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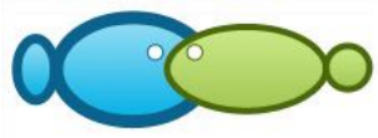
by Nofrizal Nofrizal



A study on by-catch and discard of filter nets (gombang) during West and North season in Bengkalis waters, Indonesia

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Abstract. The purpose of the study is to evaluate the composition and proportion of the main catch, by-catch and discard of the fishing gear, particularly gombang, during the west (October-December 2018) and north (January-March 2019) seasons, in Bengkalis waters, Indonesia. A series of survey activities were conducted in the field, in order to identify and assess the species of fish caught using this fishing gear. During the West season, 33 species were identified, encompassing 6 species (18.2%) as the main catch, 24 (72.8%) as by-catch and 3 (9.1%) as discarded catch, while the North season had 37 species, characterized by 6 (16.3%), 29 (78.4%) and 2 species (5.4%) as the main, by-catch, and discarded. The variety that was mostly caught include pepay shrimp, while the average rate per unit and effort was 20,346.7±15,702.1; 19,416.0±14,021.2 shrimp for *Sergetes similis*, and 331.7±518.6; 101.2±362.1 for fish, respectively for the West and North season. In addition, most of the by-catch and discard were observed to be below the maturity size (first maturity), therefore indicating the non-selective nature of the fishing gear on the size and species of fish. Also, it was speculated that the lack of proper utility regulation confers a negative impact on the sustainability of fish resources in Bengkalis waters.
Key Words: bycatch, discard, maturity, main catch, sustainability of fish resources.

Introduction. Bengkalis waters in Riau, is geographically located in the Malacca Strait, which is a separator between two countries, including Indonesia and Malaysia. These water bodies serve as a potential fish resource, with the possibility of being managed and developed for profitable economic growth in both jurisdictions (Koswara 2007). This prospect has been exploited by fishermen, through the use of various fishing gear, which include traps, as seen from the number adopted in the waters of Bengkalis Regency, totaling 414 bags, 1,066 bags of purifier, 29 splints and 72 beach trawlers units (Department of Maritime Affairs and Fisheries of Bengkalis Regency 2018). Based on the amount of capture, a declining trend has been recorded in the past five years, in the order of 8,225.00, 8,050.00, 7,580.00, 7,085.60, and 6,567.30 tons, respectively for 2013, 2014, 2015, 2016, and 2017 (Statistics Agency of Bengkalis Regency 2018).

Gombang (Figure 1) is a filtering static fishing device included in the trap group and operated in areas around the coast. Furthermore, shrimps are the main target of a catch, although the small size of the net mesh in the bag portion tends to filter fish moving with the current, leading to domination by small juvenile fish. Also, the shaped pouch containing the bobbing mouth opening on both wings are connected by a fixed anchor, and gombang are principally installed in waters with strong currents, including strait, which ensures the gear capacity to conduct proper filtration. The gombang is installed according to the target (fish or shrimp), by regulating the number and size of buoys and ballast (Budiaryani et al 2011). According to Subani & Barus (1989), a trap or an obstacle is a type of fishing gear created in a passive form, while the Minister of Maritime Affairs and Fisheries Regulation of the Republic of Indonesia No. PER.02 / MEN / 2011, classified gombang as fishing gears operated in tidal areas. Furthermore, the filternet form consists of legs or wings, body and a bag consisting of nylon poly filament,

with mouth that opens when the net is equipped with a bamboo float or drums are used to tie to the upper front end and the middle of the net mouth. Conversely, both feet are weighted at the lower front end, while a control rope connects the front end of the foot with the next rope tied to a pile (peg), which functionally restrains the net from being easily washed away under strong water currents.

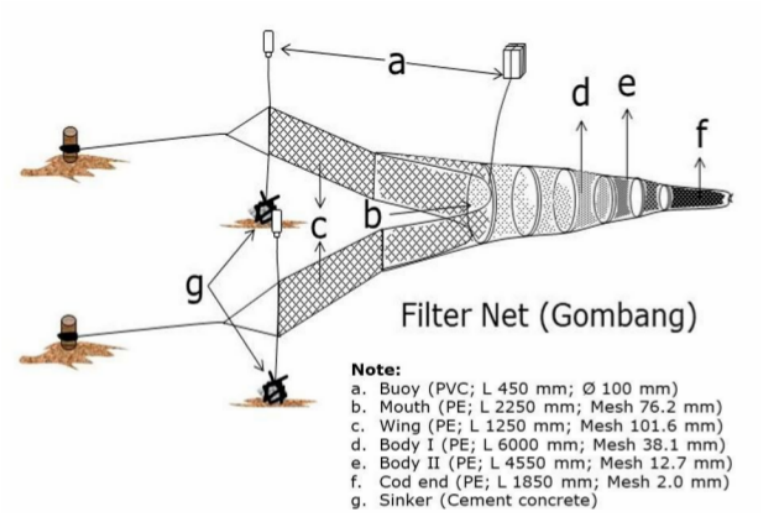

Figure 1. Construct of fishing gear "gombang" operated by fishermen in Bengkalis waters.

The content of each catch tends to vary, consisting of shrimp, fish, crabs and other marine animals, and despite the specific target, other creatures are caught alongside as by-catch, which is further discarded. Originally, this is a term only known to fishermen, as all fishing gear currently produce by-catch, which is currently an issue related to its biodiversity. Each fishing gear unit always produces a different number of by-catch. Eayrs (2007) reported an FAO estimate of approximately 7 tons for by-catch captured at sea by commercial fishermen each year, which includes gombang. In addition, the FAO Code of Conduct for Responsible Fisheries practically requests the reduction in the amount of by-catch and the consequent environmental impact resulting from fishing methods practiced globally. This regulation obliges all countries to apply the basic principles of sustainable fisheries management (Fisheries Sustainable Management), hence the by-catch problem with gombang ought to be taken more seriously, and solved immediately.

Operating with gombang fishing gear in Bengkalis is performed only in certain months, related to the prevailing season. Hence, it is necessary to pay attention to the possible coincidence with the process and spawning patterns of non-targetted economical fish, leading to the conduction of gear operations mainly between October and March, alongside the West and North seasons. This study, therefore, focuses on the catch obtained during these periods.

Previous researches have been carried out on the by-catch topic in Bengkalis waters, with the aim of observing the species caught by the gombang. However, detailed and in-depth investigation have not been conducted, hence this research was performed to obtain a solution to the bypass of good fishing gears for sustainable fisheries management.

Material and Method. This study was conducted between October 2018 and March 2019, coinciding with the West (October-December 2018) and North (January-March 2019) seasons in Bengkalis waters, Riau, precisely at the seagrass fishing center, which include (a). Perapat Tunggal-Meskom, (b). Teluk Latak and (c). Kelemantan. The survey method adopted involve the evaluation of case studies where by-catch of gombang was used.

Purposive sampling methods were applied and about 10 units of gombang fishing gears were nominated, of which 4 were of the largest size, 3 were medium fishing tackle, with 3 of smallest size (Figure 1). Therefore, it is expected that the selection of all three groups produces a representative data that describes the composition and proportion of the catch obtained in the waters of Bengkalis Riau. Furthermore, the collected fish were identified, the percentage of the main catch, by-product and discarded were estimated.

The process of recognition is made with reference to fish identification books (Saanin 1968; Kottelat et al 1993), while the observations of morphometric characteristics were performed by measuring (Endo Measuring ruler; iM3 Dental Limited, Australia and Jainco Digital Venier Clipper: width x height : 20 mm x 700 mm, India) the total length in millimeters (mm) and weight in grams (g) of fish body parts at each observation station. Subsequently, the results were analyzed with linear regression, using the SPSS Statistics 17.0 software program.

The criteria for determining the possible catches as main catch, which is highly desired, by-catch and discard were based on interviews with fishermen. Usually, the main catch is of higher economic value. Furthermore, the by-catch and discard categories include those that are unwanted and existing without the propensity of a benefit, hence disposed off in every condition.

The total catch of each gombang installation was hauled, and each species was separated and counted. The aim of this step was to determine the percentage number of species per catch, in order to estimate the proportion and magnitude of the main catch, by-catch and discarded. Therefore, the undefined varieties were identified and analyzed in the laboratory.

The catch per unit of gombang was collected after every hauling, identified on the basis of species groups, and counted to obtain the catches per unit effort (Catch Per Unit Effort / CPUE) using the following mathematical approach (Andrade et al 2007):

$$q = \frac{h}{f}$$

where: q = CPUE (individual $trip^{-1}$);
h = fishing catches at each hauling (individual);
f = the total trip of fishing (days).

The catch data were then analyzed using descriptive statistical analysis and displayed in both tabular and graphical forms, in order to provide more comprehensive information on the differences between the main catch and by-catch at any instance while operating the gombang. Subsequently, the composition data was analyzed to estimate relative abundance, using the Krebs (1985) equation as follows:

$$\text{Relative density} = \frac{\text{Number of individuals in each species}}{\text{Number of individuals for all species}} \times 100$$

The average diversity of each catch per gear was evaluated using statistical analysis by the F-test. This was conducted for each species at every time of withdrawal, from all fishing gear samples observed. Therefore answers are provided for the hypothesis "good catch has a variety of species".

Results. The results show that the catches with gombang in the West season (October-December 2018) is made up of about 33 species, encompassing 6 (18.2%) as the main catch, 24 (72.7%) as by-catch, and 3 (9.1%) as discard results. Conversely, the North season (January-March 2019) comprised of about 37 species, including 6 (16.3%) main catches, 29 (78.4%) bycatch and 2 (5.4%) discarded (Table 1).

According to Table 1 the total number of catches was 41 species, while the record for gombang was 33 species (6 main catch, 24 for by-catch, 3 discard) in the West season, and about 37 species (6 main catch, 29 for by-catch, 2 discard) were reported in the North season. Furthermore, the average yield per unit and per capture effort was significantly higher for main catch than the others ($p < 0.05$), showing more significant

amount of shrimp (*Sergestes similis*) and anchovy (*Escualosa thoracata*) than others. Conversely, the average catch per unit effort was 20,346.65±15,702.05; 19,416.02±14,021.21 animals for *S. similis* and 331.65±518.51; 101.23±362.10 other fish respectively for the West and North season.

Table 1

Composition and number of main catch, by-catch and discard

No.	Scientific name	West season (Oct-Dec 2018)		North season (Jan-Mar 2019)	
		Catch	Total (individual)	Catch	Total (individual)
	Main catch				
1	*Sergestes similis*	√	2,416,826	√	1,990,129
2	*Escualosa thoracata*	√	33,232	√	10,890
3	*Panulirus* sp.	√	583	√	921
4	*Metapenaeus monoceros*	√	371	√	788
5	*Parapenaeopsis* sp.	√	330	√	544
6	*Penaeus monodon*	√	267	√	467
	By-catch				
7	*Thryssa mystax*	√	257	√	1,024
8	*Trichiurus lepturus*	√	1,066	√	890
9	*Ilisha elongata*	√	316	√	365
10	*Harpadon nehereus*	√	304	√	212
11	*Ilisha kampeni*	√	158	√	201
12	*Secutor insidiator*	√	167	√	177
13	*Parambassis wolfii*	√	186	√	128
14	*Otolithoides biauritus*	√	125	√	89
15	*Loligo vulgaris*	√	197	√	85
16	*Pampus argenteus*	√	42	√	76
17	*Scomberomorus commerson*	√	50	√	39
18	*Harpadon microchir*	√	27	√	33
19	*Setipinna breviceps*	√	11	√	32
20	*Cynoglossus lingua*	√	36	√	12
21	*Polydactylus macrochir*	-	-	√	12
22	*Scatophagus argus*	√	10	√	8
23	*Chirocentrus dorab*	√	10	√	8
24	*Anodontostoma chacunda*	√	3	√	7
25	*Eleutheronema tetradactylum*	-	-	√	6
26	*Parastromateus niger*	√	2	√	5
27	*Mugil cephalus*	√	1	√	3
28	*Pomadasys maculatus*	-	-	√	3
29	*Ilisha megaloptera*	√	1	√	3
30	*Arius maculatus*	√	2	√	2
31	*Octopus vulgaris*	-	-	√	2
32	*Sepia officinalis*	-	-	√	2
33	*Dasyatis* sp.	-	-	√	1
34	*Tachypleus tridentatus*	-	-	√	1
35	*Selaroides leptolepis*	-	-	√	1
36	*Scylla serrata*	√	42	-	-
37	*Carangoides* sp.	√	19	-	-
38	*Hippocampus denise*	√	15	-	-
	Discard				
39	*Acetes indicus*	√	44	√	37
40	*Colomesus psittacus*	√	32	√	21
41	*Matuta planipes*	√	13	-	-

The dominance index of catch species per unit and per capture effort showed higher species of *S. similis* than others ($p < 0.05$), at 20,346.65±15,702.05 and 19,416.02±14,021.21 individuals in the West and North seasons. Conversely 331.65±518.51 and 101.23±362.10 individuals were respectively reported for other species.

The by-catch fish variety that was mostly caught in every operation during the west and north seasons were *Trichiurus lepturus,* and *Thryssa mystax*, respectively with an average of 9.85±5.40 and 9.34±4.13 individuals. Furthermore, the discarded catch per unit of sea fishing equipment was relatively low, including 3 and 2 species in the West and North seasons, respectively.

The grey histogram in Figures 2a and 2b shows the main catch is dark grey, while the white depicts the by-catch and the black stands for discard, and a comparison of the total number of each category was demonstrated with the 36 withdrawals. Specifically, the West season identifies about 2,451,609 individuals (encompassing six species) as main catches, which was much greater than the by-catch and discard, at 3,047 (24 species) and 89 (3 species) individuals, respectively. Meanwhile, the North season records 2,003,739 individuals (six species) as main catch, which was of higher significance than the by-catch and discard, respectively at 3,427 (29 species) and 58 (2 species) individuals.

The result of the main catch dominated the total lombang output from all fishing operations in both seasons. Based on the percentage of the main catch, by-catch and discard, *S. similis* was identified as the dominant species, reaching 98.5% and 99.1% in the West and North seasons, respectively, while other main catch surmounted to 1.4% and 0.5%, correspondingly. Furthermore, other species caught include *Penaeus monodon*, *Panulirus* sp., *Parapenaeopsis* sp., and *Metapenaeus monoceros,* at a percentage ranging from 0.01 to 0.02% and 0.02 to 0.05%, in the respective seasons.

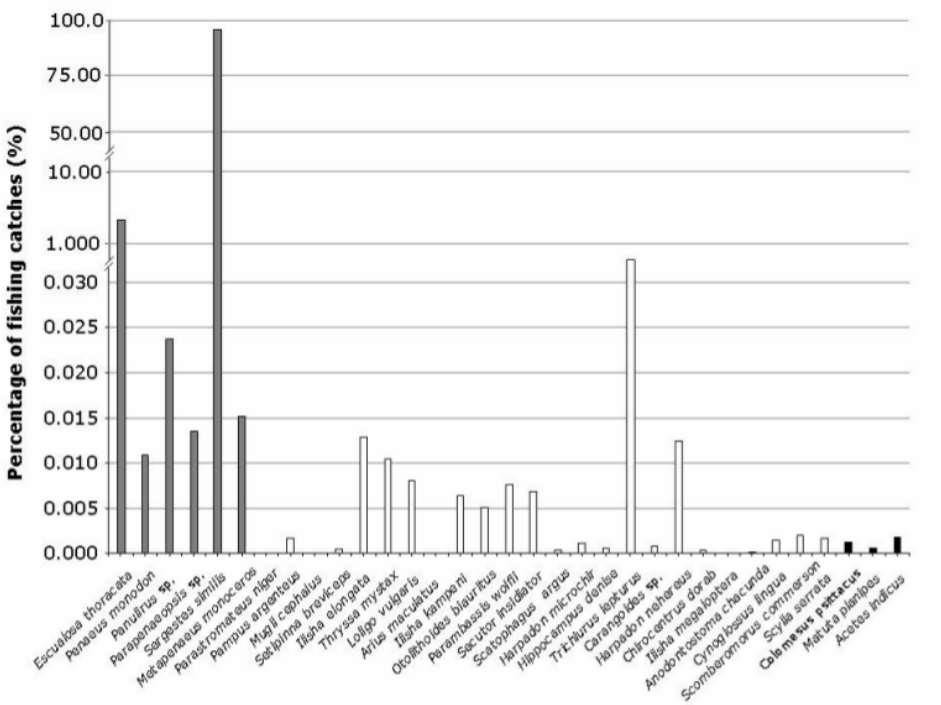

Figure 2a. Percentage of total fishing catches, by-catch and discard in the West season. Dark grey is main catch; white is by catch and black is discard.

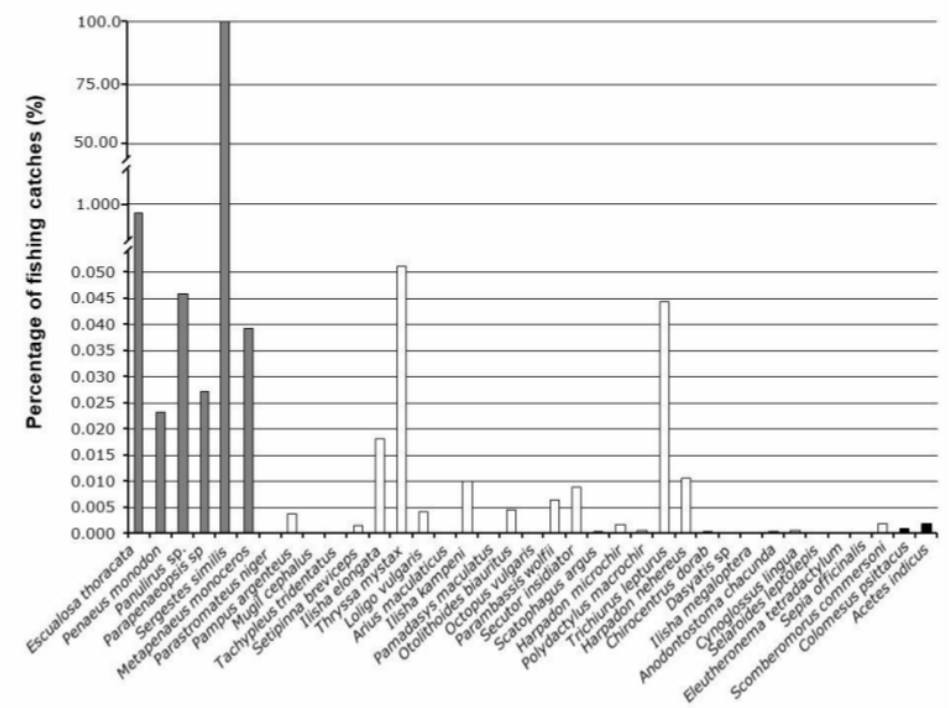

Figure 2b. Percentage of the total fishing catches by-catch and discard in the North season. Dark grey is main catch, white is by-catch and black is discard.

The histogram graph in Figure 2a shows the fishing catch in the West season, which includes 24 species as by-catch, dominated by *T. lepturus* (0.043%), while the discard comprises 3 species, encompassing the dominant *Acetes indicus* at 0.001%. Conversely, Figure 2b shows values for the North season, where 29 species of fish were caught as by-catch, characterized by the *T. mystax* as the leading variety (0.051%) while the discard consists of 2 spec[10], including the domineering *A. indicus* at 0.001%.

The total length of the fish body and the carapace length for the crustacea (shrimp and crab) were used as indicators of maturity level (first maturity). Furthermore, the average standard and carapace length (CL) was 42.0±7.0 mm (average±standard deviation) for the main catch of *E. thoracata* in the West season. The size of *P. monodon* was 92.3±8.4 mm, *Panulirus* sp. was 64.0±8.7 mm, *Parapenaeopsis* sp. was 70.3±9.0 mm, *S. similis* (17.0±2.0, mm), while *M. monoceros* was 72.0±15.1 mm. However, the species reported in the North season were cummulatively averaged at 38.7±11.6 mm (average±standard deviation) of *E. thoracata*, where *P. monodon* was about 92.3±11.5 mm, *Panulirus* sp. at 61.7±9.7 mm, *Parapenaeopsis* sp. (64.7±7.6 mm), *S. similis* was 17.7±2.1 mm, and *M. monoceros* was 63.6±9.4 mm. Interestingly, most of desired species caught were below the level of maturity (Figure 3).

Figure 4 shows an average standard length of by-catch in the West and North season characterized by mainly immature fish. Conversely, a similar phenomenon occurs in the fish size for the main catch, and Figure 5 shows a relatively smaller average size for the discard category, dominated by *A. indicus* in both seasons. Furthermore, the average size of *Colomesus psittacus* was 47.0±5.6 mm for West season and 45.3±5.5 mm for North season, which was also smaller than the mature form at 25 cm, while *Matuta planipes* was averaged at 28.3±24.6 mm, with a mature size of 10 cm. These species were particularly caught in the West season only, while *A. indicus* measured 129.0±31.0 mm carapace length for West season and 106.7±20.4 mm for North season. Meanwhile the mature size of this species is 200 mm. It means the discard of *A. indicus* are immature individuals.

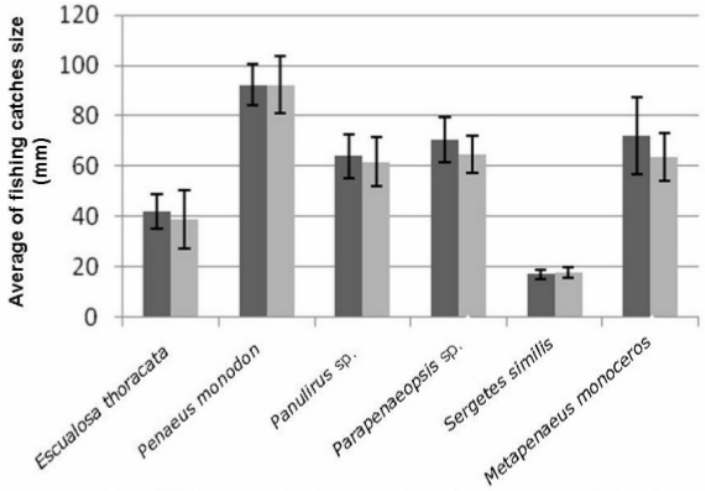

Figure 3. Average of the fishing catch sizes during the West and North seasons. Dark grey is West season and pale gray is North season.

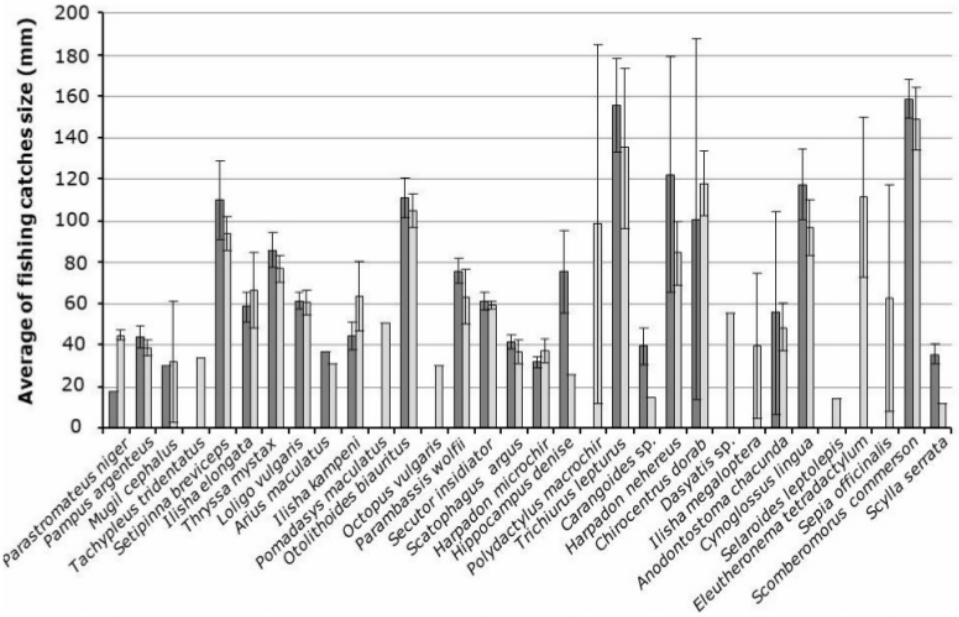

Figure 4. Average of the fishing catches length for by-catch in the west season and north season. Black is west season and grey is north season.

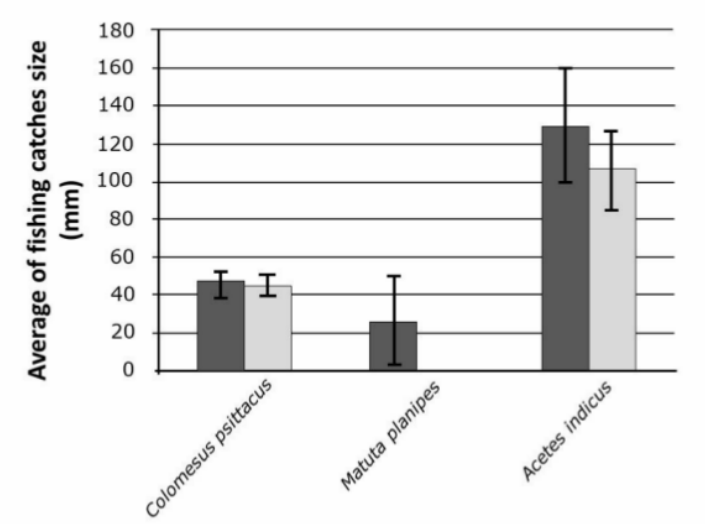

Figure 5. Average of fishing catches size for discard in the West and North seasons. Dark grey is west season and pale grey is north season.

Discussion. Both seasons recorded a total of 41 fish, crab, squid and shrimp species, obtained as main catch, by-catch and discard in Bengkalis waters. Specifically, 37 species were recorded in the North season, using the gombang gear, which is usually set in waters with strong tidal currents, characterized by the ability to filter mainly fish and shrimp that are unable to swim against the speed, leading to a drift into the bag. The native fishermen design and construct gombang with the aim of capturing *S. similis* as main catch, which is also stated in previous studies where numerous others species of fishing catches were also caught alongside, encompassing Penaidae, *Harpadon* sp., *Setipinna* sp., *Coilia* sp., *Trichiurus* sp. and others (Syofyan & Nofrizal 2005; Nofrizal et al 2018).

Gombang is not specifically designed for a single species, as various small to medium sized fish as well as some shrimps also get caught, which differ based on the season. This was due to wind direction, which blows from the sea towards the mainland and straits in the North season, characterized by water waves, carrying more fish species, although the number of catches was less than in the West season. Furthermore, the phenomenon ensued as a result of limited surrounding fish population, and also due to the duration of gombang operation, which was less in the latter season. Laevastu & Hayes (1981) affiliated the relationship of currents and fish distribution to the ability for currents to divert pelagic fish eggs, larvae and juvenile from the spawning to rearing areas, as well as feeding grounds. This migration also affects adult fish by means of orientation and as a form of natural route. Furthermore, the observed behavior is influenced especially by tidal currents, which also directly affects the distribution of adults and indirectly through food groupings.

Figure 4 shows the average of fishing catches attempt in the West and North seasons, where both had similar ratio pattern between the total main catch, by-catch and discard. Despite the high number per waving fishing gear unit for the main catch, the values recorded for by-catch was also much. This was similar with the reports by Broadhurst et al (2006) and Nofrizal et al (2018) on the non-proportionally high ratio of by-catch trawl fisheries in tropical waters compared to the main catch. These are, therefore, retained for human and animal consumption, or thrown into the sea, a practice reported to pose global problems in fishery (Zeller & Pauly 2005). Furthermore, the capture of by-catch is a possible threat to species diversity and environmental sustainability, due to the poor regulation from various regions. These broadly include all non-targeted animals and objects (rubbish) caught during a capture operations (Eayrs 2007).

The by-catch fishing gear result showed the collection of 24 and 29 species in total for both West and North seasons, respectively, characterized by a great variation in species composition. In addition, many caught fishes consisted in economically important species, despite the fact that the size depicts a low level of maturity, as seen in *Parastromateus niger, Pampus argenteus, Mugil cephalus, Setipinna breviceps, Loligo vulgaris, Arius maculatus, Pomadasys maculatus, Otolithoides biauritus, Polydactylus macrochir, Trichiurus lepturus, Harpadon nehereus, Dasyatis* sp., *Ilisha megaloptera, Anodontostoma chacunda, Eleutheronema tetradactylum,* and *Scomberomorus commerson*.

By-catch is of high concern to the community at large in the aspect of conservation, although strong efforts to do what is needed have not been realized at this time. The catches obtained for by-catch and discard are of serious concern at the international level, based on the results that affects both fish stocks in waters, and also the food chains and habitats, ultimately disrupting and damaging the ecosystem (Harrington et al 2005; Kelleher 2005; Zhou 2008; Nofrizal et al 2018)

It was established that the discard catches in both seasons were rather similar, which was attributed to the lesser species variation. These categories of fish, crab and squid in the Bengkalis waters have no economic value because the community evades their consumption, or due to the absence of recognition as a variety with sale value. Vestergaard (1996) affiliated the occurrence of discard output with the strength of economic value (non-commercial species and low economic value species, due to condition and size) as well as the direct result of management actions (minimum landing size and restrictions). Hall et al (2000) stated the following as the most common reasons for disposing bycatches, including the low commercial value, poor catch conditions and small yield below the minimum legal landing size.

Despite the small number discarded during fishing, these species tend to portray an ecological function in the ecosystem chain. Watson & Pauly (2001) affiliated the subsequent waste of potential food sources with the process of disposal, leading to a decline in sea catches globally, and also a continuously intensifying competition for inventory reductions.

Gombang catches in the West and North seasons possibly initiate a potential change in the structure of fish and shrimp commodities, which has the tendency to damage fisheries resources. This is indicated by the characteristics of the by-catch and discard yields, observed to be below the maturity size. According to Crowder & Murawski (1998) and Diamond et al (1999), an increase in juvenile fish mortality slows down the process of water resource recovery, resulting from overfishing. Also, the number of young fish, crabs and small-sized shrimp species caught also contradict the concept of fishing responsible for sustainability. Moreover, a similar phenomenon was reported by Cedrola et al (2005), Borges et al (2005), and Fonseca et al (2005), where the results of by-catch were identified as a problem in commercial capture management, encompassing the trawlers, circumference nets and all forms of fishing gear.

The decline in fish population and reduction of by-catch and discard while fishing in the West and North seasons could be prevented by using the excluder device (Nofrizal et al 2018). For example, Bycatch Excluder Device (BED) or Bycatch Reduce Device (BRD) have been adopted in removal and reduction during the capture process. Moreover, fiberglass and wire frames have been adopted as a gap for the release of by-catch during shrimp trawler fisheries in the Nordic (Grimaldo & Larsen 2005; Fonseca et al 2005), while the application of separating panels and windows with rectangular mesh nets as a BRD in trawl mouths have been associated with a reduction in the by-catch of blue whiting *Micromesistius poutassou* by 73-74% and boarfish *Paristiopterus labiosus* by 48-63% (Fonseca et al 2005). In addition, van Marlen et al (2005) reported on the propensity for reduced by-catch yield, resulting from the introduction of larger mesh size to the mouth of the pocket, subsequently providing a greater chance of survival for the output that possibly escape the mesh during capture.

Conclusions. Based on the composition, catches made through gombang fishing in Bengkalis waters were characterized by 33 species in the West fishing season (October-December 2018), comprising 6 (18.2%) as main catch, 24 (72.7%) as bycatch and 3 (9.1%) as discard. Conversely, 37 species were obtained in the North season (January-March 2019), encompassing 6 (16.3%) as as main catch, 29 (78.4%) as bycatch and 2 (5.4%) as discard. In addition, most output acquired using the good fishing gear were below the maturity size (first maturity), hence the unselective nature of the gombang is expected to impose a negative impact on the sustainability of fish resources in Bengkalis waters.

References

Andrade H. A., Pereira M. D., Mayer F. P., 2007 Alternative methods for calculating catch-per-unit effort for skipjack tuna (*Katsuwonus pelamis*) caught in the Southwest Atlantic Ocean. Brazilian Journal of Aquatic Science and Technology 1(2):63-66.

Badan Pusat Statistik Kabupaten Bengkalis, 2018 Kabupaten Bengkalis dalam Angka. Bengkalis dalam angka. Penerbit Badan Pusat Statistik Kabupaten Bengkalis, 257 pp. [in Indonesia]

Borges L., Rogan E., Officer R. A., 2005 Discarding by the demersal fishery in the waters around Ireland. Fisheries Research 76(1):1-13.

Broadhurst M. K., Millar R. B., Wooden M. E. L., Macbeth W. G., 2006 Optimising codend configuration in a multispecies demarsal trawl fishery. Fisheries Management and Ecology 13(2):81-92.

Budiaryani R. N., Saptoyo J., Sudarto A., 2011 Kajian perikanan Gombang di kecamatan Rangsang, kabupaten Bengkalis. Balai Pengembangan Penangkapan Ikan Semarang, pp. 14-25. [in Indonesian]

Cedrola P. V., Gonzalez A. M., Pettovello A. D., 2005 Bycatch of skates (Elasmobranchii: Arhynchobatidae, Rajidae) in the Patagonian red shrimp fishery. Fisheries Research 71(2):141-150.

Crowder L., Murawski S., 1998 Fisheries bycatch: implications for management. Fisheries 23(6):8-17.

Diamond S., Crowder L., Cowell L., 1999 Catch and bycatch: the qualitative effects of fisheries on population vital rates of Atlantic croaker. Transactions of the American Fisheries Society 128(6):1085-1105.

Dinas Kelautan dan Perikanan Kabupaten Bengkalis, 2018 Laporan Tahunan Kelautan dan Perikanan Kabupaten Bengkalis Tahun 2017, 48 pp. [in Indonesian]

Eayrs S., 2007 A guide to bycatch reduction in tropical shrimp-trawl fisheries. Revised edition, Rome, FAO, 108 pp.

Fonseca P., Campos A., Larsen R. B., Borges T. C., Erzini K., 2005 Using a modified nordmore grid for by-catch reduction in the Portuguese crustacean-trawl fishery. Fisheries Research 71(2):223-239.

Grimaldo E., Larsen R. B., 2005 The cosmos grid: a new design for reducing by-catch in the Nordic shrimp fishery. Fisheries Research 76:187-197.

Hall M. A., Alverson D. L., Metuzals K. I., 2000 Bycatch: problems and solutions. In: Seas at the millennium: an environmental evaluation: 3. Global issues and processes. Sheppard C. R. (ed), Pergamon, pp. 135-151.

Harrington J. M., Myers R. A., Rosenberg A. A., 2005 Wasted fishery resources: discarded by-catch in the USA. Fish and Fisheries 6(4):350-361.

Kelleher K., 2005 Discards in the world's marine fisheries. An update. FAO Fisheries Technical Paper No. 470, Rome, FAO, 131 pp.

Koswara B., 2007 Penelitian bersama (Joint research) antara Indonesia dan Malaysia mengenai pengelolaan sumberdaya perikanan di Selat Malaka sebagai sumber pertumbuhan ekonomi baru yang menguntungkan bagi kedua negara. Makalah Simposium Kebudayaan Indonesia-Malaysia Ke-X (SKIM X), 29-31 Mei 2007. [in Indonesian]

Kottelat M. K., Whitten T., Sri Kartikasari N., Wirjoatmojo S., 1993 Ikan air tawar Indonesia bagian Barat dan Sulawesi (edisi dwibahasa Inggris-Indonesia). Periplus Edition, Jakarta, 293 pp. [in Indonesian]

Krebs C. J., 1985 Ecology: the experimental analysis of distribution and abudance. Harper & Row, New York, 800 pp.
Laevastu T., Hayes M. L., 1981 Fisheries oceanography and ecology. Fishing News Books Ltd. Farnham, Surrey, England, pp. 4-23.
Nofrizal, Jhonnerie R., Yani A. H., Alfin, 2018 Hasil tangkapan sampingan (bycatch dan discard) pada alat tangkap gombang (filter net) sebagai ancaman bagi kelestarian sumberdaya perikanan. Jurnal Teknologi dan Manajemen Perikanan Laut 2(9):221-233. [in Indonesian]
Saanin H., 1968 Taksonomi dan kuntji identifikasi ikan I dan II. Binatjipta, Bandung, 520 pp. [in Indonesian]
Subani W., Barus H. R., 1989 Alat penangkapan ikan dan udang laut di Indonesia. Jurnal Penelitian Perikanan Laut (Edisi Khusus). No. 50, tahun 1988/1989, 247 pp. [in Indonesian]
Syofyan I, Nofrizal, 2005 Pengaruh pengoperasian (tidal trap) terhadap komunitas ikan dan udang di perairan Bengkalis. Oral presentation, Proceeding of Japan Society for Promotion Science (JSPS), Internasional Workshop on Eco-Friendly and Sustainable Fisheries. Hotel Ibis, Pekanbaru. [in Indonesian]
Van Marlen B., Bergman M. J. N., Groenewold S., Fonds M., 2005 New approaches to the reduction of non-target mortality in beam trawling. Fisheries Research 72(2-3):333-345.
Vestergaard N., 1996 Discard behaviour, highgrading and regulation: the case of the Greenland shrimp fishery. Marine Resource Economics 11:247-266.
Watson R., Pauly D., 2001 Systematic distortions in world fisheries catch trends. Nature 414(6863):534-536.
Zeller D., Pauly D., 2005 Good news, bad news: global fisheries discards are declining, but so are total catches. Fish and Fisheries 6(2):156-159.
Zhou S., 2008 Fishery by-catch and discards: a positive perspective from ecosystem-based fishery management. Fish and Fisheries 9(3):308-315.

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