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PRELIMINARY RESULTS OF INVESTIGATIONS ON ESCAPEMENT OF FISH UNDER THE
FISHING LINE OF A NORWEGIAN SAMPLING TRAWL

by

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ABSTRACT

The Institute of Marine Research, Bergen, has carried out combined bottom trawl and acoustic surveys for cod and haddock in the Barents Sea and the Svalbard areas since 1981. These investigations have clearly demonstrated that the currently applied survey methods in these areas underestimate the young age groups of cod considerably. One explanation may be a reduced gear efficiency for the smallest fish.

This paper describes the results of experiments with small bags under the trawl, designed to collect fish that escape under the trawl. Considerable catches of different species were obtained in the small bags. A comparison between trawl and bag catches revealed a strongly length dependent escapement of cod and haddock under the trawl. The results explain to some extent the underestimation of young cod.

INTRODUCTION

The Institute of Marine Research, Bergen, has carried out combined bottom trawl and acoustic surveys for cod (Gadus morhua L.) and haddock (Melanogrammus aeglefinus L.) in the Barents Sea and the Svalbard areas since 1981. These investigations have clearly

demonstrated that the currently applied survey methods in these areas relatively underestimate young cod considerably (Hysten, Nakken and Sunnanå, 1985).

Experiments with a two level trawl in the Barents Sea in 1985 showed that small cod and haddock entered the trawl predominantly in the lower part (Valdemars, Engås and Isaksen, 1985). These findings opened for the possibility of an escapement of small fish under the trawl. To investigate this more closely, both qualitatively and quantitatively, small bags were constructed and mounted under the trawl to collect fish that escape under the fishing line.

MATERIAL AND METHODS

The experiments were carried out in the Svalbard area on board R/V "Eldjarn" (60.3m-3400HP) in September 1985 and in the Barents Sea on board R/V "G.O. Sars" (70.0m-2250HP) in February 1986.

A standard Norwegian sampling trawl for bottom fish and shrimps was used (Fig. 1).

The gear dimensions; i.e. headline height and wingspread, were measured with acoustic trawl instruments (SCANMAR).

Direct observations of the trawl and the bags were done with an underwater vehicle equipped with a TV camera and a high frequency scanning sonar mounted as a trawl sonde (Ona and Eger, 1986).

The applied bags had a mesh size of 42mm. They were supplied with a 20cm roller for bottom protection, which was connected to the ground gear of the trawl. The headline of the bag(s) was(were) mounted to the fishing line (Fig. 2). In September 1985 only one bag was used in the centre of the bosom and covered 2m of this section, which is totally 2.5m. In February 1986 the experiments were run with one bosom bag which covered the whole bosom section and two wing bags covering half of the wings. The three bags were mounted unseparated (Fig. 3).

The duration of a tow varied from 20 minutes to 1 hour at a speed of 1.5 m/s (Doppler-log). Both day and night hauls were carried out at depths between 100 and 300m.

Sampling and measurements of the fish catch from the trawl were performed as during the routine surveys in the Barents Sea; i.e. the species composition and length distributions of the catch were determined either by sorting/measuring the total catch or a representative sample of it. The total catches of the bags were sorted and all important species were length measured. All length measurements were done to the nearest cm below.

RESULTS AND DISCUSSION

Trawl geometry

The trawl's vertical opening was 4-5m and the wingspread 15-18m. Some variation with depth occurred (Engås and Godø, 1986). Neither trawl dimension measurements nor direct observation of the trawl revealed gear distortion by mounting the bags under the trawl. The results obtained during experimental tows is consequently assumed to be comparable to results from standard hauls.

The spread of the fishing line at the wingtips was estimated to 11.5m and the distance between front tips of the wing bags was measured to 7.5m (Valdemarsen, 1986)(Fig. 3). The figures are given on the basis of direct observation by TV camera and scanning sonar respectively.

Catch

Table 1 shows the trawl and bag catches of cod and haddock in numbers distributed on length groups from the 1985 experiments (3 day and 3 night hauls) and the 1986 experiments (2 day and 4 night hauls).

Table 1. Trawl catches(TC) and bag catches(BC) of cod and haddock in numbers from the 1985 and 1986 experiments distributed on length groups(cm). The bag catches in the 1986 experiments are distributed on catch in the bosom bag(BB) and catch in the two wing bags(WB). Figures in brackets represent extrapolated BC and TC/BC values (further explanation is given text).

COD 1985 EXP.				COD 1986 EXP.			HADDOCK 1986 EXP.		
Length	TC	BC	TC/BC	TC	BC	TC/BC	TC	BC	TC/BC
					BB	WB		BB	WB
5- 9	6	6(23)	1.0(.3)	-	-	-	-	-	-
10-14	20	18(68)	1.1(.3)	-	-	1	2	9	7
15-19	67	59(221)	1.1(.3)	-	1	1	4	9	16
20-24	63	23(87)	2.7(.7)	6	10	13	73	8	37
25-29	73	24(90)	3.0(.8)	33	12	27	347	27	50
30-34	23	9(34)	2.6(.7)	86	36	68	1284	82	149
35-39	28 ¹	-	-	109	34	69	644	18	57
40-44				85	14	22	523	15	31
45-49				14	2	7	150	2	10
50-54				14	1	3	7	-	1
55-59				16	1	4	-		
60+				24	2	2	6.0		
TOTAL	280	139		387	113	217	3034	170	358

¹) length 35+

The relationship between trawl catch and bag catch in the different length groups is illustrated by the variation of the ratio TC/BC (trawl catch divided by bag catch).

In the 1985 experiments (one bag experiments) the ratio(TC/BC) was 1.1 for cod below 20cm and 3.3 for all cod above 20cm. Cod above 35cm were not caught in the bag. Haddock were scarce in all the catches. Altogether 11 specimens were found in the bag catches which was 20% of the corresponding trawl catches; i.e. TC/BC=5.0.

In the 1986 experiments both bosom and wing bag catch results are available (Table 1). A comparison of the results from the two types of bags revealed no clear difference neither in catch size nor in length distribution. When comparing the pooled bag catches with the trawl catches, cod and haddock smaller than 35cm and 20cm respectively turned out to be more numerous in the bags than in the trawl. The TC/BC ratios in Table 1 show a decreasing trawl catchability with decreasing length of cod and haddock.

The bosom bag of the 1985 experiments covered 2.0m of the fishing line in the bosom section which is 2.5m. The bosom bag used in 1986 covered the whole bosom section. Adjusting the bag data from 1985 with a factor of 1.25 ($2.5/2.0$) and multiplying the result by 3 (figures in brackets in Table 1), the two sets of ratios(TC/BC) turned out to be rather similar for cod over 25cm. Cod below 25cm were scarce in the 1986 experiments.

To make the estimates valid for the whole fishing line, it is assumed that the escapement along the uncovered part is the same as in the bag area. Extrapolation of bag catches according to geometric measurements on Fig. 3 was carried out. In Table 2 the recalculated results from all the bag hauls, 1985 and 1986 experiments combined, are presented. The pooled catches of the bags and the trawl are assumed to represent the total amount of fish which has passed the fishing line. The fraction of cod and haddock which actually is caught by the trawl($TC/(TC+BC)$) is shown against fish length in Fig. 4. The graph clearly demonstrate the underrepresentation of small cod and haddock. The abundance indices from the Barents Sea and the Svalbard surveys clearly show that cod of age 1, 2 and 3 are underestimated compared to older fish (Hysten, Nakken and Sunnanå, 1985). Assuming that cod of length 10-19cm, 20-34cm and 35-49cm are 1, 2 and 3 years respectively in February, these trawl sampling experiments imply that only about 16%, 35% and 52% of these age classes are caught by the trawl. The results from these studies thus partly explain the underestimation of the young fish in the Barents Sea and Svalbard surveys.

Table 2. Trawl catches(TC) and recalculated bag catches(BC); extrapolated to cover the area swept by the fishing line. All experiments pooled.

LENGTH	TC	COD		TC	HADDOCK	
		BC	TC/BC+TC		BC	TC/BC+TC
5- 9	6	35	0.15	-	-	-
10-14	20	105	0.16	2	25	0.07
15-19	67	341	0.16	4	38	0.10
20-24	69	167	0.29	73	69	0.51
25-29	106	198	0.35	347	118	0.75
30-34	109	212	0.34	1284	354	0.78
35-39	137	158	0.46	644	115	0.85
40-44	85	55	0.61	523	71	0.88
45-49	14	14	0.50	150	18	0.89
50-54	14	6	0.70	7	2	0.78
55-59	16	8	0.67			
60+	24	6	0.80			

Two sets of experiments carried out in two different areas and in two different periods of the year, are included in this paper. There was a considerable difference in the size distribution of cod between the two sets (Table 1). Nevertheless the relationship between cod caught by the trawl and by the bags was quite similar for those length groups containing more than 10 specimens in the pooled trawl catches in both sets of experiments (Table 1). It is thus indicated that the escapement of cod and haddock under the trawl shown in Fig. 4, is valid for northeast Arctic cod and haddock throughout the year and in its main area of distribution. The data contain relatively few fish in the extreme length groups (Table 1). The results for cod outside the length range 15-44cm therefore need to be confirmed by new experiments.

In this paper no effort has been put into analysing the effect of day/night, catch size and catch composition on cod/haddock escapement. Preliminary results from analyses of more recent data, indicate

that species composition and fish abundance may affect the proportion of cod and haddock that escape under the trawl (Engås and Godø, unpubl. results).

Direct observations of fish behaviour in front of the trawl in the North Sea has demonstrated cod escapement under the bobbins spacers (Main and Sangster, 1981). This escapement passage is possible and assumed to be the most probable, also for the studied trawl.

The bag catches also contained a considerable amount of other important fish species; redfish, long rough dab and catfishes, and trawl sampling is therefore likely to be a problem in surveys for other species than cod and haddock.

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Technical Drawing of Funnels A, B, and C

Dimensions and Geometry:

- Funnel A:** Top diameter 30 mm, bottom diameter 100 mm, height 29.7 m. Internal structure includes sections 1N2B, 1N3B, 1N1B, and 1N5B. Material specifications: PES 80 149, 3 mm; PA 210/60 268, 40; PA 210/96 99, 124; PA 210/96 40 300.
- Funnel B:** Top diameter 30 mm, bottom diameter 100 mm, height 19.5 m. Internal structure includes sections 1N2B, 1N3B, 1N1B, and 1N5B. Material specifications: PES 80 149, 3 mm; PA 210/60 268, 40; PA 210/96 99, 124; PA 210/96 40 300.
- Funnel C:** Top diameter 30 mm, bottom diameter 100 mm, height 2.60 m. Internal structure includes sections 1N2B, 1N3B, 1N1B, and 1N5B. Material specifications: PES 80 149, 3 mm; PA 210/60 268, 40; PA 210/96 99, 124; PA 210/96 40 300.

Material Specifications:

- PES 80 149, 3 mm:** Material for the top section of the funnels.
- PA 210/60 268, 40:** Material for the middle section of the funnels.
- PA 210/96 99, 124:** Material for the bottom section of the funnels.
- PA 210/96 40 300:** Material for the base of the funnels.

Headline floats 90 x 200mm

Bosom: 3 x 457mm cylindrical and 1 x 457mm half shape at ends

Wings: 6 x 457mm half shape and 4 x 356mm half shape at ends

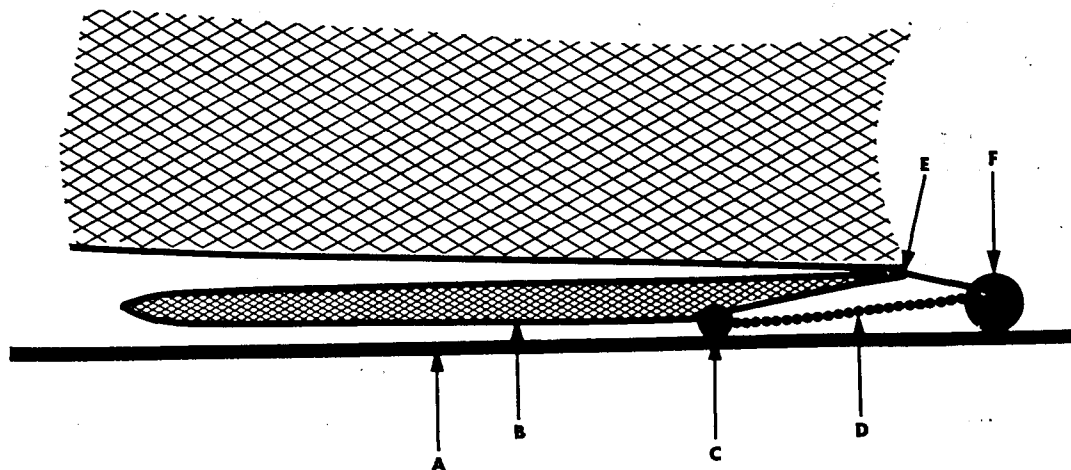


Fig. 2. Scematic presentation of the bags under the trawl from side.

A - bottom

B - bag

C - roller gear for bottom protection

D - chain connection between bobbins and roller

E - headline of the bag/fishing line of the trawl.

F - bobbins

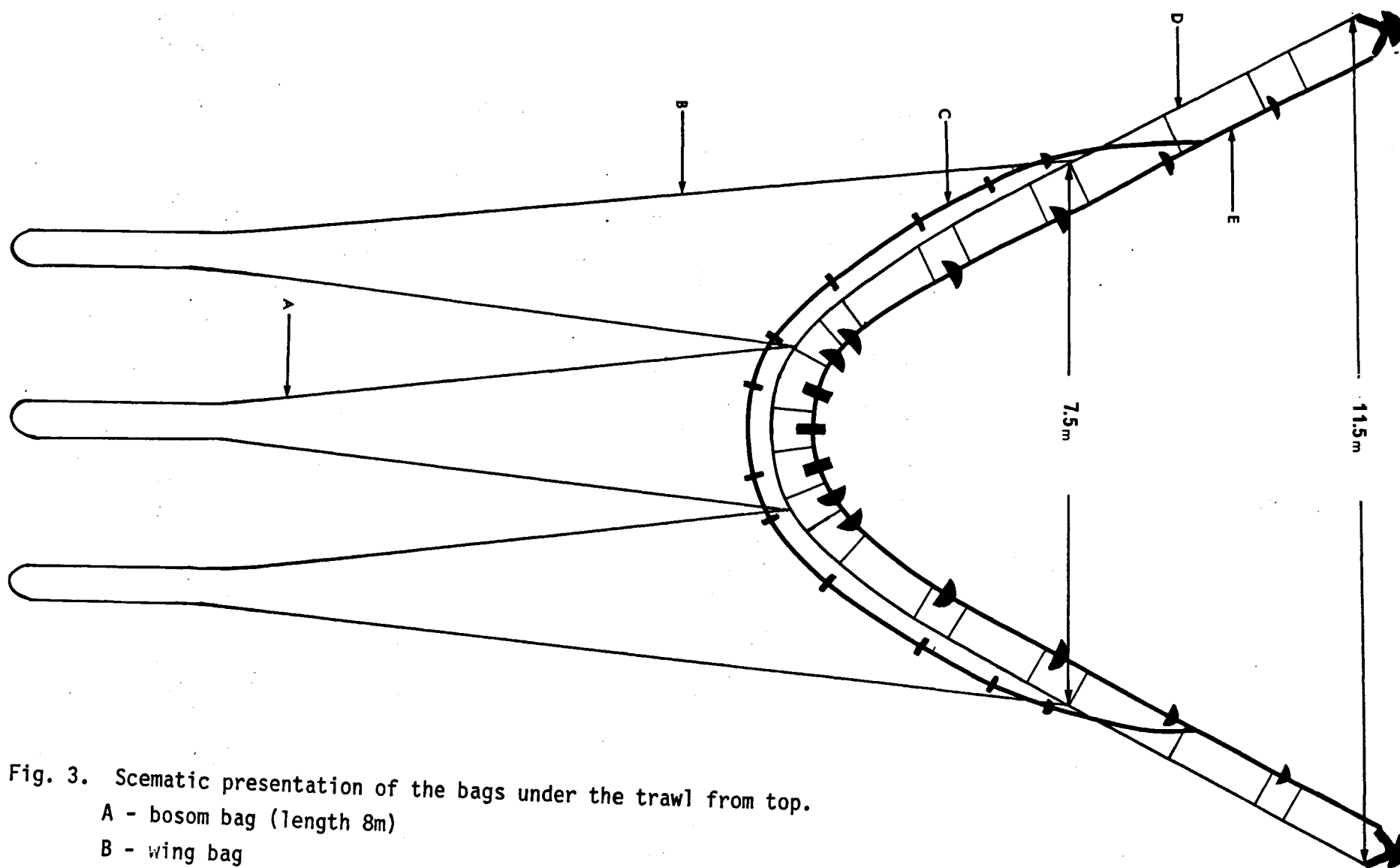


Fig. 3. Scematic presentation of the bags under the trawl from top.

A - bosom bag (length 8m)

B - wing bag

C - roller gear for bottom protection

D - fishing line of the trawl

E - ground gear of the trawl

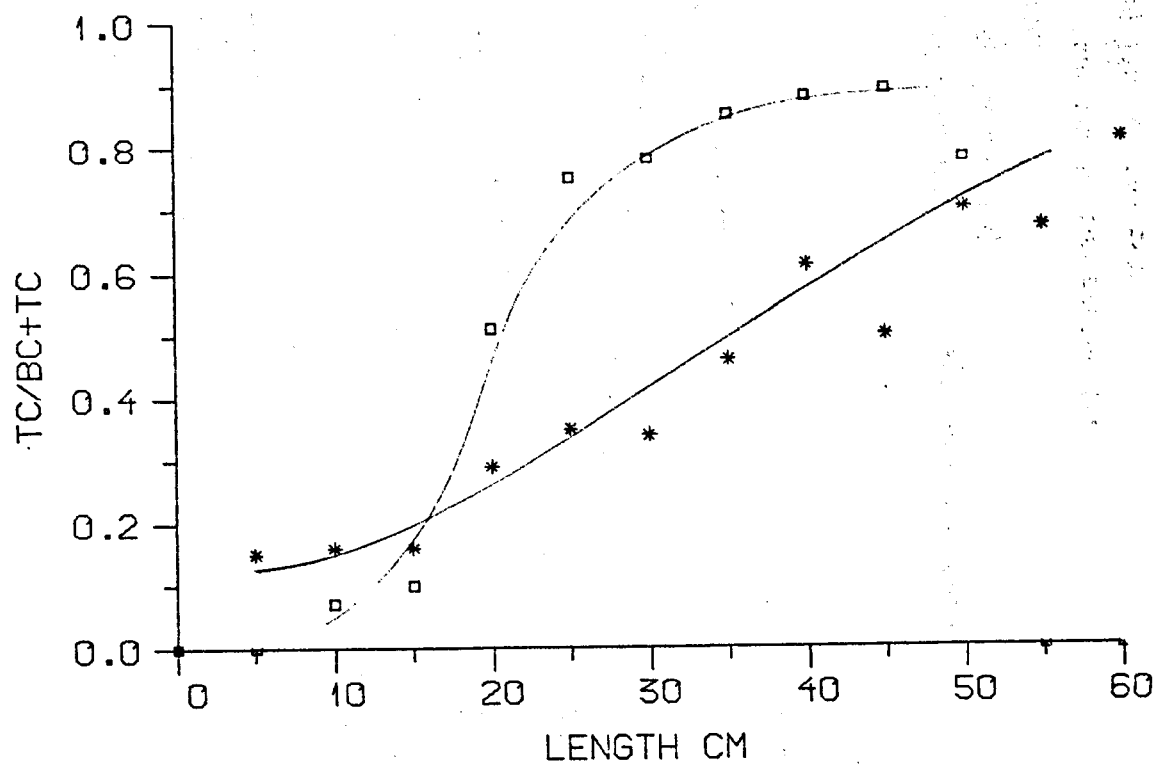


Fig. 4. The ratio between the trawl catch(TC) and the sum of the trawl catch and bag catch(BC) against fish length. Length group 5 includes fish 5 - 9cm and so on. Cod (*), haddock (□).