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# Optimum Mesh Size in Redfish Fisheries in the North Atlantic

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Abstract

Results of investigations by Russian scientists into the selectivity of trawl codends with mesh size from 88 to 137 mm in redfish fisheries are presented in this paper. Codend selectivity experiments were conducted in the Northwest Atlantic.

The paper examines the selectivity characteristics of codends, identifies benefits resulting from modifications in mesh size in the redfish fishery and explains why the increase in mesh size in the Northwest Atlantic redfish fishery is inappropriate.

## Introduction

The present-day marine fishery has become a key factor affecting biological resources and without due management can cause adverse effects. Fisheries regulation measures are multifarious and include different requirements and conditions restricting and restraining fishing activities within the scientifically-based limits. Selective fishing based on limitation of a minimum mesh size of codend to restrict catches of immature fish and to avoid excessive escapes of large fish is one of the conditions necessary for the rationale exploitation of commercial fish species. Fishing will lose its practical sense because of the low efficiency if the allowable mesh size is groundlessly increased.

When determining a minimum mesh size of trawl codends in the redfish fishery, the major difficulties are related to lacking data on survival of fish escaping from the trawl during hauling operations. Some authors believe that the fish escaping from the codend during haul-up die (Konstantinov, 1981; Konstantinov et al, 1983). The main reason of the death in fish is apparently associated with rapid changes in hydrostatic pressure during haul-up. According to some data available, the number of redfish escaped during haul-up accounts for 18-30% (Lisovsky at al, 1995). In this situation, in accordance with the precautionary approach, it should be assumed that all fish escaping from the trawl during haul-up die.

This paper summarizes data on the results of experiments with the trawl codend selectivity in the Northwest Atlantic redfish fishery available at the Polar Research Institute of Marine Fisheries and Oceanography (PINRO). The information was made available for NAFO. In 1972, K. Konstantinov published the first article on the trawl codend selectivity in the redfish fishery in the NAFO Regulatory Area. This paper also reviews investigations into the selectivity of trawl codends having different mesh sizes conducted by R. Ivanov in 1979, K. Nikeshin et al in 1981 and articles by S. Lisovsky at al published in 1995, 1997 and 2005.

## Methods

Experiments were conducted onboard PINRO's research vessels in the Northwest Atlantic in 1972-2005.

Selectivity characteristics of mid-water trawl codends of an actual mesh size from 88 to 137 mm were determined. The influence of collection bag on escapes of fish from the codend was estimated.

To estimate the trawl codend selectivity, fish collection bags with the mesh size less than that in the codend were used. They retained fish that escaped through the codend meshes. The ICES cover attached only to the

upper panel of the codend and the bag-shaped cover, which was attached around the codend, were used. The design of collection bags allowed fish to escape freely from the codend and be retained by the collection bag. The number of captured fish that escaped from the trawl through meshes was estimated.

The basic principles of the methods applied are presented in the study by A. Treschev (Treschev, 1974).

Commercial trawls were used in the experiments. Codends were constructed of nylon and polyethylene twine. Fishing conditions were similar to those in the commercial fishery. Trawling operations were conducted by vessels with the main engine power from 1500 to 1700 kW.

Results

Data obtained during experimental trawlings in the Northwest Atlantic are given in Table 1. The modal size ranged from 25-30 cm to 35-38 cm and the average weight of retained redfish varied from 0.22 to 0.31 kg. The ICES cover was used in the majority of experiments. The codend selectivity range varied from 2.4 to 3.1.

Fish that escaped through 88-137 mm meshes are almost of all lengths. For example, the length of redfish retained by 88 mm meshes and escaped through them is from 15 to 45 cm and from 15 to 34 cm respectively. For 132 mm mesh size, the length of retained redfish ranged from 16 to 42 cm, while the redfish that escaped were from 16 to 39 cm. For 137 mm mesh size, redfish from 14 to 46 cm retained, while fish from 14 to 40 cm escaped. The length composition of redfish retained and escaped is presented in Table 1.

The trawl codend selectivity for the examined mesh sizes ranged from 4.1 to 9. The L50 was estimated to be from 25 to 37.6 cm.

In 1991, investigations into the number of redfish, escaping from the codend with 128 mm mesh size during haul-up, were carried out. The investigations demonstrated that from 18 to 30% of all redfish, escaping during the whole trawling operations, escaped during haul-up, (Lisovsky at al, 1995; Lisovsky, 1997a, 1997b). It is recognized that redfish are very sensitive to hydrostatic pressure changes.

Discussion

The trawl codend selectivity varied from 2.4 to 3.1 in the experiments conducted (Table 1). These variations were primarily related to the design of trawl codends used to collect data on selectivity. The type of cover had a significant impact on the retention of redfish. Apparently the ICES cover has a larger masking effect compared to the bag-shaped cover. To control the masking effect, other methods to estimate selectivity should be applied, for example, a method of alternate trawlings.

When applying available data on selectivity, the results obtained from the experiments where a bag-shaped cover was used are preferable.

When comparing retention of redfish by mid-water trawls, having different codend mesh sizes, in the Northwest Atlantic, the retention of redfish by 88, 118, 124,126,132, 137mm mesh sizes with regard to the numbers comprises 52.8, 24.0, 28.5, 12.7, 10.0 and 3.1% respectively.

The bulk of catches (over 50%) are comprised of fish from 25 to 32 cm in length, and fish more than 32 cm in length comprise from 19.5 to 46.5% of catches (Table 2). Codends with mesh size of more than 88 mm tend to have reduced retention of fish of all lengths. It should be noted that the length composition of redfish caught using 137 mm mesh seize slightly differs from that caught using 88 mm mesh.

Redfish of almost all lengths escape from trawl codends of 88-137mm mesh sizes. A small group of fish from 41 to 47cm in length comprising 5-8% of catches does not escape from codends. The majority of individuals, constituting the bulk of catches, are more than 25 cm in length. From 42 to 92% of fish of the above-mentioned lengths escape.

The study demonstrates that the redfish fishery where trawls with a meshe of more than 100 mm are used will result in a considerable increase of fishing efforts to uptake the TAC. Increased fishing efforts will lead to recapture of small redfish and their escape through the codend meshes during haul-up and to the death from injuries caused by large changes in hydrostatic pressure.

Analysis of the greatest girth of redfish in the Northwest and Northeast Atlantic (Kovstantinov et all., 1983; Valdes E. and Froxdes E.I., 1981) shows that, with great confidence, the fish were geometrically similar (Fig.1). Redfish of the similar lengthes in the catches from the Northeast and Northwest Atlantic have identical maximum girth. This allows the selectivity data obtained to be used for both areas. In this regard, it should be noted that trawls with mesh size less than 100mm are used in the beaked redfish fishery in the Barents Sea and redfish fishery in the NEAFC Regulatory area.

Conclusion

The length of fish retained with trawl codends and those escaped from them are almost similar. Fish from 40 to 50cm in length do not escape. They comprise 5-8% of the catches taken in the Northwest and Northeast Atlantic. Most redfish that escaping are more than 25 cm in length, aged 8-9 and more, i.e. the same lengths and age as in the redfish retained by trawl codends and those that comprise the bulk of catches. Redfish within these lengths that escaped through codend meshes of 88-137 mm in size comprised 44-98%. The number of mature redfish over 32 cm escaping from trawl codends increase from 6% for 88 mm mesh to 24% for 137 mm mesh. It means that an increase in the mesh size from 88 to 137 mm leads to considerable losses of catch because redfish of more than 25 cm in length, being of commercial value, escape. This fact indicates that the use of 100mm mesh size in the redfish fishery results in increased fishing effort required for the quota uptake. Increased fishing effort, in turn, results in escapes of redfish through trawl nets and fish death as a result of injuries during trawl hauling and trawling.

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Table 1. Results from investigations into selectivity of codends having different mesh size in the redfish fisheries conducted in the Northwest Atlantic using a bag-shaped cover

| Parameters | | Name of vessel | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Menze-linsk[1] | Vladimir Gavrilov[4] | | | Vilnus[2] | | Vaigach[3] | | |
| Inner mesh size in codend, mm | | 124 | 96 | 100 | 106 | 126 | 137 | 88 | 118 | 132 |
| Divisions | | 3M, 3N | 3O | 3O | 3O | 3M | 3M | 3N | 3N | 3N |
| Number of fish in the catch, spec | in codend | 46974 | - | 11953 | 10709 | 2948 | 557 | 12767 | 2144 | 2119 |
| | in cover, | 117937 | - | 14972 | 10127 | 20222 | 17133 | 11412 | 6794 | 18073 |
| | total | 154911 | - | 26925 | 20836 | 23170 | 17690 | 24179 | 8920 | 20192 |
| Length range of fish, (cm) | retained | 22-47 | - | 20-43 | 20-41 | 21-43 | 24-46 | 17-45 | 17-47 | 16-45 |
| | escaped | 22-40 | - | 16-42 | 18-42 | 14-38 | 14-40 | 15-34 | 16-39 | 16-43 |
| | in water | 22-47 | 17-42 | 16-43 | 18-42 | 14-43 | 14-46 | 15-45 | 16-47 | 16-45 |
| Mean weight of one spec., kg | retained | 0,35 | - | 0,284 | 0,261 | 0,437 | 0,497 | 0,294 | 0,328 | 0,351 |
| | escaped | 0,19 | - | 0,18 | 0,207 | 0,294 | 0,282 | 0,149 | 0,189 | 0,205 |
| | in water | 0,23 | 46705 | 0,227 | 0,235 | 0,312 | 0,289 | 0,224 | 0,225 | 0,22 |
| Size mode of experimental series in water fish, cm | | 30; 35 | 17-42; 26-30 | 24-29 | 25-29 | 23-26; 29-32 | 24-30 | 18-20; 23-29 | 18-20; 23-29 | 18-20; 23-29 |
| Retention by number, % | | 28,5 | | 44,4 | 51,4 | 12,7 | 3,1 | 52,8 | 24 | 10 |
| Selectivity coefficient | | 2,4 | 2,6 | 2,6 | 2,6 | 2,9 | 2,9 | 2,8 | 2,5 | 2,6 |
| Selectivity range, cm | | 8,4 | 5,4 | 4,1 | 5,5 | 5,6 | 4,3 | 4,4 | 6,6 | 9 |
| | L75% | 34,0 | 27,7 | 28,1 | 30,3 | 39,3 | 41,9 | 26,8 | 32,8 | 38,8 |
| | L50% | 29,8 | 25,0 | 26,0 | 27,6 | 36,5 | 39,7 | 24,6 | 29,5 | 34,3 |
| | L25% | 25,6 | 22,3 | 24,0 | 24,8 | 33,7 | 37,6 | 22,4 | 26,2 | 29,8 |

1) Konstantinov et. al., 1981.
2) Gorchinsky et. al., 1993.
3) Lisovsky et. al., 1995.
4) Lisovsky et. al., 2005.

Table 2. Length composition of redfish in the trawl codend
and cover having different mesh in trawl codend

| Place of fish retantion | Fish length, cm | Number offish, %, with mesh size, mm | | | | | |
|---|---|---|---|---|---|---|---|
| | | 88 | 96 | 118 | 126 | 132 | 137 |
| In trawl codend | $L < 25$ | 12.2 | 6.9 | 1.6 | 9.5 | 0.8 | 0.7 |
| | $25<L<32$ | 68.3 | 58.6 | 52.0 | 84.8 | 54.1 | 52.8 |
| | $L>32$ | 19.5 | 34.5 | 45.5 | 5.7 | 45.1 | 46.5 |
| In cover | $L < 25$ | 56.3 | 21.7 | 3.1 | 11.7 | 2.7 | 1.7 |
| | $25<L<32$ | 41.6 | 72.5 | 72.5 | 82.6 | 91.6 | 74.4 |
| | $L>32$ | 3.1 | 5.8 | 24.4 | 5.7 | 5.7 | 23.9 |

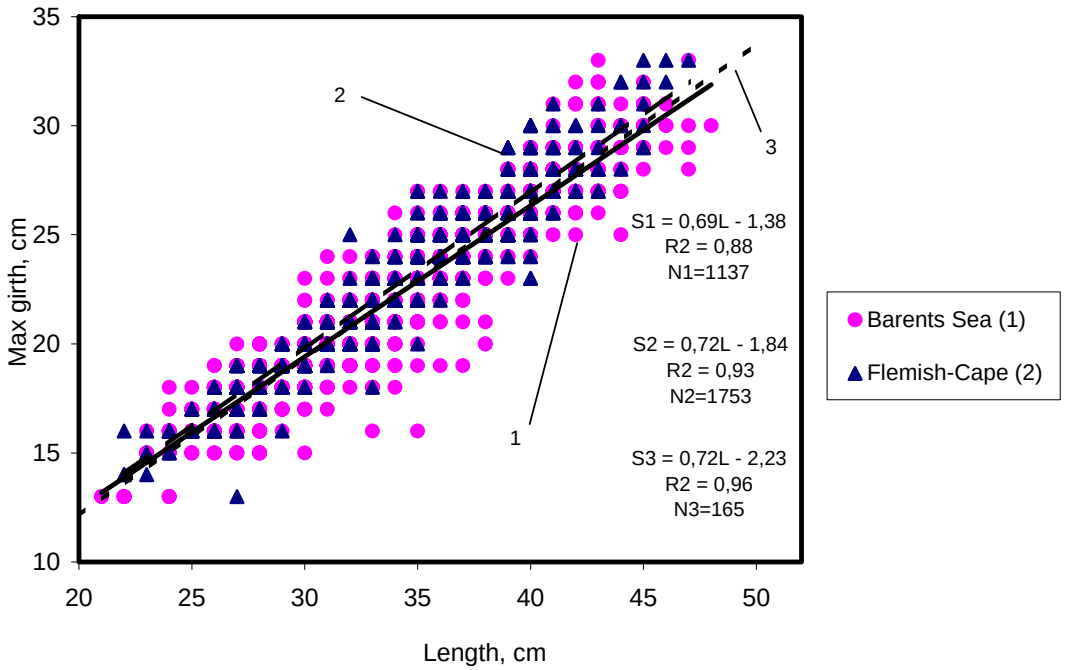


Fig.1 Relationship between the length and maximum girth for beaked redfish in the Barents Sea and Flemish-Cape (Konstantinov at all, 1983 (1,2);
Valdes and Fraxedes,1981 (3))