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Survey calibration for Greenland Halibut in Division1A inshore

by

Jesper Boje[1] and Bjarne Lyberth[2]

[1]Danish Institute for Fisheries Research, Charlottenlund Slot,
2920 Charlottenlund, DENMARK

[2]Greenland Institute of Natural Resources, P.O. Box 570,
3900 Nuuk, GREENLAND

Abstract

In order to calibrate catch efficiency of a newly initiated gillnet survey with a former longline survey in Disko Bay, NAFO Division 1A, parallel settings by the two gears were performed in 2001 and 2004. Gear efficiency was expressed as the ratio between standardized length distributions of the two gears. Variation in catch ratio by length was tested by use of a GLM model taking into account area and year effects. The model outlines that length is not a significant contributor to the overall model and the ratio relationship between the two gears within the length range 30 to 50 cm can therefore be assumed constant. This implies that longline catches from the longline survey back to 1993 in Disko Bay can be converted into gillnet equivalents and thereby the entire time series used for assessment of the stock component.

Introduction

The adult part of the Greenland halibut populations in the inshore areas of Div. 1A has since 1993 been monitored by use of a longline survey conducted near or in the areas of the commercial fishery. Bottom contours and ice conditions limit gear type to passive gears and thus prevent use of trawling gear that is normally used for monitoring purposes. A number of disadvantages have been associated with the use of longline as a survey gear. One of the most serious limitations to longlines as a monitoring gear is difficulties in estimating area exploited by the gear and thus in providing an absolute estimate of abundance (Engås and Løkkeborg, 1994). Longline fishing also introduces biases, mainly concerned with the processes by which fish actively have to seek and find the baited hook, get hooked and stay hooked until they are on deck (Løkkeborg, 1994). Use of longlines to monitor stock development of Greenland halibut in the inshore areas of Div. 1A has recently been discussed by Simonsen *et al.* (Simonsen *et al.*, 2000) and they concluded amongst others, that in order to provide a better forecast of recruitment to the fishery it might be considered that the survey targets younger age groups. As the longline survey in general does not generate sufficient data for proper statistical analyses (low catch rates resulting in high CPUE variance) it was decided to change gear type to a multi-meshed gillnet. Gillnets are used in the commercial fishery for Greenland halibut in Ilulissat and Uummannaq and are known to be effective catching fish (Simonsen and Boje, 2004). The advantage of using gillnets as a monitoring gear, is that selectivity is known and mesh sizes can be chosen to select for pre-recruit size fish. Aiming a pre-recruit size fish will keep the surveyed area in distance from the commercial fishery, a logistic problem that formerly has impeded the longline survey, due to small and concentrated fishing areas for Greenland halibut. Thus, since 2001 a parallel survey with multi-meshed gillnets have been carried out in Disko Bay, concurrent with longline settings in the same area. The present paper compares catch rates and catch distribution for the two gears and suggest a way to calibrate the catch rates of the two surveys.

Materials and Methods

Longline survey

Prior to 1993 various longline exploratory fisheries were conducted with research vessels. Due to variable survey design and gear, these surveys are not comparable. In 1993 a longline survey for Greenland halibut was initiated for the inshore areas of Disko Bay, Uummannaq and Upernavik. The survey was conducted annually covering two of three areas alternately, with approximately 30 fixed stations in each area (for further details see Simonsen *et al*. (2000)). Each setting is conducted with approx. 1 000 hooks, hookspacing 1.8 m, giving a total fishing length of about 2 km. Fishing time is more than 6 hours and up to 24 hours. In 2001, 9 settings were made parallel with gillnet survey and again in 2004 were made 10 settings in order to calibrate with the gillnet survey.

Gillnet survey

The multi-meshed gillnets were designed to target pre-fishery sized Greenland halibut, i.e. in the range 30-50 cm. Experience with the gear so far, indicate that catch rates are sufficient to allow proper statistical analyses, and the strategy is therefore to continue this survey as a monitoring tool for the inshore Greenland halibut populations in Disko Bay.

The gillnet survey was initiated in 2001 and takes place only in Disko Bay with the research vessel 'Adolf Jensen'. The location, Disko bay, is chosen due to the known presence of pre-fishery recruits in the entire area in combination with a bottom topography (approx. 3-400 m depth of flat clay ground) that allows fishing with gillnets. The northern areas, Uummannaq and Upernavik, have both tough rock grounds not suitable for gillnet fishing. Only 8 stations were fished in the starting year 2001, while in 2002 to 2004 the number was increased to 54, 58 and 51, respectively (see Table 1). The surveyed area cover the proposed young fish areas in Disko Bay, off Ilulissat and the Icefjord and off the northern icefjord Torssukattak. Mesh sizes 45, 52, 60 and 70 mm (knot to knot) with twines 0.28, 0.40, 0.40 and 0.50 mm correspondingly, were used to target the fish size groups approximately 30- 50 cm. Multi-gang gillnets being approx. 300 m were composed of 4 sections, one of each meshsize, with 2 m space between each section to prevent catchability interactions between sections. Order of the mesh size panels was set randomly from setting to setting. Soaktime is approx. 10 hours and fishing occurred both day and night. Stations were paired two and two, close to each other to analyse for within station variability. The survey uses fixed positions of stations.

The gillnets are designed to select Greenland halibut in the length range 30- 50 cm. Greenland halibut larger than 50 cm are abundant in the area, but seem mostly concentrated at the commercial fishing grounds in the immediate vicinity of Ilulissat and in the Icefjords, Kangia (Ilulissat Icefjord) and Torsukattak in the north. The gillnet survey do not cover those commercial fishing grounds. Greenland halibut smaller than 30 cm are occasional abundant in the area, but are mostly recruited from offshore areas off Disko Bay and are supposed to perform a stepwise migration towards the commercial fishing grounds near the icefjords.

In order to calibrate NPUE (nos per unit effort) between the two gear types only data from concurrent settings within year and statistical square were used. Since it has previously been shown that catch rates from both gears are independent on soak times exceeding 6 hours, all settings more than 6 hours have been included and no attempt was made to adjust for longer soak time. NPUE for longlines are expressed as numbers per 10000 hooks in order to be at a comparable level to NPUE for gillnets (expressed as numbers per setting).

In order to test whether catch ratio between longline and gillnet vary by length an analysis of variance (GLM) was conducted on log-transformed catch ratios by lengths using the model

$$\log(\text{NPUE}_{\text{longline}}/\text{NPUE}_{\text{gillnet}}) = \text{Overall mean} + \text{length} + \text{stat. sq.} + \text{year} + \text{residual}$$

by means of the statistical software SAS

Length distributions raised by CPUE for the gillnets (for each mesh size) was applied to a bimodal selectivity curve to describe the catching process. Modes were described by a normal distribution and geometrical similarity was assumed between the two.

Results

Only in statistical squares LG027-28 and LH028, which is in close vicinity to Kangia Icefjord, both longline and gillnet settings have been conducted in 2001 and 2004 (Table 1). Catch distributions from these years and statistical squares are given in Fig. 2. Due to low numbers in some of the squares distributions are rather noisy, but in general, both gears catches Greenland halibut from about 30 cm to about 70 cm. The total distribution, i.e. for statistical squares LG027-28 and LH028 in 2001 and 2004 is shown in fig. 3 (3 cm running mean).

Pairwise observations of gillnet and longline NPUE per cm group within each of the 3 statistical squares and the two years are basis for ratio calculations (Fig. 4). In Fig. 5 is given boxplots of the ratios of the NPUE's by lengths for each of the 5 cells. The upper parts shows the entire length range available and the lower part shows the lengths range 30-50 cm, in which the gillnet are designed to have almost full selectivity. Within this length range ratios vary from approx. <1 to 55, but without any trend by length indicating that catchability of the two gears is approx equal. From the upper part of the figure with the entire lengths available, ratios increases considerably after lengths of about 50 cm. This means that longline catchability versus gillnet catchability increases at these lengths, which is the expected outcome as gillnets were only designed to have fully selectivity until lengths of 50 cm.

Although the ratio of catch rates between the two gears seems more or less constant within lengths of 30 to 50 cm, an analysis of variance (GLM) was performed in order to explore the effect of length. As ratio distribution is not normal distributed (Fig. 6), ratios were log transformed to be included in the GLM. Outcome of the GLM shows that length is not a variable that contributes significant to linear relationships for log ratios, while both statistical square and year do contribute significantly (Table 2). A retransformation of the log ratio overall mean (1.95) gives a ratio of 7.1. Fig. 7 illustrates the non-linearity of ratio by length.

It is therefore proposed that gillnet survey results are applied back in time to 1993 by use of the longline standardised length distribution raised by a constant factor within the length range 30-50 cm.

References

Engås, A. & Løkkeborg, S. (1994). Abundance estimation using bottom gillnett and longline -The role of fish behaviour. In *Marine Fish behaviour in capture and abundance estimation*, pp. 134-165. Edited by A. Fernö & S. Olsen: Fishing News Books.

Løkkeborg, S. (1994). Fish behaviour and longlining. In *Marine Fish behaviour in capture and abundance estimation*, pp. 134-165. Edited by A. Fernö & S. Olsen: Fishing News Books

Simonsen, C.S., J.Boje and M.C.S. Kingsley. (2000) A Review Using Longlining to Survey Fish Populations with Special Emphasis on an Inshore Longline Survey for Greenland Halibut (*Reinhardtius hippoglossoides*) in West Greenland, NAFO Division 1A. NAFO SCR Doc 00/29.

Table 1. Settings in longline and gillnet surveys since 2001. Left: Numbers of gillnet and longline settings (bold in bracket) by stat. square in surveys in Disko Bay. Right: Numbers of G.halibut caught in gillnet and longline (bold in brackets).

	Year			
Statistical square	2001	2002	2003	2004
LA027				3
LB027				1
LD027			2	
LE027			2	
LF027			2	1
LF028			2	1
LG024			2	1
LG026				3
LG027	4	3	6	6 (**3**)
LG028	2 (**5**)	3	2	5 (**4**)
LH027		11	4	6
LH028	2 (**4**)	8	8	9 (**2**)
LH030		2		2
LJ026			2	1
LJ028			4	
LJ030		5		
LK024		2		1
LK026		2		1
LK027		3		1
LK028		4		(**1**)
LK029			4	
LK030		1		
LK031		3		
LL024				1
LL026		2		2
LL027		2		2
LL028				4
LL029			1	
LL031		1		
LM029			2	
LM030			2	
LM031			2	
LN024			2	
LN025			3	
LN026			2	
LN027			2	
LN028			2	
LP024		2		
Total	8 (**9**)	54	58	51 (**10**)

	Year			
Statistical square	2001	2002	2003	2004
LA027				27
LB027				3
LD027			28	
LE027			10	
LF027			8	6
LF028			27	76
LG024			2	3
LG026				10
LG027	80	23	36	235 (**109**)
LG028	77 (**196**)	93	45	299 (**66**)
LH027		261	29	221
LH028	34 (**51**)	509	309	177 (**85**)
LH030		29		105
LJ026			5	1
LJ028			19	
LJ030		49		
LK024		39		48
LK026		44		11
LK027		156		4
LK028		253		**(27)**
LK029			14	
LK030		42		
LK031		62		
LL024				22
LL026		48		10
LL027		33		64
LL028				166
LL029			4	
LL031		21		
LM029			9	
LM030			7	
LM031			30	
LN024			34	
LN025			114	
LN026			11	
LN027			43	
LN028			19	
LP024		48		
Total	191(**247**)	1710	803	1488(**287**)

Table 2. Analysis of variance (GLM) on log ratio values. model: log(ratio ll/gn) = overall ratio mean + length + stat.sq. + year + residuals.

Dependent Variable: logratio

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	4	33.88266802	8.47066700	14.47	<.0001
Error	57	33.37609757	0.58554557		
Corrected Total	61	67.25876558			

R-Square	Coeff Var	Root MSE	logratio Mean
0.503766	39.23275	0.765209	1.950435

Source	DF	Type I SS	Mean Square	F Value	Pr > F
LGD	1	0.64173412	0.64173412	1.10	0.2996
FELT	2	30.50743602	15.25371801	26.05	<.0001
year	1	2.73349788	2.73349788	4.67	0.0349

Source	DF	Type III SS	Mean Square	F Value	Pr > F
LGD	1	0.17198410	0.17198410	0.29	0.5900
FELT	2	23.71900248	11.85950124	20.25	<.0001
year	1	2.73349788	2.73349788	4.67	0.0349

Parameter		Estimate		Standard Error	t Value	Pr > |t|
Intercept		2.332163740	B	0.91564683	2.55	0.0136
LGD		0.011505962		0.02123045	0.54	0.5900
FELT	LG027	-0.536498891	B	0.26230094	-2.05	0.0454
FELT	LG028	-1.496521229	B	0.23600689	-6.34	<.0001
FELT	LH028	0.000000000	B	.	.	.
year	2001	-0.558610385	B	0.25854133	-2.16	0.0349
year	2004	0.000000000	B	.	.	.

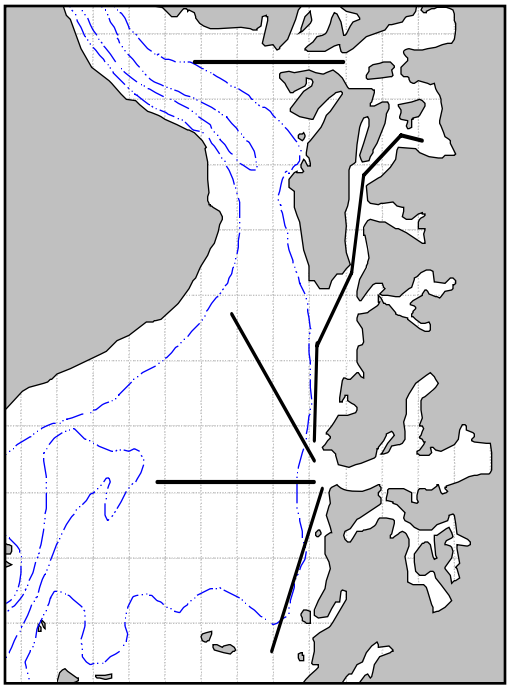

Fig. 1. Map of transsects in Disko Bay for gillnet survey. Fixed stations are positioned along transects.

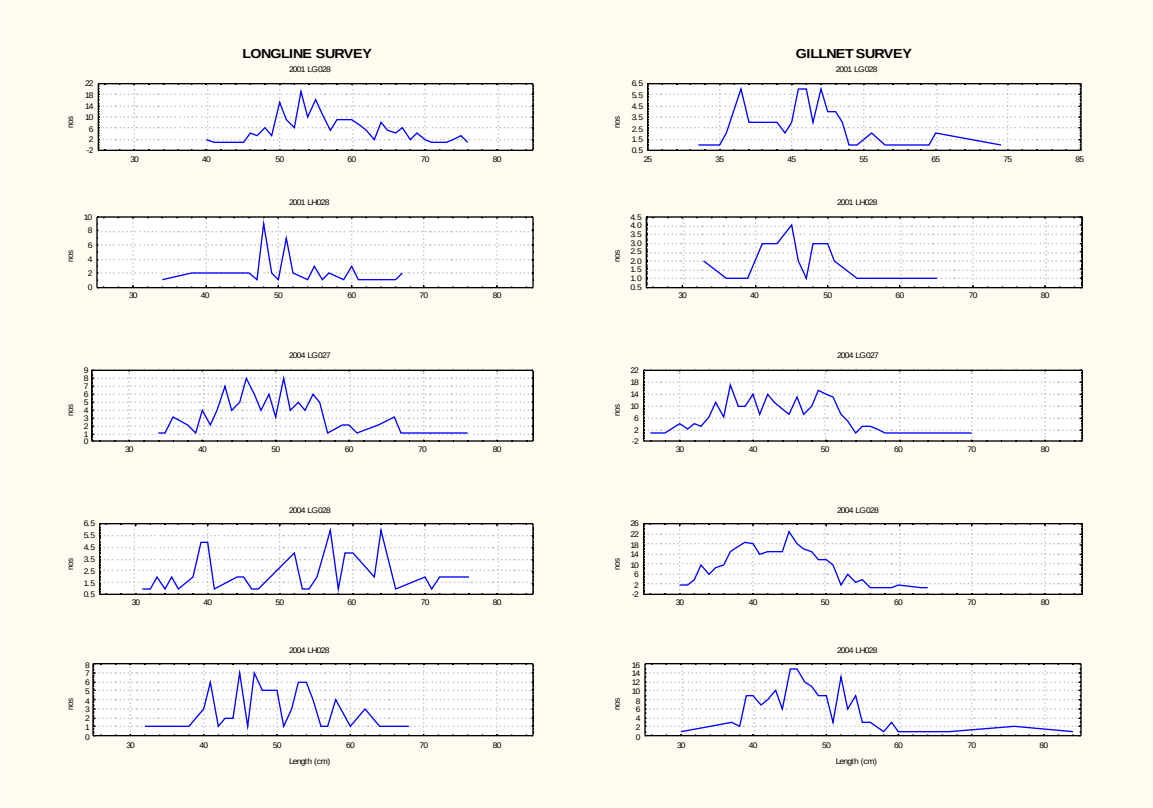

Fig. 2. Lengths distribution from longline (left) and gillnet (right) surveys by year and statistical squares where both surveys were conducted (see Table 2).

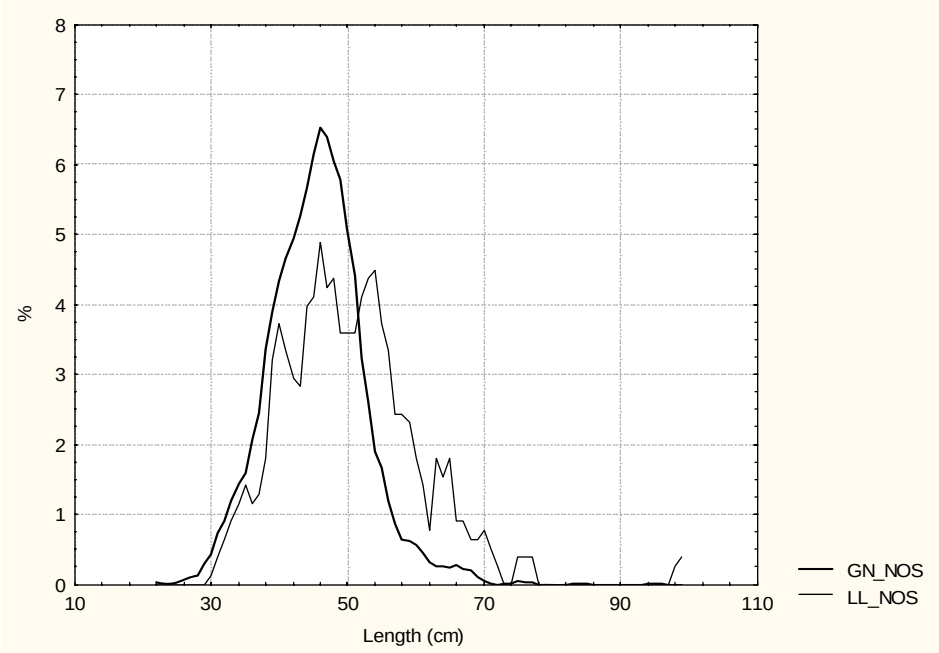

Fig. 3. Total length distributions from longline and gillnets surveys in years and statistical squares where both surveys were conducted (see Table 2).

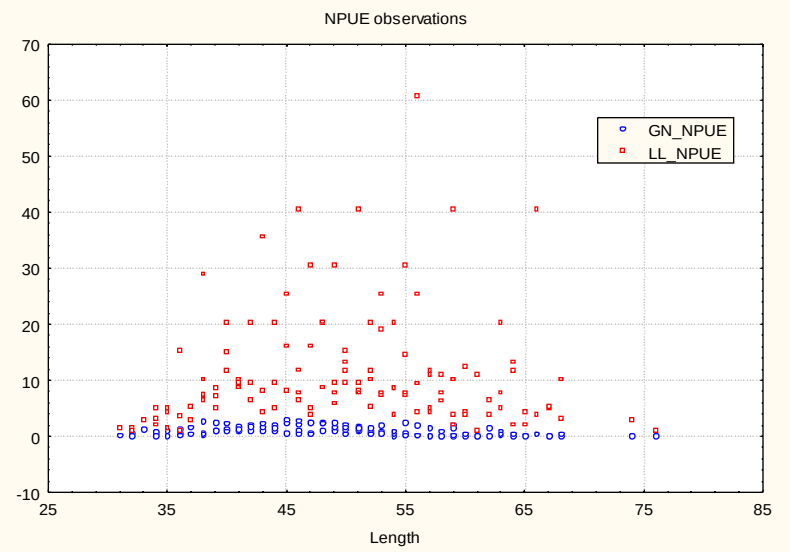

Fig. 4. Distribution of simultaneuos observations of NPUE for longline and gillnet (see Table 2). (Gillnet, GN_NPUE: nos per setting of gillnets w. 4 meshes, Longline, LL_NPUE: nos per 10 000 hooks).

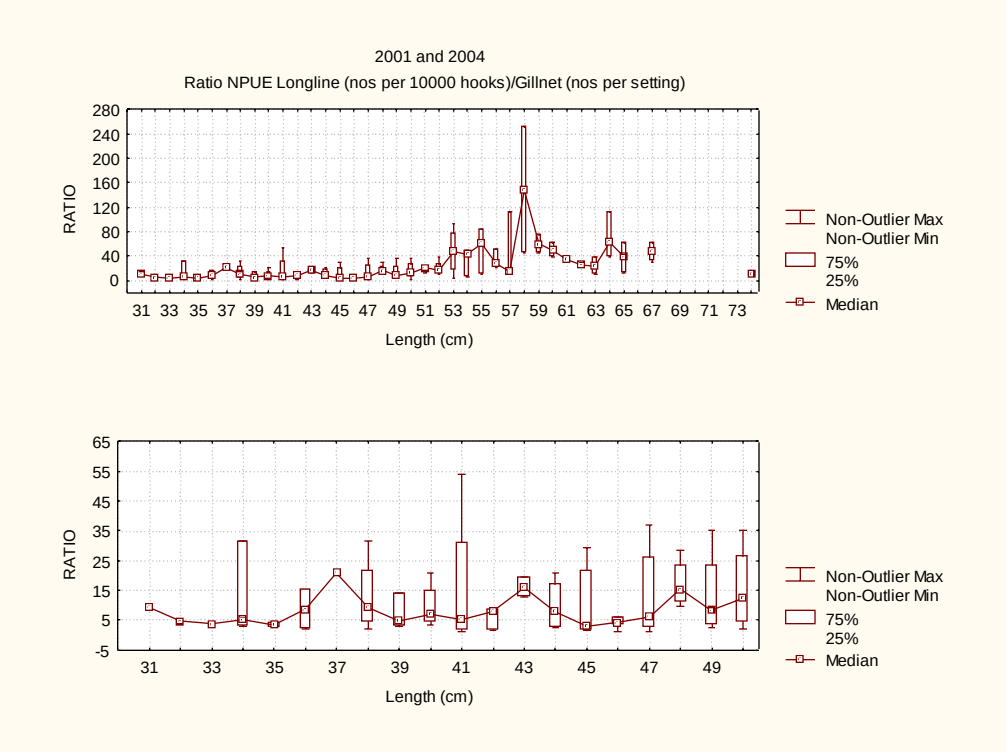

Fig. 5. NPUE ratio (medians and 25 and 75 percentiles) for entire length range (upper) and for length range 30-50 cm (lower).

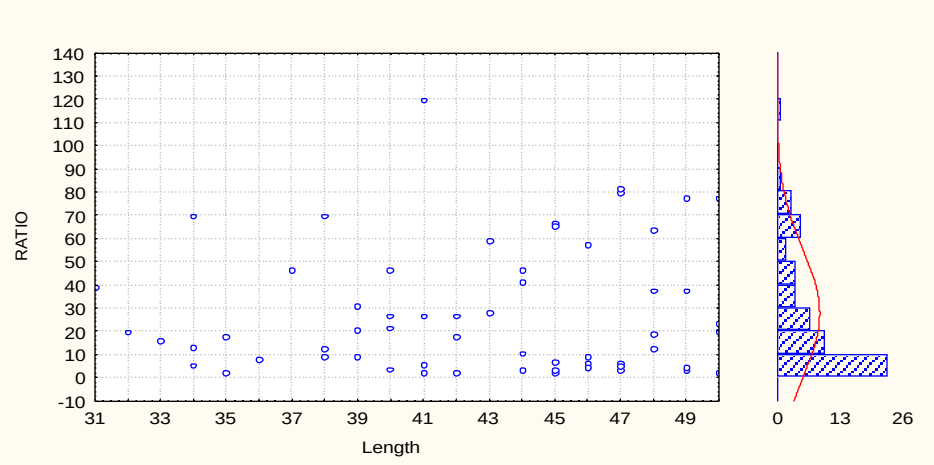

Fig. 6. Ratio distribution of $NPUE_{longline}/NPUE_{gillnet}$ in the length interval 30 to 50 cm.

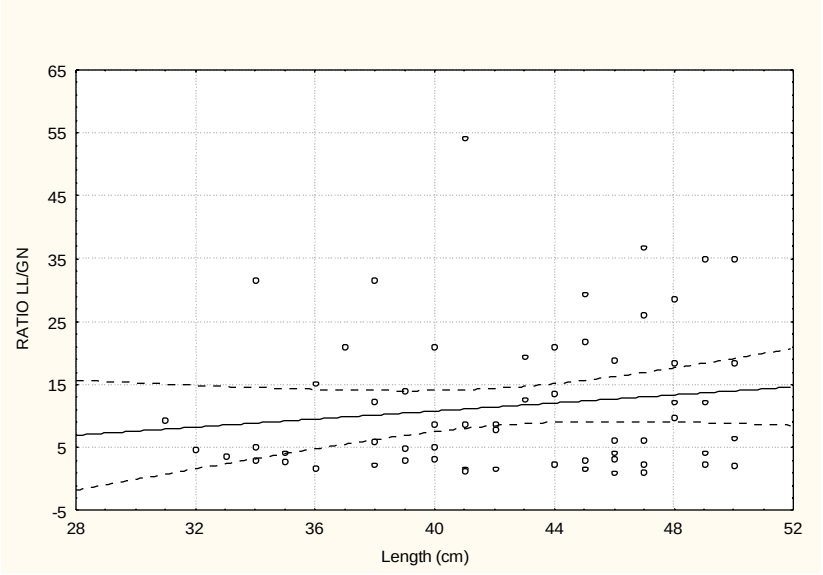

Fig. 7. Ratio distribution of $NPUE_{longline}/NPUE_{gillnet}$ in the length interval 30 to 50 cm and linear relationship (95 % confidence intervals).