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Selectivity of fishing gear for hairtail fish (*Trichiurus lepturus* Linnaeus, 1758) commodities in Pangandaran District, Indonesia

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ABSTRACT

Hairtail fish (*Trichiurus lepturus* Linnaeus, 1758) are a major commodity of high economic value in Pangandaran. This study aims to determine the most selective fishing gear for hairtail fish commodities based on the frequency of hairtail fish length, the proportion of the main catch and by-catch in Pangandaran District. Data collected are primary and secondary data. Primary data consists of catch data and fish size length. The catch is obtained by collecting the results of landing fish with gill nets and beach seines. Fish size length data obtained through direct measurement when the fish is landed. Secondary data collected is data on capture fisheries production in Pangandaran District. Data analysis consisted of calculation of length size distribution and comparison of main and by-catches with fishing gears. The analysis was carried out with the help of Microsoft Excel software. The results of this study indicate that hairtail fish in Pangandaran District were captured using gill nets and beach seines. Based on the results of the research conducted on August 2018 until January 2019, it can be concluded that gill net fishing gears are more selective compared to beach seines based on several parameters observed, namely the length distribution and the proportion of main catch : by-catch. The results showed that the comparison of the length distribution of hairtail fish that was appropriately caught between gill nets and beach seines was 85.74% : 30,74%. Comparison of the proportion of main catch : by-catch between gill nets and beach seines was 52.38%: 23.57%.

Keywords: *Trichiurus lepturus*, Selectivity, Gill nets, Beach seines, Pangandaran

1. INTRODUCTION

Pangandaran officially became a new district in the Ciamis region in 2012. The total area of Pangandaran District is 168,509 Ha with a sea area of 67,340 Ha. Pangandaran District has a beach length of 91 Km. Geographically, Pangandaran District is at coordinates 108°18'-108°47' East Longitude and 7°30'20"- 7°50'00" South Latitude [12]. According to Indonesian Law No. 21 year 2012, the formation of Pangandaran District which is a division of Ciamis District consists of 10 sub-districts, namely Parigi, Cijulang, Cimerak, Cigugur, Langkaplancar, Mangunjaya, Padaherang, Kalipucang, Pangandaran, and Sidamulih. Pangandaran District has a total area of $\pm 1,010 \text{ km}^2$ with a population of $\pm 426,171$ people in 2011 and 92 (ninety two) villages.

The main sector of the Pangandaran District people in choosing jobs other than in the tourism sector is conducting fishing. Pangandaran waters have a vast potential of marine resources. Therefore, marine fish resources in Pangandaran waters should be optimally utilized. Sustainable fishery resources will continue to support fishing activity in Pangandaran waters, increasing fishery production [4]. Fishing operations by each type of fishing gear have a significant difference, this is because each type of fishing gear has a different construction that is adjusted to the objectives of the catch and the condition of the waters in the fishing area [3].

One type of demersal fish that has important economic value and is the main target of catching in Pangandaran is hairtail fish. Hairtail fish are the main target for catching because hairtail fish have a wide-ranging market ranging from the needs for the local market and exports [7]. Hairtail fish are allometric negative and the value of L_c (50.51 cm) < L_m (58.83 cm) indicates that fish caught in a condition not yet mature or not ready to spawn. Mortality rate from arrest is greater than natural death with the rate of exploitation (E) has reached the maximum limit [14]. *Trichiurus lepturus* is caught by the traditional fishing sector using drift gillnets, fixed nets and hand-lines, and by the commercial sector, using demersal trawling [2]. The diversity of fishing gear is one of the distinctive features of capture fisheries in Indonesia, this is due to one of the reasons for the diverse commodity resources [5, 17-31].

Based on this, the authors are interested in conducting research on the selectivity of fishing gear to the hairtail fish (*Trichiurus lepturus*) commodities in Pangandaran District to calculate the selectivity of fishing gear for hairtail fish based on frequency of length distribution and proportion of main catch by-catch.

2. MATERIALS AND METHODS

The material used in this research activity is the <5 GT motorized boat owned by Pangandaran fishermen to participate in hairtail fishing with different fishing gear per *trip*, ordinary meter gauge with an accuracy of 1 mm which serves to measure the length of hairtail fish, camera digital functions to document each research activity, stationery used to record primary and secondary data during research is carried out and hairtail fish catches that are used as research objects.

This research was conducted on August 2018 until January 2019 in Pangandaran District using a case study method with quantitative descriptive analysis. As a research method, case studies seem to be appropriate for investigating when a large variety of factors and relationships are included, no basic laws exist to determine which factors and relationships are important and

when the factors and relationships can be directly observed [6]. Quantitative descriptive analysis is used as a problem solving procedure that is investigated by describing / calculating and calculating the state of the subject or object of research (someone, institution, society, etc.) at the moment based on the data and facts that appear. The sampling method used in this research is the purposive sampling method, which is to take samples randomly or the researcher intentionally collects data on certain groups to obtain complete and accurate information related to hairtail fishing activities. While the method of data collection uses the method of observation, interviews, and documentation. The type of data used is primary data and secondary data. Primary data is data collected directly during the study includes the types of main catch and by-catches, the composition of the main catch and by-catch results by type, distribution of length distribution per species of fish caught, percentage of number and weight of fish non target capture results that are utilized and which are not utilized [11].

2. 1. Determination of the Length Frequency of Hairtail Fish Catches

The measurement of the length of the captured hairtail fish is done to determine the biological feasibility of the caught hairtail fish. The measurement of all hairtail fish as the main or by-catches is done after arriving on land using a meter gauge with a scale of 0.1 cm accuracy. The data obtained are recorded and calculated on average. Total length size at first gonadal maturity of hairtail fish was 63.9 cm for males and 69.3 cm for females [9]. Another statement measures the first length of maturity for female and male hairtail fish were 56.72 cm and 59.97 cm respectively [1]. The stages that must be done to arrange a length frequency distribution are as follows:

- 1) Sort the data first in the order of the magnitude of the value that is in the data.
- 2) Determine the range (R) of data.
(R) = largest data - smallest data
- 3) Determine class (K) which is determined by Sturgess formula
 $K = 1 + 3.3 \log (n)$
(description: K = number of classes, n = number of data),
- 4) Determine the length of the class interval
Length class interval (i) = Number of classes (K) / Range (R),
- 5) Determine the lower limit of the first class. The lower edge of the first class is usually selected from the smallest data or data that comes from widening the range (data smaller than the smallest data) and the difference must be less than the length of the class interval,
- 6) Writing the class frequency in the column according to the amount of data.

2. 2. Proportion of Catches Analysis

The calculation of the proportion of catches is carried out to calculate the ratio of the dominant catches of a fishing gear. Data of catches that have been obtained are calculated using a formula then entered and presented in the form of percentage diagrams.

$$\text{Main Catch Proportion (\%)} = \frac{\text{Amount of Main Catching}}{\text{Catch Total}} \times 100\%$$

$$\text{By-catch Proportion (\%)} = \frac{\text{Amount of By-catching}}{\text{Catch Total}} \times 100\%$$

The amount of main catch in the formula means as a catch which becomes a commodity which is the object of research, namely hairtail fish caught by fishing gear. While the number of by-catch means as a catch that is not disposed of and is not an object of research but is caught in the same fishing gear.

2. 3. Data Analysis

The data analysis used in this study was to calculate the length frequency distribution of the fish caught in the catch to find out the catch of the fish caught on each catch, analysis of the proportion of the catch of the main catch and by-catch, namely data on the number and size of the main catches and by-catches from fishing operations which are calculated in the form of percentage diagrams which are then compared between main and by-catches which are larger in proportion.

3. RESULTS AND DISCUSSION

3. 1. Hairtail Fisheries in Pangandaran District

The results of research conducted to obtain fish which is one of the main catch targets of fishermen in Pangandaran District are hairtail fish. [15] Taxonomy and figure of hairtail fish (*Trichiurus lepturus*) is classified and showed as follows below:

Phylum : Chordata
Sub Phylum : Vertebrata
Class : Pisces
Sub Class : Teleostei
Order : Percomorphi
Sub Order : Scrombroidea
Family : Trichiuridae
Genus : Trichiurus
Species : *Trichiurus lepturus*



Figure 1. Hairtail Fish (*Trichiurus lepturus* Linnaeus, 1758) in Pangandaran

Based on Figure 1, morphological characteristics of hairtail fish (*Trichiurus lepturus*) namely body very long, flat like a ribbon especially the back end of the tail, Wide mouth equipped with strong and sharp catch teeth, The lower jaw is bigger than the upper jaw, The long dorsal fin starts from the top of the head to the end of the body and the fingers are weak, The anal fin grows poorly and has weak fingers, In the form of rows of small thorns there are no pelvic fins and rib lines look far below the body. The service is widespread in all tropical and subtropical waters in the world. In Indonesia, hairtail fish spread and are found in all coastal

waters of Indonesia. Based on aquatic species distribution map viewer by FAO, hairtail fish in Indonesia can be found in the Java Sea, Karimata Strait, Malacca Strait, Timor Sea and Arafura Sea.

Based on interviews conducted with middlemen, hairtail fish in Pangandaran District belong to export commodity fish which are in great demand in several countries such as Hongkong and Singapore. The hairtail (currently recognized as *Trichiurus lepturus* in Korea) is one of the most important commercial fish species too in Korea, Japan, China, and Taiwan [8]. Hairtail fish resources in the waters of Pangandaran are almost available every season, both rainy and dry seasons. This makes the hairtail fishing activities have a high intensity, almost every day fishing activities carried out by fishermen in Pangandaran District.

3. 1. 1. Productivity of Hairtail Fish in Pangandaran District

Based on observations made, consumption sized hairtail fish have a selling price of around 25,000 - 30,000 Rupiahs / kg, the price will change automatically if it has entered the restaurant that serves this fish, the price offered by sea food restaurants for 1 kg of fish reaches 60,000 Rupiahs. The high demand of the community for this fish makes the amount of fish production has decreased quite significantly as in the following Figure 2.

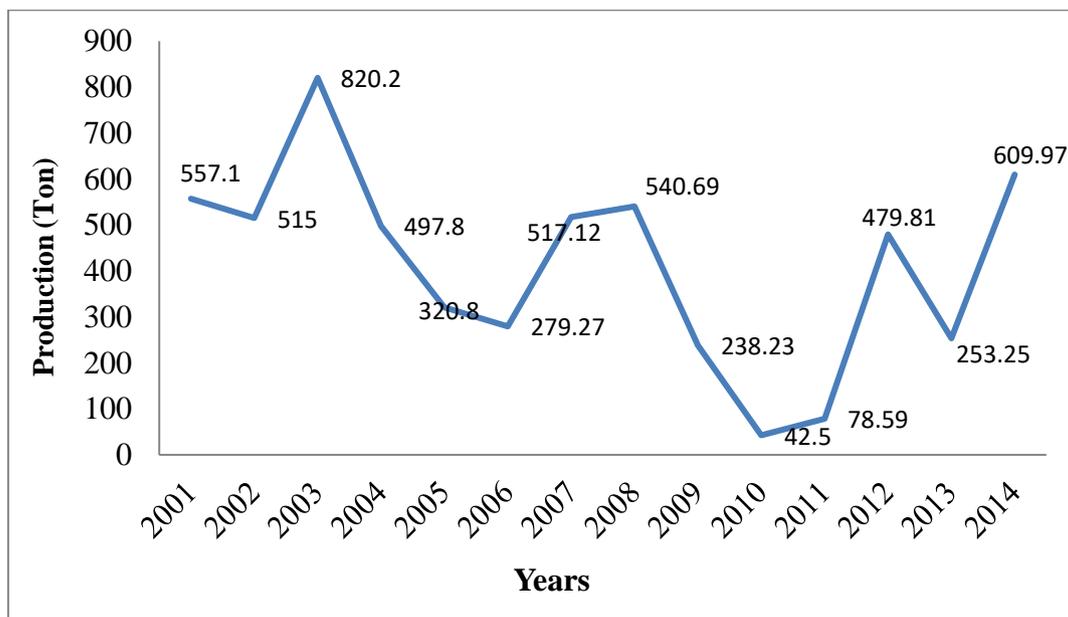


Figure 2. Production of Hairtail Fisheries in Pangandaran District

Based on the graphic images in the 14 years, the lowest production of hairtail fish caught in the waters of Pangandaran District in 2010 was only 42.5 tons. 2003 was the highest number of production compared to the previous year which was 802.2 tons [16]. Fluctuating conditions which tend to decrease in hairtail fish production in the waters of Pangandaran District are due to the high intensity of fishing activities carried out, almost every day fishermen make these fish as the main catch target. Hairtail fish habitats that have not fully recovered after the tsunami disaster a few years ago are also another reason for hairtail fish production to tend to decline.

3. 2. Fishing Unit

3. 2. 1. The Fishermen's

Fishermen in Pangandaran District belongs to traditional fishermen by relying on self experience without tools in determining fishing grounds. The total of fishermen and TPI found in Pangandaran District has a diverse amount as in the following Table [13].

Table 1. Number of Fishermen and TPI in Pangandaran District

Number	District	TPI (Unit)	Fishermen
1	Cigugur	-	-
2	Cijulang - TPI Nusawiru - TPI Batukaras	1 1	627
3	Cimerak - TPI Legokjawa - TPI Muaragatah - TPI Madasari	1 1 1	593
4	Kalipucang	1	562
5	Langkaplancar	-	-
6	Mangunjaya	-	2
7	Padaherang	-	14
8	Pangandaran - TPI Cikidang - TPI Jongorbatu - TPI Pangandaran	1 1 1	2.207
9	Parigi - TPI Parigi	1	764
10	Sidamulih	-	315
Total		10	5,084

3. 2. 2. Fishing Boat

Fishing boat operating in Pangandaran District are classified according to *Gross Tonage* (GT) sizes in the following table [13].

Table 2. Pangandaran District Fishing Vessel

No	District	Ship <5 GT	Ship 5-10 GT	Ship 10-20 GT	Ship 20-30 GT	Ship > 30 GT	Total
1	Cijulang	284	1	2	1	1	289
2	Cimerak	93	-	-	-	-	93
3	Kalipucang	154	-	-	-	-	154
4	Pangandaran	1081	-	1	1	6	1089
5	Parigi	307	-	-	-	1	308
Total		1919	1	3	2	8	1933

Referring to the Table 2, the number of fishing boats operating in Pangandaran waters is dominated by sizes <5 GT this is due to limited capital owned by fishermen and the distance taken by fishermen to carry out hairtail fish fishing is not too far (only 1-5 nautical miles).

The farthest distance taken by fishermen with <5 GT boats to carry out hairtail fish fishing activities is towards the waters of Cilacap, Central Java. While the closest distance taken by fishermen is only around the area of the Nature Reserve, Pangandaran. The dominance of <5 GT boats in Pangandaran District is due to the lack of skills of fishermen in operating large-sized boats.

3. 2. 3. Hairtail Fish Fishing Gear

Based on the results of the research conducted, the most widely used hairtail fishing gear in Pangandaran District is gill nets and beach seines. The hairtail fish caught by the two fishing devices has a significant influence on the production of fishing gear.

Table 3. Productivity of Hairtail Fish Capture During Research.

Fishing Gear	Hairtail Fish Production (Ton)	Effort (Trip)	Productivity (Ton /Trip)
Gill Nets	0.2373	18	0.013
Beach Seines	0.184	18	0.010

The amount of production from each fishing gear shows the value different, the fishing gear that produces the most hairtail fish is the gill net with a productivity of 13 kg / trip. These results are in line with the data from the following [16].

Table 4. Production of Hairtail Fish Based on Catching.

Fishing Gear	Year	Catch (Ton)	Effort (Trip)	Productivity (Ton /Trip)
Gill Nets	2013	11946.9	1865	6.406
	2014	606.92	200	3,035
	2015	-	-	-
	2016	-	-	-
	2017	10939	3334	3.281
Total		23492.82	5399	4.351
Beach Seines	2013	28.17	27	1.043
	2014	6.5	15	0.433
	2015	-	-	-
	2016	-	-	-
	2017	109.39	40	2.735
Total		144.06	82	1.757

Based on Table 4, the cause gill net fishing gear is more commonly used to catch hairtail fish is one form of government efforts to stabilize the condition of capture fisheries in Pangandaran District after the tsunami disaster a few years ago which resulted in many fishing equipment owned by fishermen missing. The local government provides assistance to fishermen in the form of gill net fishing gear, with the help of it. The addition of that fishing gear, gill nets to be dominantly used.

3. 3. Characteristics of Fishing Gear

3. 3. 1. Gill Nets

Based on the results of interviews with fishermen, the gill nets used by fishermen have a mesh size of 2 and 3 inches with a length of 200-250 m which is operated by 2 to 3 fishermen on one boat every fishing activity. The gill nets used by fishermen in Pangandaran District are bottom gill net or because the main target of gill net catches in Pangandaran District is hairtail fish. The distance of fishing areas from the Coastal area is more than 1 nautical mile (1,852 km) towards Nusakambangan waters operated in waters at a depth of 20-50 m. The trip to fishing ground takes almost 1-2 hours, time needed to setting and soaking 50 minutes with the condition

of the boat's engine turned off, time hauling 1.5 - 2 hours using a <5 GT ship assisted by outboard motorized engines.

3.3.2 Beach Seines

Based on observations and interviews conducted, the beach seines used in Pangandaran District has a mesh size of 1.25 and 2.25 inches, 310 m long main rope, rope ris above and below the 60 m, and operated by 10-20 people. The main catches of the beach seines are demersal fish located around the coastal area in Pangandaran District. In contrast to gill nets, the operating time required by beach seine's fishermen tends to be shorter, which is only 30 minutes to travel to the fishing ground and setting, while their withdrawal time hauling is 1 - 3 hours manually with drawn. The distance to reach the fishing ground is less than 1 nautical mile from around the coast.

3. 4. Selectivity of Hairtail Fish Catchers

3. 4. 1. Length Distribution of Hairtail Fish Measures

Measurements of the length of hairtail fish were carried out to determine the biological feasibility (length size) of caught hairtail fish. Hairtail fish specimens were grouped by size into five categories, namely Larvae (hatched individuals to the complete metamorphosis, 0.5 to 5 cm TL), juveniles (no gonadal development, 5 to 30 cm TL), sub-adults (initial gonadal development, 30 to 70 cm TL), small adults (mature, 70 to 100 cm TL) and large adults (>100 cmTL) [10].

Determination of the length of fish caught is a criterion in determining whether or not a fishing device to catch the target fish by knowing the limit of the length of the fish first gonad mature. The results of measurements of the length of hairtail fish caught in gill nets were in the range of 50.7 - 90.6 cm. The most caught hairtail fish are in the size of 62.7 - 66.6 cm which is as many as 110 tails, the least caught number of hairtail fish is in the size of 50.7 - 54.6 cm which is as many as 3 tails and the average size of hairtail fish in the gill nets fishing gear is 68.21 cm (sub-adults sizes).

Hairtail fish caught on beach seines were 1,032 tails. A total of 540 hairtail fish were sampled to measure length. The results of the length measurements obtained, the length of hairtail fish from beach seine fishing gear is in the long range of 15.5 cm - 72.4 cm with an average length is 39.38 cm (sub-adults sizes). The results showed the proportion of the length of gourd matured hairtail fish with gill net fishing gears more than beach seines as in the following table.

Table 5. Proportion of Length Size Results of Catching.

No.	Fishing Gear	Size Fish	
		> <i>L_m</i> (%)	< <i>L_m</i> (%)
1	Gill Nets	85.74	14.26
2	Beach Seines	30.74	69.26

Referring to [9], the hairtail fish obtained have reached the first size length mature gonad (L_m) which is > 63.9 cm as many as 463 tails (85.74%). Whereas only 14.26% or 77 of the hairtail fish have not reached L_m . This makes the 2 and 3 inch mesh gill net size selective for catching hairtail fish because hairtail fish caught 85.74% have exceeded the size of the first gonad ripe ($L_m = 72.016$ cm). Whereas, the size of hairtail fish catches on beach seines in Pangandaran District in terms of the length of the gonad mature first, most of them have not been deemed feasible. Hairtail fish caught by beach seines as many as 374 tails or 69.26% of the 540 samples measured were not feasible to catch because the value of $L_m < 63.9$ cm. While only 30.74% or 166 of hairtail fish have reached L_m . This makes the beach seines with a mesh size of 1.25 and 2.25 inches not selective for catching hairtail fish because the caught hairtail fish have not exceeded the size of the first gonad ripe ($L_m = 36,365$ cm).

3. 4. 2. Analysis of the Proportion of Main and By-catches

The proportion of the main and by-catches during the study, has the results of varying percentages between the main catches and the by-catches.

Table 6. Proportion of Main and By-catches.

No.	Fishing Gear	Proportion of Main and By-catch	
		Main Catch (%)	By-catch (%)
1	Gill Nets	52.38	47.62
2	Beach Seines	23.57	76.43

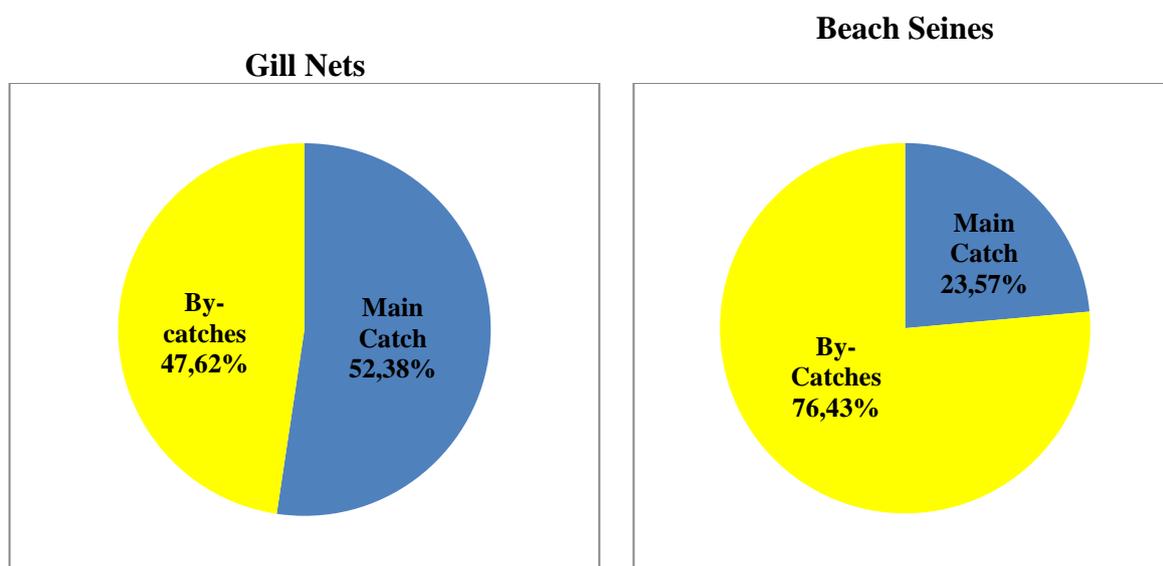


Figure 3. Proportion of Main and By-Catches.

Based on Table 6 and Figure 3, catches during the research on gill net fishing gears were able to capture 2,669 fish with a total weight of 237.3 kg. The total catch of gill nets during the study was almost all dominated by the main catch, namely hairtail fish. As many as 1,398 hairtail fish which were the main target of fishing for gill nets during the study were the most major catches with a percentage of 52.38%. The proportion of the number of by-catches in gill nets during the study amounted to 1,271, consisting of 27 fish species with a percentage of 47.62%. Based on the proportion of catches, the selectivity level of gill nets used by Pangandaran District fishermen can be categorized into fishing gear that selectively catches hairtail fish. This is because the yield of hairtail fish is more than the by-catches.

Beach seines have a catch of 4,379 fish with a total weight of 184 kg. The catches are very diverse, ranging from hairtail fish, squid, to small fish caught by this beach seine. Hairtail fish are still the main catch target by seine fishermen in Pangandaran District. The proportion of hairtail fish catches as the main catch based on the number obtained by 1,032 tails with a percentage of 23.57% was successfully captured by coastal trawlers in Pangandaran District. In addition to hairtail fish as the main catch, the proportion of by-catches is 3,347 fish with a percentage of 76.43% being successfully obtained by fishermen. Based on this, it is clear that in proportion to the amount and weight it shows that the beach seine with a mesh size of 1.25 and 2.25 inches is not selective to capture the type of hairtail fish. This is because hairtail fish catches are obtained less than the by-catches.

4. CONCLUSION

Based on the results of the research conducted, it can be concluded that gill net fishing gear is more selective compared to beach seines based on several observed parameters, namely the size distribution of length and main catch by-catch proportion. The results showed that the comparison of the length distribution of hairtail fish that was appropriately caught between gill nets and beach seines was 85.74% : 30.74%. Comparison of the proportion of main catch : by-catch between gill nets and beach seines was 52.38% : 23.57%.

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