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Selectivity of Bottom and Midwater Trawl Codends When Fishing for Deepwater Redfish in the Northwest Atlantic

by

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Abstract

Results of determination of selectivity of bottom and mid-water trawls codends when fishing deepwater redfish (Sebastes marinus) are given. Influence of a cover codend on the escapement of fish from the bottom trawl codend is estimated. Selectivity properties of the bottom trawl codend and those of the mid-water trawl codend are compared. Preconditions of exploitation of deep-water redfish stocks with a lowest damage possible are considered.

Introduction

A selective fishery based on the limitation of a minimum mesh size in fishing gears is considered to be an indispensable condition to exploit commercial stocks rationally.

In the trawl fishery fish escapement from the codend depends essentially on the mesh size in the codend. By means of mesh variation a length range of fish escaped from the codend, size of escapement of fish of different length and total fish escapement may be regulated. The escapement may also be dependent on the kind of trawl fishery and fishing conditions, i.e. whether bottom or mid-water trawl is used, duration of trawling and catch per trawling, what proves investigations to determine the selectivity of trawl codends in conditions close to those during fishing to be important.

When estimating the efficiency of fishing with codends with different mesh size, the number and length composition of fish

escaped, their state and viability should be taken into account. Evidently, a best mesh size in the codend is to ensure a maximum escapement of small-sized fish and a minimum one of fish of commercial size. It is practically impossible to satisfy simultaneously both requirements mentioned , as a higher escapement of small-sized fish may be achieved by means of a larger mesh size, what is followed by a higher escapement of fish of commercial size. The problem of "optimum" mesh size is difficult to decide also because a minimum commercial length of some fish species is not scientifically substatiated yet. With the introduction of quotas for some fish species optimization of fisheries,when taking the quotas, should be carried out in such a way as to minimize a damage to commercial stocks.

Deepwater redfish is one of the main objects of fisheries in the North West Atlantic, therefore, a rational fishery of the species is an important problem. Based on investigations of the codend selectivity, conditions of such a fishery are substantiated.

Methods

Investigation were conducted by the FRV "Suloy" in Div. 2H in October 1979 and by the FRV "Menzelinsk" in Divs. 3M and 3N (NAFO) in February and March 1981. Several set of trawlings with a bottom trawl and a set of trawlings with a mid-water trawl were performed.

When fishing with the bottom trawl there were determined:
- selectivity of trawl codends with an actual inside mesh size of 98, 127 and 134 mm;
- effect of cover codend on the escapement of fish from the codend;
- instantaneous losses of catch after changing the mesh size in trawl codends.

When fishing with the mid-water trawl selectivity of a 124 mm mesh codend was estimated. At the same time a set of trawlings by the bottom trawl with a 134 mm mesh codend was conducted to compare the selectivity of mid-water trawl codend with that of the bottom trawl codend.

The effect of the cover codend on fish escapement during trawlings with a 127 mm and 134 mm mesh codend of the bottom trawl was determined, trawlings with the cover and without it alternated, the mesh size in the codend being the same.

Instantaneous losses after changing the mesh size in trawl codends were estimated based on the results of experiments with a 127 and 134 mm mesh codends with and without the cover.

Double polyamide netting with a 3.1 mm diameter yarn was used for codends of bottom and mid-water trawls R 5700 tex. The inside mesh size was measured with a 2 mm wedged-shaped plate (the ICNAF type) at a pressure of 5 kg. The mesh size was measured right off a catch was emptied out of the codend. The inside mesh size was determined as a mean of mesh measurements at 3 positions along the codend (25 meshes at each position). Mesh in the mid-water trawl codend was measured at the top and bottom side of it.

To retain fish which escape through the top side nettings of the bottom trawl codend the ICES type cover codend was used. The cover was made of kapron netting with a 40 mm mesh size R 2700 tex. A front edge of the cover was fastened at the joint of conical and cylindrical parts of the codend. Side edges of the cover were connected to pennants.

The width of the cover codend netting in plait was 1.4 times as large as that of the top side of the codend. To avoid the escapement of fish trough the bottom side, it was covered inside the codend with a netting with the mesh size the same as that in the cover codend .

During experiments with the mid-water trawl to retain fish escaped through the codend, a bag-shaped cover made of the same netting as the bottom trawl cover codend was used. A parameter of the cross-section of the cover in plait in the cylindrical part of the codend was 26.1 m and that of codend nettings - 15.4 m. To reduce the effect of the cover on the escapement of fish from the codend, it was fixed on the conical part of the codend 8 m off the beginning of the cylindrical part.

In experiments with the bottom trawl trawlings dured 1-2 hours with the speed of about 4 knots and catches from 0.7 to

4.5 t. During investigations with the mid-water trawl the duration of trawling varied from 1 to 4 hours with the speed of 4-4.5 knots and catches from 0.7 to 8 t.

A maximum fish girth as well as their length and weight were measured during the experiments.

Discussion

Tables 1-7 and Figs 1-10 show the data obtained during experimental trawlings.

Fig. 1 indicates the relationship between length and maximum girth of deepwater redfish. The data obtained show that fish of the same length may differ in girth. With the growth of length a dispersion of girth values increases.

Tables 1-6 show the size distribution of fish retained and escaped from codends with different mesh during fishing with bottom and mid-water trawls. Figs. 2, 4, 6, 8, 10 indicate a percentage of fish of different size among those retained and escaped from codends. Selectivity curves are given in Figs. 3, 5, 7, 9. Table 7 shows the results of determination of trawl codends selectivity. According to the given data deepwater redfish escape actively from codends during fishing both with bottom and mid-water trawl. Fish practically within the whole length range fished with trawls can escape from codends with a 98 to 137 mm inside mesh size. Only a small group of fish 41 to 47 cm in length, the total number of which during fishing with all kinds of codends was about 2-3%, do not escape.

A greater part of fish escaped from codends are over 27-28 cm in length, i.e. belong to specimens of medium and large size. They constituted from 70% to 81% of fish escaped.

An increase of the inside mesh size in bottom trawls codends from 127 to 134 mm practically does not affect the retention of fish up to 32 cm in length, but results in a considerable reduction of retention of fish 33-39 cm long (Fig.6), the escapement of larger fish only grows.

A use of standard covers to determine the selectivity of of bottom trawls codends results in a lower escapement of fish

from codends. The escapement of deepwater redfish (in number of specimens) was found to increase by 13% for codends with a 127 mm mesh without cover and by 29% for codends with a 134 mm mesh.

Instantaneous losses of catch during bottom trawlings with a change of codend with a 127 mm mesh for that with a 134 mm mesh made up 21% When fishing deepwater redfish with the mid-water trawl fish escapement from codends is considerable. Thus, when fishing with codend with a 124 mm inside mesh size the escapement of deepwater redfish made up 58.3% by weight and 70% by number. Selective properties of trawl codends during mid-water trawl fishing are much higher than during fishing with the bottom trawl.

When estimating the selectivity of bottom trawl codend with a 134 mm mesh during fishing of deepwater redfish, which length frequency distribution is close to that of fish caught by mid-water trawl with a 124 mm mesh in the codend, it was found that notwithstanding a smaller mesh in the mid-water trawl codend in comparison with the bottom trawl codend, the retention decreased by 24% by weight and 40% by number.

Observations showed that in the deepwater redfish fishery both with bottom and midwater trawls fish escaped from codends were poorly viable as they hurt each other in the codend, became injured when leaving through the mesh and due to a sharp change in hydrostatic pressure during winching of a trawl.

The above said implies that chiefly fish of commercial size,which are valuable as food, escape from codends with a 98 to 134 mm mesh. The escapement of such fish from bottom trawls with a 127-134 mm mesh in the codends makes up 26-40% and from mid-water trawls with a 124 mm mesh codends - 71% by number of specimens.

Taking into account a great probability of death of fish escaped from codends the escapement of deepwater redfish may be considered to result in unjustufied losses of catch and a lower fishery efficiency. When fishing to take a quota, the escapement of deepwater redfish necessitates a higher fishing effort which results in a higher fishing mortality due to death of those

fish which have escaped from the codend.

Based on the above said, a 95-100 mm minimum alowable inside mesh size in codends of bottom and mid-water trawls may be recommended for the deepwater redfish fishery in order to minimize the damage to the stocks when fishing quotas. In this case escaped deepwater redfish will make up 10% by number of specimens, thus, practically all fish trawled will constitute a quota catch.

Table 1. Total catch of deepwater redfish from successful trawlings with a 127 mm mesh codend (Div. 3M).

Fish length, cm	Retained			Escaped			Caught		
	♂	♀	Σ	♂	♀	Σ	♂	♀	Σ
21				2		2	2		2
22	37	8	45	4	21	25	41	29	70
23	34	85	119	30	36	66	64	121	185
24	16	57	73	68	49	117	84	106	190
25	221	284	505	172	129	301	393	413	806
26	539	577	1116	475	395	870	1014	972	1986
27	1091	1117	2208	685	732	1417	1776	1849	3625
28	1151	1309	2466	659	719	1378	1876	2028	3844
29	1644	991	2635	592	411	1003	2236	1402	3638
30	3449	869	4318	1164	317	1481	4613	1186	5799
31	8166	1205	9371	1824	288	2112	9990	1493	11483
32	5839	1440	7279	1361	301	1662	7200	1741	8941
33	5570	1845	7415	972	321	1293	6542	2166	8708
34	4988	2151	7139	690	334	1024	5678	2485	8163
35	7673	4665	12338	603	499	1102	8276	5164	13440
36	4934	5584	10518	365	353	718	5299	5937	11236
37	2695	5460	8155	182	288	470	2877	5748	8625
38	938	4430	5368	69	209	278	1007	4639	5646
39	453	3158	3611	29	85	114	482	3243	3725
40	165	2017	2182	4	35	39	169	2052	2221
41	60	544	604	3	10	13	63	554	617
42	32	265	297				32	265	297
43	5	106	111				5	106	111
44		90	90					90	90
45		59	59					59	59
46		10	10					10	10
47		23	23					23	23
Σ	49706	38343	88049	9963	5538	15501	59669	43881	103550

Table 2. Total catch of deepwater redfish from successful trawlings with a 133 mm mesh codend (Div. 3M).

Fish length, cm	Retained			Escaped			Caught		
	♂	♀	Σ	♂	♀	Σ	♂	♀	Σ
21									
22	4		4	4		4	8		8
23	53		53	17	9	26	70	9	79
24	46		46	14	11	25	60	11	71
25	142	148	290	138	229	367	280	377	657
26	482	409	891	326	215	541	808	624	1432
27	821	587	1408	381	327	708	1202	914	2116
28	721	527	1248	364	311	675	1085	838	1923
29	746	400	1146	366	185	551	1112	585	1697
30	2400	510	2910	162	169	331	2562	679	3241
31	4041	527	4568	927	134	1061	4968	661	5629
32	3253	647	3900	691	125	816	3944	772	4716
33	3066	909	3975	575	171	746	3641	1071	4712
34	2768	1221	3989	363	160	523	3131	1381	4512
35	3996	2197	6193	393	285	678	4389	2482	6871
36	2068	2397	4465	246	175	421	2314	2572	4886
37	1196	2208	3404	90	160	250	1286	2368	3654
38	546	2037	2583	27	88	115	573	2125	2698
39	170	1546	1716	28	46	74	198	1592	1790
40	154	850	1004	6	18	24	160	868	1028
41	19	227	246	2	1	3	21	228	249
42		120	120		3	3		123	123
43		81	81		2	2		83	83
44		40	40					40	40
45		17	17					17	17
46		13	13					13	13
47									
Σ	26692	17618	44310	5120	2824	7944	31812	20433	52245

Table 3. Average catch per hour trawling with codends with and without cover (experiments were done to determine the influence of the cover on fish escapement from the codend). Divs. 3M and 3N.

Fish length, cm	number of specimens caught by codends with cover	Number of specimens caught by codends without cover	
		127 mm mesh	133 mm mesh
2I	0,08		
22	I,7		0,85
23	6,6	0,22	I,57
24	6,4	3,4	I,I4
25	40,6	5,6	8,7
26	93	2I,7	36,I
27	I5I	50	44
28	I48	57	49
29	I35	83	75
30	236	I4I	I35
3I	438	27I	228
32	354	2I6	25I
33	348	280	I90
34	330	273	2I5
35	524	4I8	354
36	406	335	277
37	308	284	I83
38	2I3	273	I32
39	I4I	I22	II9
40	82	86	60
4I	22	22	2I,4
42	I0,5	I0	9
43	5,3	8,8	5,6
44	3,3	4,6	3,3
45	I,8	0,7	0,7
46	0,7	0,7	0,8
47	0,9		
Total	4007	2968	2399

Table 4. Total catch of deepwater redfish from successful trawlings with a 124 mm mesh codend (mid-water trawl). Divs. 3M and 3N.

Fish length, cm	Retained, specimens			Escaped, specim.			Caught, specim.		
	♂	♀	Σ	♂	♀	Σ	♂	♀	Σ
21									
22	19	19	38	35	53	88	54	72	126
23	48	15	63	325	459	784	373	474	847
24	144	108	252	1072	1209	2281	1216	1317	2533
25	664	884	1548	4950	5363	10313	5614	6247	11861
26	1920	2499	4419	10970	10903	21873	12890	13402	26292
27	3698	3525	7223	15659	14889	30548	19357	18414	37771
28	2805	3127	5932	13224	14580	27804	16029	17707	33736
29	1266	1492	2758	4554	5964	10518	5820	7456	13276
30	637	647	1284	1929	1612	3541	2566	2259	4825
31	651	414	1065	1176	459	1635	1827	873	2700
32	733	991	1724	1033	818	1851	1766	1809	3575
33	599	1315	1914	685	1334	2019	1284	2649	3933
34	444	1652	2096	406	1152	1558	850	2804	3654
35	776	2233	3009	320	1265	1585	1096	3498	4594
36	444	1682	2126	211	432	643	655	2114	2769
37	488	2074	2562	105	532	637	593	2606	3199
38	322	2232	2554	23	185	208	345	2417	2762
39	85	1420	1505		37	37	85	1457	1542
40	105	2062	2167		14	14	105	2076	2181
41	19	1216	1235				19	1216	1235
42	8	673	681				8	673	681
43		360	361					360	360
44		182	182					182	182
45		188	188					188	188
46		77	77					77	77
47		12	12					12	12
Σ	15875	31099	46974	56677	61260	117937	72552	92359	164911

Table 5. Total catch of deepwater redfish from successful trawlings with bottom trawl with a 134 mm mesh codend. Divs. 3M and 3N.

Fish length, cm	Retained (specimens)			Escaped (specimens)			Caught (specimens)		
	♂	♀	Σ	♂	♀	Σ	♂	♀	Σ
21				7	10	17	7	10	17
22		17	17	25	15	40	25	32	57
23	52	30	82	123	149	272	175	179	354
24	102	86	188	206	230	436	308	316	624
25	716	586	1302	1427	1355	2782	2143	1941	4084
26	2022	1385	3407	2753	2690	5443	4775	4075	8850
27	3942	3246	7188	4971	4653	9624	8913	7899	16812
28	3596	3783	7379	4133	4092	8225	7729	7875	15604
29	1234	1152	2386	1136	1305	2441	2370	2457	4827
30	502	403	905	255	410	665	757	813	1570
31	153	150	303	101	135	236	254	285	539
32	159	141	300	31	102	133	190	243	433
33	202	219	421	27	90	117	229	309	538
34	105	242	347	-	54	54	105	296	401
35	112	518	630	12	109	121	124	627	751
36	173	498	671	23	74	97	196	572	768
37	107	491	598	-	36	36	107	527	634
38	110	487	597	-	38	38	110	525	635
39	57	399	456	5	-	5	62	399	461
40	38	498	536	-	25	25	38	523	561
41	8	292	300	-	-	-	8	292	300
42	-	150	150	-	-	-	-	150	150
43	5	21	26	-	-	-	5	21	26
44	-	38	38	-	-	-	-	38	38
45	-	16	16	-	-	-	-	16	16
46	-	12	12	-	-	-	-	12	12
47	-	16	16	-	-	-	-	16	16
Σ	13395	14846	28271	15235	15572	30807	28630	30448	59078

Table 6. Results of trials of selectivity of a 98 mm inside mesh size codend of bottom trawl when fishing deepwater redfish in the Central Labrador area

Fish length, cm	Retained			Escaped			Caught		
	♂	♀	Σ	♂	♀	Σ	♂	♀	Σ
I4	-	-	-	-	I	I	-	I	I
I5	-	-	-	-	-	-	-	-	-
I6	-	-	-	-	I	I	-	I	I
I7	-	-	-	-	-	-	-	-	-
I8	-	I5	I5	I	I	2	I	I6	I7
I9	-	6	6	-	2	2	-	8	8
20	27	I5	42	8	2	I0	35	I7	52
2I	29	32	6I	I6	23	39	45	55	I00
22	I4I	II9	260	48	66	II4	I89	I85	374
23	268	305	573	64	90	I54	332	395	727
24	I95	3I6	5II	75	I06	I8I	270	422	692
25	433	599	I032	I37	I82	3I9	570	78I	I35I
26	409	632	I04I	II8	I5I	269	527	783	I3I0
27	4I7	6II	I028	I08	I2I	229	525	732	I257
28	648	829	I477	II8	I36	254	766	965	I73I
29	722	639	I36I	87	80	I67	809	7I9	I528
30	II07	86I	I968	I29	80	209	I236	94I	2I77
3I	I265	799	2064	80	36	II6	I345	835	2I80
32	I50I	I002	2503	69	5I	I20	I570	I053	2623
33	II53	598	I75I	35	I9	54	II88	6I7	I805
34	600	590	II90	I8	I4	32	6I8	604	I222
35	498	648	II46	5	I3	I8	503	66I	II64
36	36I	75I	III2	3	I3	I6	364	764	II28
37	I28	395	523	2	5	7	I30	400	530
38	300	394	694	I	I	2	30I	395	696
39	I32	20I	333	-	2	2	I32	203	335
40	26	306	332	-	4	4	26	3I0	336
4I	3	II8	I2I	-	-	-	3	II8	I2I
42	3	I09	II2	-	-	-	3	I09	II2
43	-	22	22	-	-	-	-	22	22
44	-	I4	I4	-	-	-	-	I4	I4
45	-	I4	I4	-	-	-	-	I4	I4
Σ	I0366	I0940	2I306	II22	I200	2322	II488	I2I40	23628

Table 7. Main results of determination of selectivity of trawl codends when fishing deepwater redfish in Divs. 3M and 3N

Main characteristics			Fishing by trawl codend with cover		Fishing by trawl codend without cover		124 mm mesh codend of mid-water trawl	134 mm mesh codend of bottom trawl	98 mm mesh codend of bottom trawl
			127 mm mesh	134 mm mesh	127 mm mesh	134 mm mesh			
Minimum length of fish caught (cm)			2I	22	23	22	22	2I	I4
Maximum length of fish caught (cm)			47	47	46	47	47	47	45
Mode of length frequency distr.(cm)			3I и 35	3I и 35	3I и 35	3I и 35	27 и 28	27 и 28	32
Mean parameters of one fish	Caught	Length cm	33,5	33,2	33,4	33,4	28,8	28,I	-
		Weight kg	0,47	0,45	0,48	0,48	0,23	0,26	-
	Retained	Length cm	34	33,6	34,4	34	3I,8	29,I	-
		Weight kg	0,48	0,46	0,53	0,5I	0,35	0,30	-
	Escaped	Length cm	3I	3I	-	-	27,6	27,2	-
		Weight kg	0,34	0,4	-	-	0,I9	0,24	-
Minimum length of fish retained (cm)			22	2I	23	22	22	22	I8
Maximum length of fish escaped (cm)			4I	43	46	47	40	42	40
Retention of fish relative to the total number caught %		Number	85,I	84,8	74	60	28,5	47,9	90,2
		Weight	87,9	86,5	80	63	42,3	55,4	-
Retention of fish relative to the number escaped, %		Number	85	84,8	-	-	27,7	47,4	90
Selectivity coefficient			2,03	I,84	2,28	2,30	2,64	2,I4	-

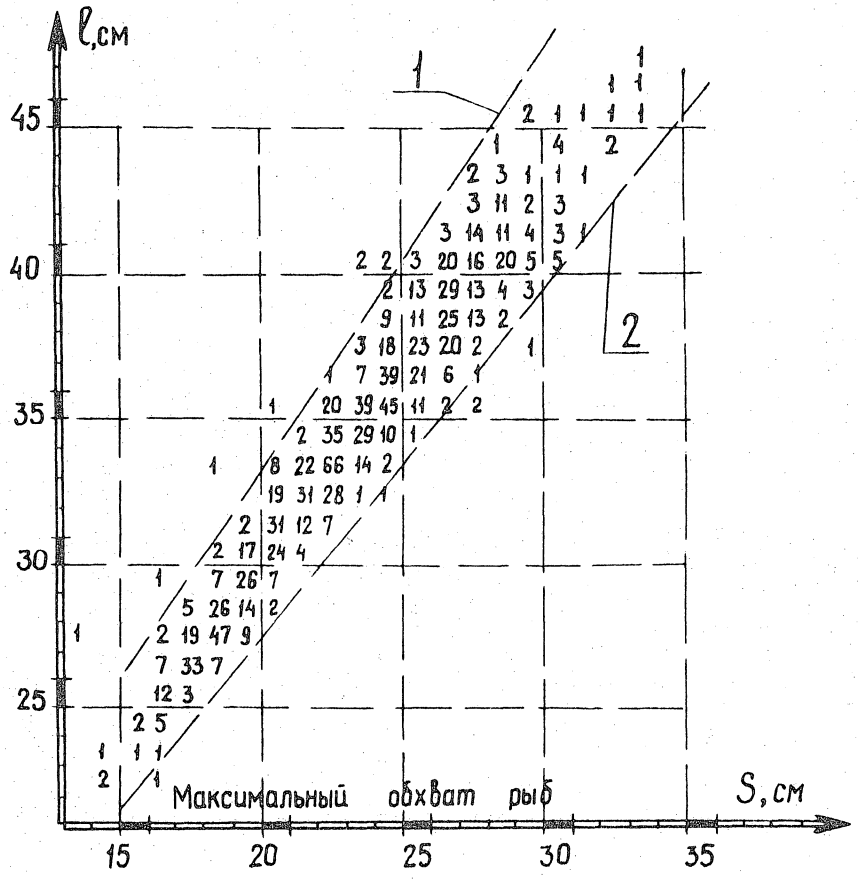

Fig. 1. Relationship between length L and maximum girth S of deepwater redfish. (The number of specimens measured totaled to 1150 fish. Figures stand for amount of fish of the given length and girth among the total number of measured fish). Upper boundary of dispersion (1), and lower boundary of dispersion (2).

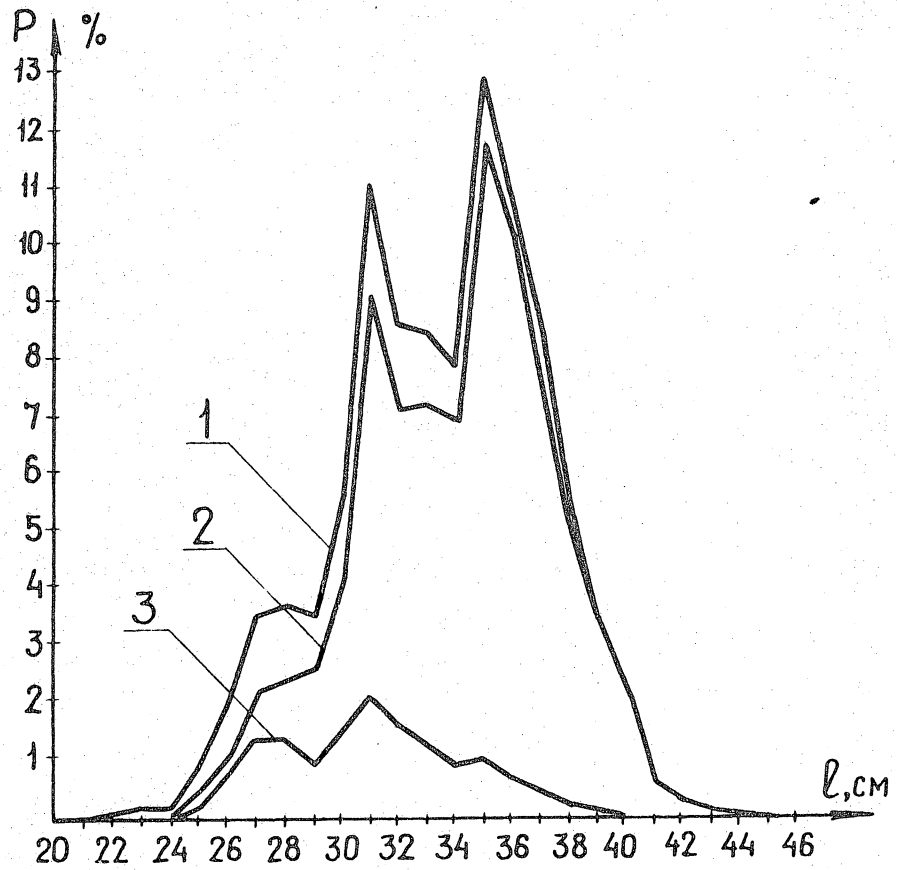

Fig. 2. Percentage of deepwater redfish of different size caught, retained and escaped during fishing with a 125 mm mesh codend with a cover. Fish caught (1), fish retained (2) and fish escaped (3).

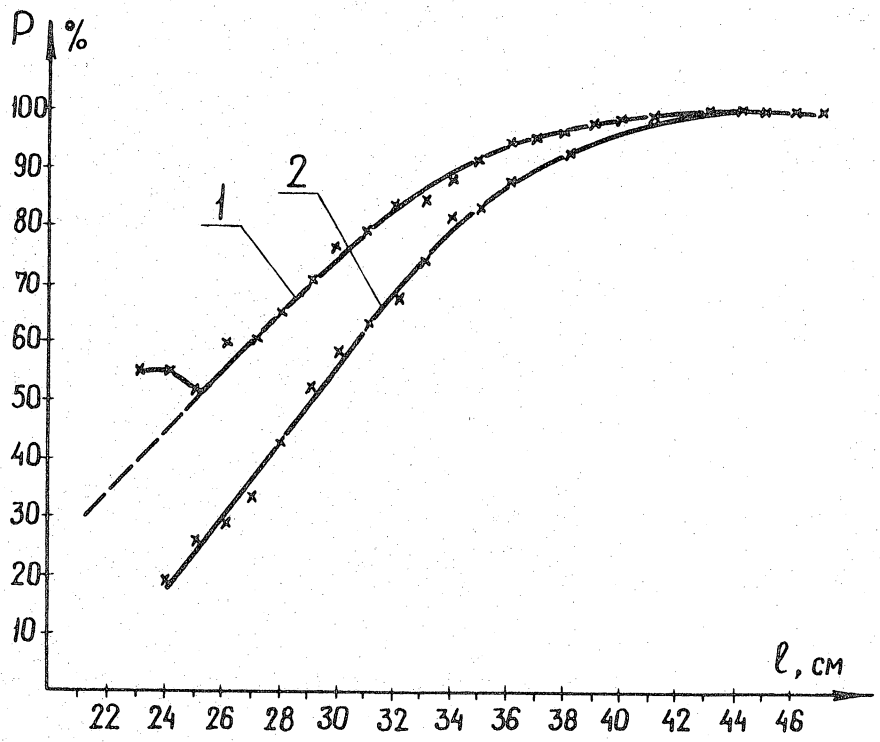

Fig. 3. Diagram of selectivity when fishing deepwater redfish with a 125 mm mesh codend. Codend with cover (1), and codend without cover (2).

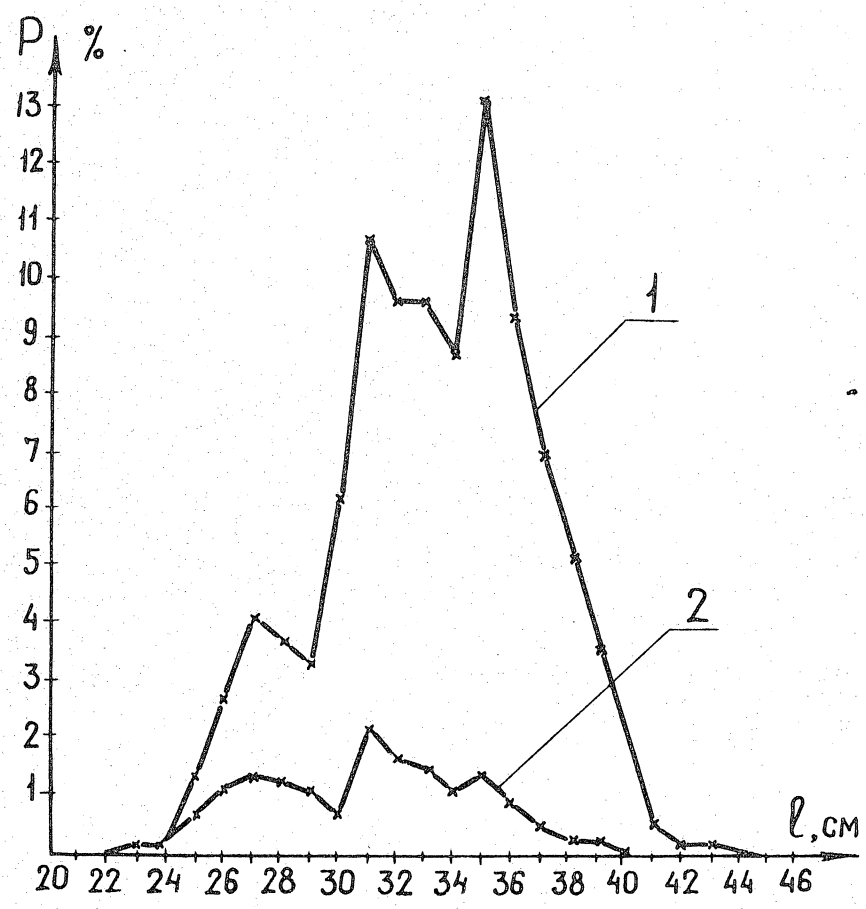

Fig. 4. Percentage of deepwater redfish of different size among fish caught and escaped when fishing with a 130 mm mesh codend. Fish caught (1),and fish escaped (2).

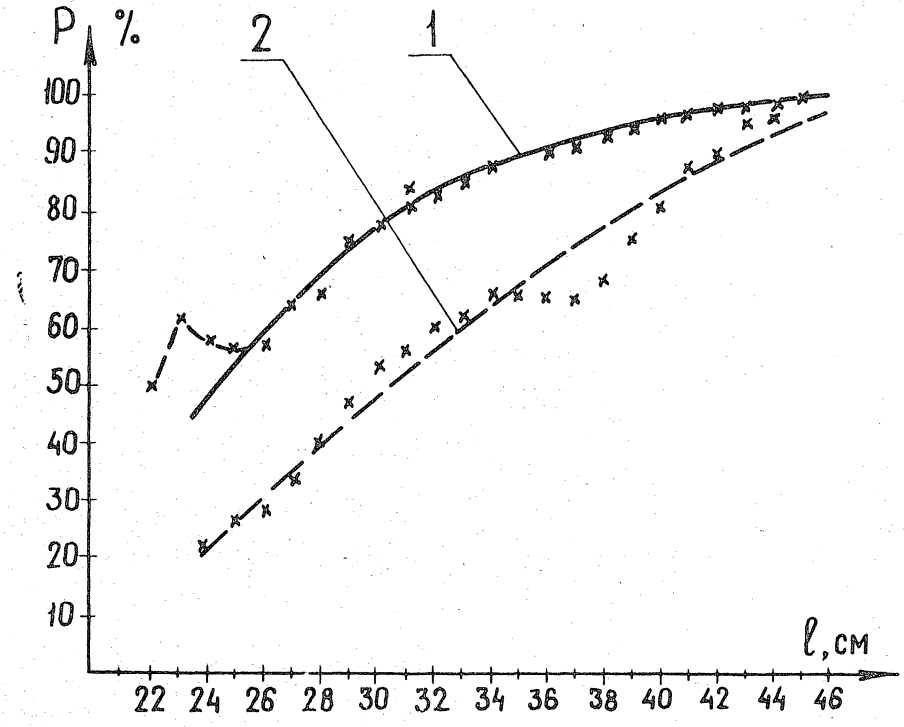

Fig. 5. Diagram of selectivity when fishing deepwater redfish with a 130 mm mesh codend. Codend with cover (1), and codend without cover (2).

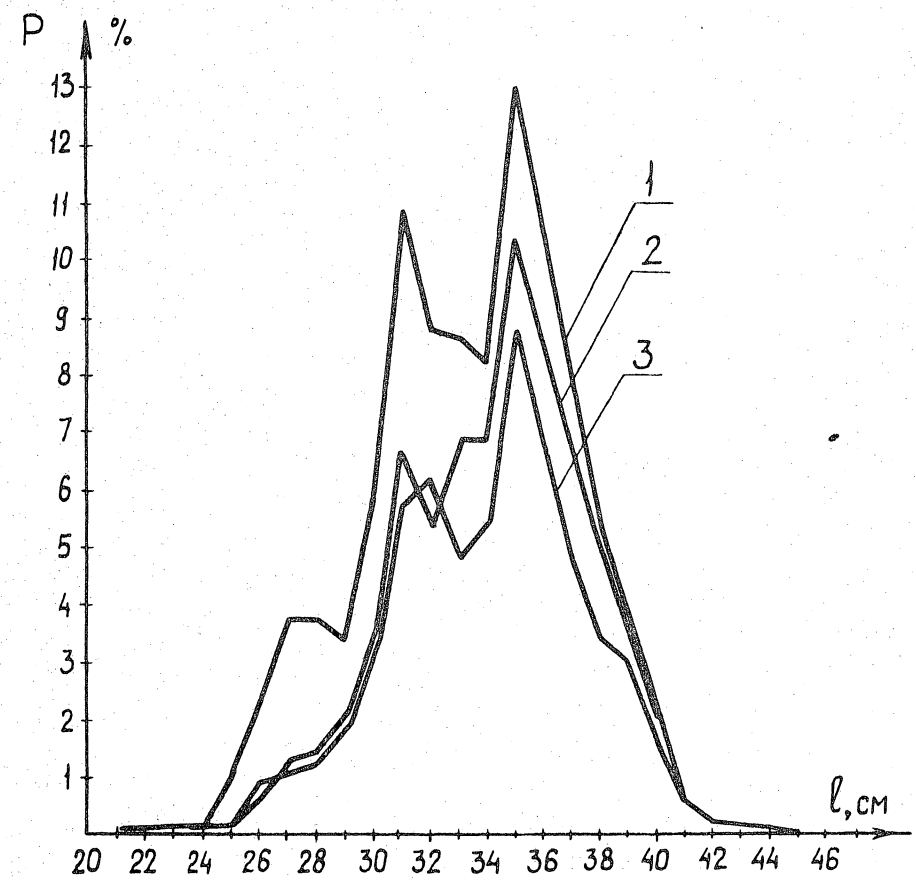

Fig. 6. Percentage of deepwater redfish of different size among fish caught and retained with a 125 mm and 130 mm mesh codend (without cover). Fish caught (1), fish retained with a 125 mm mesh codend (2), and fish retained with a 130 mm mesh codend (3).

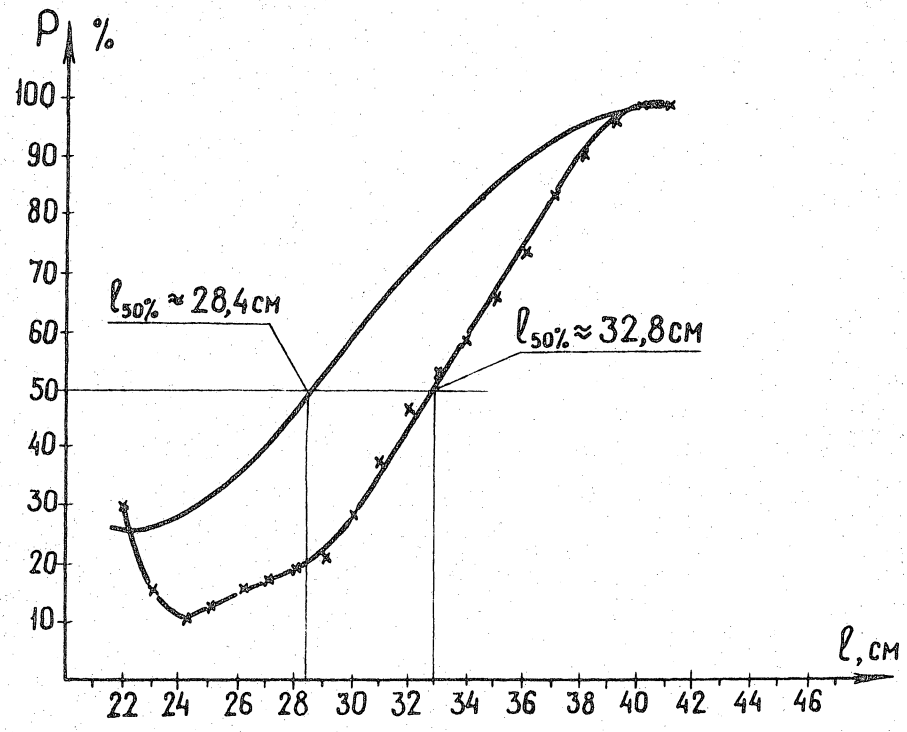

Fig. 7. Diagram of selectivity when fishing deepwater fish with a 120 mm mesh codend.

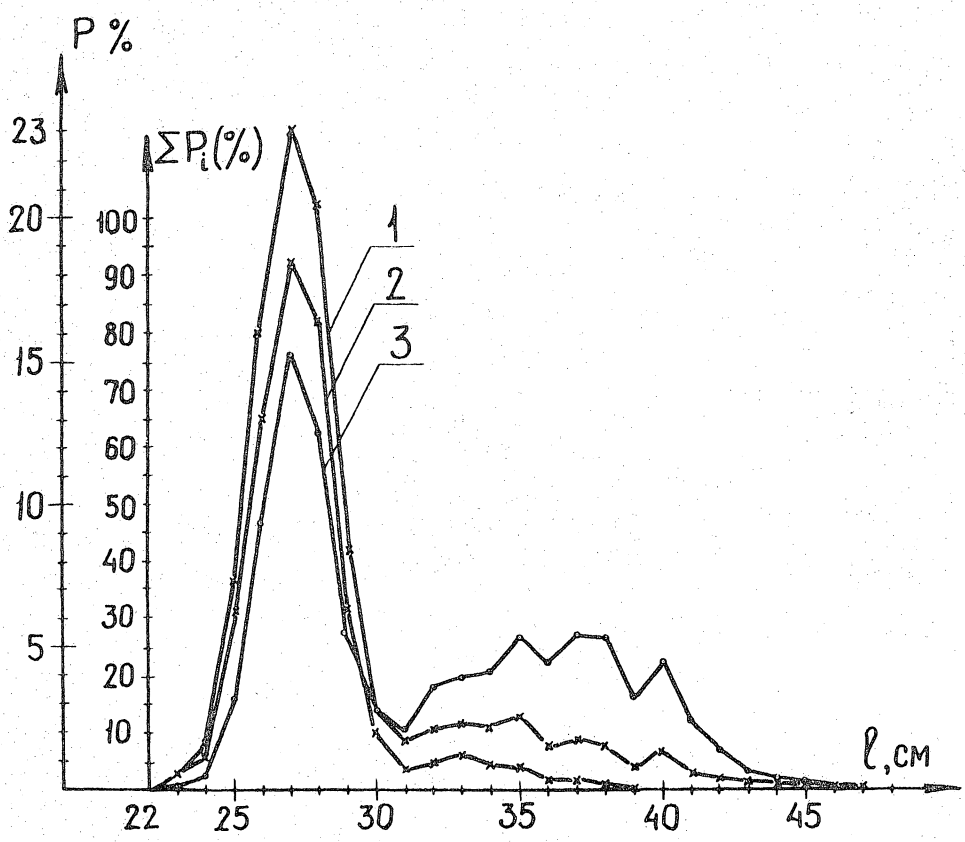

Fig. 8. Percentage of deepwater redfish of different size among fish caught, escaped and retained with a 120 mm mesh codend of mid-water trawl.

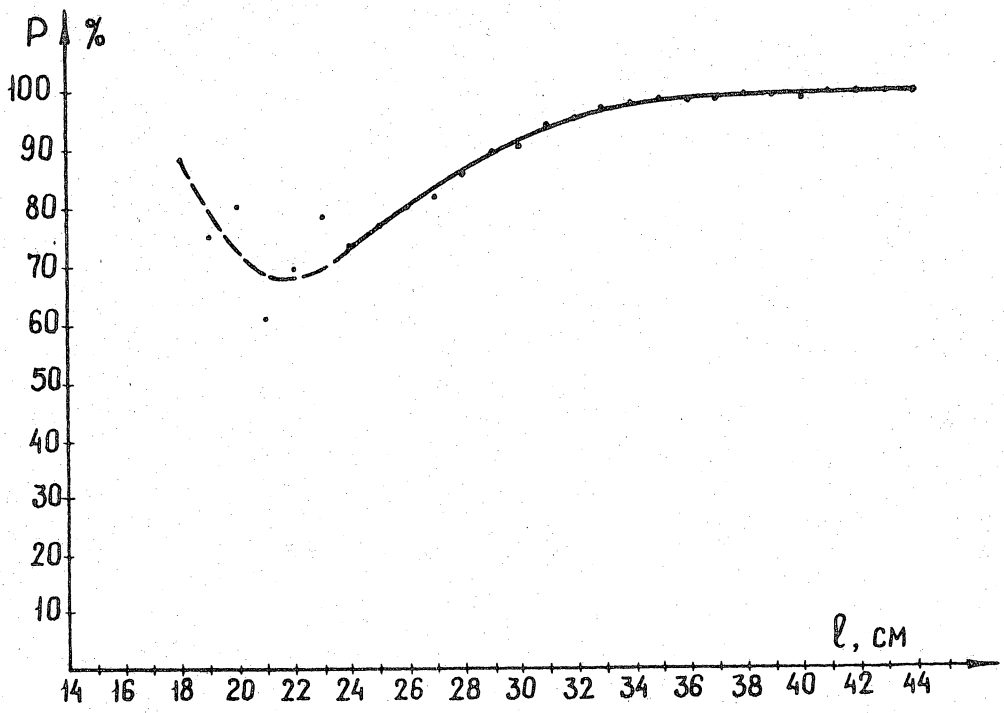

Fig. 9. Diagram of selectivity when fishing deepwater redfish with a 98 mm mesh codend.

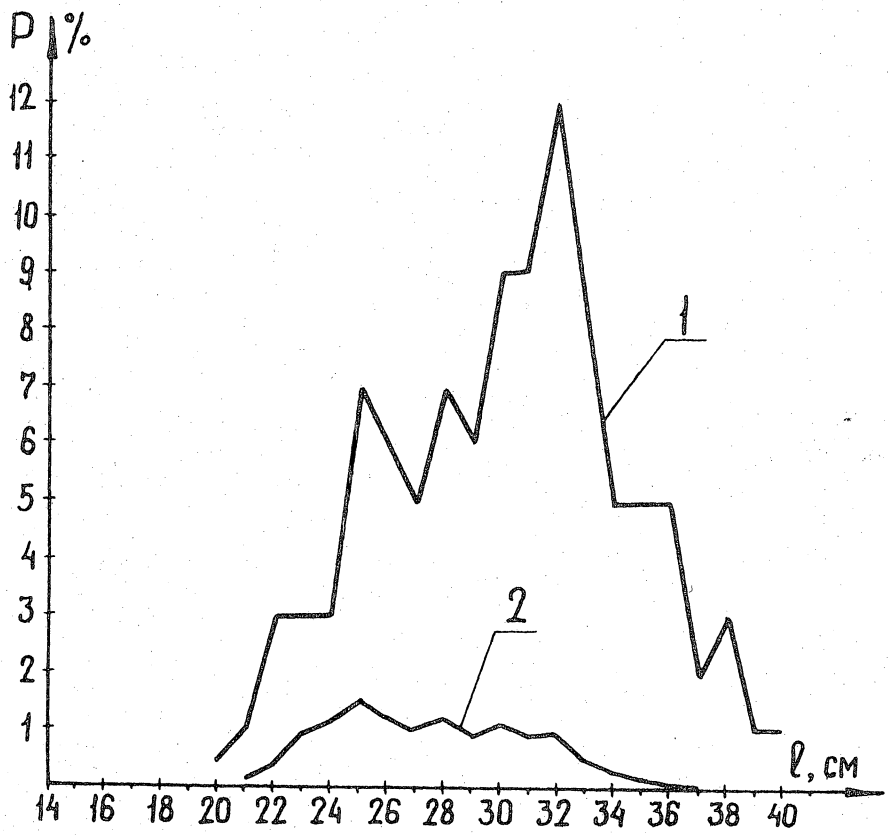

Fig. 10. Percentage of deepwater redfish of different size among fish caught and escaped during fishing with a 98 mm mesh codend. Fish caught (1), and fish escaped (2).