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Results of Stratified Random Bottom Trawl and Long-line Survey on Greenland Halibut in NAFO Div. 0B in 1990

by

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1. INTRODUCTION

Since the end of the 70-ies, the estimation of Greenland halibut in NAFO subareas is especially conducted by data of stratified-random ground fish surveys carried out by bottom trawls. Practically all main areas of the distribution of a commercial stock of Greenland halibut of Greenland-Canadian population are covered by surveys in the off shore (Sub. NAFO 0+1,2,3) on the territory between 200-1500 m isobaths.

Trawl surveys are conducted annually by Canada (Div.2J, 3KL), USSR (Div. OB, ICD, 2GH, 3KL) and Japan (Sub.I) in cooperation with Greenland Fisheries Reseach Institute (Chumakov, Bowering,1988; Bowering, Chumakov, 1989; Bowering, Brodie, 1990; Jorgensen, Akimoto, 1990).

Greenland halibut is occurred in small quantities to the north of 66°N and on the shelf with depths less than 300 m. Therefore, deepwater areas of the shelf and land slope with depths 600-1200 m available for catch by a bottom trawl were covered by bottom surveys. At the same time, high catches of halibut were taken in the deepwater bays and fiords of Newfoundland, Labrador and Western Greenland as well as at large depths of the land slope which are not available for operating with the bottom trawl by technical reasons. Initial experiments showed that long-line is better than bottom trawl especially when operating on the heavy grounds (stones) and at large depths.

In order to have more complete picture concerning Greenland halibut abundance on the slope of Labrador and the Baffin Island, the trawl and long-line surveys were conducted by the USSR vessels MG-1366 "Kapitan Shaitanov" and AI-1514 "Konakovo". The obtained data on halibut size composition showed that there are sufficient differences between a long-line and a trawl.

The aim of the paper is to discribe a long-line selectivity in comparison with a trawl one and to compare a catch per effort by a long-line and a halibut abundance estimation by a trawl on the land slope as well as to study the influence of the other factors (kind of bait, degree of satiety, and a period of 24-hours) on the long-line catchability.

2. MATERIAL AND METHODS

Long-line survey was conducted by AI-1514 "Konakovo" in September-November, 1990. There was an attempt to conduct a long-line survey on halibut at the

depth of 400-2000 m in NAFO Div. OB and 2GHJ. 86 settings were put during the survey, namely: 61 in OB and 25 in 2GHJ (Table 1). The survey was conducted by the bottom long-line using "Autoline" of the "Mustad" company and a green long-line ridge with swivels (production of Norway). The settings were equipped by traditional "J-hooks" No.7 (according to the Norwegian classification). Jack mackerel and squid were used as a bait. Settings were put along the isobaths in strata by the occasional stations net both in the afternoon and at night.

Trawl survey

Random.stratified trawl surveys in Div. OB were conducted by MG-1366 "Kapitan Shaitanov" in the period of October, 25 - November, 9, 1990. A standard bottom fish counting trawl was used as a gear. The main parameters of it were described by us earlier (Bulatova and Chumakov, 1986). 66 counting trawlings were conducted during the survey. Trawlings were carried out at the depth of 200-1500 m during an hour at a speed of 3 knots (Table 2).

3. RESULTS

3.1. Greenland halibut length composition in long-line and trawl surveys

Length data on Greenland halibut from long-line and trawl catches by strates in which the instrumental surveys on fish stocks were conducted are presented in Fig.1. Greenland halibut 46-55 cm long constituted the basis of the trawl surveys whereas 58-93 cm long constituted the long-line surveys.

Halibut length composition from trawl surveys is characterized by one-modal curves with peaks at 50-51 cm class. According to the data on age determination, this class fish are related to the abundant 1983 and 1984 year classes. This age composition is very similar to that of halibut commercial fishery on the land slope in Div.OB.

Halibut length frequencies from long-line catches are more streatched. The number of 50-90 cm long specimens was nearly the same in catches. The presented picture shows that trawl fishery on 56-57 cm fish was more effective than the long-line one. Per cent of occurrence for 56-59 cm fish is similar both in trawl and long-line catches. With the increase of fish length, per cent of occurrence for all age classes is higher in long-line catches than in the trawl ones.

It should be mentioned also that length composition of halibut trawl catches in the investigated strata is practically characterized by the similar length curves whereas long-line length compositions are quite different. To our mind, it proves the availability of multiplicative errors in the estimation of abundance of different length groups of halibut by long-lines.

3.2. Comparison of long-line and trawl selectivity

The relative selectivity (RS) of long-lines and trawls was obtained

by comparison of halibut catches per effort (CPUE) by 6-cm groups for these gears.

$$RS = \frac{\text{Line CPUE (nos. caught/1000 hooks)}}{\text{Trawl CPUE (nos. caught/60 min. tow}}$$

Calculations of (RS) were made by 3 strates only where Greenland halibut were caught and not less than 3 operations were conducted by this gear.

Catches, effort, catch per effort and relative selectivity for these strates are presented in Table 3.

To reduce RS multiplicative errors, the finding of logarithm of coefficients of the relative selectivity was tested. As it seen from Fig. 2, RS logarithm increases with the increase of fish length upto 90-95 cm. It shows that halibut of this length and longer is completely available for long-line catch in comparison with the research trawl.

The relative selectivity of long-lines in comparison with the trawls (RS) in connection with the length group is described by the one-side logarithmic equation:

$$\text{Log (RS)} = b * (\text{length group}) + a$$

The input data by 6-cm length groups are in Table down.

Statistical values and coefficients are presented in Table 4.

Transformating the calculated values into the natural ones, the correction by value exp (MS/2) equal to 1.66 was done. Using the results from Table 4, the equations for every age group allowing to transform long-line catches into the trawl ones were obtained.

Length group	Equation of re-calculation
36-41	Trawl catch = 274,000 * long-line catch
42-47	Trawl catch = 130,900 * long-line catch
48-53	Trawl catch = 62,600 * long-line catch
54-59	Trawl catch = 29,900 * long-line catch
60-65	Trawl catch = 14,300 * long-line catch
66-71	Trawl catch = 6,840 * long-line catch
72-77	Trawl catch = 3,268 * long-line catch
78-83	Trawl catch = 1,562 * long-line catch
84-89	Trawl catch = 0,747 * long-line catch
90-95	Trawl catch = 0,357 * long-line catch

These equations express uncomparable data since the distance of nearly 5,56 km is caught during 60 minutes of trawling whereas the line length with 1000 hooks constituted 1,2 km.

If we express values of trawl and long-line catches in accordance with the area of fishery (the length of the line and the trawled route) we shall obtain the following values of the long-line fishery efficiency in comparison with the trawl one:

Greenland halibut size	36-41	42-47	48-53	54-59	60-65	66-71	72-77	78-83	84-89	90-95
Rel. Eff.	0,02	0,04	0,07	0,15	0,32	0,71	1,42	2,96	6,20	13,01

Thus, following Dickson's (1986) therminology, the long-line efficiency in comparison with the trawl one varies from 0,02 for small halibut to 13,01 for the large ones.

Close values of the long-line efficiency to compare with the trawl one were obtained by Hovgard and Riget (1990) for the West Greenland cod.

3.3. Greenland halibut distribution and abundance in Div. OB and Sub. 2 in September-October, 1990

Division OB. Long-line survey in this area was conducted from September, 10 to November, 01 whereas the trawl one - from October,25 to November, 09. Long-line surveys covered the strata with depths from 751 to 1500 m and the trawl survey - from 200 to 1500 m. The main results of the surveys are presented in Tables 5 and 6. Length composition and values of a catch per effort are average values by strata which demonstrate not only the realtive density of halibut schools at various depths but allow to determine the availability of different halibut length groups for these gear as well as to obtain more reliable data on length composition and halibut abundance on the basis of equations presented in the chapter 3.2.

Greenland halibut occurred everywhere in the survey area at depths of 200-1500 m. Halibut long-line catches varied in connection with the catch depth in the range of 2-285 kg per 1000 hooks. According to the long-line survey data, the laviest density of shools of large halibut was registered in stratum No. 6 at the depth of 1001-1250 m. With the reduction of a catch depth and movement to the north (strates 5, 12 and 13) halibut catches has decreased to 8-50 kg per 1000 hooks. Halibut 36-112 cm long occurred in the long-line catches. Halibut average lengths and weights according to the long-line catches in strata as well as CPUE are presented in Table 5.

According to the trawl survey data, high density of halbut schools was registered in strata No. 6 and 13 at depth of 1000-1250 m. At the 500-1000 m depth, halibut catches did not exceed 100 kg per 1 hour of trawling. Small halibut 18-30 cm long dominated in the trawl catches on the shelves at the 200-500 m depth.

Total abundance and biomass of halibut in the counting trawl area in Div.OB constituted 88,5 mln.spec. and 78,9 thou. t correspondingly (Table 2).

The preliminary correction of halibut abundance and biomass was done with the account of coefficients of the efficiency of long-line catches

in comparison with the counting trawl presented in chapter 3.2.

Strate	Depth, m	Abundance thou.spec.	Biomass, t
5	751-1000	10369,1	10406,3
12	751-1000	3495,5	3230,0
6	1001-1250	17779,0	21815,0
13	1001-1250	3524,8	3704,8
7	1251-1500	3689,7	7188,8
Total	751-1500	38858,1	46344,9

4.DISCUSSION OF RESULTS

The initial experiment of PINRO on using of a long-line in investigations has opened wide possibilities of obtaining of data on quantitative distribution of this species at deep depths, on rocky and stone grounds, steep parts of the relief non-available for trawling gear as well as possibilities for studying of trawl selectivity and obtaining of more reliable values of abundance and biomass of this important fishery object in the Canadian zone.

Besides the merits of the long-line usage for research aims, there are demerits which require thorough investigations. It is known that long-line fishery is a passive one to compare with the trawl one. If a trawl catches fish independently on their satiety measure a long-line catches only hungry fish. It was proved by the analyses of stomach filling of halubut caught by a long-line. Only one fish of 600 specimens dissected for a nutrition analysis had food in a stomach. Other fishes were empty or had baits in them. In addition, it was revealed that the type of the used hooks influences the catchability of a long-line. Thus, in the cruise of AI-1514 "Konakovo", the lines were equipped by traditional "J-hooks" No.7 (according to the Norwegian classification) which were as appeared not fit for Greenland halibut catch. Halibut released from these hooks reached 60-80 per cent. In connection with this, halibut abundance and biomass corrected values should be considered as the underestimated. A type of bait used also makes an effect on the long-line catchability. Observations showed that an average yield was 2-3 times higher when using jack mackerel than squid. The obtained preliminary data justified also on the possible dependence of halibut catch size on the part of 24 hours. Catch reduction was revealed between 8-16 h. i.e. we can suppose the presence of a natural law connected with the nutritive activity of fish during 24 hours.

5. References

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Table 1. Results of a long-line survey conducted in September - November, 1990 in NAFO Subareas by RV "Konakovo"

Div.	Strata	Depth,m	Number of settings	Average length, cm	Average weight, kg	Catch per 1000 hooks kg	Catch per 1000 hooks No.
0B	5	751-1000	1	69,12	3,213	28,6	8,9
	12	751-1000	1	63,14	2,515	8,3	3,3
	6	1001-1250	40	74,28	5,008	126,0	24,1
	13	1001-1250	5	67,09	3,690	33,6	8,0
	7	1250-1500	14	74,01	4,468	63,2	13,6
2G	921	501- 750	1	55,63	1,659	13,6	8,2
	906	1001-1250	1	69,76	3,689	16,6	4,5
	919	1001-1250	2	69,58	3,354	43,6	13,0
2H	939	1001-1250	1	75,44	4,728	38,3	8,1
	963	1001-1250	2	70,72	4,155	42,8	10,3
	938	1251-1500	7	76,80	4,577	35,7	7,8
	964	1251-1500	1	70,65	4,000	40,0	10,0
2J	223	401- 500	1	46,83	0,824	1,4	1,7
	230	501- 750	1	69,70	3,500	2,1	0,6
	225	1001-1250	2	81,58	5,867	34,0	5,8
	226	1251-1500	1	79,81	5,028	35,7	7,1
	233	1251-1500	5	79,36	5,696	58,1	10,2

Table 2. Results of trawel survey Greenland halibut conducted in Oktober - November 1990 in Div.0B NAFO by RV "Kapitan Shaitanov"

Strata	Depth,m	Number of nets	Mean length (sm)	Mean weigh (g)	Mean catch per 60-min set number	Mean catch per 60-min set kg	Biomass, tons	Abundance, (000S)
1	201- 300	3	44,5	766	0,3	0,3	25,9	33,8
8	201- 300	3	11,0	62	12,6	0,8	121,9	1955,6
22	201- 300	3	56,5	3230	0,3	1,1	103,1	31,9
2	301- 400	3	30,1	305	47,0	14,3	1148,1	3768,2
9	301- 400	5	27,5	229	10,8	2,5	431,7	1886,7
23	301- 400	3	28,7	210	64,0	13,5	547,1	2601,7
3	401- 500	3	41,0	691	29,3	20,3	2306,6	3336,6
10	401- 500	5	29,1	298	41,8	12,5	849,1	2846,0
24	401- 500	5	29,0	269	44,0	11,9	746,6	2772,0
4	501- 750	3	47,9	1036	89,3	92,6	18801,8	18141,8
11	501- 750	6	40,2	661	63,3	41,9	4208,9	6363,3
25	501- 750	4	37,5	570	63,8	36,3	3364,1	5903,8
5	751-1000	5	48,2	1003	115,2	115,6	10404,8	10368,0
12	751-1000	4	46,4	924	85,3	78,8	3229,8	3495,3
6	1001-1250	5	51,0	1226	207,0	253,8	21795,4	17775,0
13	1001-1250	3	49,5	1050	236,3	248,3	3702,2	3524,4
7	1250-1250	3	56,2	1939	51,7	100,2	7150,0	3686,5
Total		66					78936,5	88490,5

Tabel 3. Catch, effort, CPUE and relative selection of long-lines to trawl by length group of Greenland halibut for trawl and long-line surveys at Davis Strait (Div.0B) in 1990

Area / effort	Length (cm)	Trawl Catch	Trawl CPUE	Long-line Catch	Long-line CPUE	Rel. Selec.
Strata N 006	30 - 35	7	1.4	-	-	-
1001 - 1250 m	36 - 41	41	8.2	1	0.004	0.0005
5 trawl hauls	42 - 47	213	42.6	25	0.095	0.0022
263700 hooks	48 - 53	283	56.6	75	0.284	0.0050
	54 - 59	134	26.8	107	0.406	0.0150
	60 - 65	29	5.8	132	0.508	0.0880
	66 - 71	13	2.6	108	0.409	0.1570
	72 - 77	9	1.8	174	0.606	0.3670
	78 - 83	9	1.8	211	0.800	0.4440
	84 - 89	5	1.0	179	0.679	0.6790
	90 - 95	3	0.6	99	0.375	0.6250
	96 -101	1	0.2	37	0.140	0.7000
	102 -107	1	0.2	10	0.038	0.1900
	108 -113	-	-	2	0.008	-
Strata N 007	36 - 41	1	0.3	-	-	-
1251 - 1500 m	42 - 47	24	8.0	4	0.038	0.0048
3 trawl hauls	48 - 53	63	21.0	21	0.201	0.0096
104500 hooks	54 - 59	34	11.3	47	0.450	0.0398
	60 - 65	11	3.7	57	0.054	0.0146
	66 - 70	2	0.7	69	0.660	0.9429
	72 - 77	6	2.0	75	0.718	0.3590
	78 - 83	5	1.7	73	0.699	0.4112
	84 - 89	1	0.3	66	0.632	2.1067
	90 - 95	6	2.0	24	0.230	0.1150
	96 -101	2	0.7	5	0.048	0.0686
	102 -107	-	-	2	0.019	-
Strata N 013	30 - 35	2	0.7	-	-	-
1001 - 1250 m	36 - 41	27	9.0	1	0.030	0.0033
3 trawl hauls	42 - 47	231	77.0	6	0.180	0.0023
33300 hooks	48 - 53	345	115.0	26	0.781	0.0068
	54 - 59	73	24.3	22	0.661	0.0272
	60 - 65	16	5.3	14	0.420	0.0792
	66 - 71	8	2.7	13	0.390	0.1444
	72 - 77	4	1.3	24	0.721	0.5692
	78 - 83	-	-	24	0.721	-
	84 - 89	2	0.7	9	0.270	0.3857
	90 - 95	1	0.3	6	0.180	0,0540
	96 -101	-	-	2	0.060	-

Tabl.4. Statistical values and parameters of equation of interrelations between the relative selectivity and length-groups

Parameter	Estimate	Standart error	T Value
Intercept	-10,9159	0,8388	-13,0129
Slope	0,1229	0,0128	9,6141

Analysis of variance

Source	Sum of squares	Df	Mean Square	F-Ratio
Model	93,8126	1	93,8126	92,4300
Error	23,3441	23	1,0150	-
Total(Corr.)	117,1567	24	-	-

Correlation coefficient = 0,8948 R-squared = 80,07 %

Stnd.error of est. = 1,0075

Calculation by equation

Length group	Estimate	Retrans estimate
36-41	-6,119	0,00365
42-47	-5,381	0,00764
48-53	-4,643	0,01598
54-59	-3,905	0,03343
60-65	-3,167	0,06993
66-71	-2,429	0,14628
72-77	-1,691	0,30599
78-83	-0,953	0,64006
84-89	-0,215	1,33886
90-95	0,523	2,80055

*

Retransformed estimate = exp (log - estimate).exp(ms/2)

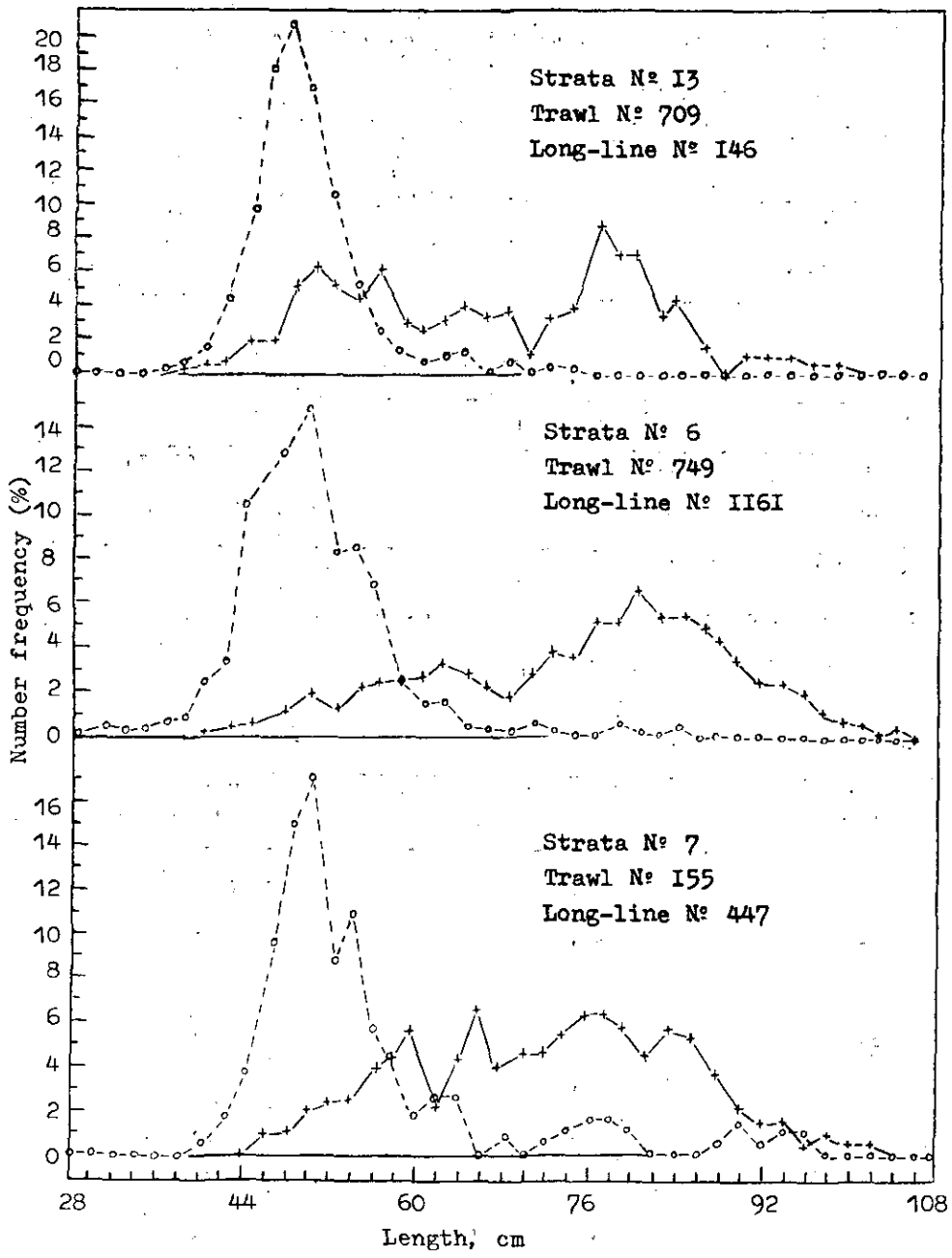

Fig.I.Length composition of Greenland halibut caught by research trawl (o - -) and research long-line (x -) in Div. 0B,I990

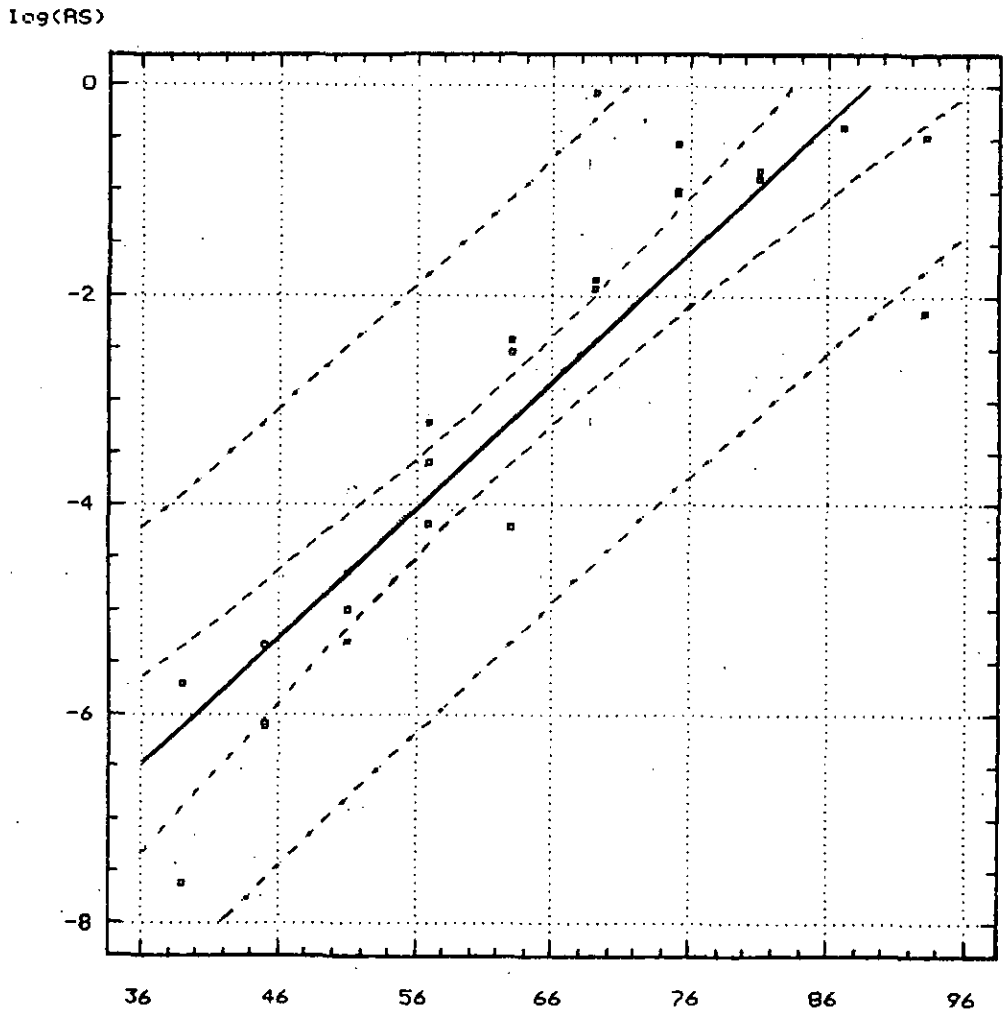

Fig. 2. Relative selection of long-line to trawl vs. size of halibut