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Conversion Factors for Silver Hake on Four Soviet Trawlers Fishing in 1981

by

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Abstract

The conversion factor for headed-gutted silver hake on Soviet trawlers fishing on the Scotian Shelf was estimated during the period April 25-July 29, 1981. Eighty-seven samples were collected for a total of about 17,000 fish. A combined mean conversion factor of 1.594 was found. Both hand and machine processing were observed with no significant difference between methods. Sample mean length and weight did not contribute significantly to the observed variation in conversion factors. However, there was a significant time-dependent trend in the data which may reflect the spawning condition of the fish. Overall the authors recommend that the conversion factor for headed-gutted silver hake be set at 1.6.

Résumé

Le facteur de conversion du merlu argenté étêté et vidé a été estimé à bord de chalutiers soviétiques pêchant sur le plateau Scotian entre le 25 avril et le 29 juillet 1981. On a recueilli 87 échantillons, soit un total d'environ 17 000 poissons. On a trouvé un facteur de conversion moyen conbiné de 1 594. Les observations sur le traitement tant manuel que mécanique ne montrent pas de différences significatives entre les deux méthodes. La longueur et le poids moyens des échantillons ne contribuent pas significativement à la variation observée des facteurs de conversion. Cependant, il y a une tendance marqée, dépendante du temps, dans les données, tendance qui peut refléter la condition sexuelle des poissons. Dans l'ensemble, les auteurs recommandent que le facteur de conversion du merlu argenté étêté et vidé soit fixé à 1,6.

Introduction

Waldron (1979) reported that the major harvester of silver hake on the Canadian East Coast was the Soviet Union. This has not changed and the USSR remains the harvester of about three quarters of the total catch.

The general practice aboard Soviet trawlers has been to base catch estimates upon production totals multiplied by a conversion factor. Weekly catch and effort reports are given in round weight converted from production totals. Soviet trawlers are currently using conversion factors of 1.416 (Baltic based) and 1.477 (Murmansk based) for headed and gutted silver hake (FAO 1979, Sinclair and Waldron, unpublished). However, the authors were unable to find, in the literature, evidence to substantiate these figures.

The accuracy of catch figures derived from production figures depends on the accuracy of the conversion factor. A low factor would result in a greater quantity of fish being removed than reported. This paper deals with conversion factors of silver hake used by the Soviet fleet operating in NAFO Division 4W during the 1981 silver hake fishery.

Materials and Methods

The experimental work was conducted between April 26 and July 29, 1981, aboard four trawlers, the Krasnoputilovets, the Anatoliy Bredov, the Kristyan Raud and the Zhemchug. A team of 2 observers was specially trained and equipped for that study. The team moved from vessel to vessel and no two vessels were covered simultaneously. Extra emphasis was placed on equipment and training in order to produce high quality results.

The observers were supplied with a Howe-Richardson 0-100 kg platform scale and a Chatillion 0-100 lbs hanging spring scale. Both scales were used simultaneously to take weights and each was calibrated periodically at sea with pre-weighed lead weights.

The calculation of the conversion factor is a simple matter:

$$C.F. = \frac{\text{round weight}}{\text{product weight}}$$

The procedure was to obtain a sample of fish, weigh it round, pass it through production and then reweigh the product form. The validity of the results depends on the accuracy of weighings, the randomness of the sample and the authenticity of the processing techniques. Every effort was made to ensure that these criteria were met. In the case of the latter criteria, attempts were made to have different individuals process the fish on separate runs and to compare the sample product form to the regular product form to ensure that the samples were processed in a way similar to the usual procedure on the vessel.

Table 1 indicates that 53% of the 1981 total Soviet catch of silver hake was processed as headed-gutted, with the majority of the remainder frozen round. Small quantities were processed in either headed-gutted-trimmed or fillet product forms. All sampling work was with headed-gutted product.

Samples of silver hake were taken in the following way - random samples of approximately 300 fish were obtained from the catch and were measured for length. Fish less than 20 cm were generally passed directly to fish meal during normal vessel production and were excluded from the study. To investigate the effect of average length on conversion factor the fish were usually separated into 2 length groups, 20-29 cm and 30+ cm. Twelve samples were not separated into length groups.

Each group of fish was then considered a separate sample. The following data were recorded for each sample.

1. Vessel Identification.

2. Set Number, to correspond with the set number recorded on regular data sheets.

3. Sample Number, each sample was given a separate number.

4. Length Range, to specify which length group the fish were separated into, either 20-29 cm, 30+ cm, or 20+ cm.

5. Week of Sampling, the week of the sample was recorded.

6. Type of Production, hand-cut, machine-cut, machine-cut-pectorals-off, machine cut-pectorals-on.

7. Mean Length, determined from the length frequency.

8. Mean Weight, calculated as the round weight of the sample divided by the number of fish in the sample.

9. Conversion Factor, calculated as indicated above.

This information was coded and the data input to a computer file. The data were then analysed using SPSS statistical packages. A total of 90 samples were collected. Of these three were eliminated from the study because of either an error in weight measurement, interference in the processing technique or the addition of extra fish to the sample. Of the remaining samples 67 were hand-cut and 20 were machine cut. Ten of the machine-cut samples did not reflect normal operations of the vessel as production at the sampling time was mainly frozen round silver hake. Five of these samples were processed in a manner which differed from the normal method of production. The fish were headed by a cut anterior to the pectoral fins. The remaining 5 samples were headed with a cut posterior

to the pectoral fins. However, these samples were included in the analysis. Regarding length grouping of the samples 38 were 20-29 cm, 37 were 30+ cm, and 12 were not separated into length groups.

Results

The frequency distributions and means of sample mean lengths, mean weight and conversion factor are presented in Figures 1-3. The distributions for machine-cut and hand-cut samples are presented separately and combined.

Sample mean lengths and weights for hand-cut samples were bi-modal due to the separation of samples into 2 size categories. Machine-cut samples, on the other hand, include samples which were not separated into size groups and thus some samples are in the middle of the mean length and mean weight range. Sample mean lengths ranged from 26.77 cm to 33.55 cm with a combined mean of 30.03 cm. Sample mean weights ranged from 144 gm to 311 gm with a combined mean of 205 gm.

The frequency distribution of conversion factors (Figure 3) was uni-modal for both machine-cut and hand-cut samples. The mean for hand-cut samples was 1.601 and for machine-cut samples 1.5731. When both types of samples were combined the mean conversion factor was 1.5944. The range of conversion factors was 1.278 to 1.772.

Scattergrams of conversion factors vs samples mean length and sample mean weight were examined for possible relationships. In the case of mean length the points were separated into 2 clumps due to the separation of fish into size groups (Figure 4). There did not appear to be any length-dependent variation in conversion factors. The same could be said about the effect of mean weight on conversion factor (Figure 5).

Average conversion factors for the 4 production methods observed are given in Table 2a. The conversion factors for hand-cut, machine-cut, and machine-cut-pectorals-off methods were virtually identical. However, when the fins were left on the conversion factor was noticably lower. Analysis of variance of conversion factor by processing method did not indicate a significant difference in conversion factor for the 4 processing methods ($p > .05$) (Table 2b).

Average conversion factors by week are given in Table 3a and are plotted in Figure 6. A dome shaped trend in conversion factors is indicated, beginning with an average of 1.475 in week 18 increasing to a maximum of 1.687 in week 23 and decreasing to 1.548 in week 30. Analysis of variance indicated a significant difference in conversion factor among the weeks ($p < .001$) (Table 3b). The high variance in week 18 may be attributed to an observation of 1.278 which stands out from the clusters in Figures 4 and 5.

Average conversion factors by vessel are given in Table 4a and are plotted in Figure 6. Analysis of variance (Table 4b) indicated a significant difference of conversion factors among vessels ($p < .001$). However this possibly is due to the variation in conversion factor with time. Since only one team of observers made the observations it is not possible to separate the time and vessel effects. However a time-trend in conversion factors is apparent within vessels. Observations in week 18-20 were from one vessel, in week 21-23 from another vessel. Thus on the same vessel there was an increasing trend in conversion factor to week 23.

To examine the combined effect of length, weight, and date on conversion factor, analysis of co-variance was used. Length and weight were used as covariates and grouping was done by week. The results are given in Tables 5 a and b. Neither mean length nor mean weight contributed significantly to the variation of conversion factor.

In summary the variables of sample mean length, mean weight, length grouping, and production type alone did not have significant effects on the observed conversion factors. The variables of week and vessel did have significant impacts, however, it is likely that the vessel effect may be a partial result of the date effect. With all data combined the average conversion factor was 1.594 (calculated as $\Sigma (x/y)/n$) with a 95% confidence interval of [1.576 - 1.612].

Discussion

The 87 samples that made up this study represent approximately 17,000 silver hake. These were selected randomly, weighted accurately, and unless otherwise noted, processed in a manner as close to actual production as possible.

Due to the fact that only a single team of observers participated in the study it was not possible to simultaneously test all the variables collected. That is, date and vessel interactions, production method and date interactions, etc. Despite these problems it is apparent that the actual conversion factor for processing headed gutted silver hake is greater than the 1.416 and 1.477 values used on Soviet trawlers. The questions of what caused the observed variation in conversion factor and what would be a reasonable conversion factor still remain.

It was expected that length and weight would have an effect on conversion factor. This was not the case possibly because of the narrow range of sample mean lengths and weights.

The apparent date effect on conversion factor cannot be explained with the data gathered in this study but it may be explained by the condition of the fish used in the study. Waldron (unpublished data) noticed a change in the length-weight relationship of silver hake throughout the 1981

fishery. From April to June (weeks 16-27) silver hake were observed to increase in weight for similar lengths. Then in July and August (weeks 28-36) weights decreased for similar lengths. This could be due to the ripening of gonads followed by spawning. One would expect ripe fish to have a higher conversion factor than spent or resting fish since the viscera would form a higher proportion of the total body weight. Leim and Scott (1966) report that silver hake spawn from June to September. Since the study spanned the pre-spawning and spawning period this may explain the temporal trend in conversion factor.

The intent of this study was to suggest a conversion factor for headed and gutted silver hake. It may be desirable to have a range of conversion factors which reflects the changing condition of the fish, variations among vessels, and variation among production methods. However, such is beyond the range of this data set, and would require very extensive study and monitoring throughout each fishing season. Alternatively a point estimate of a conversion factor which represents the average experienced through a fishery may suffice. The results of this study indicate a factor of 1.6 would be appropriate.

Impact

Based on the 1981 production log books of all Soviet trawlers within the Canadian zone the year's total round weight catch for silver hake was 37,631,686 kilograms. Of this 19,963,239 kg or 53.05% was processed as headed and gutted, 14,197,197 kg or 37.73% frozen round and the remaining 9.22% processed either as meal, headed-gutted-trimmed, skin on fillet or head off (Table 1).

Applying the recommended conversion factor of 1.6 to the headed and gutted portion of the catch 2,455 tons of silver hake would have gone unreported in 1981 (Table 6). Using the same approach 3,622 t would have gone unreported in 1979 (Table 7).

Recommendations

Should further studies into silver hake headed and gutted conversion factors take place, attention must be paid to measuring the gonadal indicies and acquiring more data for individual lengths in order to refine the prediction of changes. Differences in machine-cut and hand-cut factors were not significant and further study is not required in this area.

The use of 2 observers in experiments of this type is highly recommended. It is imperative that observers be in constant contact with all phases of the production process as the experiment is being conducted and this would be too great a job for one observer.

Acknowledgement

This project was greatly assisted by the advice of W. Barrington, Fisheries Operations Branch, Department of Fisheries and Oceans. Observers P. Turner and D. Spallin took part in the data collection. Their assistance was invaluable.

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Table 1. 1981 processing of catch in three periods.

Date	Total Fish Caught(kg)	S.H.(Round) %	S.H.(H/G) %	S.H.(Meal) %	S.H.(H/G/T) %	S.H.(S/F) %	S.H. (Head off) %
From April 15 to June 6/81	14,377,743	18.78	74.51	1.72	3.98	1.0	-
From June 7 to June 27/81	9,006,481	47.94	41.32	2.04	4.89	2.47	1.35
From June 28 to End/81	14,247,462	50.39	38.81	5.87	1.28	1.21	2.44
Total	37,631,686	14,197,197	19,963,239	1,267,974	1,194,518	539,294	469,464
% of Total		37.73%	53.05%	3.36%	3.17%	1.43%	1.24%

S.H.: Silver Hake

H/G: Headed-Gutted

H/G/T: Headed-Gutted Trimmed

S/F: Skin on Fillet

Table 2: a) Average conversion factors for the 4 processing methods observed during the study.

b) Analysis of variance between production methods.

a) PROCESS

	MEAN	SUM OF SQ	N
HAND-CUT	1.6008	.5503	(67)
MACHINE-CUT	1.5970	.0291	(10)
MACHINE-CUT-PECTORALS-ON	1.4902	.0048	(5)
MACHINE-CUT-PECTORALS-OFF	1.6080	.0138	(5)
	1.5944	.6560	(87)

b)

	SUM OF SQUARES	DEGRESS OF FREEDOM	MEAN SQUARE
BETWEEN GROUPS	.0580	(3)	.0193
WITHIN GROUPS	.5980	(83)	.0072
TOTAL	.6560	(86)	

F = 2.6841 SIG. = .0519

$F_{.05(3.83)} = 2.73$

Table 3: a) Average conversion factors for each week of the study

b) Analysis of variance between weeks.

a)

WEEK	MEAN	STD DEV	N
18	1.4750	.1448	(6)
19	1.5453	.06933	(14)
20	1.5911	.0372	(8)
21	1.6031	.0549	(15)
22	1.6622	.0663	(20)
23	1.6870	.0342	(4)
25	1.6110	.0549	(8)
30	1.5477	.0697	(12)
	1.5944	.0873	(87)

b)

	SUM OF SQUARES	DEGREES OF FREEDOM	MEAN SQUARE
BETWEEN GROUPS	.2752	(7)	.0393
WITHIN GROUPS	.3808	(79)	.0048
TOTAL	.6560	(86)	

F = 8.1566 SIG. = 0

Table 4: a) average conversion factors by vessel.

b) Analysis of variance between vessels.

a)

VESSEL CODE	MEAN	STD DEV	N
100	1.5433	.0909	(28)
200	1.6421	.0665	(39)
300	1.6110	.0549	(8)
400	1.5477	.0697	(12)
	1.5944	.0873	(87)

b.

	SUM OF SQUARES	DEGREES OF FREEDOM	MEAN SQUARE
BETWEEN GROUPS	.1899	(3)	.0633
WITHIN GROUPS	.4661	(83)	.0056
TOTAL	.6560	(86)	

F = 11.2732 SIG. = .0000

Table 5: a) Analysis of co-variance using sample mean length as a co-variante and grouping by week.

b) Analysis of co-variance using sample mean weight as a co-variante and grouping by week.

a)

SOURCE OF VARIATION	SUM OF SQUARES	DF	MEAN SQUARE	F	SIGNIF OF OF F
COVARIATES	.000	1	.000	.056	.813
LEN	.000	1	.000	.056	.813
MAIN EFFECTS	.268	7	.038	7.719	.001
WK	.268	7	.038	7.719	.001
EXPLAINED	.269	8	.034	6.761	.001
RESIDUAL	.387	78	.005		
TOTAL	.656	86	.008		

b)

SOURCE OF VARIATION	SUM OF SQUARES	DF	MEAN SQUARE	F	SIGNIF OF F
COVARIATES	.008	1	.008	1.719	.194
WT	.008	1	.008	1.719	.194
MAIN EFFECTS	.262	7	.037	7.577	.001
WK	.262	7	.037	7.577	.001
EXPLAINED	.271	8	.034	6.845	.001
RESIDUAL	.385	78	.005		
TOTAL	.656	86	.008		

Table 6. Percent of total 1981 catch by fleet and effect of 1.6 conversion factor.

Fleet	Baltic	Murmansk
Number of vessels	19	9
Percentage of total vessels	68%	32%
Percentage of total catch caught by fleet	73.1%	26.9%
Percentage of total headed and gutted production processed by fleet	85.5%	14.5%

Total headed and gutted production 1981 = 19,963,239 kg.

Baltic fleet C.F. = 1.416 ⟶ 13% lower than 1.6
Murmansk fleet C.F. = 1.477 ⟶ 8% lower than 1.6

85.5% of 20,000 tons = 17,100 ⟶ 13% of this = 2223 tons
14.5% of 20,000 tons = 2,900 ⟶ 8% of this = 232 tons

2455 tons

Table 7. Effect of 1.6 conversion factor on 1979 headed and gutted silver hake production.

1979 Production[1]

frozen round	8,981.9 ∿	9,000 tons	→ 20%
headed and gutted	31,436.6 ∿	31,500 tons	→ 70%
headed - gutted - trimmed	4,490.9 ∿	4,500 tons	→ 10%
		45,000 tons	→ 100%

Assuming a 70% - 30% split between Baltic and Murmansk headed and gutted production then:

Total headed and gutted production = 31,500 tons.

Baltic at 70% = 22,050 tons	→ 13% of this =	2866.5
Murmansk at 30% = 9,450 tons	→ 8% of this =	756
		3622.5

[1] Source - Sinclair and Waldron unpublished.

LENGTH (cm)	Combined		Machine-cut		Hand-cut	
<25.0	0		0		0	
25.0-25.5	0		0		0	
25.5-26.0	0		0		0	
26.0-26.5	0		0		0	
26.5-27.0	1	□	0		1	□
27.0-27.5	4	□□□□	0		4	□□□□
27.5-28.0	9	□□□□□□□□□	2	□□	7	□□□□□□□
28.0-28.5	23	□□□□□□□□□□□□□□□□□□□□□□□	2	□□	21	□□□□□□□□□□□□□□□□□□□□□
28.5-29.0	1	□	0		1	□
29.0-29.5	0		0		0	
29.5-30.0	0		0		0	
30.0-30.5	6	□□□□□□	6	□□□□□□	0	
30.5-31.0	3	□□□	3	□□□	0	
31.0-31.5	5	□□□□□	0		5	□□□□□
31.5-32.0	23	□□□□□□□□□□□□□□□□□□□□□□□	2	□□	21	□□□□□□□□□□□□□□□□□□□□□
32.0-32.5	7	□□□□□□□	2	□□	5	□□□□□
32.5-33.0	4	□□□□	2	□□	2	□□
33.0-33.5	0		0		0	
33.5-34.0	1	□	1	□	0	
34.0-34.5	0		0		0	
34.5-35.0	0		0		0	
35.0+	0		0		0	

MEAN 30.02517241; *MEAN* 30.6035; *MEAN* 29.85253731;

Figure 1. Distribution of sample mean lengths for all samples combined, machine-cut samples, hand-cut samples.

WEIGHT (gm)	Combined	Machine-cut	Hand-cut
<100	0	0	0
100-110	0	0	0
110-120	0	0	0
120-130	0	0	0
130-140	0	0	0
140-150	5	0	5
150-160	6	0	6
160-170	16	3	13
170-180	9	1	8
180-190	3	2	1
190-200	3	2	1
200-210	3	3	0
210-220	3	2	1
220-230	6	0	6
230-240	8	0	8
240-250	13	1	12
250-260	6	2	4
260-270	2	1	1
270-280	1	1	0
280-290	1	0	1
290-300	0	0	0
300-310	0	0	0
310-320	2	2	0
320-330	0	0	0
330-340	0	0	0
340-350	0	0	0
350+	0	0	0

MEAN 205.1034483; *MEAN* 218.4; *MEAN* 201.1343284;

Figure 2. Distribution of sample mean weights for all samples combined, machine-cut samples, hand-cut samples.

CONVERSION FACTOR

	Combined		Machine-cut		Hand-cut	
<1.20	0		0		0	
1.20-1.25	0		0		0	
1.25-1.30	1	□	0		1	□
1.30-1.35	0		0		0	
1.35-1.40	0		0		0	
1.40-1.45	4	□□□□	1	□	3	□□□
1.45-1.50	6	□□□□□□	2	□□	4	□□□□
1.50-1.55	15	□□□□□□□□□□□□□□□	5	□□□□□	10	□□□□□□□□□□
1.55-1.60	17	□□□□□□□□□□□□□□□□□	6	□□□□□□	11	□□□□□□□□□□□
1.60-1.65	20	□□□□□□□□□□□□□□□□□□□□	3	□□□	17	□□□□□□□□□□□□□□□□□
1.65-1.70	14	□□□□□□□□□□□□□□	2	□□	12	□□□□□□□□□□□□
1.70-1.75	9	□□□□□□□□□	1	□	8	□□□□□□□□
1.75-1.80	1	□	0		1	□
1.80-1.85	0		0		0	
1.85-1.90	0		0		0	
1.90-1.95	0		0		0	
1.95-2.00	0		0		0	
2.00+	0		0		0	

MEAN 1.594413793; *MEAN* 1.57305; *MEAN* 1.600791045;

Figure 3. Distribution of sample conversion factors for all samples combined, machine -cut samples, hand-cut samples.

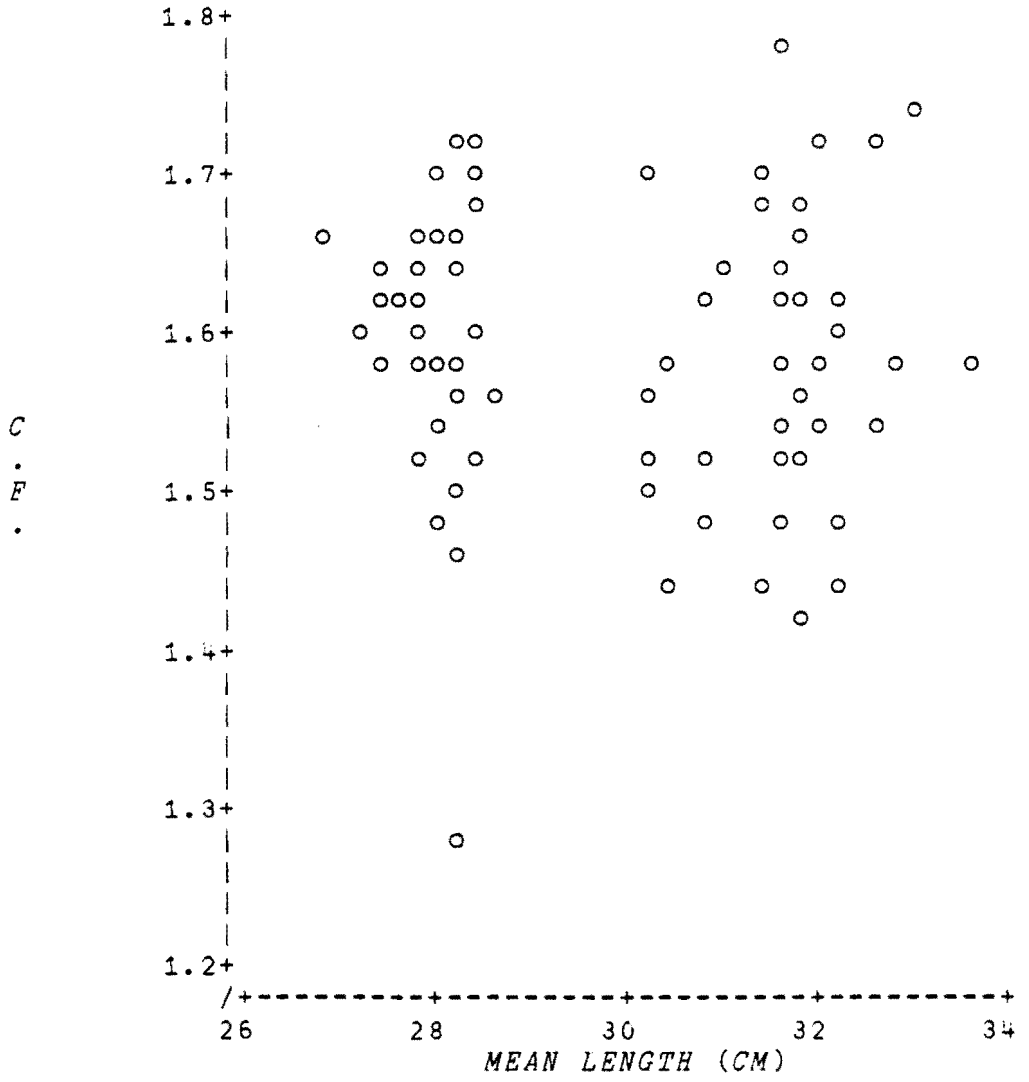

Figure 4. Scatter-plot of conversion factor and sample mean length.

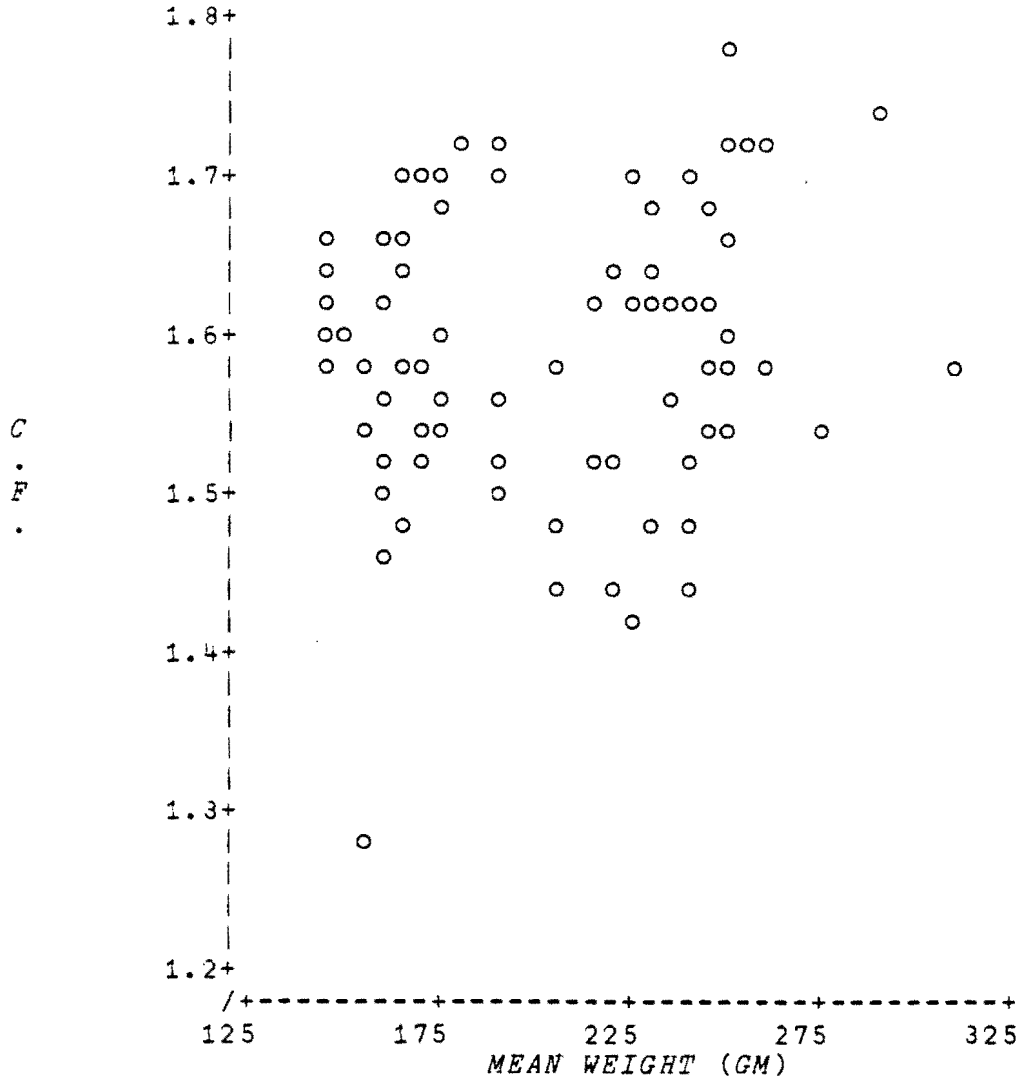

Figure 5. Scatter-plot of conversion factor and sample mean weight.

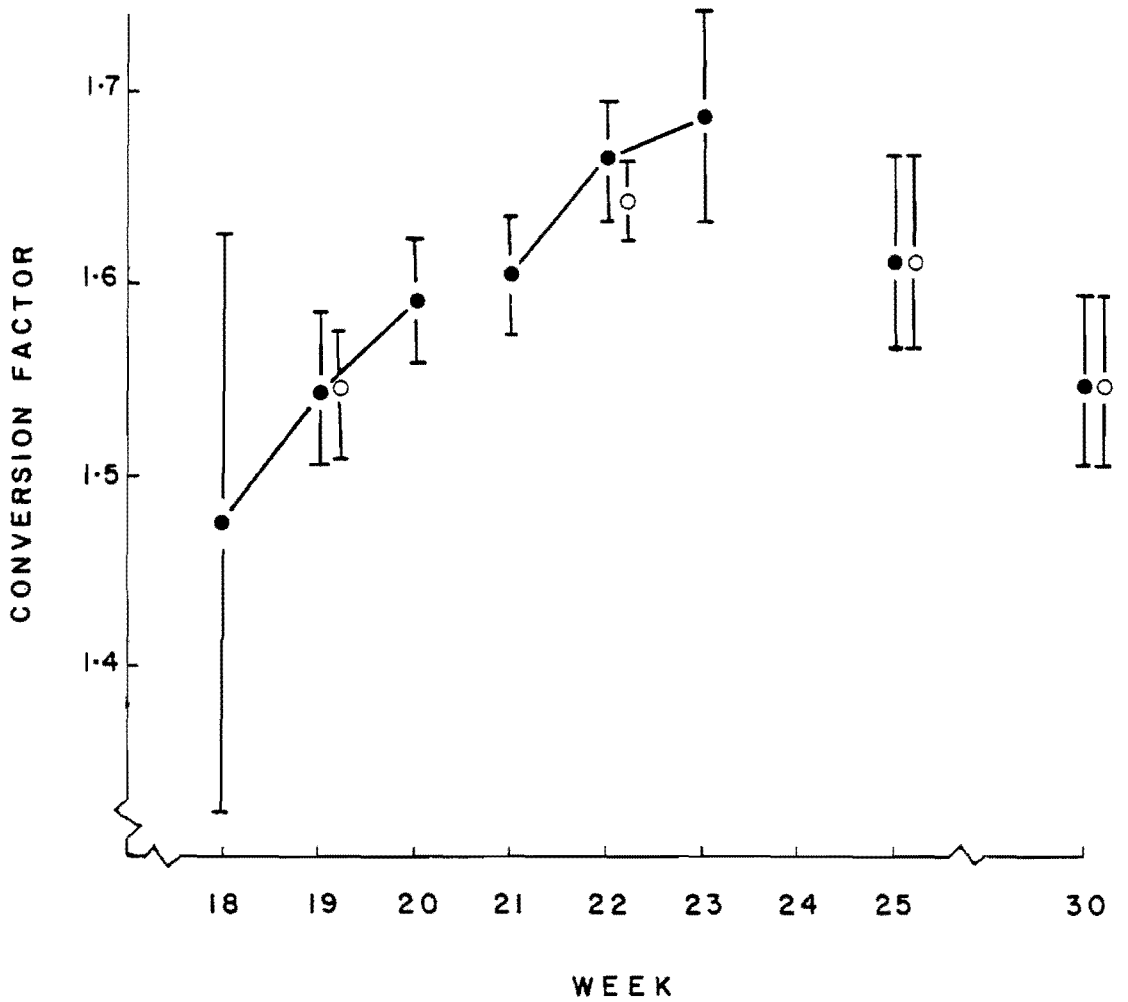

Figure 6. Average conversion factor by week (●) and by vessel (○) for all data combined. Weekly means from the same vessels are joined. Error bars indicate 95% confidence intervals.