Diversity of non-targeted species on blue swimming crab *Portunus pelagicus* gillnet fishery in Grogol, Cirebon

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Diversity of non-targeted species on blue swimming crab *Portunus pelagicus* gillnet fishery in Grogol, Cirebon

M B Satria[1,2*], **H Ahmad**[1]

[1] Indonesian Blue Swimming Crab Association (Asosiasi Pengelolaan Rajungan Indonesia-APRI), Surabaya, Indonesia
[2] Postgraduate in Agribusiness Management, Wijaya Kusuma Surabaya University, Surabaya, Indonesia

*E-mail: rajunganindonesia@gmail.com

Abstract. Non-targeted Species (NTS) data and research is needed in the management and development of the blue swimming crab fishery ecosystem. The NTS were divided into two groups, namely the retained and the discarded. This study aims to explain the diversity of NTS caught by blue swimming crab fishermen that used gillnet in the Cirebon Regency. This study uses exploration and enumeration methods to analyze the catch of NTS catched by blue swimming crab fishermen for 7 months in 2021. Shannon-Wiener diversity, Evenness, and Simpson's dominance index were further analyzed. Results showed the diversity of NTS caught by blue swimming crab fishermen with gillnets in Cirebon Regency consisted of 29 species from 23 families (9 fish, 16 crustaceans, and 4 mollusc species). The highest diversity index was observed in December (2.16) and the lowest was October (1.29). The highest population uniformity or evenness was observed in September (0.83) and the lowest in October and November (0.59). The dominance index had the highest value in August at 0.41 and the lowest in July at 0.15. The non-target species biodiversity of *P. pelagicus* fishery in Cirebon was classified as moderate diversity category, moderate to high evenness, and low dominance. These results provide information for fishermen to reduce catches of non-targeted species which requires fishermen to return and release the non-targeted species within 5 minutes and maintain the diversity of marine biota.

Keywords: blue swimming crab, diversity, gillnet, non-targeted species

1. Introduction

The fishing activity of catching crabs (*Portunus pelagicus*) in the sea waters of Cirebon Regency has long been carried out continuously by local fishermen. Cirebon sea waters are one of the areas that have potential enough crab resources, thus making this area important as a source of income for fishermen in meeting the economic needs of the family. Catching crabs in Cirebon sea waters is generally carried out by small-scale crab fishing businesses where fishermen use the main fishing gear such as gillnets and traps [1].

Gillnets or nets are passive fishing gear whose operation does not damage aquatic biological resources. However, gillnet is a fishing tool with low selectivity, so it is feared that there will be more non-targeted species (NTS) or bycatch than the main catch [2]. NTS is one of the most severe problems faced by crab fisheries in the world because the increase has the potential to reduce the abundance and diversity of aquatic biota species. Hence, it has a negative impact on the sustainability of aquatic biota

diversity [3]. Therefore, NTS diversity data is needed in the management and development of the blue swimming crab fishery ecosystem and is also needed in the assessment of the Marine Stewardship Council (MSC) certification [4].

Asosiasi Pengelolaan Rajungan Indonesia (APRI)/Indonesian Blue Swimming Crab Association is an organization that aims to initiate the sustainable management of crabs and fishery resources. APRI's fisheries improvement programs include stock assessment, stock enhancement, fisheries management, and education. One of the forms of the fisheries management program carried out by APRI is the NTS enumeration activity, which is needed in the management and development of the Indonesian blue swimming crab fishery ecosystem.

In general, the NTS of crab fisheries consists of several types of fish, crustaceans, molluscs and echinoderms according to [5], [6], and [7], and is divided into two categories, namely, those discarded and those with economic value that are retained [8]. This research needs to be carried out to expand information on the diversity of NTS from crab fisheries by gillnet fishermen, which is important for the sustainability of fishery resources, especially in the Cirebon marine area. The purpose of this study was to determine the diversity of NTS from crab fisheries by gillnet fishermen in the sea waters of Grogol Village, Cirebon District.

2. Research methodology

This research was conducted in Grogol Village, Gunung Jati Sub-district, Cirebon District, which is one of the most landing points for blue swimming crab fishermen using gillnet fishing gear. The location for landing and catching crab fishermen in Grogol Village, Cirebon Regency can be seen in Figure 1.

Figure 1. Landing locations and fishing points for gillnet crab fishermen in Grogol Village, Cirebon District.

2.1. Sampling

This study used the method of exploration and enumeration of the NTS with data collection once a week from June to December 2021 with the same fishing gear, which is a gillnet. The crab fishing area in this village covers almost the entire sea waters of Cirebon, from the coast to the sea at a distance of 2–12 miles. Landed NTS were counted, measured, and weighed, then separated by type and identified using the APRI manual book.

2.2. Data analysis

The non-target species sample was obtained from 14 boats with 14 fishermen and then analyzed to determine the ecological status of the NTS biodiversity of crab fisheries with the Shannon-Wiener diversity index, evenness index, and dominance index. The similarity of bycatch biodiversity between fishing habitats and sampling periods was determined by the Sorensen similarity index according to [9].

Shannon-Wiener species diversity index equation:

$$H' = -\sum pi \log pi \quad (1)$$

with: pi = the proportion of the number of bycatch i-th to the total number of bycatch (ni/N)

Evenness index equation (E):

$$E = \frac{H'}{H_{max}} \quad (2)$$

with: Hmax = Log number of species bycatch

Simpson's Dominance Index:

$$C = \frac{\sum ni(ni-1)}{N(N-1)} \quad (3)$$

with: ni = Number of species bycatch type to I; N = Total bycatch

3. Result and discussion

3.1. Number of species and number of individuals caught

The data was taken from June to December 2021. During the 7-month period of data collection, the number of non-targeted species was 1269 individuals consisting of 3 groups, namely fish, crustaceans, and molluscs. The number of non target species can be seen in Table 1. There were 9 families from the fish group, 16 families from the crustacean group, and 4 families from the mollusc group (Table 2).

Table 1. Non-targeted species caught by crab gillnets.

No	Species	Number of Species						
		June	July	Augst	Sept	Oct	Nov	Dec
1	Fish	5	3	4		3	3	2
2	Crustaceans	9	10	4	2	6	7	8
3	Molluscs	2	1	2	2		3	4
	Total	16	14	10	4	9	13	14

Tabel 2 showed that the results of non-targeted species from gillnet fishing gear at the data collection location were dominated by crustaceans, followed by molluscs, then fish. The most commonly found crustaceans were from the families Portunidae and Varunidae which had a very high number of individuals caught compared to other crustacean families. This is in line with the research of [9] in Kendari Bay, Southeast Sulawesi which obtained results that Portunidae is the dominant family of non-targeted species from the crustacean group in terms of species diversity and abundance. The species are *Podophthalmus vigil* (244 ind), *Charybdis feriatus* (244 ind), and *Varuna litterata* (185 ind), when these three species are compared with other groups, they are also the species with the highest number of individuals caught. Meanwhile, from the mollusc groups, three families with many caught individuals were from the Sepiidae family, namely *Sepia recurvirostra* as many as 39 individuals, the family Muricidae namely *Murex trapa* as many as 32 individuals, and the family Babylonidae namely

Babylonia sp. as many as 29 individuals. The fish group was dominated by the Cynoglossidae family, namely *Cynoglosus lingua* as many as 21 individuals, the Gerreidae family namely *Gerres filamentosus* as many as 20 individuals, and the Serranidae namely *Siganus javus* as many as 10 individuals.

Table 2. Non-targeted species from gillnets in Grogol Waters, Cirebon.

No	Family	Species	Individual							Total
			Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Fish										
1	Cynoglossidae	*Cynoglossus lingua*	2	9				6	4	21
2	Dasyatidae	*Himantura walga*	4		1		1	1		7
3	Nemipteridae	*Nemipterus furcosus*							3	3
4	Siganidae	*Siganus javus*					10			10
5	Serranidae	*Epinephelus bleekeri*	2							2
6	Drepaneidae	*Deprane punctata*			1		1	1		3
7	Serranidae	*Epinephelus coioides*	1	1						2
8	Gerreidae	*Gerres filamentosus*	6	8	6					20
9	Tetraodontidae	Pufferfish/*Lagocephalus lunaris*			1					1
Total Fish (individual)			15	18	9		12	8	7	69
Crustacean										
1	Epialtidae	*Libya* sp.	1					3		4
2	Squillidae	*Harpiosquilla harpax*	29	11			1	4	10	55
3	Penaeidae	*Metapenaeus ensis*		2						2
4	Portunidae	*Charybdis natator*					4		9	13
5	Scyllaridae	*Thenus orientalis*	9	1	2				4	16
6	Portunidae	*Podophthalmus vigil*	124	76	89	14	65	6	59	433
7	Aethridae	*Cryptopodia fornicata*		1						1
8	Portunidae	*Portunus sanguinolentus*	19	23	24					66
9	Sesarmidae	*Geocesarma angustifrons*	25					5		30
10	Portunidae	*Charybdis Feriatus*	112	17	36	23	8	8	40	244
11	Calappidae	*Calappa philargius*		2						2
12	Varunidae	*Varuna litterata*	10					104	71	185
13	Portunidae	*Charybdis lucifera*		1				4	14	19
14	Euryplacidae	*Psopheticoides sanguineus*					11			11
15	Penaeidae	Peci Shrimp/*Metapenaeus lysianassa*		1			2		3	6
16	Limulidae	*Tachypleus gigas*	1						1	
Total Crustacean (individual)			330	135	151	37	91	134	210	1087
Molluscs										
1	Babyloniidae	*Babylonia* sp.						13	16	29
2	Sepiidae	*Sepia recurvirostra*	10		3	6		4	16	39
3	Volutidae	*Melo melo*		1	4	3			4	12
4	Muricidae	*Murex trapa*	3					6	23	32
Total Molluscs (individual)			13	1	7	9		23	59	113
Total Species			16	14	10	4	9	13	14	80
Total Individual			358	154	167	46	103	165	276	1269

From the whole group, there are at least 4 species that are almost found every month: *Himantura walga* (except July and September), *Podophthalmus vigil* (all months), *Charybdis feriatus* (all months), and *Sepia recurvirostra* (except July and October). In line with the results of this study, [9] in Kendari Bay, Southeast Sulawesi, *Podophthalmus vigil* was found in almost every sampling period. There are quite a number of non-targeted species that are quite rare and few in number, including *Lagocephalus lunaris*, *Cryptopodia fornicata*, and *Tachypleus gigas*. Each of the three species was found only once, with the number of one individual, and was only found in the June-August period.

Based on monthly observations, September is the month in which the fewest non-targeted species are found, only consisting of only 4 species with a total of 46 individuals. Most non-targeted species were found in June and December, where there were 16 species with 358 individuals and 14 species with 276 individuals.

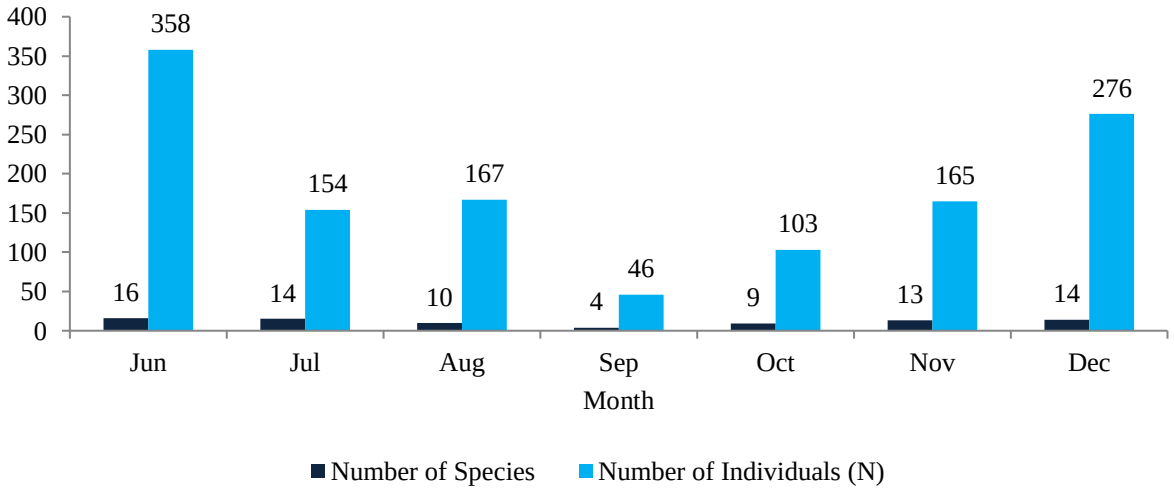

Figure 2. The number of species and individuals of non-targeted species during June-December 2021 in the waters of Grogol Village, Cirebon.

The results obtained in this study indicate that the number of non-targeted species caught by gillnet, both species, and individuals, increases in June, then decreases and reaches a low point in September, which then increases again until December (as shown in Figure 2). The same condition is shown by the results obtained by [10] related to fish biodiversity in Bangladesh, which is also a tropical country.

3.2. Diversity, species evenness, and dominance index

The results obtained for diversity, species evenness, and dominance of non-targeted species in the waters of Grogol Village, Cirebon show that in general the three indices have a range of 1.15-2.16 for the Shannon-Wiener diversity index, then 0.59-0.83 for the evenness index, and 0.15-0.43 for the Simpson dominance index (Table 3).

The highest Shannon-Wiener diversity index value was found in December (2.16), and the lowest was in September (1.15), with a seven-month average of 1.57. This value indicates that the ecological status of non-targeted species in the waters of Grogol Village is classified as moderate, which according to [11] can be interpreted as where the conditions are high productivity, fairly balanced ecosystem conditions, and moderate ecological pressure. The Shannon-Wiener (H) diversity index is generally used to describe species diversity in a community and accounts for both the abundance and evenness of species present in an area. According to [12] and [13], when all the species that make up the population community are equally abundant, diversity is shown to be higher. Some of the results of the diversity index values are closely related to the number of species and individuals caught by gillnets. The higher the number of species and individuals obtained, the higher the value of the Shannon-Wiener diversity index. However, in some months, the Shannon-Wiener diversity index value is not in harmony with the

number of species and individuals. [14] assessed that in some cases, high values of the Shannon diversity index were associated with a low number of individuals, and low values of the diversity index were associated with a high number of individuals. The diversity index of non-targeted species in the waters of Grogol Village tends to be higher when compared to studies in other locations in Indonesia, one of which was studied by [9] in Lasongko Bay, Southeast Sulawesi. Lasongko Bay has a species diversity index value for crab fisheries ranging from 0.652 to 0.88 with low ecological status. According to [15], the diversity values and variations in abundance of Portunidae species may be caused by differences in aquatic habitat conditions and sampling methods.

Table 3. Shannon Wiener diversity index, species evenness, and Simpson dominance of non-targeted species in Grogol Waters, Cirebon.

Month	Diversity Index (Shannon-Wiener)	Evenness Index	Dominance Index (Simpson)
June 2021	1.83	0.66	0.15
July 2021	1.69	0.63	0.41
August 2021	1.37	0.60	0.43
September 2021	1.15	0.83	0.36
October 2021	1.29	0.59	0.35
November 2021	1.50	0.59	0.29
December 2021	2.16	0.82	0.23
Average	1.57	0.67	0.32

The Evenness index (E) shows that the average value of evenness for non-targeted species in Grogol Waters, Cirebon is 0.67. The highest evenness value was in September (0.83) and the lowest was in October and November (0.59). The evenness index value (E) varies between 0 and 1, and according to [12] and [13], the closer to 1 the more evenly distributed the fish populations that make up the community. Based on the results obtained, non-targeted species caught in crab fisheries are of moderate-to-high status. This indicates that the non-targeted species in the waters of Grogol Village are relatively evenly distributed and have a fairly good distribution.

As for the Simpson dominance index, the highest value was found in August at 0.43 and the lowest in June at 0.15, with an average value of 0.32 during June-December 2021. The value of the Simpson dominance index is included in the low to moderate category, which indicates that the level of dominance is quite low. [11] stated that a low dominance index value indicates that there are no species that strongly dominate the catch. Similar results were found in [9] study in Lasongko Bay, Southeast Sulawesi, where the dominance index value was 0.242–0.534, which was in the low to moderate status category.

In general, the Shannon-Wiener diversity index graph has a similar trend to the number of species and the number of individuals, where the value decreases and reaches its lowest point in September (0.15) then increases again until December. It can be said that in this study, the diversity index value is in line with the number of non-targeted species caught by gillnet, both species and individuals. This is also said by [15], who say that the value of Shannon-Wiener diversity is influenced by the number of species and the abundance of each type of fish. The value of the species evenness index obtained from June to December 2021 shows a decrease in June–August, then increases in September, decreases again, and then increases until December. The evenness index value almost has a pattern that is in line with the Shannon-Wiener diversity index, but there was a big difference in September, where this month the evenness index value increased. As for the Simpson dominance index, it tends to have low fluctuations and has a slightly inverse pattern to the Shannon-Wiener diversity index and the species evenness index. This was also found in the temporal observation of crustacean bycatch in the crab fishery in Kendari

Bay, Southeast Sulawesi, by [9], where the temporal community structure of bycatch in March–October tends to have a consistent pattern between the Shannon–Wiener diversity index and the species evenness index.

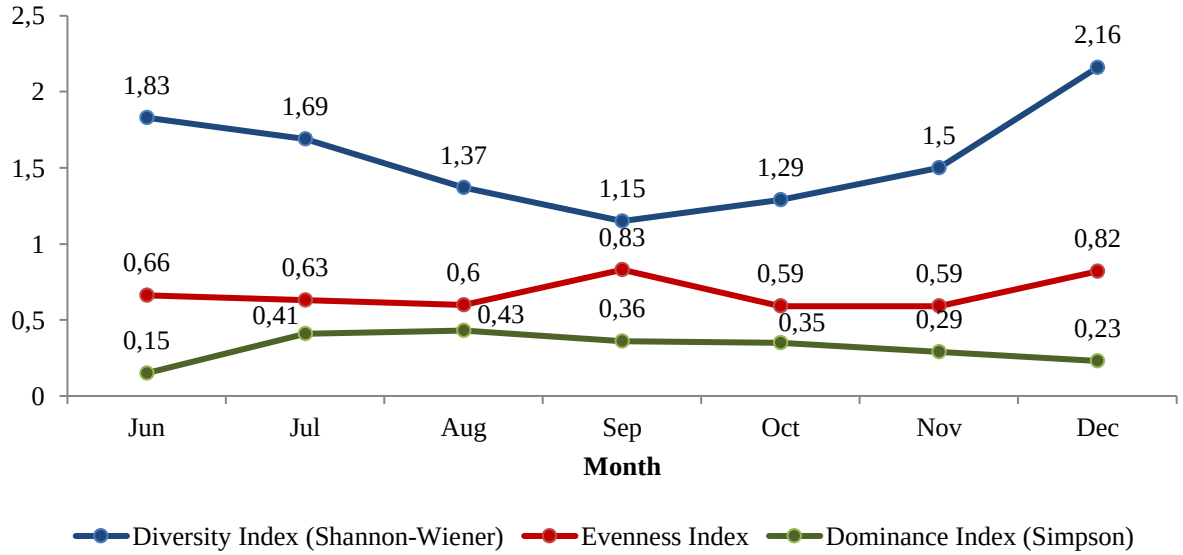

Figure 3. The graph of the Shannon-Wiener diversity index, species evenness, and Simpson dominance for non-targeted species in the waters of Grogol Village, Cirebon.

4. Conclusion

The most non-targeted species found in the waters of Grogol, Cirebon District, are from the crustacean group with the highest number of species: *Podophthalmus vigil*, *Charybdis feriatus*, and *Varuna litterata*. During the period June–December 2021, the least number of species and the fewest individuals of non-targeted species were found in September. The Shannon-Wiener diversity index shows the diversity of non-targeted species in the waters of Grogol, Cirebon District is in the category or status of being moderate, which can be interpreted as where the conditions are high productivity, fairly balanced ecosystem conditions, and moderate ecological pressure. The species evenness index, categorized as moderate to high, indicates that the non-targeted species in the waters of Grogol Village are relatively evenly distributed and have a fairly good distribution. The Simpson dominance index shows that the level of dominance of non-target species in these waters is quite low.

5. Recommendation

The diversity of non-targeted species in the waters of Grogol, Cirebon District, is due to the conditions of high productivity, fairly balanced ecosystem conditions, and moderate ecological pressure. They are relatively evenly distributed and have a fairly good distribution, with quite low dominance. Therefore, several data collection points in Cirebon District are deemed necessary to be added in order to obtain conditions for non-targeted species that cover a wider range of waters and also information about retained and discarded non-targeted species. This is intended so that the management of non-targeted species can be carried out better by considering aspects of the benefits of these non-targeted species for fishermen. Information regarding habitat and environmental conditions in the study area may also be needed so that the results obtained can also describe the existing habitat and environmental conditions. Given the importance of fisheries management with a good database, it is hoped that other studies can provide more detailed and comprehensive information.

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