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Investigating the Mesh Size Selectivity of Olive Flounder (*Paralichthys olivaceus*) Gillnets for Fisheries Resource Management in the East Sea

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Abstract: This study aimed to evaluate the mesh selectivity of gillnets used in olive flounder (*Paralichthys olivaceus*) fishing by examining the distribution of total length (TL) across various mesh sizes. A marine fishing experiment was conducted at Gajin Harbor in Goseong County, Gangwon Province, employing experimental gear with four different mesh sizes: 90, 105, 135, and 150 mm. Mesh selectivity analysis involved a comparative assessment of selectivity curve methods through normal, log-normal, and bi-normal functions. Among these, the bi-normal function demonstrated the best fit for estimating the mesh selectivity curve within the SELECT model. The critical finding was the net size at which 50% of the minimum landing size (35 cm in TL) of olive flounder was selected, ranging from 108.7 to 121.1 mm. According to the bi-normal function curve, this size was estimated as 114.0 mm. Our findings indicate that using a mesh size larger than the theoretically estimated size in mesh selectivity analysis can further decrease the catch of immature individuals. These findings provide essential data for devising strategies to efficiently utilize and manage olive flounder resources.

Keywords: olive flounder; gillnet; selectivity; SELECT model; minimum landing size

Key Contribution: This study aimed to evaluate the mesh selectivity of gillnets used in olive flounder (*Paralichthys olivaceus*) fishing by examining the distribution of total length (TL) across various mesh sizes. Our findings indicate that using a mesh size larger than the theoretically estimated size in mesh selectivity analysis can further decrease the catch of immature individuals.

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1. Introduction

The olive flounder *(Paralichthys olivaceus)* is a benthic fish species classified within the order Pleuronectiformes and family Paralichthyidae. These fish primarily inhabit the sandy bottoms of coastal waters, ranging in depths from 10 to 200 m. They are distributed along the coastlines of Korea, the Kuril Islands, Japan, and the South China Sea [1]. During their juvenile stages, olive flounders feed on small crustaceans such as copepods and *Acetes japonicus*, whereas adults primarily feed on small fish and crustaceans [1].

On the eastern coast of Korea, gillnet fishing is the predominant method used for catching olive flounders. Unlike other fishing methods such as trawling or purse seining, gillnet fishing is relatively simple and does not require specialized equipment, making it a popular choice in coastal waters [2]. Typically, gillnets are designed to hang vertically underwater, anchored by floats at the top and weights at the bottom. They passively capture fish that get ensnared by their gills or bodies [3–5]. Several studies have focused on understanding changes in selectivity and determining appropriate mesh sizes for gillnet-based catching mechanisms, aiming for effective resource management.

Examples of these studies include research on mesh selectivity in gillnets for male and female snow crab [6,7] and silver pomfret [8], as well as studies on trammel net mesh selectivity for *Cynoglossidae* sp. [9] and flatfish [10]. The following research states that setting the gillnets is important because the mesh size of the net has selectivity that determines the target species and individual size to be caught. In addition, for sustainable resource use, it is important to reduce the congestion of juvenile fish by utilizing the mesh selectivity of gillnets.

South Korea has set a minimum catch size limit for the capture of marine resources in order to propagate and protect marine resources that are at risk of depletion due to excessive fishing. The minimum catch size is set as a standard for distinguishing juvenile fish for the protection of juvenile fish. The standard is based on length at sexual maturity, and this length is a term that indicates the average total length of individuals in which 50% of the population has matured. Based on these standards, regulatory standards are set after taking operational realities into consideration and through sufficient consultation with the fishing industry. Recent fisheries legislation has increased the minimum catch size of olive flounder from 21 to 35 cm to protect juvenile fish (as stated in Article 6 of the Enforcement Decree of the Fisheries Act).

Changes in olive flounder production were analyzed using statistical data from the National Statistics Portal (KOSIS). The total production of flounder in the East Coast region was 3714 tons in the last five years from 2018 to 2022, and in terms of the monthly catch, May had the highest production at 1064 tons, accounting for 29.2% of the total. Production began to decline from June, reaching 534 tons, accounting for 14.9% of the total production. According to the statistical survey results, September had the lowest catch amount at 94 tons, accounting for 2.5% of the total production. When looking only at the east coast region, the catch rate was high from April to May, showing a similar trend to the monthly catch amount nationwide (Figure 1). The catch of flounder in the East Coast region was approximately 17% in 2022 from the total captive fishery, and the catch of flounder from the captive fishery showed a tendency to gradually increase every year. Regions along the eastern coast, including Gangwon Province, where gillnet fishing for olive flounder is widely practiced, have continuously called for adjustments to this minimum landing size. However, despite the ongoing debate, there is a lack of scientific research addressing this increase in minimum size. This highlights the urgent need for comprehensive studies on resource ecology and catch selectivity based on mesh size.

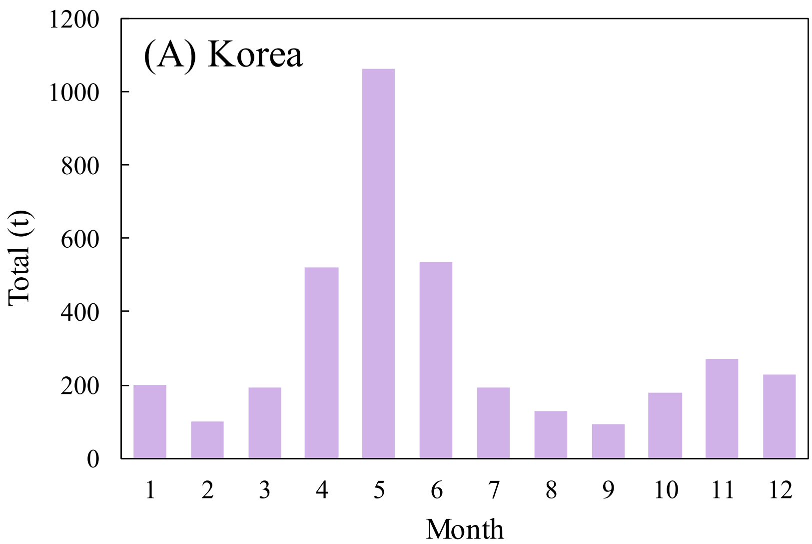

Figure 1. *Cont.*

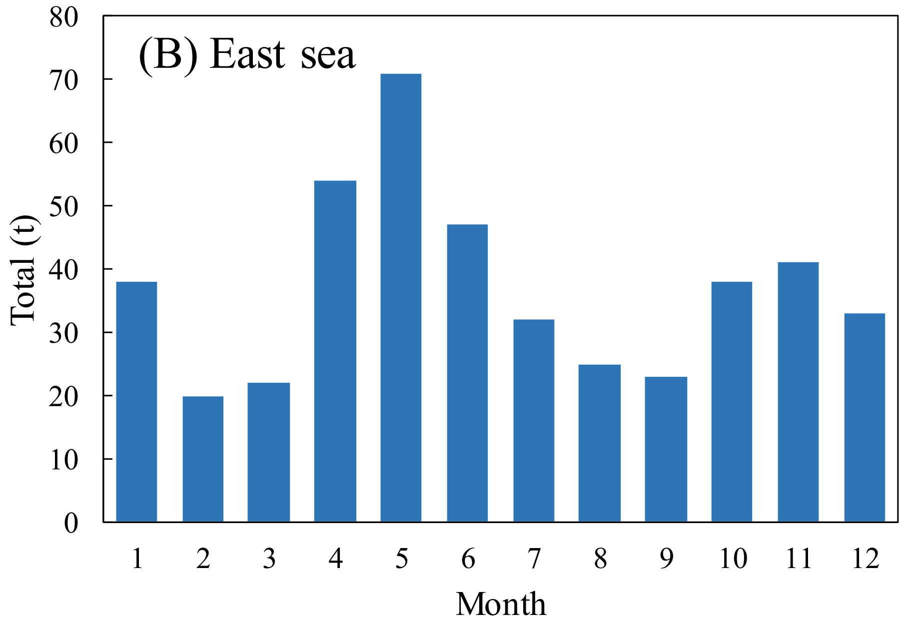

Figure 1. Monthly average catch of olive flounder in Korean waters (**A**) and in the East Sea (**B**) from 2018 to 2022.

To address this research gap, this study was conducted to evaluate gillnet fishing, using four types of gillnets with different mesh sizes, to facilitate the rational use and management of olive flounder resources on the eastern coast of Korea. Specifically, this study aimed to provide foundational data for developing resource management plans that enable the rational utilization and management of olive flounder resources by analyzing the ecological characteristics and catch selectivity associated with each mesh size.

2. Materials and Methods

2.1. Marine Fishing Experiment

2.1.1. Experimental Gear

Marine fishing experiments were conducted in Goseong-gun, Gangwon-do, from January to December 2022. A single gillnet, a commonly employed method for capturing olive flounders along the eastern coast of Korea, was used for the experiment. Four types of test gear were fabricated, each with different mesh sizes: 90, 105, 135, and 150 mm. The first two mesh sizes are standard and are commonly used in commercial gillnets. The lengths of the float and sinker lines were designed to be 78.3 and 93.5 m, respectively, forming a trapezoidal shape. To ensure consistent efficiency across all gear types, both the structure and deployed area of each gear type were set identically.

To ensure the reliability of the mesh selectivity analysis, the mesh sizes of the experimental gear were measured using a Vernier caliper (Mititoyo, IT-012U). A total of 20 meshes were measured and the results were averaged (Table 1). The basic structure of each gear type is illustrated in Figure 2. During the experiment, the gear was arranged in ascending order of mesh size for three rounds of testing, combining 12 widths into one set for each test. The specific arrangement of the test gear is depicted in Figure 3.

Table 1. Composition of the experimental fishing gears for mesh size selectivity.

Mesh Size (mm)	Minimum Size (mm)	Maximum Size (mm)	Mean Size (mm)	Length of Float Line (m)	Length of Sink Line (m)
90	86.4	100.5	96.6	78.3	93.5
105	100.4	105.5	102.7		
135	126.8	134.0	139.2		
150	143.9	152.3	148.8		

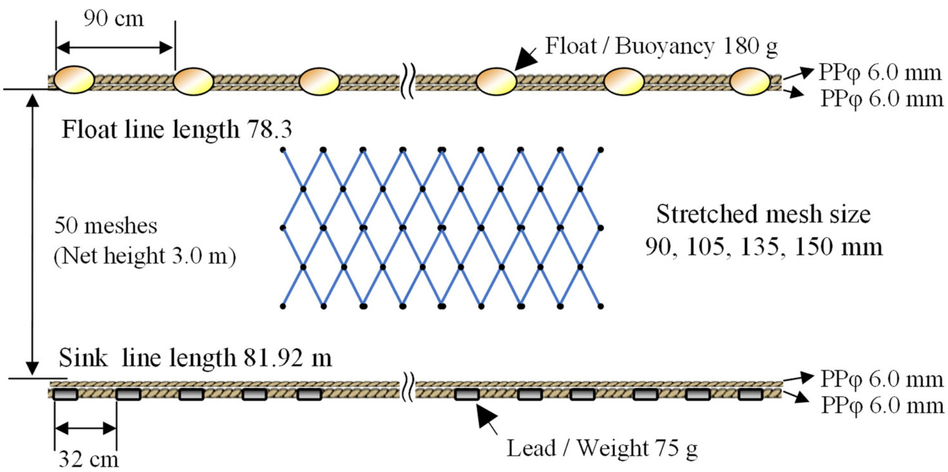

Figure 2. A schematic presentation of the layout of netting panels in the fishing experiment.

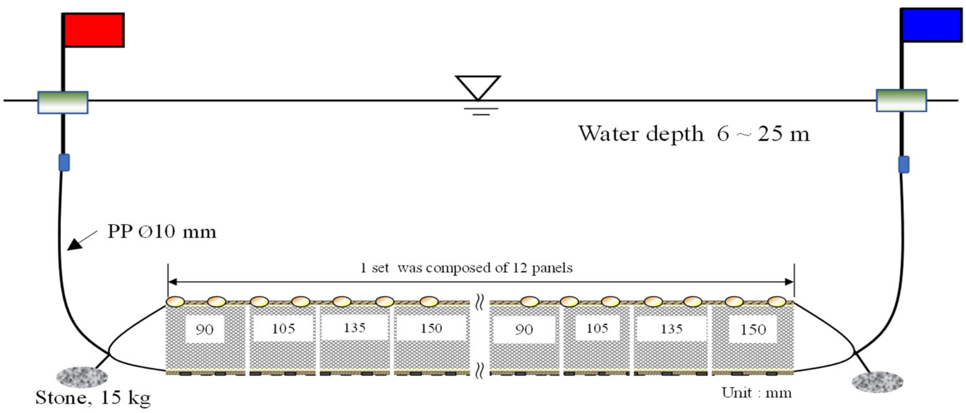

Figure 3. A schematic presentation of the construction of the experimental gillnet for olive flounder.

2.1.2. Experimental Methods

The marine fishing experiment was conducted in waters near Gajin Harbor in Goseong County, Gangwon Province, from January to December 2022. The Suwonho (2.97 tons), a coastal gillnet fishing vessel, was chartered for the experiment. The fishing depth varied from 6 to 25 m, and the fishing grounds were adjusted based on the season. The locations for the marine test are illustrated in Figure 4. The vessel departed around 12 PM, the nets were cast, and after a 2 h submersion, they were retrieved using a lifting device before returning to port. The catch was then sorted by mesh size, and a comprehensive count survey was conducted. Each catch was classified by species, with representative body lengths measured to the nearest 0.1 mm and weights to the nearest 0.1 g using an electronic scale (Sartorius, QUINTIX 6102, Goettingen, Germany).

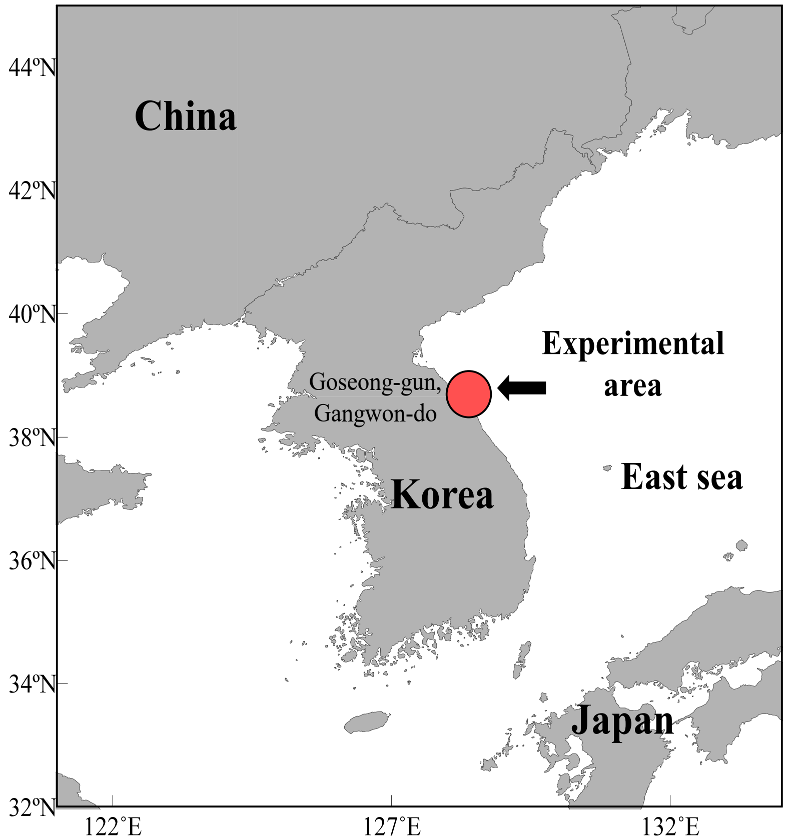

Figure 4. Location of the experimental area for evaluating mesh selectivity of gillnets for olive flounder.

2.2. Estimation of Mature Body Length

For effective resource management of olive flounders, the appropriate mesh size was calculated based on the estimated mature body length. The entire catch of olive flounders from the marine experiment was used as samples, and each sample was categorized by mesh size to conduct a comprehensive survey on body length, body weight, and gonad weight. The total length (TL) and girth length (GL) were measured to the nearest 0.1 mm, body weight (BW) to the nearest 0.1 g, and gonad weight (GW) to the nearest 0.01 g using an electronic scale (Sartorius, QUINTIX 6102).

For the analysis of the mature body length of the olive flounder, the proportion of mature individuals was calculated under the assumption that individuals with 50% TL during the estimated spawning period participate in the spawning of that year [6]. During the spawning period, the mature ratio of females was calculated, and 50%, 75%, and 97.5% of the TL were estimated using Equation (1) along with the logistic curve.

$$P_i = \frac{1}{1 + e^{(b_1 - b_2 TL_i)}}, \tag{1}$$

where P_i represents the maturity rate in the TL class i, TL_i is the TL of the TL class i, and b_1 and b_2 are constants.

Gonadal development was categorized into four stages based on visual assessment considering factors such as gonad size and color and the size of ovarian follicles. These stages included immature, maturing, mature, and spent. Our objective was to estimate the mature body lengths at 50%, 75%, and 97.5%, which would facilitate efficient resource management and help develop future management strategies that are tailored to the resource levels of the target species.

2.3. Estimation of the Mesh Selectivity Curve

The mesh selectivity curve was estimated using the SELECT (Share Each Length's Catch Total) model. To estimate the mesh selectivity curve, three different methods were employed: the normal function, log-normal function, and bi-normal function [5,7,8,11]. When denoting mesh selectivity as $s(R_{ij})$, the normal function, log-normal function, and bi-normal function can be defined by Equations (2), (3), and (4), respectively.

$$\text{Normal function: } s(R_{ij}) = \exp\left(-\frac{(R_{ij}-R_0)^2}{2\sigma^2}\right), \tag{2}$$

$$\text{Log-normal function: } s(R_{ij}) = \exp\left(-\frac{(\ln R_{ij}-\ln R_0)^2}{2\sigma^2}\right), \tag{3}$$

where R_0 represents the relative mesh size given at the maximum efficiency of the mesh selectivity curve, and σ is a parameter determining the width of the curve [4,7,8].

$$\text{Bi-normal function: } s(R_{ij}) = \frac{1}{\delta}\left[\exp\left(-\frac{(R_{ij}-R_\alpha)^2}{2\sigma_\alpha^2}\right)+\omega\exp\left(-\frac{(R_{ij}-R_\beta)^2}{2\sigma_\beta^2}\right)\right], \tag{4}$$

where R_α and R_β represent the relative length (the ratio of fish total length to mesh size) that ensures the maximum efficiency in the first curve (right side first term) and the second curve (right side second term), respectively. Additionally, σ_α and σ_β are parameters determining the width of each curve, ω is a parameter determining the relative maximum value for the second curve, and δ is a correction coefficient to ensure that the maximum value of the mesh selectivity curve equals 1.

Estimates for each function's parameters and the relative catch intensity can be obtained as values that maximize the logarithmic likelihood function, excluding the integer terms, as defined by Equation (5). The parameter estimation was performed using the SOLVER function within the commercial software EXCEL 2016 (Microsoft, USA).

$$\ln L = \sum_{j=1}^{n}\sum_{i=1}^{k}\left(C_{ij}\ln \varnothing/(R_{ij})\right) \tag{5}$$

The goodness of fit for each model was assessed using model deviance, D_m, and the appropriate model was selected using the Akaike Information Criterion (AIC). The model with the minimum AIC value was chosen as the optimal model [7,12,13].

3. Results

3.1. Results of Marine Fishing Experiment

The marine fishing experiment was conducted a total of 26 times using four types of supporting line gillnets. The experimental results were compared and analyzed as follows: a total of 44 fish species were recorded, with a total of 520 fish counts (equivalent to 348,851 g). The highest catch rate was observed for olive flounder at 47.87% (n = 182, 167,009 g), followed by bluefin sea robin (12.87%; n = 118, 44,900 g) and stone flounder (10.86%; n = 53, 37,872 g). The catch per unit effort (CPUE) (g/net) was highest for olive flounder at 527 g/net, followed by bluefin sea robin at 144 g/net and stone flounder at 121 g/net. Detailed catch data and catch ratios are presented in Table 2.

Table 2. Species composition of fishes caught using the experimental gillnets.

Common Name	Scientific Name	Catch in Number Individual	Ratio (%)	Catch in Weight (g)	Ratio (%)	CPUE [(1)] (g/net)
Fishes						
Olive flounder	*Paralichthys olivaceus*	182	33.09	167,009	47.87	526.7
Bluefin sea robin	*Chelidonichthys spinosus*	118	21.45	44,900	12.87	143.9
Stone flounder	*Kareius bicoloratus*	53	9.64	37,872	10.86	121.4
Brown sole	*Pseudopleuronectes herzensteini*	46	8.36	23,000	6.59	73.7
Greenling	*Hexagrammos otakii*	27	4.91	16,715	4.79	53.6
Chub mackerel	*Scomber japonicas*	14	2.55	1904	0.55	6.1
Round nose flounder	*Eopsetta grigorjewi*	12	2.18	2145	0.61	6.9
Marbled sole	*Pleuronectes yokohamae*	11	2.00	12,545	3.60	40.2
Shaggy sea raven	*Hemitripterus villosus*	11	2.00	2269	0.65	7.3
Yellow tail	*Seriola quinqueradiata*	9	1.64	7768	2.23	24.9
Arabesque greenling	*Pleurogrammus azonus*	7	1.27	3518	1.01	11.3
Jacopever	*Sebastes schlegelii*	6	1.09	2840	0.81	9.1
Rough scale sole	*Clidoderma asperrimum*	4	0.73	783	0.22	2.5
Black progy	*Acanthopagrus schlegelii*	3	0.55	3008	0.86	9.6
Pacific cod	*Gadus macrocephalus*	3	0.55	2292	0.66	7.3
Elknorn sculpin	*Alcichthys elongates*	3	0.55	385	0.11	1.2
Crest head flounder	*Pseudopleuronectes schrenki*	3	0.55	764	0.22	2.5
Yellow goosefish	*Lophius litulon*	3	0.55	4837	1.39	15.5
Whip sculpin	*Gymnocanthus intermedius*	2	0.36	378	0.11	1.2
Goggle eye	*Cookeolus japonicas*	2	0.36	590	0.17	1.9
Elf sculpin	*Enophrys diceraus*	2	0.36	220	0.06	0.7
NEI [(2)]		18	3.09	11,087	3.18	35.5
Crustaceans						
Sand crab	*Ovalipes punctatus*	3	0.55	611	0.18	2.0
Swimming crab	*Portunus trituberculatus*	2	0.36	560	0.16	1.8
Portunidae sp.	*Trituberculatus* sp.	1	0.18	318	0.09	1.0
Japanese swimming crab	*Charybdis japonica*	1	0.18	160	0.05	0.5
Gastropods						
Conch sp.	*Buccinidae* sp.	2	0.36	137	0.04	0.4
Sea cucumber	*Stichopus japonicas*	1	0.18	141	0.04	0.5
Cephalopods						
Webfoot octopus	*Amphioctopus fangsiao*	1	0.18	99	0.03	0.3
Total	550	100	348,851	100		

[(1)] CPUE: weight of species/(12 panels × 26 times). [(2)] NEI: not elsewhere included.

For each type of experimental fishing gear type, the 90 mm mesh captured a total of 46 individuals (18,003 g), with the majority of the catch falling in the 24–28 cm range for olive flounder. In the 105 mm mesh, a total of 50 individuals (31,004 g) were caught, also in the 41–45 cm range for olive flounder. In the 135 mm mesh, a total of 47 individuals (33,002 g) were captured, with the most catches once again in the 41–45 cm range for olive flounder. The 150 mm mesh yielded the lowest catch of all mesh types, with a total of 39 individuals (85,000 g) captured. Mesh size selectivity was analyzed using catch data by mesh size, and the average TL of the analyzed olive flounder was calculated at 42.8 cm, with the most catches in the 38–48 cm TL class. The catches for each fishing gear are illustrated in Figure 5.

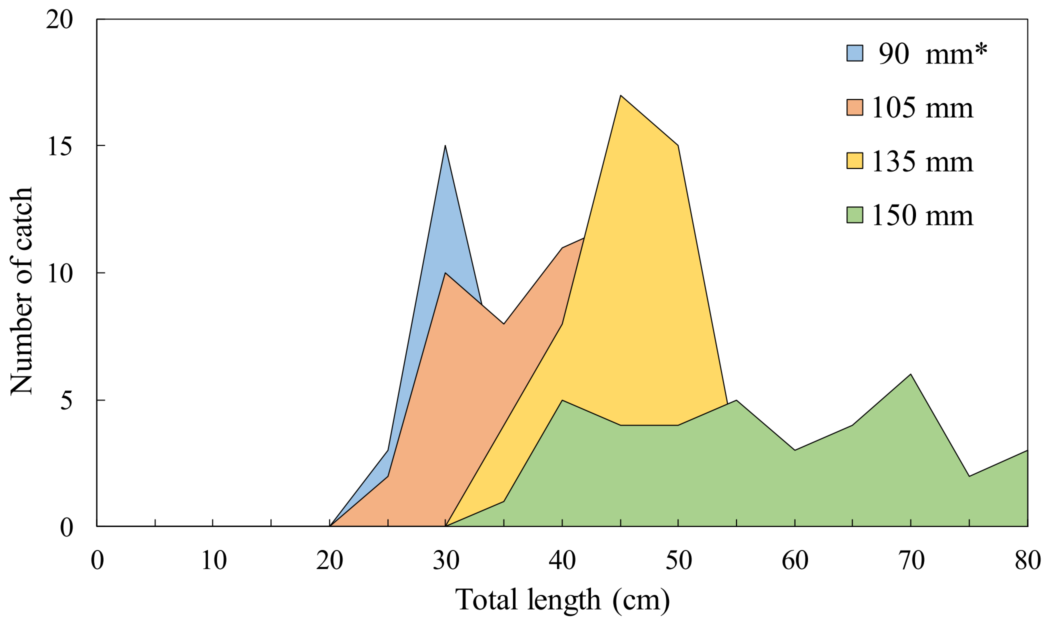

Figure 5. Length distributions of olive flounder caught using four different mesh sizes of the experimental nets. *: Mesh size.

3.2. Mature Body Length

The spawning period of olive flounder was estimated through monthly visual observations; maturity was categorized into four stages: immature, maturing, mature, and spent. Female individuals at the maturing stage or beyond began appearing in April, with mature individuals being prominent in May. Spawning activities initiated in July, and spent individuals were observed from August. Thus, the spawning period for olive flounders in the East Sea was estimated to span from May to September, based on the monthly maturity stage survey.

The mature body length of olive flounders was analyzed using TL and visually determined mature individual ratio data from a total of 182 individuals. None of the individuals were mature at a TL of 35 cm or less, whereas all individuals at 50 cm or more participated in spawning. The mature body length was estimated using the logistic function, and the 50%, 75%, and 97.5% TL of female olive flounders along the eastern coast was 43.0, 51.8, and 72.2 cm, respectively.

3.3. Mesh Size Selectivity

The mesh selectivity curves were estimated using the SELECT model by analyzing the body length distribution according to mesh size. Three distinct mesh selectivity curves were assessed, as depicted in Figure 6. Additionally, Table 3 provides the parameters of the equations for each model's mesh selectivity curve, the relative catch efficiency, and the AIC values. During the assessment, the model deviance (MD) was 71.5 for the normal distribution function, 59.4 for the log-normal function, and 42.7 for the bi-normal function. The bi-normal function displayed the smallest MD value. Both the normal and log-normal functions exhibited significantly larger model deviances compared to the bi-normal function. Furthermore, the estimated AIC values were 231.8, 223.6, and 214.5 for the normal, log-normal, and bi-normal functions, respectively, with the bi-normal function showing the lowest value. Consequently, the bi-normal function, which exhibited the lowest AIC value, was deemed the most suitable model for estimating the mesh selectivity curve based on the SELECT model.

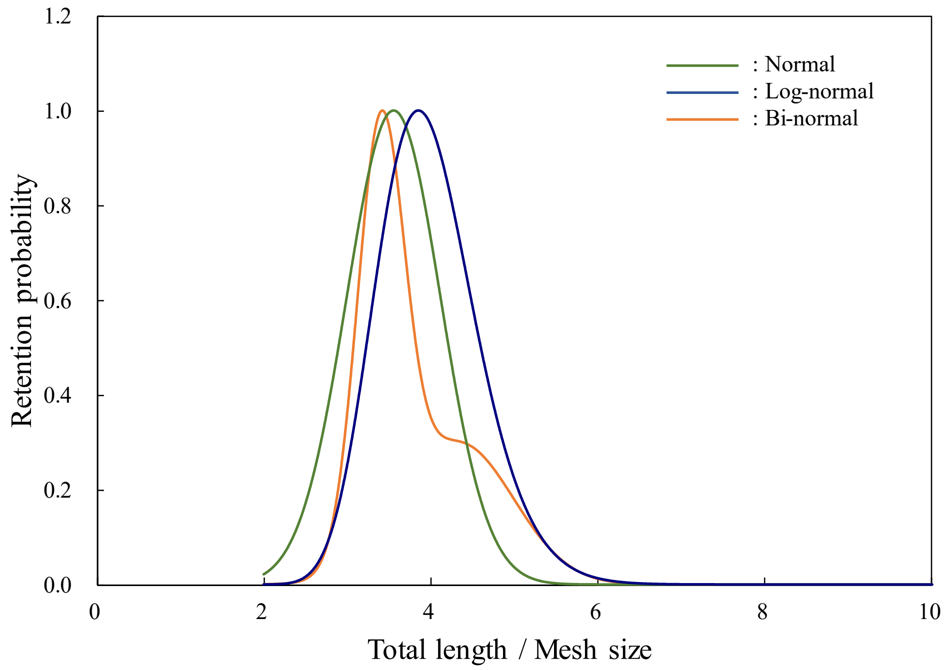

Figure 6. Comparison with the master curve of the gillnet for olive flounder captured using gillnets with four different mesh sizes.

Table 3. Parameter estimates and model deviance for each model.

Model	**Parameter**											
	R_0 (R_α)	R_α	σ (σ_α)	σ_β	ω	δ_δ	p_1	p_2	p_3	p_4	p_5	p_6
Normal	3.555		0.561				0.300	0.332	0.255	0.114	0.025	0.604
Log-normal	3.852		0.151				0.065	0.175	0.429	0.331	0.025	0.604
Bi-normal		3.400	0.281	0.657	0.336	1.124	0.129	0.326	0.319	0.226		
	MLL [1]		MD [2]		d.f [3]		AIC [4]					
Normal	−104.9		71.5		36.0		231.8					
Log-normal	−100.8		59.4		36.0		223.6					
Bi-normal	−96.3		42.7		36.0		214.5					

[1] Maximum log-likelihood (MLL). [2] Model deviance (MD). [3] Degree of freedom (d.f). [4] Akaike Information Criterion (AIC).

The optimal mesh size for olive flounder gillnets was determined by inputting the minimum mature body size values into each mesh selectivity curve and estimating the mesh size and selection range at 25%, 50%, and 75%, as presented in Table 4. For each calculated mesh selectivity curve, the mesh size at which 50% of olive flounders (with a mature body size of 43.0 cm) were selected (L_{50}) ranged from 133.5 to 148.8 mm. The smallest size, 133.5 mm, was observed in the log-normal function. The bi-normal function curve, which exhibited the best model fit, estimated the L_{50} value at 140.1 mm. The mesh sizes currently employed in the olive flounder coastal gillnet fishery along the eastern coast range from 135 to 150 mm, aligning with the existing standard mesh sizes. The selection range (SR) was broadest in the normal function at 26.7 mm and narrowest in the bi-normal function at 12.4 mm.

Table 4. Mesh size (mm) of 25%, 50%, and 75% selection for minimum landing size (43.0 cm) of olive flounder and the selection ranges in each selection curve model.

Model	L_{25} (1)	L_{50}	L_{75}	S.R (2)
Normal	164.1	148.8	137.4	26.7
Log-normal	143.8	133.5	125.4	18.4
Bi-normal	146.8	140.1	134.4	12.4

(1) L_{25}, L_{50}, L_{75}: 25%, 50%, 75% selection length. (2) Selection range.

However, as it is not feasible to catch only female olive flounders, the mesh sizes and SRs for 25%, 50%, and 75% based on the current minimum landing size of 35 cm were estimated, as presented in Table 5. The mesh size at which 50% of olive flounders are selected (L_{50}) ranged from 108.7 to 121.1 mm. The smallest size, 108.7 mm, was estimated using the log-normal function. In the bi-normal function curve, which had the most suitable model fit, the L_{50} value was estimated to be 114.0 mm. The mesh sizes currently used in the olive flounder coastal gillnet fishery along the eastern coast range from 135 mm to 150 mm, which are slightly smaller than the existing standard mesh sizes. This suggests that, theoretically, using mesh sizes of 114.0 mm or larger could potentially decrease the capture of immature individuals. The SR was broadest in the normal function at 21.8 mm and narrowest in the bi-normal function at 10.1 mm.

Table 5. Mesh size (mm) of 25%, 50%, and 75% selection for minimum landing size (35.0 cm) of olive flounder and the selection ranges in each selection curve model.

Model	L_{25} (1)	L_{50}	L_{75}	S.R (2)
Normal	133.6	121.1	111.8	21.8
Log-normal	117.1	108.7	102.0	15.0
Bi-normal	119.5	114.0	109.4	10.1

(1) L_{25}, L_{50}, L_{75}: 25%, 50%, 75% selection length. (2) Selection range.

4. Discussion

Olive flounder is one of Korea's primary fisheries resources, harvested from the waters of the East, West, and South Seas. It is important to note that capturing olive flounders smaller than 35 cm is prohibited by law, as stipulated in Article 6 of the Enforcement Decree of the Fisheries Act. In regions along the eastern coast, particularly Gangwon Province, where gillnet fishing for olive flounder is widely practiced, there has been persistent demand for adjustments since the recent increase in the minimum landing size from 21 to 35 cm.

Compared to other large-scale fishing methods, the gillnet fishing method is relatively simple, as it does not require specialized equipment or facilities. Olive flounders, predominantly caught using this method, become ensnared in the nets, with mesh sizes corresponding to the size of the targeted fish species [4,14–19]. Single gillnets often allow many fish to escape during the hauling process, which is why fishers tend to prefer support-line gillnets, which have a lower escape rate, or trammel nets, which are temporarily allowed under specific restrictions [20]. However, due to the risk of overfishing, the use of trammel nets, capable of catching various fish sizes, is closely regulated [21,22]. It is crucial to conduct a comprehensive study to understand the differences in catches according to gillnet types. This study investigated the current fishing situation in the eastern coastal regions and conducted a selectivity study on four mesh sizes for olive flounder fishing based on mature body length.

The spawning season for olive flounders inhabiting the waters off the eastern coast of Korea is estimated to span from May to September, with 50% of females having a TL of 43.0 cm. This aligns with previous research findings, which reported a range of 40–45 cm. To ensure the reliability of mature body length analysis in the future, continuous research and the collection of an adequate number of individuals during the spawning season are necessary.

Among the selectivity curves estimated in this study, the function model with the smallest AIC was the bi-normal function assuming constant relative fishing intensity. Therefore, in this study, the bi-normal function was adopted as the optimal net selectivity curve of olive flounder for gillnets. The bi-normal function was found to be suitable for gillnet selectivity curves for dotted gizzard shad, cod, etc. [7,14,15,23–25]. In addition, the selectivity curve of gillnets for sardine was expressed as a log-normal function, and for mackerel, it was expressed as a skew-normal function or log-normal function [5,26–28]. The mesh size selectivity curve of gillnets for a significant number of fish species was expressed as a bi-normal function, but the selectivity curve of gillnets for some fish species was expressed as a logistic function [13,29].

The optimal mesh size, estimated based on mature body length using various selectivity models, ranged 102.0–133.6 mm, and the range based on the minimum landing size was 108.7–121.1 mm. Although these estimated values slightly deviate from the standard mesh sizes of 135–150 mm currently used by fishers, it is important to acknowledge that some variation in mesh size can occur when analyzing olive flounder as a single species. Additionally, the relatively low overall count of olive flounder caught in each TL category during this study somewhat undermines the reliability of the selectivity analysis. Kim et al. [30] suggested a method to calculate an optimal mesh size that ensures economically efficient catches. Therefore, it is crucial to carefully consider the mesh size that can facilitate efficient management of resources and ensure economic efficiency when calculating mesh sizes.

This study takes a comprehensive approach, considering both mesh selectivity and resource management aspects to effectively utilize olive flounder resources. The findings underscore the importance of implementing quantitative restrictions, such as catch limits, and qualitative restrictions such as mesh size regulations, by integrating fisheries management and resource management. It is essential to diligently monitor the current state of resources and proceed with efficient and rational resource management practices.

5. Conclusions

This study aimed to provide fundamental data for developing efficient resource management strategies by examining mesh selectivity and varying mesh sizes in the gillnet fishery for olive flounder on the eastern coast of Korea.

The key findings of this study are as follows:

1. The mesh size used in the olive flounder gillnet fishery along the eastern coast of Korea varies depending on the fishing season, ranging from 90 to 150 mm. The most commonly used mesh sizes are 90 and 135 mm. The preferred gear type is the support-line gillnet, which allows fewer individuals to escape during lifting.
2. Analysis of the maturity ratio of females caught from May to September, estimated to be the spawning period, revealed that the mature body length (TL) of female olive flounder inhabiting the eastern coastal area was 43.0 cm (50%), 51.8 cm (75%), and 72.2 cm (97.5%).
3. Mesh selectivity of the gillnet was analyzed using the body length distribution of olive flounder according to mesh size. The total length range of olive flounder increased with an increase in mesh size. The bi-normal function exhibited the best fit for estimating the mesh selectivity curve within the SELECT model. The optimal mesh size was determined by calculating the mesh sizes at which 25%, 50%, and 75% of olive flounders are selected based on the L_{50} value from each mesh selectivity curve (i.e., females' mature length) and the minimum landing size (35 cm). The mature body length ranged 133.5–148.8 mm, and the range of the L_{50} value for the appropriate mesh size, estimated based on the minimum landing size (35 cm), was 108.7–121.1 mm. In the analysis and comparison, the range of L_{50} values based on the mature body length was 133.5–148.8 mm, and that based on the minimum

landing size was 108.7–121.1 mm. The optimal mesh size derived from the bi-normal function curve based on the mature body length was estimated at 140.1 mm, whereas that estimated based on the minimum landing size was 114.0 mm.

In conclusion, using a mesh size larger than the theoretically estimated size in mesh selectivity analysis can further reduce the capture of immature individuals. These results will serve as foundational data for establishing effective measures for the efficient use and management of olive flounder resources in future studies.

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