

The effect of material type and mesh size of the drift gillnet selectivity on Abe's flyingfish, *Cheilopogon abei*, in Seram Sea, Indonesia

Agustinus Tupamahu, Haruna, Frentje D. Silooy

Department of Fisheries Resources Utilization, Faculty of Fishery and Marine Science, Pattimura University, Ambon, Indonesia. Corresponding author: A. Tupamahu, agustupamahu02@gmail.com

Abstract. The purpose of this study was to analyze the selectivity of flyingfish drift gillnets, especially the size of the mesh and the type of thread used by fishermen. The drift gillnets consist of 4 pieces sized as follows: (1) a monofilament net with a knot to knot mesh size of 3.2 cm and a twine diameter of 0.25 mm, (2) 3.8 cm mesh size 210d3 multifilament, (3) 3.8 cm mesh size 0.25 mm monofilament, and (4) 3.2 cm mesh size 210d3 multifilament. The nets were operated together for 38 fishing trips. The results showed that the fishing efficiency of the multifilament material type was better than monofilament. The size of Abe's flyingfish caught during the study was distributed within a total length interval of 14–26 cm. The fish modal lengths for the 3.2 and 3.8 cm monofilament meshes are 16.5 and 17.5 cm, while for the 3.2 and 3.8 cm multifilament meshes size modal classes they are of 16.5 and 20.5 cm. For the size of Abe's flyingfish, the monofilament is more selective than the multifilament drift gillnet.

Key Words: monofilament, multifilament, mesh of net, length distribution, optimum size.

Introduction. Flyingfish has long been known in Indonesia as an important marine product commodity with egg prices reaching USD 20-30 kg⁻¹ dry weight (Nessa et al 1977; Genisa 1981; Hutomo et al 1985; Tebaiy et al 2019). In the waters of the western Pacific, flying fish were found in 6 genera with a total of 31 species (Parin 1999) of which 18 species were found in Indonesian waters. Flyingfish fishing activities in Indonesian waters are mostly carried out in Eastern Indonesia, especially the Makassar Strait and the Flores Sea, the Seram Sea, the Banda Sea, and the waters of the Sangihe Talaut Islands.

In Maluku waters, especially in the Banda Sea and Seram Sea, fishermen catch flyingfish with drift gillnets, and the caught fish is processed into dry fish. The flyingfish gillnet fishing activities are carried out in the Seram Sea by fishermen from Geser and Gorom Islands. Two types of netting material are used, namely PA multifilament 210D3 and PA monofilament with a yarn diameter of 0.25 mm, while the mesh sizes used are 3.2 cm and 3.8 cm. One of the dominant flyingfish species caught with drift gill nets in the Seram Sea is *Cheilopogon abei* (Parin 1996). This species was caught with a drift gillnet with a mesh size of 3.8 cm with PA monofilament material in the Seram Sea. Adults have a fork length range of 182.6-243.3 mm and in the range of 202-212 mm and 213-223 mm at first gonad maturity for male and female, respectively (Tuapetel 2021).

Many studies related to the biological aspects of flyingfish in eastern Indonesia have been carried out (Ali et al 2004; Makatipu & Syahailatua 2005; Syahailatua et al 2006; Tuapetel et al 2015; Tuapetel et al 2017; Tuapetel 2021; Rehatta et al 2021). Gear selectivity is the property of fishing gear to reduce or remove unusable fish size and incidental catch (Arimoto 2001). In addition to biological factors information for management policies, research related to the selectivity of fishing gear is also needed. Research related to the selectivity of flyingfish drift gillnet is still limited and has been carried out in Ambon Island waters on 3 dominant species caught (*Cheilopogon suttoni*, *C. abei* and *Hirundichthis oxycephalus*) with 3 mesh sizes of 3.2, 3.8 and 4.4 cm

(Hutubessy & Syahailatua 2010). In addition, the selectivity of the drift gillnet meshes with sizes of 3.2, 3.8 and 4.4 cm has been on the species of *H. oxycephalus* in the northern part of the Makassar Strait (Pallo et al 2019).

The selectivity of gill nets is highly dependent on the shape and size of the fish and on the size of the meshes, but it is also influenced by the thickness of the thread, the type of material, and the hanging ratio (Hamley 1975). In relation to fishing activities for flyingfish, especially *C. abei* by fishermen from the Gorom Island in the Seram Sea, this study was conducted to analyze the selectivity of drift gillnets, with a focus on the size of the drift gillnets and the type of net material used by fishermen.

Material and Method

Description of the study sites. This study is a fishing experiment using a combinations of drift gillnet mesh sizes of 3.2 and 3.8 cm and material types of PA monofilament of 0.25 mm and PA multifilament of 210D3). The study was carried out in the Seram Sea around Gorom Island at the Astronomical position of 402'8.842"-403'37.498"S and 131027'1.456"-131027'48,524"E. Figure 1 shows the area of fishing location in the Gorom waters of Seram Sea. The fishing operation was carried out in 38 trips from October to December 2019.

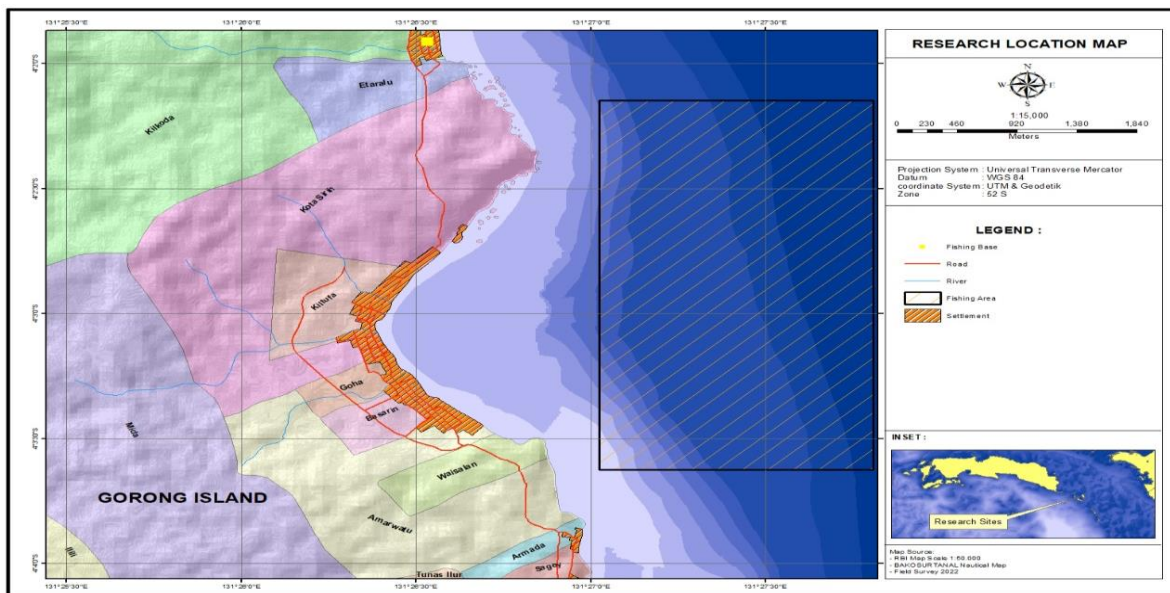


Figure 1. Fishing area of drift gillnet of *Cheilopogon abei* in Seram Sea, Indonesia.

Design of drift gillnet. The design specifications for the drift gillnets used in the trial of fishing *C. abei*, consisting of the mesh size and material type, are: 3.2 cm monofilament, 3.2 cm multifilament, 3.8 cm monofilament, 3.8 cm multifilament, as shown in Table 1.

Data collection. The catch data of *C. abei* for each combination of mesh size and material type are categorized into gilled and entangled capture processes, then the total length is measured to the nearest 0.1 cm.

Data analysis. Data on the total length of the catch of *C. abei* were grouped into several classes of total length with a class interval of 1.0 cm, then a frequency distribution of the total length was made for each treatment combination of mesh size and type of drift gillnet material based on the catch process. The selectivity of *C. abei* drift gillnets for each combination of a mesh size and material type was determined using the total catch length class, specifically for the gilled process using the Holt method (Hovgard & Lassen 2000):

$$S_{l,m} = \exp\left[-\frac{(C_{lm} - K_m)^2}{2\sigma^2}\right]$$

Where:

$S_{l,m}$ - selectivity of mesh size of m at total length of l ;

C_{lm} - catch of mesh size of m at total length of l ;

K_m - selectivity factor at mesh size m ;

σ^2 - curve width.

Table 1

Drift gillnet specification

Variable	Unit	3.2 cm mesh size		3.8 cm mesh size	
		Monofilament 0.25 mm	Multifilament 210 D ₃	Monofilament 0.25 mm	Multifilament 210 D ₃
Net stretch length	m	70	70	70	70
Length of float line	m	39	39	39	39
Hanging ratio	%	57	57	57	57
Number of meshes depth	mesh	50	50	42	42
Net height	m	1.38	1.38	1.38	1.38
Float number	float	88	88	88	88

Results. The total catch was of 1,900 individual *C. abei*, captured during the fishing experiment. Figure 2 shows that the frequency distribution of the length of the fish caught for each combination of mesh size and type of material was analyzed based on the gilled and entangled process. Most *C. abei* catches are caught through a gilled process, with both monofilament and multifilament material types. The total catch of the PA multifilament yarn type (1,099 individuals) was higher than that of the monofilament PA yarn (801 individuals).

C. abei catches are distributed over a total length interval from 14.0 to 26.0 cm. The frequency distribution of the total length of fish caught with monofilament gill nets was unbalanced: the proportion of small fish caught was higher for both the 3.2 cm mesh size and 3.8 cm mesh sizes. The highest frequency for the 3.2 cm mesh size was in the total length class of 16–17 cm, for the 3.8 cm mesh size it was in the 17-18 cm total length class.

The frequency distribution of the total length in fish caught with a multifilament drift gill net at a mesh size of 3.2 cm was unbalanced: the proportion of small fish caught was higher. The frequency distribution of the total length in the mesh size of 3.8 cm tends to be normal: the proportion of smaller and larger sizes of the captured fish tends to be balanced. The highest frequency of fish caught in the mesh size of 3.2 cm was in the total length class of 16-17 cm, while in the mesh size of 3.8 cm it was in the total length class of 20-21 cm.

Selectivity. Figure 3 shows that the relative selectivity was different for the type of material and mesh size. The bigger the mesh size, the higher the optimum catch probability. The optimum catch probability also differs between types of net yarn even though the mesh size is the same

The maximum catch probability of fish at a total length of 17.9 cm with a mesh size of 3.2 cm and monofilament yarn type increased for a total length of 21.2 cm with a mesh size of 3.8 cm and multifilament yarn type. The maximum catch probability with a mesh size of 3.2 cm and multifilament yarn type is smaller than the monofilament yarn type, namely at a total length of 16.5 cm, as well as for a mesh size of 3.8 cm, namely at a total length of 19.5 cm.

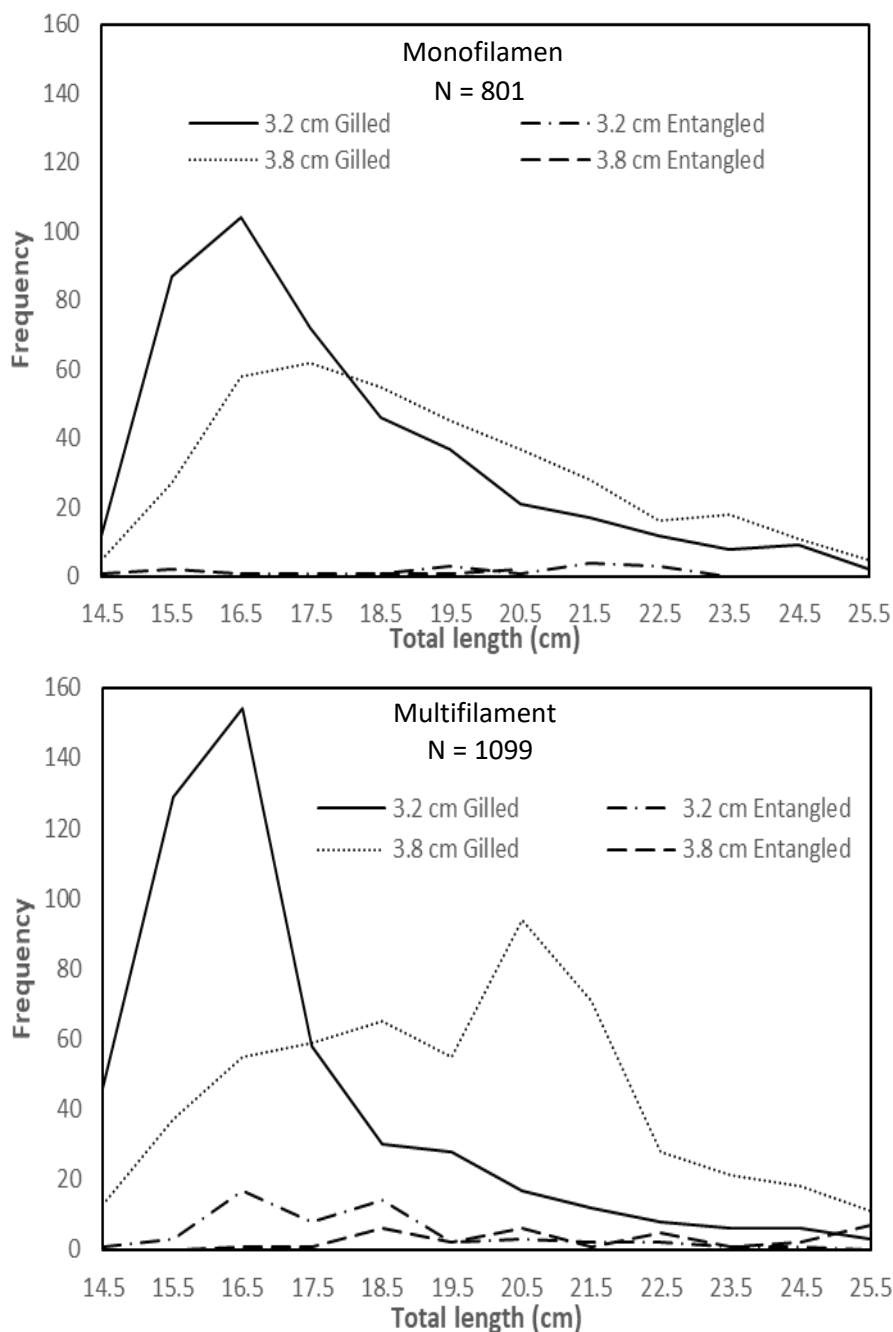


Figure 2. Length frequency distribution of *Cheilopogon abei* for two mesh sizes and two material types.

Discussion. *C. abei* lives at a water depth ranging from 0 to 20 m (Parin 1996). In the waters of the island of Ambon, this species is commonly caught with drift gillnets of monofilament material type and mesh sizes of 3.2 and 3.8 cm (Hutubessy et al 2006). The distribution of the total length of fish caught with mesh sizes of 3.2 and 3.8 cm in this study ranged between 14 and 26 cm, while in Ambon Island waters, this type of fish was caught with the same mesh size with monofilament threads ranging from 18 to 30 cm (Hutubessy & Syahailatua 2010). Most of the fish were caught in the waters of the Ambon Island by bouncing in gill nets with a mesh size of 3.2 cm, while at a mesh size of 3.8 cm they were caught by entanglement. In this study, most of *C. abei* were caught by entanglement for both 3.2 and 3.8 cm mesh sizes. The difference in the way the fish were caught in this study and in the waters of the island of Ambon, especially in the mesh size of 3.2 cm, may be due to the distribution of the caught fish and to the different hanging ratio values of the nets.

Fishermen usually consider both the type of material and the physical attributes of the gear used for the catch. Various scientific studies have been carried out regarding the

fishing efficiency between monofilament and multifilament net material types, but the results of this comparison do not clearly determine which one is better. Some studies (Predel 1963; Washington 1973) found multifilament to be superior to monofilament nets while other studies showed the opposite (Hysten & Jacobsen 1979; Aydin et al 2008). This difference may be caused by the type of fish considered as the target of catching. In this study, the type of multifilament material was found better for catching *C. abei*.

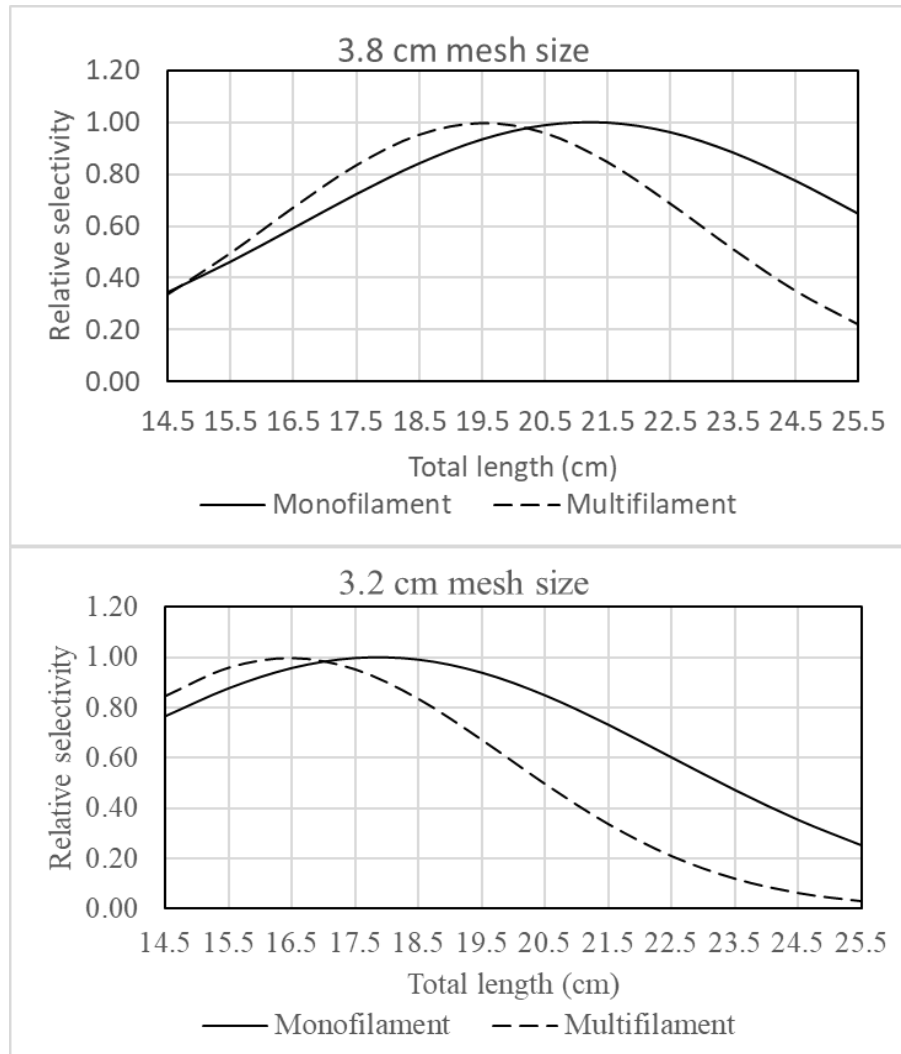


Figure 3. Estimation of *Cheilopogon abei* drift gillnet selectivity.

The normal, log-normal and gamma selectivity curves describe the bell shape of the gillnet selectivity curve (Hovgard & Lassen 2000). The selectivity curve in this study shows a normal distribution. The frequency distribution of the total length spreads normally only for the type of multifilament material with a mesh size of 3.8 cm, while for the other mesh size and material combinations their distribution is skewed. Therefore, further analysis needs to be carried out using log-normal and gamma models.

Reproductive results are highly dependent on the stock of adult fish (Pelletier et al 2009), whose size is determined at the first maturity of gonads, when the individual is capable of producing new individuals. The range of the total length at first maturity of the *C. abei* gonads in the Seram Sea was 24.3-25.3 cm (Tuapetel 2021). For management purposes, it is recommended to capture *C. abei* from the Seram Sea by using a 3.8 cm drift gillnet with a monofilament material type.

Conclusions. The conclusion of this study is that drift gillnet with multifilament material has a good fishing efficiency for catching *C. abei* in the Seram Sea. *C. abei* drift gillnet

with a mesh size of 3.8 cm with monofilament material is more selective than the 3.2 cm and 3.8 cm mesh sizes with a multifilament material and the 3.2 cm mesh size with monofilament material.

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Conflict of interest. The authors declare no conflict of interest.

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Authors:

Agustinus Tupamahu, Department of Fisheries Resources Utilization, Faculty of Fishery and Marine Science, Pattimura University, Ambon, Indonesia, e-mail: agustupamahu02@gmail.com

Haruna, Department of Fisheries Resources Utilization, Faculty of Fishery and Marine Science, Pattimura University, Ambon, Indonesia, e-mail: haruna.unpatti@gmail.com

Frentje Dusyan Silooy, Department of Fisheries Resources Utilization, Faculty of Fishery and Marine Science, Pattimura University, Ambon, Indonesia, e-mail: frentje.silooy@fpik.unpatti.ac.id

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