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Gear and Behaviour Committee

Preliminary results of comparative selection experiments with midwater trawls and bottom trawls in the North - East Atlantic

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Introduction

Already at the 1969 Statutory Meeting in Dublin, the members of the Gear and Behaviour Committee have been asked

> "that, where possible, they should start to examine mesh selection in pelagic trawls" (P.-v.Réun. 1969, p.44).

In the following years, however, there was no response to this request, and the matter was liable to be forgotten. This situation changed completely in 1974: At the Twelfth Meeting of NEAFC the Norwegian Delegation presented a memorandum (NC 12/216) which reads as follows:

> "It is known that at least a part of the trawler fleet operating in the Barents Sea and Bear Island/Spitsbergen Area has in recent years taken into use midwater trawls for catching Arcto-Norwegian cod and haddock. Small sized fish of 2 - 4 years old have a higher availability to this gear than to bottom trawls. The use of the midwater trawl in these fisheries therefore increases the mortality of young fish. This should be prevented in order to ensure a more rational exploitation of the stocks. The use of midwater trawl for catching protected species in Region 1 should therefore be prohibited."

Also in 1974, the Council adopted the following resolution (C.Res. 1974/4:18):

"It was decided, that member countries should carry out investigations into the selectivity of pelagic trawls, with particular reference to demersal species and report the results to the 1975 Statutory Meeting."

In a letter of 11 February 1975, the General Secretary reminded the delegates of ICES and the members of the Gear and Behaviour Committee of this resolution. In the same letter reference was made to the Liaison Committee Report 1974 (Coop. Res.Rep., No. 44, p.10-11), in which it is noted that the increasing use of pelagic trawls in the North-East Arctic waters could have the effect of reducing the age at which fish become available to the fishery, and that information on the selectivity of pelagic trawls needs to be obtained.

In view of the great interest shown in the possible effects of midwater trawling on fish stocks, the Institut für Fangtechnik decided to include comparative selection experiments with pelagic trawls and bottom trawls in its research program 1975.

Material and methods

The experiments were carried out with FRV ANTON DOHRN (ex FRV WALTHER HERWIG) - a diesel-electric stern trawler of 83.2 m length o.a., 1987 gross tons, capable of developing 2000 h.p. at 190 r.p.m. - during a cruise to the North-East Atlantic in April/May 1975.
The trawls used were

a - the German "standard" roundfish bottom trawl with a 140 ft. groundrope, i.e. the same trawl-type which has been used in previous German selection trials, and

b - a four-panel midwater trawl of 1000 meshes circumference and 40 cm mesh length at the net mouth. This trawl was used in connection with 8 m^2-Süberkrüb boards and 150 m-bridles. A front weight of 1050 kg was attached to each of the two lower bridles, and the footrope was loaded by chains of a total weight of 360 kg. The headline was mounted with 150 floats à 3.2 litres. The vertical

net opening, measured by means of a netsonde, varied between 25 and 29 m.

The codends and covers used as well as the physical properties of their netting yarns are described in Table 1. As to the covers, it has to be mentioned that two different types were used in the experiments: A topside cover of ICES specifications was fitted to the bottom trawl codend, while a full cover was fitted to the midwater trawl codend. From Table 1 it can be seen that the full cover was made of an unusually strong netting yarn. This was necessary because, on a stern trawler, the unprotected underside of the cover is exposed to wear and tear during shooting and hauling the gear.

The mesh opening of the bottom trawl codend was determined immediately after each haul by measuring one marked row of consecutive meshes running the full length of the codend parallel to its long axis in the middle of the upper panel. The mesh opening of the midwater trawl codend was determined in the same way. In this case, however, four rows (i.e. one row per panel) were measured after each haul.

The length composition of the cod and haddock catches was ascertained by measuring the total length to the centimeter below.

To study the girth/length relationship of cod, the unconstricted maximum body girth was measured to the nearest millimeter. Whenever a fish body was swollen with gases, the coelom and air bladder were punctured prior to the measurement.

Results

During the cruise in April/May this year, dense fish concentrations could be found neither in the Barents Sea nor off Spitsbergen and Bear Island. Everywhere cod and haddock were only caught in small quantities, and even in areas in which the best catch results were obtained, rather long tows were necessary to scratch up at least medium-sized catches.

The selection experiments were carried out in the following three areas:

a - Söle Bank/East of Vardö (Sub-area I): 20 - 26 April 1975
b - East of Vardö/East Bank (Sub-area I): 27 - 30 April 1975
c - Gardar Bank (Division II b): 9 - 10 May 1975.

Söle Bank/East of Vardö

In this area echo traces indicated the presence of fish in the midwater, and 19 hauls were made with the pelagic trawl. During the hows the footrope was between 1 and 200 m above the bottom.

The catches, ranging from 1,2 to 2,7 metric tons per 2 - 4 hours'fishing time (av. 715 kg/hour), were of rather uniform composition. About 2/3 of the total catch weight consisted of cod and about 1/3 of haddock. The by-catch was negligible.

The relative length composition of the total cod catch (codend plus cover) is shown in Fig. 1 (solid line). It can be seen that the bulk of the catch consisted of fish between about 30,5 and 67,5 cm in length. Within this range the length frequency curve shows two pronounced peaks at 40,5 - 42,5 cm and 54,5 - 57,5 cm. - The corresponding curve for haddock (Fig. 2, solid line) shows two secondary peaks at 17,5 and 26,5 cm, and two main peaks at 37,5 and 50,5 cm.

The selection data obtained from the combined midwater trawl catches are compiled in Table 2. The corresponding cod and haddock selection curves, being smoothed by using three-point moving averages and fitted by eye, are shown at the bottom of Figures 4 and 5. - The selection factors were found to be 3,65 for cod and 3,06 for haddock.

East of Vardö/East Bank

Immediately after the completion of the midwater trawl trials east of Vardö, bottom trawl experiments were started on the same fishing ground. Due to decreasing catches, however, the work had to be continued on the adjacent East Bank.

In the area East of Vardö/East Bank a total of 13 hauls was made with the bottom trawl. The catches, ranging from 0,9 to 8,4 metric tons per 2 - 3 hours' fishing time (av.845 kg/hour) were heterogeneously composed. Approximately, 65 % of the total catch weight consisted of cod, 11 % of haddock and 24 % of by-catch (mainly redfish, long rough dab, catfishes and sponges).

The relative length composition of the total cod catch is shown in Fig. 1 (broken line). It becomes obvious from this figure that the cod caught by the bottom trawl was, on an average, somewhat bigger than that caught by the midwater trawl. The difference found, however, was by far not as great as that recently reported by Olsen (1975).

As to the length composition of the total haddock catch, Fig. 2 (broken line) shows that small fish of 24,5 cm in length were most abundant, whilst individuals of 30,5 - 63,5 cm in length occured in less numbers. This indicates that small haddock are more vulnerable to bottom trawls than to midwater trawls.

The selection data obtained from the combined bottom trawl catches are given in Table 3. The selection curves for cod and haddock are shown at the top of Figures 4 and 5. - The selection factors were found to be 3,62 for cod and 3,49 for haddock.

A comparison between Tables 2 and 3 makes clear that there was no difference between the cod selection factors derived from the two types of trawls. In the case of haddock, however, the bottom trawl experiments resulted in a higher selection factor (3,49) than the midwater trawl experiments (3,06).

Gardar Bank

On this bank which is located some 30 nautical miles to the east of Bear Island (Division II b), 8 hauls were made with the bottom trawl. Owing to bad weather conditions, the midwater trawl could not be used in this area.

The catches varied between 1,2 and 4,1 metric tons per 95 - 150 minutes' fishing time, and the average catch per hour amounted to 1,1 metric tons. About 3/4 of the total catch weight were made up by cod, while about 1/4 consisted of by-catch (predominantly redfish, catfishes, long rough dab, skates and rays).

The relative length composition of the total cod catch is illustrated in Fig. 3. The curve shows a very pronounced maximum at 37,5 cm and a secondary peak at 46,5 - 47,5 cm. This means that the cod caught on the Gardar Bank was considerably smaller than that caught in the area Söle Bank/ East of Vardö/East Bank.

Cod girth/length relationship

The relationships between maximum body girth (G) and total length (L) of cod are described by the regression equations $G = 0{,}483\ L - 1{,}193$ cm (Söle Bank, midwater trawl, $n = 429$) and $G = 0{,}503\ L - 1{,}968$ cm (Gardar Bank, bottom trawl, $n = 542$). The corresponding regression lines are shwon in Fig. 7. - From Fig. 8 it becomes obvious, that there was no difference at all between the girth of cod caught by the midwater trawl on the Söle Bank and that of cod caught by the bottom trawl on the Gardar Bank. Fig. 8 also shows that cod caught in July 1968 southwest of Bear Island (Bohl, 1969) have been much thicker than that caught during these trials east of Bear Island. It has to be taken into account, however, that the feeding season in April/May 1975 had just begun.

Summary

As far as cod is concerned, the experiments described in this paper reveal no difference in the selectivity of midwater trawls and bottom trawls. In the case of haddock, however, the selection factor obtained from the midwater trawl (3,06) was found to be lower than that obtained from the bottom trawl (3,49). Since the data on which the latter selection factor is based, are rather scanty, further experiments should be made to verify this difference.

The length compositions of the catches show that small cod were, as a rule, more vulnerable to the midwater trawl than to the bottom trawl (Fig. 1). In the case of haddock, however, the bottom trawl is shown to catch relatively more small-sized fish than the midwater trawl (Fig. 2).

Arcto-Norwegian cod were found to be more slender in April/May 1975 than in July 1968. The difference in the body girth may be due to the different seasons in which the measurements were taken.

References

Bohl, H. (1969): Trawl mesh selection experiments on cod (Gadus morhua L.) off Bear Island. Ber.Dt.Wiss.Komm.Meeresforsch.20, 1:84-90

Brandt, A.v. and P.J.G.Carrothers (1964): Test methods for fishing gear materials (twines and netting). In: Modern Fishing Gear of the World 2, Fishing News (Books) Ltd., London

Olsen, S. (1975): Selectivity of pelagic trawls. Working paper submitted to the working group meetings of the ICES Gear and Behaviour Cttee, Ostende, 21 - 25 April 1975.

Table 1: Information about codends and covers used

	Bottom trawl	Midwater trawl
Codend		
Number	57	62
Material and type of fibre	Polyamide continuous	
Construction of netting yarn	Twisted	Plaited
of netting	Double braided	
Method of manufacture	Hand - made	
Treatment of netting yarn	Thermo-fixed	?
of netting	Untreated	
Rtex (g/1000 m)	5,655	10,925
Runnage (m/kg)	177	91.5
Diameter (mm)	2.7	~5.0
Flexibility[1], wet (g)	30	51
Amount of twist in turns/meter(t/m)	62	-
Twist factor = αtex = t/m $\cdot\sqrt{\text{Rtex}/100}$	147	-
Weaver-knot breaking load, wet (kp)	292	457
Breaking load, without knot, dry (kp)	306	533
without knot, wet (kp)	267	474
Breaking length, dry (km)	54.1	48.8
wet (km)	47.2	43.4
Knot breaking length, wet, 1/2 (km)	25.8	20.9
Elongation (%) at a load		
of 5 kp	1.8	0.2
of 10 kp	3.3	2.4
of 30 kp	9.6	8.3
of 50 kp	13.1	11.7
of 1/2 weaver-knot breaking load, wet (kp)	21.5	24.1
Cover		
Type	Topside cover of ICES specification	Full cover
Material and type of fibre	Polyamide continuous	
Construction of netting yarn	Twisted	
of netting	Single braided	
Tex	23tex x 16 x 3	23tex x 64 x 3
Mesh opening (mm)	60	

[1] The flexibility has been determined by means of the "Lötzener Methode" described by v.Brandt and Carrothers (1964).

Table 2

Compilation of selection data for grouped hauls

Midwater trawl; Söle Bank/ East of Vardö

Date	20 - 26 April '75		
Locality (central positions)	71°20'N, 32°20'E and 70°18'N, 32°15'E (Sub - area I)		
Depth range (m)	245 - 420		
Headline above the bottom (m)	30 - 220		
Vertical net opening (m)	25 - 29		
Number of hauls	19		
Towing time per haul (minutes)	115 - 240		
Av. duration of haul (minutes)	158		
Range of total catch/haul (baskets)	17.8 - 40.8		
Av. total catch/hour(baskets)	11		
Type of mesh gauge	ICES gauge; 4 kg pressure		
Codend mesh opening - mean (mm)	147.8		
- range (mm)	135 - 168		
- no. measured	3,192 (= 19 x 4 x 42)		
Species studied	Cod	Haddock	By-catch
Range of catch/haul(baskets)			
- codend	4.5 - 20.5	2.3 - 8.0	+ - 1.2
- cover	4.8 - 15.0	1.0 - 8.3	+ - 2.0
Av.catch/hour (baskets)			
- codend	3.7	2.3	0.1
- cover	3.3	1.5	0.2
25 - 75% selection range (mm)	135	90	-
No. of fish in selection range			
- codend	4,341	2,249	-
- cover	4,207	2,200	-
Total number of fish			
- codend	7,444	5,709	-
- cover	13,829	9,584	-
50% retention length (mm)	540	453	-
Selection factor	3.65	3.06	-

Additional comments:

The net weight of one basket filled with cod or haddock was about 65 kg.

The by-catch consisted of Sebastes spec., Cyclopterus lumpus and Mallotus villosus. Moreover, very few Clupea harengus, Argentina spec., Pollachius virens, Hippoglossoides platessoides and Reinhardtius hippoglossoides were caught.

Table 3

Compilation of selection data for grouped hauls

Bottom trawl; East of Vardö / East Bank

Date	27 - 30 April '75		
Locality (central position)	70°15'N, 32°50'E (Sub - area I)		
Depth range (m)	188 - 216		
Number of hauls	13		
Towing time per haul (minutes)	120 - 180		
Av. duration of haul (minutes)	155		
Range of total catch/haul(baskets)	13.5 - 129.5[1)]		
Av. total catch/hour (baskets)	13		
Type of mesh gauge	ICES gauge, 4 kg pressure		
Codend mesh opening - mean (mm)	134.6		
- range (mm)	126 - 150		
- no.measured	585 (= 13 x 45)		
Species studied	Cod	Haddock	By-catches
Range of catch/haul (baskets)			
- codend	3.8 - 71.0	0.5 - 4.3	0.5 - 35.3[1)]
- cover	2.5 - 15.5	0.8 - 3.3	0.8 - 13.3
Av. catch/hour(baskets) - codend	6.3	0.7	2.0
- cover	2.1	0.8	1.1
25 - 75% selection range (mm)	104	82	-
No. of fish in selection range			
- codend	2,233	562	-
- cover	2,114	629	-
Total number of fish - codend	8,604	1,372	-
- cover	6,720	3,692	-
50% retention length (mm)	487	471	-
Selection factor	3.62	3.49	-

1) One haul of three hours duration yielded 34.5 baskets sponges and 95 baskets fish.

Additional comments:

The net weight of one basket filled with cod or haddock was about 65 kg.

The bulk of the by-catches consisted of Sebastes spec., Hippoglossoides platessoides, Anarhichas minor, A. lupus and sponges. Small quantities of Anarhichas denticulatus, Cyclopterus lumpus, Argentina spec., Pollachius virens, Brosmius brosme, Pleuronectes platessa, Hippoglossus hippoglossus, Reinhardtius hippoglossoides, skates and rays were also caught.

Table 4

Compilation of selection data for grouped hauls

Bottom trawl; Gardar Bank

Date	9 - 10 May '75	
Locality (central position)	74°15'N, 22°40'E (Div. II b)	
Depth range (m)	212 - 280	
Number of hauls	8	
Towing time per haul (minutes)	95 - 150	
Av. duration of haul (minutes)	126	
Range of total catch/haul (baskets)	19.0 - 63.3	
Av. total catch/hour (baskets)	17.3	
Type of mesh gauge	ICES gauge; 4 kg pressure	
Codend mesh opening - mean (mm)	134.7	
- range (mm)	126 - 149	
- no. measured	360 (= 8 x 45)	
Species studied	Cod	By - catch
Range of catch/haul (baskets)		
- codend	7.5 - 38.0	4.0 - 9.0
- cover	7.0 - 13.3	0.5 - 5.0
Av. catch/hour(baskets)		
- codend	7.4	3.3
- cover	5.4	1.2
25 - 75% selection range (mm)	90	-
No. of fish in selection range		
- codend	3,065	-
- cover	3,140	-
Total number of fish		
- codend	7,495	-
- cover	9,868	-
50% retention length (mm)	452	-
Selection factor	3.36	-

Additional comments:

The net weight of one basket filled with cod was about 65 kg.

The by-catch consisted of Sebastes spec., Anarhichas minor, A. denticulatus, A. lupus, Hippoglossoides platessoides, skates and rays. Furthermore small quantities of Melanogrammus aeglefinus, Cyclopterus lumpus, Argentina spec., Reinhardtius hippoglossoides, Pollachius virens, Micromesistius poutassou, sponges and stones were caught.

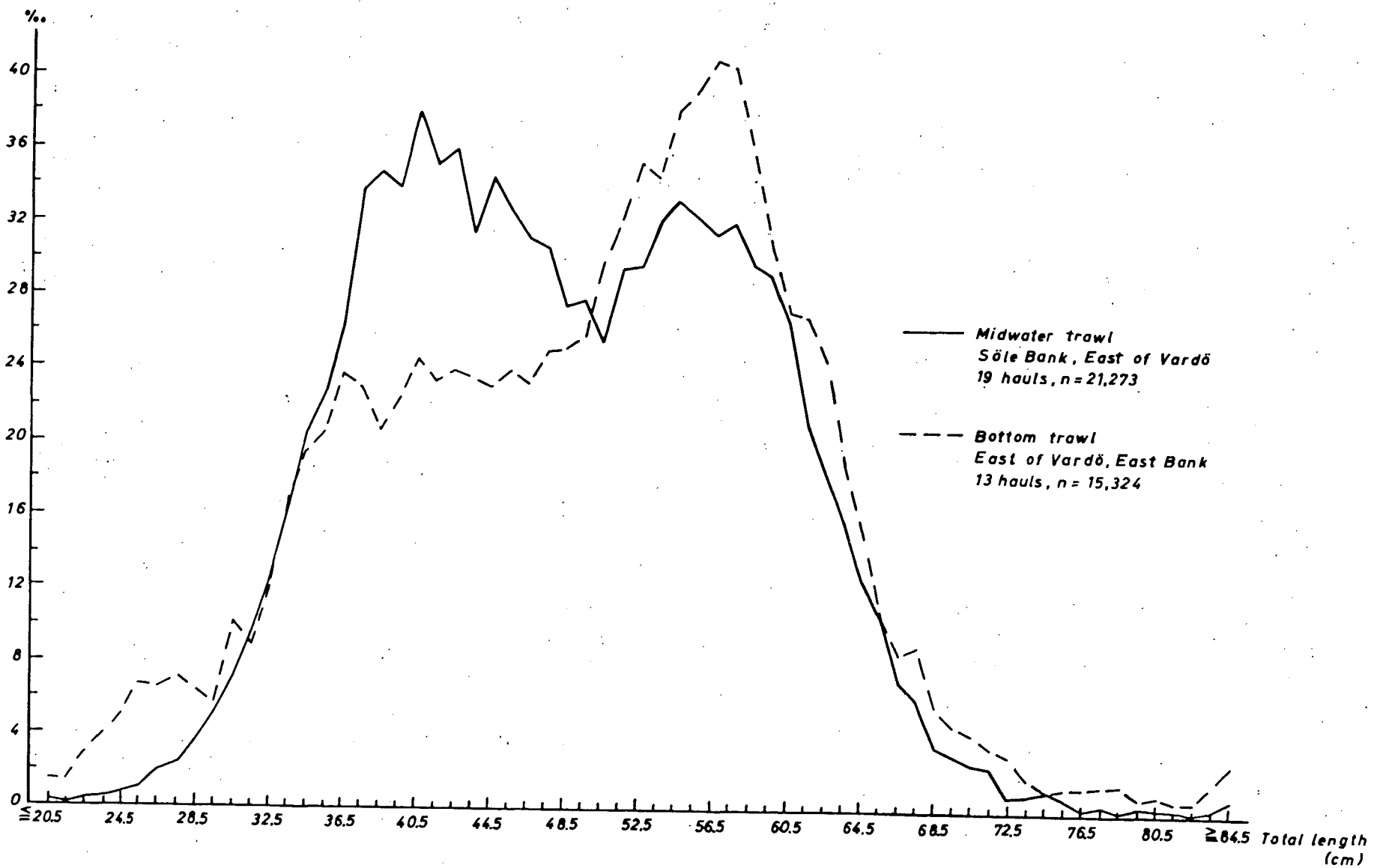

Fig. 1: Relative length composition of cod (codend plus cover)

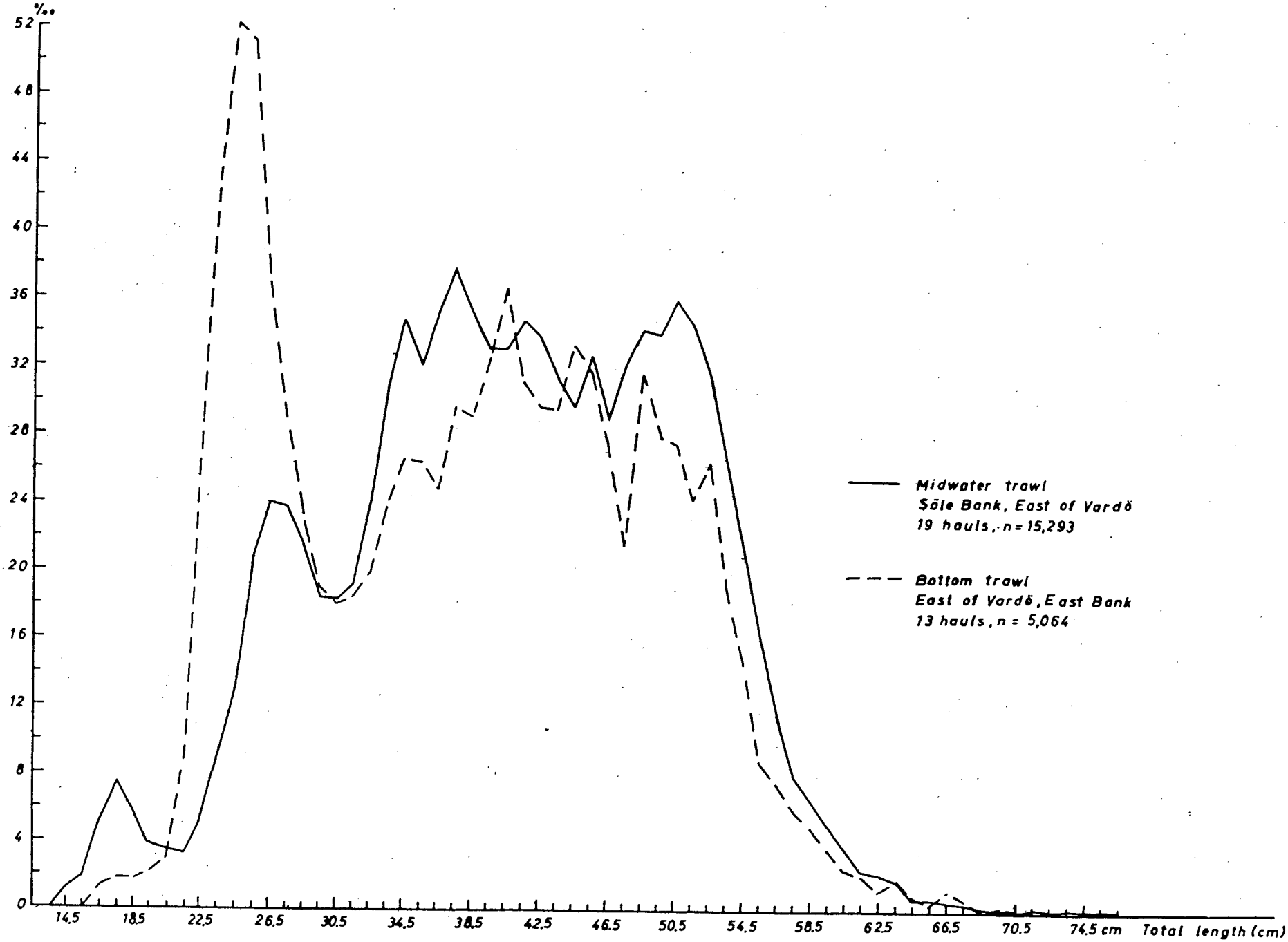

Fig. 2: Relative length composition of haddock (codend plus cover)

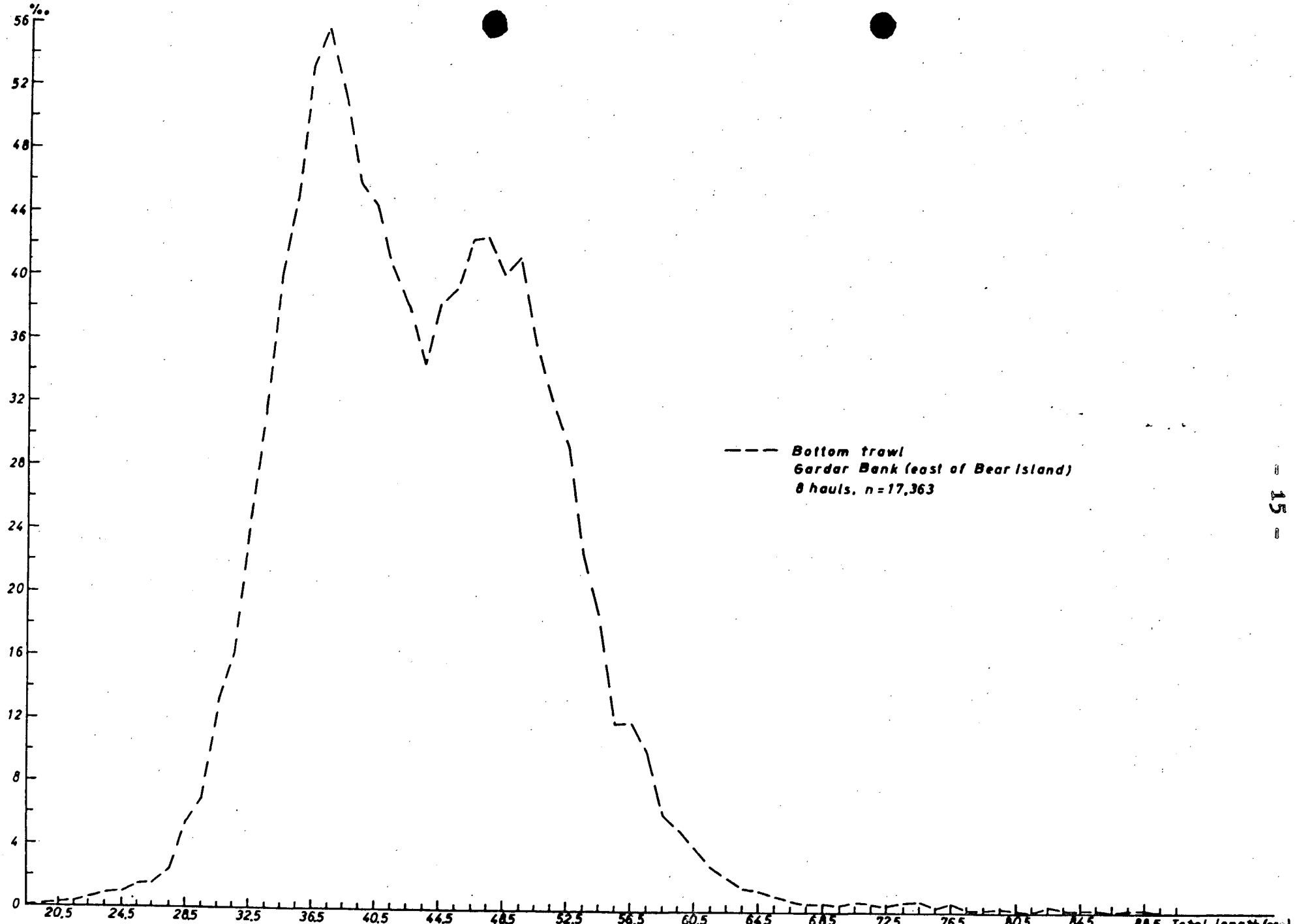

Fig. 3: Relative length composition of cod (codend plus cover)

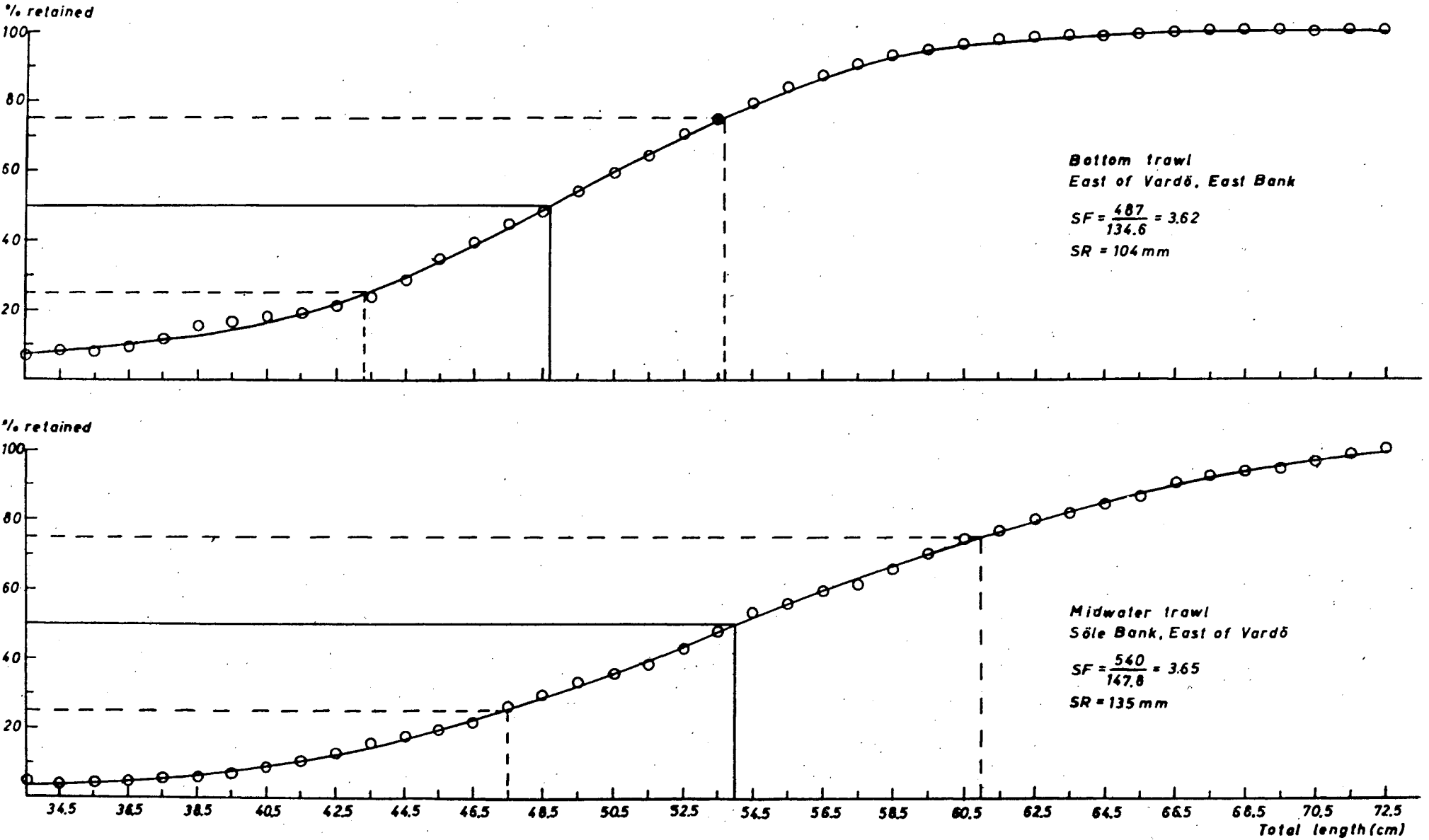

Fig. 4: Cod selection curves for combined hauls

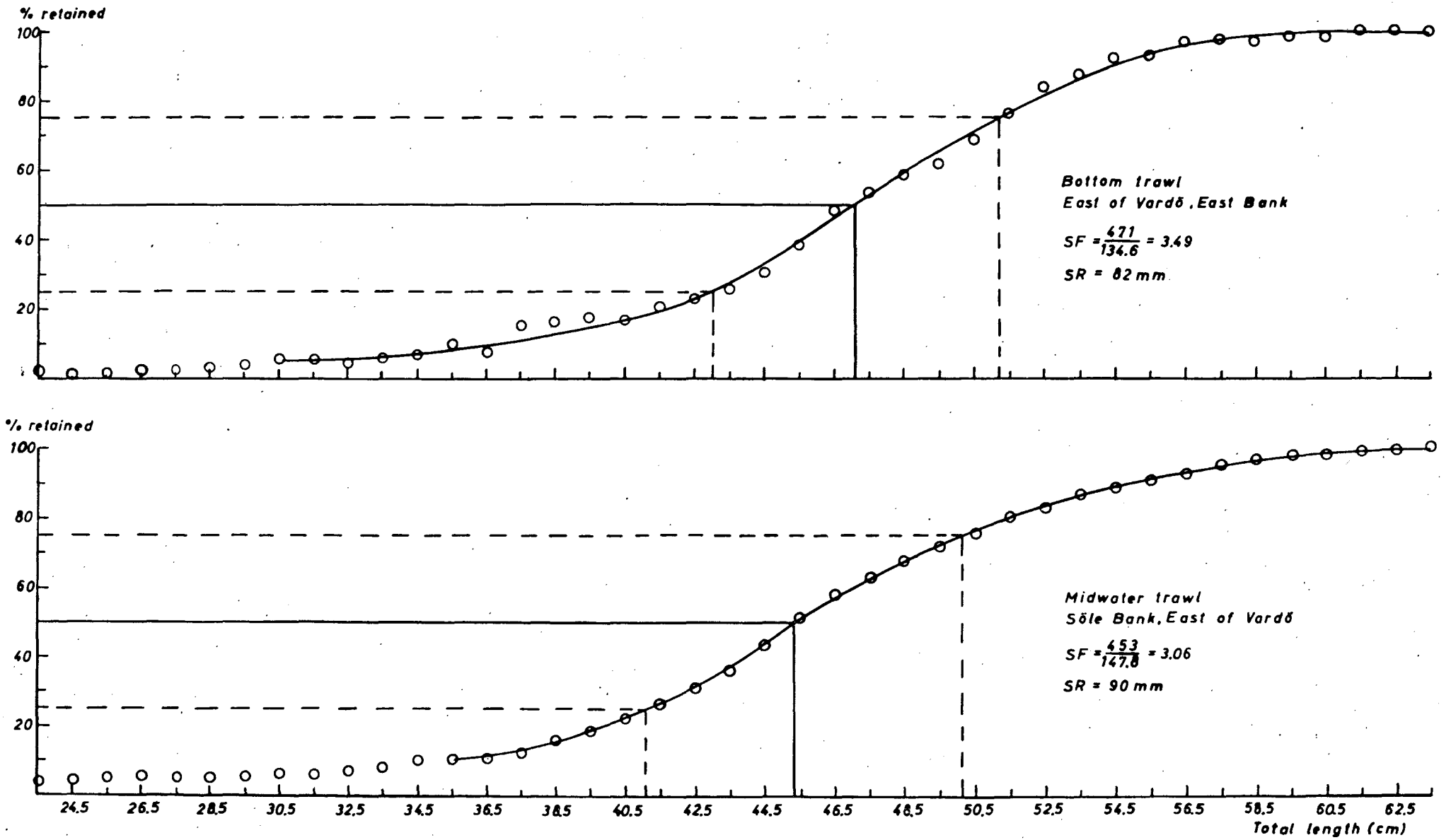

Fig. 5: Haddock selection curves for combined hauls

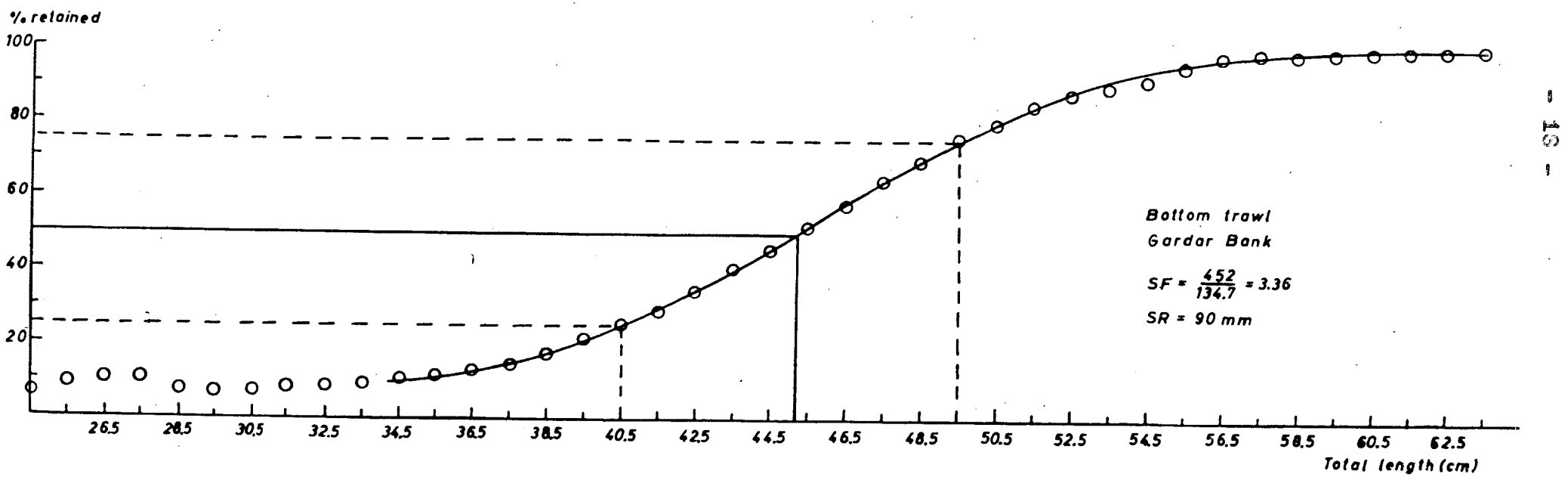

Fig. 6: Cod selection curve for combined hauls

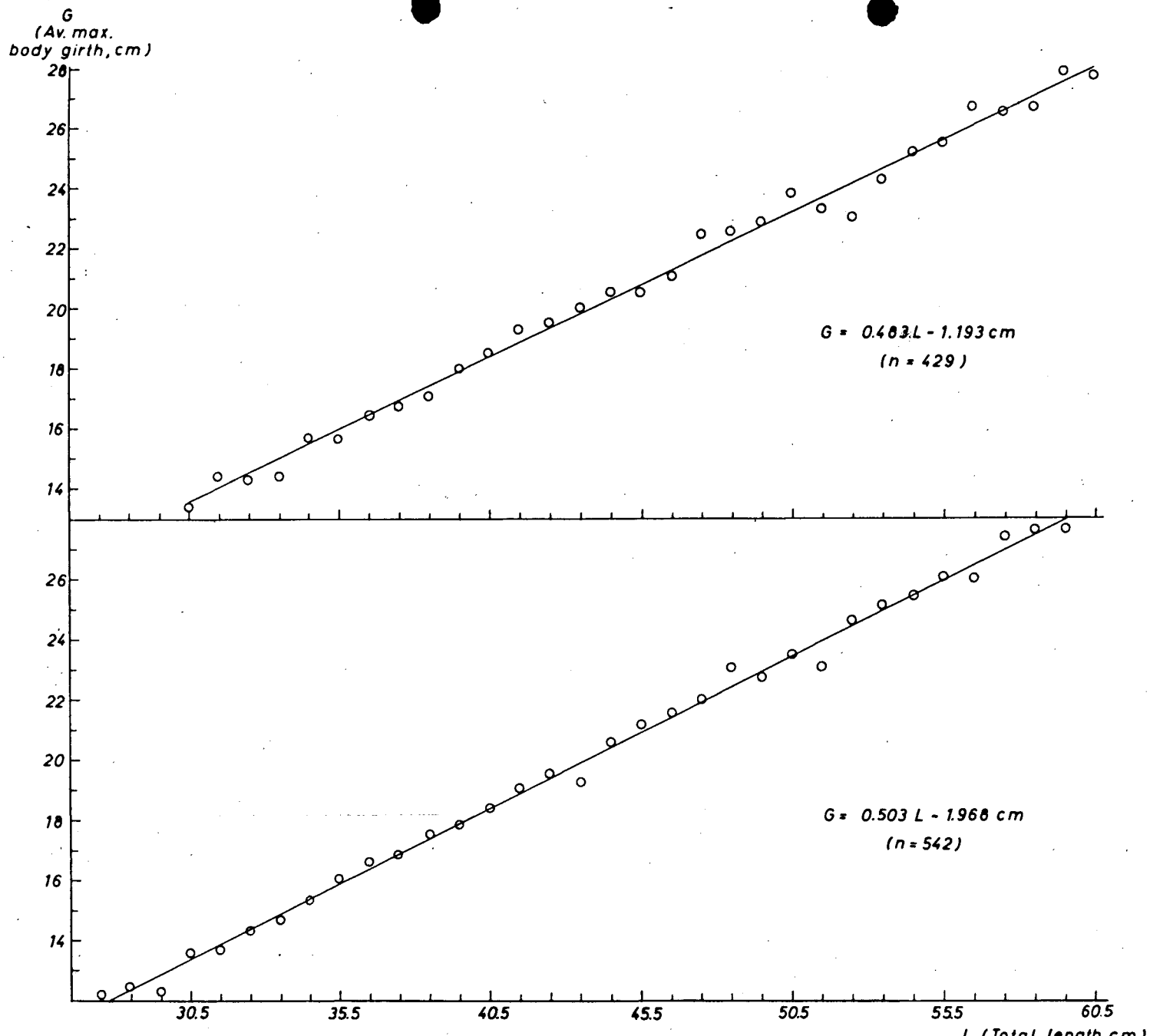

Fig. 7: Cod girth/length relationships

Above: Midwater trawl, Söle Bank (Sub-area I), 22 April '75
Below: Bottom trawl, Gardar Bank (Division IIb), 11 May '75

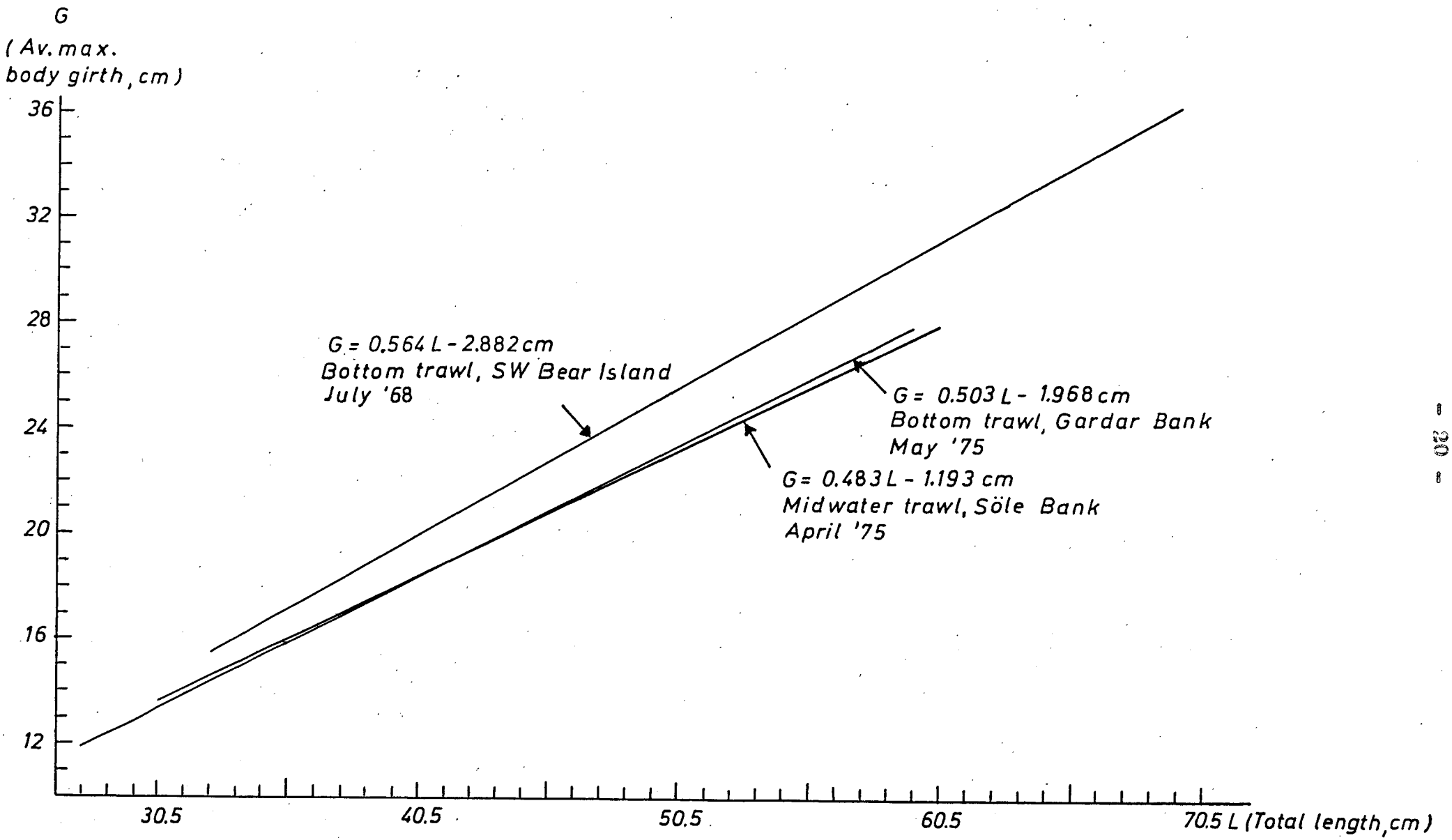

Fig. 8 : Comparison of cod girth/length relationships