Further Evaluation of Square Mesh Panels to Improve Selectivity for Cod in Demersal Trawls

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Summary

During the period 1990-93 work was carried out with square mesh selector panels which achieved encouraging results in releasing juvenile haddock and whiting.

In 1991 trials were carried out onboard the *MFV CONGENER* using various configurations of escape panels to encourage the escape of juvenile cod.

Poor concentrations of codlings at the time of the trials resulted in no firm conclusions being reached (Arkley, Internal Report No. 1420). As a result, MAFF commissioned further trials using the configuration which showed the most promise.

Two sets of sea trials were carried out on the *MFV CHRISTEL STAR* sailing from Bridlington with the intention of targeting satisfactory concentrations of codlings.

There appeared to be little indication that the use of square mesh panels would contribute to the release of juvenile cod.

Supplementary work on two different configurations appeared to show much more encouraging results.

Contents

1. Introduction

Codends of many types have been observed with remote-controlled underwater television and it has been seen that as the codend fills with fish it takes on a bulbus shape. As the codends become blocked by fish with the build up of catch, the diamond meshes become elongated by the increasing strain. In consequence there remains only a small area where the meshes are open. The main area of fish release is from this region just fore side of the 'bulb'.

In light of these observations much work has been carried out to improve the selectivity of fishing gears and of codends in particular. This has involved using various devices within the trawl and the codends that enable juvenile fish to escape.

Work carried out in the period 1990-1993 led to the successful introduction of square mesh selector panels or escape windows in the upper part of codends and extensions which have achieved encouraging results with respect to the release of juvenile haddock and whiting.

Up to the present time however, these configurations have not enabled the successful release of juvenile or undersize cod and effort has been subsequently directed to finding a solution to this problem area.

It is generally accepted that cod have a tendency to remain very close to the sea bed at most times and that this behaviour continues once the fish is caught in a demersal trawl.

Using this behavioural response as a guide it was decided to investigate a number of experimental designs of selection devices based on the use of square mesh panels situated in the lower sheet of the net. The designs selected were those which showed the most promise in previous trials conducted by Seafish onboard the *MFV CONGENER* in 1991 (Arkley, Internal Report No. 1420).

In order to try and obtain the best evaluation of the experimental gear it was decided to select a fishing operation and a fishery that would provide representative commercial fishing conditions and at the same time reasonable concentrations of small codlings.

2. Materials and Method

Two simple square mesh panel configurations were tested in a standard demersal trawl normally used in the Yorkshire Coast ground fishery. The fishing vessel chosen for the operation was the Bridlington based trawler *MFV CHRISTEL STAR (H56).* The trial covered two periods of five days' duration - one in August and one in October - which enabled some flexibility in targeting adequate concentrations of codling.

The *CHRISTEL STAR* is a stern trawling vessel of length 13m and a GRT of 29.87 with a 195 kW engine. It is 11 years old and has been fished in this area by its owners Messrs Gary and Andrew Lee through all of this period.

The trials took the form of a standard comparative fishing exercise using the alternate haul procedure. Four tows per day were carried out; each of two and a half hours' duration to enable the operation to follow as near to the normal commercial pattern as the nature of the trials permitted.

Each day two tows were carried out with the standard gear and two with an experimental panel fitted directly in front of the codends in place of a section of parallel extension. The changeover was carried out each day at mid-day so that each gear was fishing at different periods ie. experimental gear would fish two hauls in the afternoon on one day and two in the morning the following day, following the changeover the standard gear would fish for two tows in the afternoon, with two in the morning the following day. In this way any bias due to time of day fished was reduced.

Six hauls for each gear were carried out in each of the two trials giving a total of six hauls for variant 1 and six hauls for variant 2 - the other twelve being the standard gear. In each haul all of the cod were measured to give length distributions. Other vessels working in the same area were asked to provide catch details in order that the trials vessel could establish whether catches were representative in terms of species mix, quantity and size range.

The two different panel configurations used are shown in *Figs. 1 & 2* and were constructed of 90mm and 95mm U/C knotless PE netting respectively. The first panel used *(Fig. 1)* was constructed in order to provide the fish with a greater area of release. This was done by incorporating additional side panels constructed in square mesh netting. The arrangement thus consisted of a square mesh lower sheet and side sheet with standard diamond mesh above.

Panel two was a straight forward construction of 95mm square mesh lower sheet and standard diamond top sheet.

The associated diamond mesh netting was 100mm (current legal minimum mesh size).

3. Results

The sizes of the catches for each haul were adequate to evaluate the performance of the two panels: each haul produced between 70 and 90 small codlings (under MLS), in fact the consistency of each haul showed that these results obtained by comparative fishing methods could be considered with some confidence.

An examination of the length distributions for both sets of gear (i.e. panel 1 and panel 2) in *Figs. 3 & 4* shows that there are no obvious reductions in undersize fish. There is however a slight shift to the right in the length distribution of the fish from the experimental panel using the 95mm square mesh panel.

Tables 2 & 3 show a summary of the catches for both the experiments with panel 2 showing an increase in discards by percentage of 25, this should not be seen as significant in any way and is probably attributable to fishing conditions rather than to the effect of the panel *(see Table 1).*

The results for the two trials were run through a software package called Genstat (Nag Ltd) Statistical Analysis.

An analysis of variance (ANOVA) was carried out to examine whether there was any significant difference between the mean numbers of fish per haul in the following size classes:-

i. 11-34cms
ii. 35-40cms (EC Grade 5)

The results are summarised in *Table 1* and were scrutinised for any significant differences between the two panels and the standard gear for the size ranges of fish mentioned above.

Table 1

PANEL 1 USING 90mm SQUARE MESH SIDE AND BOTTOM

COD SIZE RANGE	MEAN NUMBER FISH/HAUL			VARIANCE RATIO (calc.)	p=0.05 V.R. (table)	NULL HYPOTHESIS 95% CONFIDENCE
	PANEL 1	CONTROL	DIFF.			
11-34cms	74.8	59.7	15.1	2.37	5.00	33.22
35-40cms	21.3	19.7	1.6	0.14	5.00	3.52

PANEL 2 USING 95mm SQUARE MESH BOTTOM ONLY

COD SIZE RANGE	MEAN NUMBER FISH/HAUL			VARIANCE RATIO (calc.)	p=0.05 V.R. (table)	NULL HYPOTHESIS 95% CONFIDENCE
	PANEL 2	CONTROL	DIFF.			
11-34cms	93	123	40	0.27	5.00	88
35-40cms	60.5	76.5	16.5	0.67	5.00	36.3

In the case of the first variant (panel 1) it can be seen that the calculated v.r. (variance ratio) is less than the tabulated one at p=0.05m for both size classes (11-34cms, v.r. = 2.37 and 35-40cms v.r. = 0.14 against tabulated of 5.0) therefore the effect of the panel is not seen as significant at the 0.05% level.

The second variant produced calculated v.r.'s of 0.27 and 0.67 for the ranges 11-34 and 35-40 respectively; again they are less than the tabulated value of 5.0 and so the effect of panel 2 is not seen as significant at the 0.05% level.

We can also look at the results of the difference of means with respect to the null hypothesis with some confidence.

In each case there is seen to be no significant differences between the experimental panels used and the normal gear. In each case the difference of means (15.1, 1.6, 40 and 16.5) were all less than the value required to satisfy the null hypothesis at the 0.05% level.

4. Discussion

The trials showed little positive escape response to the square mesh sections. The indications are that the selection of codlings predominantly takes place in the codend itself and is most likely to be of a passive rather than of a dynamic nature. If this is the case, the shorter the length of time the codling spend in the codend then the chance of release is most reduced. Anecdotal evidence from fishermen would seem to bear out this hypothesis.

No significant improvements were gained even with the increase in square mesh size to 95mm.

Monitoring of the panels' performance during the trials failed to give any indications of the square mesh panels selectivity, ie. codling were not seen as 'stickers' in either panel, nor were any codling seen to wash out during hauling.

Indications from this and previous exercises of a similar nature seem to suggest that any solution for the release of undersize codlings should be looked at within the codend itself and possibly with diamond mesh in a different size and/or configuration.

At the end of these trials, it was decided to utilise two spare days testing two different codend configurations: these can be seen described in the Appendix but as only four hauls were carried out on each configuration no significant analysis could be carried out.

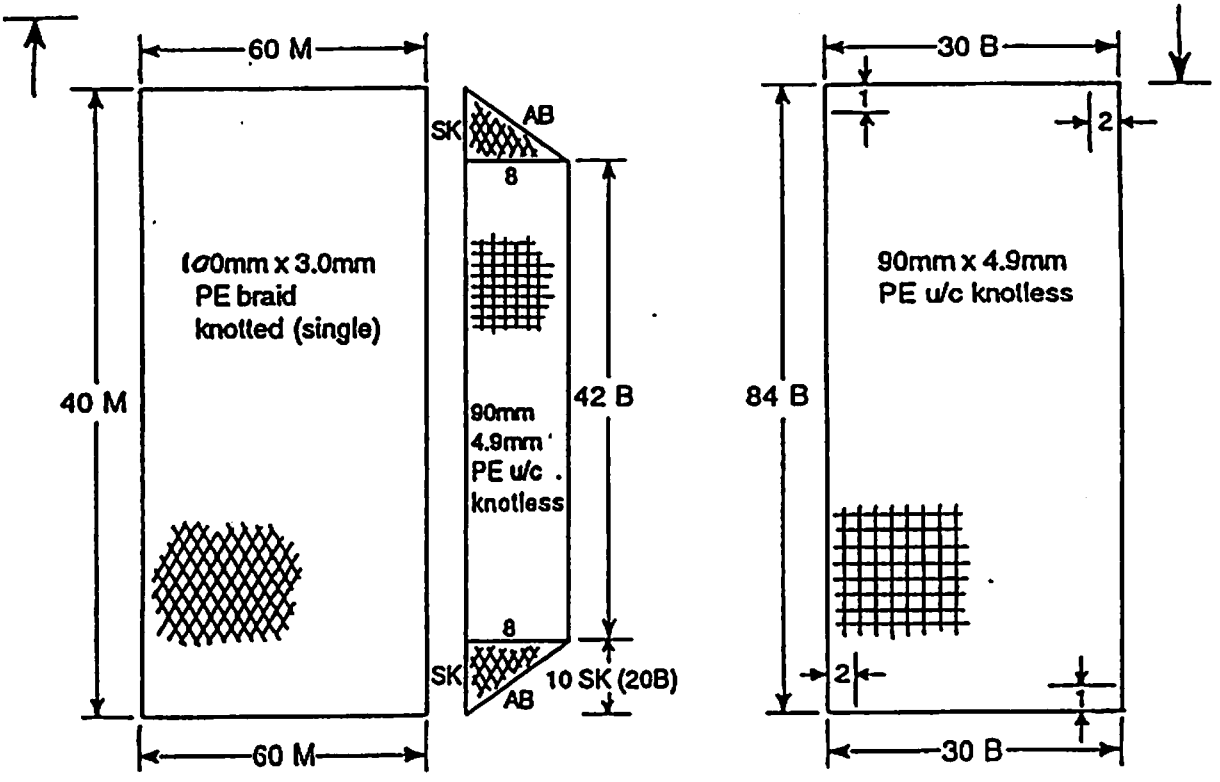
5. Conclusions

An examination of the results from these and previous trials (Internal Report No. 1420) would seem to give little indication that the use of square mesh panels would contribute to the release of juvenile cod.

It would be of some interest to see what the effect of these panels would be when there are large quantities of codling on the grounds.

The supplementary work on the two codend configurations appears to have shown more promise and would merit further trials to look at the experimental designs more closely.

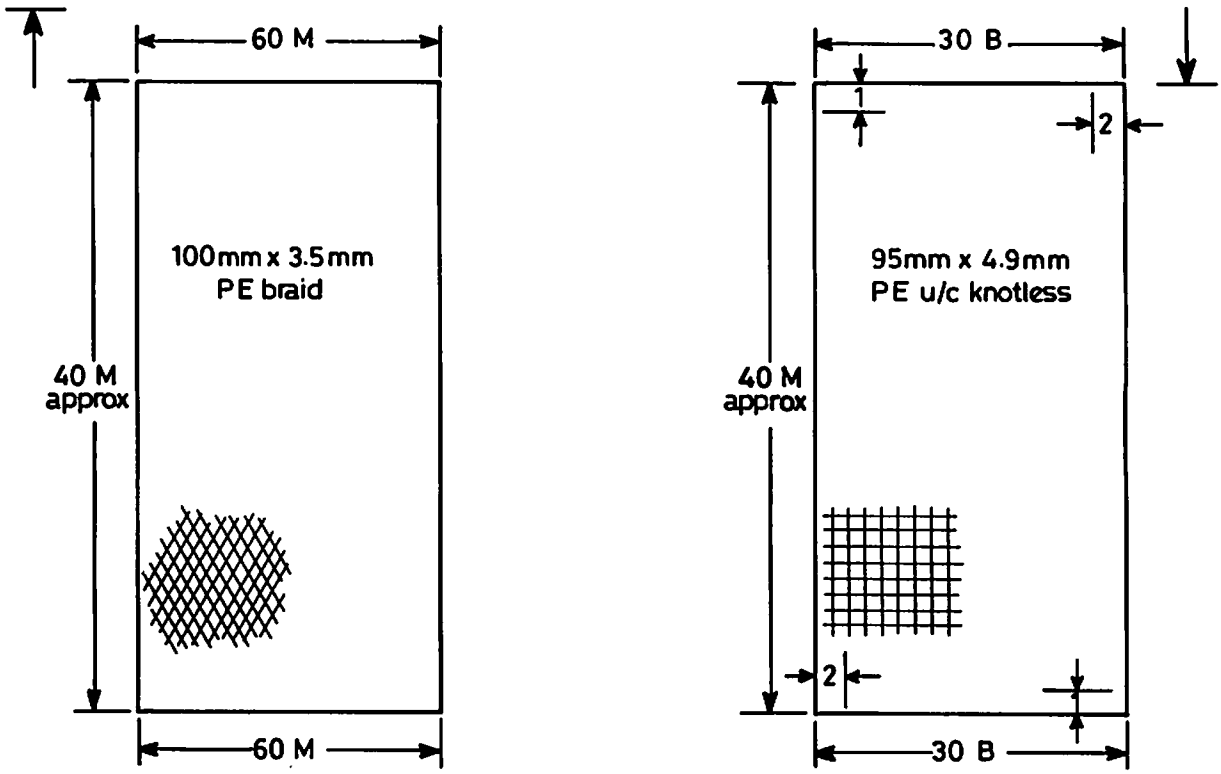
In light of the work being carried out using trawls with separator panels, perhaps it would be reasonable to investigate further the potential shown by the codend configuration described in the Appendix.



NOTES:- *Side panels rigged for adjustment from 8 bars deep to 10 bars deep by cutting away second selvedge (white).*

Experimental Panel Details for the 90mm Square Mesh Panel Arrangement Incorporating Square Mesh Side Panels

Figure 1



NOTES:- *Original mesh size for square mesh panel was 90mm. This was increased to 95mm to try and improve on release rates of codling.*

Experimental Panel Details for 95mm Square Mesh Lower Sheet and Standard Diamond Mesh Top Sheet

Figure 2

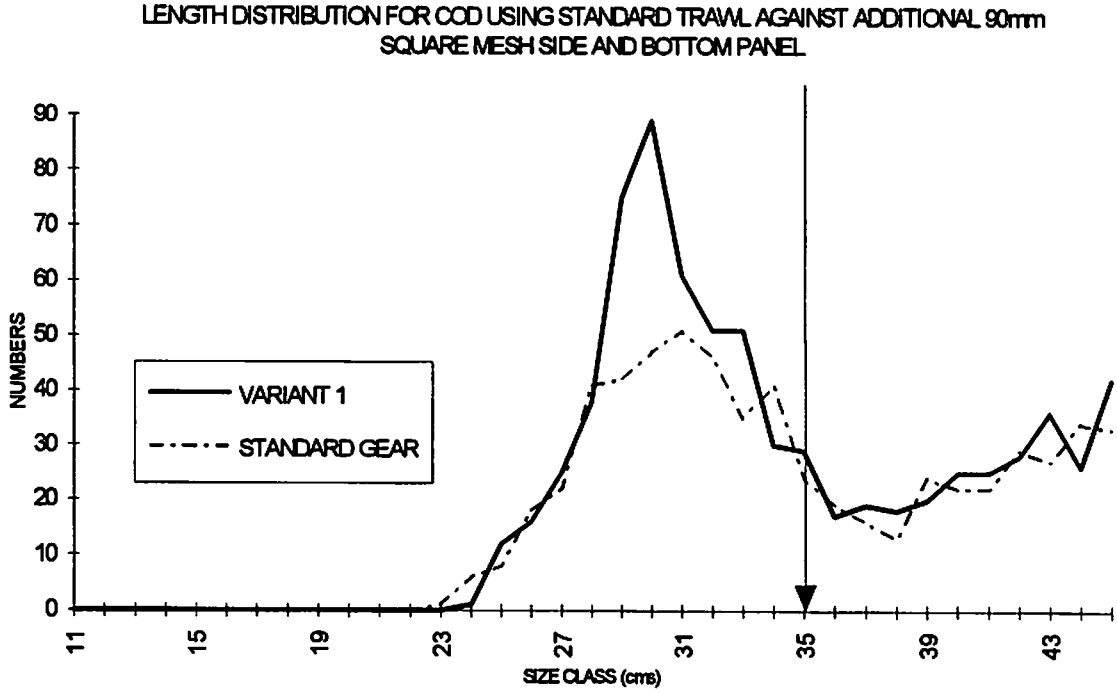


Figure 3

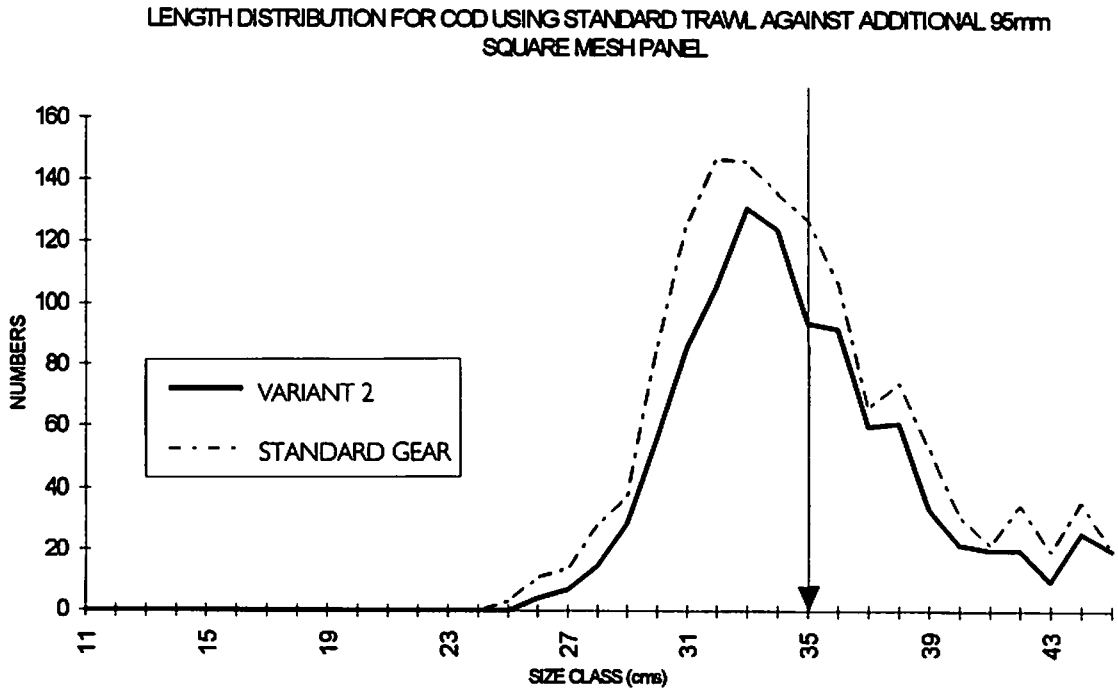


Figure 4

Table 2
Length Frequency Data Comparing Standard Codend Against Panel 1

VARIANT: 100mm TOP PANEL, 90mm SQUARE MESH SIDE AND 80mm BOTTOM PANEL			STANDARD GEAR		
SAMPLE TOTAL:		933	SAMPLE TOTAL:		804
RAISED TOTAL:		933	RAISED TOTAL:		804
MLS (cm)		35	MLS (cm)		35
% DISCARDS		48	% DISCARDS		45
% RETAINED		52	% RETAINED		55
CLASS cm	RAISED NUMBERS	FREQ. %	CLASS cm	RAISED NUMBERS	FREQ. %
11	0	0	11	0	0
12	0	0	12	0	0
13	0	0	13	0	0
14	0	0	14	0	0
15	0	0	15	0	0
16	0	0	16	0	0
17	0	0	17	0	0
18	0	0	18	0	0
19	0	0	19	0	0
20	0	0	20	0	0
21	0	0	21	0	0
22	0	0	22	0	0
23	0	0	23	1	0
24	1	0	24	6	1
25	12	1	25	8	1
26	16	2	26	18	2
27	25	3	27	22	3
28	38	4	28	41	5
29	75	8	29	42	5
30	89	10	30	47	6
31	61	7	31	51	6
32	51	6	32	46	6
33	51	6	33	35	4
34	30	3	34	41	5
35	29	3	35	24	3
36	17	2	36	19	2
37	19	2	37	16	2
38	18	2	38	13	2
39	20	2	39	24	3
40	25	3	40	22	3
41	25	3	41	22	3
42	28	3	42	29	4
43	36	4	43	27	3
44	26	3	44	34	4
45	42	5	45	33	4
46	29	3	46	32	4
47	35	4	47	26	3
48	19	2	48	19	2
49	18	2	49	22	3
50	20	2	50	25	3
51	18	2	51	15	2
52	12	1	52	11	1
53	12	1	53	8	1
54	8	1	54	4	0
55	6	1	55	3	0
56	8	1	56	5	1
57	3	0	57	3	0
58	5	1	58	2	0
59	1	0	59	4	0
60	2	0	60	1	0
61	1	0	61	2	0
62	1	0	62	1	0
63	1	0	63	0	0
64	0	0	64	1	0
65	0	0	65	0	0
66	0	0	66	0	0
67	0	0	67	0	0
68	0	0	68	0	0
69	0	0	69	0	0
70	0	0	70	0	0

DIFFERENCES BETWEEN GEARS

(PERCENT AND NUMBERS)

	%	n
REDN. DISCARDS:	-25	-91
LOSS MARKETABLE:	-9	-38

SPECIES: COD
GEAR: VARIANT 1/STANDARD GEAR

COMMENTS:
MFV CHRISTEL STAR
100mm COD-END STANDARD

Table 3
Length Frequency Data Comparing Standard Codend Against Panel 2

VARIANT: 100mm TOP PANEL AND 95mm SQUARE MESH BOTTOM PANEL			STANDARD GEAR		
SAMPLE TOTAL:		1232	SAMPLE TOTAL:		1162
RAISED TOTAL:		1232	RAISED TOTAL:		1620
MLS (cm)		35	MLS (cm)		35
% DISCARDS		45	% DISCARDS		48
% RETAINED		55	% RETAINED		52
CLASS cm	RAISED NUMBERS	FREQ. %	CLASS cm	RAISED NUMBERS	FREQ. %
11	0	0	11	0	0
12	0	0	12	0	0
13	0	0	13	0	0
14	0	0	14	0	0
15	0	0	15	0	0
16	0	0	16	0	0
17	0	0	17	0	0
18	0	0	18	0	0
19	0	0	19	0	0
20	0	0	20	0	0
21	0	0	21	0	0
22	0	0	22	0	0
23	0	0	23	0	0
24	0	0	24	0	0
25	0	0	25	3	0
26	4	0	26	11	1
27	7	1	27	14	1
28	15	1	28	28	2
29	29	2	29	38	3
30	58	5	30	86	6
31	86	7	31	126	8
32	106	9	32	147	10
33	131	11	33	146	10
34	124	10	34	136	9
35	94	8	35	127	8
36	92	7	36	107	7
37	60	5	37	66	4
38	61	5	38	74	5
39	34	3	39	53	3
40	22	2	40	32	2
41	20	2	41	22	1
42	20	2	42	35	2
43	10	1	43	20	1
44	26	2	44	36	2
45	20	2	45	21	1
46	16	1	46	19	1
47	23	2	47	22	1
48	22	2	48	20	1
49	20	2	49	16	1
50	25	2	50	23	2
51	33	3	51	15	1
52	13	1	52	17	1
53	13	1	53	16	1
54	16	1	54	8	1
55	6	0	55	12	1
56	5	0	56	9	1
57	7	1	57	4	0
58	6	0	58	3	0
59	2	0	59	2	0
60	1	0	60	2	0
61	3	0	61	0	0
62	0	0	62	0	0
63	1	0	63	1	0
64	1	0	64	0	0
65	1	0	65	0	0
66	2	0	66	0	0
67	0	0	67	0	0
68	0	0	68	0	0
69	0	0	69	0	0
70	0	0	70	0	0

DIFFERENCES BETWEEN GEARS

(PERCENT AND NUMBERS)

	%	n
REDN. DISCARDS:	24	177
LOSS MARKETABLE:	14	111

SPECIES: COD
GEAR: VARIANT 1/STANDARD GEAR

COMMENTS:
MFV CHRISTEL STAR
100mm COD-END STANDARD

APPENDIX

Following limited success with the use of 90mm and 95mm square mesh panels, it was decided to look at a possible solution in the codend arrangement. Two configurations were tried:-

1. Using 110mm diamond codend mesh size; the meshes were set onto shortened selvidge ropes using a hanging coefficient of 0.72.

2. Using the same mesh size but turning it through 90° to the normal direction of the netting. This has the effect of producing a more consistent and greater mesh opening.

Looking at the length distributions *(Figs. 5 & 6 for configurations 1 & 2 respectively)* and the summary of results *(Tables 4 & 5)* it can be seen that the codend configuration of meshes turned through 90 degrees achieved a substantial reduction over the range 25-40cm and a reduction in discards and EC grade five fish of 90% and 13% respectively. The configuration consisting of 110mm meshes hung at 0.72 showed a substantial reduction (though not as pronounced as the aforementioned configuration) over the range 25-35cm and a reduction of discards by 62%.

Although no great significance can be attached to these results they should be seen as a potentially promising way of reducing cod discards without a significant increase in mesh size and would be well worth following up with future trials on a more sound experimental footing.

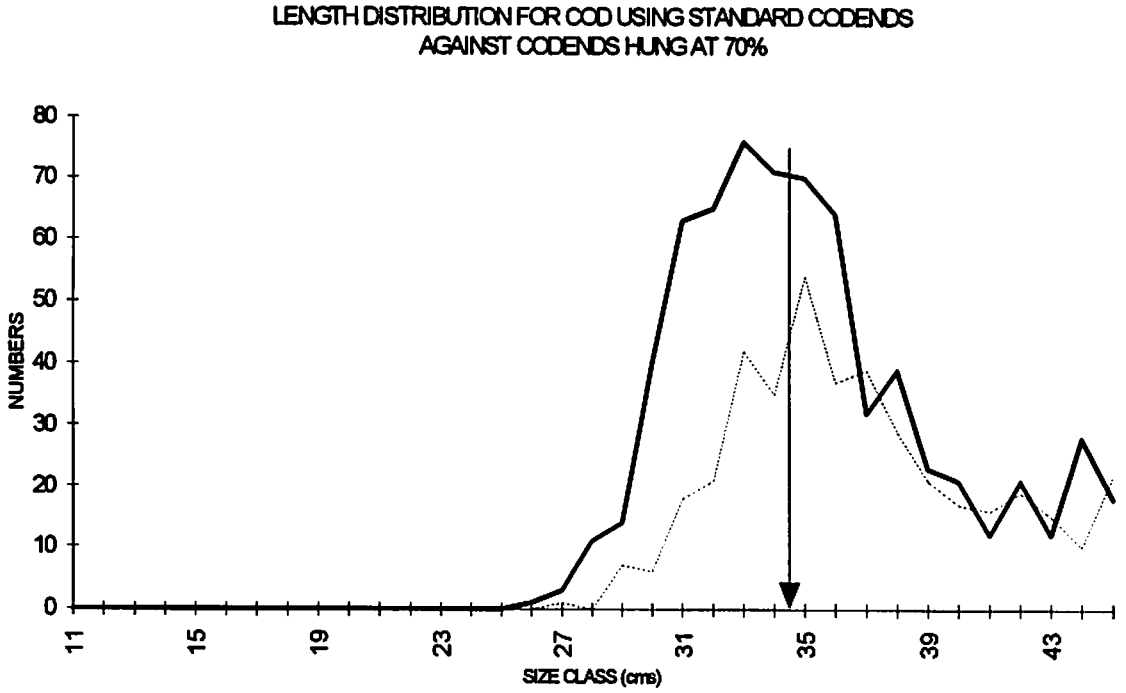


Figure 5

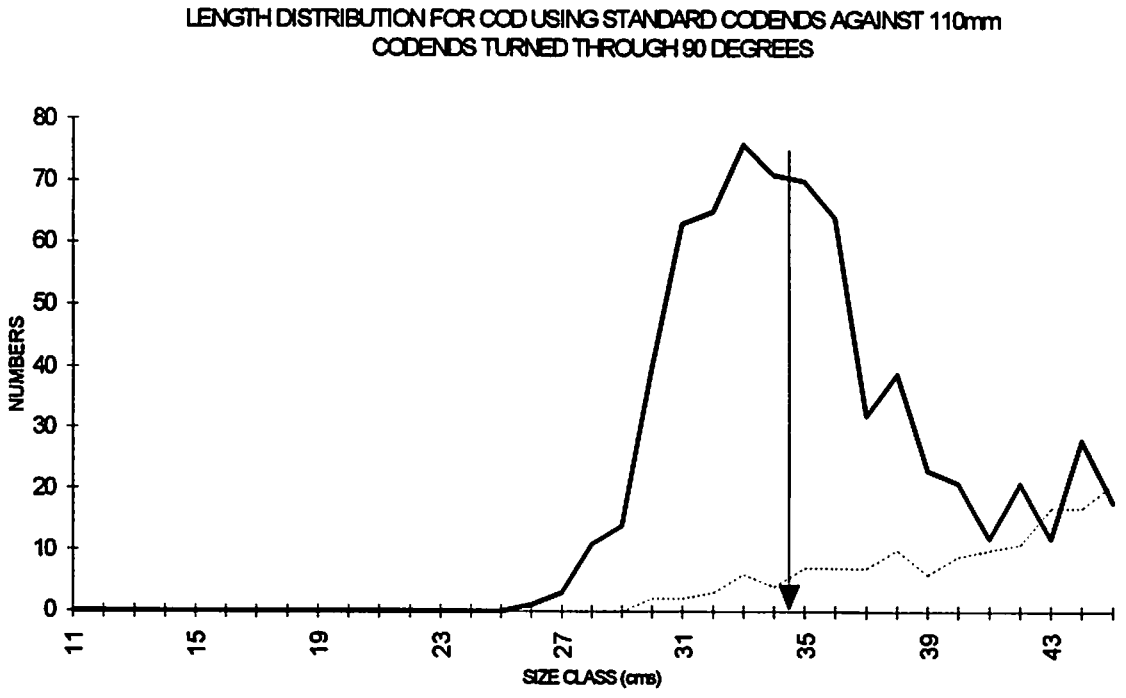


Figure 6

Table 4
Length Frequency Data Comparing Standard Codend Against Experimental Codend Hung at 70%

VARIANT: 110mm HUNG AT 70%			STANDARD GEAR		
SAMPLE TOTAL:		543	SAMPLE TOTAL:		837
RAISED TOTAL:		543	RAISED TOTAL:		837
MLS (cm)		35	MLS (cm)		35
% DISCARDS		24	% DISCARDS		41
% RETAINED		76	% RETAINED		59
CLASS cm	RAISED NUMBERS	FREQ. %	CLASS cm	RAISED NUMBERS	FREQ. %
11	0	0	11	0	0
12	0	0	12	0	0
13	0	0	13	0	0
14	0	0	14	0	0
15	0	0	15	0	0
16	0	0	16	0	0
17	0	0	17	0	0
18	0	0	18	0	0
19	0	0	19	0	0
20	0	0	20	0	0
21	0	0	21	0	0
22	0	0	22	0	0
23	0	0	23	0	0
24	0	0	24	0	0
25	0	0	25	0	0
26	0	0	26	1	0
27	1	0	27	3	0
28	0	0	28	11	1
29	7	1	29	14	2
30	6	1	30	40	5
31	18	3	31	63	8
32	21	4	32	65	8
33	42	8	33	76	9
34	35	6	34	71	8
35	54	10	35	70	8
36	37	7	36	64	8
37	39	7	37	32	4
38	29	5	38	39	5
39	21	4	39	23	3
40	17	3	40	21	3
41	16	3	41	12	1
42	19	3	42	21	3
43	15	3	43	12	1
44	10	2	44	28	3
45	22	4	45	18	2
46	20	4	46	17	2
47	14	3	47	17	2
48	20	4	48	17	2
49	14	3	49	14	2
50	14	3	50	16	2
51	15	3	51	13	2
52	6	1	52	12	1
53	5	1	53	14	2
54	6	1	54	6	1
55	6	1	55	8	1
56	6	1	56	7	1
57	5	1	57	2	0
58	0	0	58	3	0
59	2	0	59	2	0
60	0	0	60	1	0
61	0	0	61	0	0
62	0	0	62	0	0
63	0	0	63	1	0
64	0	0	64	0	0
65	1	0	65	0	0
66	0	0	66	0	0
67	0	0	67	0	0
68	0	0	68	0	0
69	0	0	69	0	0
70	0	0	70	0	0

DIFFERENCES BETWEEN GEARS

(PERCENT AND NUMBERS)

REDN. DISCARDS:
LOSS MARKETABLE:

SPECIES: COD
GEAR: VARIANT 1/STANDARD GEAR

COMMENTS:
MFV CHRISTEL STAR
100mm COD-END STANDARD

Table 5
Length Frequency Data Comparing Standard Codend Against Experimental Codend Turned Through 90°

VARIANT: 110mm MESH TURNED THROUGH 90 DEGREES			STANDARD GEAR		
SAMPLE TOTAL:		543	SAMPLE TOTAL:		0
RAISED TOTAL:		543	RAISED TOTAL:		0
MLS (cm)		35	MLS (cm)		35
% DISCARDS		3	% DISCARDS		#DIV/0!
% RETAINED		97	% RETAINED		#DIV/0!
CLASS cm	RAISED NUMBERS	FREQ. %	CLASS cm	RAISED NUMBERS	FREQ. %
11	0	0	11	0	0
12	0	0	12	0	0
13	0	0	13	0	0
14	0	0	14	0	0
15	0	0	15	0	0
16	0	0	16	0	0
17	0	0	17	0	0
18	0	0	18	0	0
19	0	0	19	0	0
20	0	0	20	0	0
21	0	0	21	0	0
22	0	0	22	0	0
23	0	0	23	0	0
24	0	0	24	0	0
25	0	0	25	0	0
26	0	0	26	1	0
27	0	0	27	3	0
28	0	0	28	11	1
29	0	0	29	14	2
30	2	1	30	40	5
31	2	1	31	63	8
32	3	1	32	65	8
33	6	2	33	76	9
34	4	1	34	71	8
35	7	3	35	70	8
36	7	3	36	64	8
37	7	3	37	32	4
38	10	4	38	39	5
39	6	2	39	23	3
40	9	3	40	21	3
41	10	4	41	12	1
42	11	4	42	21	3
43	17	6	43	12	1
44	17	6	44	28	3
45	21	8	45	18	2
46	22	8	46	17	2
47	20	7	47	17	2
48	21	8	48	17	2
49	16	6	49	14	2
50	10	4	50	16	2
51	11	4	51	13	2
52	8	3	52	12	1
53	8	3	53	14	2
54	5	2	54	6	1
55	2	1	55	8	1
56	1	0	56	7	1
57	2	1	57	2	0
58	0	0	58	3	0
59	2	1	59	2	0
60	1	0	60	1	0
61	0	0	61	0	0
62	2	1	62	0	0
63	0	0	63	1	0
64	0	0	64	0	0
65	0	0	65	0	0
66	0	0	66	0	0
67	0	0	67	0	0
68	0	0	68	0	0
69	0	0	69	0	0
70	0	0	70	0	0

DIFFERENCES BETWEEN GEARS		
(PERCENT AND NUMBERS)		
	%	n
REDN. DISCARDS:	95	327
LOSS MARKETABLE:	49	240

SPECIES: COD
GEAR: VARIANT 2/STANDARD GEAR

COMMENTS:
MFV CHRISTEL STAR
100mm COD-END STANDARD