

Selectivity of the Traps and Push Net Fishing Gear in the Glass Eels (*Anguilla* spp.) Capture Fishery in the Cikaso River Waters, Sukabumi, Indonesia

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ABSTRACT

Selectivity is a standard of the level of friendliness of a fishing gear that is reviewed based on the diversity of catches obtained. Nowadays, fishing gear construction and techniques are developed to obtain selective fishing methods. This study compared the selectivity of traps and push nets in glass eel fishing in the Cikaso River, Indonesia. The study was conducted from December 2020 to April 2021. The catch diversity index and relative abundance were used to analyze the selectivity of catch diversity in both fishing gears. Comparative analysis shows that push nets have slightly better selectivity than traps. However, the study's overall results showed a fairly good selectivity of both fishing gears in catching glass eels (*Anguilla* spp.) as their main catch target.

INTRODUCTION

Selectivity is one of several standard criteria for environmentally friendly fishing gear (Hasmidar et al., 2024). Currently, the development of fishing gear construction, fishing aids, and fishing techniques continues to be carried out to obtain a selective fishing method (Fitri, 2020). Selective fishing gear methods are also a primary requirement in facilitating the flow of sustainable fisheries resource management (Mollen et al., 2023).

The selectivity of fishing gear is generally divided into two criteria: size selectivity and selectivity of catch species (Humphries et al., 2019; Yulianto et al., 2023). Size selectivity is generally reviewed based on the diversity of catch sizes, with the main point of comparison being the size of the first gonad maturity based on scientific studies or the catchable size permitted by local government regulations. Fishing gear can be considered selective in terms of size when it obtains catches at sizes above the minimum limit that is allowed to be caught (Jørgensen et al., 2009; Widiyastuti et al., 2021). Meanwhile, species selectivity is reviewed based on the diversity of catch species. Fishing gear is considered selective in species when it obtains catches that are dominant or specific to certain species (Cerbule et al., 2022; Dewanti et al., 2023).

Glass eel capture fisheries are widely carried out in the coastal waters of southern Java, one of which is in the Cikaso River, Sukabumi, Indonesia (Annida et al., 2021). Catching glass eels primarily provides input for seed providers in national eel aquaculture to export (Iskandar et al., 2021). Local communities around the Cikaso River generally catch glass eels using two types of traditional fishing gear: traps and push nets. Traps are usually set in riverbanks that have significant rocky gaps. Meanwhile, push nets are used on sandy or rocky riverbanks. These two fishing gears are generally used simultaneously throughout the potential time for catching glass eels at night during high tide (Annida et al., 2022).

This study was conducted to compare the level of selectivity of catch types with traps and push nets in glass eel fisheries in the Cikaso River, Sukabumi, Indonesia. The results will be used to evaluate the level of use of both fishing gears based on the selectivity criteria of catch types.

LITERATURE REVIEW

Indonesia is known to have a wealth of biological biodiversity, including in the fisheries sector (Napitupulu et al., 2022). However, the richness of Indonesian fishery species poses a major challenge in realizing sustainable fisheries management. One of the basics is finding a selective fishing method (Ditya et al., 2022).

The phenomenon often encountered in Indonesian fisheries is related to the selectivity of fishing gear, which is multispecies and multigear. Multispecies refers to a condition where a fishing gear obtains diverse catches due to the high diversity of potential catch types in natural waters (Annida et al., 2023). Meanwhile, Multigear refers to the tendency of fishing gear to obtain various kinds of catches (Annida et al., 2024). These two phenomena are the basis for the main challenges for every capture fisheries expert to find the construction of

fishing gear, the use of fishing aids, and fishing techniques that increase the selectivity of the catch (FAO, 2022).

Evaluation studies of the level of selectivity of catches of various types of fishing gear are also widely carried out to assess the level of environmental friendliness of fishing gear. Different analysis methods are commonly used, such as comparison of diversity indexes and composition or relative abundance of catches (Nugroho et al., 2015). In general, each analysis is used to see the structure of the diversity of catches obtained by a fishing gear. Furthermore, this analysis is used to represent whether a fishing gear tends to obtain predominantly specific catches (selective) or diverse (non-selective) (Annida, 2022).

METHODOLOGY

The study was conducted in the Cikaso River, Sukabumi, Indonesia, precisely at a distance of +11 km from the Cikaso River Estuary area (Gambar 1). The traps and push net fishing gear were operated for data acquisition in this study from December 2020 to April 2021. The fishing gear was operated for 3 hours at each setting at night. The exact operating time of the tool was determined based on the dynamics of the highest tide that occurred in the area. Determination of high tide as a potential fishing time is based on the fact that glass eels move from the sea waters around the river mouth at high tide (Annida et al., 2021).

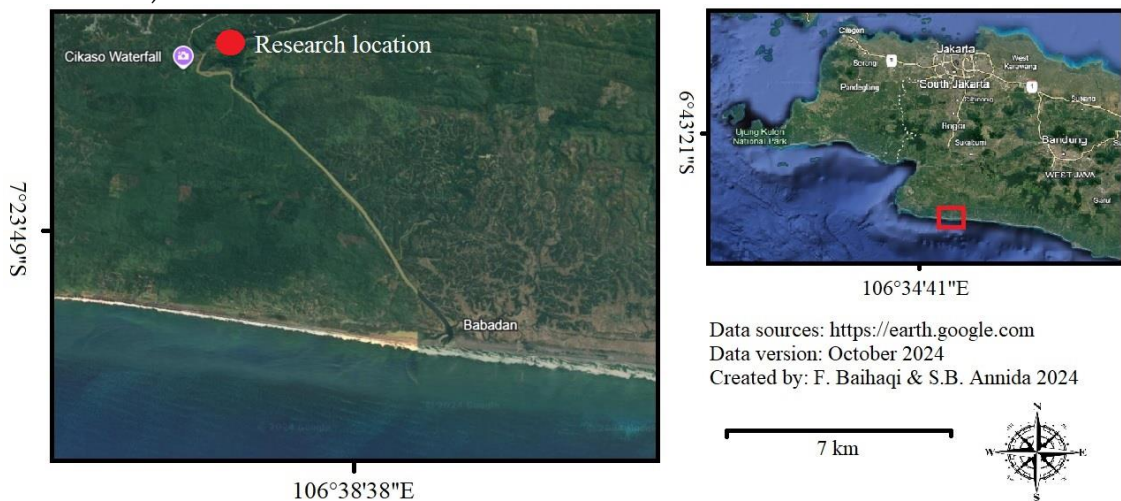


Figure 1. Research Map

Each type of catch from both fishing gears was collected for identification. The caught fish were preserved by soaking in a 4% formalin solution for 3 hours. Then, the fish samples were washed with running water, and final preservation was executed in an 80% ethanol solution (Baihaqi et al., 2022). This preservation technique maintains the color pattern of the sample fish's melanophore, one of the characteristics of fish identification (Simanjuntak et al., 2021).

Glass eels, as the main catch, were identified based on the percentage ratio of the ano-dorsal length to the total length (Hakim et al., 2016). Meanwhile, bycatch was identified by referring to Hiroshi et al., (2004) and Kottelat et al., (1993).

The analysis of fishing gear selectivity is reviewed based on the catch's diversity index and relative abundance. Both of these analyses provide information on the structure of species diversity of the catch from each fishing gear that represents its level of selectivity. The diversity index used is derived based on the Shannon-Weiner calculation function. The relative abundance is calculated based on the percentage of the number of individuals of one species to the total number of individuals caught from all species (Krebs, 2014).

RESEARCH RESULT

Construction and Technical Operation of Fishing Gear

Traps and push net fishing gear differ in construction and technical operation. Traps consist of a tubular bamboo frame and are covered with fine cloth or waring. There are two openings in the mouth of the traps, namely the front opening, which is circular with a diameter of 11 cm, and the inner opening, which is narrowed and triangular with an area of $\pm 0.75 \text{ cm}^2$. Traps are passive fishing gear. Traps are generally placed in rock crevices covered by grass and dry leaves as camouflage for the fishing gear. The traps are typically set at night near high tide and lifted after low tide (Figure 2).

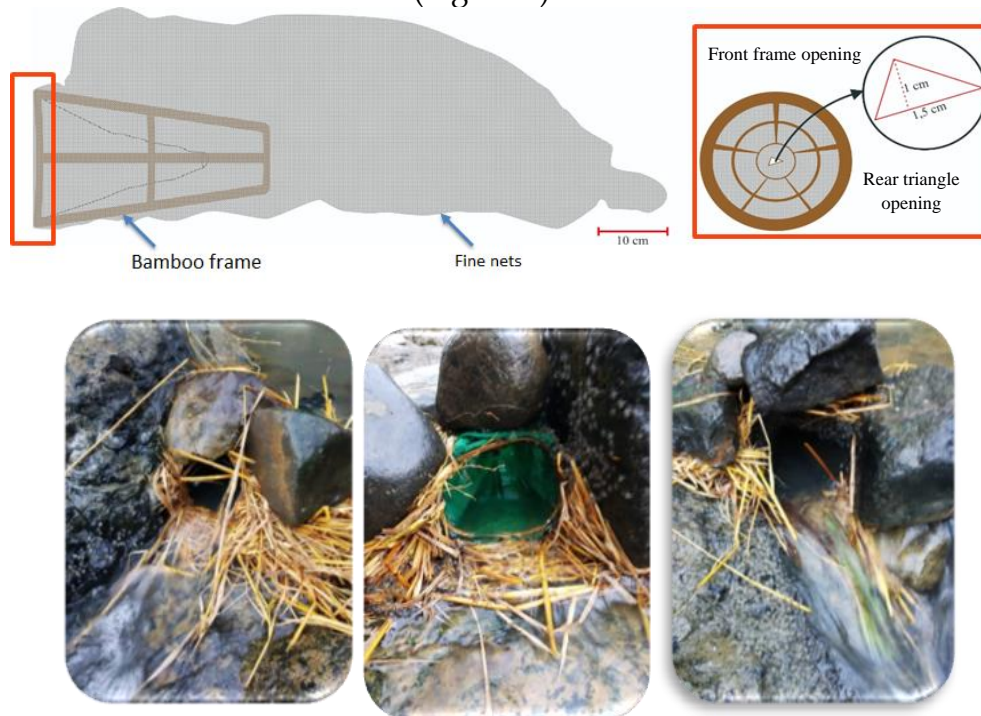


Figure 2. Construction and Technical Operation of Glass Eel Trap Fishing Gear

Meanwhile, a push net is a traditional fishing gear consisting of a net cloth or waring measuring $150 \times 150 \text{ cm}^2$ with a mesh size of 0.2 - 0.48 mm. This net cloth is supported by four wooden slats, each 150 cm long. The net is actively operated in shallow waters such as river banks and coastal waters. The operation of the net fishing gear in catching glass eels is generally carried out at night and high tide with the help of lighting from a petromax lamp or headlamp (Figure 3).

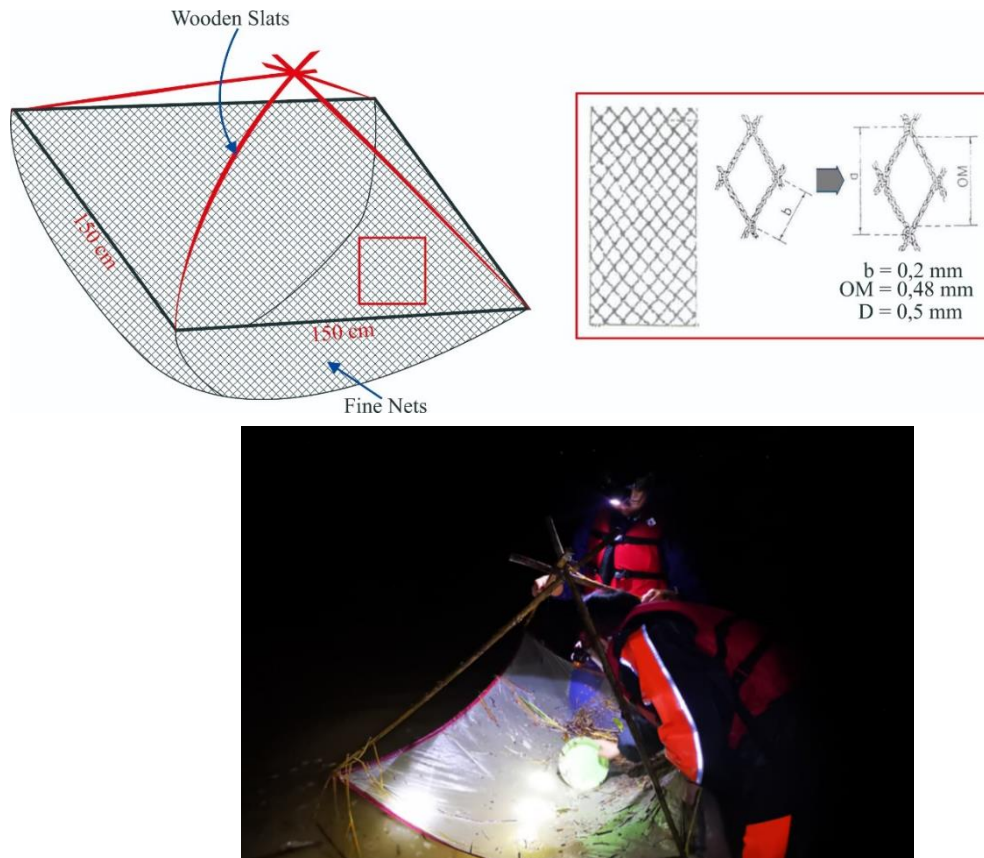


Figure 3. Construction and Technical Operation of Push Net Fishing Equipment

Relative Abundance of Catch

The relative abundance of catches on both fishing gears showed quite a good selectivity, with a high tendency to catch glass eels, especially from the *Anguilla bicolor bicolor* species, as the main catch (Table 1). The comparative test results on the relative abundance of the two fishing gears did not show a significant difference ($P > 0.05$). Overall, both fishing gears obtained 19 species of catch consisting of 3 main catch species and 16 bycatch.

Shannon-Weiner Diversity Index

The results of the diversity index calculation show a deficient level of diversity and uniformity of catch results (H' & $E < 0.03$). However, the catch results of both fishing gears show high dominance ($D > 0.98$). This calculation shows excellent selectivity of catch types in both fishing gears used in glass eel capture fisheries in the Cikaso River, Sukabumi, Indonesia (Table 2).

Table 1. Relative Abundance of Catches (%) from Traps and Push Nets in the Glass Eel Fishery in the Cikaso River, Sukabumi, Indonesia

Group of Catches	Scientific Name	November 2020		December		January 2021		February		March		April	
		Traps	Push net	Traps	Push net	Traps	Push net	Traps	Push net	Traps	Push net	Traps	Push net
Main Target	<i>A. bicolor bicolor</i>	97,49	99,13	98,01	99,27	98,56	99,30	98,63	99,51	97,80	99,41	97,33	99,46
	<i>A. nebulosi</i>	0,13	0,10	0,16	0,15	0,20	0,20	0,30	0,18	0,19	0,13	0,07	0,07
	<i>A. marmorata</i>	0,05	0,05	0,04	0,08	0,09	0,07	0,11	0,10	0,04	0,04	0,02	0,01
Bycatches	<i>Microphis brachyurus</i>	0,32	0,19	0,27	0,10	0,27	0,15	0,21	0,07	0,24	0,11	0,21	0,02
	<i>Glossogobius giuris</i>	0,12	0,02	0,09	0,01	0,05	-	0,03	-	0,17	0,02	0,07	-
	<i>Eleotris melanosoma</i>	0,17	0,02	0,17	0,02	0,05	0,01	0,01	-	0,11	0,02	0,19	0,01
	<i>Eleotris fusca</i>	0,39	0,19	0,22	0,09	0,09	0,02	0,07	0,03	0,19	0,03	0,24	0,05
	<i>Bunaka gyrinoides</i>	0,15	0,01	0,11	0,02	0,05	0,01	0,02	0,01	0,08	0,04	0,12	0,05
	<i>Butis butis</i>	0,12	0,03	0,06	0,01	0,05	-	0,02	-	0,11	0,02	0,17	0,01
	<i>Giuris margaritacea</i>	0,05	0,01	0,05	0,02	0,05	0,03	0,07	0,01	0,15	0,03	0,24	0,05
	<i>Osteomugil cunnesius</i>	0,05	0,08	0,05	0,13	0,06	0,14	0,04	0,05	0,04	0,06	-	0,11
	<i>Kuhlia marginata</i>	0,07	0,02	0,05	0,04	0,05	0,01	-	-	0,04	-	0,02	0,02
	<i>Neoespicula depressifrons</i>	-	-	0,02	-	-	-	-	0,01	0,02	0,01	0,05	0,01
	<i>Dichotomyctere nigroviridis</i>	0,05	-	0,04	0,02	0,01	-	-	-	-	-	0,17	0,01
	<i>Nemacheilus fasciatus</i>	0,22	0,01	0,11	0,01	0,03	-	0,04	0,01	0,13	0,02	0,24	0,02
	<i>Atyopsis moluccensis</i>	0,32	0,08	0,34	0,03	0,22	0,02	0,27	0,03	0,41	0,03	0,48	0,06
	<i>Leandrites indicus</i>	0,22	0,04	0,12	0,02	0,11	0,01	0,12	0,01	0,17	0,02	0,21	-
	<i>Parathelphusa maculata</i>	0,03	-	0,05	-	0,03	0,01	-	-	0,08	-	0,05	0,01
	<i>Varuna litterata</i>	0,05	0,01	0,04	-	0,05	0,01	0,04	-	0,04	0,02	0,12	0,01

Table 2. Diversity Index of Catches from Traps and Push Nets in Glass Eel Fisheries in the Cikaso River, Sukabumi, Indonesia

Time of Research	Traps			Push net		
	H'	E	D	H'	E	D
November 2020	0,017	0,006	0,950	0,010	0,004	0,983
December	0,012	0,004	0,961	0,010	0,004	0,985
January 2021	0,011	0,004	0,971	0,007	0,003	0,986
February	0,011	0,004	0,973	0,007	0,003	0,990
March	0,019	0,007	0,957	0,010	0,004	0,988
April	0,024	0,008	0,947	0,012	0,004	0,989

Note:

H' : Diversity index

E : Evenness index

D : Dominance index

DISCUSSION

Fishing gear selectivity refers to a fishing gear's ability to catch certain types or sizes of fish according to its main catch target (Hufiadi, 2017). Selective fishing gear can also select unwanted species or fish that are still too small (Breen et al., 2016). This selectivity is essential to maintain the balance of the marine ecosystem and prevent overfishing (Haruna et al., 2023).

Nowadays, research on the selectivity of fishing gear is widely carried out as basic data in developing fishing gear construction or the use of fishing aids in

an effort to continue obtaining selective fishing gear and methods (Bhanja et al., 2024). Efforts to obtain selective fishing gear and methods are carried out solely to achieve measurable fisheries management to realize sustainable capture fisheries (Trenggono, 2023).

In the Code of Conduct for Responsible Fisheries (CCRF) issued by the Food and Agriculture Organization (FAO), gear selectivity is one of the essential principles for supporting responsible and sustainable fisheries. The CCRF provides guidelines for member countries and the fisheries sector to use fishing practices that reduce negative impacts on ecosystems, including selective fishing gear (FAO, 2009). Some important points regarding gear selectivity are reducing bycatch, preventing fishing below the catchable size, developing environmentally friendly technology, maintaining the sustainability of aquatic ecosystems, and increasing fishermen's participation in implementing selective fishing practices (FAO, 2021).

In general, the selectivity of fishing gear is divided into two types: size selectivity and selectivity of the catch species. Size selectivity emphasizes that fishing gear is considered selective if it can avoid catching species that are below the criteria for being suitable for catching or are still in the early stages. In the realm of species selectivity, a fishing gear is said to be selective if it has a high tendency to catch certain species and minimizes bycatch (Lucchetti et al., 2020; Susilawati, 2022; Yulianto et al., 2023).

Glass eel capture fisheries are fishing activities that target eels (*Anguilla* spp.) as the main catch target in the glass eel phase. The glass eel catch is then used as input in eel cultivation activities (Kaifu et al., 2021; Wahju et al., 2021). One of the areas that is a source of relatively high glass eel catch production in Indonesia is the Cikaso River, Sukabumi, West Java (Annida et al., 2021; Rahmi et al., 2021).

The Cikaso River is known as one of the large rivers in Sukabumi Regency, which, along with the Cimandiri and Cibareno Rivers, has a high intensity of glass eel fishing. Local fishermen in the Cikaso River generally catch glass eels using two types of traditional fishing gear: traps and push nets. These two fishing gears are commonly used in different riverbank water conditions (Annida et al., 2021; Wahju et al., 2021).

Push nets are commonly used with fine sand and small rocks in riverbanks. In its technical operation, push nets are generally assisted by a headlamp as a source of light, which also attracts a group of glass eels to enter the catchable area (Annida et al., 2021, 2022; Sutherland, 2006). Meanwhile, traps are generally set in large rocky riverbanks that have gaps. The gaps in the rocks are the locations for installing traps. The mouth opening of the traps is installed against the water current. Traps are generally accompanied by bait such as worms, pellets, or bread (Annida et al., 2021, 2022).

The observations during 6 months of research from November 2020 to April 2021 showed that 19 catch species were collected in both fishing gears. Three of the 19 species were identified as glass eels with the *Anguilla bicolor bicolor*, *A. marmorata*, and *A. nebulosa*. In another study, Wahju et al., (2021) stated that pushing nets and traps in the Cimandiri River collected three main catches and

eight to nine bycatch species. The three main catch species obtained were *Anguilla bicolor bicolor*, *A. marmorata*, and *A. nebulosa*. The similarity in the main catch is possible because the two areas are connected in the line of the southern coast of Java, which faces the Indian Ocean directly.

The three glass eels, which are the main catches, have a very dominant relative abundance (>97%) in each month in both fishing gears. Glass eels eel of the species *A. bicolor bicolor* have the highest relative abundance of the total catch obtained in both fishing gears in each month. Susilawati, (2022) categorizes fishing gear as selective in terms of species if the composition of the main catch is >60%. This condition indicates a good level of selectivity in both fishing gears when targeting glass eels as the main catch.

The high level of selectivity of both fishing gears is further strengthened by the meager value of the diversity and evenness index calculations (H' & $E < 0.03$) and the very high value of the dominance index ($D > 0.98$). Regarding the selectivity of fishing gear, the three diversity indices can be a depiction of the selectivity of the type of catch as viewed from the structure of the catch obtained. The lower the diversity and evenness index value indicates, the more selective a fishing gear is. Meanwhile, the higher dominance index suggests an excellent tendency for fishing gear to obtain certain species as its main catch (Dewanti et al., 2023; Kartawijaya et al., 2011; Purwanto et al., 2021; Rahman et al., 2015).

CONCLUSIONS AND RECOMMENDATIONS

Both traps and push nets used by local fishermen in the Cikaso River, Sukabumi, Indonesia, are highly selective in catching glass eels (*Anguilla* spp.) in terms of relative abundance and diversity index of the catch. Nineteen catch species were successfully identified during the study period for both fishing gear. The nineteen species consisted of 3 glass eels as the main catch and 16 species as bycatch. The highest catch composition in both fishing gears came from the *Anguilla bicolor-bicolor* species.

Both fishing gears can be recommended for catching glass eels in the Cikaso River, which has different river characteristics. Traps can be operated in large rocky and crevice riverbank waters, while push nets can be used in sandy and small rocky waters.

ADVANCED RESEARCH

Traps and push nets for catching glass eels still require various developments in the construction of fishing gear and fishing aids. Research on increasing the effectiveness and efficiency of catches needs to be carried out and developed further to increase catch production.

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