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Length-weight Relationship and Condition Factor of Greenland Halibut in West Greenland Waters

by

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Introduction.

The fishery for Greenland halibut is increasing at West Greenland, especially in the northern districts, Jakobshavn, Umanak and Upernavik, Division 1A. Most often the fishery takes place in icefiords. The relationship between length and weight and condition factor of Greenland halibut in the West Greenland area are important parameters if a proper assessment is to be made in the future. Previously only Smidt (1969) has published information on these parameters for Greenland halibut at West Greenland based on samples from 1909 to 1965, but Smidt does not give estimates on the regression parameters in the length-weight relationship.

This paper analyses the weight-length relationship based on samples from research investigations in the period 1985-1988, and the condition factors based on data from commercial landings in the period 1985-87.

Material and Methods.

Greenland halibut were collected at long-line surveys carried out by research vessels of the Greenland Fisheries Research Institute during the period 1985-1988 (Table 1). The fish were weighted and measured immediately after being caught. Weights are by nearest 10 g and lengths are total length to the centimeter below.

Least-squares regressions of weight (g) on length (cm) were calculated after logarithmic (base 10) transformation of the two variables. Pairs of these regressions were compared by covariance analysis (Conradsen,1984 and Hicks, 1982).

During 1985-1987 length and weight of Greenland halibut from the commercial fishery have been measured in four areas of West Greenland; Godthaab fiord (Division 1D), Jakobshavn district (1A), Umanak district (1A) and Upernavik district (1A) (Fig. 1). Both winter and summer sampling data are available except for Upernavik district where all data are from summer 1986. Measurements were done with use of the balances of the fishery plants and gutted weights are by

nearest 100 g and lengths are total lenght to the centimeter below.

Condition factors were calculated as

$$C = \text{weight (g)}/\text{length (cm)}^3 \times 10^3$$

for selected length groups: 60-64 cm, 75-79 cm and 90-94 cm. Condition factors of each length group from the different areas were compared by a one-way ANOVA and comparisons of means were done by use of Waller-Duncan test (SAS anon., 1985).

Results.

Length-weight relationship on research data.

Least-squares regression analysis is summarized together with calculated weight for selected lengths in Table 2. Plots of the empirical data is shown as well as plots of the tranformed data with regression lines in Fig. 2-7. The weight-length regressions were highly significant ($P<0.0001$) with coefficients of determination ranging from 0.96 to 0.99. Calculated weights at the 40 cm length group in the different samples differed not markedly from each other but in the 60 cm and 80 cm length groups differences were much greater ranging 120 g and 550 g respectively, with the greatest weight in the Umanak sample at both lengths groups.

Differences between years are statistically evident when pairs of regressions are compared by covariance analysis. In the three samples from Jakobshavn, which were taken at the same season a significant difference was found between the 1985 and the 1987 samples. In comparisons with the non-significant slopes, 1985-86 and 1986-87, the intercepts were significantly different in both cases (Table 3).

Comparing regression parameters from different areas but same season of sampling (Umanak 1987 versus Jakobshavn 1985,-86,-87 and Godthaab versus Julianehaab) significant differences between the slopes are found. This could indicate differences between areas. However influence from difference between year of sampling can only be excluded in the comparison between the samples from Umanak 1987 and Jakobshavn 1987.

Condition factor estimated from commercial landings.

Condition factors calculated for selected length groups of four areas of investigation are shown in Table 4. The condition factors increase markedly with increasing length of the fish. For all three length groups one-way analysis of variance show a significant difference between areas (60-64 cm : $F=15.49$, $p<0.0001$, 75-79 cm : $F=8.46$, $p<0.0001$ and 90-94 cm : $F=17.96$, $p<0.0001$). For the 60-64 cm length group test on means (Waller-Duncan test) shows, that the mean of Godthaab area material was significant ($p<0.05$) lower than

the mean of samples from the other areas, which mutual not differs (see text table). In the case of the 75-79 cm length group test on means results in two groups; Jakobshavn and Umanak having significantly ($p<0.05$) higher means than Upernavik and Godthaab (see text table). For the 90-94 cm length group the mean of Godthaab was significantly ($p<0.05$) lower than the mean of Upernavik, the latter being significantly ($p<0.05$) lower than the means of Jakobshavn and Umanak (see the text table).

Text Table

Mean condition factor by area and length group and results of tests on means. Values underscored by the same line are not significantly different from each other ($p<0.05$).

	Jakobshavn	Upernavik	Umanak	Godthaab
60-64 cm	8.891	8.855	8.742	8.400
	Jakobshavn	Umanak	Upernavik	Godthaab
75-79 cm	9.240	9.154	8.688	8.660
	Jakobshavn	Umanak	Upernavik	Godthaab
90-94 cm	10.432	10.253	9.313	8.789

Discussion.

Pairs of comparisons of the parameters of the weight-length regressions based on research data showed significant differences in either slope or intercept for all comparisons. However, the sample from Umanak 1987 is the one differing most from the others, weight at length being greater in this sample.

Samples from Jakobshavn from three succeeding years at the same season show significantly differences between the years in the parameters of the weight-length regressions. However, the differences in weight at length were not great.

Comparisons of samples from different areas but from the same season also show significant differences of the regression parameters, but influence of yearly differences could only be excluded in one of these comparisons.

The analysis of condition factor based on data from commercial landings during 1985-87 show, that condition factors of fish from Godthaab Fiord generally are lower than fish from the other areas investigated. Furthermore, Greenland halibut from Upernavik have a lower condition factor than fish from Jakobshavn and Umanak but a higher one than fish from Godthaab Fiord at least for the greater length groups.

Results from the analysis of research data and commercial data are not concurrent. There can be several reasons for this. The research data cover a length interval from about 30 cm to 100 cm with most fish in the midrange of this interval, while data from commercial landings include fish sorted in length groups above 60 cm (60-64 cm, 75-79 cm and

90-94 cm) and are therefore based on relatively bigger fish. Furthermore, measurements of weight of fish by different balances at the fishery plants can be biased according to the quality of the balances. Also differences in precision of the gutting procedure at the fishery plants may be a source for bias of the results.

Based on length-weight samples during 1953-65 Smidt (1969) showed that fish from the stock in Godthaab Fiord are in poorer condition than those from the stocks in the other areas of investigations, which include Julianehaab district, Jakobshavn district and Umanak district. This seems to be in accordance with the present analysis of the condition factor based on data from commercial landings, but inconsistent with the results from research investigations in January 1987. Smidt (1969) also described the stock in Umanak as a stock in good condition, which is supported by these investigations.

References.

Conradsen,K. 1984. En introduktion til statistik.(5. Ed) The Institute of Mathematical Statistics and Operations Research, The Technical University of Denmark (in Danish).

Hicks, C.R. 1982. Fundamental concepts in design of experiments. (3rd Ed.) New York: Holt, Reinhart and Winston. 425 pp

Smidt, E. 1969. The Greenland Halibut, Reinhardtius hippoglossoides (Walb), Biology and Exploitation in Greenland Waters. Medd. Danm. Fisk.-og Havunders. V.S., 6:79-148.

SAS Institute Inc., 1985. SAS User' s Guide: Statistics, Version 5ed Edition. Cary, NC: SAS Institute Inc., 956 pp.

Table 1. Summary of research samples for length-weight relationship of Greenland halibut in West Greenland.

Research investigations, Round fish		Division	Month	Year	No of fish	Length range (cm)
Julianehaab district	(JUL88)	1F	Jan	1988	282	31- 86
Godthaab Fiord	(GHB87)	1D	Jan	1987	522	38- 91
Jakobshavn district	(JAK85)	1A	Oct	1985	214	35- 95
"	(JAK86)	1A	Aug	1986	489	26-100
"	(JAK87)	1A	Aug	1987	527	30- 95
Umanak district	(UMA87)	1A	Sep	1987	355	30- 96

Table 2. Summary of regression analyses of log weight against log length (base 10) and calculated weights for selected lengths.

	Int.	Slope	R2	Retransformed equations (g)	Calculated weights (kg) for selected lengths 40 cm	60 cm	80 cm
JUL88	-2.2703	3.1360	0.98	$W = 0.00537\ L^{3.1316}$	0.57	2.02	4.99
GHB87	-2.4143	3.2188	0.96	$W = 0.00385\ L^{3.2188}$	0.55	2.04	5.14
JAK85	-2.4921	3.2553	0.97	$W = 0.00322\ L^{3.2553}$	0.53	1.98	5.05
JAK86	-2.3538	3.1800	0.98	$W = 0.00443\ L^{3.1800}$	0.55	2.00	4.99
JAK87	-2.2696	3.1390	0.98	$W = 0.00538\ L^{3.1390}$	0.57	2.05	5.06
UMA87	-2.6680	3.3691	0.99	$W = 0.00215\ L^{3.3691}$	0.54	2.10	5.54

Table 3. Comparison of regression parameters by covariance analysis. For every comparison upper symbol shows test for slopes and lower symbol test for intercepts. - indicates non-signicant at 5%-level, + indicates significant at 5%-level and ++ indicates significant at 1%-level. Intercept were not compared statistically when slopes differed significantly.

	GHB87	JAK87	JAK86	JAK85	UMA87
JUL88	+	- ++	- ++	+	++
GHB87		+	- ++	- ++	++
JAK87			- ++	+	++
JAK86				- ++	++
JAK85					+

Table 4. Condition factors (C) by area and length group. S.D. = standard deviation, n = number of fish.

	60-64 cm			75-79 cm			90-94 cm		
	C	S.D.	n	C	S.D.	n	C	S.D.	n
Godthaab	8.400	0.729	(231)	8.660	0.897	(45)	8.789	1.109	(13)
Jakobshavn	8.891	0.852	(313)	9.240	0.938	(264)	10.432	1.165	(132)
Umanak	8.742	0.965	(184)	9.154	1.019	(330)	10.253	1.029	(108)
Upernavik	8.855	0.974	(79)	8.688	1.065	(59)	9.313	0.911	(39)

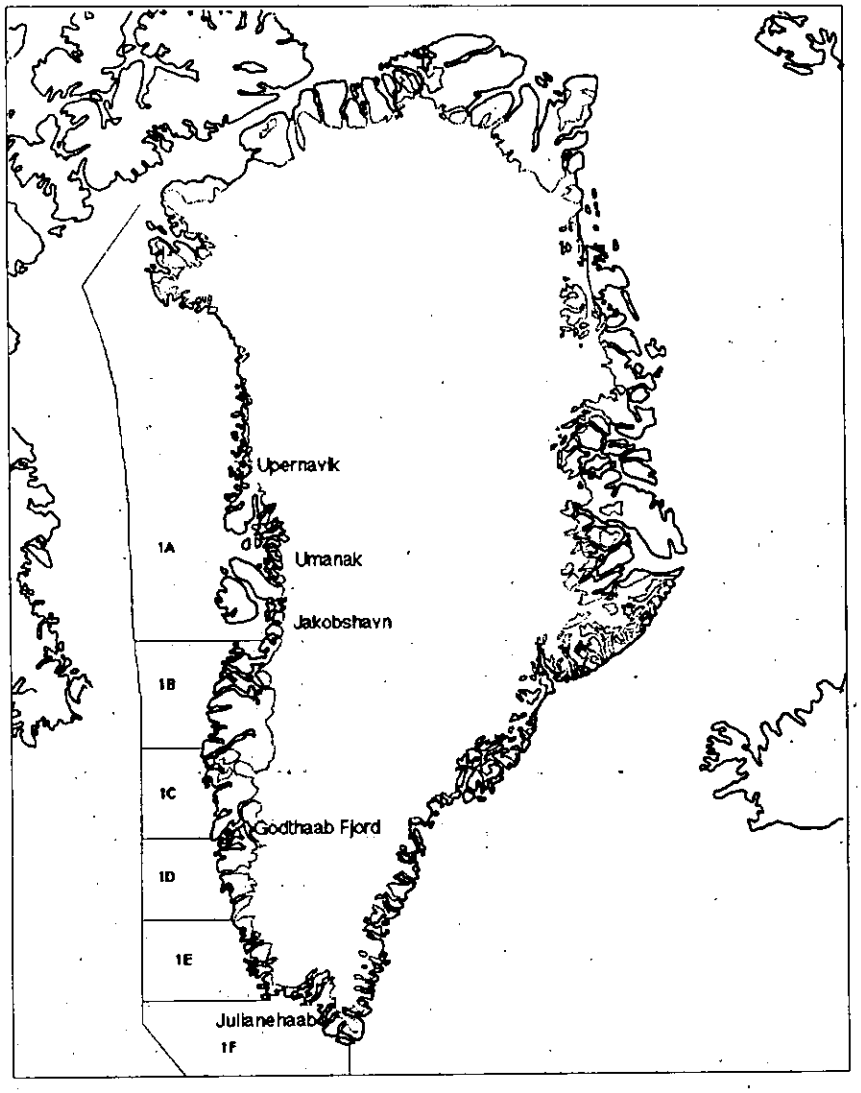


Fig. 1. Map showing localities mentioned in the text.

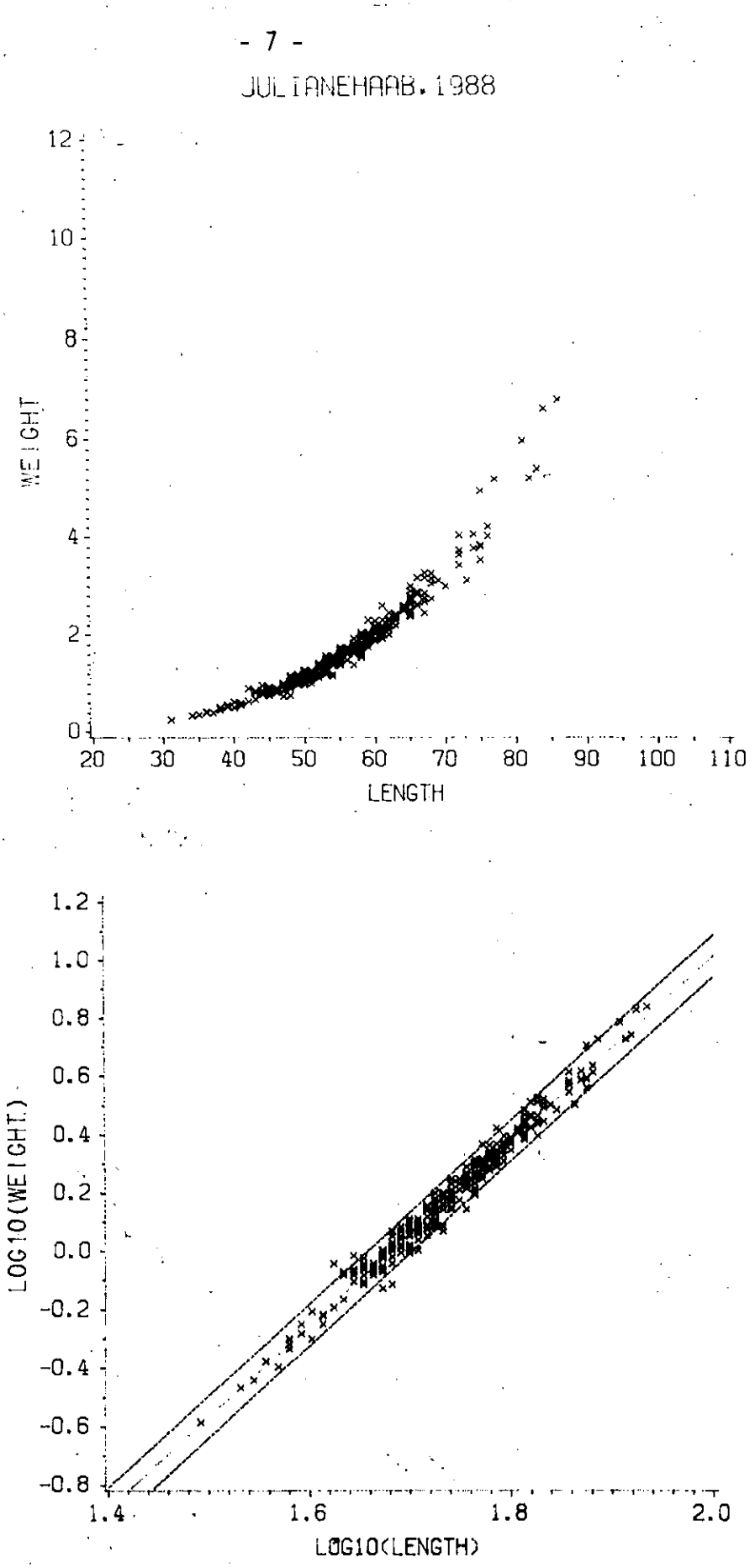
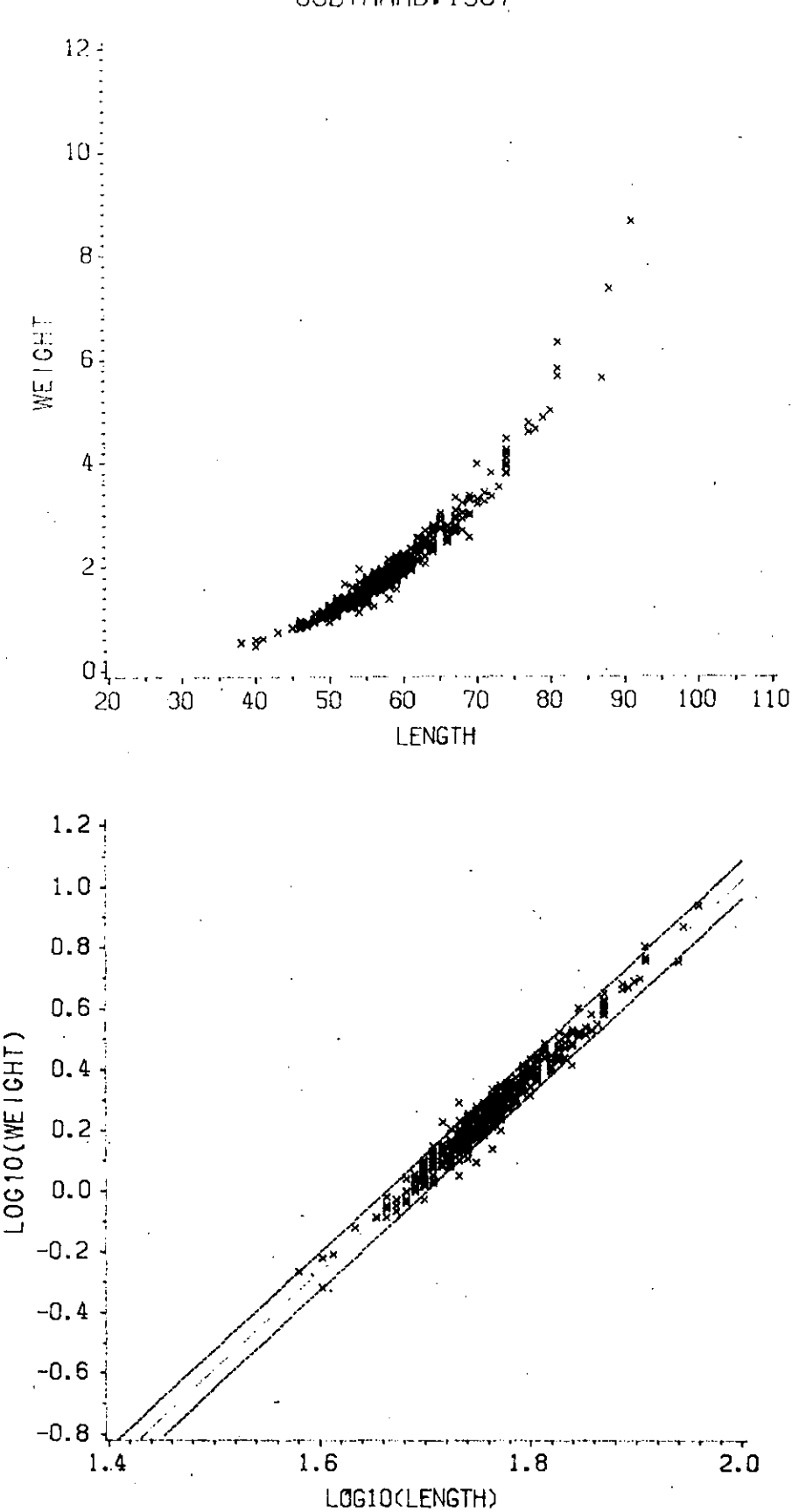


Fig. 2. For each analysis a plot of the empirical data as well as a plot of the transformed data with regression line and 95% confidence limits.



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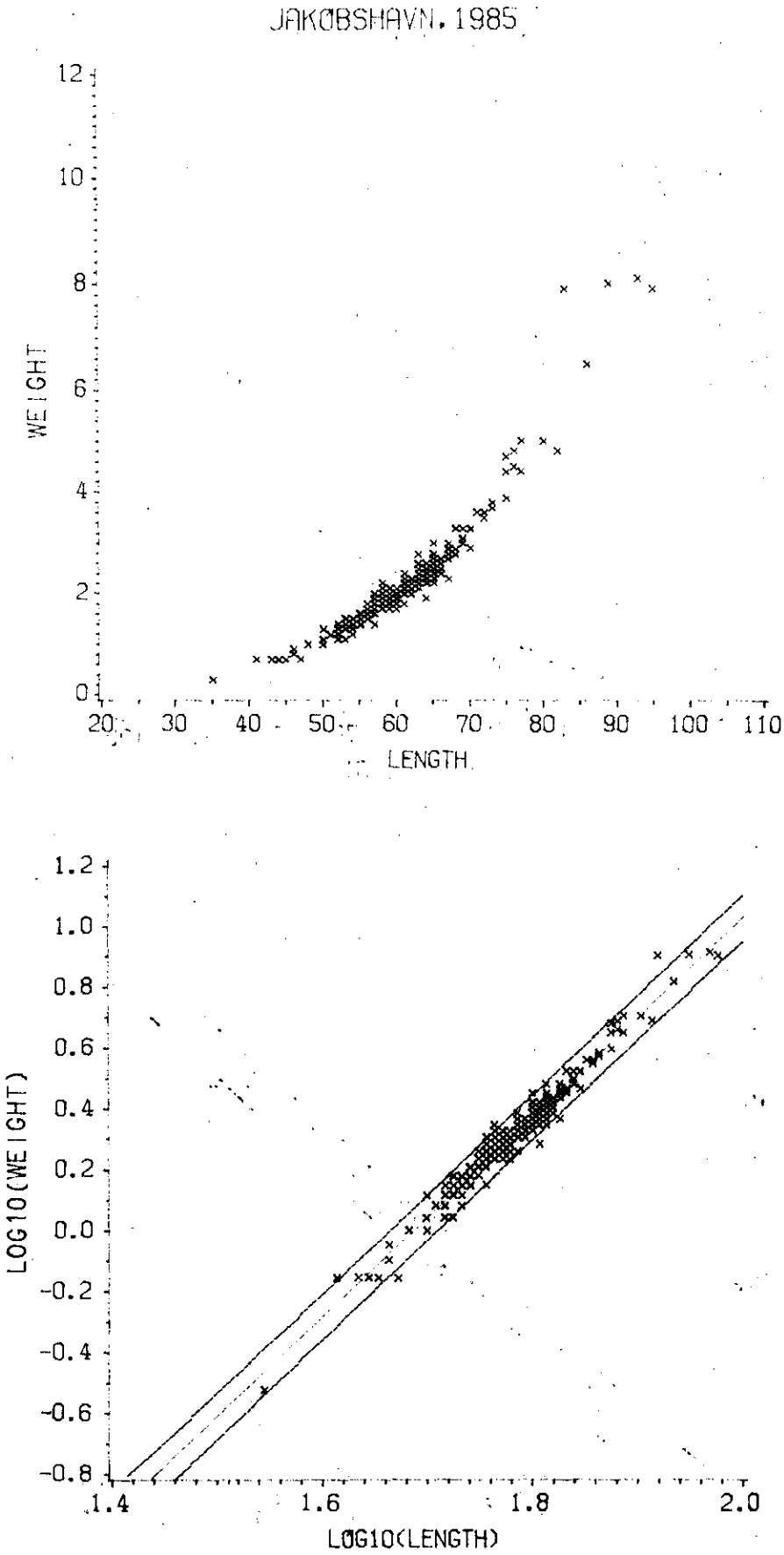

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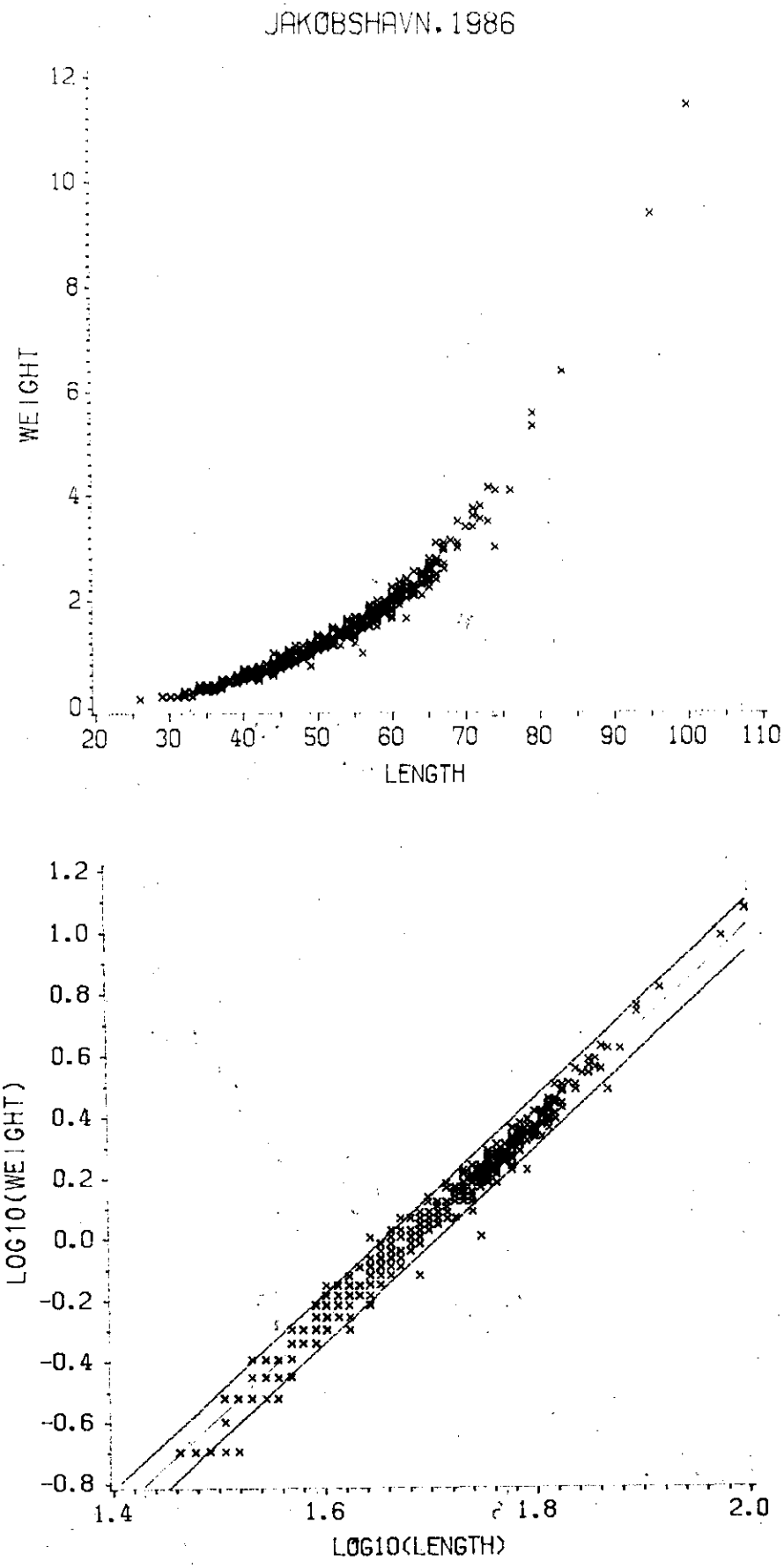

Fig. 5. For each analysis a plot of the empirical data as well as a plot of the transformed data with regression line and 95% confidence limits.

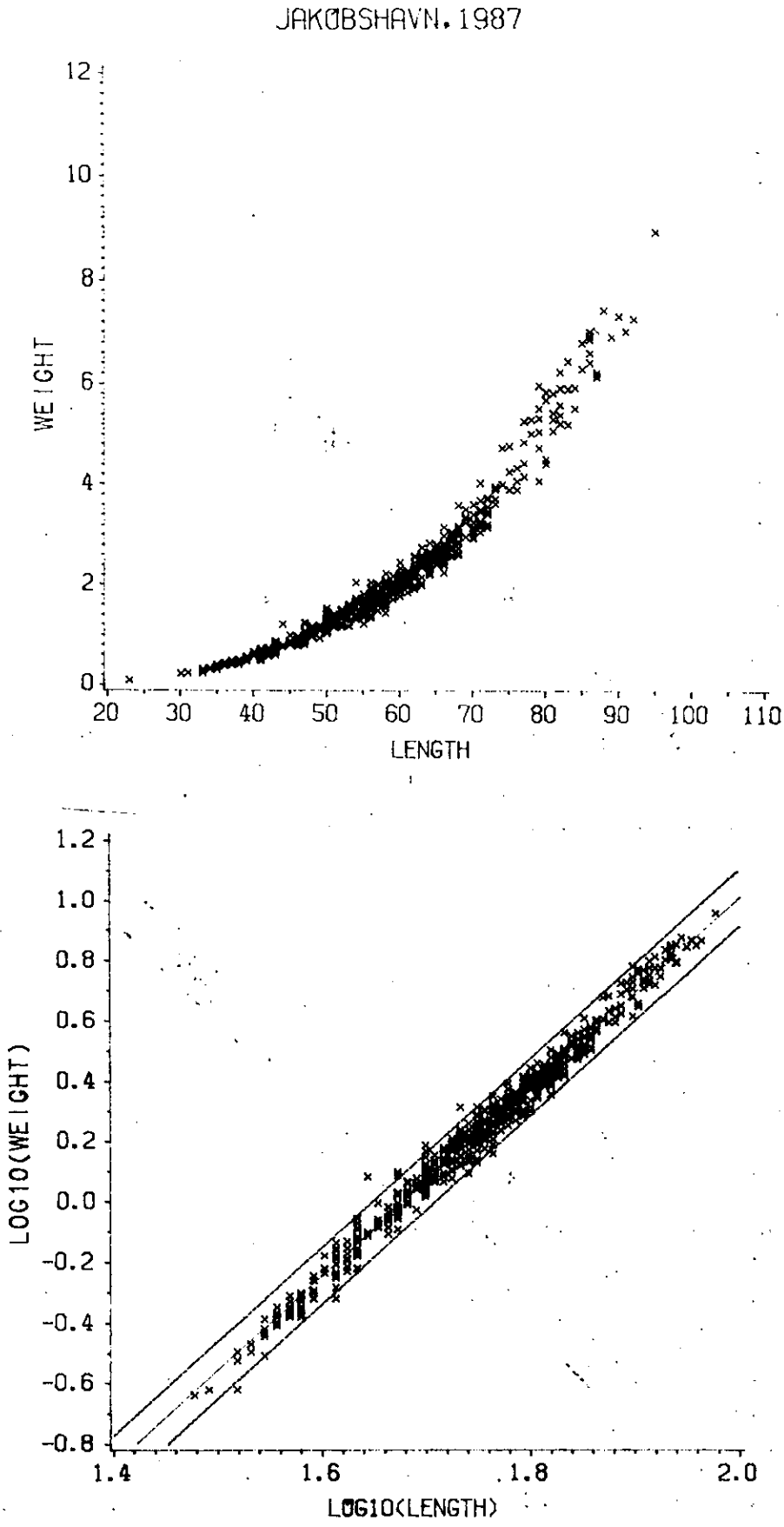

Fig. 6. For each analysis a plot of the empirical data as well as a plot of the transformed data with regression line and 95% confidence limits.

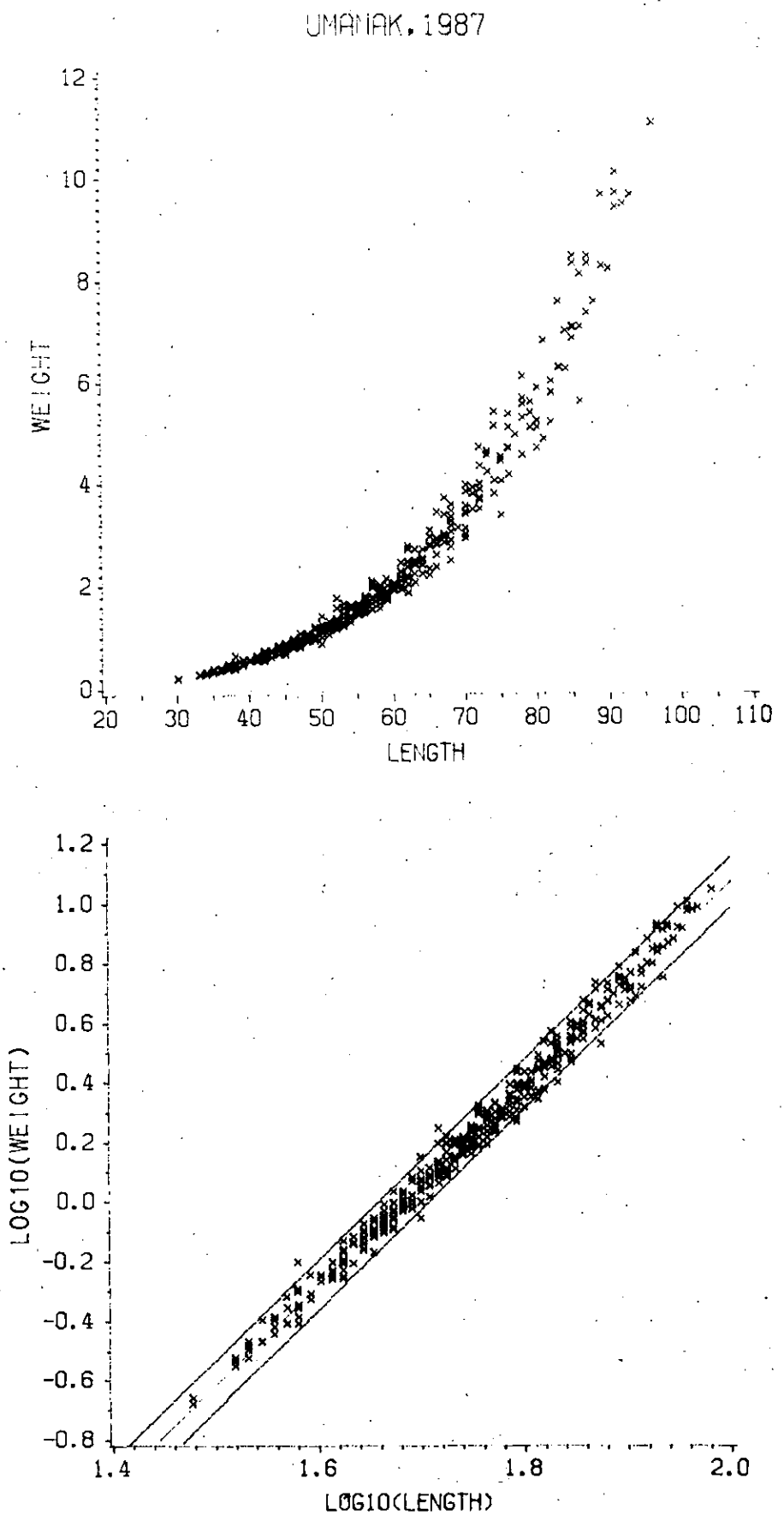

Fig. 7. For each analysis a plot of the empirical data as well as a plot of the transformed data with regression line and 95% confidence limits.