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Shell height-meat weight allometry of Georges Bank scallop (*Placopecten magellanicus*) stocks

By

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ABSTRACT

This document provides a shell height measure equivalent to the meat count currently in regulation (33 meats per 500 g) and presents analysis of shell height-meat weight allometric relationship for scallop stocks on the Canadian side of Georges Bank. Over 8,000 scallops ranging in height from 48 to 166 mm (meat weight 1.14 - 79.95 g) were collected from the commercial fleet and stock survey cruises during 1982 to 1985. To establish an equivalent shell height measure to the current meat count, it is assumed here that the average meat weight corresponding to 33 meats per 500 g is 15.15 g.

In this type of allometric relationship, over 90 % of the variability in the meat weight values is explained by the shell height measurements. Variability in this relationship was looked at from seasonal and annual points of view. A strong seasonal component has not been established significantly for all sets of data. However, annual variability has been shown to occur between successive years. The percentage difference between annually-derived equations and the generalised equation is less than 5 %.

An equivalent mean shell height for a 15.15 g meat is determined at 101 mm using the equations presented here. From the point of view of enforcement of a management measure for the scallop fishery, practical considerations may seriously diminish the usefulness of a shell height measurement as an alternative to the application of a meat count on the commercial catch.

RESUME

Ce document établit une mesure de hauteur de coquille équivalente au compte de chairs couramment en vigueur (33 chairs par 500 g) et présente une analyse de la relation allométrique hauteur de coquille - poids de chair pour les stocks de pétoncles de la portion Canadienne du banc Georges. Plus de 8,000 pétoncles variant en hauteur de 48 à 166 mm (poids de chair 1.14 - 79.95 g) ont été prélevés de la flottille commerciale et des croisières d'inventaires de recherche pendant les années 1982-1985. Pour établir une mesure de coquille équivalente au compte de chairs en vigueur, on assume que le poids moyen d'une chair correspondant à 33 chairs par 500 g est égal à 15.15 g.

Plus de 90 % de la variabilité des valeurs de poids de chairs s'explique par les mesures de hauteurs de coquille dans ce genre de relation allométrique. On a examiné cette variabilité du point de vue saisonnier et annuel. On n'a pas pu établir significativement une forte composante saisonnière pour tous les groupes de données. Cependant, on a pu démontré de la variabilité annuelle entre des années successives. Il y a une différence, exprimée en pourcentage, de moins de 5 % entre des équations dérivées sur une base annuelle et l'équation généralisée.

D'après ces équations, une hauteur de coquille moyenne qui correspondrait à une chair de 15.15 g serait de 101 mm. Du point de vue de la mise en vigueur d'une mesure de gestion pour la pêche au pétoncle, des considérations pratiques pourraient sérieusement diminuer l'utilité d'une mesure de hauteur de coquille comme alternative à l'application d'un compte de chairs sur les prises commerciales.

INTRODUCTION

Mollusc morphometric studies have long been interested in length-weight relationships (Wilbur and Owen 1964), especially for bivalve species of commercial importance (cockles, mussels, clams, etc.). A great deal of variability is inherent to this relationship due to geographic location, environmental conditions, and biological production. High variability may even be encountered over a relatively small geographical scale (MacDonald and Thompson 1985). Variability in meat weight of scallop species is primarily due to fluctuations in food supply and the reproduction cycle (Mottet 1979). In the deep-sea scallop, *Placopecten magellanicus*, metabolic studies (Thompson 1977; Robinson et al. 1981) have shown the transfer of energy reserves from the adductor muscle (meat) to the gonad at some time of the year. This energy partitioning between somatic and gonadal growth injects fluctuations in the average meat weight for a given shell height (Haynes 1966).

For some special purposes, it may be necessary to grant less importance to seasonal particularities. Practical considerations would dictate that such a length-weight relationship covers a broad range of possibilities if it is to serve the regulatory aspects of a fishery management plan and its enforcement. One of the measures of the Georges Bank scallop fishery management plan involves a size limit placed on scallop adductor muscles shucked defined as meat count. This meat count is presently set at 33 meats per 500 g.

The objectives of this report are (1) to provide a shell height measurement equivalent to the meat count currently used and (2) to present analysis of shell height-meat weight allometric relationship for scallop stocks on the Canadian side of Georges Bank. A shell height equivalency has been requested by fishery managers as some elements of the fleets fishing Georges Bank may, at times, come to port (where the meat count enforcement takes place) without their complete catch being already shucked out.This equation is an important component in the evaluation of yield to the fishery, in the computation of stock biomass, and in general applications in the context of stock assessment.

MATERIALS AND METHODS

The commercial fleet operates year round on Georges Bank. It is therefore possible to get samples of live scallops from the fleet on an annual basis. Fishermen are instructed to save live, 30 scallops of mixed size from the last tow of a fishing trip. The high landed value of scallops makes the collection of large samples difficult. Samples are also collected during the course of stock surveys at sites to give good geographical coverage as part of a biological investigation of somatic and reproductive growth cycles. Information on location fished and depth is available through fishing logbooks or survey logs.

Processing of samples is carried out as soon as possible. When scallops are shucked, the adductor muscle (meat), gonad and soft tissues (i.e. remainder of the animal) are bagged separately and the top valve of the shell is kept. Samples are stored at -17 C until further processing. Shell height is measured as the distance between the umbo and the farthest ventral margin in a straight line to the nearest mm. After meats are thawed, they are blotted for a standard time and wet weight recorded to the nearest 0.001 g.

Fishery biologists are familiar with the non-linearity of the length-weight allometric relationship $W = a \; L^{b}$ where the weight (W) is proportional to a power b of the length L times a constant a. Length-weight data may, however, be fitted to a linear regression if logs are taken instead (in the case at hand):

$$\ln \text{meat weight (g)} = a + b \ln \text{shell height (mm)}$$

The log transformation reduces the variability inherent to the collection of biological data and allows the use of the predictive function of regression analysis. Individual shell height and meat weight measurements were used as point values in subsequent statistical analyses (covariance, least-square regression, etc.). Homogeneity of residual variances was examined through the 95 % confidence interval of regression coefficient and tested by a chi-square test (P: 0.05 level).

To establish an equivalent shell height to the meat count presently in regulation, the procedure adopted here assumes that the average meat weight corresponding to 33 meats per 500 g is 15.15 g. When fishing vessels are shellstocking (i.e. stockpiling scallops on the deck for shucking later at sea or at dock site) they would retain scallops which shell height would guarantee them with some degree of certainty that the meat inside that shell is equal or over 15.15 g. If scallops in the shell of too small a size are carried to port where opportunities for blending are no longer available, the fishing trip being over, there is potential for considerable loss of resources; not to mention the non-compliance with the meat count regulation. Therefore, from a statistical point of view, one is considering the lower extremity of a confidence interval rather than the average shell height corresponding to a meat weight of 15.15 g i.e. a shell height measurement at the low end of the range that would give a meat equal to or greater than 15.15 g, say, 95 % of the times.

RESULTS

Data under investigation in this report cover the time period from 1982 to 1985. In the first years too few samples were collected to allow a study of the height-weight relationship variability within a particular year. In all, 8,128 scallops collected during 271 separate occasions, were examined; general statistics (table 1) provide an estimate of the height and weight values measured. The data set covers a wide range of shell height and meat weight values, from 50-mm shell to over 160-mm; from about 1 g wet meat weight to almost 80 g. Sexes were not analysed separately as Haynes (1966) showed that there was no significant difference in meat weight according to sex. Scallops are shucked regardless of sex under commercial conditions. Table 2 introduces a partitioning of the data according to factors pertinent to the fishery. Scallops less than 90 mm are under age 4 and do not contribute significantly to the fished biomass while scallops over 100 mm (age 5) are all fishable. The groupings by meat weight in terms of 10 g, 10-15 g, and over 15 g do not necessarily correspond to the shell height groupings. They partially reflect the weight composition of the stocks for any particular year and outline the arrival of a sizeable year class when the under 10-g group makes up over 40 % of the scallops collected (Mohn et al 1985). 10 and 15 g are average meat weights for meat counts of 50 and 33 per 500 g respectively.

Figures 1 to 4 give the geographical coverage of the sampling program on the Canadian side of Georges Bank on an annual basis. Table 3 gathers information on time of sampling, location coordinates for each sample numbered consecutively and depth (m) at each collection site. Water depths referring to the scallop habitat on Georges Bank are well represented. Table 4 lists intercept and slope (regression coefficient) values of least-square fit regression of meat weight on shell height (independent variable) for all individual samples. Coefficients of determination indicating the strength of the relationship are usually high; in most cases, over 90% of the variability in meat weight is explained by the shell height variable. Product moment correlation coefficients were producing at least a few percentage points higher than coefficients of determination, establishing beyond doubt the covariability of meat weight and shell height. There is a general overlap in the regression coefficient mean values of individual samples when plotted with respective 95 % confidence limits against time (figs 5 a-d). Regular stock surveys are carried out in August of each year. To get a better insight in data from this time period, slopes of survey samples are plotted separately in figures 6 a-c, e. Since all survey samples were collected during August, the time variability is considerably reduced compared to results covering a full year period. However, the range of slope values is still fairly wide; when all survey data are pooled together to generate a linear regression, residual variances are homogeneous (goodness of fit prob. level 0.000) suggesting a normal distribution of y values around x values. Some data are also available from a short survey time series in May 1985 (fig. 6d) showing the same trends as August survey data series.

Some authors (Haynes 1966; Posgay and Haynes 1965) have investigated the geographical variability of the meat weight-shell height relationship for Georges Bank scallops dividing the Bank in areas such as Eastern, Southern and Great South Channel and have found significant differences between these areas. The Bank is over 31,000 squared km within the 90-m isobath and a very dynamic oceanographic environment. It is therefore not surprising that differences are noticed amongst areas where scallop concentrations are known to occur. We have not attempted to examine this type of variability as the part of Georges Bank under Canadian jurisdiction is quite small (1/6 of total area). From a fishery management point of view, further subdivisions of the Canadian portion may not be practical at all. However, seasonal and annual variability were focussed on.

Seasonal variability

With the collected data, it was not possible to look at this type of variability for every year; 1982 data are excluded. Seasons were established according to the physiological state of Georges Bank scallops since somatic and gonadal cycles are interlinked. September is spawning month for scallops in the Canadian portion of the Bank (personal observations) and was thus isolated as a season. Follows a rest period for the scallop and a time of the year when general biological production is lower; October to March inclusive defines another season. Comes April and better weather conditions for food production, somatic growth resumes. April to August constitute the last of the 3 seasonal types. Table 5 presents parameters of regression analysis for data grouped on a seasonal basis. Two cases of the spawning season (Sep 83 and Sep 85) have heterogeneous residual variances and should not be considered. Other seasonal data have approximately 80% of the meat weight variability explained by shell height (coefficient of determination). Except for the first and last set of data , there is no significant difference either in the slope or intercept values ruling out a strong seasonal (as defined here) component in this allometric relationship. Haynes (1966) who looked at seasonal variability for different areas of Georges Bank found significant differences in other areas but the Eastern part. His definition of seasons was slightly different from ours.

Annual variability

Year to year variability was also looked at, grouping data on a calendar basis. First the allometric relationship was established with shell height as the independent variable, then with meat weight as the independent variable. Given certain practical considerations it is also worthwhile to pool all available data into one generalised equation. In any event, it is a strong relationship with a coefficient of determination equal to 0.8 or greater. Table 6 has regression values when shell height is considered as the independent variable. About 5% of the observed meat weight values are beyond 2 standard deviations of the estimated values. All regressions have homogeneous residual variances (p: 0.05 level). There is overlap in both slope and intercept 95% confidence intervals for 1982 and 1984 (table 6), better illustrated (fig. 7) in the elliptical regions covered by the values of these sets of data in a plot of intercept-slope. The lack of association of 1983 and 1985 data with each other or the grouping 1982-1984 suggests a possible element of variability between successive years.

Depending on the purpose at hand, it may be preferable to have the meat weight as the independent variable (table 7) in this allometric relationship. Once again there is some overlap of the regression parameter confidence intervals; 1983 and 1984 data for both slope and intercept while 1982 and 1985 data for slope interval only. Whichever variable is considered as independent, there is a significant element of annual variability that one may choose to consider.

Moreover, both shell height and meat weight are subject to natural variability. In this case, Ricker (1973) advocates the use of GM functional regression to describe the relationship and predict meat weight from shell height or vice-versa. The parameters of the regressions including all data have been used to generate corresponding GM functional regressions (identified as all data $_{GM}$ in tables 6 and 7). Figure 8 reproduces the linear and GM functional regressions over the range of values observed in the data for easy referencing.

According to the regression analyses performed one may estimate a shell height value (mean and 95 % confidence intervals) corresponding to a meat weight of 15.15 g (33 meats per 500 g). Except for 1982 data, the generalised equations represent other years fairly (expressed as the percentage difference from the annual shell height to the shell height estimated by the regression including all data) (tables 8 and 9). Using parameters of the GM functional regressions will provide the same results regardless of whether shell height or meat weight is taken as the independent variable.

DISCUSSION

Over 8,000 scallops were shucked during the course of four years of study from the Canadian side of Georges Bank (over 95% of the samples) with data collected on shell height and meat weight over a vast size range. This range should be adequate to give a general representation of the relationship between shell height and meat weight for those scallop aggregations.

Depending on the purpose at hand, one may choose shell height or meat weight as the independent variable and express their covariability in a linear form. Other authors (Bricelj et al 1987) have used functional regression to describe allometric relationships of this type in another pectinid species. Statistical expertise consulted cautioned against the use of Ricker's functional regression formula. Therefore, although functional regression results are presented, they should not be emphasized over the results derived conventionally. An equivalent mean shell height for a 15.15 g meat is determined at 101 mm. Annual variability has been shown to exist for the variables studied here and it would be more appropriate to generate year-specific equations. There might be circumstances when this procedure would not be practical. Usage of these variables in a fishery regulation is a good case at hand. The percentage difference between annually-derived equations and the general equation is less than 5% in any event.

From the strict point of view of enforcement of a management measure, shell edge breakage may lead to an underestimate of the true height of a scallop shell. The shell edge of an actively growing scallop is brittle and breaks easily under commercial fishing conditions when scallops are not treated as the ones collected as biological samples. The brittleness at the edge corresponds to the zone of new growth where the shell is considerably thinner than in older areas closer to the umbo (hinge). To acknowledge this possibility, one should try to measure the height of shells that show the least visible breakage and a continuous smooth edge.

Enforcement of a shell height may encounter other difficulties that, realistically, may even jeopardise its applicability. For example, in mixed catches of bagged scallop meats and unshucked (yet) scallops in the shell, how is one to allocate both types of sampling? Shellstocking (stockpiling) as a fishing practice may not threaten the stocks when only large scallops are put aside to shuck later. But, at times, the unsorted catch is stockpiled and rejected scallops (presumably because of their small size) are not returned to the grounds. As such, the practice of shellstocking should be discouraged.

These allometric equations may also be used in the conduct of stock assessment exercises when one item is known, for example, shell heights from survey samples or meat weights from port sampling data and corresponding values are required for the other variable to, say, establish biomass.

The parameters of the general equation meat weight on shell height presented here are very similar to the values (-11.766, 3.169 from 5,863 cases) given by Serchuk and Rak (1983) for Georges Bank for the time period 1978 to 1982. But they are somewhat different from values established by Haynes (1966) from material collected much earlier from 1958 to 1962 (-10.842, 2.949 from 6,646 cases).

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Table 1.- Statistics of scallop data collected from 1982 to 1985 inclusive.

Year	N	Mean	S.D.	Min	Max
Shell height (mm)					
1982	1,088	92	13.5	48	144
1983	2,022	102	14.8	48	156
1984	2,260	95	16.0	52	165
1985	2,758	93	13.2	64	166
Meat weight (g)					
1982	1,088	14.04	7.02	1.14	57.70
1983	2,022	16.29	9.20	1.70	65.52
1984	2,260	12.93	8.51	1.29	79.95
1985	2,758	12.68	7.14	2.62	66.91

Table 2.- Grouping on a percentage basis of scallop data collected according to shell height and meat weight measurements.

Shell height Year	N	%<90mm	%90-100mm	%>100mm
1982	1,088	44	29	27
1983	2,022	21	29	50
1984	2,260	39	25	36
1985	2,758	46	31	23
Meat weight Year	**N**	**%<10g**	**%10-15g**	**%>15g**
1982	1,088	31	34	35
1983	2,022	26	29	45
1984	2,260	45	28	27
1985	2,758	41	36	23

Table 3.- Environmental data pertaining to sampling programs carried out between 1982 and 1985. Data is given as day, month, year, 2 digits each. Latitude and longitude are in degrees and minutes, North and West respectively.

Date	Latitude	Longitude	Depth (m)	Sample No.
270482	4145	6605	94	1
110582	4158	6641	64	2
170582	4155	6648	79	3
310582	4204	6645	84	4
160682	4201	6609	88	5
190682	4202	6623	84	6
190682	4146	6613	79	7
030782	4200	6628	81	8
060782	4201	6632	86	9
240782	4204	6619	92	10
240782	4152	6617	81	11
090882	4158	6612	83	12
130882	4200	6631	75	13
160882	4204	6607	94	14
160882	4204	6613	94	15
160882	4203	6620	84	16
170882	4209	6631	143	17
170882	4205	6641	70	18
170882	4205	6656	107	19
180882	4205	6702	59	20*
240882	4154	6603	94	21
250882	4158	6614	79	22
250882	4149	6612	80	23
270882	4149	6606	90	24
270882	4147	6559	98	25
280882	4145	6611	84	26
280882	4145	6624	77	27*
280882	4154	6636	70	28
280882	4159	6649	63	29
280882	4208	6706	82	30
300882	4136	6621	83	31
300882	4137	6615	90	32
300882	4136	6609	96	33
300882	4128	6615	93	34
310882	4121	6628	90	35
310882	4123	6631	90	36
120683	4201	6715	47	37
180683	4158	6657	60	38
210683	4154	6618	82	39
260683	4204	6620	85	40
090783	4149	6611	82	41
090783	4152	6611	75	42
110783	4116	6626	89	43*

Table 3.- continued.

Date	Latitude	Longitude	Depth (m)	Sample No.
110783	4154	6608	91	44
180783	4156	6645	67	45
190783	4200	6649	62	46
250783	4147	6630	76	47
260783	4154	6604	93	48
270783	4206	6633	76	49
270783	4143	6612	89	50
020883	4148	6558	93	51
030883	4205	6612	93	52
030883	4203	6615	85	53
030883	4201	6622	84	54
030883	4204	6626	80	55
040883	4208	6625	156	56
040883	4209	6634	143	57
040883	4203	6640	71	58
050883	4201	6644	70	59
050883	4201	6650	73	60
050883	4203	6656	60	61
050883	4203	6702	57	62
050883	4204	6707	50	63
060883	4207	6722	136	64
070883	4146	6707	46	65
070883	4149	6701	63	66*
070883	4158	6702	61	67*
070883	4152	6648	59	68
080883	4202	6705	55	69
080883	4206	6703	56	70
080883	4154	6634	70	71
080883	4157	6625	81	72
090883	4153	6623	83	73
090883	4154	6614	79	74
090883	4153	6614	80	75
100883	4141	6614	84	76
100883	4153	6608	88	77
100883	4150	6611	78	78
100883	4147	6605	90	79
100883	4145	6604	94	80
130883	4203	6641	86	81
160883	4150	6552	119	82
160883	4140	6608	93	83
170883	4205	6707	56	84*
170883	4134	6619	92	85
170883	4145	6619	78	86
180883	4129	6629	87	87
180883	4119	6636	85	88
180883	4120	6631	87	89
180883	4120	6628	90	90
190883	4126	6618	89	91*
190883	4131	6608	98	92

Table 3.- continued.

Date	Latitude	Longitude	Depth (m)	Sample No.
200883	4135	6603	94	93
200883	4141	6600	95	94
270883	4207	6659	69	95
120983	4202	6601	91	96
210983	4159	6630	76	97
240983	4133	6618	95	98
240983	4142	6611	93	99
240983	4155	6620	86	100
240983	4124	6622	89	101
121083	4156	6616	76	102
011183	4146	6638	98	103
121283	4202	6651	56	104
280184	4159	6621	77	105
200284	4205	6647	66	106
200284	4203	6647	81	107
240284	4141	6618	83	108
140484	4150	6612	77	109
160484	4145	6625	77	110
060584	4139	6619	81	111*
190584	4202	6709	55	112
190584	4206	6648	66	113
190584	4156	6704	61	114
270584	4205	6641	75	115
280584	4201	6710	55	116
290584	4154	6646	55	117
090684	4155	6647	64	118
140684	4206	6658	61	119
200684	4152	6610	88	120
110784	4150	6607	86	121
110784	4143	6605	95	122
120784	4149	6606	83	123
180784	4147	6604	77	124
230784	4140	6616	84	125
250784	4143	6615	90	126
310784	4159	6637	81	127
010884	4135	6610	96	128
010884	4136	6622	84	129
010884	4138	6558	101	130
020884	4127	6615	92	131
020884	4119	6624	97	132
020884	4122	6631	90	133
050884	4202	6723	47	134*
050884	4205	6727	81	135
050884	4204	6715	47	136

Table 3.- continued.

Date	Latitude	Longitude	Depth (m)	Sample No.
060884	4207	6706	64	137
060884	4205	6701	59	138
060884	4208	6653	102	139
060884	4202	6648	73	140
060884	4206	6640	75	141
070884	4200	6631	77	142
080884	4208	6620	161	143
080884	4206	6629	81	144
080884	4205	6616	86	145
150884	4147	6630	72	146
150884	4141	6558	77	147
150884	4148	6556	104	148
150884	4149	6558	90	149
150884	4144	6619	81	150
150884	4144	6620	79	151
160884	4154	6619	79	152
160884	4157	6612	83	153
160884	4155	6602	95	154
160884	4201	6604	94	155
170884	4205	6607	95	156
170884	4204	6636	79	157
170884	4204	6620	84	158*
180884	4201	6620	83	159
180884	4158	6636	75	160
180884	4155	6623	79	161
190884	4155	6632	76	162
190884	4152	6630	80	163
190884	4149	6616	82	164
190884	4149	6624	82	165
200884	4152	6607	91	166
200884	4146	6633	73	167*
200884	4146	6621	79	168
240884	4156	6643	66	169*
270884	4149	6616	84	170
040984	4137	6620	83	171
100984	4150	6618	84	172
280984	4200	6649	62	173
301084	4150	6605	84	174
311084	4152	6617	73	175
121184	4202	6649	64	176
131184	4157	6637	75	177*
171184	4203	6649	64	178
181184	4137	6616	84	179
180385	4157	6638	66	180

Table 3.- continued.

Date	Latitude	Longitude	Depth (m)	Sample No.
310385	4152	6641	73	181
030485	4143	6617	83	182
150485	4206	6703	55	183
200485	4158	6637	81	184
200485	4200	6632	73	185
270485	4153	6625	81	186
010585	4146	6613	86	187
020585	4147	6637	73	188*
020585	4147	6619	75	189
060585	4157	6650	64	190
070585	4201	6640	72	191
110585	4154	6612	81	192
120585	4207	6656	66	193
130585	4153	6623	81	194
130585	4142	6617	81	195
220585	4205	6612	100	196
220585	4202	6625	91	197
220585	4158	6629	86	198
220585	4153	6627	82	199
220585	4144	6623	77	200
220585	4136	6621	86	201
220585	4137	6615	92	202
220585	4126	6604	95	203
220585	4144	6558	107	204
220585	4149	6557	101	205
220585	4154	6603	97	206
220885	4140	6609	88	207
290585	4205	6702	59	208
030685	4139	6615	84	209
050685	4135	6613	97	210
100685	4144	6628	73	211
120685	4205	6649	61	212
120685	4200	6621	84	213
260685	4129	6630	94	214
290685	4151	6619	79	215
020785	4141	6614	84	216
060785	4152	6615	79	217
110785	4204	6622	79	218
170785	4204	6652	66	219
300785	4140	6613	73	220
030885	4140	6615	81	221
070885	4206	6628	89	222
080885	4201	6639	73	223
080885	4206	6655	66	224
090885	4156	6646	69	225
090885	4157	6633	77	226
090885	4158	6625	81	227
100885	4138	6618	86	228
100885	4154	6615	80	229

Table 3.- continued.

Date	Latitude	Longitude	Depth (m)	Sample No.
100885	4145	6614	85	230
100885	4146	6620	78	231
110885	4204	6637	79	232
110885	4205	6622	86	233
110885	4201	6619	86	234
120885	4155	6647	62	235
120885	4158	6637	74	236
120885	4158	6616	81	237
120885	4155	6619	80	238
120885	4146	6637	69	239
130885	4152	6625	83	240
130885	4149	6619	82	241
130885	4150	6628	74	242
140885	4148	6602	95	243
140885	4153	6603	93	244
140885	4159	6601	94	245
170885	4148	6629	72	246
190885	4156	6625	59	247
210885	4203	6720	48	248
210885	4207	6703	61	249
210885	4204	6707	51	250
220885	4153	6627	79	251
220885	4145	6623	77	252
220885	4138	6620	84	253
230885	4135	6612	93	254
230885	4142	6607	92	255
230885	4148	6557	100	256
240885	4133	6609	94	257
240885	4120	6622	95	258
240885	4123	6630	91	259
250885	4128	6636	82	260
280885	4205	6644	70	261
040985	4148	6639	68	262*
040985	4157	6620	79	263
130985	4204	6658	51	264
140985	4205	6654	55	265
121085	4129	6614	90	266
231085	4138	6622	84	267
291085	4152	6636	73	268
221185	4159	6638	73	269
231185	4200	6649	62	270
241185	4155	6646	70	271

* Sample with less or more than 30 animals.

Table 4.- Characteristics of statistical parameters of the least square fit regression between shell height and meat weight and coefficients of determination.

Sample No.	Intercept	95 % C.I.		Slope	95 % C.I.		Adjusted r^2
1	-8.753	-11.082	-6.424	2.483	1.967	2.999	.768
2	-13.193	-15.318	-11.067	3.548	3.083	4.013	.894
3	-11.623	-13.153	-10.093	3.162	2.824	3.500	.927
4	-13.032	-14.684	-11.379	3.518	3.149	3.886	.929
5	-8.861	-10.444	-7.277	2.533	2.178	2.888	.880
6	-9.671	-12.964	-6.378	2.757	2.033	3.482	.673
7	-14.391	-16.076	-12.706	3.740	3.369	4.111	.936
8	-11.731	-13.712	-9.751	3.182	2.736	3.628	.880
9	-12.546	-15.560	-9.533	3.374	2.701	4.047	.783
10	-9.687	-11.174	-8.201	2.691	2.357	3.024	.904
11	-10.327	-13.999	-6.654	2.890	2.107	3.672	.660
12	-11.708	-14.033	-9.382	3.164	2.643	3.685	.841
13	-12.343	-14.326	-10.360	3.294	2.861	3.728	.893
14	-9.322	-11.191	-7.453	2.563	2.148	2.977	.846
15	-10.063	-13.010	-7.116	2.736	2.090	3.382	.719
16	-10.285	-11.866	-8.704	2.833	2.482	3.184	.904
17	-12.561	-15.317	-9.805	3.267	2.670	3.865	.811
18	-11.754	-13.423	-10.084	3.175	2.806	3.545	.914
19	-12.246	-14.688	-9.803	3.270	2.733	3.807	.842
20	-8.665	-10.410	-6.919	2.458	2.078	2.839	.813
21	-9.618	-11.992	-7.245	2.659	2.129	3.189	.783
22	-11.642	-12.951	-10.333	3.127	2.825	3.428	.939
23	-11.277	-12.682	-9.872	3.046	2.737	3.355	.933
24	-12.069	-12.597	-11.540	3.213	3.095	3.331	.991
25	-12.485	-13.321	-11.648	3.287	3.100	3.473	.978
26	-12.627	-14.069	-11.184	3.341	3.019	3.664	.939
27	-11.730	-12.656	-10.803	3.175	2.969	3.381	.972
28	-12.976	-14.198	-11.754	3.435	3.165	3.705	.959
29	-11.145	-12.363	-9.928	3.018	2.740	3.295	.945
30	-12.586	-13.631	-11.541	3.330	3.101	3.559	.968
31	-12.530	-14.110	-10.950	3.322	2.981	3.664	.932
32	-12.369	-13.368	-11.369	3.286	3.067	3.505	.970
33	-11.462	-12.685	-10.239	3.084	2.808	3.360	.948
34	-11.481	-13.021	-9.941	3.119	2.780	3.459	.924
35	-10.758	-11.750	-9.766	2.952	2.733	3.172	.963
36	-11.097	-12.154	-10.040	3.024	2.791	3.257	.961
37	-9.317	-12.616	-6.018	2.690	1.988	3.392	.676
38	-11.610	-15.517	-7.702	3.184	2.300	4.067	.648
39	-13.742	-17.987	-9.498	3.570	2.653	4.487	.683
40	-10.252	-13.229	-7.276	2.795	2.158	3.431	.734
41	-11.259	-15.569	-6.949	3.018	2.106	3.929	.608
42	-13.735	-15.445	-12.025	3.546	3.171	3.920	.928
43	-14.866	-17.384	-12.347	3.783	3.233	4.333	.894
44	-11.772	-14.038	-9.506	3.129	2.637	3.621	.853
45	-12.637	-14.007	-11.267	3.316	3.013	3.619	.945
46	-12.031	-14.237	-9.825	3.188	2.702	3.674	.861
47	-11.975	-12.942	-11.008	3.230	3.015	3.445	.970
48	-11.916	-13.781	-10.051	3.129	2.712	3.546	.890
49	-12.891	-15.474	-10.309	3.409	2.852	3.967	.843
50	-12.608	-14.696	-10.521	3.299	2.850	3.748	.886

Table 4.- continued.

Sample No.	Intercept	95 % C.I.		Slope	95 % C.I.		Adjusted r^2
51	-13.794	-15.328	-12.260	3.516	3.181	3.851	.951
52	-13.714	-15.066	-12.362	3.479	3.180	3.778	.941
53	-13.534	-15.390	-11.678	3.467	3.057	3.878	.911
54	-11.960	-13.344	-10.577	3.170	2.867	3.473	.940
55	-12.167	-13.827	-10.507	3.202	2.838	3.566	.918
56	-13.315	-15.090	-11.539	3.363	2.969	3.756	.913
57	-15.087	-17.536	-12.638	3.751	3.223	4.279	.879
58	-12.111	-13.365	-10.858	3.235	2.961	3.509	.953
59	-12.834	-14.414	-11.254	3.422	3.080	3.763	.935
60	-12.316	-13.770	-10.862	3.291	2.965	3.617	.936
61	-11.838	-13.069	-10.608	3.199	2.934	3.464	.955
62	-11.906	-13.635	-10.177	3.214	2.840	3.588	.914
63	-12.153	-13.700	-10.606	3.248	2.910	3.587	.930
64	-11.824	-13.204	-10.443	3.094	2.798	3.390	.940
65	-12.889	-14.148	-11.630	3.432	3.163	3.702	.959
66	-10.864	-13.420	-8.309	3.016	2.479	3.554	.830
67	-7.501	-10.936	-4.067	2.308	1.595	3.020	.646
68	-12.553	-14.139	-10.967	3.357	3.015	3.699	.933
69	-12.663	-14.452	-10.874	3.348	2.947	3.749	.910
70	-10.793	-12.424	-9.161	2.936	2.580	3.291	.908
71	-10.369	-12.275	-8.464	2.885	2.482	3.287	.881
72	-13.973	-15.691	-12.255	3.620	3.247	3.994	.931
73	-12.518	-13.656	-11.381	3.303	3.063	3.544	.965
74	-12.480	-13.493	-11.467	3.287	3.065	3.510	.969
75	-13.114	-14.557	-11.672	3.411	3.091	3.730	.943
76	-12.198	-13.388	-11.008	3.213	2.958	3.468	.958
77	-12.869	-13.926	-11.812	3.339	3.103	3.574	.967
78	-12.534	-13.858	-11.210	3.295	3.004	3.586	.949
79	-13.239	-14.560	-11.918	3.424	3.133	3.714	.953
80	-13.968	-15.140	-12.797	3.582	3.327	3.837	.966
81	-12.411	-16.677	-8.145	3.262	2.369	4.154	.655
82	-9.942	-13.644	-6.241	2.604	1.790	3.418	.591
83	-12.824	-13.853	-11.796	3.340	3.115	3.564	.970
84	-13.569	-17.676	-9.462	3.515	2.645	4.386	.741
85	-11.528	-14.835	-8.222	3.078	2.373	3.782	.732
86	-11.997	-13.284	-10.710	3.174	2.904	3.445	.952
87	-12.523	-13.678	-11.367	3.301	3.056	3.545	.963
88	-12.065	-13.674	-10.456	3.201	2.864	3.539	.928
89	-15.415	-17.628	-13.203	3.911	3.441	4.382	.909
90	-11.299	-12.476	-10.122	3.033	2.780	3.286	.954
91	-11.395	-12.366	-10.423	3.038	2.824	3.252	.968
92	-8.876	-10.591	-7.161	2.480	2.110	2.850	.866
93	-10.487	-12.151	-8.822	2.803	2.441	3.164	.896
94	-12.860	-13.743	-11.978	3.317	3.122	3.512	.977
95	-15.953	-18.563	-13.344	4.093	3.514	4.673	.878
96	-12.035	-13.266	-10.805	3.159	2.887	3.431	.951
97	-12.460	-15.443	-9.476	3.266	2.610	3.921	.781
98	-8.605	-12.919	-4.290	2.459	1.552	3.366	.507
99	-13.050	-14.961	-11.138	3.368	2.955	3.781	.906
100	-12.087	-14.328	-9.846	3.193	2.717	3.670	.866

Table 4.- continued.

Sample No.	Intercept	95 % C.I.		Slope	95 % C.I.		Adjusted r^2
101	-12.314	-14.244	-10.384	3.215	2.801	3.630	.897
102	-14.910	-18.794	-11.025	3.723	2.886	4.560	.739
103	-11.419	-12.834	-10.005	3.015	2.714	3.317	.935
104	-11.162	-12.705	-9.619	2.981	2.644	3.317	.919
105	-13.351	-15.661	-11.041	3.452	2.951	3.954	.872
106	-14.877	-17.233	-12.521	3.792	3.277	4.306	.887
107	-13.921	-16.936	-10.906	3.580	2.915	4.244	.806
108	-13.085	-15.484	-10.686	3.369	2.847	3.891	.857
109	-11.708	-14.322	-9.094	3.071	2.506	3.637	.809
110	-14.268	-15.723	-12.813	3.624	3.307	3.940	.950
111	-13.079	-15.229	-10.929	3.401	2.941	3.860	.891
112	-11.319	-12.950	-9.689	3.108	2.751	3.466	.916
113	-11.430	-13.328	-9.532	3.064	2.652	3.475	.889
114	-12.064	-14.044	-10.083	3.280	2.837	3.723	.887
115	-11.108	-14.121	-8.095	2.982	2.281	3.683	.721
116	-11.840	-14.880	-8.800	3.221	2.574	3.869	.780
117	-14.002	-15.795	-12.209	3.704	3.311	4.097	.928
118	-11.089	-13.431	-8.747	3.029	2.503	3.554	.827
119	-11.873	-13.582	-10.165	3.076	2.703	3.450	.907
120	-12.399	-13.656	-11.142	3.265	2.988	3.543	.952
121	-10.996	-12.786	-9.207	2.946	2.562	3.329	.895
122	-11.825	-13.894	-9.755	3.109	2.654	3.565	.870
123	-13.916	-16.042	-11.789	3.596	3.130	4.062	.896
124	-11.709	-12.999	-10.419	3.108	2.819	3.396	.944
125	-11.743	-13.157	-10.329	3.109	2.797	3.422	.935
126	-11.688	-13.762	-9.574	3.024	2.553	3.494	.856
127	-13.495	-15.088	-11.902	3.531	3.186	3.876	.938
128	-12.344	-13.428	-11.261	3.213	2.970	3.456	.962
129	-12.406	-13.961	-10.851	3.298	2.953	3.643	.929
130	-9.656	-11.657	-7.656	2.559	2.121	2.997	.831
131	-10.196	-11.782	-8.611	2.757	2.407	3.107	.899
132	-12.030	-12.996	-11.064	3.194	2.978	3.409	.969
133	-12.197	-13.990	-10.404	3.245	2.837	3.652	.902
134	-11.817	-13.479	-10.154	3.170	2.813	3.527	.928
135	-12.186	-12.970	-11.402	3.187	3.014	3.359	.980
136	-10.292	-13.109	-7.475	2.824	2.192	3.456	.741
137	-12.346	-13.125	-11.566	3.264	3.091	3.437	.981
138	-11.978	-13.134	-10.823	3.191	2.935	3.448	.957
139	-11.989	-13.061	-10.918	3.097	2.863	3.331	.962
140	-11.692	-12.747	-10.638	3.129	2.892	3.366	.962
141	-13.196	-14.594	-11.799	3.418	3.111	3.724	.947
142	-12.868	-14.001	-11.735	3.390	3.138	3.642	.963
143	-14.453	-17.893	-11.012	3.481	2.715	4.246	.747
144	-11.248	-13.173	-9.324	2.945	2.534	3.357	.881
145	-12.579	-13.998	-11.160	3.206	2.894	3.519	.938
146	-11.440	-13.944	-8.935	3.027	2.481	3.573	.815
147	-12.911	-16.350	-9.473	3.372	2.577	4.166	.720
148	-11.054	-12.911	-9.198	2.859	2.447	3.272	.874
149	-12.603	-14.215	-10.991	3.276	2.926	3.627	.927
150	-10.843	-11.754	-9.931	2.942	2.743	3.141	.969

Table 4.- continued.

Sample No.	Intercept	95 % C.I.		Slope	95 % C.I.		Adjusted r^2
151	-10.698	-11.835	-9.562	2.920	2.669	3.171	.951
152	-11.362	-12.392	-10.332	3.059	2.832	3.286	.963
153	-11.591	-13.131	-10.051	3.060	2.722	3.398	.922
154	-13.566	-16.127	-11.005	3.450	2.886	4.014	.843
155	-9.256	-10.851	-7.660	2.486	2.142	2.829	.883
156	-12.324	-13.772	-10.876	3.102	2.782	3.423	.931
157	-12.762	-13.994	-11.530	3.357	3.089	3.626	.958
158	-12.285	-14.272	-10.298	3.182	2.739	3.626	.885
159	-9.334	-10.588	-8.081	2.578	2.307	2.849	.929
160	-11.835	-12.812	-10.857	3.186	2.969	3.403	.969
161	-12.253	-13.155	-11.351	3.258	3.059	3.458	.975
162	-11.306	-12.367	-10.244	3.062	2.837	3.286	.964
163	-11.768	-12.575	-10.961	3.175	3.001	3.349	.980
164	-11.533	-12.262	-10.804	3.109	2.949	3.269	.982
165	-11.568	-12.389	-10.747	3.121	2.948	3.295	.979
166	-10.922	-12.287	-9.558	2.919	2.620	3.218	.932
167	-12.301	-12.792	-11.810	3.282	3.177	3.387	.994
168	-11.528	-12.237	-10.820	3.098	2.943	3.254	.983
169	-10.717	-12.965	-8.469	2.884	2.393	3.375	.865
170	-11.084	-12.262	-9.905	2.953	2.688	3.218	.947
171	-11.825	-13.996	-9.654	3.115	2.634	3.596	.858
172	-13.142	-14.670	-11.615	3.379	3.042	3.716	.936
173	-11.633	-14.401	-8.864	3.100	2.470	3.730	.776
174	-11.010	-13.039	-8.981	2.925	2.492	3.357	.868
175	-13.159	-14.706	-11.612	3.428	3.086	3.769	.936
176	-11.882	-13.837	-9.927	3.143	2.710	3.577	.883
177	-12.655	-14.819	-10.491	3.338	2.860	3.816	.905
178	-14.258	-15.762	-12.754	3.631	3.307	3.956	.948
179	-12.869	-14.224	-11.514	3.358	3.054	3.662	.946
180	-11.198	-12.500	-9.895	3.028	2.734	3.323	.939
181	-11.947	-13.210	-10.683	3.187	2.912	3.462	.951
182	-15.836	-18.356	-13.316	3.941	3.388	4.494	.880
183	-11.552	-13.199	-9.905	3.094	2.722	3.466	.909
184	-12.022	-13.700	-10.345	3.197	2.818	3.577	.911
185	-10.580	-12.873	-8.287	2.885	2.361	3.409	.813
186	-11.289	-12.558	-10.019	3.067	2.783	3.352	.944
187	-11.147	-12.781	-9.513	3.017	2.654	3.379	.909
188	-11.060	-13.349	-8.772	3.033	2.531	3.535	.866
189	-10.946	-12.298	-9.593	2.939	2.634	3.245	.930
190	-10.937	-12.348	-9.527	2.990	2.671	3.309	.927
191	-11.929	-14.970	-8.888	3.205	2.513	3.898	.754
192	-10.271	-12.709	-7.833	2.785	2.240	3.330	.789
193	-11.563	-13.906	-9.221	3.107	2.573	3.641	.829
194	-10.586	-12.423	-8.749	2.907	2.496	3.318	.878
195	-12.075	-13.270	-10.881	3.206	2.943	3.469	.956
196	-9.662	-11.235	-8.090	2.567	2.218	2.917	.886
197	-11.714	-13.867	-9.561	3.139	2.668	3.610	.865
198	-11.825	-13.608	-10.043	3.196	2.791	3.600	.900
199	-12.285	-13.432	-11.138	3.308	3.054	3.562	.961
200	-11.101	-12.739	-9.463	3.024	2.654	3.394	.906

Table 4.- continued.

Sample No.	Intercept	95 % C.I.		Slope	95 % C.I.		Adjusted r^2
201	-10.140	-11.905	-8.375	2.792	2.397	3.186	.878
202	-11.666	-12.872	-10.460	3.118	2.848	3.389	.950
203	-10.764	-11.627	-9.901	2.868	2.677	3.058	.970
204	-9.731	-11.362	-8.101	2.633	2.278	2.989	.888
205	-10.524	-12.178	-8.871	2.787	2.422	3.151	.894
206	-8.392	-9.971	-6.812	2.359	2.011	2.707	.868
207	-8.923	-11.800	-6.047	2.469	1.830	3.108	.680
208	-12.476	-14.287	-10.666	3.298	2.890	3.706	.904
209	-12.813	-14.881	-10.745	3.358	2.900	3.815	.886
210	-10.849	-13.038	-8.660	2.932	2.444	3.419	.839
211	-10.505	-12.715	-8.295	2.875	2.389	3.361	.834
212	-11.521	-13.885	-9.157	3.134	2.596	3.672	.830
213	-11.938	-13.371	-10.505	3.231	2.908	3.553	.935
214	-9.628	-13.241	-6.014	2.707	1.894	3.521	.610
215	-10.583	-12.699	-8.467	2.900	2.427	3.374	.843
216	-7.279	-10.012	-4.546	2.213	1.608	2.819	.655
217	-11.616	-13.285	-9.948	3.150	2.782	3.518	.913
218	-11.489	-12.253	-10.724	3.117	2.949	3.285	.980
219	-6.968	-8.880	-5.056	2.123	1.711	2.535	.792
220	-11.732	-13.790	-9.675	3.116	2.657	3.576	.869
221	-11.822	-14.166	-9.478	3.153	2.647	3.658	.849
222	-15.819	-17.660	-13.979	3.867	3.472	4.261	.933
223	-13.036	-14.291	-11.780	3.455	3.182	3.727	.959
224	-12.993	-14.240	-11.745	3.415	3.136	3.694	.956
225	-11.644	-12.973	-10.314	3.169	2.879	3.459	.945
226	-12.272	-13.346	-11.198	3.271	3.043	3.499	.967
227	-10.209	-11.708	-8.710	2.809	2.477	3.141	.912
228	-11.639	-13.659	-9.618	3.112	2.663	3.561	.874
229	-12.175	-13.245	-11.106	3.228	2.990	3.466	.964
230	-12.344	-13.591	-11.098	3.258	2.987	3.529	.954
231	-11.967	-13.254	-10.680	3.190	2.903	3.477	.947
232	-10.416	-12.517	-8.314	2.863	2.417	3.309	.856
233	-10.553	-12.345	-8.761	2.829	2.437	3.220	.883
234	-12.654	-15.125	-10.183	3.310	2.779	3.840	.848
235	-12.614	-15.576	-9.652	3.369	2.710	4.028	.789
236	-11.033	-12.948	-9.119	3.008	2.580	3.436	.877
237	-15.222	-16.768	-13.676	3.879	3.542	4.216	.950
238	-12.231	-13.544	-10.918	3.261	2.972	3.551	.948
239	-11.678	-12.888	-10.468	3.174	2.916	3.432	.956
240	-11.046	-12.086	-10.006	2.995	2.772	3.218	.963
241	-11.425	-12.717	-10.133	3.083	2.796	3.369	.944
242	-11.518	-13.317	-9.719	3.109	2.715	3.502	.900
243	-12.109	-14.098	-10.120	3.169	2.735	3.603	.885
244	-13.083	-14.544	-11.622	3.384	3.064	3.705	.942
245	-7.311	-9.201	-5.420	2.057	1.649	2.465	.785
246	-12.948	-14.517	-11.378	3.421	3.075	3.767	.934
247	-11.510	-14.118	-8.903	3.095	2.510	3.679	.801
248	-11.108	-12.880	-9.335	3.012	2.619	3.404	.894
249	-12.420	-15.001	-9.840	3.260	2.694	3.825	.827
250	-12.078	-15.709	-8.448	3.198	2.401	3.996	.696

Table 4.- continued.

Sample No.	Intercept	95 % C.I.		Slope	95 % C.I.		Adjusted r^2
251	-12.746	-15.046	-10.445	3.375	2.865	3.886	.863
252	-12.410	-13.681	-11.140	3.304	3.027	3.580	.954
253	-13.863	-15.681	-12.046	3.583	3.183	3.984	.920
254	-13.009	-14.175	-11.844	3.400	3.145	3.655	.963
255	-12.936	-14.291	-11.582	3.365	3.064	3.667	.947
256	-13.203	-14.446	-11.961	3.393	3.112	3.673	.955
257	-10.964	-12.670	-9.259	2.946	2.566	3.326	.897
258	-12.703	-14.893	-10.512	3.357	2.877	3.837	.876
259	-11.949	-13.023	-10.875	3.205	2.968	3.442	.964
260	-13.242	-14.892	-11.592	3.455	3.100	3.809	.932
261	-11.421	-13.265	-9.577	3.037	2.622	3.453	.885
262	-9.093	-12.109	-6.076	2.569	1.906	3.232	.725
263	-10.804	-13.336	-8.272	2.917	2.344	3.489	.788
264	-12.386	-14.913	-9.858	3.284	2.728	3.840	.834
265	-10.844	-13.429	-8.260	2.927	2.348	3.505	.786
266	-12.395	-14.311	-10.478	3.233	2.818	3.648	.897
267	-10.204	-11.996	-8.412	2.773	2.380	3.167	.877
268	-11.383	-13.906	-8.860	3.070	2.518	3.623	.816
269	-11.601	-14.178	-9.023	3.096	2.529	3.663	.811
270	-12.571	-14.800	-10.341	3.333	2.828	3.839	.862
271	-13.028	-15.767	-10.289	3.426	2.817	4.034	.820

Table 5.- Regression analysis of meat weight on shell height for some data grouped into 'seasons'. The last column, expressed as a percentage ratio refers to the number of cases whose residual y-value is beyond 2 standard deviations.

Time period	N	Intercept	95% C.I.		Slope	95% C.I.		Adjusted r^2	%2 S.D. outliers
Apr-Aug 1983	1,752	-13.080	-13.415	-12.744	3.415	3.342	3.488	.828	5.48
Sep 1983	180	-12.772	-13.458	-12.086	3.325	3.177	3.473	.917	8.33*
Oct 1983-Mar 1984	210	-11.592	-12.548	-10.636	3.056	2.848	3.263	.801	4.29
Apr-Aug 1984	1,847	-12.054	-12.406	-11.703	3.178	3.101	3.255	.779	4.33
Sep 1984	90	-10.290	-11.523	-9.058	2.773	2.498	3.048	.818	3.33
Oct 1984-Mar 1985	263	-11.045	-11.643	-10.447	2.960	2.828	3.092	.882	4.56
Apr-Aug 1985	2,403	-11.004	-11.285	-10.723	2.971	2.909	3.033	.785	4.74
Sep 1985	115	-12.191	-13.307	-11.074	3.237	2.989	3.485	.854	1.74*
Oct-Dec 1985	180	-10.116	-10.990	-9.242	2.768	2.575	2.961	.817	3.89

* Heterogenous residual variances at P level 0.05.

Table 6.- Regression analysis of meat weight on shell height (independent variable) for data grouped on an annual basis and for data pooled together to produce a general equation. All $data_{GM}$ refers to the parameters of a GM functional regression.

Year	N	Intercept	95% C.I.		Slope	95% C.I.		Adjusted r^2	%2 S.D. outliers
1982	1,088	-11.640	-11.969	-11.311	3.137	3.064	3.210	.868	5.42
1983	2,022	-12.897	-13.210	-12.583	3.371	3.303	3.439	.824	5.64
1984	2,260	-11.996	-12.304	-11.687	3.164	3.096	3.232	.787	4.56
1985	2,758	-10.994	-11.251	-10.737	2.969	2.912	3.025	.792	4.79
All data	8,128	-11.607	-11.763	-11.451	3.097	3.063	3.131	.794	4.75
All $data_{GM}$	8,128	-13.330	-13.171	-13.489	3.476	3.441	3.511		

Table 7.- Regression analysis of shell height on meat weight (independent variable) for data grouped on an annual basis and for data pooled together to produce a general equation. All data$_{GM}$ refers to the parameters of a GM functional regression.

Year	N	Intercept	95% C.I.		Slope	95% C.I.		Adjusted r^2	%2 S.D. outliers
1982	1,088	3.817	3.800	3.833	0.277	0.270	0.283	.868	5.97
1983	2,022	3.964	3.951	3.978	0.244	0.239	0.249	.824	5.24
1984	2,260	3.952	3.939	3.965	0.249	0.244	0.254	.787	4.78
1985	2,758	3.874	3.861	3.886	0.267	0.262	0.272	.792	4.42
All data	8,128	3.913	3.905	3.920	0.257	0.254	0.259	.794	4.55
All data$_{GM}$	8,128	3.834	3.824	3.842	0.288	0.285	0.292		

Table 8.- Predictive value of shell height (mm) corresponding to a 15.15g meat (mean), % difference from annual shell height to the shell height estimated by regression including all data (Δ_1), and % difference from annual shell height to the shell height estimated by GM functional regression (Δ_2).

Year	Shell height (mean)	% Δ_1	% Δ_2
1982	97.28	-4.73	-3.90
1983	102.80	0.68	1.55
1984	104.70	2.54	3.43
1985	101.40	-0.70	0.17
All data	102.11		
All data$_{GM}$	101.23		

Table 9.- Predictive value of shell height (mm) corresponding to a 15.15g meat (mean), % difference from annual shell height to the shell height estimated by regression including all data (Δ_1), and % difference from annual shell height to the shell height estimated by GM functional regression (Δ_2); meat weight used as independent variable.

Year	Shell height (mean)	% Δ_1	% Δ_2
1982	96.59	-4.07	-4.58
1983	102.28	1.58	1.04
1984	102.44	1.74	1.20
1985	99.51	-1.17	-1.70
All data	100.69		
All data$_{GM}$	101.23		

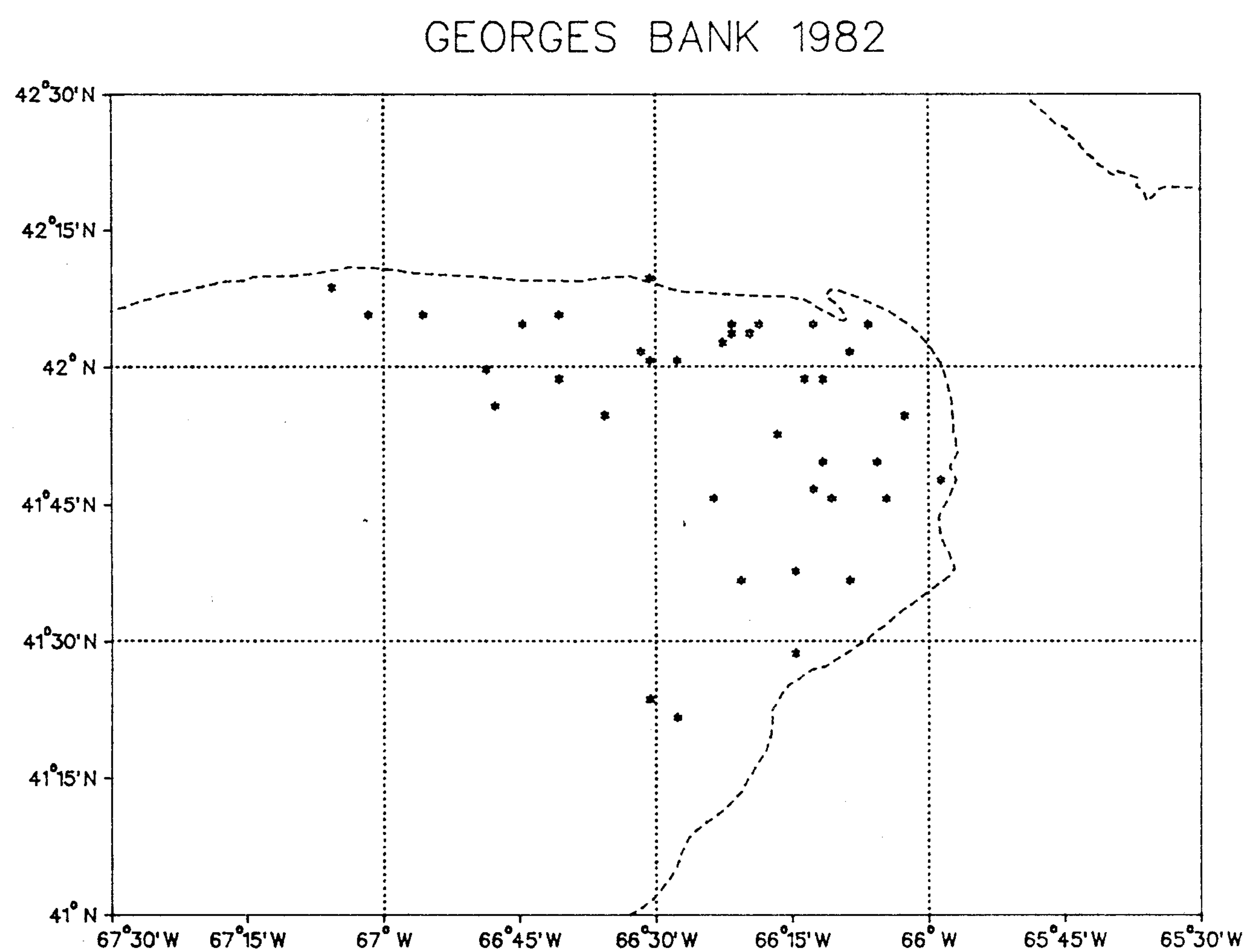

Figure 1- Location of samples from Georges Bank in 1982. The 100-m isobath is delineated.

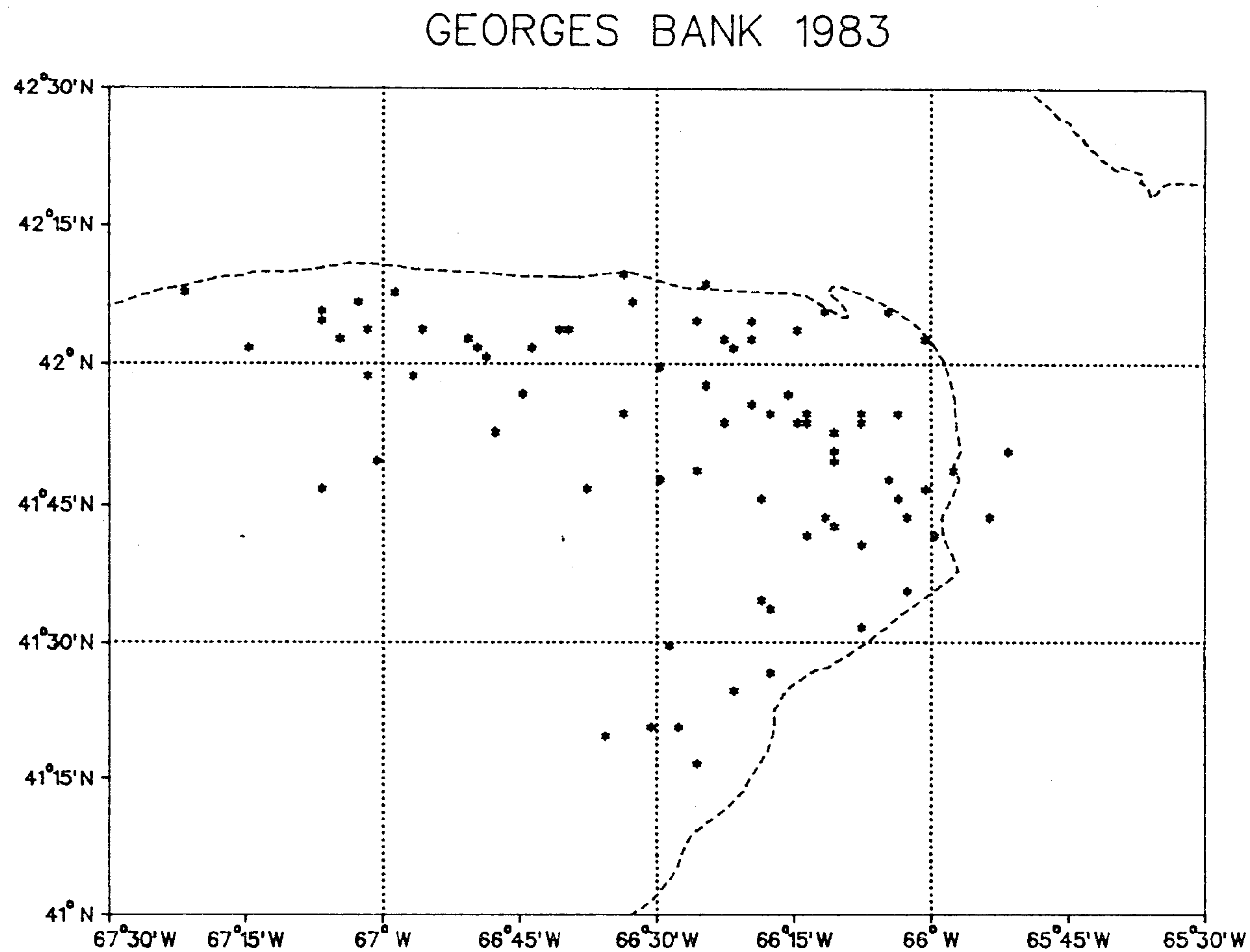

Figure 2.- Location of samples from Georges Bank in 1983. The 100-m isobath is delineated.

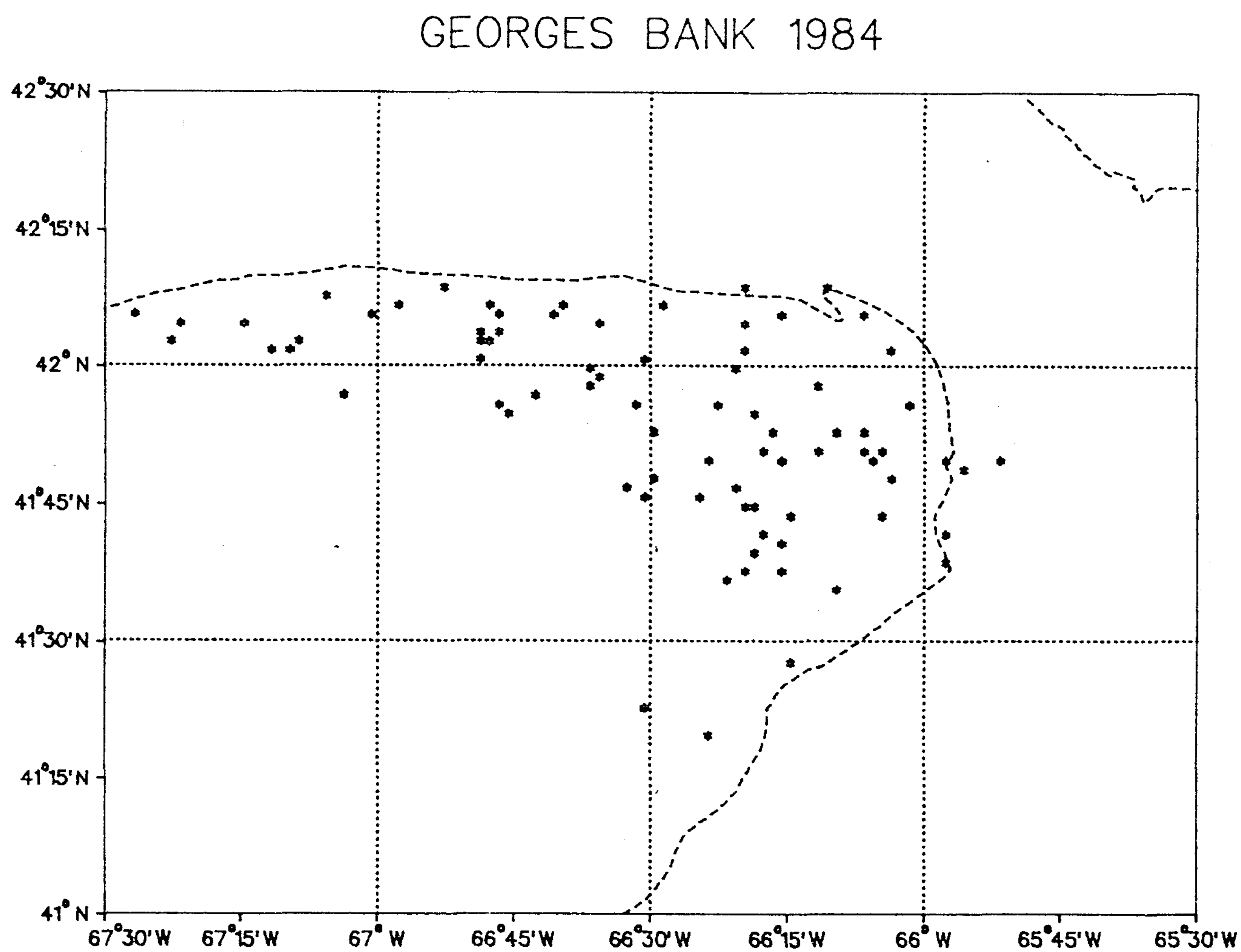

Figure 3.- Location of samples from Georges Bank in 1984 The 100-m isobath is delineated.

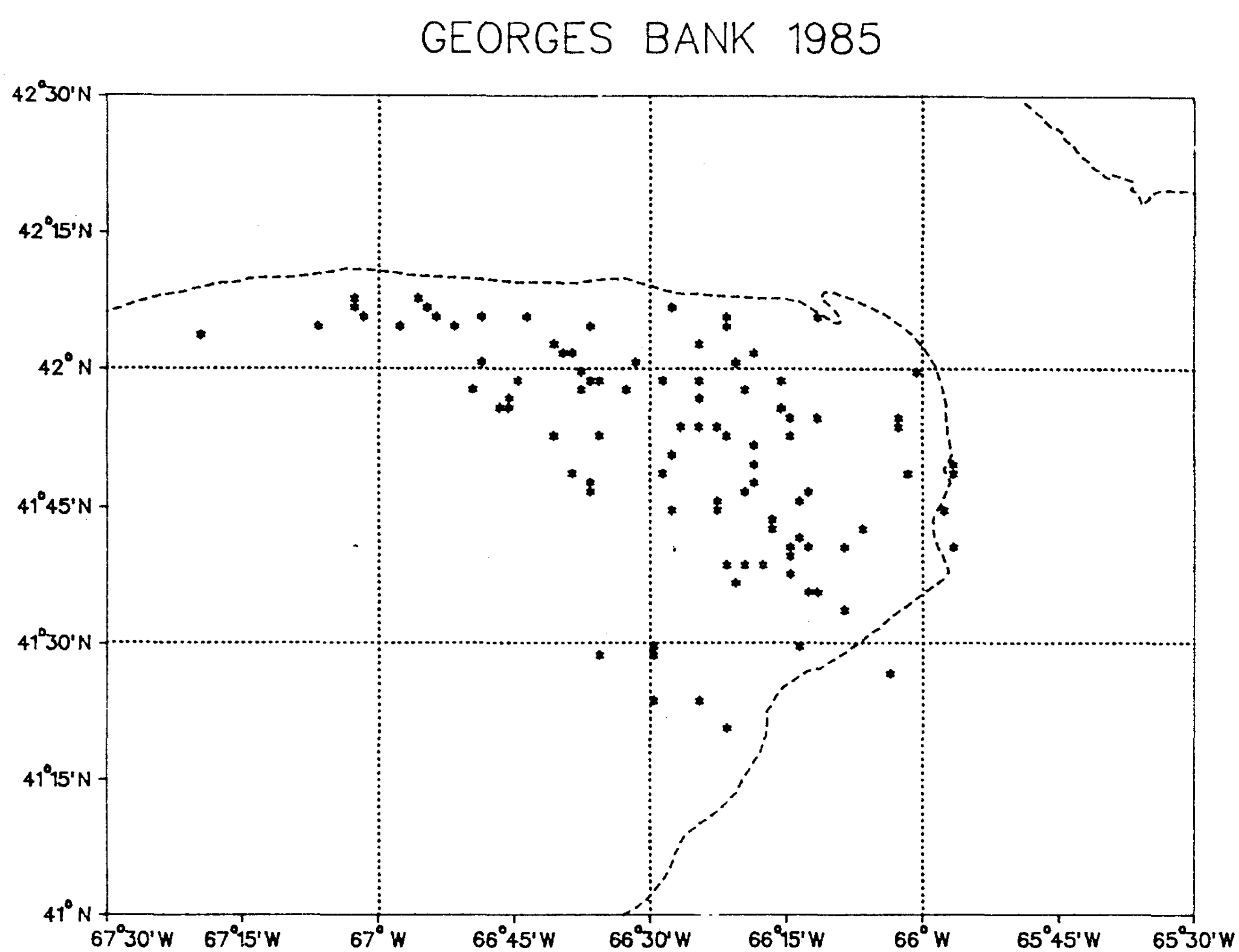

Figure 4- Location of samples from Georges Bank in 1985. The 100-m isobath is delineated.

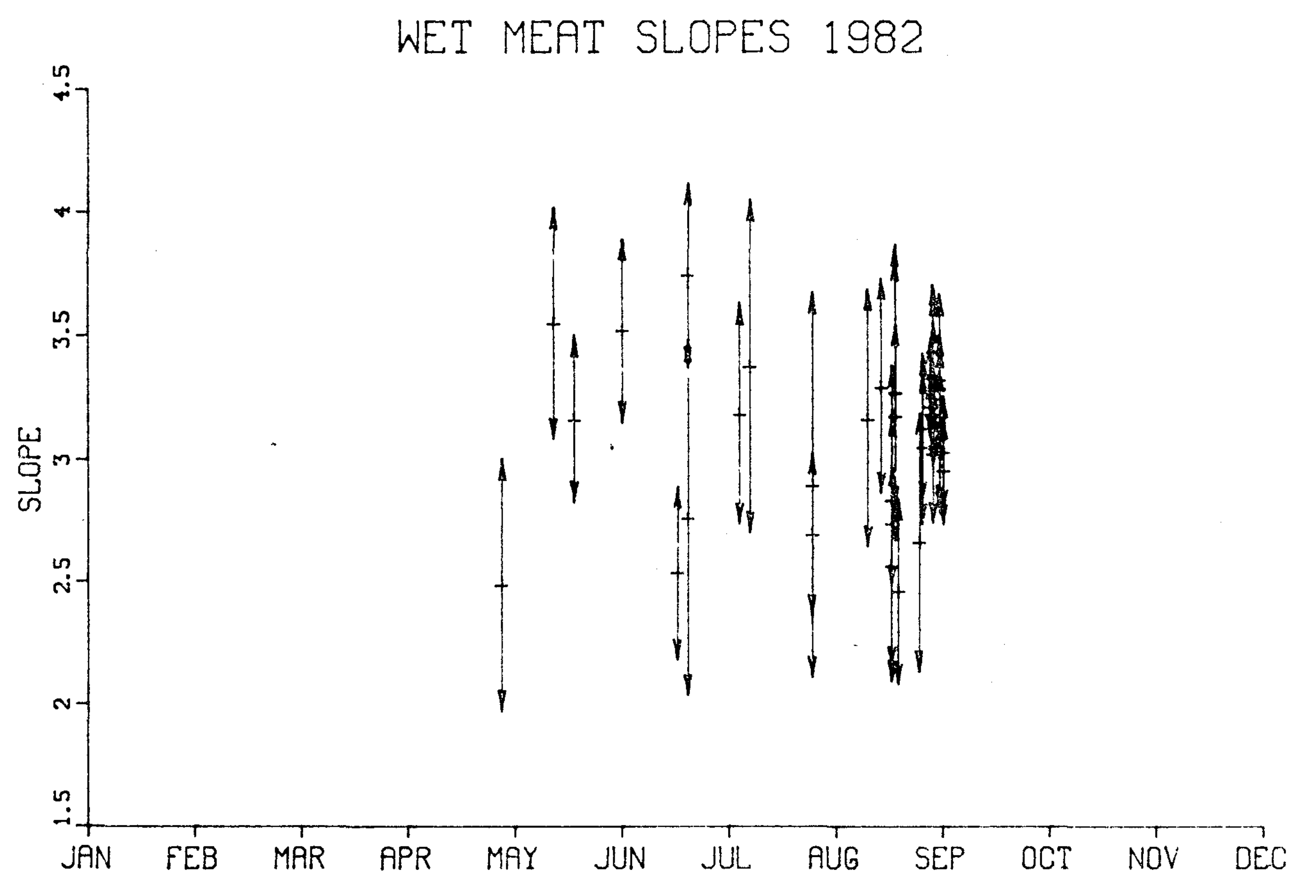

Figure 5a.-Mean values and 95 % confidence interval for regression coefficients of meat weight on shell height on an annual basis.

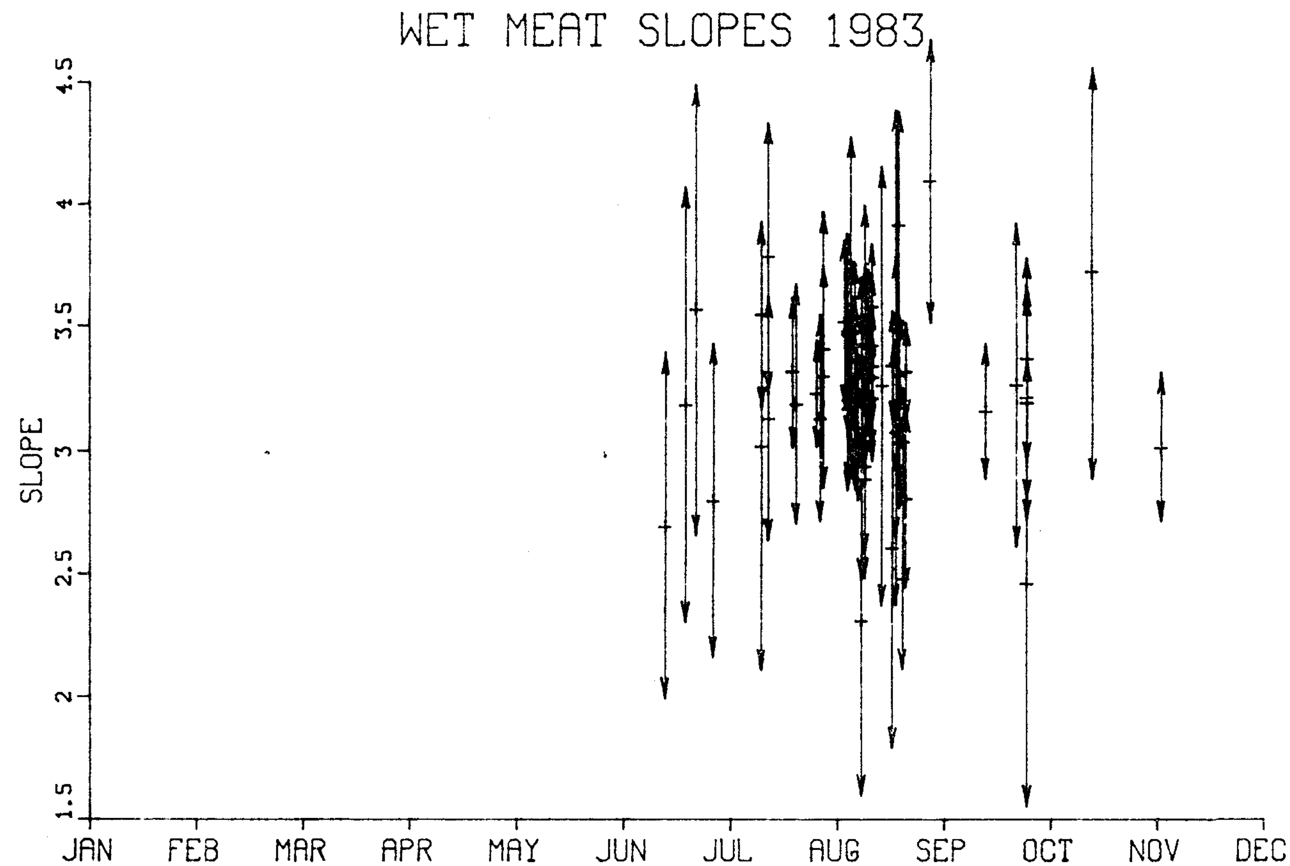

Figure 5b.-Mean values and 95 % confidence interval for regression coefficients of meat weight on shell height on an annual basis.

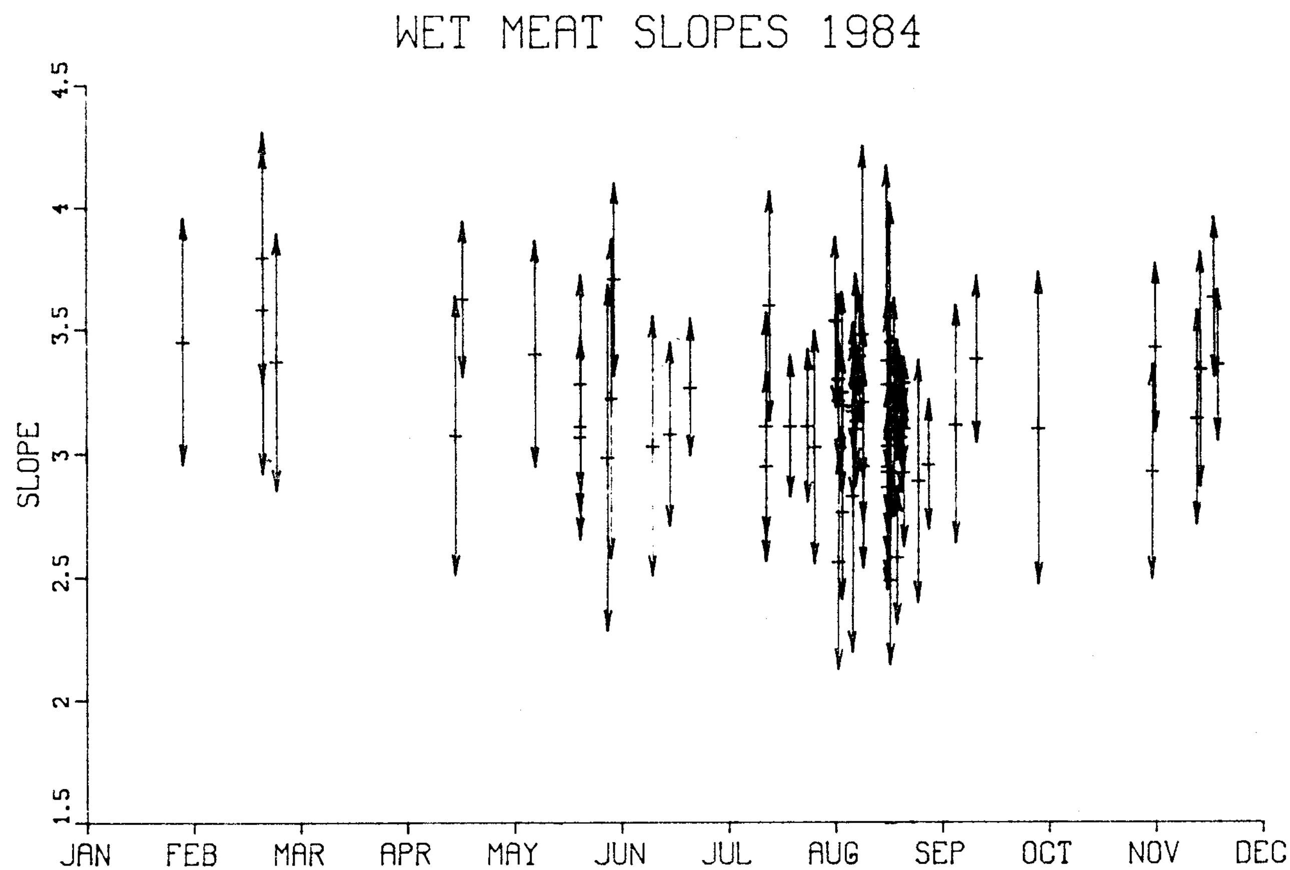

Figure 5c.-Mean values and 95 % confidence interval for regression coefficients of meat weight on shell height on an annual basis.

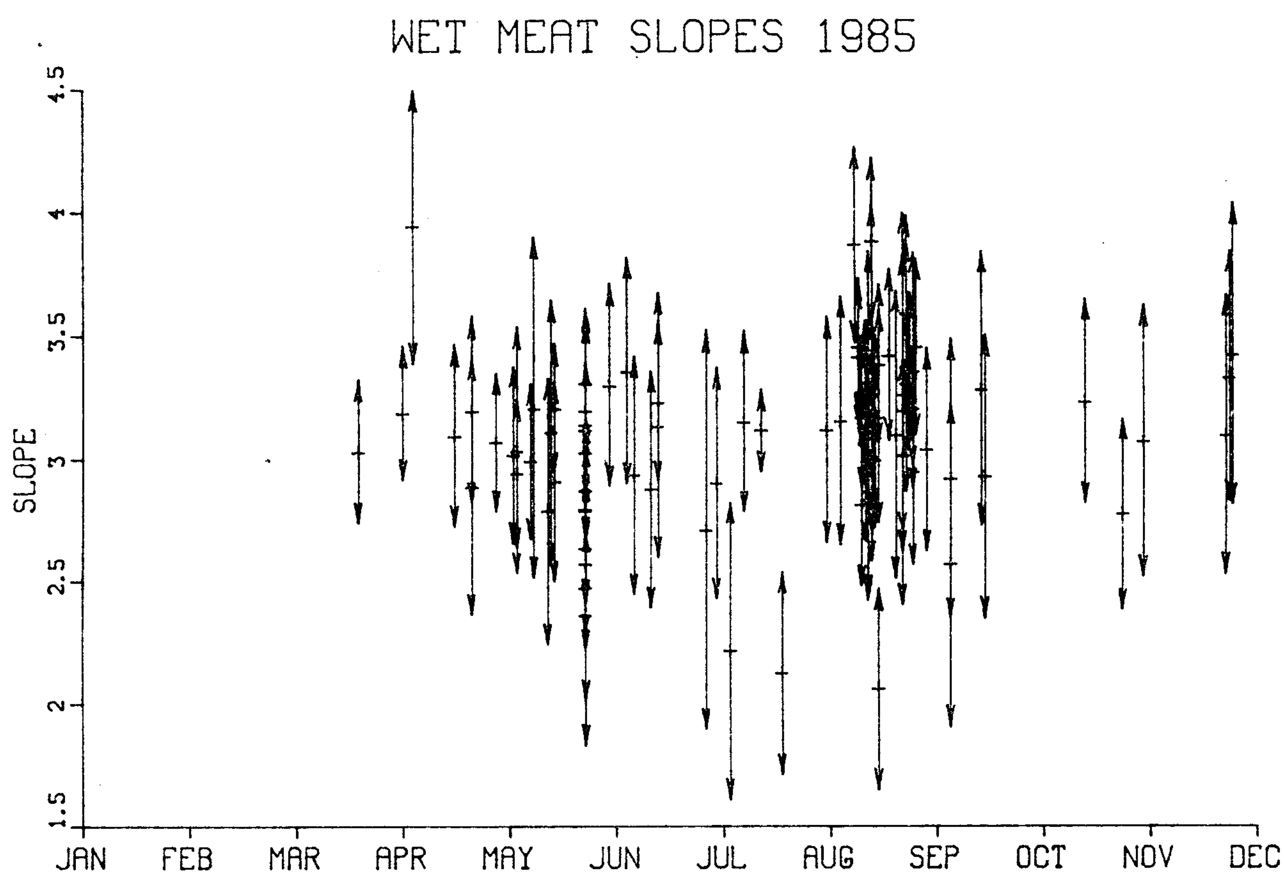

Figure 5d.-Mean values and 95 % confidence interval for regression coefficients of meat weight on shell height on an annual basis.

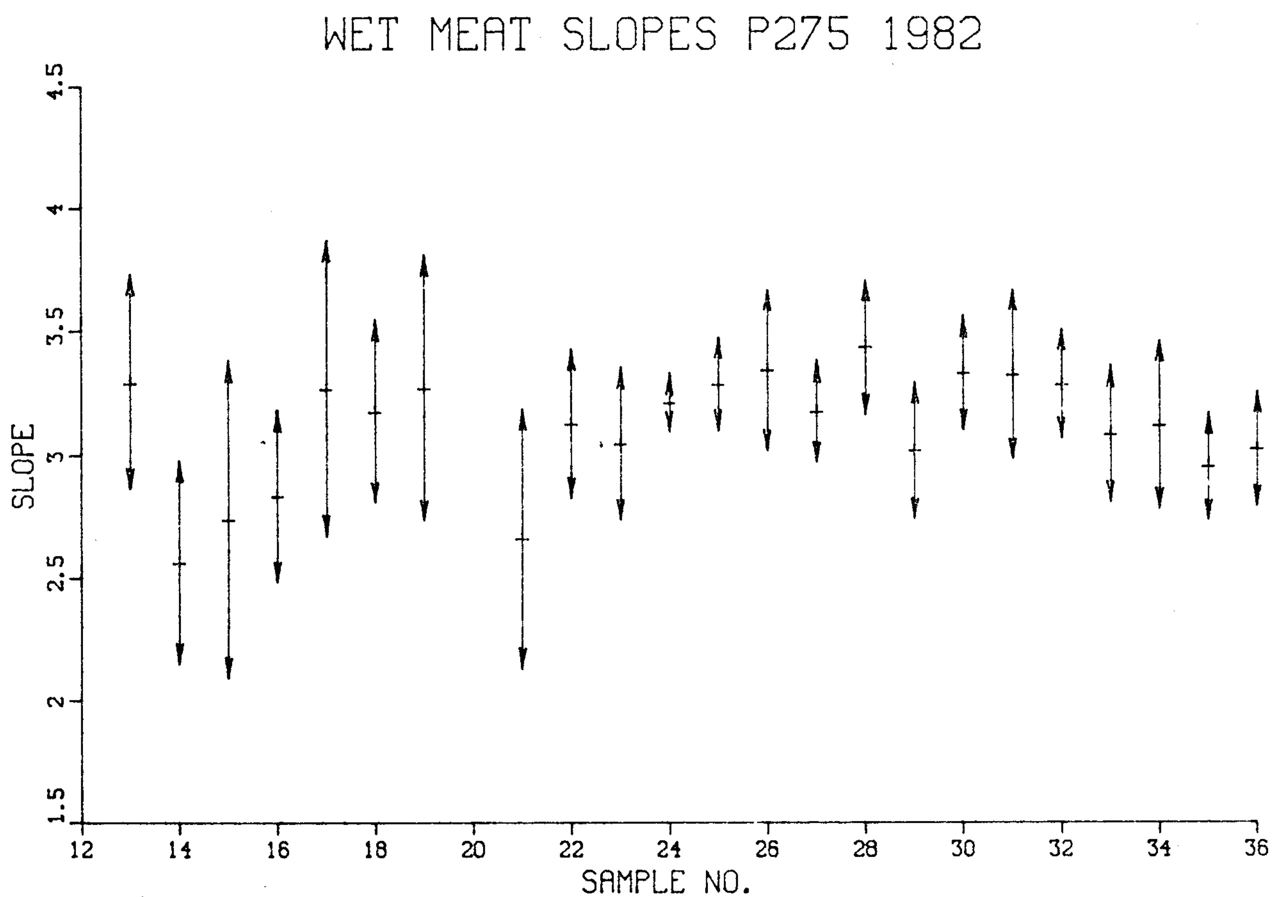

Figure 6a.- Mean values and 95 % confidence interval for regression coefficients of meat weight on shell height for samples collected during stock survey. Some sample slopes do not appear on the graph as they refer to commercial samples collected in August.

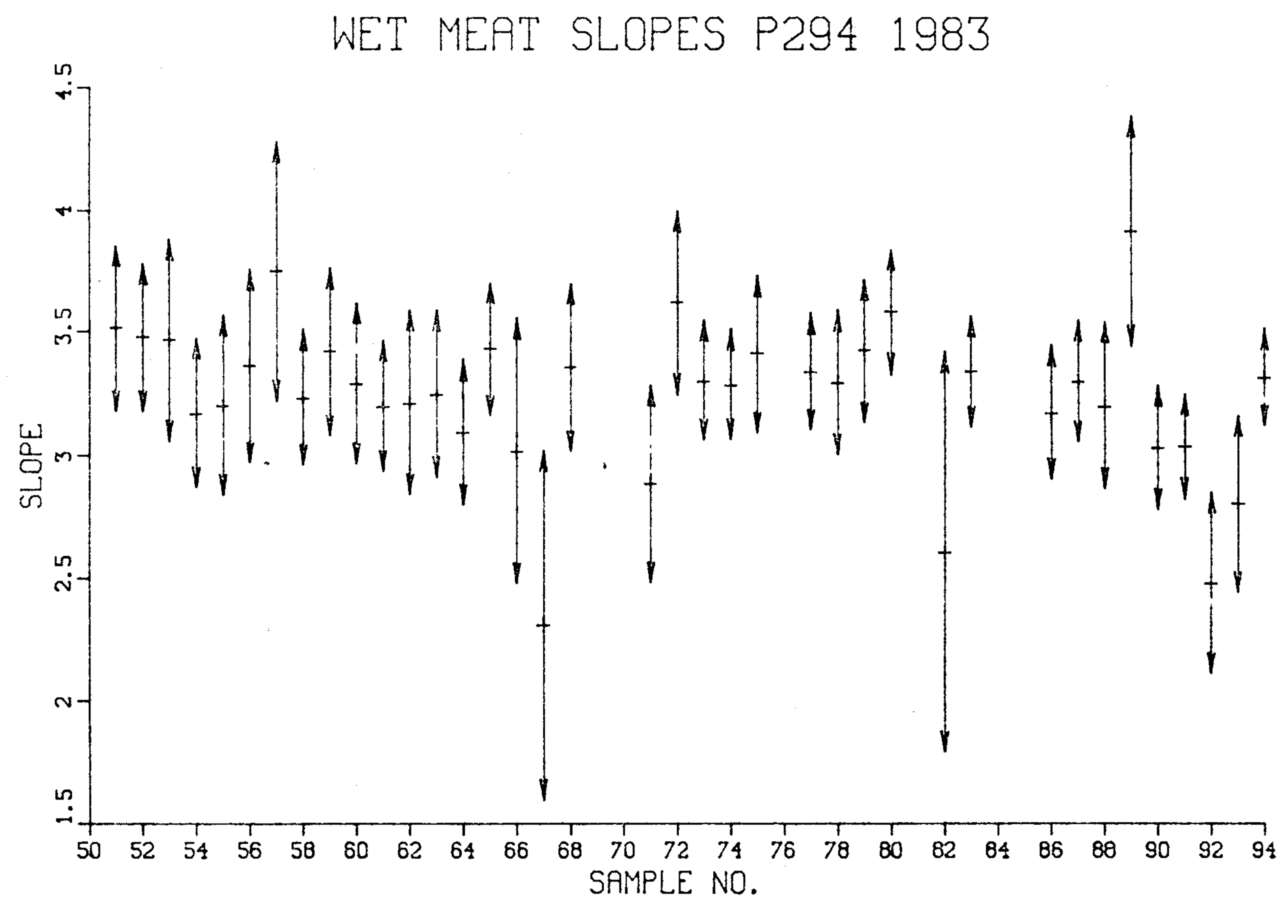

Figure 6b.- Mean values and 95 % confidence interval for regression coefficients of meat weight on shell height for samples collected during stock survey. Some sample slopes do not appear on the graph as they refer to commercial samples collected in August.

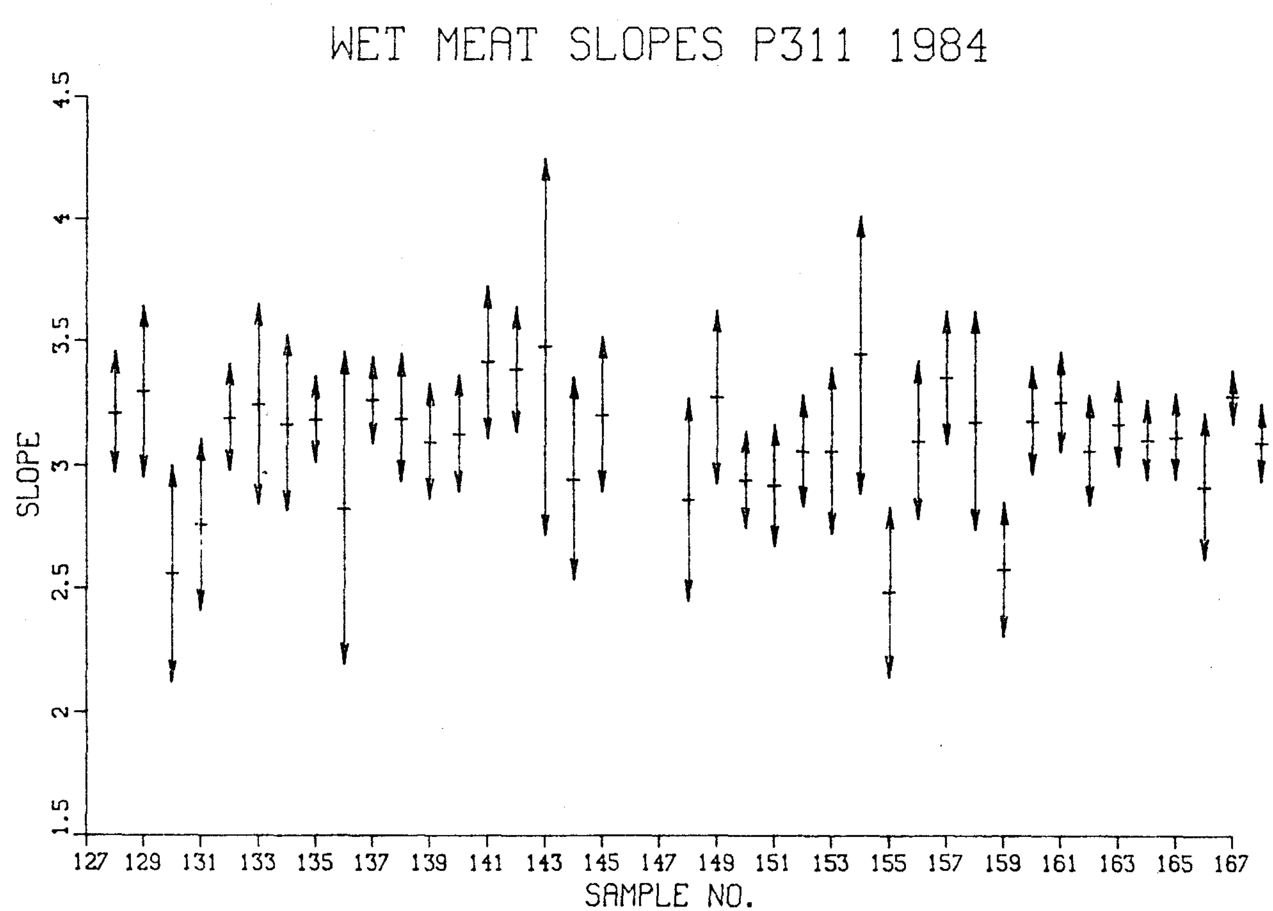

Figure 6c.- Mean values and 95 % confidence interval for regression coefficients of meat weight on shell height for samples collected during stock survey. Some sample slopes do not appear on the graph as they refer to commercial samples collected in August.

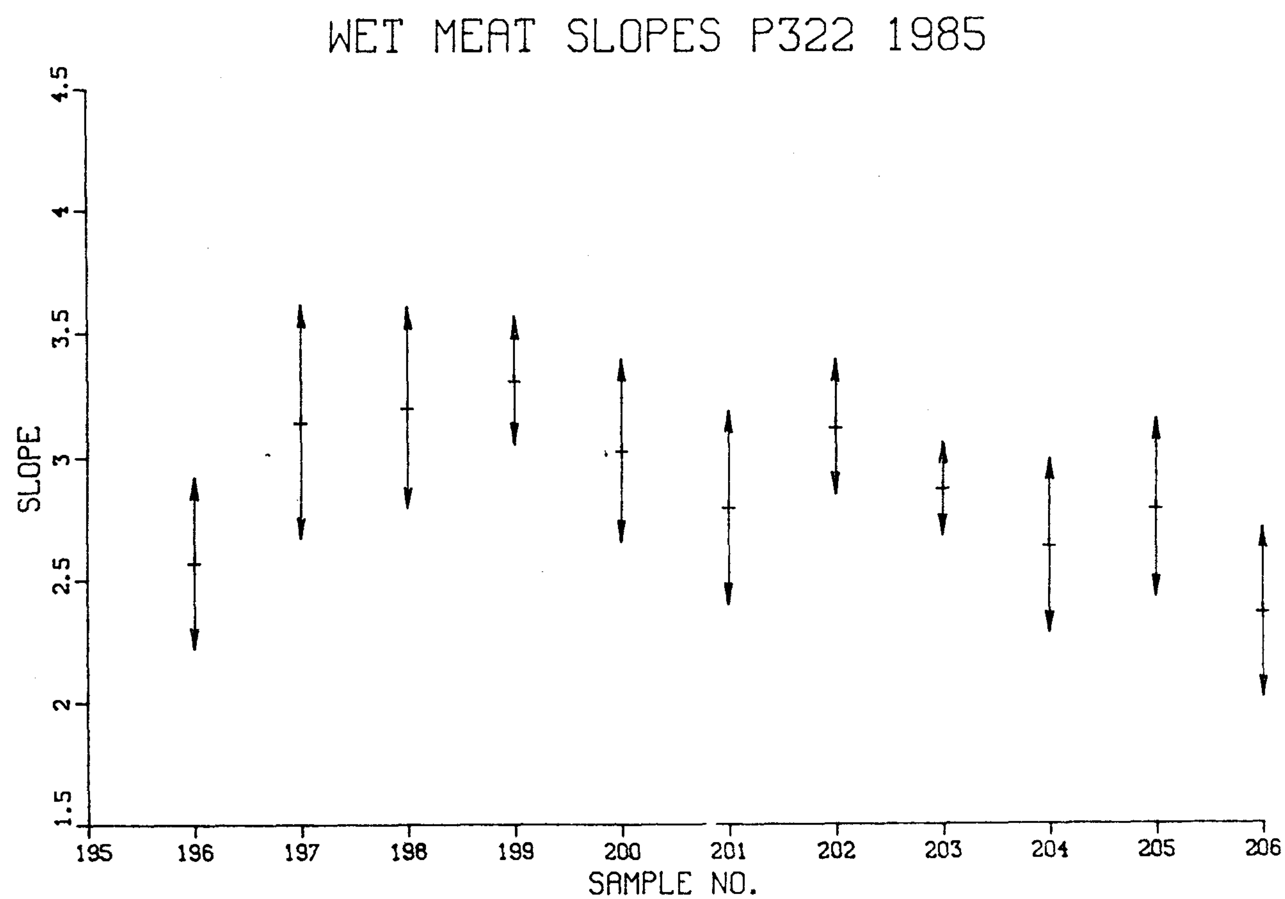

Figure 6d.- Mean values and 95 % confidence interval for regression coefficients of meat weight on shell height for samples collected during stock survey.

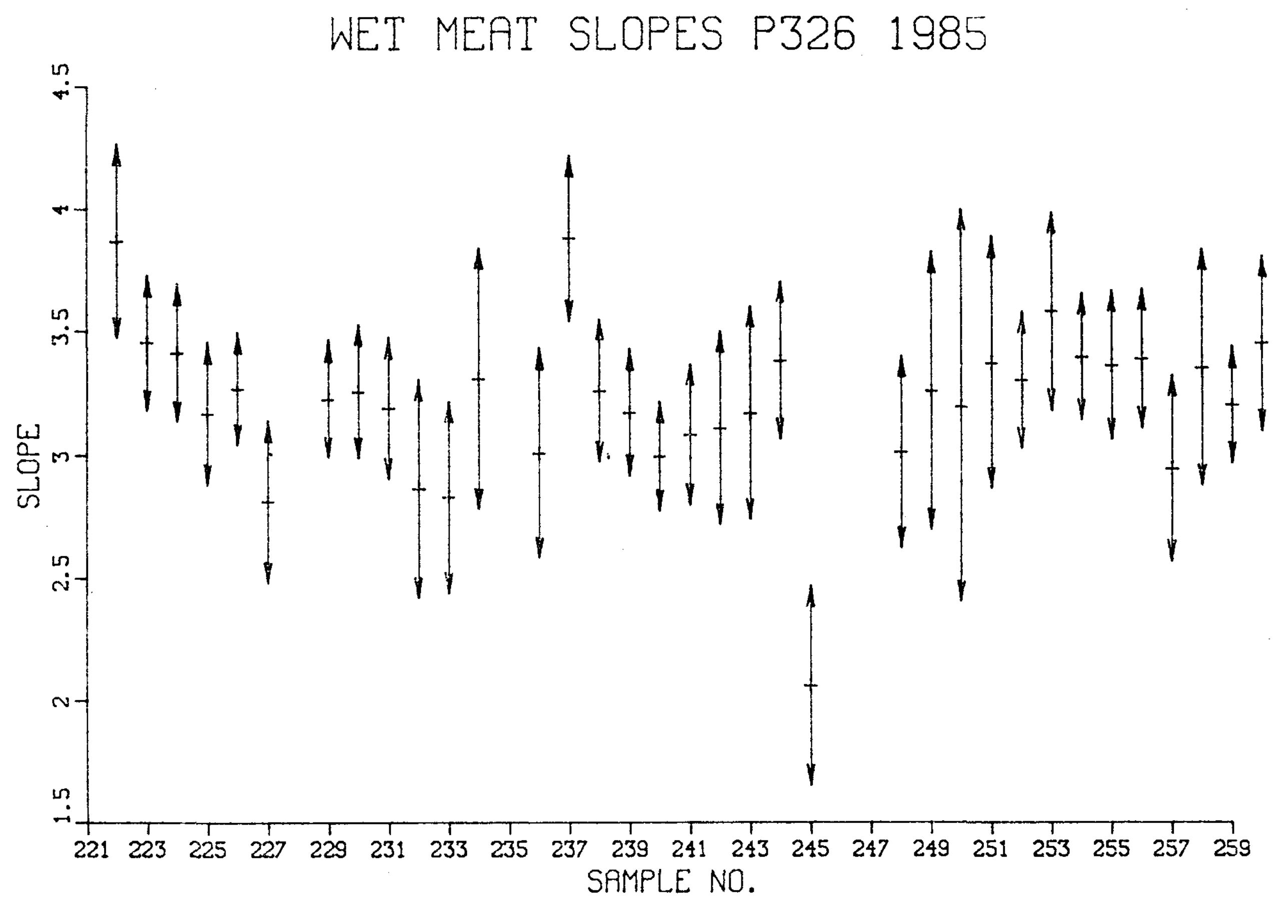

Figure 6e.- Mean values and 95 % confidence interval for regression coefficients of meat weight on shell height for samples collected during stock survey. Some sample slopes do not appear on the graph as they refer to commercial samples collected in August.

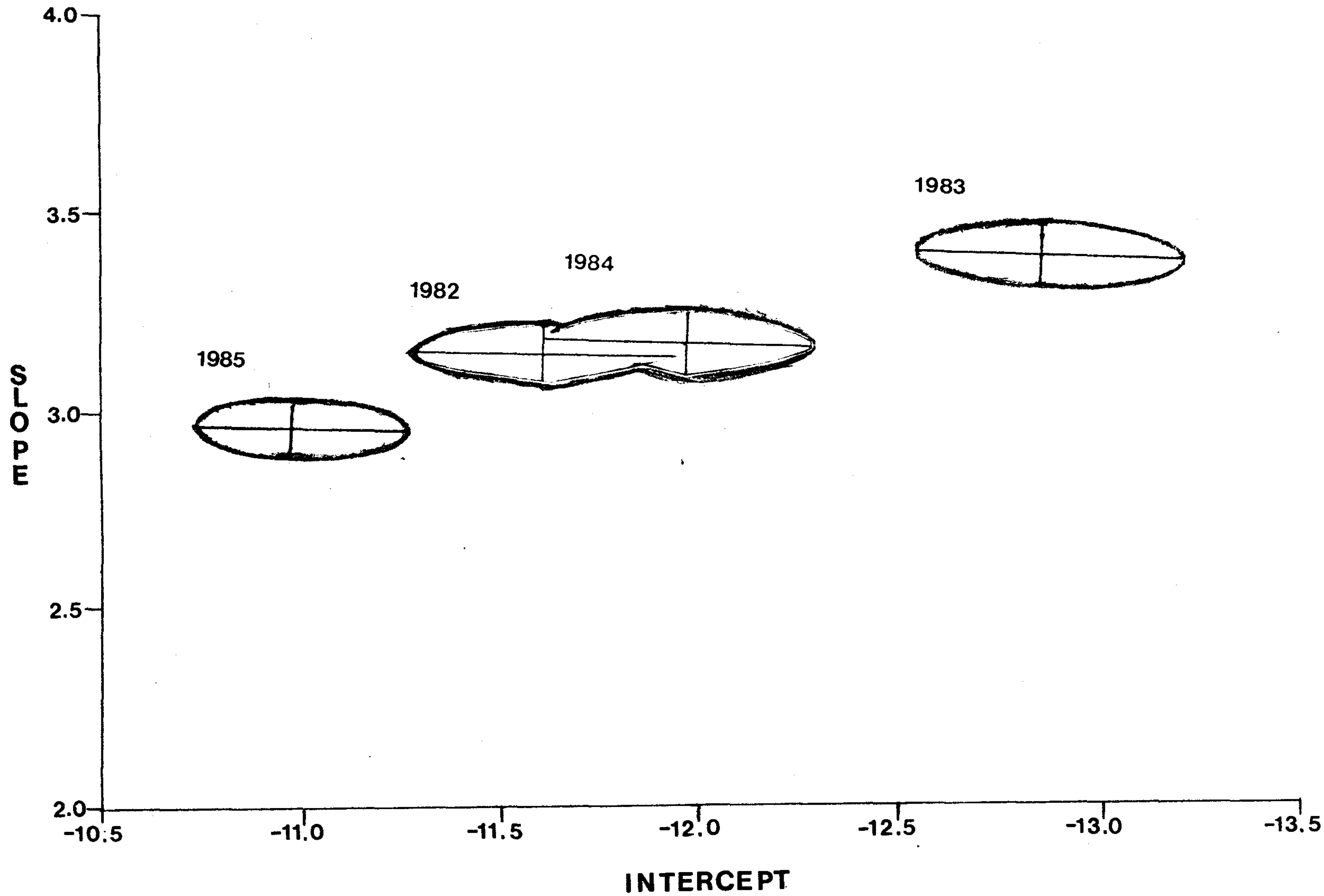

Figure 7.- 95 % confidence ellipses of intercept and slope mean values for data pooled on an annual basis. The range of slope values is narrow indicating the tightness of these values around the mean for each equation.

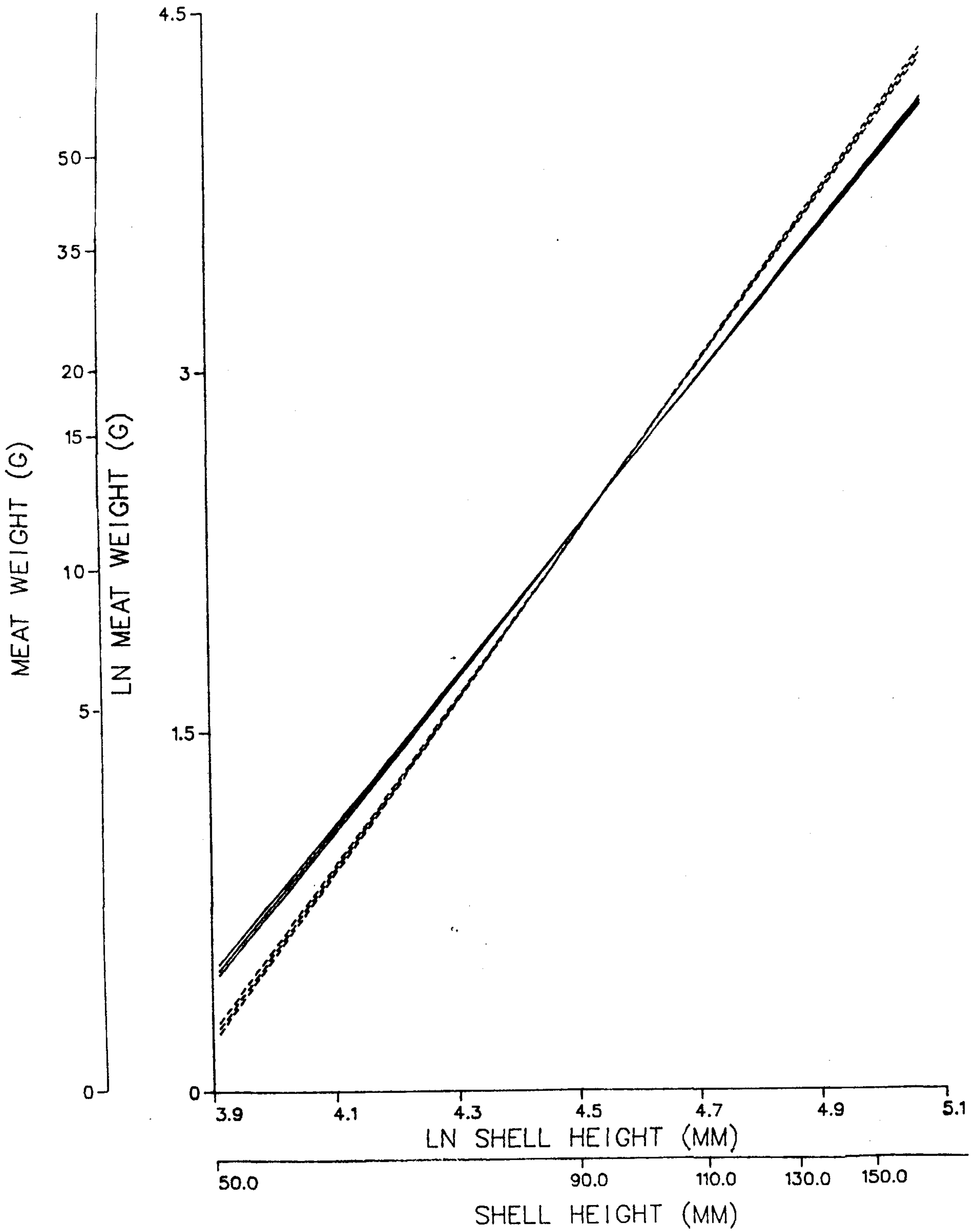

Figure 8.- Log-log plot of meat weight on shell height. Regression with 95 % confidence interval (smooth line). GM functional regression with 95 % confidence interval (dashed line). Corresponding scales for meat weight and shell height are also given.