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Relationship of Catching and Oceanographic Parameters of Boat Lift Net (*Bagan pete-pete*) using Mercury Lamp and Led Lamp

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Abstract

Fishing areas can be predicted from oceanographic parameters such as temperature, salinity, turbidity, and current. Nowadays, research on the influence of oceanographic parameters to the catch of fishing gear *bagan pete-pete* (boat lift net) using LED lamps especially in multi-species tropical waters is limited. This study was aimed at analyzing the relationship of catching and oceanographic parameters of *bagan pete-pete* which using both mercury lamps and LED lamps. It was conducted in waters of Barru District of Makassar Strait, South Sulawesi.

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Field observations were conducted from October to November 2012 and April to May 2013 (50 trips). The total weight of catching by using LED lamps was 33.412.00 kg with value of 131.114.500.00 IDR, whereas by using mercury lamp was 54.524.00 kg with value of 176.117.000.00 IDR. The catch of *bagan pete-pete* with mercury lamps was influenced by temperature in a depth 5 meters and turbidity while the catch of *bagan pete-pete* with LED lamps was influenced by the temperature in a depth 5 meters and current in a depth 1 meter. The catch of *bagan pete-pete* by using both mercury lamp and LED lamp is linear to the temperature, means that catching increases when the temperature increases. Mercury lamp is also influenced by turbidity because it has a very limited ability to penetrate into the waters, unlike LED.

Keywords: boat left net; catch; LED lamp; mercury lamp; oceanographic parameters

1. Introduction

Fishing areas can be determined by oceanographic parameters such as temperature, salinity, and turbidity currents. The spread of fish in one place will change according to the changing of environment, and this cause a kind of fish will choose a suitable place to its conditions both in short and long terms [1]. Fishing techniques by using light in Indonesia, especially in Barru District still use mercury lamps that are known have high energy. A better alternative to change it is to use the energy-saving lamp, such as Light Emitting Diode (LED) lamp. LED lamp has been applied in many various fields. Technology of LED grows due to its efficiency, long life, low heat radiation, and shock resistance [1]. The use of LED semiconductor lighting has been recognized as an important way to save energy and protect environment [2].

The research of LED lamps using has been applied in the sub-tropical waters, such as Japan. Application of LEDs to fishing lights for Pacific saury showed that the average catch by using LED lamps and conventional lights were almost similar, reaching 55% electricity savings and fuel consumption [4]. Catching squid by using LED lamps could reduce fuel consumption by up to 47%, but it less stable than fishing by using Metal Halide Lamp (MHL) or LED lamps combined with MHL. There was a possibility of different lighting field around boats between LED lamps and MHL [5].

The research of the influence of oceanographic parameters such as temperature, salinity, turbidity, and currents to catch by using LED lamps especially in boat lift net (bagan pete-petet) with multi-species tropical waters today is still very limited. Research on brightness and current velocity conducted by [3] in boat lift net bagan rambo with mercury lamp revealed that brightness did not have a significant influence on the catch, while the current velocity at a depth of 15 meters was very influential on the catch. The more the current velocity, the smaller the catches. Therefore, it is necessary to do a research of the relationship of catches using both mercury lamp and LED lamps and oceanographic parameters. The aims of this study were: (1) to analyze catches using mercury lamp and LED lamps, (2) to analyze the relationship the catch with hauling time, and (3) to analyze oceanographic parameters that affect the catch of bagan pete-pete using both mercury lamps and LED lamps.

2. Research Method

2.1. Location and Time Research

Operation of bagan pete-pete was conducted in waters Barru District, Makassar Strait, South Sulawesi. Fishing process was done by using two bagan pete-pete at 4° 22'48.7 " to 4° 33'47.8" South Latitude up to 119° 25'05.0 " to 119° 33'42.7" East Longitude. Two bagan pete-pete were operated at a depth of 25 to 50 meters with distance of 3 to 11. 5 nautical miles from shore Barru (Figure 1). Field observations were made during the 50 trips from October to November 2012 and April to May 2013.

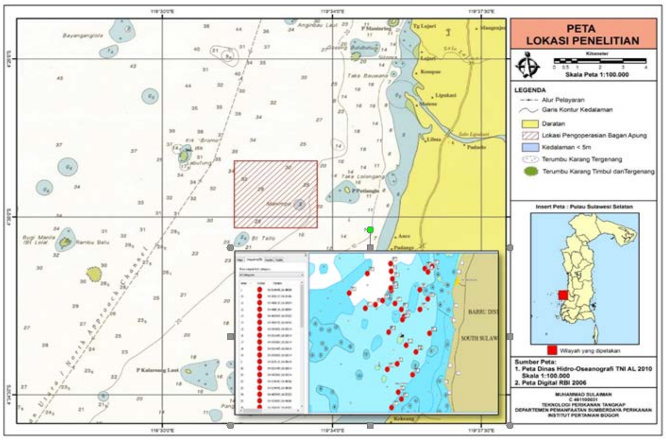

Figure 1: Location *bagan pete-pete* operation during the research

2.2. Method of Data Collecting

2.2.1 Fish catch data collection

Data was collected in three part activities. observing fish species, observing catch weight in kg of the hauling time, and recording fish selling price in IDR.

2.2.2 Observations several oceanographic parameters

Observations of oceanographic parameters were performed to elucidate the interaction of parameters measured. Current velocity was measured by using a current meter after hauling time in the depth of 3 points namely surface, 5 meters and 10 meters.

Temperature and salinity were measured by using cammerer water sampler equipped with a thermometer to determine the temperature and taking water samples at several depths. Salinity was measured with a hand-held refractometer (Atago 0-40 0/00) in the same location, depth and time of which the temperature measured. Water turbidity was measured by using turbidity meter (La Motte 2020i turbid meter).

2.3. Data Analysis

2.3.1. Type, weight and value of the catch

Type of catch was identified and the weight was calculated in kg. After that, the price was valued in IDR based on the observation time (before night, midnight, after night).

2.3.2. The catch result

The following analysis was comparing the caught of using mercury lamp and LED lamps which operated at three different periods namely, before night (between 6 pm to 10 pm), midnight (between 10 pm to 2 am) and after night (between 2 am to 6 am). The differences of catching between using mercury lamp and LED lamps was based on time group and analyzed by using a randomized block design [4] with SPSS ver. 20.

$$Y_{ij} = \mu + \gamma_i + \beta_i + \varepsilon_{ij} \quad (1)$$

Notes:

Y_{ij} = number of catches in intensity to the group i to j

μ = general mean catches

Y_i = effect of treatment intensity to i

β_i = effect of group j

Y_{ij} = experimental error in intensity to the group i to j

i = 1,2

j = 1,2,3

Furthermore, in the Tukey test (W) with formula [4]:

$$W = q\alpha\ (\rho . f_e) S_y \quad (2)$$

Notes:

$q\alpha$ = value table

ρ = number of treatment

f_e = degrees of freedom error

S_y = standard error mean

It assumed that only light intensity was considered to influence, and fishing ground was similar. Oceanographic parameters were also considered similar as the two boat lifnets (bagan pete-pete) were located in the same location.

2.3.3. Oceanographic parameters

Oceanographic data were statistically analyzed using correlation analysis to determine the relationship between oceanographic parameters namely turbidity (X1), current velocity in depth of 1 meters (X2), current velocity in depth of 5 meters (X3), current velocity in depth of 10 meters (X4), temperature in depth of 1 meters (X5), temperature in depth of 5 meters (X6), temperature in depth of 10 meters (X7), salinity in depth of 1 meters (X8), salinity in depth of 5 meters (X9), and in depth of 10 meters (X10) of three depths and the catches (Y) [5]:

$$r = \frac{n\sum X_i Y - (\sum X_i)(\sum X_i)}{\sqrt{\{n\sum X_i^2 - (\sum X_i)^2\}\{\sum Y_i^2 - (\sum Y_i)^2}} \quad (3)$$

It was followed by analysis of variance (F test) to get the best regression model and to determine how much the influence of namely turbidity (X1), current velocity in depth of 1 meters (X2), current velocity in depth of 5 meters (X3), current velocity in depth of 10 meters (X4), temperature in depth of 1 meters (X5), temperature in depth of 5 meters (X6), temperature in depth of 10 meters (X7), salinity in depth of 1 meters (X8), salinity in depth of 5 meters (X9), and in depth of 10 meters (X10) to catch results (Y) by comparing between F-count and F-table.

Regression analysis was used to determine the relationship between the dependent variable of the catch (Y) and independent variables such as namely turbidity (X1), current velocity in depth of 1 meters (X2), current velocity in depth of 5 meters (X3), current velocity in depth of 10 meters (X4), temperature in depth of 1 meters (X5), temperature in depth of 5 meters (X6), temperature in depth of 10 meters (X7), salinity in depth of 1 meters (X8), salinity in depth of 5 meters (X9), and in depth of 10 meters (X10) [6]. All analyses were done with SPSS version 20.

$$Y = b_0 + b_1X_1 + b_2X_2 + b_3X_3 + \cdots . . + b_iX_i + \varepsilon \quad (4)$$

Notes:

$b_1, b_2, \ldots, b_i$ = coefficient of each factor
b_0 = constant
ε = influence residual

3. Results And Discussion

3.1. Research Result

3.1.1. Species, weight and value of the catches

Species of fish caught by fishing gear bagan pete-pete using both mercury lamp and LED lamps (Figure 2) during the research were generally small pelagic fish. The dominant species of fish caught were Hardenberg's anchovy (Stolephorus insularis), Indian anchovy (Stolephorus indicus), Indian scad (Decapterus ruselli), Indian mackerel (Rastrelliger canagurta), Fringescale sardinella (Sardinella fimbriata), Golden ponyfish (Leiognatus aureus) and squid (Loligo sp).

Other groups of fish caught by bagan pete-pete are small fish that could not be identified, Savalai hairtail (Leiognatus aureus), Blackfin barracuda (Sphyraena genie), Goldband fusilier (Scomberoides lysan), Torpedo Scad (Megalaspis cordyla), White-spotted spinefoot (Siganus canaliculatus), Rainbow sardine (Dussumieria acuta), Obtuse barracuda (Sphyraena obtusata), and Goldband fusilier (Pterocaesio chrysozona). These fish groups caught were not dominant during the overall study, although sometimes there was a dominant caught. Study proposed by **[7]** and **[8]** shows similar results of fish caught by bagan rambo (a boat lift net which is larger than bagan pete-pete) are anchovy, Indian mackerel, Indian scad, Fringescale sardinella and squid. Total weight of catch using LED lamps in this study was 33.674 kg with value of 129.063.500 IDR whereas by using mercury lamp was 54.429 kg with value of 174.554.000 IDR. The visible differences in the weight and value of the catch might be due to the number and capacity of electricity used.

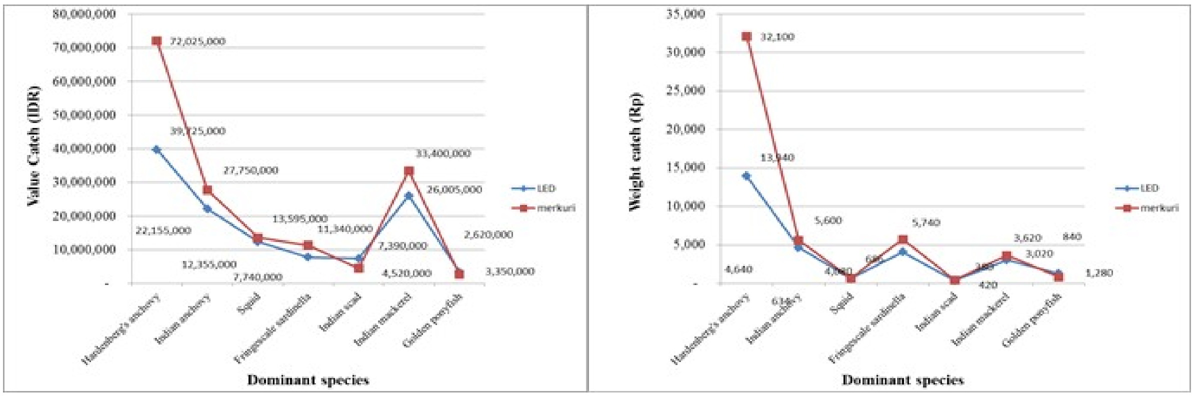

Figure 2: Weight (kg) and value (USD) dominant fish caught during the study

3.1.2. Relationship the catch and hauling time

Analysis of relationship between catch weight (kg) and hauling time during the study showed that the lowest catch using mercury lamp occurred at midnight and the highest catch occurred after midnight. Analysis of the catch value (IDR) during the study also showed that both lowest and highest catch values using mercury lamp occurred at midnight (Figure 3). The average weight of catches from the highest to the lowest one was before midnight, midnight and after midnight respectively. The highest average value of the catch also occurred before midnight.

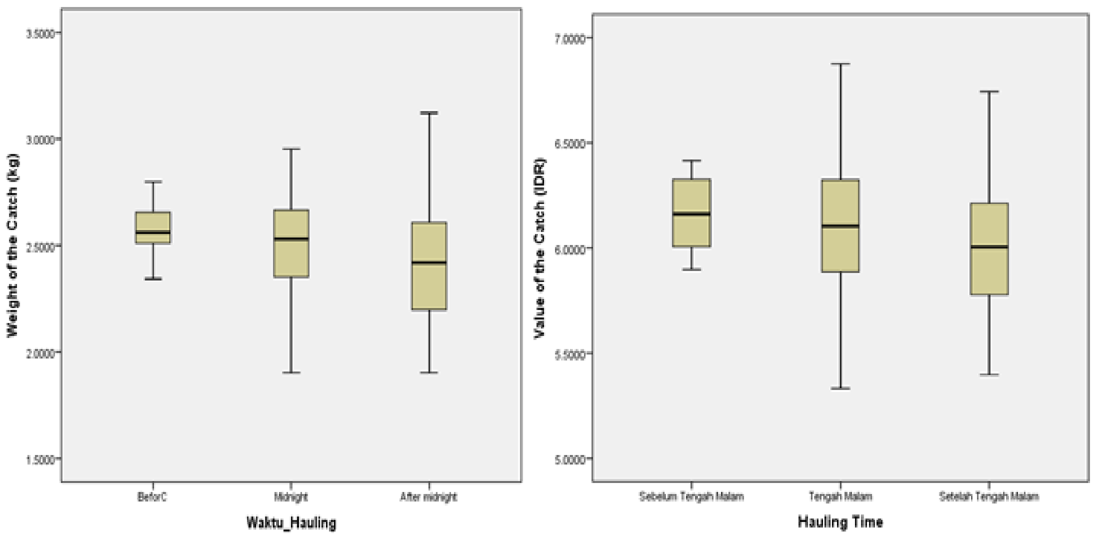

Figure 3: Distribution of the weight (kg) and the value (IDR) of the catch mercury lamps to do with the time hauling

Analysis of relationship between the catch weight (kg) and the hauling time during the study (Figure 4) shows that the lowest and the highest catch using LED lamps occurred at midnight. Analysis of the catch value (IDR) during the study (Figure 4) also shows that the lowest catch value using LED lamps occurred in midnight and the highest catch value occurred after midnight. The average weight of catches from the highest to the lowest one was before midnight, midnight and after midnight respectively. The highest average value of the catch in IDR also occurred before midnight, after midnight and midnight.

High average catches before midnight might be generally caused by the domination of positive phototaxis fish caught that came to lighting area because the fish likes approaching the light, not for searching food. The positive phototaxis fish was anchovies, Fringescale sardinella and Indian mackerel.

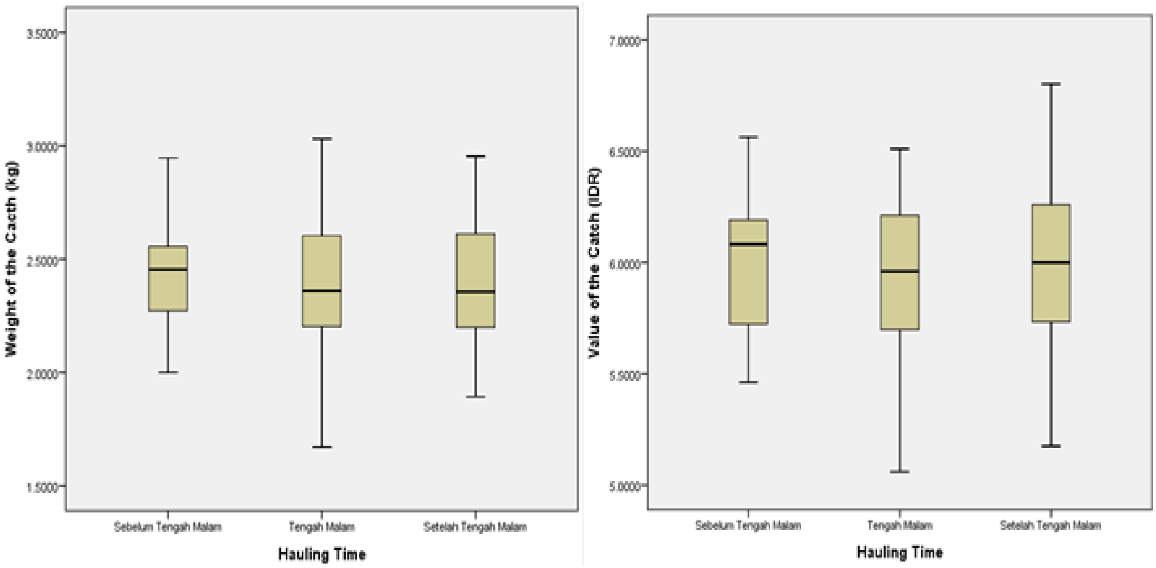

Figure 4: Distribution of the weight (kg) and the value (IDR) of the catch LED lamps to do with the time hauling

3.1.3. Relationship between the catches and oceanographic parameters

Oceanographic parameters are parameters that greatly affect the catch. The analysis results of oceanographic parameters to catch using mercury lamp indicated that temperature at a depth of 5 meters and turbidity affected the weight of the catch. The results of further analysis to determine the oceanographic parameters which influenced most on the catch by using SPSS version 20 shows that the correlation was 0.660 (Table 1) which means that the relationship between the two variables namely temperature and turbidity in depth of 5 meters was in the strong category. The value of R2 or determination coefficient obtained was 43.6%, which can be interpreted that the temperature in depth of 5 meters and turbidity as independent variables have the contribution effect of 43.6% to the weight of catches using mercury lamp and the rest of 57.4% are affected by other oceanographic parameters.

Table 1: Summary of oceanography parameters model prediction toward the weight of catch with mercury lamps

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.588[a]	.346	.329	190.45766	.346	20.118	1	38	.000
2	.660[b]	.436	.406	179.23634	.090	5.907	1	37	.020

a. Predictors: (Constant), Temperature at a depth of 5 meters

b. Predictors: (Constant), Temperature at a depth of 5 meters, Turbidity

Based on F-test or test of the significance value (Sig), the value of Sig was 0.00 which was less than 0.05 (significant criterion), thus the regression model based on research data was significant which means that the linear regression models meet the criteria of linearity (Table 2).

Regression model equations obtained based on Table 2 were:

Equation 1--- Y = -3546.281+ 139.586 X1 (Temperature at a depth of 5 meters)

Equation 2--- Y = -3399.175+ 138.515 X1 () -205.174 X2 (Temperature at a depth of 5 meters and Turbidity)

Table 2: Coefficient of oceanography parameters towards the weight of catch with mercury lamps

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
	B	Std. Error	Beta		
1. (Constant)	-3546.281	913.503		-3.882	.000
Temperature 5 meters	139.586	31.121	.588	4.485	.000
2. (Constant)	-3399.175	861.810		-3.944	.000
Temperature 5 meters	138.515	29.291	.584	4.729	.000
Turbidity	-205.174	84.419	-.300	-2.430	.020

a. Dependent Variable: The weight of catch with mercury lamps

The analysis results predicted that the oceanographic parameters which affect the weight of the catch using LED lamps were temperature at a depth of 5 meters and current at a depth of 1 meter. Result of correlation analysis was 0.750 (Table 3) which can be interpreted that the relationship between the two variables namely temperature at a depth of 5 meters and current at a depth of 1 meter was in the strong category. R2 value or determination coefficient obtained was 56.2%, which can be interpreted that the temperature at a depth of 5 meters and current at a depth of 1 meter as independent variables contributed influence of 56.2% to the weight of catches using mercury lamp and other oceanographic parameters contributed influence of 44.8 %.

Table 3: Summary of oceanography parameters model prediction toward the weight of catch with LED lamps

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.658a	.433	.419	195.77025	.433	31.351	1	41	.000
2	.750b	.562	.540	174.19163	.129	11.787	1	40	.001

a. Predictors: (Constant), Temperature at a depth of 5

b. Predictors: (Constant), Temperature at a depth of 5, current at a depth of 1 meter

Based on F test or test of significance value (Sig) at table 4, the Sig value obtained was 0.00 or less than 0.05 (significant criterion). It means that the regression model based on research data was significant, in other words, the linear regression models meet the criteria of linearity.

Regression model equations obtained based on Table 4 were:

Equation 1--- Y = -4869.593+ 183 359 X1 (Temperature at a depth of 5 meters)

Equation 2--- Y = -5335.572+ 202 350 X1- 616 300 X2 (Temperature at a depth of 5 meters and current at a depth of 1 meter).

Equation 1 shows that each additional temperature at a depth of 5 meters will increase the catch. Equation 2 shows that the catch will increase if the temperature rises at a depth of 5 meters and the current falls down at a depth of 1 meter.

Table 4: Coefficient of oceanography parameters towards the weight of catch with LED lamps

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-4869.593	960.498		-5.070	.000
	Temperature 5 meters	183.359	32.747	.658	5.599	.000
2	(Constant)	-5335.572	865.339		-6.166	.000
	Temperature 5 meters	202.350	29.658	.726	6.823	.000
	current 1 meter	-616.300	179.509	-.366	-3.433	.001

a. Dependent Variable: The weight of catch with LED lamp

3.2. Research Discussion

The catch during the study showed that weight of catches using mercury lamps was higher or more significant than catching by using LED lamps. It is because the intensity of the mercury lamps used was higher than LED lamps. The high intensity of mercury lamp was due to the number of lamps and watts used even though the mercury lamps had lower penetrating power than LED lamps.

Unlike the case with the weight, the value (IDR) of catches showed that the value of catch using mercury lamps was not significant or not significantly different with LED lamps. The analysis showed that the cause of insignificant value of catches due to the high value of the catch of white anchovy fish (*Stolephorus indicus*) on catches using LED lamps.

One of the causes why the catch using LED lamps got the high amount of white anchovy fish was light. The light was very influential because the catch using mercury lamp was influenced by temperature at a depth of 5 meters and turbidity, while the catch using LED lamp was influenced by temperature and current at a depth of 5 meters. This indicated that the mercury lamp had a very limited ability to penetrate into the waters, but the LED lamp was more focused so that it could penetrate into deeper waters. This is in accordance with the opinion of [9] that the LED lamps have the highest light illumination and efficiency among light sources. LED lamps emit directional light while others emit light in all directions. Meanwhile, white anchovy fish which is more economical is caught around the beach or 3 to 4 miles from the mainland because the waters have higher level of turbidity.

The results of this study also indicate that catches using mercury lamp and LED lamps are also influenced by temperature, where the temperature and the catches are linear. The catch will increase if the temperature also increases. This is in accordance with the opinion [10], the temperature can affect the spread of fish due to: (1) as a regulator of metabolic processes which may affect demand for food and the level of acceptance and growth rate, (2) as a regulator of body movement activities or swimming speed and (3) as a nerve stimulator.

The influence of current on mercury lamp and LED lamps is significant. It means that current also affects the number of catches. The influence of current has a big relationship with the operation of fishing gear because the hauling time with a strong current makes fishing net not appropriate under the chart although the anchor rope has been stretched. Even bagan rambo, the larger chart larger than bagan pete-pete cannot be operated at current velocity of 0.34 m/sec [7], as well as the bagan pete-pete.

The catch using mercury lamp was influenced by turbidity however the catch using LED lamps was not influenced by turbidity. Analysis of the catch was different from the statement of [3] which stated that brightness did not influence the catches. The difference occurred because bagan rambo used more lamps and more watts which could penetrate into deeper and farther waters. Bagan pete-pete which had smaller size and used less lamps caused turbidity parameter that influenced the catch. Bagan pete-pete using LED lamps was not influenced by turbidity because LED lamps could penetrate deeper and farther waters.

4. Conclusions and Suggestion

4.1. Conclusions

The total weight of the catches using LED lamps in this research is 33.412.00 kg with a value of 131.114.500.00 IDR whereas the total weight of the catches using mercury lamp is 54.524.00 kg with a value of 176.117.000.00

IDR. Relationship between the catch weight (kg) and the hauling time of mercury lamps indicate that the use of low catches occurred in the middle of the night and the highest catch occurred after midnight whereas the catch value (IDR) indicates that both the highest and lowest and the catch rate in the middle of the night, with an average weight and value of the catch from the highest to the and lowest was before midnight, midnight and after midnight. Relationship between the catch weight (kg) and the hauling time of LED lamps indicate that the lowest and the highest catch values occurred at midnight, whereas the catch value (IDR) indicate that the lowest catch value occurred during the midnight and the highest catch value (IDR) occurred after midnight, with an average weight and value of catches from the highest to the lowest one was before midnight, midnight and after midnight. The number of catches by using mercury lamp is affected by temperature at a depth of 5 meters and turbidity by 43.6% while the number of catches using LED lamp is influenced by temperature at a depth of 5 meters and current at a depth of 1 meter by 56.2%.

4.2. Suggestion

Development of fishing gear of bagan pete-pete using LED lamps still requires further research on the abundance of plankton and the productivity of waters around lighting. However, further research is needed to study the wider grouping objects and predictive variables that have continuous time series in order to obtain a clearer influence of oceanographic parameters to catches.

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