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K. Groeneveld and A.D. Rijnsdorp
Netherlands Institute for Fishery Investigations
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Abstract.

In this paper the catch efficiency of an 8 m beam trawl with 8 tickler chains, designed for sampling sandy and muddy grounds, is compared with a similar trawl equipped with a flip-up rope, that can be employed in more stony areas. It is shown that the beam trawl with the flip-up rope has a significant lower catch rate for sole, plaice, dab, turbot and whiting, but not for cod. The effect of fish size on catch efficiency was tested for plaice, sole, dab and whiting. In sole, plaice and whiting the flip-up especially reduced the catch efficiency for the smaller fish.

Introduction

In the North Sea and English Channel a monitoring program of the flatfish stocks was started in 1985 with particular emphasis on sole. A beam trawl was chosen as survey gear because this is the only type of trawl that has a sufficiently high catch efficiency for this species. The program is carried out by Belgium, England and the Netherlands. In the first year the sampling of the stony grounds in the southwestern part of the North Sea appeared to be very difficult due to the catch of large stones and boulders that damaged the netting. In order to include these areas in the survey a modified beam trawl was used in the following year which was equipped with a flip-up to avoid the catch of stones and boulders.

In this paper the catch efficiency of both beam trawls is compared using data of the survey carried out in 1988 which was completely carried out with parallel hauls of both trawls. In the comparison the following species are included: sole, plaice, dab, turbot, cod and whiting.

Survey gear.

A drawing of the standard 8 m beam trawl is given in Figure 1. The mesh size in the cod end is 4 cm (stretched mesh). Eight tickler chains of short links (16 mm), 4 from the shoes and 4 from the groundrope, run in front of the net . The beam trawl is fished at 4 knots with a variable warp that depends on the depth and the coarseness of the seabed. After each haul it is checked whether the gear had sufficient ground contact reflected in the wear of the shoes.

The flip-up rope connects the groundrope with the beam and lifts the groundrope from the seabed when stones and boulders on the seabed are met by the gear. In Figure 2 the flip-up is shown. It is composed of a two chains running parallel to the ground rope and a netting of nylon lines from the chains to the beam. One of the chains is closely attached to the ground rope with links of 4 / 8". On the upper nylon line 8 floats are fixed. The meshes of the flip-up rope are approximately 40 x 40 cm.

Material and methods

The gear comparison was carried out during the routine beam trawl survey in August - September 1988 by RV ISIS sampling the southern and southeastern part of the North Sea between 51°30' - 56°00' N and between 2°00' - 7°00' E. The research vessel is designed to work with two beam trawl at the same time that allowed us to compare parallel hauls of the standard beam trawl with the beam trawl and flip-up. A total of 93 hauls were carried out of which 81 were valid for both nets and were available for comparison.

After each haul of 30 minutes the catch is analysed separately and all fish species are sorted out and measured to the cm below. Otolith samples are collected for sole, plaice, dab, turbot, brill, cod and whiting.

The catch efficiency of both trawls is analysed by analysis of variance (ANOVA) according to the model:

$$N = e^{a + F1 + F2} \times \varepsilon$$

where N is the number caught per hour fishing and F_1 and F_2 are the discrete levelled factors haulnumber (81 levels) and fishing gear (2 levels) and ε is an error term with a

Poisson distribution, with an expected value of 1 and a variance which is proportional to the fitted values: $\sigma^2 = E(N)$.
The deviance (R) between the observed catch number ($N_{observed}$) and the fitted catch number (N_{fitted}) was calculated according to McCullah & Nelder (1983) as
$R = (N_{observed} - N_{fitted}) / \sqrt{N_{fitted}}$

Results

Table 1 shows the average number per hour fishing in the 81 comparative hauls and show that for most species the catch was lower in the beam trawl equipped with the flip-up rope. ANOVA showed that the differences between the beam trawls were statistically significant in plaice, sole, dab, turbot and whiting, but not in cod (Table 2). The parameter estimates of the difference are given in Table 3.

The numbers of sole, plaice, dab and whiting caught allowed us to study the effect of fish size, or age, on the catch efficiency of both trawls. For sole and plaice three groups were distinguished: age-groups 0-2 (corresponding to approximately 10-25 cm), age-groups 3-5 (corresponding to approximately 25-40 cm) and age-groups 6+ (corresponding to approximately >=35 cm). In dab the size groups 10-15 cm, 15-20 cm and >= 20 cm, and in whiting the size groups 10-20 cm, 20-30 cm and >=30 cm were compared.

In sole and plaice the reduction in catch efficiency of the flip-up was only significant in the smallest age-groups. No reduction in catch efficiency was observed in the older age-groups (Table 3). Also in dab the catch efficiency was reduced by the flip-up in the two smallest size-group, but not in the >20 cm group. In whiting the reduction was significant in all size-groups, but the effect decreased with increasing fish size.

The overall length distribution of sole and plaice by the standard 8 m beam trawl and the 8 m beam trawl with flip-up as shown in Figure 3 clearly show the effect of fish size on the reduction in catch efficiency of the flip-up.

As it was not possible to change the standard net and the flip-up net between portside and starboard the trend in the catches of both nets were studied in relation with haul number. To this end the deviance (R) of the observed catch number and the predicted catch number from the ANOVA was calculated for each haul of the 8-m beam trawl with flip-up rope. The results are plotted in Figure 4 and show that there is no trend in

the residuals of neither plaice or sole. This indicates that during the experiment no change in the catch efficiencies of both beam trawls did occur.

Discussion

The results of the present study show that the catch efficiency of the 8-m beam trawl equipped with a flip-up rope is lower than that of the standard gear. This result appears to contrast the results of Fonteyne (1987), who compared a standard beam trawl with one equipped with a flip-up rope on board of a commercial vessel fishing for sole and plaice. In his study only marketable fish were analysed for which no difference in the catch efficiency was observed. Also a comparison of the total length distribution of sole, plaice and lemon sole did not show a significant difference.

In our study no significant differences were observed for the larger size groups in those species for which the catches were high enough to allow the separate analysis of age- or size-groups, except in whiting and plaice. This is in agreement with the result for cod, mainly fish >20cm, for which no significant difference in catch efficiency could be detected. The reduced catch efficiency of the 8-m beam trawl with flip-up rope appears to be related to fish size, as a significant reduction was observed in the smallest size-groups for all species studied.

The results of the present study indicates that beam trawl surveys using different fishing gears could yield results that differ for the various size-groups or age-groups sampled. As it is not at all clear why the flip-up rope specifically affect the catch efficiency of smaller fish further research should be carried out.

Literature.

Fonteyne, R. 1987. Studie naar de invloed van een "touwschot" in de boomkorvisserij met kettingmatten. Mededeling van het Rijkstation voor Zeevisserij (CLO Gent) Publikatie nr. 218. 23 pp.

McCullagh, P. and Nelder, J.A. 1983. Generalized Linear Models. Chapman and Hall, London. pp 261.

Table 1. Average catch per hour fishing in the standard 8-m beam trawl and the 8-m beam trawl equipped with a flip-up rope in 81 parallel hauls taken in the southern and southeastern North Sea.

		standard	flip-up rope
Sole	total	6058	1974
Sole	Age-group 0-2	5543	1394
Sole	Age-group 3-5	452.7	528.5
Sole	Age-group 6+	63.1	50.8
Plaice	total	68540	37560
Plaice	Age-group 0-2	52180	21150
Plaice	Age-group 3-5	16230	16200
Plaice	Age-group 6+	146.2	213.6
Dab	total	153100	113600
	10-14cm	74020	59070
	15-19 cm	58000	40520
	>= 20 cm	8786	7903
Whiting	total	5243	3468
	10-19cm	1845	1071
	19-26 cm	2785	1833
	>= 27 cm	439	306
Turbot		146	90
Cod		368	447

Table 2. Results of the ANOVA of total number caught per fishing hour.(N) according the model $N = \alpha + Haul + Gear$.

	SS				MS		
	total	unexpl	haul	gear	unexpl	haul	gear
d.f.	161	80	80	1	80	80	1
Sole	24680	834.7	21670	2177	10.4	271**	2177**
Plaice	201600	4167	188300	9180	52.1	2354**	9180**
Dab	340800	29380	305500	5870	367.3	3819**	5870**
Turbot	637.6	102.4	521.8	13.42	1.28	6.5**	13.4**
Cod	2689	231.4	2450	7.67	2.89	30.63**	7.67ns
Whiting	12920	562	11990	364	7.03	149.9**	364**

ns not significant
* P<0.05
** P<0.01

Table 3. Parameter estimates for the effect of fishing gear on the numbers per hour fishing from the ANOVA model: $N = \alpha + Haul + Gear$.

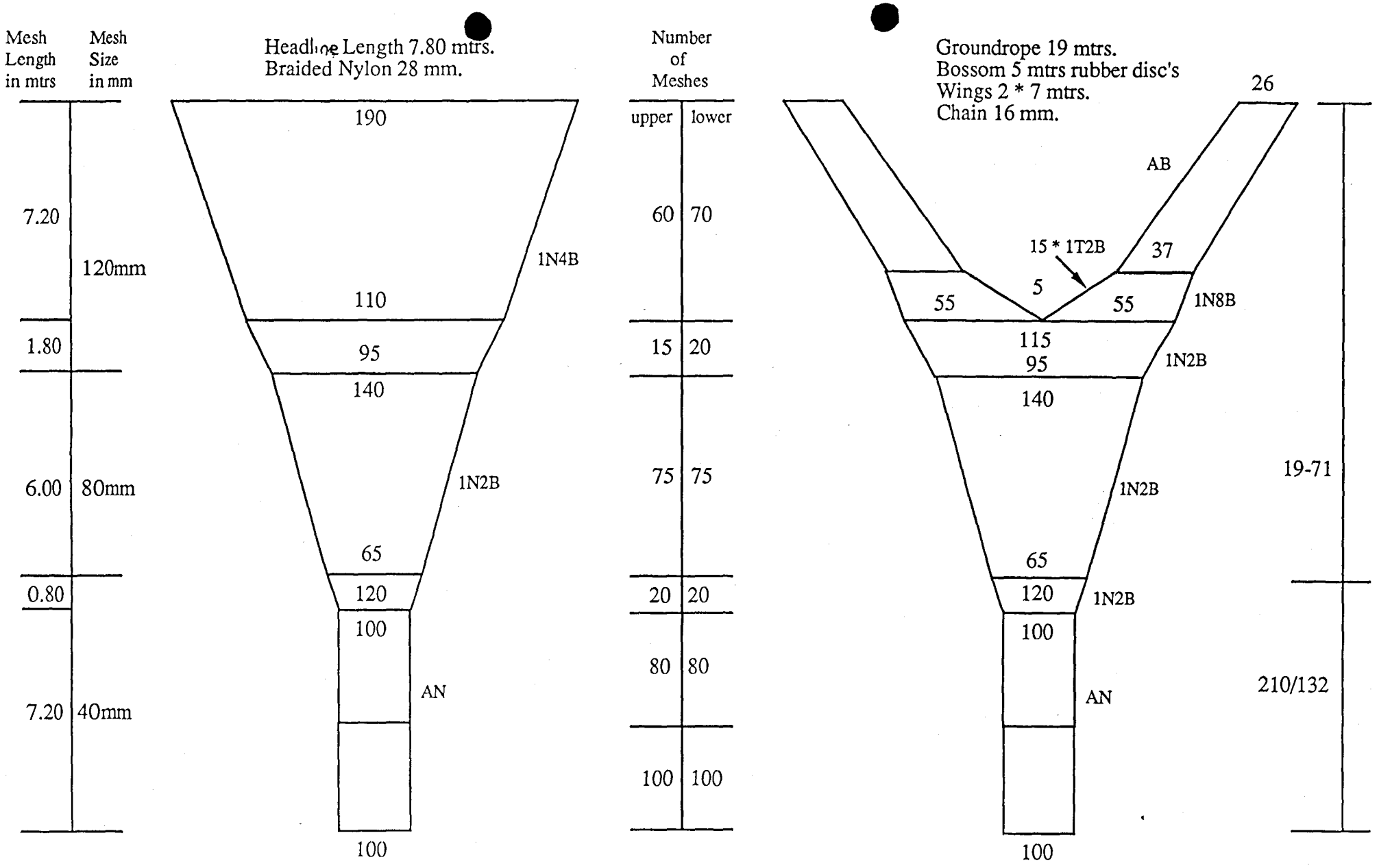
	Gear	S.E.	exp(Gear)	1/exp(Gear)	
Sole	0.497	0.111	1.64	0.61	P<0.01
Plaice	0.612	0.053	1.84	0.54	P<0.01
Dab	0.298	0.004	1.35	0.74	P<0.01
Turbot	0.484	0.134	1.62	0.62	P<0.01
Cod	-0.194	0.094	0.82	1.21	N.S.
Whiting	0.413	0.002	1.51	0.66	P<0.01

Table 4. Results of the ANOVA of number caught per fishing hour.(N) by age-group or size class according the model $N = \alpha + Haul + Gear$.

	SS				MS ···		
	total	unexpl	haul	gear	unexpl	haul	gear
d.f.	161	80	80	1	80	80	1
Sole (age-groups)							
0-2	26490	591.6	23840	2657	7.40	298^{**}	2657^{**}
3-5	1575	290.5	1279	5.86	3.63	16.0^{**}	5.86^{NS}
6+	296.1	57.29	237.5	1.33	0.72	2.97^{**}	1.33^{NS}
Plaice (age groups)							
0-2	216900	6088	197300	13550	76.1	2466^{**}	13550^{**}
3-5	36120	2212	33910	0.02	27.7	423.9^{**}	0.02^{NS}
6+	888.6	93.78	782.1	12.7	1.17	9.78^{**}	12.7^{**}
Dab (size groups)							
10-14 cm	228400	40440	186300	1684	505.5	2328.8^{**}	1684^{NS}
15-19cm	116700	8209	105400	3116	102.6	1317.5^{**}	3116^{*}
>=20 cm	27970	3526	24400	46.7	44.1	305.0^{**}	46.7^{NS}
Whiting							
15-19 cm	7640	397.4	7035	207.9	4.97	87.9^{**}	207.9^{**}
20-26 cm	7667	463.5	7006	197.7	5.79	87.6^{**}	197.7^{**}
>=27 cm	1437	202.3	1211	23.9	2.53	15.1^{**}	23.9^{**}

Table 5 Parameter estimates for the gear effect for different age or size classes of sole, plaice, dab and whiting from the ANOVA model: $N = \alpha + Haul + Gear$.

	Gear	S.E.	exp(Gear)	1/exp(Gear)	
Sole (age-groups)					
0-2	1.381	0.030	3.98	0.25	P<0.01
Plaice (age-groups)					
0-2	0.903	0.008	2.47	0.41	P<0.01
6+	-0.379	0.107	0.68	1.46	P<0.01
Dab (size groups)					
15-19 cm	0.359	0.006	1.43	0.70	P<0.01
Whiting (size groups)					
10-19 cm	0.544	0.038	1.72	0.58	P<0.01
20-26 cm	0.418	0.030	1.52	0.66	P<0.01
>= 27 cm	0.361	0.075	1.43	0.70	P<0.01



8 mtrs BeamTrawl-net

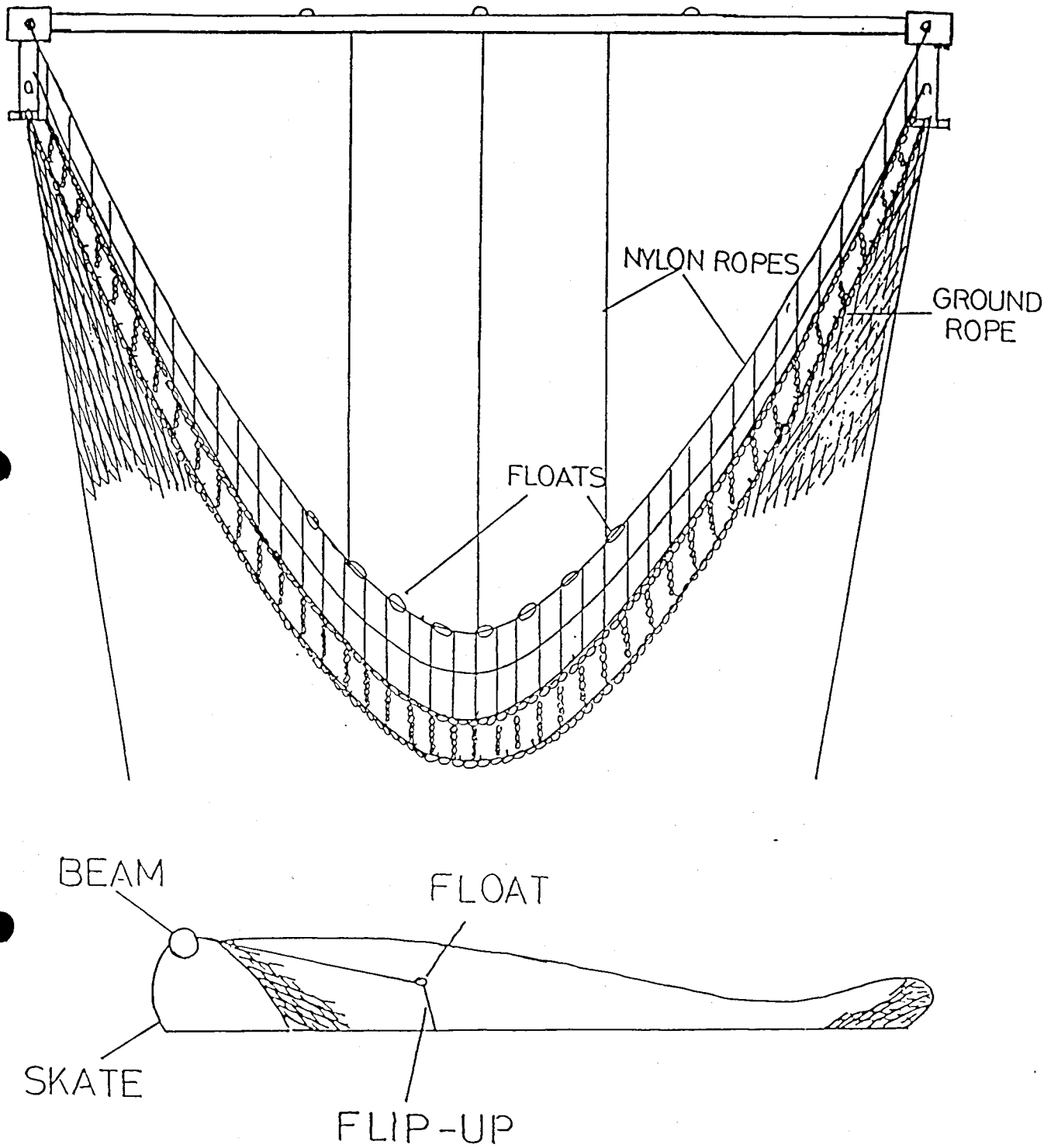


Figure 2. Upper panel: Top view of the flip-up rope (meshes of about 40 cm) and attachment to groundrope and beam.
Lower panel: Side view of the trawl with the approximate location of the flip-up rope.

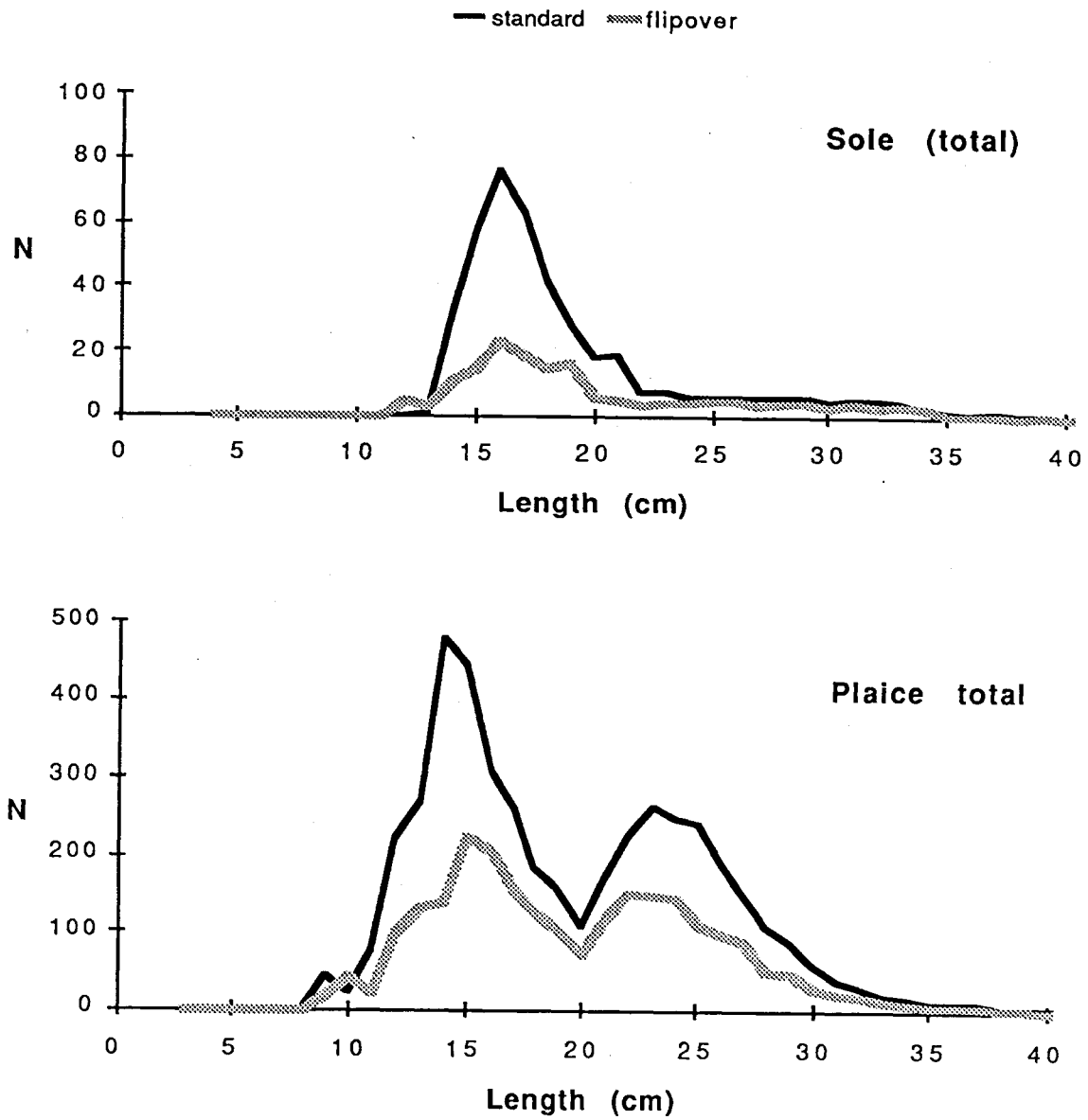


Figure 3. Length distribution of the total catch of sole and plaice in the standard 8-m beam trawl and the one equipped with a flip-up rope.

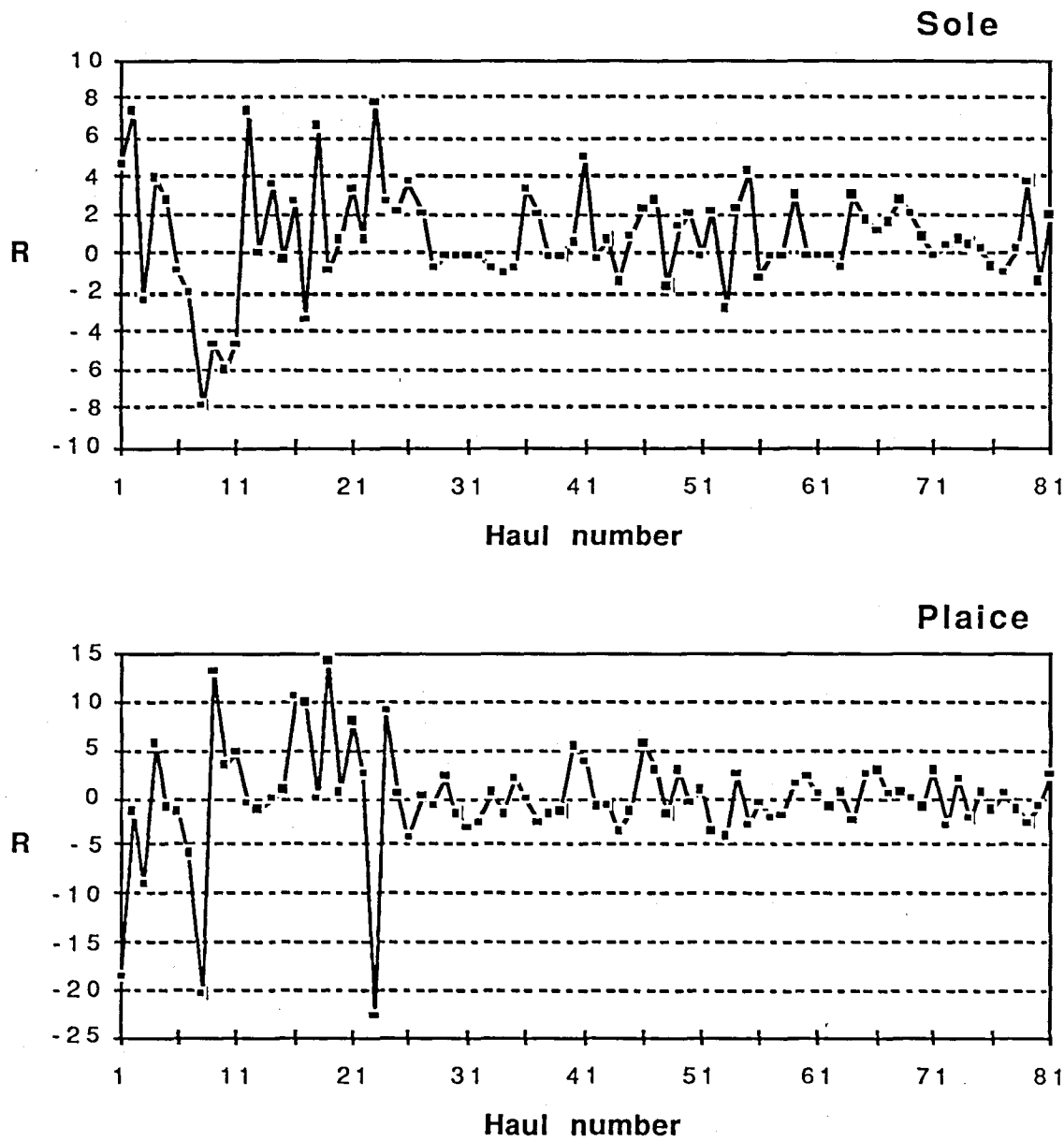


Figure 4. Time trend in the deviance (R standardized residual) between the observed number of sole and plaice caught in the beam trawl with flip-up rope and the predicted catch from the ANOVA model: $N = \alpha + \text{Haul} + \text{Gear}$.