

The productivity of gill net mono multifilament modification operating in Rembang waters, Indonesia

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Abstract. Gillnet is a type of fishing gear widely operated in Rembang waters but needs to be studied, especially with the focus on the design and construction aspect in order to increase its productivity. This research was conducted to determine the effect of gill net mono multifilament modification on fishing productivity through the use of an experimental fishing method and the data collected using direct observation of the genuine and modified gill net for 8 fishing trips. The results showed the modified gill net had a catch consisting of 12 fish species while the genuine net had only 6. Moreover, the highest net productivity for the modified gill net was found to be $1.74 \text{ kg (minute)}^{-1}$ while the lowest was $0.17 \text{ kg (minute)}^{-1}$. Meanwhile, the genuine gill net had $0.45 \text{ kg (minute)}^{-1}$ and $0.02 \text{ Kg (minute)}^{-1}$ respectively. The productivity value of modified gill net is higher than gill net genuine.

Key Words: gillnet modification, catch, productivity, Rembang waters.

Introduction. Rembang waters are located in the northern part of Java Island and this led to its inclusion in the North Coast (Pantura) waters of Central Java, Indonesia. It has approximately $1,014 \text{ km}^2$ area with a coastline of 63 km (Wijayanto et al 2019). Moreover, the fishery potentials in Rembang Regency include capturing commodities such as snapper, tuna, mackerel, scad, sardinella, anchovy, Ariid catfish, and swim crab as well as aquaculture fisheries (DMF of Rembang Regency 2020). There are various types of fishing gears operated in Rembang, including mini purse seine, seine net, trammel net and gill net; where the majority of fishermen use gill nets and trammel nets.

Gillnet is a type of traditional fishing gear (Rodriguez-Climent et al 2012; Deniz et al 2020) which is usually operated passively in the water (Von Brandt 2005) and classified by Zydellis et al (2013) to have a mesh used in trapping the targeted fish with width varying between 15 and over 250 mm. A float is installed at the top while an anchor is placed at the bottom to maintain the position of the fishing gear in the water column.

Gillnet has become one of the alternative fishing gears preferred by Rembang fishermen since the issuance of Minister of Marine Affairs and Fisheries Regulation (PERMEN KP) No.71 of 2016 which prohibits destructive and environmentally unfriendly operations of fishing gears such as cantrang and trawl. Gillnet was selected as a replacement due to its environmental friendliness and passivity which inhibits it from damaging the seabed ecosystem as well as its low bycatch (Park et al 2011; Fitri et al 2017). Meanwhile, some fishermen are challenged by the low catch attributed to this method compared to seine net and trawl fishing gear. This shows there is a need to modify the design and construction of gillnet toward ensuring better productivity.

The modification of gill net mono multifilament is targeted on increasing the catch productivity and selectivity of the catch size (Karakulak & Erk 2008; Rodriguez-Climent et al 2012; Zydellis et al 2013; Fitri et al 2017; Deniz et al 2020; Ramírez-Amaro & Galván-

Magaña 2019; Ford et al 2020) and this is subsequently expected to increase fishermen's income. The research objective was to analyze the productivity value between modified gill net and genuine gill net.

Material and Method. The research was conducted on December 2019 in Rembang waters (Figure 1). The research used experimental fishing methods while the gill net was modified using mono multifilament net type with one unit reported to be consisting of 60 pieces (Fitri et al 2019). A swivel was also added for an easier catch while the bait is fixed at the bottom of the net to attract the fishes (Fitri et al 2019). The modified net design is, however, shown in Figure 2.

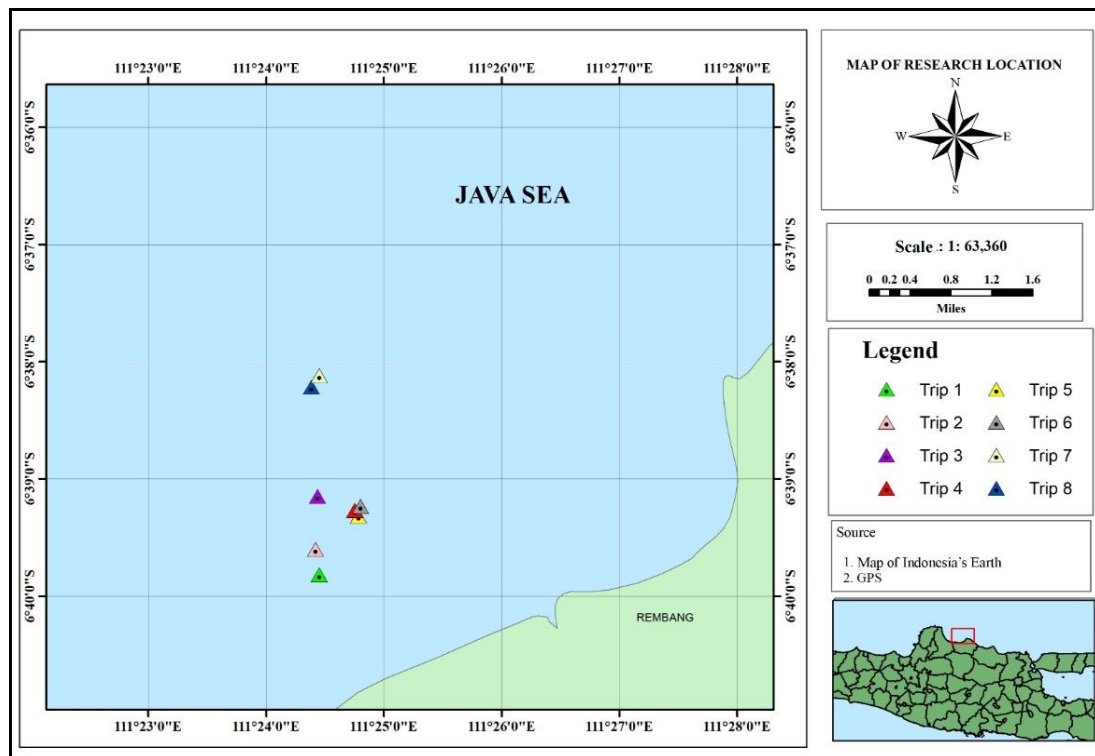


Figure 1. Map of the research location, Rembang waters.

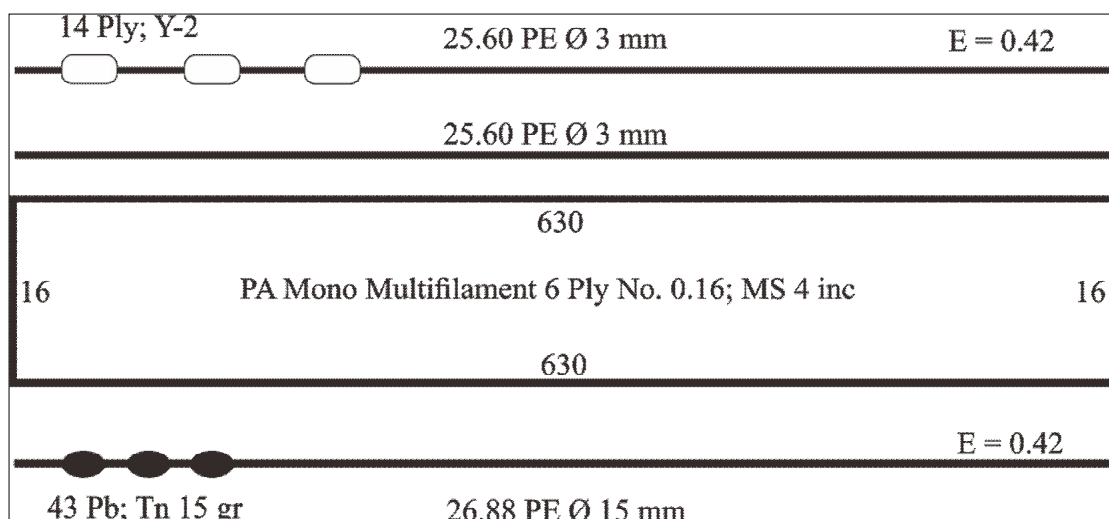


Figure 2. The design of mono multifilament gill net (Ply (layers/ twist yarn); Y (Yarn); E (hanging ratio); PA (Polyamide); MS (mesh size); PE (Polyethylene); Ø (diameter); Pb (lead); Tn (tin).

Data were collected through direct observation of the operations of genuine and mono multifilament gill net in Rembang waters over 8 fishing trips. The ship that was used

during fishing activities had the following specifications: dimensions (6 x 2.3 x 1) m, outboard engineering and 20 HP engine power. The fishing fleet consisted of 2-3 people, with the fishing ground being located 2 miles away. The time operation of the gill net starts in the afternoon until the morning. Genuine gill net and modified gill net were placed close together in one trip and this means the aquatic oceanography and other external factors were assumed to be the same for them. The operation of the fishing gear involves setting, immersing, and hauling with the setting stage conducted by lowering the gear at the fishing ground after which the gill net was soaked for 1-2 hours while the hauling stage involves lifting the gill net. The catch was, however, separated or grouped based on the fish type, length, and weight.

Data analysis. The productivity of the substitute fishing gear trial prohibited by the Regulation of the Minister for Marine Affairs and Fisheries in Indonesia (PERMEN KP) No.71 of 2016 was analyzed using the formula of Dahle (1989) in Nelwan et al (2015) as follows:

$$Prd = C/(V.t) \dots\dots\dots (1)$$

where: Prd is the productivity in kg (minute)⁻¹, C is the total catch in kg, t is the effective time of fishing operation, while V is the net volume (length x width).

The effective fishing time was calculated starting from the period the net was set down to when it was lifted or hauled.

The composition of the catch type in the gill net was evaluated using the following formula:

$$Pi = n_i/N \dots\dots\dots (2)$$

where: Pi is the catch composition, ni is the number of species catch and N is the total catch.

The interval data for the total length of fish and maturity (Lm) caught was in reference to the fish base data and are presented in tables and graphs after which they were analyzed using comparative descriptive methods.

Results and Discussion. The composition of the catch from the operation of the genuine gillnet had 6 fish species (*Eleutheronema tetradactylum*, *Lates calcarifer*, *Xiphias gladius*, *Rastrelliger* sp., *Scomberomorus commersoni* and *Euthynnus affinis*) while the modified gillnet had 11 fish species (*E. tetradactylum*, *L. calcarifer*, *X. gladius*, *Rastrelliger* sp., *S. commersoni*, *E. affinis*, *Plotosus canius*, *Sphyræna barracuda*, *Pampus argenteus*, *Caranx sexfasciatus*, *Selaroides leptolepis*) and one crustacean species (*Portunus pelagicus*) (Table 1). The most dominant type of fish caught was *E. tetradactylum* with 65.16% for genuine and 71.86% for the modified gill net.

Table 1
The catch composition

No.	Fish species	Genuine gill net		Modified gill net	
		Weight (kg)	Percentage (%)	Weight (kg)	Percentage (%)
1	<i>Eleutheronema tetradactylum</i>	26.839	65.16	113.839	71.86
2	<i>Lates calcarifer</i>	2.874	6.98	11.874	7.49
3	<i>Xiphias gladius</i>	5.213	12.66	10.213	6.45
4	<i>Rastrelliger</i> sp.	2.81	6.82	7.91	4.99
5	<i>Scomberomorus commersoni</i>	2.047	4.97	3.547	2.24
6	<i>Euthynnus affinis</i>	1.408	3.42	2.404	1.52
7	<i>Plotosus canius</i>			1.146	0.72
8	<i>Sphyræna barracuda</i>			1.105	0.70
9	<i>Portunus pelagicus</i>			0.478	0.30
10	<i>Pampus argenteus</i>			0.408	0.26
11	<i>Caranx sexfasciatus</i>			5.117	3.23
12	<i>Selaroides leptolepis</i>			0.386	0.24
	Total catch	41.191		158.427	

The main catch. Main target for the gillnet fishermen in Rembang is *E. tetradactylum* which is categorized as a carnivorous fish species (Tritawani et al 2013) reported to be living in shallow waters (Sunarni & Maturbongs 2018), and observed to have become one of the most important commodities for traditional fishermen operating gill net at inshore waters (Moore et al 2011; Horne et al 2011). The length of this species mostly caught by the genuine gill net was found to be in the range of 37-43 cm which was recorded to be 54% of the total catch while the modified gill net was between 35 and 41 cm with 37% as shown in Table 2.

Table 2

Total length interval of caught Kuro fish (*Eleutheronema tetradactylum*)

Interval	Genuine gill net		Interval	Modified gill net	
	Frequency	Percentage		Frequency	Percentage
23-29	2	15%	28-34	9	33%
30-36	1	8%	35-41	10	37%
37-43	7	54%	42-48	6	22%
44-50	3	23%	49-55	1	4%
51-57	0	0%	56-62	1	4%
N	13		N	27	
Min	23 cm		Min	28 cm	
Max	50 cm		Max	59 cm	

The by-catch of the modified gill net was found to be greater than the genuine gill net. This is due to the placement of bait on the modified gillnet as a chemical attractor so that it attracts the attention of fish in the catchable area (Kallayil et al 2003; Fitri et al 2018a, 2018b). The by-catch of several fish species have a high price (Abdulqader et al 2020) and this consequently increases the income of the fishermen. Moreover, the average length of each species caught by the modified gill nets was higher than for the genuine net. Some of the species suitable to be caught include *S. barracuda* with 66 cm, *C. sexfasciatus* with 58.5 cm, and *S. leptolepis* with 17.33 cm while those not suitable include *X. gladius* with 98 cm, *Rastrelliger* sp. with 15.92 cm, *S. commersoni* with 38.2 cm, *E. affinis* with 17.44 cm, *P. pelagicus* with 8 cm, and *P. argenteus* with 18 cm as shown in Table 3.

Table 3

Average total length of genuine and modified gill net catch

No.	Fish species	Average length of catch (cm)		Data from fishbase.org		
		Genuine gill net	Modified gill net	Max length	Min length	Lm
1	<i>Eleutheronema tetradactylum</i>	38.33	38.85	200	50	-
2	<i>Lates calcarifer</i>	36	46	200	150	-
3	<i>Xiphias gladius</i>	93	98	455	300	221
4	<i>Rastrelliger</i> sp.	12.88	15.92	34.5	20	17
5	<i>Scomberomorus commersoni</i>	23.21	38.2	240	120	85
6	<i>Euthynnus affinis</i>	13.08	17.44	100	60	39.8
7	<i>Plotosus canius</i>	-	38.5	150	80	-
8	<i>Sphyraena barracuda</i>	-	66	200	140	66
9	<i>Portunus pelagicus</i>	-	8			> 10
10	<i>Pampus argenteus</i>	-	18	60.0	30	25,3
11	<i>Caranx sexfasciatus</i>	-	58.5	120	60	42
12	<i>Selaroides leptolepis</i>	-	17.33	22	15	11.9

Note: Lm = length of the first maturity.

The catch of the modified gillnet consisted of multispecies and this shows the possibility of applying it as an alternative tool for cantrang and trawl by fishermen due to its ability to catch more than one species (Fitri et al 2019; Broadhurst & Sterling 2020). Meanwhile, the types of species caught showed the modified gill net fishing gear has lesser types compared to the trawl (Silveira et al 2020; Gamaza-Márquez et al 2020). Several studies also showed the seabed ecosystem of the waters used as the washout area for the bottom of the trawl nets experienced degradation (dos Santos & de Almeida 2020). Besides being destructive, some of the catches with the use of the net are in damaged condition because they are caught in the codend (Sistiaga et al 2020). Meanwhile, the gill net has been classified as passive fishing gear (Kraus et al 2017) and this means it does not have an impact on the seabed ecosystem (Lucchetti et al 2020; Paradis et al 2018; Pierdomenico et al 2018).

Catch per trip. The highest catch per trip for the genuine gill net was found to be 8.23 kg while the modified gill net had 27.87 kg both on the 7th trip. Meanwhile, the lowest catch was recorded on the 2nd trip as observed with the 0.489 kg recorded for genuine gill net and 4.489 for the modified gill net as shown in the complete data of Figure 3.

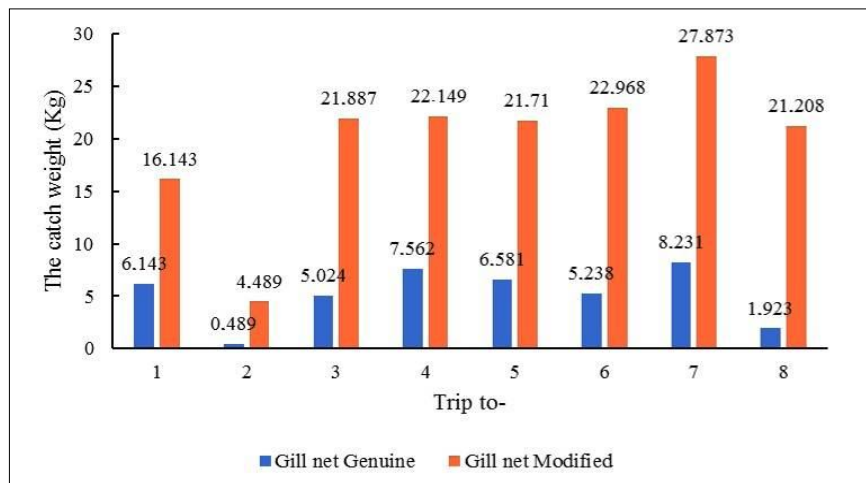


Figure 3. Graph of genuine and modified gill net catch per trip.

The catch for the modified gill net was observed to be generally higher than for the genuine net at each trip and this is associated with several factors including oceanography such as temperature, salinity, current, and chlorophyll-a (Tangke et al 2011), as well as the fishing season (Chodriyah & Hariati 2010; Abdillah et al 2019). Moreover, the bait added to the modified gill nets also attracts biota other than fish such as crab (*P. pelagicus*) and this is in line with the findings of Fitri et al (2018a) and Archdale & Kawamura (2011) that adding bait to traps or pots increases the chance of catching a crab.

Gill net productivity. The productivity value of both the genuine and modified gill net is presented in Figure 4.

The graph of the gill net productivity value tends to decrease as the operating time increases (Nelwan et al 2015) with the highest value found at the 5th trip for the two nets with the genuine and modified gill nets having 0.45 kg (minute)⁻¹ and 1.75 kg (minute)⁻¹ while the lowest values were found in the second fishing trip with 0.02 kg (minute)⁻¹ and 0.17 kg (minute)⁻¹ respectively. This means the productivity trend of the modified gill net is higher and the mono multifilament gill net was observed to have shown a positive value during the fishing trial period for the 8 trips and considered applicable as the main choice for Rembang fishermen to replace cantrang and trawl.

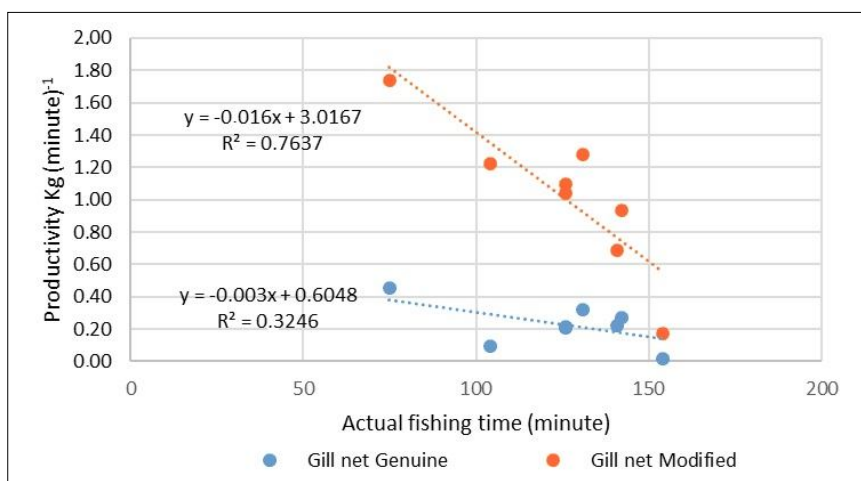


Figure 4. Productivity value of genuine and modified gill net.

Conclusions. The fishes caught by the genuine gill net were 6 species while the modified net had 12 species with the interval length of *kuro* fish (*E. tetradactylum*) mostly caught found to range between 37 and 43 cm with 54% and 35-41 cm with 37% respectively. Moreover, the highest values for the genuine and modified gill net productivity were recorded at the 5th trip with $0.45 \text{ kg (minute)}^{-1}$ and $1.75 \text{ kg (minute)}^{-1}$ respectively while the lowest was observed found in the second trip with $0.02 \text{ kg (minute)}^{-1}$ and $0.17 \text{ kg (minute)}^{-1}$ respectively.

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