International Journal of Environment, Agriculture and Biotechnology
Vol-7, Issue-6; Nov-Dec, 2022

Journal Home Page Available: https://ijeab.com/
Journal DOI: 10.22161/ijeab

Peer Reviewed

The Selectivity of Buton Pot's Escape Gap in Kotania Bay, Maluku, Indonesia

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Received: 09 Nov 2022; Received in revised form: 22 Nov 2022; Accepted: 28 Nov 2022; Available online: 04 Dec 2022

***Abstract*— *This research was aimed at proving the differences between the catch results of fish trapped inside the bubu buton (fish pot) and those that escaped through the escape gap and to analyze the selectivity of the escape gap for the dominant trapped fish. This research was carried out in Kotania Bay in the period of March-May 2019 through fishing experiment. Five units of bubu buton with a dimension of 70x70x26 cm, containing 4 escape gaps in each unit, were used during the experiments carried out with a total of 11 trips. The results showed that there were 19 fish families caught during the study, dominated by Scaridae family. There was a significant difference between the weight of the trapped fish and those that escaped through the escape gap at the significance level of $t\_\alpha 0,05$. Among the 19 families caught, the trapped percentage was different between the fish trapped inside the fish pot and those that escaped through the escape gap. The 50% trapped and escape chance (L50) of the Scaridae family from the escape gap was found in fish with a total length of 22.3 cm, which became the indication of sustainable management.*

Keywords*— *Fish pot's, escape gap, Scaridae, 50% trapped chance.

I. INTRODUCTION

One of the bay waters with potential biological resources in Maluku is Kotania Bay, located in West Seram Regency. There are 4 (four) important ecosystems in the Kotania bay area, namely estuarine, mangrove, seagrass and coral reef ecosystems which make it rich in marine aquatic resources [1]–[3]. In the seagrass ecosystem, Kotania Bay contains 28 fish families, consisting of 40 fish species, dominated by the Siganidae, Lethrinidae, Lutjanidae and Scaridae families [4]. To take advantage of fish resources in Kotania Bay, fishermen use a variety of fishing gears, namely gill nets, handlines, bottom-trolling line, and fish traps/pots.

The fish pots used by fishermen to catch various species of coral reef fish in Kotania bay are called bubu buton, which are similar to those used by fishermen in the Kepulauan Seribu known as bubu tambun. This is a passive fishing gear that allows fish to enter it easily but will be difficult for them to escape [5]. Fish pot has several desirable characteristics for modern fishing gears (Cole et al., 2003; Dayton et al., 1995). These characteristics are; it needs less labor and uses low energy when compared to the active fishing gears; it only affects the seabed area in accordance with the size of the pot itself; the fish caught alive have minimal physical damage which is a prerequisite for high quality products; the fish caught alive result in unnecessary by-catch to be released back into the sea with low mortality. These characteristics show that it is more environmentally friendly as fishing method than the other gears.

Even though fish pot is considered as an eco-friendly fishing method, it can also affect the environment when it is operated in coral reef waters that have a high diversity of species. The results of research on *bubu tambun* fish pots in the coral reef waters of Seribu islands showed that the percentage of the main catch was 42% while which of the by-catch was 58%, which was dominated by the Chaetodotidae, Phomacentridae and Monachantidae families [9]. The results of research on buton fish pots in Wakal waters on the island of Ambon showed that there were 22 fish families consisting of 44 species caught with the proportion of main catch of 78% and bycatch of 22% [10].

Both research results indicate that there were more by-catch products than which of the main catch. The great number of bycatch is an indication of the cause of declining fish stocks in various parts of the world [11]. In order to preserve the recruitment in the context of the sustainability of coral reef fish resources, the pressure on bycatch fish must be minimized. Therefore, to increase the sustainability of coral reef fish resources so that recruitment can be preserved, the amount of bycatch products must be minimized by increasing the selectivity of the pots [12]. There are some ways to increase the selectivity of pots, such as, improving the size of the net, funnel, or by using escape gap [13]. Various studies have been conducted on the use of escape gap as evidence to increase the selectivity of the pots [14]–[17].

In general, the buton pots used by fishermen in Kotania Bay have a small size; with a dimension of 70 cm long, 70 cm wide, and 26 cm high. The pots are operated at low tide depths ranging from 0.5 - 1.5 m in order to take advantage when various types of fish looking for food at high tide. The small size and timing of the operation (operated in shallow waters) make it possible to catch the unfit-sized target fish as well as various types of by-catch fish. Therefore, it is necessary to conduct research in order to minimize the impact of Buton pots on both target and by-catch fish through escape gaps. The purpose of this study was to prove the difference between the catch fish trapped inside the pots and those that escaped through the escape gap to the cover net, and to analyze the selectivity of the escape gap towards the dominant trapped fish..

II. RESEARCH METHOD

The research was conducted in the period of March – May 2019 in Kotania bay, West Seram Regency, Maluku. The research location is shown in Figure 1. This research was an experimental catch using 5 units of buton pots. The specifications and dimensions of the buton pots are shown in Figure 2.

The shape of buton pots used in the research resembled a heart. The pots had a dimension of 70 cm long, 70 cm wide and 26 cm high. The funnel had an oval shape, with a height of 26 cm and diameter of 22 cm. The cover net was designed to accommodate fish that can escape through the escape gap. The dimension of the net cover was 65 cm long, 65 cm wide and 26 cm high. The escape gaps were located on both sides of the pots with net cover, in which each side had two escape gaps. The shape of the escape gap was a circle with a diameter of 5 cm.

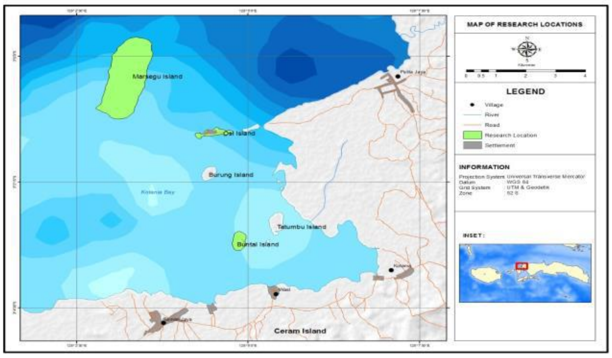

Fig.1: Research location in Koatania Bay, Maluku Indonesia. The location of experimental fishing are Osi and Mursegu island waters

The data collection process was carried out as follows: the pots were operated at a water depth of 0.5 – 1.5 m at low tide; the distance between pots was ranging between 10 - 15 m; the length of soaking time was 2 days; in order to keep the pots remained at the bottom of the water, chunks of dead coral were used to cover the entire top of the pots. The fish caught in the pots were separated from the fish caught in the cover net and then the total length (cm) and weight (gram) of each species caught were measured. Furthermore, each pot that had its catch collected was then reset, and this experiment was carried out for a total of 11 fishing trips.

The t-test was used to prove the difference between the catch fish trapped inside the pots and those that escaped to the cover net. The t-test formula (test of two means):

$$t = \frac{Y_1 - Y_2}{S_{\bar{Y}_1 - \bar{Y}_2}}$$

Where Y_1 is the catch fish result, Y_2 is the catch fish escaped to *cover net*, $S_{\bar{Y}_1 - \bar{Y}_2}$ is the variance of two means.

The chance of every total length class of both the trapped and escaped fish from the escape gap for the dominant trapped fish is calculated using the logistic function model:

$$SL = \frac{Exp\ (a + bx)}{1 + Exp(a + bx)}$$

Where SL is the escape chance of fish's total length size class (L), a is the intersection of line equation, b is line coefficient, and x is the total length class.

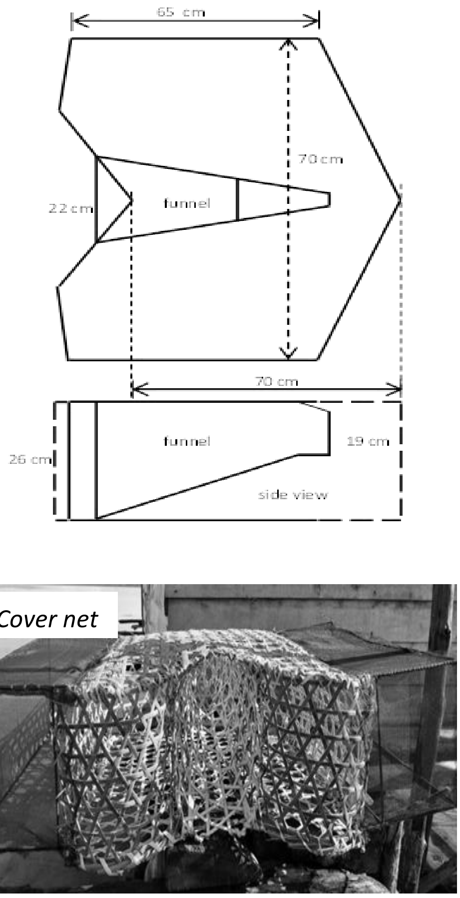

Fig. 2: *The specifications and dimension of buton fish pot used during the research. The picture on the above is a sketch of buton pot, on the below is the photograph of buton pot and cover net*

III. RESULTS AND DISCUSSION

3.1. Catch Composition

During the research, there were 463 fish caught with a total weight of 91,472 grams. The catch consisted of 19 families, dominated by the Scaridae family by 38.23% and followed by Siganidae 21.0%, Zanclidae 6.0%, Mullidae 5.8%, Serranidae 5.8%, Lethrinidae 5.4%, Acanthuridae 4.8% and other families by 13.0% (Figure 3). By weight, the catch was dominated by Scaridae by 57%, Siganidae 14.7%, Mullidae 7.8%, Serranidae 4.3%, Balistidae 3.8%, Lethrinidae 3.1%, Acanthuridae 2.2%, and other families by 9.3% (Figure 4).

The Scaridae family dominated all catches, both by total individuals and weight, because at the time of the research, the pots were installed in the fishing area where most of the bottom waters were covered by sand and dead coral reefs and only a small part was covered with live coral. According to [18], this family is known as parrotfish, which consumes algae from dead coral substrates and chews algae and rocks to form coral sand, so that it makes this family one of the most important sand producers in coral reef ecosystems.

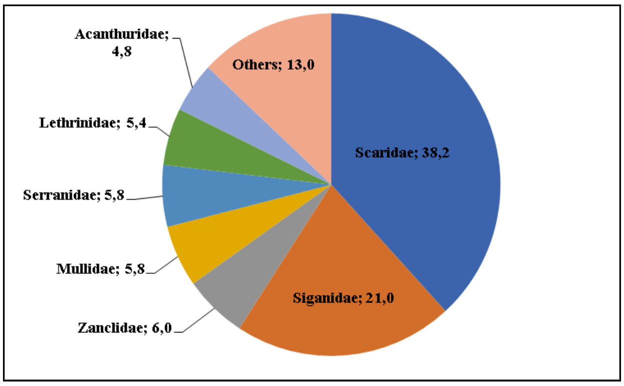

Fig. 3: The percentage of total individual catch

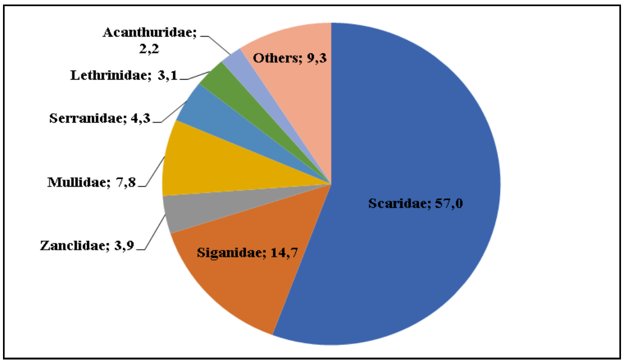

Fig. 4: The percentage of total weight of catch (grams)

Fish around coral reefs can be grouped into three categories, namely the main group, target group and the indicator group[19]. The results of this research indicated that most of the catch was from the main group (51.7%), consisted of Scaridae, Acanthuridae, Pomacentridae, Balistidae, and Holisentridae families. The total catch from the target group was 38.7%, consisted of Serranidae, Siganidae, Mullidae, Lethrinidae, and Haemulidae families, and the total catch from the indicator group was 7.6%, consisted of Zanclidae and Chaetodontidae families.

3.2. The difference between the catch results of *buton* pot and cover net

The t-test showed that there was no difference in the total individual catch between the pot and net cover ($t\alpha$ 0,05 > tcount) but there was a difference in the total weight between them ($t\alpha$ 0,05 < tcount). The average number of individual catch in the pot/trip/pot and cover net/trip/pot is 4 fishes, while the average weight of catch in the pot/trip/pot is 1,275.6 grams, different from the average weight of catch in the cover net/trip/cover net of 381.1 grams.

The number of fish that escaped through the escape gap and was in the cover net was 240, more than those that trapped in the pot which was 222 (Table 1). From 19 families caught, there were 8 (eight) families that all fish escaped through the escape gap, namely Holisentridae, Pomacentridae, Chaetodontidae, Muraenidae, Diodontidae, Ostracidae, Labridae and Monacanthidae families.

The results of this research indicated that different fish families have different percentages of fish that were trapped or escaped to the cover net. This is because the ability of the fish to escape through the escape gap is influenced by the body morphology of the fish. [20] also obtained data that different body shapes will have different chances of fish being caught. The presence of thorns on the body of the fish also affects the chances of escaping or being caught in a particular fishing gear. Also observed that the morphology of the conger eel had an effect to the ability to escape from the pot [21]. The presence of mucus in the conger eel's body enables the conger eel to escape from the pot even though the mesh size of the pot is smaller than the body girth.

Table 1. The results of total individual catch in pot and cover net

No	Famili	Pot		Cover	
		Individual	%	Individual	%
1	Scaride	105	59,3	72	40,7
2	Siganidae	52	53,6	45	46,4
3	Mullidae	18	66,7	9	33,3
4	Serranidae	19	70,4	8	29,6
5	Haemulidae	3	100,0		
6	Lethrinidae	7	28,0	18	72,0
7	Holisentridae			11	100,0
8	Acanthuridae	4	18,2	18	81,8
9	Zanclidae	2	7,1	26	92,9
10	Pomacentridae			15	100,0
11	Chaetodontidae			7	100,0
12	Balistidae	10	71,4	4	28,6
13	Muraenidae			1	100,0
14	Diodontidae			1	100,0
15	Ostraciidae			3	100,0
16	Dasyitidae	2	100,0		
17	Labridae			1	100,0
18	Monacanthidae			1	100,0
19	Plotosidae	1	100,0		

Table 2. The results of total weight (grams) of catch in *pot and cover net*

No	Famili	Pots		Cover	
		Weight (g)	%	Weight (g)	%
1	Scaride	43.049,0	82,6	9.051,5	17,4
2	Siganidae	10.440,0	77,8	2.970,5	22,2
3	Mullidae	6.130,0	85,5	1.040,0	14,5
4	Serranidae	2.960,0	74,7	1.000,0	25,3
5	Haemulidae	1.030,0	100,0		
6	Lethrinidae	1.270,0	44,9	1.560,0	55,1
7	Holisentridae			910,0	100,0
8	Acanthuridae	1.090,0	53,7	940,0	46,3
9	Zanclidae	210,0	14,2	1.270,0	85,8
10	Pomacentridae			741,0	100,0
11	Chaetodontidae			640,0	100,0
12	Balistidae	2.810,0	79,6	720,0	20,4
13	Muraenidae			100,0	100,0
14	Diodontidae			150,0	100,0
15	Ostraciidae			480,0	100,0
16	Dasyitidae	520,0	100,0		
17	Labridae			90,0	100,0
18	Monacanthidae			70,0	100,0
19	Plotosidae	230,0	100,0		

3.3. The selectivity of escape gap for Parrotfish (Scaridae)

The curve of the selectivity of escape gap for parrotfish of the Scaridae family is presented in Figure 6. The curve uses the selectivity parameters a and b by -14.87 and 0.67. Thus, the logistic function of the curve of the selectivity of the 5 cm circular-shaped escaped gap of *Buton* pot is as follows:

$$r_L = \frac{\exp(-14{,}87 + 0{,}67L)}{1 + \exp(-14{,}87 + 0{,}67L}$$

Based on this logistic function equation, the calculations were made based on the total length of the fish which were then plotted into a selectivity curve (Figure 5). Figure 6 shows that the chance of parrotfish being caught is 50% (L50) using an escape gap in the pot with a total length of 22.2 cm. This value indicates that at the size of 22.2 cm, parrotfish have a chance of being caught and escaping from the escape gap for 50%.

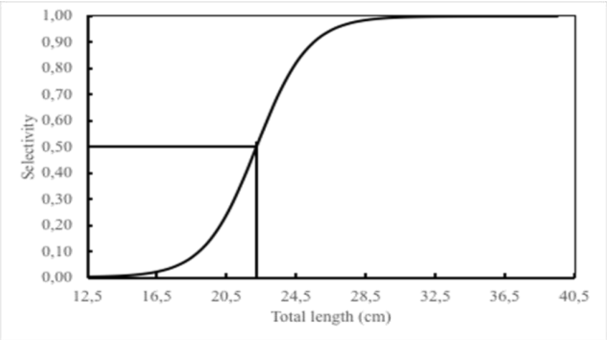

Fig.5:The chance of being caught in the total length class of parrotfish (Scaridae) in buton pot with a 5 cm square-shaped escape gap

Furthermore, Figure 5 shows that, with a total length of 12 - 14 cm, parrotfish from the Scaridae family have no chance of being caught. This means that, with that size, any parrotfish that enter the buton pot have a chance to escape through the circular-shaped escape gap with a diameter of 5 cm. With a total length of 14 – 15 cm, the chance of being caught is 1.0% and the chance of being caught continues to increase exponentially until it is 99.0% at a total length of 29 – 30 cm. Furthermore, the total length > 30 cm has a 100% chance of being caught. Explained that there are several factors that influence the selectivity of the catch in the pot, such as the pot mouth, which includes shape and size, and escape gap, which includes shape, size, and position [12]. Furthermore, explained in more detail the technical factors that affect the selectivity of the pot regarding the shape and size of the mesh, and the escape gap [21]

Parrotfish from Scaridae family consists of many species. Stated that there are 39 species of parrotfish in Indonesian coral reef waters [22]. According to [23], generally, parrotfish found in Indonesian waters consist of Scarus quoyi, Scarus dimidiatus, Scarus ghobban, Chlorurus bleekeri, Cetoscarus bicolor, and Scarus niger. During the research, there were approximately 4 species observed according to the names given by the local fishermen, namely kakatua ijo (green parrotfish), kakatua biru (blue parrotfish), kakatua putih (white parrotfish), and kakatua kuning (yellow parrotfish). There is a lack of information related to the size of the first spawning of the Scaridae family in Indonesia. One of the information related to the size of the first spawning of the Scaridae family, from Scarus rivulatus species, in the waters of South Konawe, Sulawesi, is 24.2 cm for male and 17.5 cm TL for female [24]. The results showed that the Scaridae family with a total length of 22.2 cm has a 50% chance of being caught and escaped through the escape gap with a diameter of 5 cm. Therefore, in order to catch the Scaridae family fish sustainably using a buton pot, it is recommended to use an escape gap in accordance with the design made in this research.

IV. CONCLUSION

There was a difference in the total weight of the catch trapped inside the buton pot and those escaped through the escape gap to the cover net, where the percentage of escaping and being trapped inside the pot varied in accordance with the fish family. The 50% chance to escape the Scaridae family through an escape gap with a diameter of 5 cm was found in fish with a total length of 22.2 cm. The use of a buton pot equipped with a circular-shaped escape gap with a diameter of 5 cm can be an alternative as one of the factors in coral reef fisheries management.

ACKNOWLEDGEMENTS

This research is an idea for several undergraduate students to conduct research related to buton pot in Kotania Bay. Therefore, I would like to thank Dasad Samal, Hikmah Wahyuningsih and the bubu Buton fishermen who had helped in the fishing construction and operation.

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