

The effects of trawl codend mesh size selectivity on the length composition of catches of pandora, *Pagellus erythrinus* L. 1758 in the shelf area of the Montenegrin coast (South Adriatic)

Aleksandar JOKSIMOVIĆ^{1*}, Slobodan REGNER² and Jacques SACCHI³

¹*Institute of Marine Biology, Dobrota bb, P. Box 69, 85 330 Kotor, Montenegro*

²*Institute for multidisciplinary research, Bulevar Despota Stefana 142, Belgrade, Serbia*

³*French Research Institute for Exploitation of the Sea, Avenue Jean Monnet BP 171, 34200, Sète, France*

*Corresponding author, e-mail: acojo@ac.me

Selectivity curves of pandora (*Pagellus erythrinus*, L. 1758) have been estimated in the area of the Montenegrin shelf (South Adriatic), for trawls with bar mesh sizes of 13.5, 16.1, 17.5, 22 and 35 mm (according to national legislation in Montenegro bar mesh size is measured from knot to knot which is, according to Commission Regulation (EC) No. 129/2003, stretched mesh size divided by 2). Although the existing national legislation prescribes that the minimum mesh size of the trawl be not smaller than 20 mm, trawls with forbidden mesh sizes are often used in this area. Results obtained showed that meshes smaller than 20 mm (13.5 mm, 16.1 mm, 17.5 mm) catch large numbers of immature individuals, since the length of 50% retention (L50%) for all these meshes is smaller than the length of fish at first spawning and which is, for *Pagellus erythrinus* in Montenegrin waters, ≈ 12 cm. L50% is longer than the average length of the first spawning only for nets with openings of 22 mm and 35 mm bar mesh size.

Key words: *Pagellus erythrinus*, trawl mesh size, selectivity, Montenegrin shelf (South Adriatic)

INTRODUCTION

Pandora, (*Pagellus erythrinus*, L. 1758), Sparidae, Percoidei, one of the economically most significant species in trawling fisheries over the Montenegrin shelf, was previously thoroughly investigated (LEPETIĆ, 1965; RIJAVEC, 1975) with respect to its biology and population dynamics in the region.

However, in the intervening time, some important changes have happened in this area.

Until 1990 only one trawler with 132 kW engine power operated in this region with a mean annual fishing effort of 70 days. Therefore demersal stocks have been only slightly exploited, and their biomass could be considered as almost virgin. Since 1991 the number of trawlers with more powerful engines has increased, reaching 37 vessels in 1998. Although the number of trawlers and their fishing effort has decreased since 1999 (16 vessels in 2002), a decline of biomass from 1998 to 2000 was observed. From

2641 tons in 1998, biomass fell to 2197 tons in 2000 (REGNER & JOKSIMOVIĆ, 2002).

Therefore, among the other economically important species, particular attention was paid to investigations of gear selectivity influence on catch structure of Pandora, since the regulation of mesh size is the most important method of regulating mortality, together with regulation of fishing effort, (PALOHEIMO & CADIMA, 1964; KIMURA, 1977; HOYDAL *et al.*, 1982; WILEMAN *et al.*, 1996; GFCM, 1999).

MATERIAL AND METHODS

Material was collected during the period from May 2002 to May 2004, with commercial trawlers operating over the Montenegrin shelf to the 300 m isobath (Fig.1). The bar mesh sizes (diamond) of the codend ranged from 13.5 to 35 mm.

Thirty-two trawl hauls from different vessels were analyzed in total. The lengths of 3201 individuals of *P. erythrinus* were

measured. Duration of hauls were from 0.58 to 3.77 hours. For every haul data on the characteristics of the boat (LOA, beam, engine power) and of the net (length of the net and codend, bar mesh sizes of the net and codend) were recorded (Table 1). Local times, as well as the geographical coordinates of the beginning and of end of hauls were noted.

Collected material was almost entirely processed on board. Total length (L), from the peak of the mandible to the stretched end of the caudal fin, was measured to the nearest millimeter. Data obtained were ranged by frequencies of 1 cm length classes.

Although the existing legislative provisions prescribe that the minimum codend mesh size of the trawl be not smaller than 20 mm, trawls with forbidden mesh sizes are often used in this area. Therefore experiments with covered codend were not necessary for estimates of selectivity. The specimens were collected by means of trawls with bar codend mesh sizes of

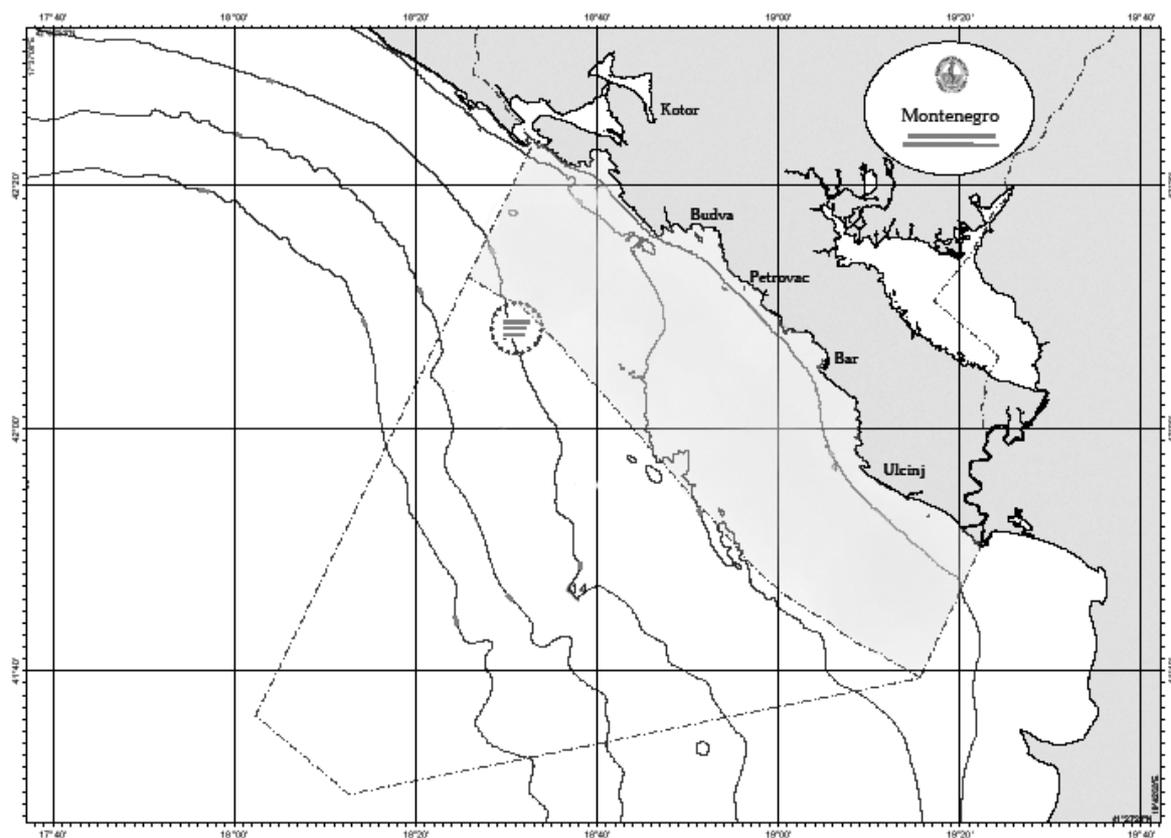


Fig. 1. Investigated area - Montenegrin coast

Table 1. Data on comercial vessels and hauls

Vessels	Length Overall (m)	Width (m)	Gross Register Tonnage	Power (KW)	Length net (m)	Mesh size (mm)	Number of hauls	Number of specimens
ALBATROS	22.6	6.34	73	300	26	13.5	10	462
BASTIANA	14.23	4.25	14.59	160	35	16.1	4	278
PASQUA	22.26	5.32	53.94	382	69	17.5	7	884
USKOK	25.3	6.23	87	185	44	22	5	1209
MOGREN	27.74	5.74	49.83	412	39	35	6	368

13.5, 16.1, 17.5, 22 and 35 mm, and selectivity curves were calculated for each mesh size. The results obtained were used here as a basis for analyzing the effects of mesh size selectivity on the length composition of *Pagellus erythrinus* caught by trawls. The selection curve was fitted to the logistic function (PAULY, 1984).

Since the parameters of the von BERTALANFFY (1938) growth curve were known, with $L_{\infty} = 32.76$ cm, $K = 0.202$, $t_0 = -1.97$ (JOKSIMOVIĆ, 1999), the logistic function was also expressed using the PAULY (1983) length conversion method as a function of age. To compute the observed values of both length and age selectivity curves, mortality rates for every mesh size were estimated: $Z_{13.5} = 1.76$; $Z_{16.1} = 3.11$; $Z_{17.5} = 0.49$; $Z_{22} = 0.59$; $Z_{35} = 0.99$ (JOKSIMOVIĆ, 1999).

Thus, using the same function both lengths and ages of 50%, 75% and 25% retention were estimated.

Since the logistic function asymptotically tends to 1, the length at which the fish that entered the net are fully retained (L') was estimated as $L' \approx L_{50\%} * 2$.

FISAT (GAYANILO *et al.*, 1996) computer program packages were used for fitting the curves to the data.

RESULTS

The distribution of the number of individuals for different mesh sizes shows that length frequency peaks shift towards the right side of the frequency distribution axis with mesh size increase (Fig. 2).

The parameters of the logistic function, obtained from its linearized form by a linear regression method, are given in Table 2.

Results obtained show that with mesh size increase the lengths of the first capture (L_T), 50% retention (L_{c50}) and of 100% retention (L') also increase (Fig. 3).

The result of the test of comparison of regression lines obtained, performed by analysis of covariance for single Y per X (SOKAL & ROHLF, 1981) was:

$$F_{(4, 21)} = 14.6, P < 0.005$$

Thus, the test showed significant a difference between forbidden (13.5, 16.1, 17.5 mm) and allowed (22, 35 mm) mesh sizes (Fig. 4).

The significance of the difference between mesh sizes of 22 mm and 35 mm was also tested, using the F-test for two regression coefficients SOKAL & ROHLF (1981), and the following values were obtained:

$$F_{(1,9)} = 0.748, P < 0.5$$

This comparison did not show a significant difference between the selectivity curves of 22 mm and 35 mm mesh sizes.

The values of L_{c50} for mesh sizes of 13.5 mm, 16.1 mm and 17.5 mm were 7.60 cm, 8.68 cm, and 10.82 cm, respectively. On the other hand, L_{c50} values for the mesh sizes of 22 mm and 35 mm, which significantly differ from the forbidden ones, were 15.0 cm and 15.26 cm.

DISCUSSION

Pandora reaches sexual maturity at a length of ≈ 12 cm (RIJAVEC, 1975), while the minimal length which is permitted by the law is 11 cm.

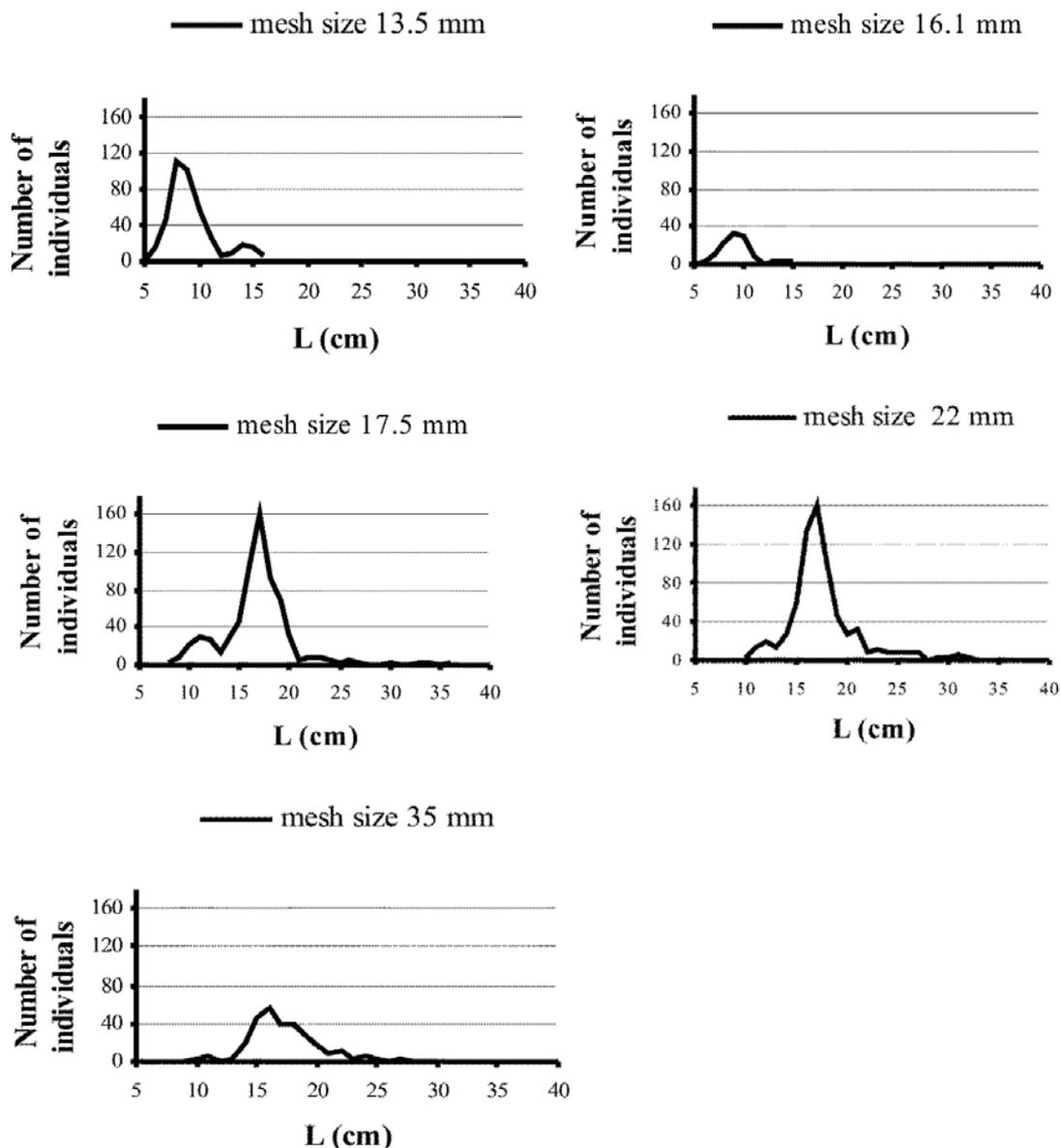


Fig. 2. Length frequencies of *Pagellus erythrinus* caught by the trawls with the bar mesh size range from 13.5 mm to 35 mm

So, the L50% values for forbidden mesh sizes show that these nets catch disproportionately large number of immature individuals. This is obviously harmful since in this way they do not reach the age of first spawning.

Only for mesh sizes of 22 mm and 35 mm L50 % was longer than the length of first maturity, and therefore only these meshes allow substantially large number of juveniles, as far as fishing mortality by trawling is concerned, to recruit to mature part of the population, i.e. to reproduce. Since there was no significant

difference between these meshes, it seems, as far as Pandora is concerned, that there is no sense in using mesh sizes larger than 22 mm in the investigated area.

Similar research was performed in the north Adriatic (JUKIĆ & PICCINETTI, 1987, 1988) and it was found that for a mesh size of 20.5 mm L50% was 11.8 cm, while L50% of 16.4 cm was estimated for a mesh size of 27.5 mm. Also (VRGOČ, 1995) found in the middle Adriatic that for a mesh size of 20 mm L50% was 11.3 cm. As far as other Mediterranean regions are

Table 2. Estimated parameters of *Pagellus erythrinus* selectivity curves as a function of age (T_1 , T_2), ages of 50% retention ($t_{50\%}$), age selectivity range ($t_{25\%}$, $t_{75\%}$), lengths of 50% retention ($L_{50\%}$), length selectivity range ($L_{25\%}$, $L_{75\%}$), and ages and lengths of 100% retention (t' , L')

Mesh size (mm)	T_1	T_2	r	$t_{25\%}$	$t_{50\%}$	$t_{75\%}$	$L_{25\%}$	$L_{50\%}$	$L_{75\%}$	t'	L'	N
13.5	14.72	-12.96	0.984	1.06	1.14	1.22	7.16	7.60	8.03	2.27	12.85	10
16.1	12.3	-9.10	0.999	1.23	1.36	1.47	8.10	8.68	9.26	2.70	14.58	4
17.5	6.37	-3.53	0.673	1.50	1.81	2.12	9.37	10.82	12.20	3.61	17.83	7
22	7.10	-2.52	0.921	2.37	2.81	3.24	13.26	15.0	16.60	5.61	23.39	5
35	11.24	-3.90	0.925	2.60	2.88	3.16	14.20	15.26	16.30	5.76	23.72	6

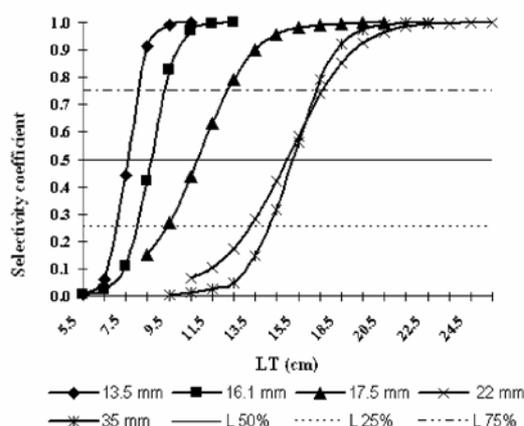


Fig. 3. Length selectivity curves of *Pagellus erythrinus* for the bar mesh size range from 13.5 mm to 35 mm

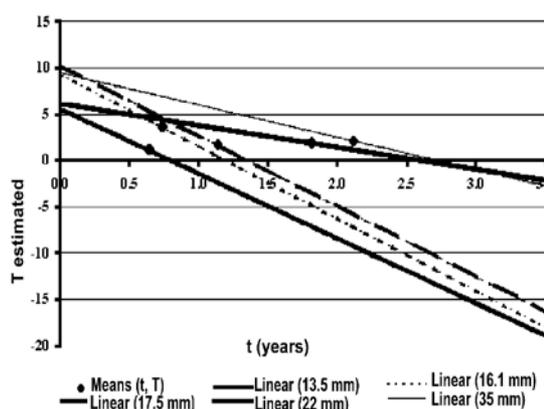


Fig. 4. Test of comparison of regression lines obtained, performed by analysis of covariance for single Y per X

concerned, TOSUNOĞLU (2007) found that $L_{50\%}$ of Pandora in Izmir Bay was 12.4 cm for the 44 mm (i.e. 22 mm according to Montenegrin national legislation) mesh size.

It is difficult to explain those low values of $L_{50\%}$ with respect to our research, where

$L_{50\%}$ for a mesh size of 22 mm was 15 cm. Considering these differences the estimation of selectivity of Pandora should be made with the same ship and net in the areas of the middle and south Adriatic upon which more concrete conclusions may be drawn.

REFERENCES

- BERTALANFFY, L. von 1938. A quantitative theory of organic growth (inquiries on growth laws. II). Human Biology, 10(2): 182-213.
- COMMISSION RECCOMANDATION (EC) 129/2003. Official Journal of the European Commission, L 22, 25. January 2003.
- GAYANILO, F.C.Jr., P. SPARRE & D. PAULY. 2005. FAO-ICLARM Stock Assessment Tools II (FiSAT II). FAO Computerized Information Series (Fisheries). No. 8, Revised version. Rome, FAO. 2005. 168 p.
- GFCM. 1999. General fisheries commission for the Mediterranean (GFCM). Report of the first session of the Scientific Advisory Committee. FAO Fish. Rep., 601: 52 pp.
- HOYDAL, K., C.J. RØRVIK & P. SPARRE. 1982. Estimation of effective mesh sizes and their utilization in assessment. Dana, 2: 69-95.

- JOKSIMOVIĆ, A. 1999. Stanje, struktura i stepen ugroženosti populacije arbuna (rombuna), *Pagellus erythrinus* (Linnaeus, 1758), na području Crnogorskog primorja (State, Structure and Exploitation Level of Red Pandora, *Pagellus erythrinus* (Linnaeus, 1758), Population in the Montenegrin Coastal Waters., Faculty of Sciences). M.S. Thesis. Prirodno-matematički fakultet, Univerzitet u Kragujevcu. 73 pp.
- JUKIĆ, S. & C. PICCINETTI. 1987. Biological and economic aspects of mesh size regulation in the multispecies demersal fishery of the Adriatic Sea. *Acta Adriat.*, 28(1/2): 199-219.
- JUKIĆ, S. & C. PICCINETTI. 1988. Contribution to the knowledge on the short and long-term effects of the application of 40 mm codend mesh size in Adriatic trawl fishery-Eastren Adriatic coast. *FAO Fish. Rep.*, 394: 282-290.
- KIMURA, D.K. 1977. Logistic model for estimating selection ogives from catches of codends whose ogives overlap. *J. Cons.*, 38(1): 116-119.
- LEPETIĆ, V. 1965. Sastav i sezonska dinamika ihtiobentosa i jestivih avertebrata u Bokokotorskom zalivu i mogućnosti njihove eksploatacije (Composition and Seasonal Dynamics of Ichthyobentos and Edible Invertebrates in the Bay of Boka Kotorska and Possibilities of their Exploitation). *Stud. Mar. Sin.*, 1: 164 pp.
- PALOHEIMO, J.E. & E. CADIMA. 1964. On statistics of mesh selection. ICNAF Serial No. 1394/Doc. No. 98.
- PAULY, D. 1983. Length - converted catch curves. A powerful tool for fisheries research in the tropics. *ICLARM Fishbyte*, 1(2): 9-13.
- PAULY, D. 1984. Fish populations dynamics in tropical waters: a manual for use with programmable calculators. *ICLARM Stud. Rev.*, 8: 325 p.
- REGNER, S. & A. JOKSIMOVIĆ. 2002. Estimate of demersal biomass of the Montenegrin shelf (South Adriatic). *Stud. Mar. Sin.*, 23(1): 33-40.
- RIJAVEC, L. 1975. Biology and Dynamics of *Pagellus erythrinus* (L.) in the Boka Kotorska Bay and off the Coast of Montenegro (South Adriatic). *Stud. Mar. Sin.*, 8: 3-110.
- SOKAL, R.R. & F.J. ROHLF. 1981. *Biomerty*. W. H. Freeman & Co., San Francisco. 859 pp.
- TOSUNOĞLU, Z. 2007. Trawl codend design (44 mm diamond PE mesh) and the effect of selectivity for *Pagellus erythrinus* and *Pagellus acarne*, two species with different morphometrics. *J. Appl. Ichthyol.*, 23: 578-582.
- VRGOČ, N. 1995. Obilježja rasta populacije oslića (*Merluccius merluccius*), trlje blatarice (*Mullus barbatus*), arbuna (*Pagellus erythrinus*) i škampa (*Nephrops norvegicus*) Jadranskog mora (Growth Parameters of Population of Hake, (*Merluccius merluccius*) Red mullet (*Mullus barbatus*), Red Pandora (*Pagellus erythrinus*) and Norway lobster (*Nephrops norvegicus*) from the Adriatic Sea). M.S. Thesis. Sveučilište u Zagrebu. 101 pp.
- WILEMAN, D.A., R.S.T. FERRO & R.B. MILLAR. 1996. Manual of Methods of Measuring the Selectivity of Towed Fishing Gears. *ICES Coop. Res. Rep.*, 215: 126 pp.

Received: 11 May 2009

Accepted: 10 September 2009

Utjecaj selektivnosti promjera oka mreže na dužinsku raspodjelu arbuna, *Pagellus erythrinus* L. 1758, u kočarskim lovinama na području kontinentalne podine crnogorskog primorja (južni Jadran)

Aleksandar JOKSIMOVIĆ^{1*}, Slobodan REGNER² i Jaques SACCHI³

¹*Institut za biologiju mora, Dobrota bb, P.P. 69, 85 330 Kotor, Crna Gora*

²*Institut za multidisciplinarna istraživanja, Bulevar Despota Stefana 142, 11 000 Beograd, Srbija*

³*Francuski Institut za istraživanje mora, Avenue Jean Monnet BP 171, 34 200, Sète, Francuska*

*Kontakt adresa, e mail: acojo@ac.me

SAŽETAK

Krivulje selektivnosti arbuna (*Pagellus erythrinus*, L. 1758) procjenjivane su na kontinentalnoj podini crnogorskog primorja korištenjem dubinskih povlačnih mreža (koća) čija je veličina oka na saki mreže iznosila 13.5 mm, 16.1 mm, 17.5 mm, 22 mm i 35 mm, (mjereno od čvora do čvora). Rezultati istraživanja pokazuju kako su se mreže, čija minimalna veličina oka na saki ne smije biti manja od 20 mm, na ovom području upotrebljavale i sa manjim veličinama oka od propisane. Rezultati dobiveni istraživanjima pokazuju da su mreže čija je veličina oka bila ispod 20 mm (zakonom propisana minimalna veličina oka) lovile izrazito veliki broj spolno nezrelih jedinki, a 50% dužina zadržavanja u mreži (L50%) za navedene mreže bila je ispod dužine kod koje nastupa prva spolna zrelost kod ove vrste (12 cm). Za mreže čija je veličina oka bila veća od 20 mm, dužina L50% bila je veća od dužine pri kojoj nastupa prva spolna zrelost. Provedena istraživanja potvrđuju opravdanost reguliranja veličine oka na pridnenim povlačnim mrežama kao jednog od ključnih čimbenika zaštite nedoraslih primjeraka, te samim time i osiguravanja dugoročno održivog iskorištavanja obnovljivih bogatstava mora.

Ključne riječi: *Pagellus erythrinus*, promjer oka, koća, selektivnost, crnogorsko primorje