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Effects of Hanging Ratio on Gill Net Selectivity for Annular Sea Bream (*Diplodus annularis*) in the Northern Aegean Sea, Turkey

Adnan Ayaz, Ugur Altinagac, Ugur Ozekinci, Ozgur Cengiz and Alkan Oztekin
Faculty of Fisheries, Canakkale Onsekiz Mart University, Canakkale, Turkey

Abstract: This study has been conducted in the North Aegean Sea around the coasts of the Gallipoli peninsula at 3-30 m of water depth between February 2007 and June 2009. In order to test the effect of the hanging ratio on the selectivity, 9 gillnets with 3 different hanging ratios (E = 0.4-0.6) and 3 different mesh sizes (18-20-22 mm) have been made use of. Other than, the hanging ratios and mesh size all other features and specifications of gill nets were identical. Select method was used to fit gillnet selectivity curves. A total of 64 fishery operations have been performed in the study. The lognormal model gave the best fit for all hanging ratios (for hanging ratio (E) = 0.4-0.6, the model deviance = 138.9, 66.19, 56.23, respectively). It was determined that there was no significant selectivity differences among the same mesh size for different hanging ratios. The results showed that there is no effect of hanging ratios on size selectivity of annular sea bream (*Diplodus annularis* L.) in north Aegean gillnet fishery.

Key words: Annular sea bream, gillnet selectivity, select method, hanging ratio, Northern Aegean Sea

INTRODUCTION

For sustainable fishery purpose knowing of the selectivity of the fishing gear is important for the protection of young individuals and the development of appropriate management policies. In parallel to this gillnets are the most frequently used fishing gear because of ease of their use, their low costs and high selectivity (Holt, 1963; Hamley, 1975; Reis and Pawson, 1992; Metin *et al*., 1998; Kara, 2003). It has been reported that the net mesh size, body shape, fish size, hanging ratio, the thickness and the flexibility of the netting twine, the visibility of the twine, fish behaviour affect the selectivity of gill nets (Clarke, 1960; Hamley, 1975). However, it has been stated expressly that the major factor affecting the selectivity is the mesh size (Von Brandt, 1975).

For this reason, the studies on selectivity have mostly focused on the effect of mesh size on the size selectivity (Van Densen, 1987; Karunasinghe and Wijeyaratne, 1990; Pet *et al*., 1995; Santos *et al*., 1995; Petrakis and Stergiou, 1996; Psuty and Borowski, 1997; Santos, 1998; Madsen *et al*., 1999; Purbayanto *et al*., 2000; Fujimori and Tokai, 2001; Lucena and O'Brien, 2001; Fabi *et al*., 2002; Stergiou and Erzini, 2002; Park *et al*., 2004; Fonseca *et al*., 2005; Ozekinci, 2005; Askey *et al*., 2007; Revill *et al*., 2007; Karakulak and Erk, 2008; Ayaz *et al*., 2009; Prchalova *et al*., 2009). There have been a low number of publications on the effects of other factors on selectivity. These studies focused on the effect of seasonal variations (Moth-Poulsen, 2003), the twine thickness (Yokota *et al*., 2001; Holst *et al*., 2002) and the hanging ratio on selectivity (Balik and Cubuk, 2001). Moth-Poulsen (2003) has stated that the effect of seasonal changes is considerable on selectivity. Holst *et al*. (2002) have stated that the twine thickness affects the catch efficiency but it has little effect on the selectivity. Similarly, Yokota *et al*. (2001) found that the effect of the twine thickness has no effect on selectivity. However, they have reported a positive correlation between the twine thickness and the mesh opening and also emphasized that this could be important in selectivity. In the studies where the effect of hanging ratio on selectivity were investigated, a significant findings stating the effect of hanging ratio on selectivity could not be attained (Sulaeman *et al*., 2000; Balik and Cubuk, 2001).

In this study, the effect of different hanging ratios on the size selectivity of annular sea breams (*Diplodus annularis* L.) caught in gill nets located in the Northern Aegean Sea were investigated.

MATERIALS AND METHODS

This study had been conducted in the Northern part of Aegean Sea, around the coasts of the Gallipoli Peninsula at 3-30 m of water depth between February 2007 and June 2009 (Fig. 1). In order to test the effect of the hanging ratio on the selectivity, 9 gillnets with 3 different hanging ratios (E = 0.4-0.6) and 3 different mesh sizes (18-20-22 mm) have been made use of. The other specifications of the nets were kept the same except for the hanging ratio and the mesh size. Two of the three hanging ratios (E = 0.4-0.5) are being massively used in the nets by the fishermen fishing along the North Aegean

Corresponding Author: Ozgur Cengiz, Faculty of Fisheries, Canakkale Onsekiz Mart University, Canakkale, Turkey

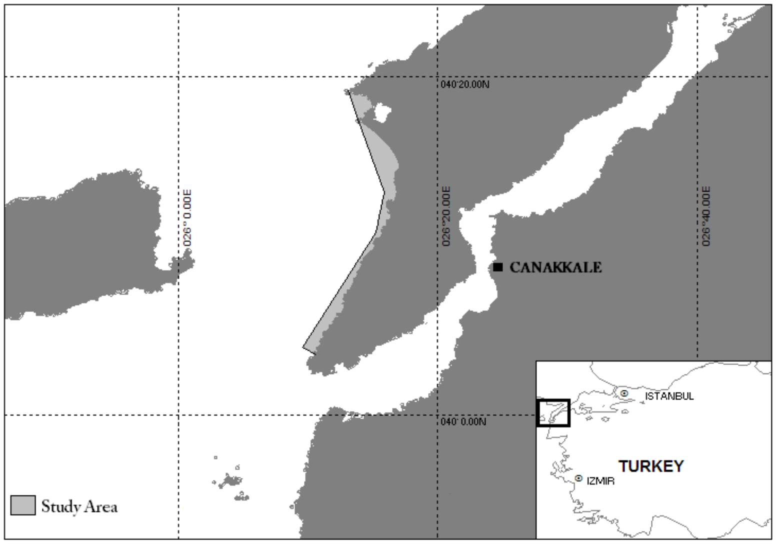

Fig. 1: Study area

were carried out in total. The total length distributions of fish caught by nets were recorded. Length measurements of caught fish were made in mm sensitivity. The mesh sizes corresponding to each hanging ratio were analyzed among themselves in selectivity calculations. The select method has been used in the selectivity calculations (Millar, 1992; Millar and Holst, 1997; Millar and Fryer, 1999). The standard selectivity program GILLNET (Generalized Including Log-Linear N Estimation Technique) has been used to estimate the selectivity parameters of the nets (CONSTANT, 1998). Using this program, it is possible to calculate the selectivity curve parameters using five different models normal location, normal scale, lognormal, gamma and bi-normal methods. Two criteria have been taken into consideration in the determination of the selectivity curve of the suitable model.

The first one is the smallest deviance and the second one is the p-value displaying the degree of model compatibility which was set to the critical value of 0.05. In order to compare the results obtained at different hanging ratios for the same mesh size, Microsoft Excel has been used. The selectivity curves of the suitable model which have been obtained from GILLNET have been overlaid in Microsoft Excel. One-way ANOVA has been used to investigate the significance of the variation in the fish total size distributions among the trial nets of the same mesh size and varying hanging ratios.

RESULTS AND DISCUSSION

Sixty four fishery operations have been performed in the study. About 902 annular sea breams were caught in

Table 1: Number annular sea bream captured by experimental nets

	Nominal bar length (mm)			
Hanging ratio	18	20	22	Total
0.4	108	118	117	343
0.5	62	98	104	264
0.6	80	109	106	295
Total	250	325	327	902

the trials and the most fish (327 fish) were caught using the 22 mm mesh size nets (Table 1). Based on the selectivity parameters which have been calculated by the GILLNET software, the lognormal model which yielded the lowest model deviance for all hanging ratios has been selected as the best model (for E = 0.4-0.6, the model deviance = 138.9, 66.19, 56.23, respectively) (Table 2). The calculated model lengths and spread values were shown in Table 3.

The model lengths and spread value were observed to increase with increasing mesh size (Table 3). The frequency distributions (%) and selectivity curves with respect to the variations in twine thickness in the trial nets were shown in Fig. 2 and 3.

The difference in variation of the total fish length distribution at the same mesh size and at different hanging ratios were found insignificant according to the results of the selectivity curves and the one-way ANOVA test ($p>0.05$).

The differences among the catch efficiencies of the nets were also identified as insignificant ($p>0.05$). In this study, no statistically significant differences have been observed among the length selectivity or the catch efficiency of the fish caught using nets with the same

Table 2: Result of select method for the estimation of gillnet selectivity for different hanging ratios

Spec.	Model	Equal fishing power parameters	M. Dev.	p	Fishing power mesh size parameters	M. Dev	p	df	Hang. ratio
Annular	Normal scale	(k1, k2) = 0.28169, 0.02640	172.28	0.0000	(k1, k2) = 0.28416, 0.02628	172.48	0.0000	34	0.4
Sea	Normal location	(k, s) = 0.27987, 1.02263	158.47	0.0000	(k, s) = 0.28221, 1.02669	156.94	0.0000	34	
Bream	Log normal	(m, s) = 2.3143, 0.08702	138.9	0.0000	(m, s) = 2.32187, 0.08702	138.9	0.0000	34	
(*Diplodus*	Gamma	(k, a) = 0.00222, 126.79809	149.17	0.000	(k, a) = 0.00222, 127.79809	149.17	0.0000	34	
annularis)	Bi-modal	No fit			No fit				
	Normal scale	(k1, k2) = 0.28155, 0.02501	90.24	0.0000	(k1, k2) = 0.28377, 0.02491	90.37	0.0000	32	0.5
	Normal location	(k, s) = 0.27952, 0.95028	78.5	0.0000	(k, s) = 0.28152, 0.95328	78.29	0.0000	32	
	Log normal	(m, s) = 2.31554, 0.08069	66.19	0.0000	(m, s) = 2.32206, 0.08069	66.19	0.0004	32	
	Gamma	(k, a) = 0.00194, 145.35542	73.59	0.0000	(k, a) = 0.00194, 146.35542	73.59	0.0000	32	
	Bi-modal	No fit			No fit				
	Normal scale	(k1, k2) = 0.28097, 0.02417	74.34	0.0000	(k1, k2)= 0.28305, 0.02408	74.44	0.0000	28	0.6
	Normal location	(k, s) =0.27864, 0.94260	68.1	0.0000	(k, s) = 0.28063, 0.94546	67.94	0.000	28	
	Log normal	(m, s) = 2.31197, 0.08135	56.23	0.0000	(m, s) = 2.31859, 0.08135	56.23	0.0012	28	
	Gamma	(k, a) = 0.00192, 146.39032	61.83	0.0002	(k, a) = 0.00192, 147.39032	61.83	0.0002	28	
	Bi-modal	No fit			No fit				

Table 3: Model length and spread values for the best fitting models of gillnet selectivity model

	Hanging ratio			
Mesh size	0.4	0.5	0.6	Model
18 mm				
Modal length	10.110	10.640	10.090	Log normal
spread	0.892	0.821	0.830	
20 mm				
Modal length	11.240	11.180	11.210	Log normal
spread	0.991	0.912	0.923	
22 mm				
Modal length	12.360	12.300	12.330	Log normal
spread	1.090	1.003	1.015	

mesh size and differing hanging ratios. Balik and Cubuk (2001) have supported these findings. The effects of hanging ratio have been found significant on the catch efficiency in recent studies (Samaranayaka *et al.*, 1997; Balik and Cubuk, 2001; Gray *et al.*, 2005). In the present study, it was expected to have a negative correlation between the hanging ratio and the spreading of the curves and for the nets with small hanging ratios to have higher catch efficiencies.

Although, the mesh size curves for the hanging ratio E = 0.4 were as expected, they were not as expected for the hanging ratios E = 0.5 and 0.6. Sulaeman *et al.* (2000) has reported that the spreading of the curves increased with decreasing hanging ratio. The body form of the fish and the hanging ratio which are among the factors affecting selectivity (Clarke, 1960; Hamley, 1975) were thought to be so by being interactive themselves because as the hanging ratio decreased, the tension of the net decreased and therefore the chance of the fish getting caught in the net increased (Sulaeman *et al.*, 2000).

Because the annular sea bream did not have any morphological structures other than the fin rays which would cause them to get tangled in the net, the hanging ratio was considered not to affect the selectivity and the

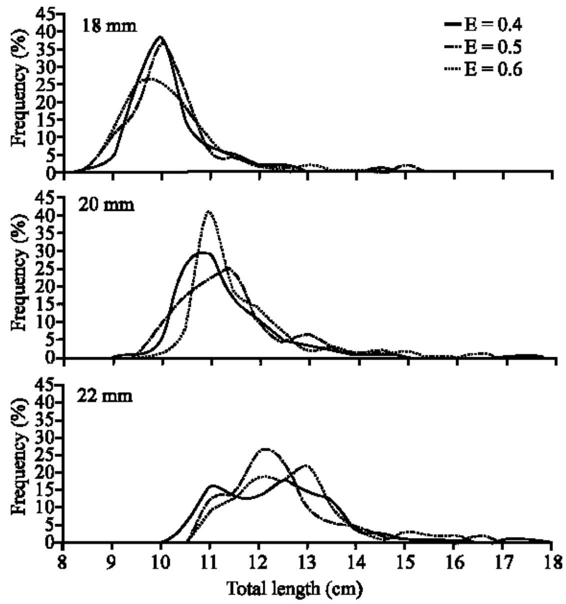

Fig. 2: Frequency distribution (%) of different hanging ratios and mesh sizes for annular sea bream

catch efficiency. The model length was determined as 9.97-12.52 cm for 18-20-22 mm mesh size in various studies conducted using gillnets (Petrakis and Stergiou, 1995; Metin *et al.*, 1998; Stergiou and Erzini, 2002; Stergiou and Karpouzi, 2003; Karakulak and Erk, 2008). The lengths of the fish which have been caught in the nets that have been used in the study were also within the provided range.

The length of annular sea bream at initial reproduction were determined as 13 cm in the western parts of the Mediterranean Sea (Fischer and Schneider, 1987; Froese and Pauly, 2006), 13 cm for the southern coasts of Portugal (Santos, 1998) and 10-10.5 cm (female-male) for the Aegean Sea and it has been recommended

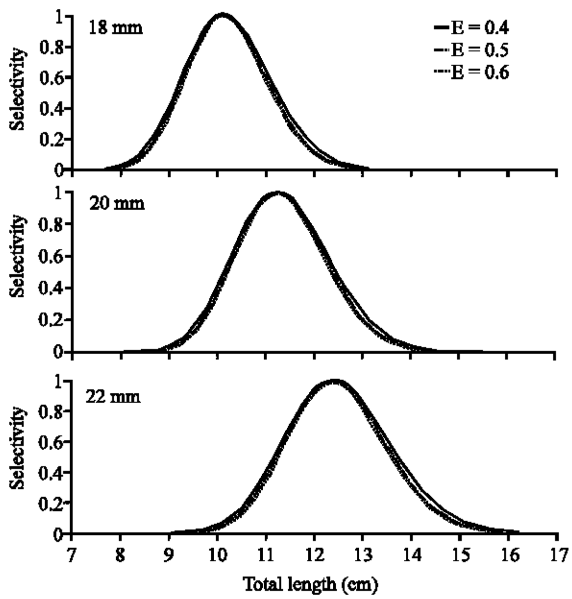

Fig. 3: Selectivity curves of different hanging ratios and mesh size for annular sea bream

that fish that were <11 cm of total length should not be caught (Kinacigil *et al*., 2008). Metin *et al.* (1998) have proposed the use of nets having 22 mm mesh size or more in the catching of annular sea bream. Similarly in the study, it has been detected that fish which have not yet achieved their initial reproduction lengths were caught in high ratios in the nets with mesh sizes <22 mm. This result supports Metin *et al.* (1998).

CONCLUSION

In the present study, it has been observed that the hanging ratio was not effective on selectivity. However, it is known that as the hanging ratio decreased fish being caught in the net becomes more tangled as a result of the elastic stretching of the net getting decreased. Low hanging ratio may be effective on selectivity of fish which morphologically more available to tangle. This case related with fish morphology is important for fisheries management.

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