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LACUBA Lamp Innovation to Enhance Gill Net Fisheries in Central Tapanuli

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Abstract

The fishing gear that is widely used by fishermen in Central Tapanuli is a gill net to exploit resources around Sibolga Bay, but the catch of gill net fishermen fluctuates, mostly decreases, because in fishing it does not use fishing aids. Therefore, fishing aids are needed to increase catches, one of which is by using LACUBA. The objectives of this study were to determine the composition of the catch in the gill net with or without LACUBA, and to determine the effect of using LACUBA on the gill net catch. This research was conducted from February to April 2024 in Sibolga Bay, Central Tapanuli. The method used in the study was experimental fishing method, with a complete randomised design (CRD), where treatment and control were given. The treatment was to attach the designed LACUBA to the net sheet when operated in the water with the first 30 metres of gill net using LACUBA and the remaining 570 metres without LACUBA with a total net length of 600 metres. The results showed that the catch of gill nets using LACUBA had an effect on catches, where the Annova analysis test with a completely randomised design, obtained significant results, where (P <0.05) is 0.000 <0.05. This is also shown through the total catch of 16,845 grams, without LACUBA 8,290 grams 14 times. Gill nets with LACUBA can increase catches compared to without LACUBA, because of the addition of attractants to the net, so that fish including positive phototaxis will be caught in the net, besides that fish that are looking for prey are also caught because they want to prey on their food in the gill net area.

Keywords: Fish behavior, gill net, light fishing

1. INTRODUCTION

Central Tapanuli Regency is one of the regions in North Sumatra Province. Central Tapanuli has 200 km of coastline, and is rich in fisheries resources, which makes it the center of the local economy [1]. Most of the Central Tapanuli Regency area is on the coast and has great potential in the fishing industry, especially marine fisheries [2]. Most of the population in coastal Central Tapanuli work as fishermen, and their main income is from selling fish catches from the sea [3].

The large potential of fish resources makes fishermen on the coast of Central Tapanuli make fisheries activities a source of their income, especially in catching fish [4]. One of the fishing gears widely used by fishermen in Central Tapanuli is the gill net. Although the number of resources is quite abundant, the catch of gill net fishermen often fluctuates, where there are times when the results are many, and there are times when there are none at all. This can occur due to various factors, including the number of users of similar fishing gear and the number of fishing activities in the coastal areas of Central Tapanuli, and still using fishing methods that are still classified as traditional and without using fishing aids [5].

Based on the conditions stated above, it is necessary to have an innovation to increase the catch of fishermen, the innovation that can be done is to use technology that can increase the catch, one of the efforts is to use the addition of lights as a fishing aid that serves to attract fish attention [6][7]. In this study, the lights used are LED dipping lights made from 5-watt “Krisbow” brand high-brightness LEDs emergency lights. The number of lights made was 2 units.

The use of additional light in the form of lights on fishing gear is based on fish behavior, which is called phototaxis or stimulation of the presence or absence of light in the water, especially in the sense of sight of fish. The utilisation of lights is intended to attract the attention of fish that have positive phototaxis will react to light by approaching the light source, while fish that have negative phototaxis will not be attracted by light sources in the waters, but rather become a food source for fish that are looking for prey [8]. In this research, the type of lamp used is COB LED lights with a series circuit and installed on a net with a total of 2 pieces on the net.

One of the attractor innovations that is currently developing quite fast and easy to use is the underwater dipping lamp (LACUBA). The use of this type of lamp is more efficient in collecting fish, due to its placement at the bottom of the water so that the level of penetration is better when compared to lamps installed on the surface of the water. The operation of fishing gear with the light fishing method, namely fishing using fishing aids, namely lights (the addition of LACUBA), has been shown to be able to increase catches [9]. In this study, the lights used are COB LED lights and are attached to a net that is only 60 metres long. In addition, the use of LACUBA can be said to be suitable for use in gill net fishing gear, because it is directly attached to the net wall so that the lamp becomes one with the net body in the water, making it easier for fish to get closer to the net body and be easily caught. Based on this analysis, underwater dipping lights are one of the attractors (lure), in order to increase the catch. Therefore, in this study it is necessary to optimize underwater dipping lights (LACUBA) as an attractor with a gill net to increase catch. The objectives of this study were to determine the composition of the catch in the gill net with or without LACUBA, and to determine the effect of using LACUBA on the gill net catch.

2. METHODS

2.1. Time and Place of Research

This research was conducted from January to February 2024. The research was conducted on Panjang Island, Central Tapanuli Regency. The research location is shown on the map in Figure 1.

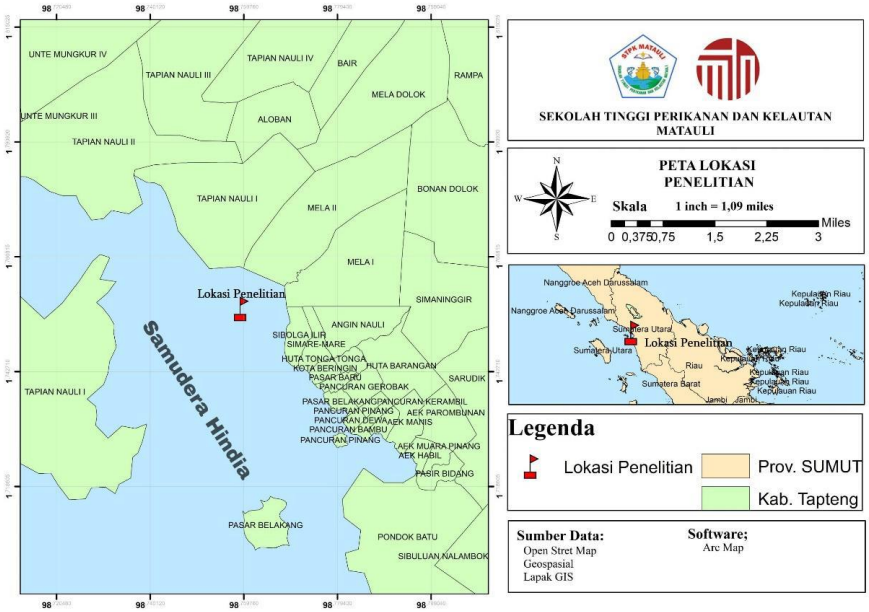

Figure 1. Map of Research Location

2.2. Tools and Materials

The tools and materials used in the LACUBA innovation research on gill net fisheries in Central Tapanuli are presented in Table 1.

Table 1. Tools and Materials used in the Research

No	Tools and Materials	Quantity	Fuction
1	Gill net	1 unit	As the main tool for implementing LACUBA
2	Vessel < 5 GT	1 unit	Sea transportation
3	Camera	1 unit	For documentation
4	Scales	1 unit	To weigh the fish
5	Bucket	1 unit	Place/container of caught fish
6	3-volt COB LED light	4 units	Lighting sources in the LACUBA
7	9-volt box battery	2 units	Power source LACUBA
8	Jar	2 units	LACUBA Container
9	Swivel	2 units	To hang the LACUBA on the net body
10	Ballast	2 units	As heavy media on LACUBA
11	Cable	3 meters	Light and battery connectors
12	Ties cable	1 pack	Wide swivel and bottle fastener
13	Cable tape	1 roll	Cable adhesive

2.3. LACUBA Making

Making (Figure 2) LACUBA begins with preparing a bottle/jar container that is the same size as the width of the 3 Volt COB LED lamp. After getting the appropriate size, 4 pieces of 3 Volt COB lights are inserted into the jar/bottle on all sides of the bottle, then in the center of the lamp is given a ballast, then the top of the lamp and stone is given a base so that the position of the lamp and stone is fixed, 4 pieces of LED lights are connected to 2 9 Volt battery boxes in the top position of the lamp, and a switch is given on the outside of the bottle/jar. The bottle/jar is closed and the side of the jar is coated with duct tape so that water cannot easily enter, then the bottle/jar lid is given a swivel so that the LACUBA can be attached to the fishing gear.

Figure 2. LACUBA Contruction

2.4. Illustration of LACUBA Installation on a Gill Net

After the LACUBA unit was constructed, the LACUBA was installed on a 40-sheet gill net with a total length of 600 m, where the side using the LACUBA was 30 m away with 15 m installed in the center so that the range could fulfill the 30 m, and the rest was not installed with the LACUBA as a control. The placement of the LACUBA is presented in Figure 3 below.

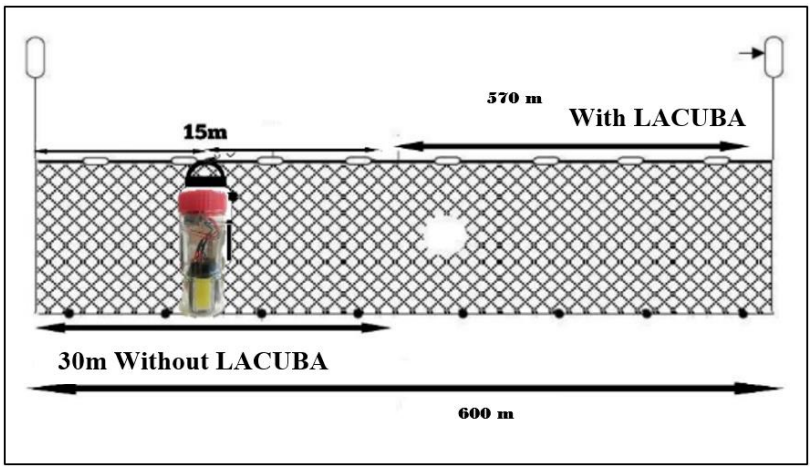

Figure 3. Illustration of LACUBA Installation on a Gill Net

2.5. Research Method

The research was conducted using the experimental fishing method. According to [10], the experimental fishing method is catching fish using treated fishing gear. Hanafiah (2005) added that an experiment is a series of actions taken on an object to be investigated in order to determine its effect. The experimental method uses 1 treatment, which is using LACUBA installed on the gill net with a total length of 600 meters, where 30m is installed one LACUBA, while the next 30m is not given LACUBA which is referred to as control. This trial was conducted in the waters of Sibolga and Tapanuli Tengah bays (west coast waters of North Sumatra) with 30 replications of the operation of the gill net fishing gear. The design used in the study was a completely randomized design (CRD) (Table 2).

Table 2. Gill Net Experimental Design

Treatment	Replay														Total
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	
Without LACUBA (Control)	0,7	0,3	0,5	0,36	0,71	0,61	0,4	0,38	0,45	0,51	0,45	0,57	0,91	1,43	8,370 kgs
With LACUBA (Treatment)	0,8	0,9	0,7	1,24	1,27	1,10	1,33	0,63	0,92	1,33	1,59	1,22	1,95	1,82	16,846 kgs
Total	1,5	1,2	1,2	1,6	1,98	1,71	1,73	1,01	1,37	1,84	2,04	1,79	2,86	3,25	25,216 kgs

2.6 Data Analysis

2.6.1 Type of Fish Caught with or Without LACUBA

In this study, the parameters observed were the number of catches, types (species) of catches, and the effectiveness of gill net fishing gear using LACUBA and without using LACUBA. The percentage of the number of catches based on the weight and type of catch is calculated using the formula [11] as follows:

$$P = \frac{ni}{N} \times 100\% \quad (1)$$

Description: P = Total fish caught (grams); ni = Number of species to 1 (grams); N = Total number of fish caught LACUBA/non LACUBA

The percentage of catch effectiveness using LACUBA was calculated using the following formula:

$$lamp\ effectiveness = \frac{hauling}{JHTI} \times 100\% \quad (2)$$

The indicator of the effectiveness value is if the effectiveness value is less than 30%, it can be said that the fishing gear has a less effective effectiveness, the value of 30%-60% of the fishing gear has an effective value, and the value greater than 60% of the fishing gear has a very effective effectiveness [12].

2.6.2 Effect of LACUBA on Gill Net Catches

In this study, as for testing the effect of LACUBA on gill net catches, namely by using statistical analysis consisting of several statistical tests, starting from the normality test, homogeneity, and anova test. The three tests were analysed using SPSS 21 software. The use of these statistical tests is intended to make the data obtained in the field valid and can be presented in the form of tables or diagrams. Data on the number and type of catches are presented in the form of graphs and tables to facilitate the analysis process. Data that has been made in tabular form is then analysed for normality (0,722 > 0,05) and homogeneity (0,240 > 0,05) using the Kolmogorov-Smirnov test to test whether the data is normally distributed or not. If the data is normally distributed and homogeneous, then the next analysis uses the One Way ANOVA test (0,000 < 0,05).

3. RESULTS AND DISCUSSION

3.1. Composition of Catch in Gill Nets with or without LACUBA

The total fish catch, using LACUBA gear for 14 fishing trips, amounted to 16,845g. The main fish catches (fishes that are abundant and marketable) obtained with this LACUBA tool consist of male mackerel (*Rastrelliger kanagurta*), female mackerel (*Rastrelliger brachysoma*), *Nemipterus japonicus*, *Upeneus mullocensin*, *Penaeus merguiensis*, *Sphyraena baracuda*, and *Sillago sihama* as well as by-catch fish, by-catch, which is a smaller number of catches or fish whose selling price is lower in the market, consists of *Gazza minuta*, *Terapon jarbua*, *Pseudopleuronectes americanus*, *Moolgarda seheli*, *Pennahia argentata*, *Harpiosquilla raphidea*, *Priacanthus tayenus*, yellow mackerel (*Selaroides leptolepis*), *Lethrinus obsoletus* and *Geres punctatus*. Figure 4 below shows the main and bycatch results during 14 fishing trips using LACUBA.

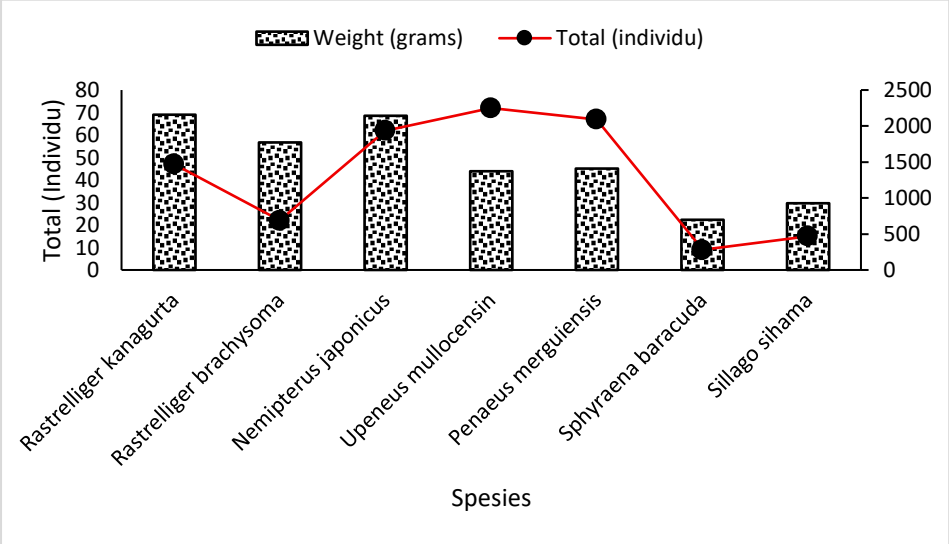

Figure 4. Composition of main catch (HTU) with LACUBA, showing dominance of rastrelliger kanagurta

In Figure 4, it can be seen that the fish with the highest catch was female mackerel, weighing 2,160g and the fish with the lowest catch was barracuda weighing 700g. Although mackerel has a larger catch weight, but the number is less when compared to Mullidae and also Nemipterus japonicus, which have a total fish weight of 1,370g and 2,140g respectively. This is because the weight of female mackerel obtained during the implementation of this study tends to be greater than the fish with the highest number of *Mullidae*.

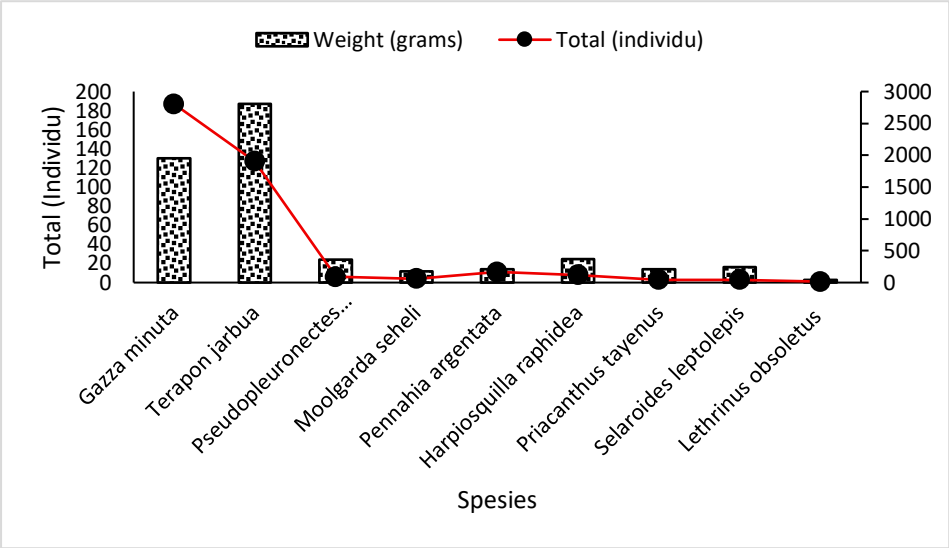

Figure 5. Composition of Bycatch (HTS) with LACUBA, showing dominance of *Terapon jarbua*

In Figure 6, it can also be observed that the weight of *Pseudopleuronectes americanus* is heavier than that of *gazza minuta*, which, although it has a larger number of fish, when compared to *Pseudopleuronectes americanus*.

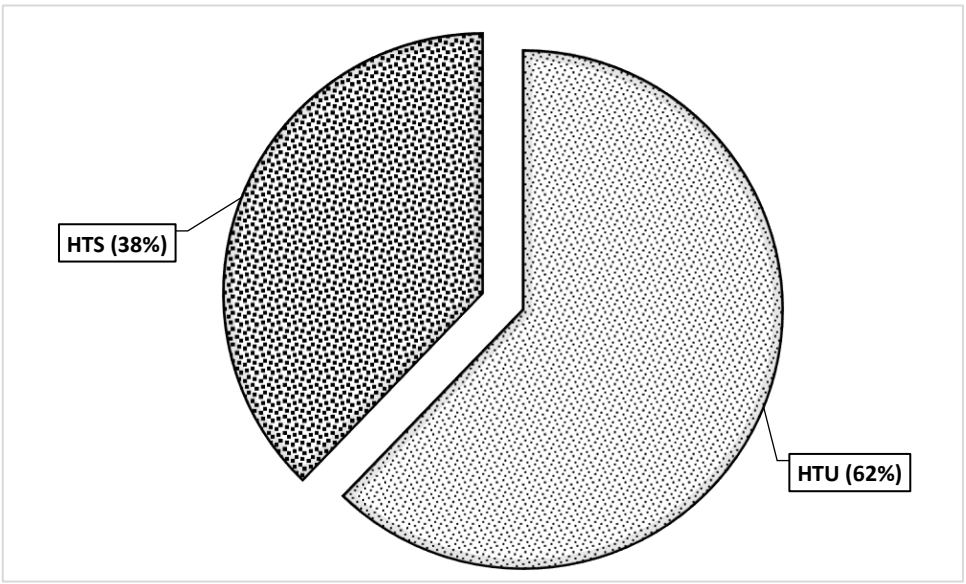

Figure 6. Percentage of HTU and HTS with LACUBA

Figure 6 shows the percentage of gill net catch using LACUBA divided into two categories: main catch (HTU) and by-catch (HTS). The results show that the main fish catch is more, which is 62% and compared to the by-catch, there is only 38% of the total fishing activity.

The fish caught without using LACUBA during the 14 fishing trips was 8,200g. The main fish catch consisted of male mackerel (*Rastrelliger kanagurta*), female mackerel (*Rastrelliger brachysoma*), *Nemipterus japonicus*, *Upeneus mullocensin*, *Penaeus merguiensis*, *Sphyraena baracuda*, and *Sillago sihama*, while the by-catch consisted of *Gazza minuta*, *Terapon jarbua*, *Pseudopleuronectes americanus*, *Moolgarda seheli*, *Pennahia argentata*, *Harpiosquilla raphidea.* The following are the main catch and by-catch results of the gill net without LACUBA.

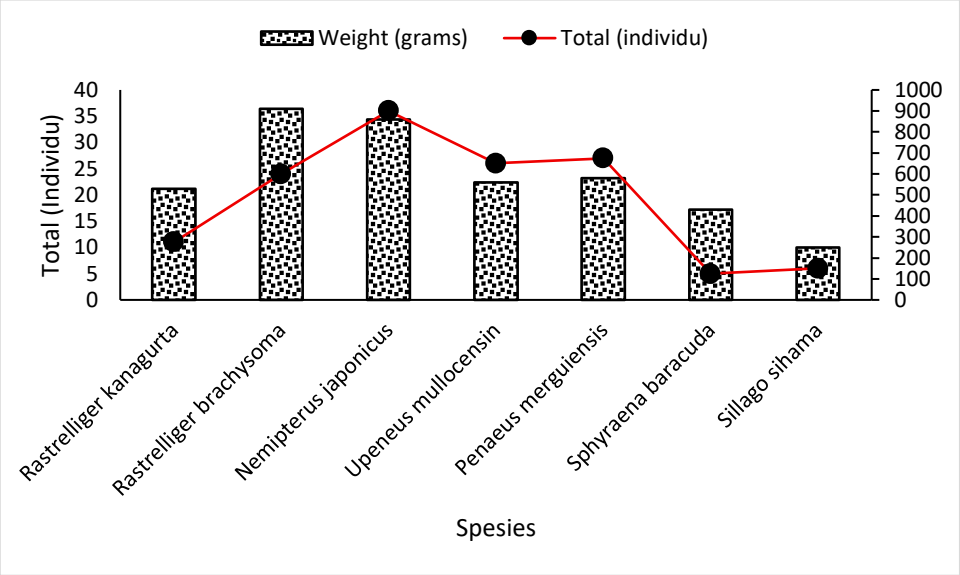

Figure 7. Main catch (HTU) without LACUBA

In Figure 7, it can be seen that the main catch of the gill net without using LACUBA is less than the main catch of the gill net using LACUBA. The fish that has the heaviest weight in the gill net without LACUBA is male mackerel with a weight of 910g, and the fish with the highest number is Nemipterus japonicus as many as 36 fish's.

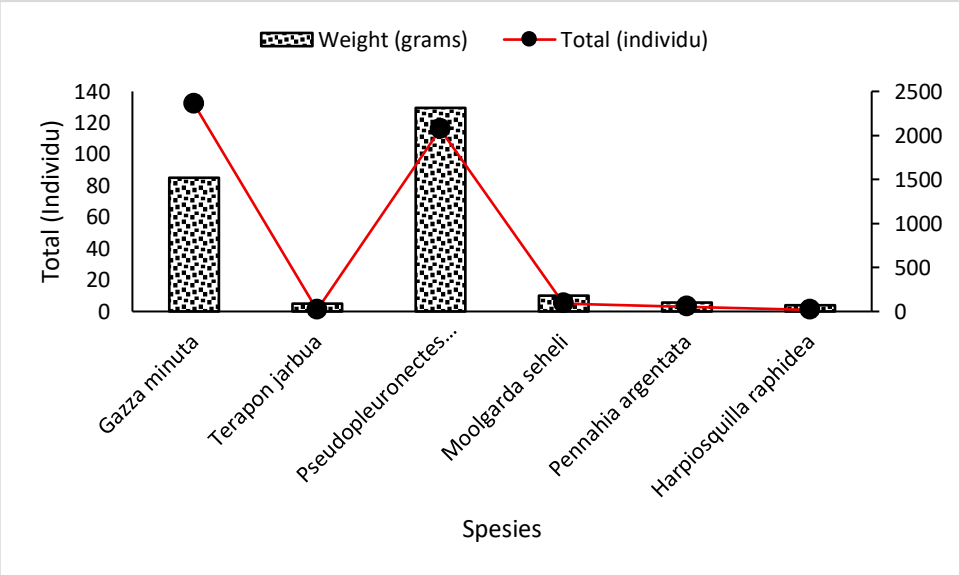

Figure 8. Bycatch (HTS) without LACUBA

From the previous statement in Figure 8, the main catch of gill nets weighed less overall than gill nets using LACUBA. This is also similar to the bycatch of the gill net without LACUBA, the fish with the heaviest total weight is *Pseudopleuronectes americanus* weighing 2,210g and the fish with the highest number is *Gazza minuta* with 132 fish.

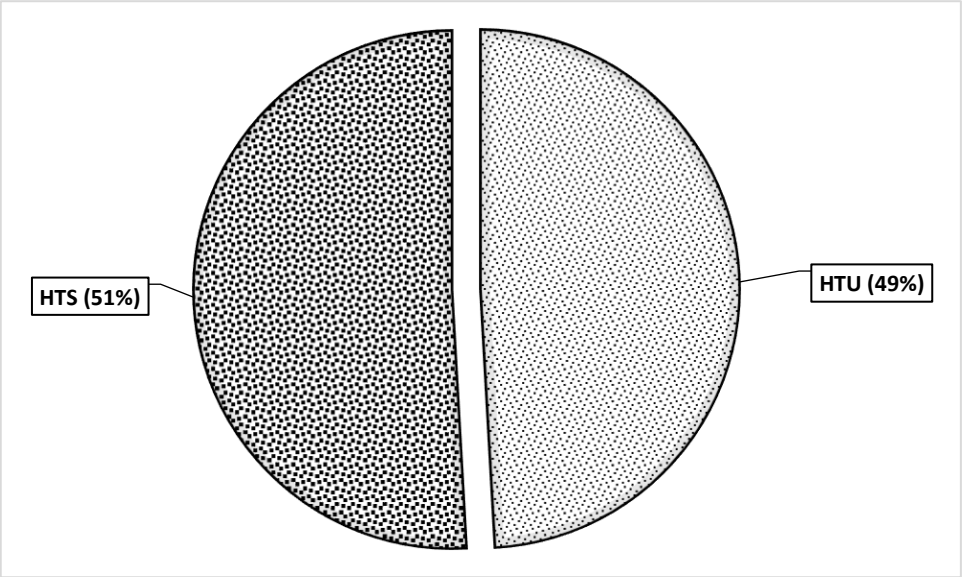

Figure 9. Presentase HTU and HTS Without LACUBA

Figure 9 shows that in the 2 categories between the main catch and bycatch without using LACUBA, the bycatch fish is slightly more dominant than the main catch. The bycatch is in the range of 51% while the main catch is 49% of the total catch of the gill net without LACUBA. There are several factors that cause this to happen, due to the absence of attractors in the seawater when conducting fishing, which has an impact on random catches, so that the targeted fish are only obtained less than the by-catch fish.

3.2. Catch Ratio of Gill Net with or Without LACUBA

The comparison of the catch of the gill net using or without LACUBA is quite large, because the fish caught using LACUBA is more than the fish caught without using LACUBA. As explained in the background of this research, the LACUBA innovation is intended to make fishing carried out by fishermen more efficient and get more catches than without using LACUBA itself. Therefore, the concept of using LACUBA is intended to be a lure for fish, especially pelagic fish or marketable target fish, in order to get more catches when compared to fishing without using LACUBA.
Figure 10 shows that the ratio of catches with or without the use of LACUBA is quite far, with 67% of the catches using LACUBA and only 33% of the total catches without LACUBA.

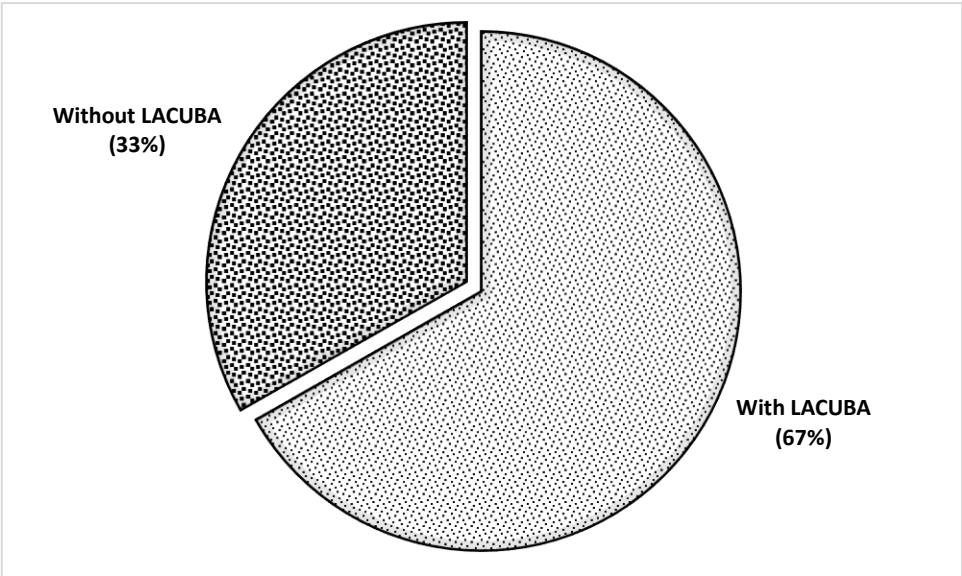

Figure 10. Comparison of Catches with and without LACUBA

In the results listed above, it can be seen that the fish caught by the gill net using LACUBA is more than the catch of the gill net without using LACUBA. The comparison between the gill net and LACUBA amounted to 16,845g consisting of 15 species of fish and 1 species of crustaceans namely male mackerel (*Rastrelliger kanagurta*), female mackerel (*Rastrelliger brachysoma*), *Nemipterus japonicus*, *Upeneus mullocensin*, *Penaeus merguiensis*, *Sphyraena baracuda*, and *Sillago sihama*, *Gazza minuta*, *Terapon jarbua*, *Pseudopleuronectes americanus*, *Moolgarda seheli*, *Pennahia argentata*, *Harpiosquilla raphidea*, *Priacanthus tayenus*, yellow mackerel (*Selaroides leptolepis*), *Lethrinus obsoletus* and *Geres punctatus*. The main fish catch using LACUBA ranged from 10,480g which was dominated by mackerel with a weight of 2,160g and by-catch fish using LACUBA ranged from 6,365g which was dominated by *Pseudopleuronectes americanus* with a weight of 2,805g. Meanwhile, the fish caught by the gill net without using LACUBA only weighed 8,200g consisting of 11 species of fish and 2 species of crustaceans. The fish species caught are male mackerel (*Rastrelliger kanagurta*), female mackerel (*Rastrelliger brachysoma*), *Nemipterus japonicus*, *Upeneus mullocensin*, *Penaeus merguiensis*, *Sphyraena baracuda*, and *Sillago sihama*, *Gazza minuta*, *Terapon jarbua*, *Pseudopleuronectes americanus*, *Moolgarda seheli*, *Pennahia argentata*, *Harpiosquilla raphidea*, *Priacanthus tayenus*, yellow mackerel (*Selaroides leptolepis*), *Lethrinus obsoletus* and *Geres punctatus*. The main catch of fish in the gill net without using LACUBA ranged less than the bycatch of the gill net without LACUBA, weighing 4,030g which was dominated by male mackerel weighing 900g, while the bycatch of fish without using LACUBA was 4,170g which was dominated by *Pseudopleuronectes americanus* weighing 2,210g.

The total catch of 14 fishing trips using or without LACUBA was more dominated by gill nets that used LACUBA, which was around 67% more caught compared to gill nets without LACUBA, which was only around 33% of the total number of fishing trips. Therefore, the use of LACUBA has an impact on the catch of the gill net, because it has a significant influence on the catch.

3.3 Effect of using LACUBA on Gill Net Catches

The results of the research conducted to determine the catch through 14 fishing trips using LACUBA tools are presented in the following table:

Table 3 Total Catch with and without LACUBA

Replay	Weight (g)	
	With LACUBA	Without LACUBA
1	820	740
2	955	300
3	675	550
4	1240	360
5	1270	710
6	1100	610
7	1330	400
8	630	380
9	920	450
10	1330	510
11	1590	450
12	1215	570
13	1950	910
14	1820	1430
Total	16846	8370

In table 3 above, it can be observed that the number of fish caught by the gill net using LACUBA is more than the gill net without the LACUBA treatment. The total weight of the gill net catch using LACUBA was 16,845g while the total weight of the gill net catch without using LACUBA was only 8,370g.

From Table 3 it can also be seen that the total catch of the gill net using LACUBA is more than the gill net without using LACUBA, this is also supported by the results of data analysis using 3 statistical analysis tests ranging from data normality analysis using the Kormogolov Smirnov data normality test with normal distribution (P> 0.05) [13] which is 0.722, so that it can be called this data is normally distributed, after that it is tested again, with a homogeneity test, where the data obtained is homogeneous or has similar properties [14] with a significance value (P> 0.05) with a significance value of 0.240 and the last analysis using the One Way

Annova analysis test with a Complete Randomized Design, getting significant results, where ($P < 0.05$) which is 0.000.
Fish caught using gill nets equipped with LACUBA are generally classified as animals that are attracted to light or positive phototaxis, so the fish will approach the area where the light is located. The presence of LACUBA will invite phytoplankton and zoopalnkton to be present around the light, then invite larger fish to be present because there is food for them, so the process is called the food chain. This is why the use of LACUBA can increase catches, due to the behaviour of fish that like light and forage around light areas.

4. CONCLUSION

The conclusions of this study are as follows; 1) The types of fish caught in the gill net using LACUBA are more when compared without using LACUBA; 2) The use of LACUBA influenced the catch. Further research needs to be done using a larger number of LACUBA so that the proof results are better. In addition, it is also necessary to develop the LACUBA design so that it is more optimal and not easily broken or resistant at a deeper depth.

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