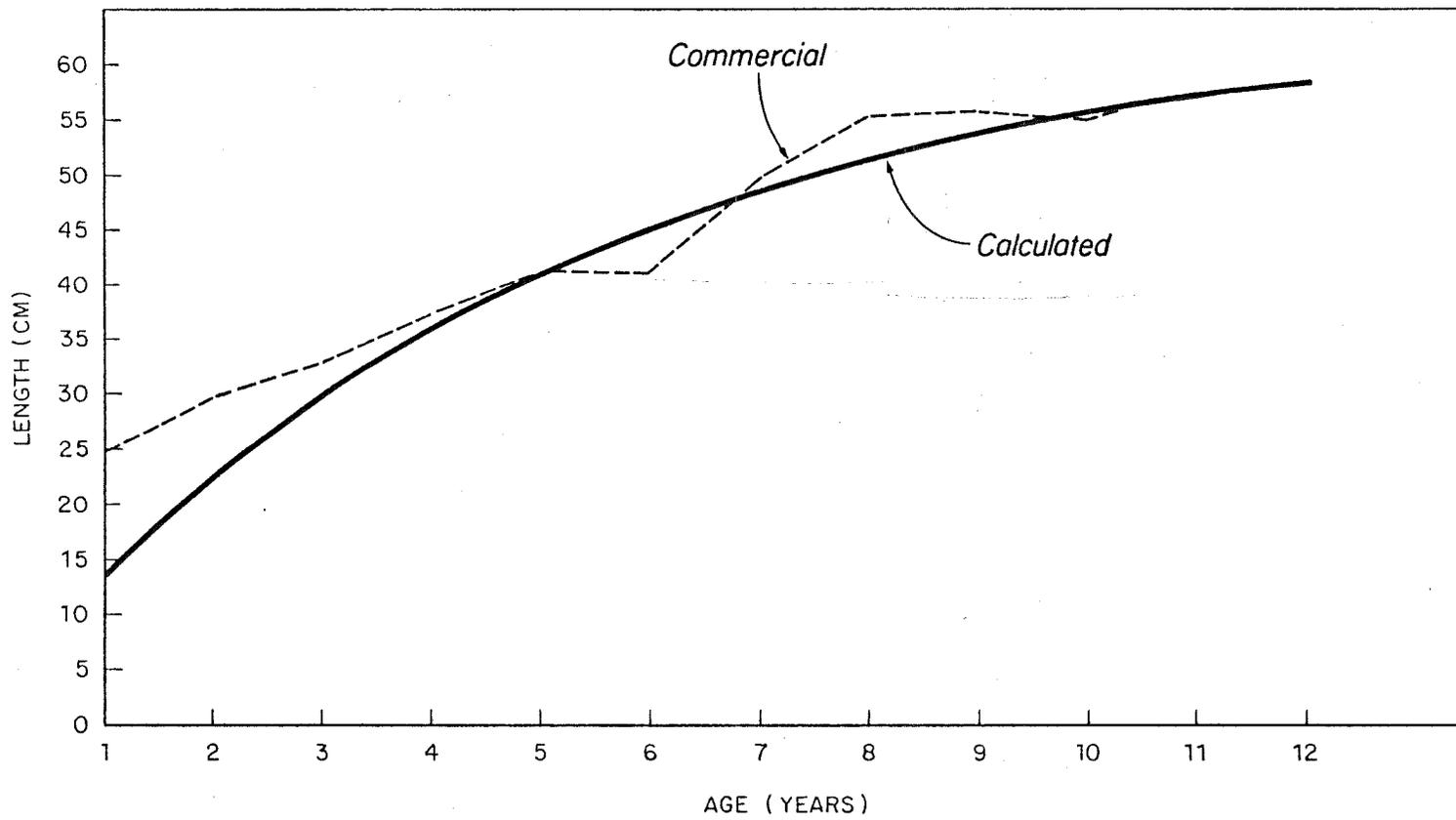


Figure 3. Lengths-at-age of Silver Hake from the Gulf of Maine stock.

**FIGURE 4 IS MISSING**

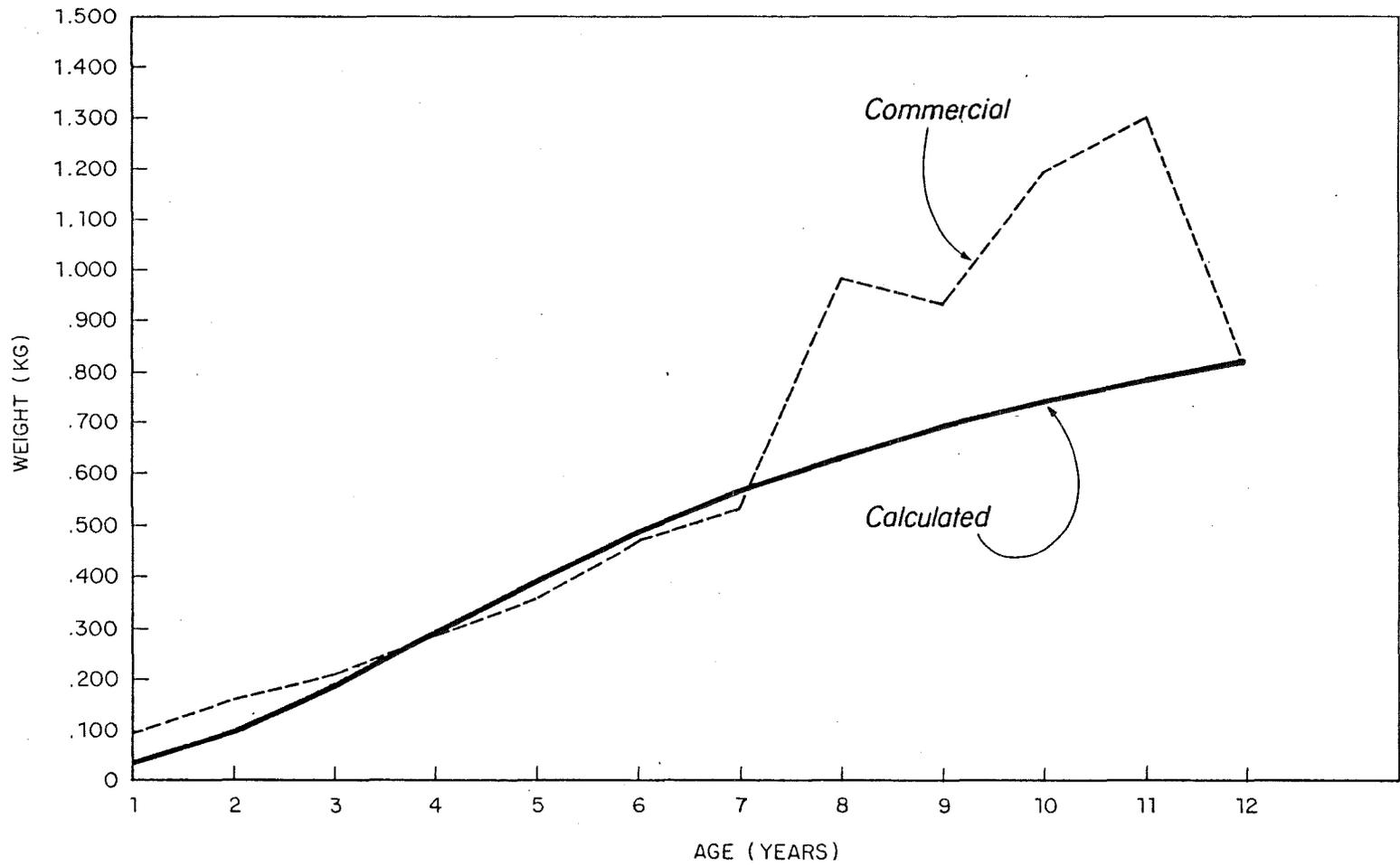


Figure 5. Wiegths-at-age of Silver Hake from the Georges Bank stock.

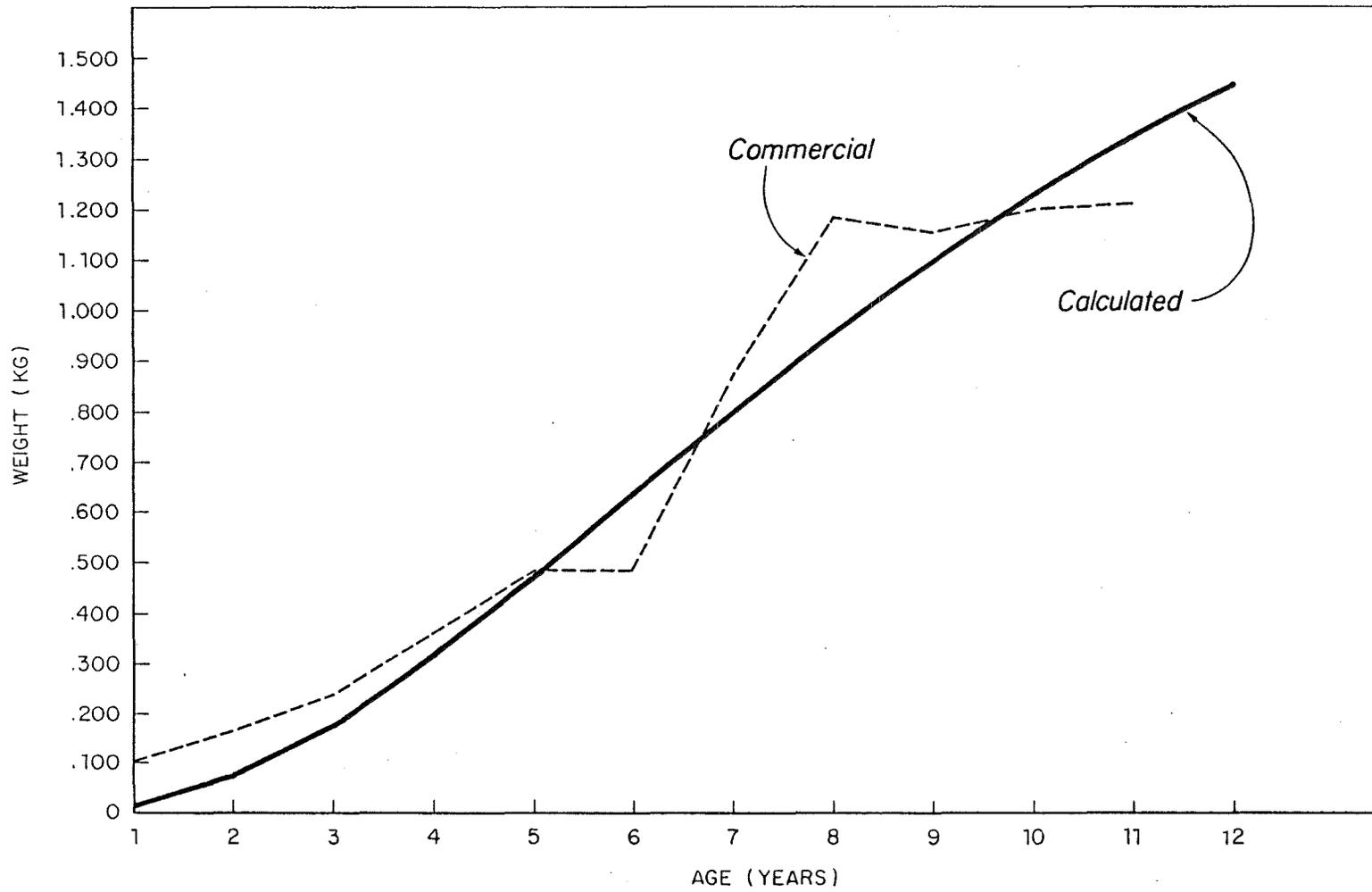


Figure 6. Weights-at-age of Silver Hake from the Gulf of Maine stock.