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A Comparision of the Selectivity in Trawl and Long-line Fishery for Greenland Halibut

by

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1. Introduction

Joint Japan-Greenland surveys have taken place off shore in NAFO Subarea 1 annually since 1987 with estimation of trawlable biomass of Greenland halibut as the main goal. Similar investigations have been carried out by Canada (Atkinson et. al., 1982) and GDR/USSR (Ernst et al., 1991). At the same time surveys and commercial fisheries with long-line and gill-net have taken place in the fjords in North West Greenland (Riget and Boje, 1989). The length distribution obtained from the two areas differed markedly, the average fish taken in the fjords being considerable larger than fish taken off shore. In order to investigate the possibilities for an off shore long-line fishery, a trial fishery was carried out by a commercial long-liner in NAFO Division 1D in August, 1991. Simultaneous the same area was covered by the joint Japan-Greenland bottom trawl survey and a significant difference in selectivity of the two types of gear was noticed, the length distribution in the off shore long-line catches resembling the in shore catches closely. In this paper a comparison of selectivity of the two types of gear is given according to the method developed by Hovgård and Riget (1990).

2. Material and methods

Long-line

The long-line survey was conducted in NAFO Div. 1D in the period 5.8.91 to 22.8.91 by the Faroese long-liner Varsol on 563 GRT. The vessel was equipped with an Mustad Autoliner and fishing was carried out with 7.5 mm polypropylene long-lines with 75 cm ganglions spaced 1.8 m and mounted with 'EZ-baiter Circle Hooks' and baited with squids. In total 23 settings covering depths between 970 and 1427 m were made. The number of hooks per setting varied from 500 to 3925 and the total number of hooks used were 57598. Fishing was carried out day and night and average fishing time was about 5 hours.

Trawl

Only trawl hauls performed in the same area and depth range covered by the long-line survey are included in the analysis. These hauls were carried out in the period 5.8.91 to 11.8.91 and a total of 26 hauls were made. The trawl survey was carried out by the Japanese R/V Shinkai Maru (Yano and Jørgensen, 1992). Trawling time was 30 min and trawling speed was 3.5 kn. The mesh size was 140 mm with a 30 mesh liner in the cod-end. Wing spread was approximately 45 m. Trawling was carried out in day time only (for further information about vessel and gear see Yamada et. al., 1988a). CPUE is given per 0.15 km^2 swept corresponding to an average trawl haul.

3. Results and discussion

The length distributions of Greenland halibut in the two depth strata 950-1200 and 1200-1450 m are given by trawl survey and long-line survey in Fig 1. In the trawl survey the length ranged from 27 cm to 112 cm with an unimodal distribution showing a distinct mode at 48 cm in both depth strata.

In the long-line survey the length range from 42 cm to 120 cm and the length distribution differed markedly from the trawl catches as the long-line catches almost exclusively consisted of fish between 50 cm and 95 cm without any distinct modes. However, there was a tendency towards larger fish being slightly more abundant in depth stratum 1200 - 1450 m.

The relative selection (RS) of long-lines as compared to trawl is derived by comparing CPUE of the two gears (Hovgård and Riget, 1990), i.e as:

$$RS = \frac{\textit{Longline CPUE}}{\textit{Trawl CPUE}} \quad \frac{(\textit{nos. caught/1000 hooks})}{(\textit{nos. caught/0.15km}^2\ \textit{swept})}$$

calculated by 6-cm groups and by depth strata (Table I). Catches outside the size range 42 - 101 cm in the shallow strata and 42 - 95 cm in the deep strata were not included in the calculations due to too few observations. Possibly the selectivity of the long-line drop off at these lengths (Table I) but the few observations makes it difficult to drew any firm conclusions.

CPUE values are usually subject to multiplicative errors and the RS-values were therefore log-transformed. The log(RS) increased to about 70 cm showing that only Greenland halibut at this size and above are fully recruited to the long-line as compared to the trawl (Fig. 2). From Fig. 2 and Table I it is seen that the relative selection is larger in the deep stratum. This is due to a combination of a decrease in CPUE for the trawl and an increase in CPUE on the long-line in this stratum as compared to the shallow stratum.

The relative selection of the long-line as compared to the trawl was then analyzed by a one-side ANOVA, i.e.

log(RS) = (effect due to length) + noise

where length are the 6-cm groups given in Table 1. The statistics and the estimates from the ANOVA are given in Table II.

When transforming the RS back to an arithmetic scale the RS have been corrected by exp(MS/2) i.e. 1.712 (Table 2).

Hence the following equations for translating long-line catches (per 1000 hooks) to trawl catches (per 0.15 km^2 swept) can be obtained for different size groups of Greenland halibut:

Size	Equation
42-47	Trawl catch = 79.93 * long-line catch
48-53	Trawl catch = 9.83 * long-line catch
54-59	Trawl catch = 2.34 * long-line catch
60-65	Trawl catch = 0.71 * long-line catch
66-71	Trawl catch = 0.24 * long-line catch
72-77	Trawl catch = 0.20 * long-line catch
78-83	Trawl catch = 0.13 * long-line catch
84-89	Trawl catch = 0.10 * long-line catch
90-95	Trawl catch = 0.10 * long-line catch
96-101	Trawl catch = 0.06 * long-line catch

The coefficient in the equations given above do obviously not covariate linear with length, hence the simple linear regression used by Chumakov and Soshin (1991) is not applicable in this context.

The equations relate rather incomparable units i.e. a trawl path on 3.2 km vs a long-line on 1.8 km. Instead the catches are transformed according to Dickson (1986) to obtain comparable path length:

Size	42-47	48-53	54-59	60-65	66-71	72-77	78-83	84-89	90-95	96-101
Rel. Eff.	0.02	0.18	0.76	2.49	7.38	8.85	13.62	17.70	17.70	29.50

This implies that the efficiency of a long-line is 0.02 of that of a trawl for fish in the size group 42-47 cm, while the long-line is about 30 times more efficient for catching fish in the size group 96-101 cm.

These results are in good accordance with Hovgård and Riget (1990) who obtained comparable figures for cod at West Greenland and with Chumakov and Soshin (1991) who made the same experiment on Greenland halibut in Subarea 0. However, while the CPUE in the trawl was in the same size range, the efficiency of the Russian long-lines were about an order of a magnitude lower than measured in this study, probably due to inefficient hooks (Chumakov and Soshin op. cit.).

The observed selection pattern can be caused by at least two factors (or a combination of them). 1) Large Greenland halibut is able to avoid the trawl or 2) the long-lines attract large Greenland halibut from a vast area. During six joint Japan-Greenland surveys that have taken place since 1987 the length distribution in Div. 1D at 1000-1500 m depth (600-1000 m in 1987) have been unimodal with a distinct mode at 47-49 cm (Yamada et al. 1988b; Yatsu and Jørgensen, 1989; Jørgensen and Akimoto, 1990; Jørgensen and Akimoto, 1991; Yano and Jørgensen, 1992) and the expected growth of Greenland halibut in that period has not been observed. This implies that large fish to a great extend are able to escape the trawl and the biomass estimates obtained from trawl surveys then are underestimated to an unknown extend.

4.References

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Table II. ANOVA of log(RS) vs. Greenland halibut length group.

Statistics

Source	Df	SS	MS	F	R^2
Model	9	94.45	10.49	9.76	0.907
Error	9	9.68	1.08		

Estimates

Length group	Estimate	[1]Retransf. Estimate
42-47	-7.172	0.012
48-53	-5.076	0.102
54-59	-3.640	0.428
60-65	-2.449	1.407
66-71	-1.367	4.888
72-77	-1.157	5.126
78-83	-0.722	7.918
84-89	-0.444	10.460
90-95	-0.498	9.911
96-101	0.0	16.300

[1]Retransformed estimate = exp(log-estimate) * exp(MS/2)

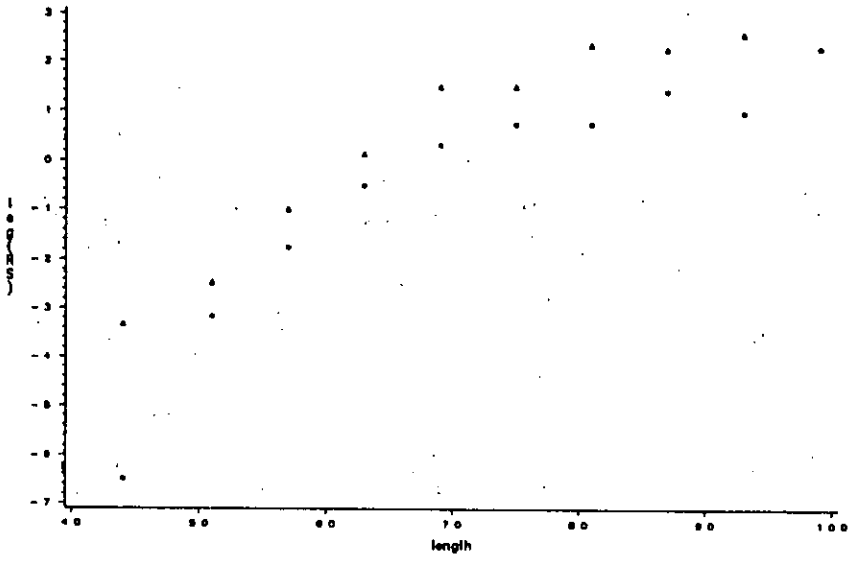
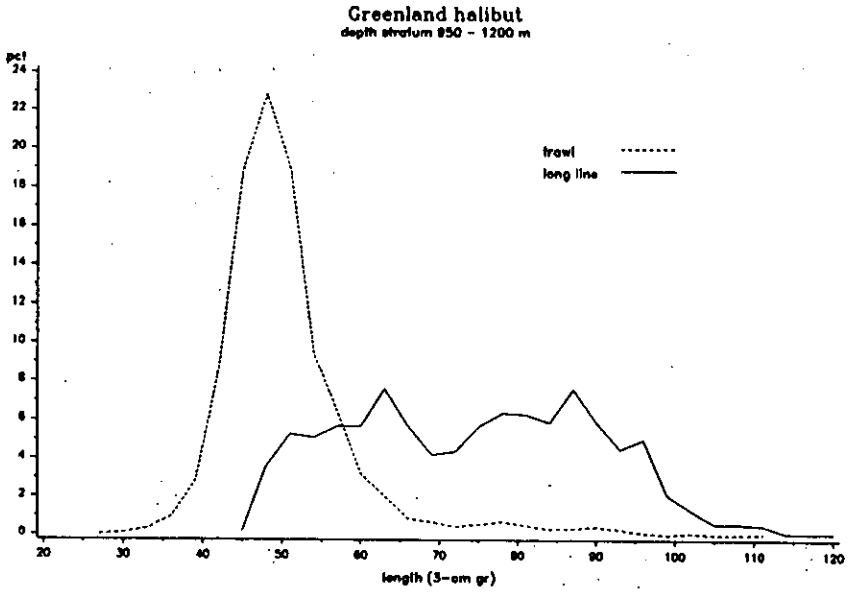


Fig. 2. Relative selection of long-line to trawl vs. size of Greenland halibut. Asterisk: depth stratum 950-1200 m, Triangles: depth stratum 1200-1450 m.



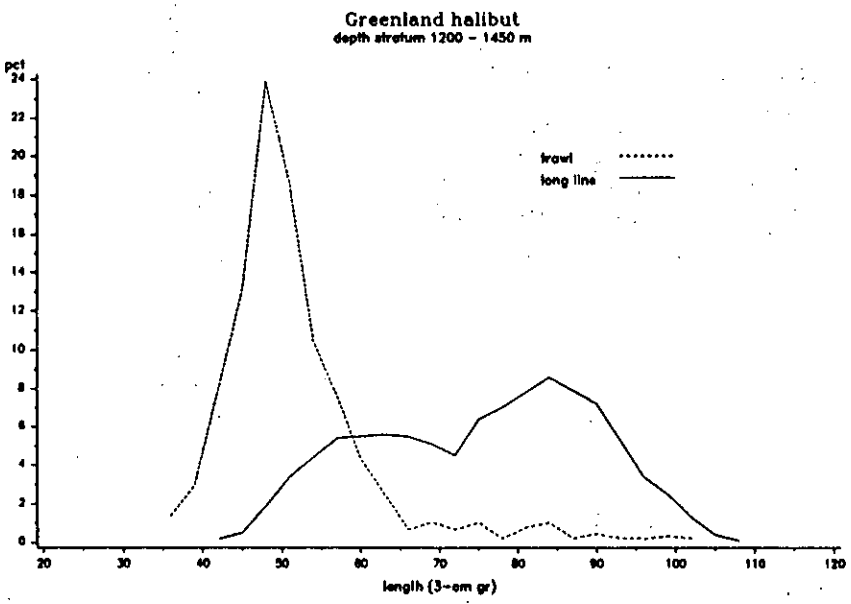


Fig. 1. Length distribution (in 3-cm groups) of Greenland halibut by depth stratum and gear.