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On Minimal Codend Mesh Size in Mid-water Redfish Fishery in Division 3O of NAFO Regulatory Area

by

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Abstract

In Division 3O, primarily, redfish of two species *Sebastes mentella* and *S. fasciatus* are harvested. The bulk of catch (85%) is made up by *S. fasciatus*.

Calculations showed that with the change of mesh size from 132 mm to 88 mm in mid-water trawls in the redfish fishery the yield per recruit significantly increased. When using mesh size of 118, 100 and 88 mm instead of 132 mm the largest yield per recruit would rise in 2.2, 3.1 and 3.5 times and concern fish aged 14, 10 and 8 years, respectively.

With reducing mesh size the total yield per recruit increased during the calculation period to the age of 18 years. It became larger in 3.5-3.8 times for considered range of mesh size in the trawl codends from 132 mm to 88-100 mm.

Previously it was also mentioned that the long-term positive effect for redfish harvesting by mid-water trawls with the increase of mesh size from 90-100 mm to 130 mm in Div. 3O as well as in the other areas of the North Atlantic during 15-20 years would have not been achieved under any acceptable fishing mortality.

Since in Div. 3O *S. fasciatus* predominate their fishery by trawls with 90-100 mm mesh size would not have significant influence on structure of the other commercial redfish stocks in NAFO Regulatory Area.

By-catch of every regulatory species in redfish fishery using trawls with 90-130 mm mesh size did not exceed 0.35%.

Thus, diminishing mid-water trawl mesh size in redfish harvesting in Div. 3O from 130 to 90-100 mm would not be harmful for other stocks and enlarge the efficiency to a great extent. The yield per recruit would increase in more than 3.5 times and, in perspective this diminishing of mesh size would be profitable for fishery.

Introduction

According to STATLANT 21A statistical report, the catch of redfish species in Div. 3O in recent 40 year period varied from 2.8 x 10^3 tons (1995) to 22.1 x 10^3 tons (2001), in 2004, the catch was estimated at only 2.9 x 10^3 tons.

One of the technical measures for rational exploitation of fish commercial stocks is limitation of minimal mesh size in codends that permits immature fish catch to be minimized and excessive escape of commercial size fish to be avoided.

Redfish stocks were determined and divided into NAFO regulatory units before 1976. Based on the analysis of biological data (size and weight, age, growth rate and others) and, in some cases, because of disputes, 8 stocks and regulatory units were established (Atkinson, 1986).

Later, proceeding from the analysis of growth rate, life duration, main length-age groups and maximal age Nikolskaya (Nikolskaya, 1981) showed that redfish stock in Div. 3L differed from that one in Div. 3NO in which the stock should be considered as single. In this connection, fishing limits (TAC) for Div. 3L and Div. 3NO should be determined separately.

Canadian scientists (Atkinson and Power, 1986) having analyzed available data showed that the redfish stock in Div. 3K resembled that one in Div. 3L. Alongside with that, they assumed that Div. 3O and 3P were separate units of regulation, the stock status in Div. 3N remained to be unclear and required further investigation.

According to the results from research in 1987-1993, it was shown that in Div. 3NO a single redfish stock migrating within those divisions was distributed (Vaskov, 1994). The similarity of redfish length distribution in both divisions corroborates that. So, in 1988, in those divisions, the appearance of strong year-class predominating in both Div. 3N and Div. 3O was observed.

The results from Canadian autumn-spring surveys in 1991-2002 in those divisions indicated that there redfish length composition was of the same character, and, in some surveys (spring survey in 1995, spring and autumn surveys in 2000) it was practically identical (Power, 2003).

At present, redfish trawl fishery in international waters of Div. 3O in NAFO Regulatory Area is limited by minimal mesh size of 130 mm in codends and TAC (Anon., 2005). Fishery measure for them has not been established.

In 200-mile zone of Canada, the minimal mesh size in trawls is of much less than 130 mm and fishery measure for redfish has been established as being equal to 22 cm (Anon., 2004).

Therefore, it is important to determine the optimal mesh size in mid-water trawls in the fishery of redfish species in the whole Div. 3O of NAFO Regulatory Area.

Methods

Yield per recruit for redfish from Div. 3O was calculated using Russell method (Russel, 1942). The age of recruit at the beginning of its fishery exploitation is taken to be equal to three years that corresponds to length-age composition of catch by small-meshed cover during the trials to determine selectivity (Lisovsky *et al.*, 2005). Eighteen years is considered as the maximal age of redfish (Vaskov, 2004). The above-mentioned shows that recruit fishing duration is equal to difference between the oldest and youngest age that is fifteen years.

Structure and age composition in catch by the trawl with 100 mm mesh size was determined on the basis of catch data obtained during Russian research on selectivity in Div. 3O of NAFO Regulatory Area (Lisovsky *et al.*, 2005). Proceeding from the assumption that here all fish occurrence frequency in a catch corresponds to probability of catching by trawl with the given mesh this value has been taken as being equal to fishing mortality F for each age group, respectively. In this case, the bulk of catch by trawl with 100mm mesh and, correspondingly, fishing mortality relate to fish aged 7-10 and $F_{7\text{-}10} = 0.2152$.

In accordance with ICES advice, variation of fishing mortality was taken as proportional to selectivity of trawl codend with different mesh size under other equal conditions (Anon., 1996). The catch corresponding to new mesh size was calculated for each size group of fish proportionally to its selectivity coefficients. Parameters of codend selectivity regarding redfish for trawls with 100 mm and 132 mm mesh size in Div. 3O were determined based on previously published data (Lisovsky *et al.*, 2005).

When calculating yield per recruitment of redfish from Div. 3O for mesh with inner size of 88 mm and 118 mm selectivity coefficients have been established using results from research in Div. 3N (Lisovsky *et al.*, 1995) since in these areas the redfish stock structure is similar.

In further calculation of yield per recruitment it the number of recruits entering fishing at age 3 are taken to amount to 1 000 individuals.

The abundance of recruits in every following fishing year and then that one of caught recruits were calculated using Beverton-Holt equations by formulas (1) and (2) (Beverton, Holt, 1957).

$$N_{(i+1)} = N_i * e^{-(M+Fi)}, \qquad (1)$$

where F_i – fishing mortality of i age group of recruit of previous fishing year,
M – natural mortality was taken to be equal to 0.1 for all age groups,
N_i – number of recruits of previous fishing year.

Catch:

$$C_i = \frac{F_i}{F_i + M} * N_i * (1 - e^{-(F_i+M)}), \qquad (2)$$

where N_i – number of recruits from i age group.

Weight and length of each age group were determined by Bertalanfy equation the parameters of which were derived using length-age key (Vaskov, 2004).

The by-catch size of regulated fish species was determined with the aid of data from Russian observers aboard fishing vessels and the results of hauls in the period of mid-water trawl selectivity research regarding redfish from Div. 3O.

Results and Discussion

In Div. 3O, two redfish species *S. mentella* and *S. fasciatus* are the main objects of fishing. *S. fasciatus* made up the bulk of catch (85%) (Vaskov, 2004). This species is characterized by smaller size and earlier maturation than *S. mentella* (Vaskov, 2005).

Our data indicated (Lisovsky *et al.*, 2005) that in Div.3O redfish with average length of 25 cm aged 7-8 were distributed (Fig. 1).

Our calculations of possible yield per redfish recruit from Div. 3O of NAFO Regulatory Area showed that when changing the trawl mesh size from 132 mm to 88 mm the yield per recruit significantly increased. So, the greatest yeild per 1 000 recruits when applying 118, 100 and 88 mm instead of 132 mm would increase in 2.2, 3.1 and 3.5 times and concern fish aged 14, 10 and 8 years, respectively (Fig. 2). At the same time, it was previously observed that the length of fish escaped from the codends with those mesh size and those ones retained was similar (Lisovsky *et al*., 1995, 2005; Lisovsky, 1997, 2001).

When diminishing mesh size the total yield per recruit rose during the calculation period to age of 18 years. It increased in 3.5-3.6 times for studied range of mesh size change in the trawl codends from 132 mm to 88-100 mm (Fig. 3).

It was also mentioned before that the long-term positive effect for redfish species harvesting by mid-water trawls with the enlargement of mesh size from 90-100 mm to 130 mm in Div. 3O, as well as in the other areas of the North Atlantic during 15-20 years would have not been achieved with any acceptable fishing mortality (Lisovsky, 1997, 2001).

As it was noticed, in Div. 3O, redfish *S. fasciatus* prevailed. In Div. 3LMN, this species portion in catch reduces and *S.mentella* predominate. Therefore, redfish fishery by trawls with 90-100 mm mesh size would have no negative impact on structure of other redfish commercial stocks in NAFO Regulatory Area.

The analysis of catches by mid-water trawls with mesh size from 100 mm to 135 mm made on the basis of PINRO data showed that the by-catch of every regulatory fish species did not exceed 0.35% (Fig. 4). The other materials (Lisovsky *et al*., 2005), where it is shown that the total catch by such gears did not exceed 3%, give the analogous results without dividing by species.

Thus, the decrease in mid-water trawl mesh size in the fishery of redfish in Div. 3O from 130 mm to 90-110 mm would not be harmful for other stocks and considerably enlarge its efficiency. Catch per recruit would rise in more than 3.5 times and, in perspective, this diminishing of mesh size would not damage fishery.

As it was mentioned before (Lisovsky *et al*., 1995, 2005; Lisovsky, 1997, 2001), when lifting trawl from 18 to 30% of red fish escape and dye due to abrupt change of hydrostatic pressure. Therefore diminishing mesh size and, correspondingly, escape will have a positive effect on the stock.

Conclusion

In the redfish harvesting in Div. 3O of NAFO Regulatory Area the mesh size in mid-water trawls is reasonable to be diminished from 130 to 90 mm. This change would not be harmful for other stocks, however permit yield per recruit to be increased and result in long-term profits for fishery.

As it was mentioned before (Lisovsky *et al*., 1995, 2005; Lisovsky, 1997, 2001), when lifting trawl from 18 to 30 % of red fish escape and dye due to abrupt change of hydrostatic pressure. Therefore diminishing mesh size and, correspondingly, escape will have a positive effect on the stock.

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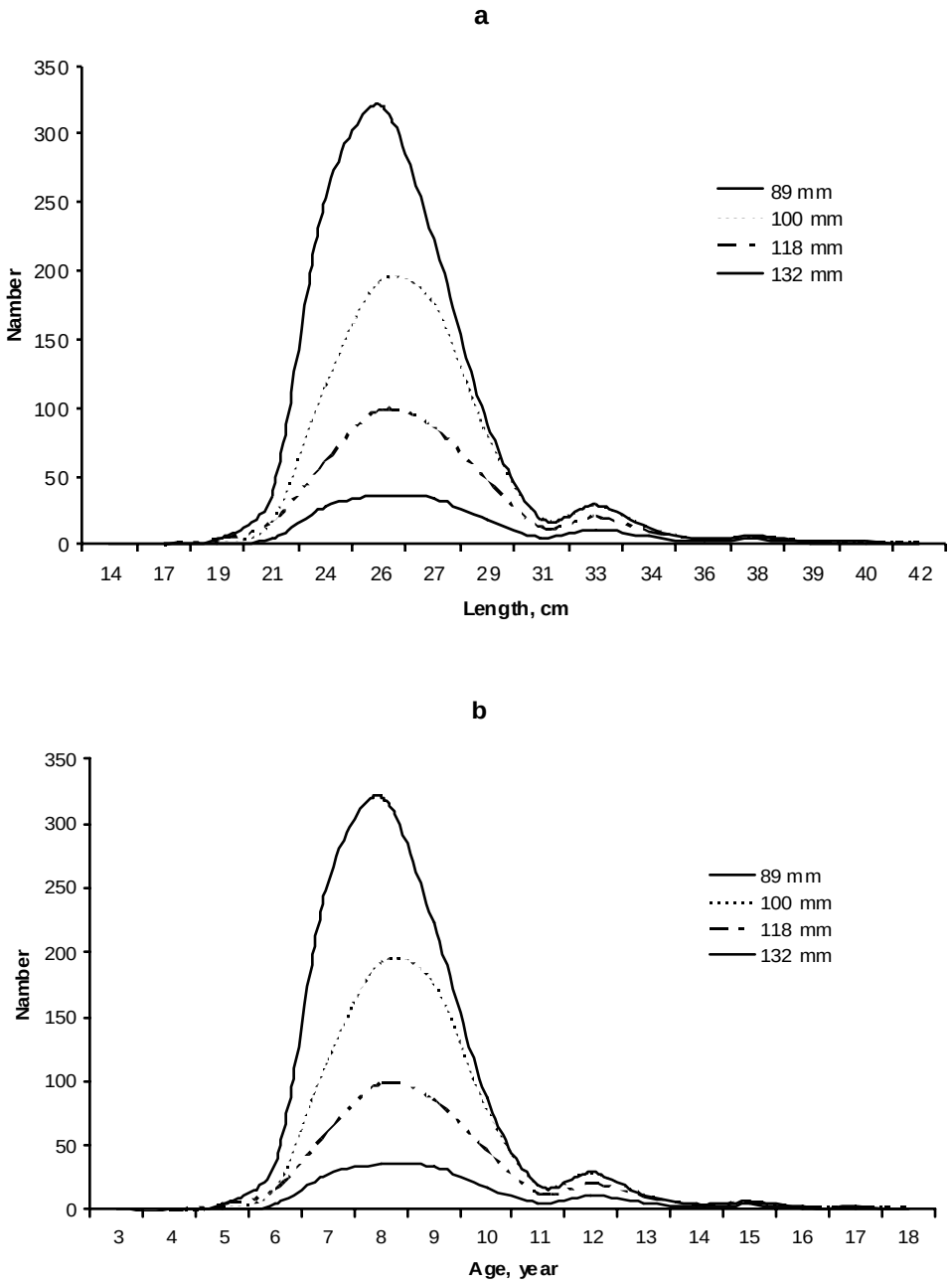

Fig.1. Fish occurrence structure in catch by mid-water trawl with different inner mesh size in trawl codend by age (a) and length (b) in Div.3O of NAFO Regulatory Area.

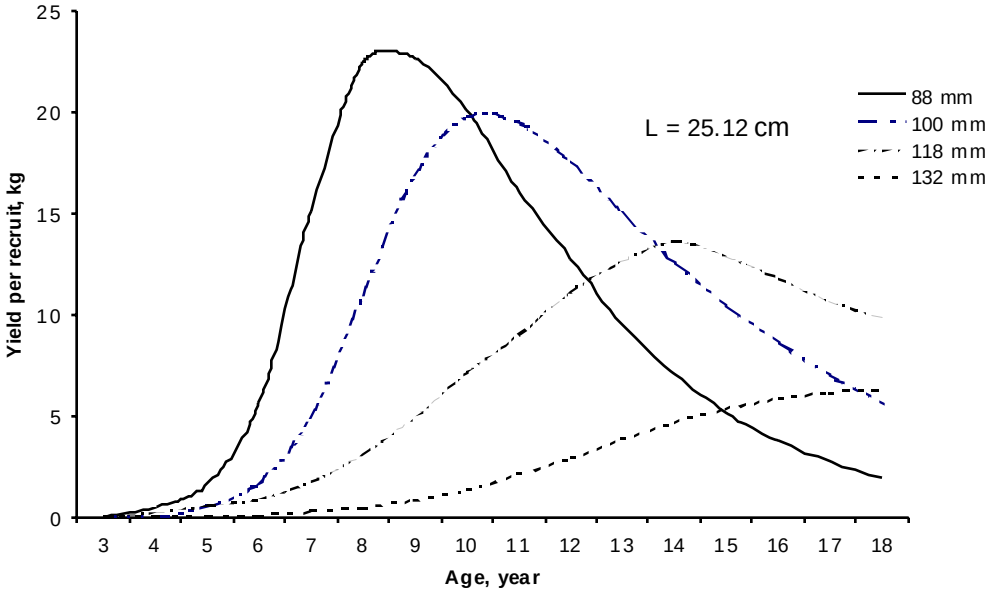

Fig. 2. Variation of possible yield per recruit (recruitment) of redfish by age when changing mesh size from 132 to 88 mm in mid-water trawls, in Div. 3O of NAFO Regulatory Area.

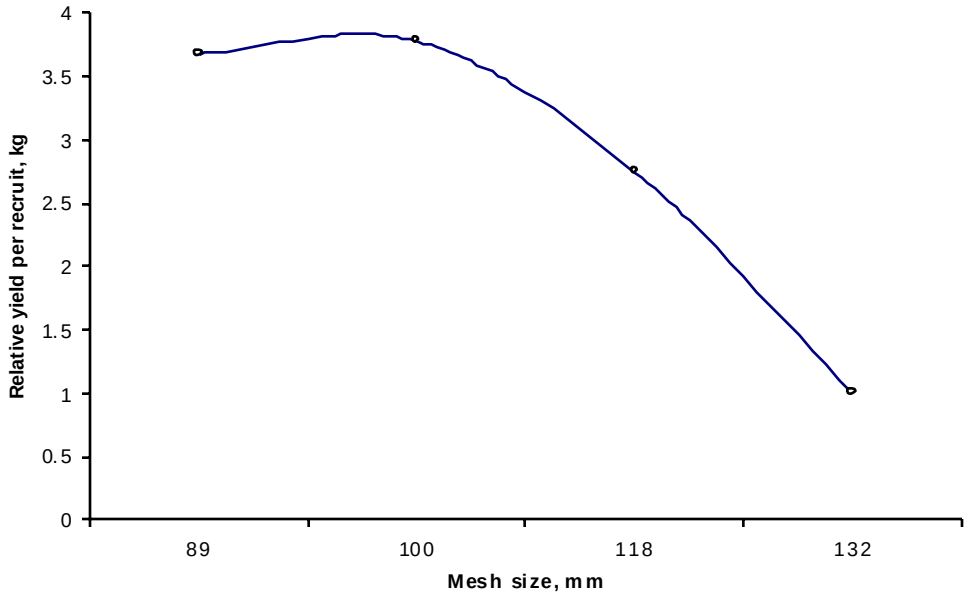

Fig. 3. Variation of possible catch per redfish recruit (recruitment) depending on inner codend mesh size in the period of fishing in Div. 3O of NAFO Regulatory Area.

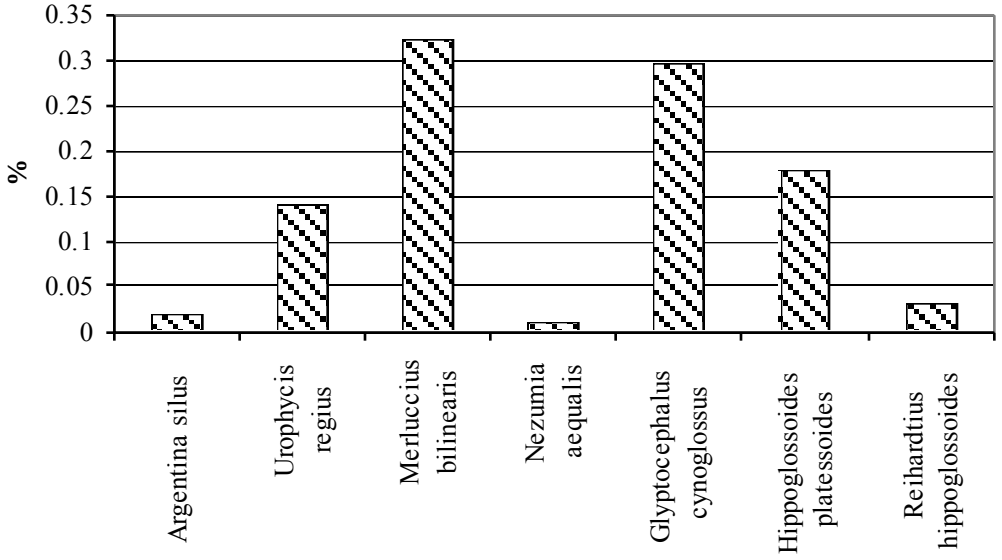

Fig. 4. By-catch of different fish species in mid-water fishery of deep-water redfish from Div. 3O in 2004.