Research on the Selectivity of Gillnets Used in Romanian Turbot Fisheries *(Eugen Anton)*	"Cercetări Marine" Issue no. 46 bis **Pages 24-31**	**2016**

RESEARCH ON THE SELECTIVITY OF GILLNETS USED IN ROMANIAN TURBOT FISHERIES

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ABSTRACT

For an integrated management of fishery resources, the whole environment - resource - exploitation assemblage and ecological, biological and fishery management measures must be considered.

Fishery management is a complex exploitation action and includes a series of measures concerning fishing effort, the type of techniques which can be used (overall dimensions, mesh size), gear selectivity, limiting access to resources (minimum size of fish targeted, fishing quotas, banned fishing seasons and areas).

In view of the above, this research aimed at improving the selectivity of gillnets used for turbot fishing at the Romanian Black Sea coast. The estimated results are protecting juivenile turbot generations by elaborating some measures on the minimum size of turbot speciments which can be fished and minimum mesh size.

Key-Words: Black Sea, gillnets, hanging coefficient, selectivity, turbot

AIMS AND BACKGROUND

In recent years, gillnets have started to be wideluy used for demersal fisheries (turbot, dogfish etc.). Increasing fishing effort with this type of gears, namely using undersized mesh nets, can seriously affect demersal fish stocks, which have already decreased dramatically.

EXPERIMENTAL

Consequently, this investigation on turbot gillnet selectivity was performed. Research work was performed in the field and consisted of observations and biometric measurements on turbot individuals detained in gillnets with varying mesh sizes (160, 180 and 200 mm), set-up at sea both by NIMRD experts and economic operators performing fishing activities at the Romanian Black Sea coast, using boats and vessels.

The turbot gillnets were manufactured in NIMRD's prototype workroom from polyamide nets, with varying mesh sizes, ranging from 160 mm to 200 mm, thread diameter 0.5 mm, set on PP ropes 3.5-4 mm in diameter, with a horizontal setting coefficient (U_1) of 0.25.

Launching at sea of the turbot gillnets was made aboard NIMRD's boats, with direct assistance of specialized staff.

Fig. 2. Turbot gillnets launching and recovery (NIMRD original photos).

The Holt method (Holt, 1963) was used to determine gillnet selectivity.

RESULTS AND DISCUSSION

Gillnet selectivity depends on the mesh size, as well as other factors, such as: gear design, visibility and extended area of the net, material of the net and fish behavior.

Turbot catches on length classes, obtained with the three gillnet types (a = 160-200 mm) and the perimeter of the maximum cross-section for each length class, respectively, are shown in Table 1.

As outlined by the data in Table 1, in gillnets with a = 200 mm, turbots with a total body size ranging between 42-54 cm were caught. Pursuant to EC Regulation no. 850/98, the minimum allowed size in turbot fisheries is L_t = 45 cm.

For a = 200 mm turbot gillnets, set at a U_1= 0.25 coefficient, the detention of turbots with a total body length (L_t) ranging between 42-44 cm was made by entangling (clenching the hard fin rays in the mesh edges).

By comparing the perimeters of the maximum cross-sections of the specimens in the 42-44 cm (P_t = 76-79 cm) length classes to the mesh perimeter (P_a= 80 cm), it resulted that there is a small difference between these sizes ($P_t < P_a$), which allows L_t = 42-44 cm turbot individuals to escape a = 200 mm mesh size.

Table 1. Number of turbot individuals detained by the 160-200 mm mesh size gillnets.

Ref. no	Length clases L_t (cm)	Number of specimens detained by a = 160 mm, Ø 0.5 (160 tex) mesh sizes (individuals)	Number of specimens detained by a = 180 mm, Ø 0.65 (240 tex) mesh sizes (individuals)	Number of specimens detained by a = 200 mm, Ø 0.5(160 tex) mesh sizes (individuals)	Maximum cross-section perimeter (P_t) (cm)
1	38	3	0	0	72
2	40	2	3	0	74
3	41	5	7	0	74
4	42	2	19	2	76
5	43	1	17	5	77
6	44	1	12	26	79
7	45	1	5	33	82
8	46	0	0	6	85
9	47	0	0	2	89
10	48	2	1	2	93
11	49	2	0	1	95
12	50	1	0	2	101
13	52	0	1	1	107
14	54	0	0	1	108

In order to reduce the entangling of undersized turbot specimens, it is recommended to use a higher horizontal setting coefficient (U_1 =0.5-0.6), with the view to reducing the number of meshes on the area unit (the net grid is looser).

For turbot gillnets with 160 and 180 mm, respectively, mesh sizes, turbots with a total body size ranging between 38-52 cm were reported. The catch of undersized turbot specimens (38-44 cm) was facilitated by the use of a smaller mesh size compared to a = 200 mm gillnets, as well as by the use of a small setting coefficient (U_1 = 0,25) and, therefore, a net grid with a larger mesh number on the area unit.

Unlike the a = 200 mm gillnets, the a =160 and 180 mm gillnets have a mesh size edge perimeter smaller or equal to the maximum cross-section perimeter ($P_a \leq P_t$), for 38-44 cm (Table 1) total length turbot individuals. For such reasons, the a =160-180 mm (P_a = 64-72 cm) gillnets detain by clenching (trekking) turbot individuals with a total body length ranging between 40-44 cm (P_t = 74-79 cm), while a = 200 mm ($P_a > P_t$) gillnets allow their escape from the mesh.

The probability of one fish entangling in the gillnet depends on the horizontal (U_1) and vertical (U_2) setting coefficients (Fig. 2) (FAO, 1978 b).

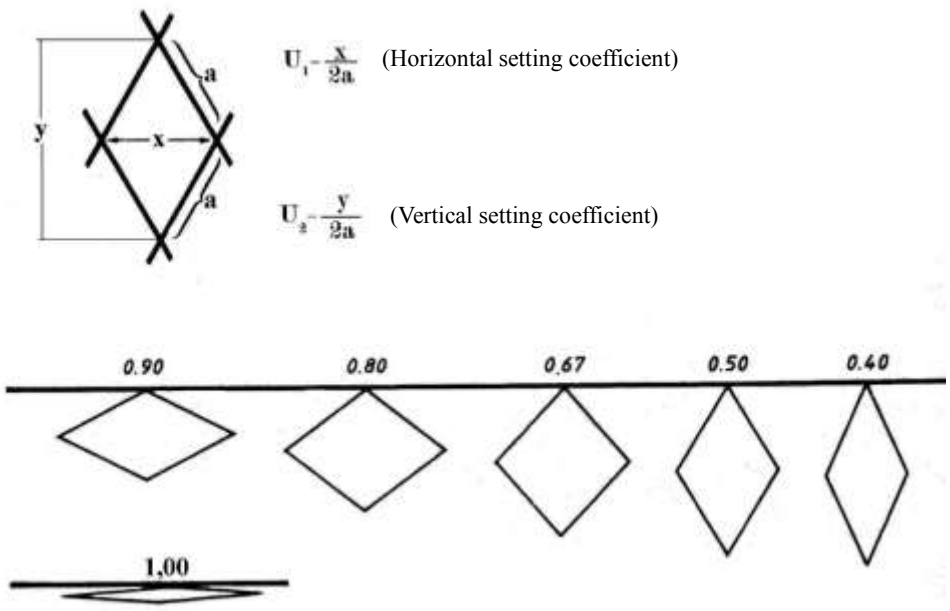

Fig. 2. Variation of mesh shape in relation to the horizontal setting coefficient.

The Holt method (1963) implies the estimation of minimum lengths (L_m) of fish belonging to a certain species which can be detained by clenching by two gillnets with different mesh sizes and the standard deviation (S), respectively. The input data for analysis are represented by the number of fish specimens detained, divided on length classes, for each gear (C_a and C_b) and by the two sizes of the mesh edges (m_a and m_b). In addition, only length classes where frequency overlaps consecutively are used for analysis.

As concerning turbot gillnets used for survey fishing (situation reported

previously), the 180 mm (m_a) and 200 mm (m_b) mesh size gillnets and the number of detained fish (C_a and C_b) divided on length classes (L_c) were taken for analysis, only for cases in which the frequency overlapped consecutively (Table 2).

Table 2. Number of turbot individuals caught, on length classes, with 180 and 200 mm mesh size and 6,350 m/kg thread thinness gillnets.

A	B	C	D
Length class (L_t) (cm) (x)	Number of individuals detained in 180 mm (m_a) (C_a) mesh size	Number of individuals detained in 200 mm (m_b) (C_b) mesh size	$\ln \frac{C_a}{C_b}$ (y)
38	0	0	-
40	3	0	0
41	7	0	0
42	19	2	-2.251
43	17	5	-1.224
44	12	26	0.773
45	5	33	1.887
46	0	6	-
47	0	2	-
48	1	2	0.693
49	0	1	-
50	0	2	-
52	1	1	0
54	0	1	-

In order to determine the minimum lenghts $L_{m_a} = -2.\frac{a.m_a}{b.(m_a + m_b)}$ and $L_{m_b} = -2.\frac{a.m_b}{b.(m_a + m_b)}$ of turbot specimens which can be detained by entanglement by the two gillnet types (m_a = 180 mm and m_b = 200 mm), as well as the common standard deviation $S = \sqrt{\frac{-2.a.(m_b - m_a)}{b^2.(m_a + m_b)}}$ and the selectivity factor $S_F = \frac{-2.a}{b.(m_a + m_b)}$, it was required to calculate the constants $a = \bar{y} - b.\bar{x}$ and $b = \frac{S_{x_i y_i}}{S_{x_i^2}}$ using the linear regression method (Table 3)

Table 3. Calculation of the a and b constants using the linear regression method.

Ref. no.	Length classes (cm) x_i	x_i^2	$\ln \frac{C_b}{C_a}$ y_i	y_i^2	$x_i.y_i$
1	42	1764	-2.251	5.067	-94.542
2	43	1849	-1.224	1.498	-52.632
3	44	1936	0.773	0.598	34.012
4	45	2025	1.887	3.561	84.915

n $\sum x_i = 174$ $\sum x_i^2 = 7574$ $\sum y_i = -0.815$ $\sum y_i^2 = 10.724$ $\sum x_i.y_i = -28.247$

$$\bar{x} = 43.5 \qquad \bar{y} = -0.20375$$

$$\frac{1}{n}.\left(\sum x_i\right)^2 = 7569\,; \qquad \sum x_i{}^2 - \frac{1}{n}.\left(\sum x_i\right)^2 = 5$$

$$\frac{1}{n}.\left(\sum y_i\right)^2 = 0.166; \qquad \sum y_i{}^2 - \frac{1}{n}.\left(\sum y_i\right)^2 = 10.558$$

$$\frac{1}{n}.\sum x_i.\sum y_i = -35.4525$$

$$S_{x_i^2} = \frac{1}{n-1}.\left[\sum x_i{}^2 - \frac{1}{n}.\left(\sum x_i\right)^2\right] = 1.667$$

$$S_{y_i^2} = \frac{1}{n-1}.\left[\sum y_i{}^2 - \frac{1}{n}.\left(\sum y_i\right)^2\right] = 3.52$$

$$S_{x_i.y_i} = \frac{1}{n-1}.\left[\sum x_i.y_i - \frac{1}{n}.\sum x_i.\sum y_i\right] = 7.21$$

$$b = \frac{S_{x_i.y_i}}{S_{x_i^2}} = 4.33$$

$$a = \bar{y} - b.\bar{x} = -188.15$$

The L_{m_a}, L_{m_b}, S and S_F parameters were finally obtained by replacing a, b, m_a and m_b in the following formulae:

$$L_{m_a} = -2.\frac{a.m_a}{b.(m_a + m_b)} = 41.2cm\,;$$

$$L_{m_b} = -2.\frac{a.m_b}{b.(m_a + m_b)} = 45.7cm\,;$$

$$S = \sqrt{\frac{-2.a.(m_b - m_a)}{b^2.(m_a + m_b)}} = 1.06$$

$$S_F = \frac{-2.a}{b.(m_a + m_b)} = 2.28$$

CONCLUSIONS AND RECOMMENDATIONS

Data processing through the Holt Method (1963) proved that, for the detention of turbot specimens with a minimum total length of 45 cm (size stipulated in EC Regulation no. 73/2016), 200 mm mesh size gillnets are optimal, as they detain by clenching turbot individuals with a size in compliance with the legislation in force (45.7 cm).

In addition, the analysis of practical results outlines that a normal catch capacity, not injurng the detained specimens and the net being sturdy enough, is provided when the d/a ratio (d = diameter of the net thread and a = mesh size) ranges between 0.025 - 0.0025, in relation to the net mesh size. For such reasons, in practice, a d/a ratio = 0.0025 is recommended for a = 200 mesh size turbot gillnets.

Selective fishing requires compliance with the condition that the minimum length of fish targeted by fisheries must exceed the length at first maturity, allowing the fish to spawn at least once.

Using selective gears, with mesh size allowing the escape of young, sexually immature specimens, in commercial fisheries will provide for a sustainable exploitation of fishery resources.

The recommendations and measures aiming at securing a sustainable exploitation of fishery resources, using selective gears, were underpinned both by the conclusions of our research and by other information sources covering environmental protection actions both nationally and internationally. After analzying and interpreting the available data, several measures and recommendations aimed at solving the critical issues were identified, as follows:

At regional level:

- Regional harmonization of the legal and institutional framework for a sustainable use of marine living resources;
- Assessing the efficiency of the fishery management system and the impact of current fishing practices;
- Developing joint projects and programmes for the protection and rehabilitation of marine living resources and habitats.

At national level:

- Elaborating the regulations for fishery activity:
    - Using new, state of the art fishing gears, manufactured only after a prior environmental impact assessment;
    - Using a minimum mesh size of 200 mm for turbot gillnets;
    - Complying with legal provisions in force (Law no. 23/2008 and annual Prohibition Orders) for marine fisheries;
    - Increasing control actions in fishing areas (Coast Guard and Fishery Inspection);

- Special protection of spawning, forage and wintering areas of fish species;
- Regular updating of the prohibition order with measures and recommendations resulting from research.

REFERENCES

Adam A., D. Bogatu, M. Răuţă, C. Cecală, N. Jelescu, C. Nicolau, C. Firulescu (1981), "Industrial Fisheries", Technical Publishing House, Bucharest;

Anton E. (2003), Research on the selectivity of fishing gear used in Romanian fisheries and elaboration of recommendations to provide the sustainable exploitation of pelagic fisheries resources. Project: PN 03-140303, NIMRD Constanta;

Anton E., Nicolaev S., Maximov V., Radu G., Radu Elena, Papadopol N.C., Staicu I. (2006), Recherches concernant l'influence de l'effort de pêche avec des filets maillants et filets maillants pour esturgeons sur les populations de dauphins du secteur roumain de la mer Noire. *Cercetari marine*. Recherches marines. INCDM. ISSN:0250-3069, **36**:457-468;

Anton E., Radu G., Radu E., Adam A., Adam Adrian (2012), Research on the selectivity of the pelagic trawls used in the Romanian costal fishery with trawls tonnage vessels. Journal of Environmental Protection and Ecology, Vol. 13, No 3 A, pp. - 1791;

Baranov F.I. (1914), "The capture of fish by gillnets". Mater. Poznanyu Russ. Rybolov 3(6): 56 -99 (Partially translated from Russian by W. E. Ricker);

Holt S.J. (1963), A method for determining gear selectivity and its application. ICNAF Spec. Publ., (5): 106-15;

FAO (1978), FAO catalogue of fishing gear designs. Catalogue FAO de plans d'engins de pêche. Catalogo de la FAO de planos de aparajos de pesca. Farnham, Surrey, Fishing New Boocks for FAO, 159 p.