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Multifilament Gillnet Selectivity for the Red Mullet (*Mullus barbatus*) in the Eastern Black Sea Coast of Turkey, Trabzon

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Abstract

The mesh selectivity of multifilament gillnets for red mullet (*Mullus barbatus*) was investigated using four different stretched mesh sizes (32, 36, 40 and 44 mm). Experimental fishing operations were carried out in Trabzon (Turkey) coasts of the Black Sea in springtime between 2002 and 2003. Selectivity on *M. barbatus* was assessed using the SELECT method, implemented in the PASGEAR software. Five different functional models; normal location, normal scale, gamma, log-normal and bi-model were used to fit the selectivity curve to the catch data. It was shown that the bi-model function was the best to fit the data. For the selectivity curves on the bi-model, the optimum lengths (100% retention probability for the 32, 36, 40 and 44 mm mesh sizes) were obtained as 14.24 cm, 16.02 cm, 17.8 cm, and 19.58 cm, respectively. Considering the minimum allowable landing size (13 cm) 36 mm was found the most adequate mesh for exploiting the red mullet as it evidenced more conservative approach towards fishing management.

Key words: Red mullet, gillnet, mesh selectivity, SELECT method, Black Sea

Introduction

Red mullet, *Mullus barbatus*, is one of commercially important fish species of the Black Sea and it has recently been subjected to important decrease (FAO, 2004). Decrease in the red mullet catch along the Turkish coasts was namely as a result of improper fisheries management and illegal fishing practices (Özbilgin *et al*., 2004). The gillnets are predominant gear for the catch red mullet owing to prohibition of area within the 3 miles range for bottom trawls and also the existence of unfavourable bottom structure.

Gillnets are passive fishing gears, being vertical walls of netting kept erect in water column by means of float and sinkers and set perpendicular to the direction of movement of target fish (Hameed and Boopendranath, 2000). The gear due to the simplicity of its design, construction, operation and low investment cost has been very popular among small-scale fishers. Most fishing gears, specially trawl gears, are unselective for the larger sizes, while such gears as gillnets are selective for a certain length range only, thus excluding the capture of very small and very large fish. This property of fishing gear is called gear selectivity (Sparre and Venema, 1998). Gillnets are accepted as a very selective gear in worldwide. Since nets with certain mesh sizes are more likely to catch fish of certain lengths, there will be a notable decrease in the number of fish caught that are either smaller or larger than this length (Hamley, 1975).

Numerous studies (Hamley, 1975; Millar, 1992; Samayaranaka *et al*., 1997; Yokota *et al*., 2001) have already proved that mesh size, net construction material, visibility of net in the water and hanging ratio affect the gillnet selectivity to various extent. Although gillnets are one of the most frequently used fishing gear for red mullet, the impact they have on the selectivity of the target population is unknown. The analysis of the selectivity of this type of gear will provide biological fishery information for the management and development of the Turkish artisanal fishery.

Material and Methods

Experimental Fishing Trials

The samplings were carried out in Trabzon coasts of the Black Sea from two quadrangle stations, Faroz and Darıca during two periods from May to June 2002 and from April to June 2003. The coordinates of the stations referring to the corner-points are 41º00'46" N; 39º42'45" E, 41º00'40" N; 39º42'46" E, 41º00'44" N; 39º43'57" E, 41º00'37" N; 39º43'55" E and 41º03'12" N; 39º32'20" E, 41º03'11" N; 39º32'18" E, 41º02'26" N; 39º33'23" E, 41º02'25" N; 39º33'22" E, respectively. Experimental fishing by gillnets of four mesh sizes 32 mm (that are currently used by local fishers), 36, 40 and 44 mm was accomplished during the night. Nets were set on sunset (18:00 h) and retrieved at midnight (24:00 h), thus having an average soak time of 6 hours. Fishing experiments were repeated 15 times during the whole study and maintained in operation almost similar fishing conditions. A gill-netter of 9 m long and 38 HP main engine was hired from the local fleet to conduct the fishing trials.

Gillnets were designed to operate at bottom and were placed in a range of depth between 10 to 20 m, over muddy bottoms. The design and specifications of the nets used in the experiment were similar to those used by local fishers in terms of number of meshes deep, hanging ratios, lead lines and floats (Figure 1). The experimental gillnet was composed of four sheets of different meshes (32, 36, 40 and 44 mm end to end), each 50 m long and height of 50 meshes (average 2 m). To minimize the effect of net-piece on the catch each, sheet of different meshes were configured 5 meters apart. For all meshes the hanging ratio was 0.50 and all nettings were made of PA multifilament (110 D/3). During the survey, a total of 373 *M. barbatus* individuals were caught with the gillnets sorted by mesh size, and the data of total length (TL) were grouped into 1 cm intervals.

Estimation of Gillnet Selectivity Curve

Gillnet selectivity for *M. barbatus* was estimated by PASGEAR software (version April 2007) (Kolding, 1999), which is a customised data base package intended for experimental fishery data from passive gears, available at http://www.cdcf.no/data /pasgear. It is based on the general statistical model (SELECT) described by Millar (1992), and its specific application on gillnets and hooks are described by Millar and Holst (1997), and Millar and Fryer (1999).

Five models of selection curves; normal location, normal scale, gamma, log-normal and bi-modal (Millar and Fryer, 1999) in PASGEAR were tested in the present study. The normal location model has fixed spread whereas in normal scale model both the modes and the spreads of selection curves are increasing with mesh size (i.e. geometric similarity). The log-normal, gamma and bi-modal models are asymmetrical retention modes (i.e. skewed distributions). The bi-modal curve is appropriate if the fish are caught by both gilled and entangled.

The goodness of fit was evaluated by comparison of deviances within the models. A high deviance may indicate that the chosen model is not suitable for the data. In general, the model deviance should not be much larger than the number of degrees of freedom (Park *et al*., 2004). It is even more desirable for the model deviance to be smaller than the number of degrees of freedom for a better fitness. The lowest deviance value corresponding to the best fitting (Dos Santos *et al*., 2003; Erzini *et al*., 2003) was observed in bi-model.

Results

A total of 373 individuals of *M. barbatus* were caught during the experimental fishing operations. The length frequency distributions caught in four different meshes of gillnets were presented in Figure 2. The highest number of catch (60.6%) was obtained in the smallest mesh size of net and the number of individuals caught for fishing period was decreased with the increase of mesh size. The average

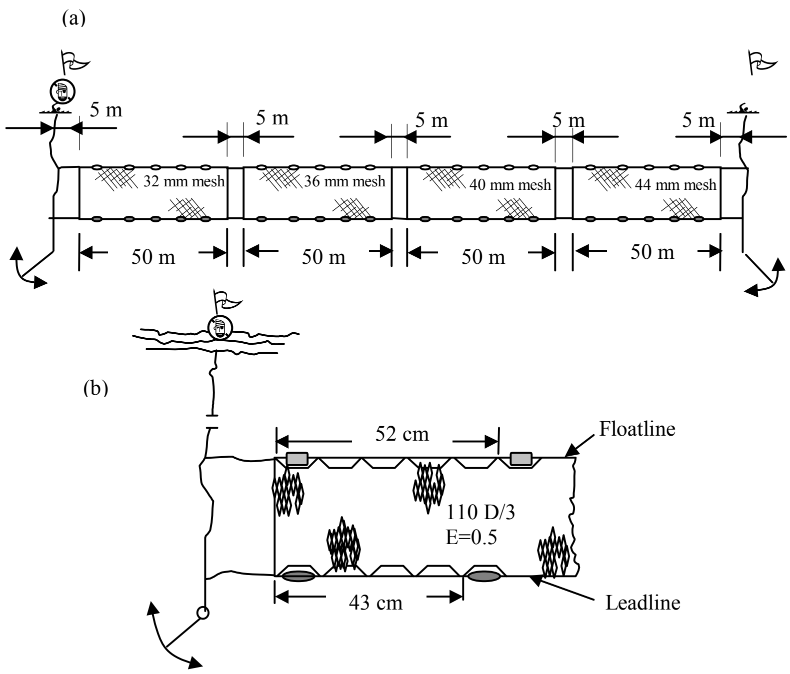

Figure 1. Diagrammatic representation of (a) gillnets experimental panels, and (b) rigging details for mesh sizes 32, 36, 40, 44 mm. (D is the denier number of twine and E is the hanging ratio, defined as the ratio between the length of netting frame and the stretched netting).

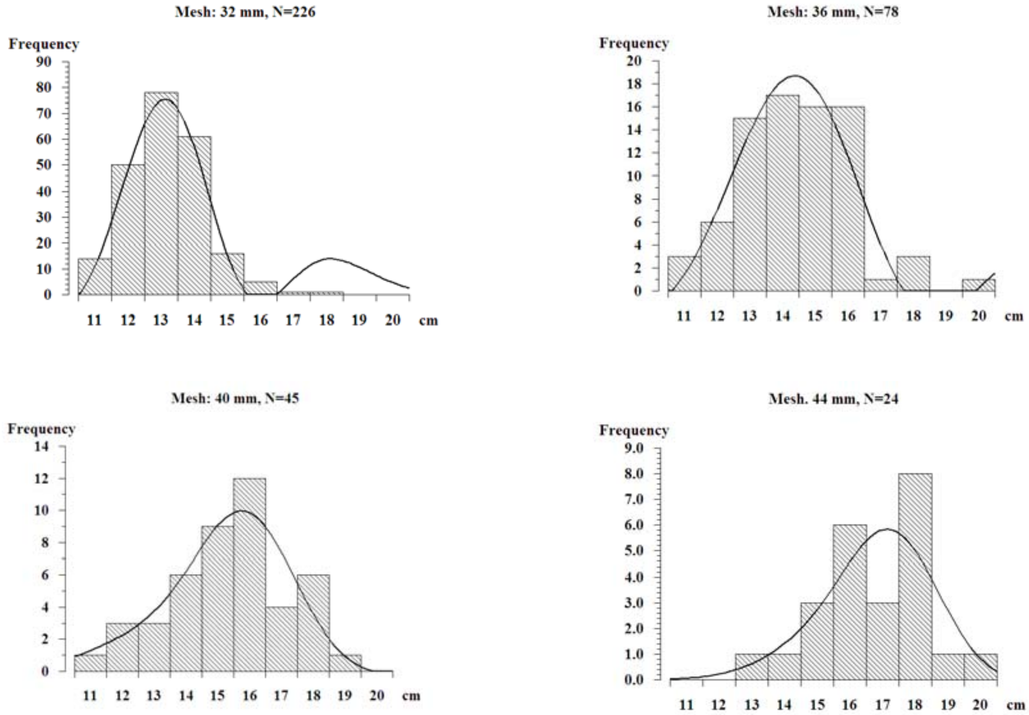

Figure 2. Histogram of length-frequency distributions of *Mullus barabatus* and fixed catch curve (line) using data obtained by gill nets of 32, 36, 40 and, 44 mm mesh sizes, in Trabzon coasts (N= number of fish caught).

proportions in terms of numbers for the nets of 36, 40 and 44 mm meshes were 20.9%, 12.1% and 6.4%, respectively. The use of larger mesh sizes resulted in increased mean length of captured fish (13.2 cm for 32 mm mesh size, 14.4 cm for 36 mm mesh size, 15.4 cm for 40 mm mesh size, and 16.8 cm for 44 mm mesh size). The mean length of fish is almost linearly proportional to the increasing mesh size as may be seen from the observed and fitted catch curves (Figure 3).

Selectivity curves using the PASGEAR software for normal location, normal scale and bi-model are presented in Table 1. The bi-modal model had the lowest deviance value, indicating the best fit. The common mesh selection parameter k_1 relating the modal length to the mesh size was found to be 0.445. On the basis of this parameter, the corresponding model lengths for 32, 36, 40, and 44 mm meshes were calculated to be 14.24 cm, 16.02 cm, 17.8cm, and 19.58cm, respectively. Selectivity curves based on bi-model for the different mesh sizes were shown in Figure 4.

Length frequency distributions for the red mullet were also examined in terms of skewness, which is available in the PASGEAR. It was seen that the catch data for the gillnets of 32 and 36 mm mesh sizes are skewed to the right, whereas gillnets of 40 and 44 mm mesh sizes are skewed to the left but to a lesser extend (approaching more normal curve), and the magnitude of the skewness decreases with the increasing mesh size (Figure 2).

Discussion

In the present study, the bi-model (bi-normal) was found to best represent the selectivity curve of gillnet for the red mullet. As generally stated in many studies (Poulsen *et al*., 2000; Fujimori and Tokai, 2001; Dos Santos *et al*., 2003; Erzini *et al*., 2003) that for several fish species, bi-modal curves may produce better fit than unimodal models. This may be attributed to the fact that in gillnets some part of the catch is due to entanglement rather than wedged or gilled (Hamley, 1975; Sbrana *et al*., 2007; Carol and Garcia-Berthou, 2007).

Skewness in distribution of catch, as seen in Figure 2, may be interpreted that most fish are entangled in 32 and 36 mm gillnets, whereas most fish are wedged or gilled in 40 and 44 mm gillnets (Hamley, 1975; Pet *et al*., 1995; Kurkilahti *et al*., 1998; Dos Santos *et al*., 2003).

The main idea behind the fishery regulations is to permit adults to contribute to recruit before being caught. Petrakis and Stergio (1996) and Fabi *et al.* (2002) have reported that length at first maturity for *M. barbatus* is 11.2 cm and 11 cm, respectively. Almost no catch smaller than length at first maturity was observed by the experimental nets of our study. Minimum landing size established for *M. barbatus* is 13 cm (Anon, 2004). The ratio of undersized fish (<13 cm) captured by 32, 36 and 40 mm meshes were 28.3%, 11.5% and 8.8%, respectively. However, no undersized individuals were taken by 44 mm mesh.

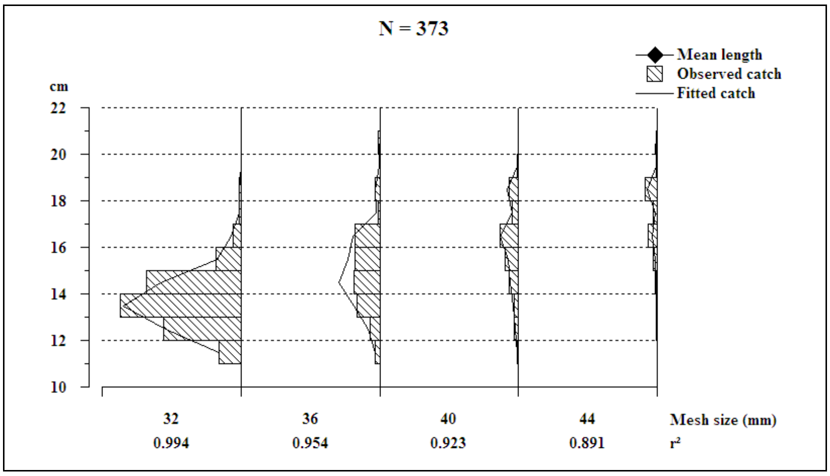

Figure 3. Length distribution histograms of observed catch data and calculated regression (equation line) of mean size at capture for *Mullus barbatus* caught with different mesh sizes (stretched mesh 32, 36, 40, 44 mm).
N= Total number of fish included into regression analysis.

Table 1. Fitted parameters and deviances for the fit. d.f. is degrees of freedom

Model	Parameters	Model deviance	d.f.
Bi-modal	$(k_1, k_2, k_3, k_4, w)=(0.445, 0.034, 0.484, 0.069, 0.376)$	16.899	29
Normal location	$(k, \sigma)=(0.452, 1.899)$	41.090	32
Normal scale	$(k_1, k_2)=(0.458, 0.048)$	26.648	32
Gamma	$(k, \alpha)=(0.006, 77.429)$	30.160	32
Lognormal	$(\mu_1, \sigma)=(2.695, 0.120)$	33.037	32

μ_i = mean size (length) of fish caught in mesh size $i=k_1.m_i$, σ_i=standard deviation of the size of fish in mesh $i=k_2.m_i$ or $\alpha.m_i$, k_i is the ratio of L_j midpoint of length class j to mesh size m_i and w is the proportion of the bi-modal selection curve.

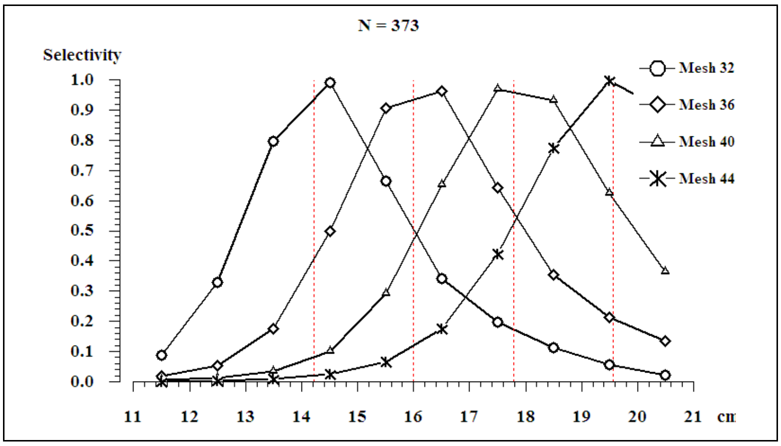

Figure 4. Gillnet selection curves for *Mullus barbatus* caught with different mesh sizes (stretched mesh 32, 36, 40, 44 mm).
N= Total number of fish caught.

For management purposes, all the mesh sizes were found to be in agreement with the actual minimum landing size. There is no minimum mesh size established for *M. barbatus* in Turkish fishery regulations. According to this study, the most recommended mesh size would be 36 mm, even though this net catches less fish than 32 mm net, assuring more protection for the juveniles. However, the scarcity of total number of fish should be mentioned as the potential drawback due to limitation of the study.

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