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The Effect of the Use of Chafing Gear on Selection Factor

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Trawl nets used by stern trawlers have to possess more resistance than those used by side trawlers. This requirement is necessary in view of the great weight of fish sometimes lifted aboard in a single haul. The large quantity of fish threatens to break the codend and thus cause the loss of the catch. For this reason the codends were until now made of double netting, which evidently provided great strength to the net, not ensuring, however, sufficient selectivity. In order to increase the selectivity and simultaneously secure necessary strength of the net, two variant forms of reinforcement of the codend were proposed, one consisted of fastening a piece of netting with double mesh size to its upper side and the other of a piece of netting fastened in the same manner but with the mesh four times larger than the mesh of the codend. This piece of netting, used for reinforcement, is called "chafing gear" in the present paper. It was rigged over the upper side of the codend in such a manner as to affect the selectivity to a minimum degree and simultaneously prevent possible breaking of the codend netting under the pressure of great weight of fish.

Chafing gear was attached in such a way that each mesh of it was covering exactly four meshes of the codend, whereas in the other variant each mesh covered 16 meshes of the codend.

Our investigations aimed to find out how the proposed chafing gear affected the selectivity of fishing gear.

Area of Investigations

The investigations were carried out in the Convention Area, on fishing grounds from Flemish Cap to Sambro Bank. Figure 1 shows the regions of fishing operations. The depths at which trawling was performed varied from 60 m to 360 m.

The investigations were carried out in the period from 4 April till 18 June 1965 and the hauls were made only during daytime. The work was performed on the fishing vessel of the Sea Fisheries Institute - M/T "Wieczno" of length 61.0 m, 797 GRT, 1375 hp.

Methods of Measuring Mesh and Some Remarks on the Applied Measuring Gauges

Internal mesh size was measured wet after use, when the codend was hauled on board and fish emptied. Mesh measurements were performed with the standard ICES gauge, made by Dutch company "Observator". This gauge gives the dimensions of the mesh under a load of 4 kg.

The use of the ICES gauge seemed to be justified for the following reasons:

1) Though the Polish fishing fleet is operating in both the NEAFC and ICNAF areas, more vessels, however, are fishing in the NEAFC area where ICES gauge is in use;

2) ICES gauge is based on a single pressure value, not on the tolerance between 4.5 kg and 6.0 kg, which in turn affects the interpolation of the results obtained;

3) The training of controllers for both areas, with equal requirements for both of them, becomes a more practical and facilitated task.

Fish Measurements

The measurements of fish were performed with the accuracy of 1 cm. All fish which were retained in the codend,as well as those which escaped from it into the cover, were measured. The following species were included in the investigations: cod, haddock, redfish, American (Canadian) plaice, yellowtail. The selection properties of the codends were established by means of the codend covers, which captured fish on their escape from the primary netting of the codend. The weight of fish retained and escaped was determined in each haul.

Codends

The codends used in the investigations were identical with those used by Polish stern trawlers. The dimensions of the codend were as follows: length 20.0 m, width over upper and lower edge was 5.2 m in stretch. These dimensions were always the same for all codends irrespective of the mesh size used.

A sketch of the codend and its chafing gear is given in Fig. 2.

Chafing gear

The chafing gear, applied over the after part of the codend, covered its upper side, while on the lower side a common type of hide was rigged. The dimensions of the chafing gear were as follows: length 12.0 m, width 5.2 m. These dimensions were the same in all experiments. Chafing gear was attached along lateral edges to the joining of both sides of the codend. The upper edge of the chafing gear was fastened mesh-to-mesh to the primary netting of the codend. The lower edge of the chafing gear fastened to the second row of codend meshes right behind the meshes used for selvage. The meshes of the chafing gear were not joined to the meshes of the codend beyond the lacings, but the netting with large meshes was fastened in such a manner that the twine of large and small meshes stretched over each other.

Covers for selection experiments

Commonly used type of cover was applied in the investigations. Its mesh was 40 mm measured wet.

The bag of the cover was wider than the proper codend, commenced at the after part of the belly and was divided into two parts. Its foremost part stretched over the frontal part of the codend, unprotected here by chafing gear. The other part covered the codend with chafing gear.

The fish retained in either of the parts were separately counted and the data brought into the tables refer to this kind of bags.

Kinds of codends and chafing gear used in the experiments

Codends, used in the experiments, were marked with symbols and numbers:

BS 2: - Codend made of double Stylon (Polish polyamide fiber) of 3.5 mm diameter. The mesh size of the codend was 113.4 mm to 114.6 mm and it was used as a control codend to enable the comparison of the influence of chafing gear on decreasing the selective properties of the gear. No chafing gear was rigged on this codend.

BS 3: - Codend made of the same material as BS 2, i.e. of double Stylon twine of 3.5 mm diameter. Its mesh size was 108.9 mm to 114.4 mm and the chafing gear with grate-shaped mesh, made of single twine of 5.0 mm diameter, was rigged on it. The mesh size of this chafing gear was four times larger than the mesh of the codend (16 meshes of the codend against one mesh of the chafing gear).

BS 4: - Corresponding to the codends BS2 and BS 3, but of mesh size 117.6 mm. Chafing gear made of double Stylon twine of 3.5 mm diameter, having mesh size two times larger than the mesh of the codend itself (four meshes of the codend against one mesh of the chafing gear).

BS 5: - Codend made of single Stylon twine 5.0 mm in diameter and mesh size 123.0 mm - 128.5 mm. No chafing gear was used on this codend.

So for the experiments two codends without chafing gear were used, differing from each other by the material they were made of, and two codends with different kinds of chafing gear used on them. The mesh sizes of the codends were 108.9 mm to 128.5 mm.

Results

The results obtained are presented in Tables I to XV. From the tables codend BS2, the one without chafing gear, has the highest selection factor in comparison to other codends.

Selection factors of this codend for particular fish species were as follows: cod, 3.92; haddock, 3.78; redfish, 2.85; American plaice, 2.42 and yellowtail, 2.29. In one case only, namely for redfish, the selection factor of BS3 was higher, being 2.92, than the factor of BS2, but this might be attributed to a chance cause, since selection factors of the codend BS3 in relation to other species remained lower than those of the codend BS2.

On comparison of the results for BS2 and BS5, the codends without chafing gear, but made of twine of different thickness (BS2 made of double twine of 3.5 mm diameter and BS5 of single twine of 5.0 mm diameter), it appears that for BS2 the factor is higher than for BS5. This is true for all five species of fish investigated. Expressing these values in percent we can see that for BS5 the selection factor is lower in comparison to BS2 (assumed to be 100% for BS2) by 13.5% for cod, by 15.1% for haddock, 18.9% for redfish, 9.1% for American plaice and by 5.1% for yellowtail.

It seems that the use of twine of comparatively large diameter (5 mm) was responsible for lowering the selection properties of the BS5 codend. The mesh, made of this twine, was considerably stiffer than the mesh made of double twine. This relatively large diameter of the twine and hence its stiffness most probably influenced the value of the selection factor. Such an assumption is based on the investigations on the effect of the thickness of twine upon the selection, in which thicker twine reduced the value of selection factor. In these investigations carried out by Cieglewicz and Strzyzewski, the selection factor for the codend made of comparatively thin cotton twine, No. 40/24, was 3.7, whereas for the codend made of thick cotton twine, No. 20/54, only 3.1.

According to our recent observations it appears that, not only the thickness of the netting of which the codend is made influences the selection, but also the thickness of the twine of which the chafing gear was made. It has been found

that even large mesh of such chafing gear does not provide the highest value of selection factor when thick twine is used for its netting. Such a conclusion may be drawn from the comparison of selection factors for the codends BS3 and BS4. The codends in both cases were made in the same manner of double Stylon of 3.5 mm diameter. On the bag BS3 there was, however, rigged the chafing gear made of a single twine of 5 mm diameter with the mesh size four times larger than the mesh of the codend (one mesh of the cover against 16 meshes of the codend), whereas on the codend BS4 there was rigged chafing gear, which was made of double twine of 3.5 mm diameter with the mesh only two times larger than the mesh of the codend (4 meshes against one mesh of the chafing gear).

Initially it was assumed that the codend with chafing gear of larger mesh size would provide sharper selectivity, but this assumption proved wrong, since selection factor for BS3 (with larger mesh size in the chafing gear), calculated on the basis of our experiments, was 3.67, while for the codend BS4 (with smaller mesh size in the chafing gear) was 3.77.

From these data we have to conclude that the thickness of twine, both in the codend and in the chafing gear, exerts a great influence upon selective properties of the gear.

We have to add here that the selection factor for the control codend BS2 is lower in relation to the codend BS4 by 3.8% only, while for the codend BS3 it is lower by 6.4%.

The escapement of fish in the frontal part of the codend - as seen from the data given in the tables, relating to cod in the codends BS4 and to redfish in the codend BS3 - is insignificant in comparison to the escapement in the terminal part of the codend. Hence the conclusion that the terminal part of the codend decides the selection.

Mesh size of investigated codends and chafing gear in relation to manila 114 mm mesh

As already mentioned, in the ICNAF area the selectivity provided by the size of mesh in the codends should correspond to the selectivity of nets made of manila netting with 114 mm mesh. According to F. D. McCracken, this mesh size relates to cod length of 40 cm. Using the formula

$$\frac{L}{s} = m$$

where

L = fish length

s = selection factor

m = mesh size

and substituting L = 40 cm and for s the values obtained for selection factors for particular codends, we obtain respective mesh sizes which shall be equivalent to manila mesh 114 mm. Thus for the codends used in our experiments the mesh sizes providing equal selectivity shall be the following:

BS2 - 102 mm mesh in the codend (no chafing gear)
BS3 - 109 mm mesh in the codend, 436 mm mesh in the chafing gear
BS4 - 106 mm mesh in the codend, 212 mm mesh in the chafing gear
BS5 - 118 mm mesh in the codend (no chafing gear).

It should be noted that these figures refer to the twine measurements performed in wet state by means of ICES gauge.

Conclusions

The results of our investigations indicate that, in spite of the use of chafing gear different to that recommended by ICNAF, it is possible by proper selection of mesh size in the codend and in the chafing gear to maintain adequate selectivity, for cod and other fish species, equivalent to the selectivity of manila net with mesh size 114 mm.

Hence the conclusion that it is admissible to use other chafing gear than the ICNAF type, providing that the requirements of necessary selection for captured fish species be fulfilled.

These requirements are best met by the codends BS3 and BS4 with chafing gear, the selection properties of which for cod were in comparison to the codend without chafing gear (BS2) decreased, according to our investigations, only by 6.4% and 3.8% respectively.

If the mesh size, as pointed out above, is 109 mm in the codend BS3 and 436 mm in its chafing gear, 106 mm in the codend BS4 and subsequently 212 mm in the chafing gear - required selectivity shall be maintained and these types of codends should be approved for practical fishery.

Literature cited

Cieglewicz, W. and W. Strzyzewski "Investigations on the selection of the Baltic cod by codend as the basis for establishing the minimum mesh size" (in Polish). Reports of the Sea Fisheries Institute in Gdynia, No. 10/A, 1959.

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TABLE I

Summary of results of Selectivity experiments, Subareas 3 and 4, 1965

Species	Kind of codend	Hauls (No.)	Mesh size (mm)	Number of fish			Weight of fish					50% fish length (cm)	Range 25%-75% (cm)	Selection factors	Decrease of s.f. from BS2="0"
				escaped	retained	total	escaped		retained		total				
							(kg)	(%)	(kg)	(%)	(kg)				
Cod	BS 2	6	114,3	2459	1101	3560	658	25	1229	75	2587	44,9	38,3-48,4	3,92	0,0
	BS 3	9	114,4	5371	5693	11064	1731	16	9053	84	10784	40,9	37,7-46,8	3,67	-6,4
	BS 4	6	117,6	3475	3916	7391	1394	15	7633	85	9027	44,4	39,1-50,3	3,77	-3,8
	BS 5	9	124,4	2476	2470	4946	851	14	5358	86	6209	45,2	39,5-50,2	3,39	-13,5
Haddock	BS 2	5	113,4	2061	827	2888	574	37	997	63	1571	42,9	36,4-45,5	3,78	0,0
	BS 5	3	127,3	2000	1408	3408	841	42	1138	58	1979	40,9	33,6-44,8	3,21	-15,1
Redfish	BS 2	5	114,6	6845	2321	9166	1408	59	982	41	2390	32,7	28,9-35,7	2,85	0,0
	BS 3	3	109,3	5017	4019	036	869	25	2563	75	3432	32,0	29,9-34,9	2,92	+2,5
	BS 5	1	128,5	206	166	372	62	37	105	63	167	29,7	25,7-39,1	2,31	-18,9
American plaice	BS 2	3	113,6	301	610	911	30	12	220	88	250	27,5	24,5-29,2	2,42	0,0
	BS 3	3	108,9	371	670	1041	30	17	144	83	174	25,4	23,1-27,1	2,33	-3,7
	BS 5	2	123,0	735	1490	2225	76	15	437	85	513	27,1	24,4-29,6	2,20	-9,1
Yellow-tail	BS 2	1	114,2	149	760	909	21	9	242	91	263	26,6	24,6-27,7	2,29	0,0
	BS 5	1	127,0	232	1003	1235	35	8	425	92	460	26,6	21,2-28,9	2,15	-6,1

TABLE II Selectivity experiments for cod with codend BS 2

Length groups (cm)	Escaped (No.)	Retained (No.)	Total	Smoothed (%)
	2		2	0,0
	-		-	1,5
20	21	1	22	3,5
	61	4	65	5,2
	78	4	82	6,2
	143	12	155	7,8
	150	18	168	9,1
25	204	20	224	8,8
	126	9	135	8,9
	79	10	89	10,1
	56	8	64	11,6
	32	4	36	10,1
30	83	6	89	10,4
	97	15	112	13,0
	128	30	158	20,1
	101	39	140	21,4
	123	26	149	19,8
35	184	30	214	17,1
	161	40	201	18,8
	148	43	191	22,3
	96	31	127	24,6
	73	27	100	25,7
40	93	32	125	26,5
	73	27	100	28,1
	41	19	60	30,0
	35	16	51	37,7
	17	17	34	42,9
45	19	17	36	50,8
	13	16	29	53,2
	9	12	21	62,8
	6	19	25	70,6
	3	11	14	81,4
	2	17	19	87,8
	1	20	21	94,9
	-	25	25	98,4
	-	11	11	98,2
	1	18	19	98,2
		22	22	98,2
		14	14	100,0
		23	23	
		17	17	
		13	13	
		24	24	
61		334	334	
Total	2459	1,101	3,560	
Weight (kg)	658	1,929	2,587	
%	25	75		
Mesh size (mm)		114.3		
50% fish length (cm)		44.9		
Selection factor			3.92	
Range 25%-75% (cm)			10.1	
Number of hauls			6	

TABLE III Selectivity experiments for cod with codend BS 3

Length Groups	Escaped			Retained	Total	Smoothed %
	1st part	2nd part	total			
1.	2.	3.	4.	5.	6.	7.
		1	1		1	
		-	-		-	
	3	1	4		4	
	-	4	4		4	
20	3	5	8		8	0.0
	4	14	18		18	3.3
	12	34	46	5	51	4.6
	26	72	98	4	102	7.3
	19	93	112	10	122	7.5
25	24	165	189	22	211	9.1
	21	155	176	17	193	9.8
	32	245	277	32	309	10.9
	21	194	215	34	249	12.4
	22	187	209	32	241	14,7
30	16	294	310	65	375	16,7
	15	253	268	65	333	19,2
	20	351	371	97	468	19.5
	11	359	370	83	453	20.2
	9	360	369	102	471	22.4
35	5	349	354	132	486	26.3
	1	275	276	119	395	32.2
	5	266	271	172	443	36.2
	4	237	241	156	397	38.0
	4	197	201	111	312	40.7
40	1	198	199	178	377	44.6
	1	127	128	134	262	50.3
	1	147	148	164	312	53.4
	-	121	121	158	279	59.1
	-	73	73	155	228	64.5
45	-	87	87	192	279	68.6
	-	63	63	141	204	71.1
	1	56	57	175	232	76.0
		32	32	163	195	81.4
		20	20	114	134	75.7
50		21	21	161	182	87.4
		12	12	93	105	90.1
		10	10	138	148	92.5
		4	4	91	95	96.3
		-	-	92	92	98.0
55		2	2	105	107	98.6
		2	2	86	88	98.6
		-	-	81	81	98.2
		2	2	64	66	98.1
		2	2	73	75	98.1
60				108	108	99.1
61				1,769	1,769	
Total	281	5,090	5,371	5,693	11,064	
Weight (kg)	48	1,683	1,731	9,053	10,784	
%			16	84	100	
Mesh size (mm)			111.4			
50% fish length (cm)			40.9			
Selection factor				3.67		
Range 25%-75% (cm)				9.1		
Number of hauls				9		

TABLE IV Selectivity experiments for cod with codend BS 4

Length	Escaped			Retained	Total	Smoothed %
	1st part	2nd part	total			
1.	2.	3.	4.	5.	6.	7.
		1	1		1	4.8
	1	5	6	1	7	8.5
	1	15	16	2	18	11.5
	2	28	30	3	33	11.5
25	3	39	42	7	49	10.1
	4	47	51	4	55	12.4
	4	64	68	13	81	12.1
	4	73	77	12	89	13.9
	9	91	100	14	114	13.6
30	10	166	176	31	207	15.8
	12	172	184	46	230	17.4
	17	254	271	56	327	17.3
	11	272	283	49	332	16.0
	9	196	205	40	245	16.9
35	13	222	235	58	293	21.0
	3	189	192	71	263	22.2
	10	210	220	54	274	21.5
	8	184	192	42	234	21.5
	5	117	122	45	167	24.1
40	1	158	159	80	219	30.7
	4	113	117	71	188	34.0
	3	161	164	96	260	38.5
	-	101	101	70	171	42.5
	2	71	73	72	145	46.8
45	2	68	70	70	140	55.4
	-	57	57	113	170	56.6
	-	68	68	78	146	60.3
	1	50	51	80	131	61.4
	1	29	30	69	99	68.0
50	-	30	30	82	112	73.4
		21	21	71	92	78.7
		13	13	78	91	80.5
		17	17	63	80	83.3
		11	11	65	76	85.1
55		8	8	83	91	88.8
		8	8	69	77	91.6
		4	4	73	77	94.0
		2	2	78	80	97.4
				62	62	99.2
60				100	100	100.0
61				1,765	1,765	
Total	140	3,335	3,475	3,916	7,391	
Weight (kg)	42	1,352	1,394	7,633	9,027	
%			15	85	100	
Mesh size (mm)				117.6		
50% fish length (cm)				44.4		
Selection factor				3.77		
Range 25%-75% (cm)				11.2		
Number of hauls				6		

TABLE V Selectivity experiments for cod with codend BS 5

Length	Escaped	Retained	Total	Smoothed %
1.	2.	3.	4.	5.
15	1		1	
	3	1	4	
	1	-	1	
	2	1	3	
	4	-	4	
20	5	-	5	3.3
	18	2	20	5.6
	42	3	45	7.2
	39	2	41	7.3
	53	6	59	6.6
	123	6	129	7.2
	82	6	88	7.4
	66	8	74	8.6
	56	5	61	8.6
	41	3	44	7.0
30	78	5	83	8.1
	91	12	103	7.4
	145	7	152	8.6
	114	12	126	8.9
	133	19	152	13.0
35	197	40	237	15.3
	199	39	238	16.9
	147	31	178	17.9
	136	34	170	20.4
	118	37	155	23.4
40	157	56	213	26.4
	118	48	166	32.0
	80	55	135	37.7
	48	37	85	42.7
	32	25	57	43.7
45	36	28	64	48.6
	23	32	55	57.0
	13	29	42	61.7
	21	29	50	65.3
	9	20	29	68.1
50	7	24	31	73.8
	9	27	36	80.0
	6	43	49	85.2
	2	26	28	90.8
	3	34	37	88.4
55	9	37	46	88.0
	4	52	56	90.0
	2	58	60	95.4
	2	57	59	96.9
	1	40	41	98.0
60		86	86	99.2
61		1,348	1,348	99.2
Total	2,476	2,470	4,946	
Weight (kg)	851	5,358	6,209	
%	14	86	100	
Mesh size (mm)			124.4	
50% fish length (cm)			3.39	
Selection factor			45.2	
Range 25%-75% (cm)			10.7	
Number of hauls			9	

TABLE VI Selectivity experiments for haddock with codend BS 2

Length	Escaped	Retained	Total	Smoothed %
1.	2.	3.	4.	5.
	1		1	
	1		1	
15	9		9	
	6		6	
	11		11	
	15		15	
	14		14	
20	55		55	
	73		73	0.6
	113	2	115	0.6
	88	-	88	0.6
	109	-	109	1.1
25	145	5	150	1.6
	87	3	90	2.7
	140	2	142	2.7
	111	4	115	5.0
	78	7	85	4.7
30	156	4	160	5.2
	100	5	105	4.8
	103	8	111	7.8
	54	7	61	9.7
	85	10	95	11.8
35	104	10	120	17.1
	79	30	109	21.8
	64	21	85	29.4
	57	32	89	33.2
	33	21	54	39.3
40	41	31	72	39.3
	25	14	39	37.7
	27	14	41	42.4
	15	20	35	50.9
	17	27	44	64.2
45	14	40	54	71.3
	12	44	56	79.0
	7	38	45	83.9
	6	47	53	88.6
	3	39	42	93.2
50	1	52	53	97.0
	-	35	35	99.4
	-	35	35	100.0
	-	25	25	
	1	30	31	
55	1	20	21	
		21	21	
		20	20	
		18	18	
		10	10	
60		23	23	
61		47	47	
Total	2,061	827	2,888	
Weight (kg)	574	997	1,571	
%	37	63	100	
Mesh size (mm)			113.4	
50% fish length (cm)			42.9	
Selection factor			3.78	
Range 25%-75% (cm)			9.1	
Number of hauls			5	

TABLE VII Selectivity experiments for haddock with codend BS 5

Length	Escaped	Retained	Total	Smoothed %
1.	2.	3.	4.	5.
	3		3	
15	15		15	
	27		27	
	44		44	
	42		42	
	39		39	
20	23		23	
	13		13	
	5		5	
	4		4	
	2	1	3	
25	12	-	12	
	11	-	11	
	7	-	7	
	9	-	9	0.0
30	29	2	31	6.4
	8	-	8	2.1
	55	8	63	9.2
	106	14	120	16.6
	107	42	149	19.9
	171	50	221	28.2
35	210	106	316	30.6
	231	128	359	40.9
	217	135	252	42.6
	199	125	324	47.1
	130	125	255	46.2
40	108	113	221	46.6
	77	51	128	50.4
	33	50	83	57.0
	16	39	55	68.2
	17	47	64	71.8
45	11	27	38	75.5
	9	41	50	79.6
	5	30	35	87.8
	2	45	47	90.2
	3	25	28	95.0
50		24	24	96.4
		10	10	100.0
		20	20	
		15	15	
		22	22	
55		18	18	
		16	16	
		7	7	
		12	12	
		8	8	
60		10	10	
		42	42	
Total	2,000	1,408	3,408	
Weight (kg)	841	1,138	1,979	
%	42	58	100	
Mesh size (mm)			127.3	
50% fish length (cm)			40.9	
Selection factor			3.21	
Range 25%-75% (cm)			11.2	
Number of hauls			3	

TABLE VIII Selectivity experiments for redfish with codend BS 2

Length	Escaped	Retained	Total	Smoothed %
1.	2.	3.	4.	5.
	2		2	
	4		4	2.8
	11	1	12	12.1
	18	7	25	17.7
15	59	12	71	19.3
	153	23	176	17.4
	91	26	117	15.9
	319	45	364	16.9
	334	64	398	12.5
20	736	74	810	11.1
	659	59	718	9.7
	513	69	582	12.0
	354	67	421	14.3
	281	50	331	14.1
25	435	56	491	12.9
	409	57	466	12.7
	398	67	465	16.0
	494	135	629	21.2
	286	109	395	25.2
30	361	131	492	29.2
	320	160	480	33.6
	266	185	451	43.8
	142	190	332	52.7
	94	141	235	63.2
35	54	141	195	72.7
	23	139	162	83.3
	12	137	149	89.6
	10	103	113	91.2
	5	48	53	92.1
40	1	21	22	95.3
	-	1	1	90.1
	1	3	4	91.7
Total	6,845	2,321	9,166	
Weight (kg)	1,408	982	2,390	
%	59	41	100	
Mesh size (mm)			114.6	
50% fish length (cm)			32.7	
Selection factor			2.85	
Range 25%-75% (cm)			6.8	
Number of hauls			5	

TABLE IX Selectivity experiments for redfish with codend BS 3

Length	Escaped			Retained	Total	Smoothed %
	1st part	2nd part	total			
10						0.0
		3	3		3	4.2
	3	4	7	1	8	10.8
	9	7	16	4	20	14.7
	9	59	68	9	77	14.0
15	29	164	193	22	215	9.9
	32	225	257	22	279	9.4
	35	232	267	30	297	9.1
	34	417	451	46	497	9.3
	36	498	534	50	584	9.3
20	31	679	710	79	789	9.4
	11	384	395	42	437	10.3
	8	270	278	35	313	10.5
	7	176	183	22	205	10.8
	1	120	121	14	135	11.1
25	2	121	123	17	140	10.9
	1	129	130	15	145	11.8
	-	120	120	18	138	11.8
	-	131	131	18	149	13.1
	1	114	115	19	134	17.8
30		167	167	62	229	25.8
		127	127	72	199	37.0
		175	175	159	334	49.1
		174	174	304	478	62.4
		114	114	359	473	76.2
35		75	75	614	689	86.1
		42	42	579	621	92.4
		30	30	557	587	95.2
		9	9	350	359	97.5
		-	-	231	231	98.8
40		2	2	181	183	99.6
				65	65	99.6
				18	18	100.0
				4	4	
				1	1	
Total	249	4,768	5,017	4,019	9,036	
Weight (kg)	15	854	869	2,563	3,432	
%			25	75	100	
Mesh size (mm)				103.9		
50% fish length (cm)				32.0		
Selection factor				2.92		
Range 25%-75% (cm)				5.0		
Number of hauls				3		

TABLE X Selectivity experiments for redfish with codend BS 5

Length	Escaped	Retained	Total	Smoothed %
1.	2.	3.	4.	5.
	1		1	
15	3		3	
	-		-	
	9	1	10	
	8	-	8	
	11	-	11	
20	7	-	7	
	3	-	3	
	1	-	1	
	3	-	3	0.0
	4	-	4	10.0
25	7	3	10	17.7
	10	3	13	29.2
	17	9	26	34.5
	19	16	35	42.6
	30	27	57	47.3
30	24	23	47	51.3
	14	19	33	57.7
	7	14	21	60.0
	7	9	16	64.0
	4	9	13	54.6
35	8	5	13	64.1
	2	11	13	67.7
	2	8	10	71.5
	4	4	8	65.6
	1	2	3	72.7
40		2	2	88.9
		1	1	100.0
Total	206	166	372	
Weight (kg)	62	105	167	
%	37	63	100	
Mess size (mm)			128.5	
50% fish length (cm)			29.7	
Selection factor			2.31	
Range 25%-75% (cm)			13.4	
Number of hauls			1	

TABLE XI Selectivity experiments for American plaice with codend BS 2

Length	Escaped	Retained	Total	Smoothed %
1.	2.	3.	4.	5.
	1		1	
	1		1	
	3		3	11.1
15	2	1	3	15.5
	13	2	15	15.5
	7	-	7	4.4
	9	-	9	0.0
	1	-	1	2.1
20	15	1	16	4.1
	31	2	33	7.2
	49	5	54	7.8
	34	3	37	13.6
	13	4	17	18.9
25	27	9	36	31.1
	16	13	29	34.6
	29	15	44	46.0
	18	26	44	54.8
	11	27	38	73.0
30	7	55	62	83.6
	5	50	55	90.2
	6	61	67	91.9
	2	30	32	94.9
	-	38	38	97.1
35	1	39	40	99.2
		44	44	99.2
		31	31	100.0
		19	19	
		16	16	
40		14	14	
		12	12	
		8	8	
		8	8	
		12	12	
45		6	6	
		9	9	
		8	8	
		2	2	
		6	6	
50		4	4	
		3	3	
		5	5	
		-	-	
		3	3	
55		2	2	
		-	-	
		3	3	
		3	3	
		1	1	
60		10	10	
Total	301	610	911	
Weight (kg)	30	220	250	
%	12	88	100	
Mesh size (mm)			113.6	
50% fish length (cm)			27.5	
Selection factor			2.42	
Range 25%-75% (cm)			4.7	
Number of hauls			3	

TABLE XII Selectivity experiments for American plaice with codend BS 3

Length	Escaped	Retained	Total	Smoothed %
1.	2.	3.	4.	5.
				0.0
		1	1	11.1
	2	1	3	15.9
	6	1	7	21.4
	5	1	6	10.3
15	5	-	5	8.6
	10	1	11	10.0
	15	4	19	16.4
	21	5	26	15.2
	35	2	37	14.9
20	36	9	45	13.4
	40	7	47	18.1
	33	8	41	19.6
	28	9	37	24.0
	28	11	39	31.8
25	40	30	70	43.2
	34	48	82	58.4
	18	51	69	73.6
	9	69	78	85.3
	4	57	61	93.5
30	1	76	77	96.9
	1	65	66	99.1
		58	58	99.5
		36	36	100.0
		21	21	
35		37	37	
		10	10	
		10	10	
		7	7	
		9	9	
40.		6	6	
		3	3	
		2	2	
		2	2	
		2	2	
45		1	1	
		2	2	
		-	-	
		3	3	
		1	1	
50		4	4	
Total:	371	670	1,041	
Weight (kg)	30	144	174	
%	17	83	100	
Mesh size (mm)			108.9	
50% fish length (cm)			25.4	
Selection factor			2.33	
Range 25%-75% (cm)			4.0	
Number of hauls			3	

TABLE XIII Selectivity experiments for American plaice with codend BS 5

Length	Escaped	Retained	Total	Smoothed %
1.	2.	3.	4.	5.
10		1	1	
	5	-	5	
	2	-	2	0.0
	3	-	3	2.6
	12	1	13	8.3
15	29	6	35	12.0
	32	4	36	10.8
	23	1	24	10.9
	19	4	23	11.4
	14	2	16	16.1
20	44	10	54	18.9
	46	16	62	23.0
	46	15	61	24.2
	28	8	36	22.2
	57	14	71	22.7
25	96	34	130	27.8
	96	58	154	39.0
	60	68	128	49.8
	46	65	111	59.4
	25	50	75	69.4
30	21	103	124	79.0
	15	102	117	87.3
	11	119	130	92.0
	3	109	112	96.3
	-	98	98	98.8
35	1	128	129	99.4
	1	101	102	99.4
		67	67	99.7
		62	62	100.0
		32	32	
40		55	55	
		40	40	
		21	21	
		26	26	
		13	13	
45		14	14	
		12	12	
		10	10	
		8	8	
		4	4	
50		2	2	
		1	1	
		2	2	
		-	-	
		-	-	
55		1	1	
		-	-	
		-	-	
		-	-	
		2	2	
60		1	1	
Total:	735	1,490	2,225	
Weight (kg)	76	437	513	
%	15	85	100	
Mesh size (mm)			123.0	
Selection factor			2.20	
Range 25%-75% (cm)			5.2	
Number of hauls			2	

TABLE XIV Selectivity experiments for yellowtail with codend BS 2

Length	Escaped	Retained	Total	Smoothed %
1.	2.	3.	4.	5.
20	1		1	7.4
	7	2	9	7.4
	17	-	17	10.4
	10	1	11	8.6
	10	2	12	16.7
25	31	10	41	32.0
	27	33	60	45.7
	25	34	59	65.2
	15	73	88	78.5
	5	93	98	92.3
30	1	100	101	98.0
		103	103	99.7
		76	76	100.0
		52	52	
		27	27	
35		29	29	
		28	28	
		10	10	
		26	26	
		12	12	
40		15	15	
		12	12	
		9	9	
		5	5	
		4	4	
45		3	3	
		1	1	
Total:	149	760	909	
Weight (kg)	21	242	263	
%	9	91	100	
Mesh size (mm)			114.2	
50% fish length (cm)			26.6	
Selection factor			2.29	
Range 25%-75% (cm)			3.1	
Number of hauls			1	

TABLE XV Selectivity experiments for yellowtail with codend BS 5

Length	Escaped	Retained	Total	Smoothed %
1.	2.	3.	4.	5.
	1		1	
15	1		1	
	-		-	0.0
	4		4	11.1
	2	1	3	22.0
	2	1	3	28.9
20	4	1	5	29.5
	11	6	17	23.6
	27	5	32	32.0
	11	9	20	33.2
	14	9	23	39.6
25	34	18	52	39.7
	29	24	53	44.1
	31	34	65	55.2
	23	49	72	66.1
	18	64	82	76.7
30	14	74	88	85.6
	5	87	92	92.9
	-	72	72	97.5
	1	50	51	99.3
		34	34	99.3
35		54	54	100.0
		57	57	100.0
		54	54	
		62	62	
		44	44	
40		55	55	
		36	36	
		25	25	
		27	27	
		12	12	
45		12	12	
		11	11	
		8	8	
		2	2	
		5	5	
50		-	-	
		1	1	
Total:	232	1,003	1,235	
Weight (kg)	35	425	460	
%	8	92	100	
Mesh size (mm)			127.0	
50% fish length (cm)			26.6	
Selection factor			2.15	
Range 25%-75% (cm)			7.7	
Number of hauls			1	

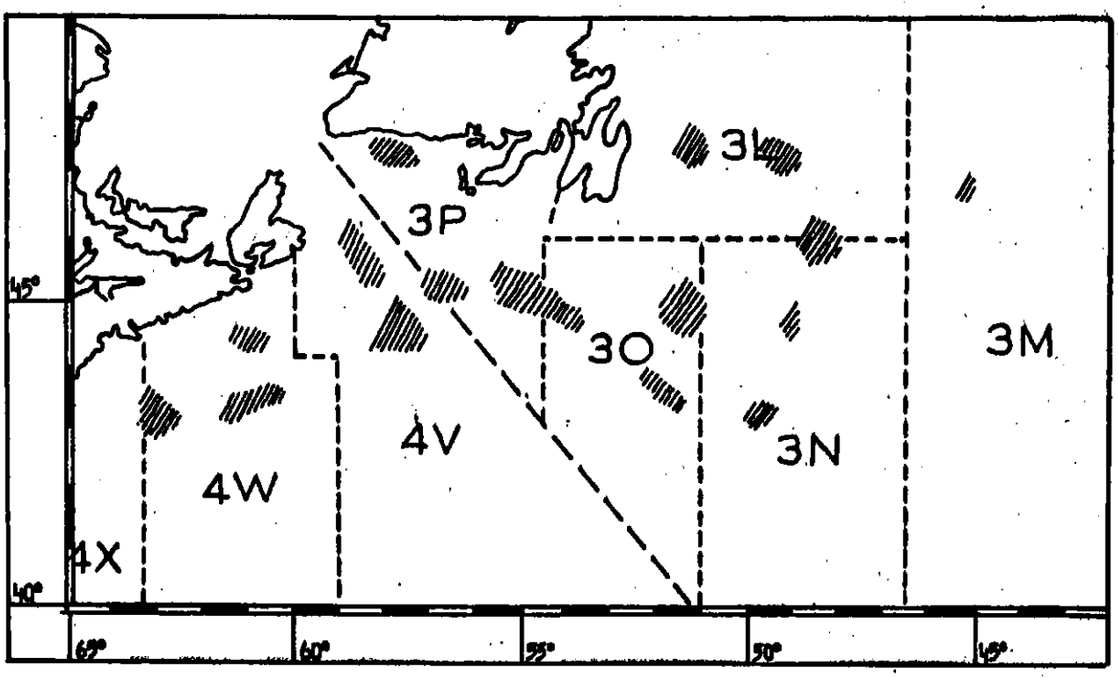

Fig. 1. Region of Investigations. Fishing places are shaded.

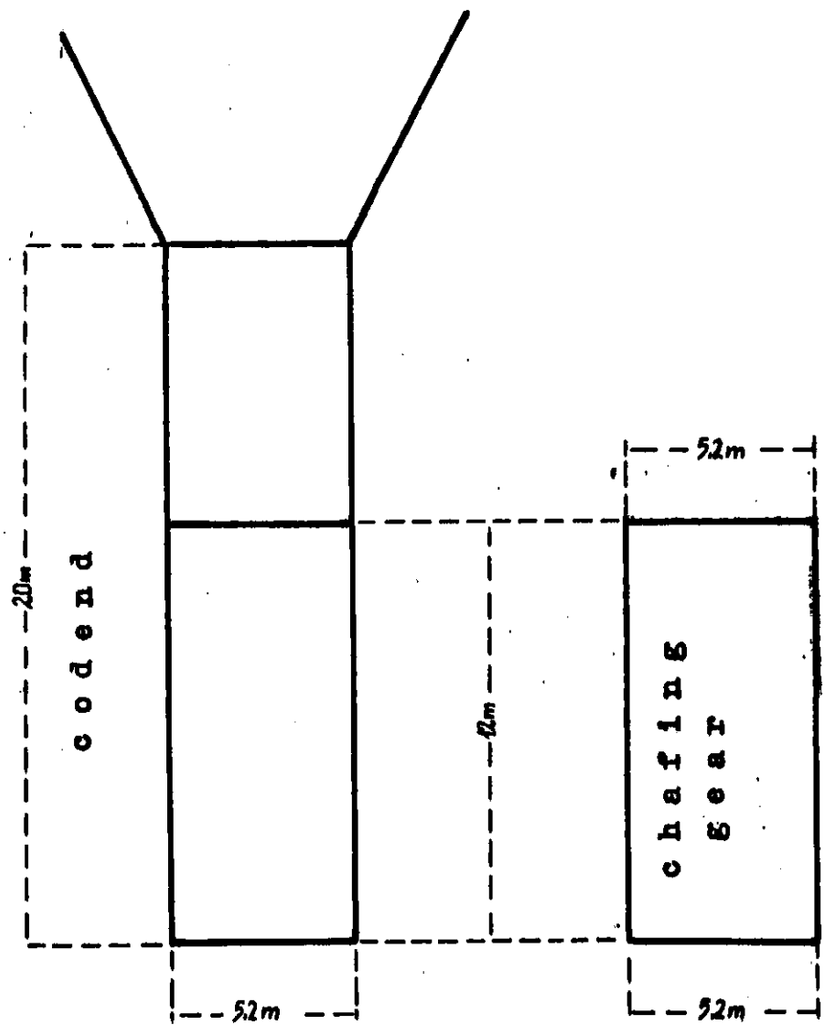

Fig. 2. Codend Measurements