The Analysis of the Effect of Environmental Factors on Fish Species in Maro River, Merauke Regency

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ABSTRACT

This study aimed to determine the fish species caught and analyze the effect of environmental factors on the presence of fish in Maro Estuary. The data were collected by identifying the caught fish to determine their species. While the measurement of environmental parameter data was done by directly measuring the temperature, salinity and pH of water. Furthermore, the data were analyzed using a regression model to determine the effect of oceanographic factors on the catches. The results showed that the species of fish caught were *Polydactylus plebeius*, *Mugil cephalus*, *Argyrosomus amoyensis*, *Cinetodus froggatti*, *Lates calcarife*, *Eleutheronema tetradactylum* and *Pampus argenteus*. The environmental factors that influence the presence of fish in the waters of the Maro Estuary in Merauke Regency were salinity and pH of water.

KEYWORDS: *Maro estuary, fish species, environmental parameter.*

INTRODUCTION

Geographically, Merauke Regency is in a strategic area which is located in the southern part of the island of Papua and facing directly to the Arafura Sea and is influenced by the pattern of current movement that moves from the northern part of the Arafura Sea at certain season. In addition, a large land area with dense forests and mangrove ecosystems that are still well organized and well maintained is a potential for supplying nutrients into the waters [1].

The potential of the fisheries sector in Merauke Regency is promising both in marine and freshwater fisheries. The data from the government of Merauke Regency showed that the fish production for local consumption by species in 2013 has a total of 6,192,824 kg with a production valued IDR 161,376,50,000 [2].

The characteristics of the organisms that inhabit the Maro Estuary are very specific and are typical to study. The underwater conditions are mostly sedimentary mud and sand that cause several environmental factors also has an effect on the life of organisms within. At the front side of the Maro Estuary, the existence of aquatic biota in the area are very unique, this is due to the bottom of the waters which is only in the form of desert and mud, so that it is thought that the existence of these biota is caused by abundant food given the increasing run-off from the mainland which supplies nutrients to the sea or by other environmental factors [1].

There have been some studies conducted related to the composition of the fish species in catches, such as studied [3] in the Musi River Downstream in April, with a total of 67 fishes found with a total of 24 species and in June with a total of 106 fishes found with a total of 25 species. Another study [4] that caught 17 species of fish in Maro River, Gudang Arang area, Maro Village, Merauke Regency, namely: *Kurtus gulliveri, Eleutheronema tetradactylum, Polydactylus plebeius, Cinetodus crassilabris,Cinetodus froggatti, Argyrosomus amoyensis, Mugil cephalus, Megalops cyprinoides, Thryssa scratchleyi, Lebtobrama sp, Lates calcarifer, Marilyna meraukensis, Scomberomorus commerson, Nibea squamosal, Rhinoptera javanica, Harpadon microchir, Datnioides Campbelli.* However, there were no data shown from the study on fish species in Maro Estuary related to environmental factors using a regression model.

To answer this problem, it is necessary to conduct a study on the composition of fish species and the influence of environmental factors on catches in the Maro Estuary, Merauke Regency, which later provides a justification on the species and environmental factors that have an effect on fish in Maro Estuary, Merauke Regency.

METHODS

This study was conducted in Maro Estuary for 3 months, starting from October – December 2015. While the field sample analysis was carried out in the laboratory of the Department of Aquatic Resources Management, Faculty of Agriculture of Musamus University [4]. The selection of research implementation at the Maro estuary was due to

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the fact that the area is an area with environmental conditions that fluctuate annually and the fishing base in the Maro River is carried out by local fishermen in Merauke Regency.

Figure 1. Map of research location

In this study, tools and materials used were: gill net, fishing boat, *thermometer*, *refractometer*, pH meter, fish identification book, camera, cool boxe, SPSS software, scale, fish samples, tissue papers and stationery. This study examined the composition of species and the influence of environmental factors on the presence of fish in the waters of the Maro Estuary. To answer these problems, this study used an approach by analyzing environmental factors (physical and chemical) on the catches. Furthermore, the data were analyzed using a regression test where the X variables are the environmental factors (temperature, salinity and pH) and the Y variable is the catches. The results of data analysis of the two variables were used to predict the effect of the relationship between environmental factors on the existence of fish in the Muro Estuary. The data were collected from direct measurements on the field of fishing operations including the species of the catches. The fishing gear used was *gill net*. The measurement of physical factors was conducted using a thermometer, refractometer and pH meter for measuring temperature, salinity, and pH, respectively.

The data were analyzed using regression model by grouping field data into two variables, Y as catches and X as environmental factors. Regression analysis was used to determine the dependent variable where Y (catch) on the measurement results of the independent variables of temperature (x1), salinity (x2) and pH (x3). Furthermore, the data were processed using SPSS (*Statistical Product and Service Solution*) software.

RESULTS AND DISCUSSION

A. The Composition of Fish Catches

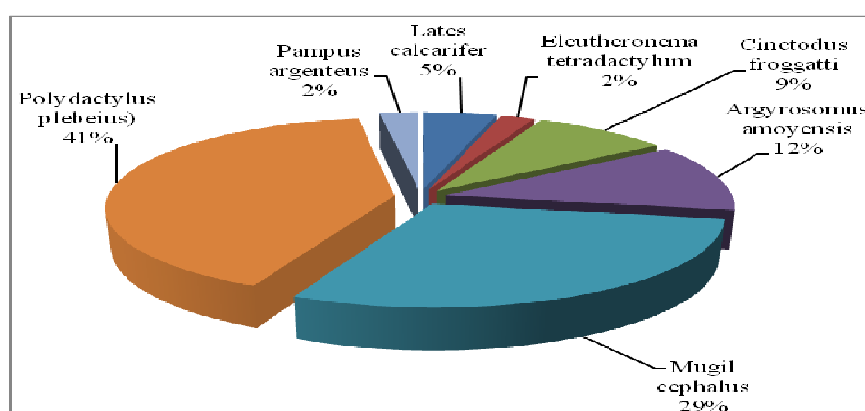The composition of the fish catches in the study conducted for 3 months can be seen in Figure 2 below:

Figure 2. The percentage of the composition of fish catches

As seen in Figure 2 above, it is known that the highest percentage in the composition of fish catches in the Maro Estuary is *Polydactylus plebeius*, with 41 %, followed by *Mugil cephalus*, with 29 %, *Argyrosomus amoyensis*, with 12 %, *Cinetodus froggatti* with 9%, *Lates calcarifer*, with 5%, *Eleutheronema tetradactylum*, with 2 % and *Pampus argenteus*, with 2 %.

Based on the 7 species of fish found, according to the results of previous study, [5] the number was lower allegedly due to prolonged drought resulting in changes in environmental factors so that catches decreased in numbers and fishermen were rarely fishing on that month. The highest percentage was *Polydactylus plebeius*. According to the results of the study, it was allegedly caused by the ability or high level of adaptation. *Polydactylus plebeius* can live in estuary areas with changing environmental conditions such as salt levels which at a certain time when there is a tide, the mass of water will move towards the inner river to carry the mass of salt water and other environmental factors. *Polydactylus plebeius* habitats are mainly found in waters that are still affected by fresh water discharges and are found in river mouths with shallow water depths. With a percentage of 29%, the *Mugil cephalus* is thought to be caused by the ability of this type of fish to be able to tolerate fluctuating salt levels in the estuary area. The type of fish of *Mugil cephalus* is indeed a type of explorer fish that can enter into rivers or swamps with low salinity or visit river mouths with salinity which tends to be high due to the ability to adapt to environmental factors. [6] *Mugil cephalus* species have a percentage of life 80% by which they can live in fresh waters even though some species of fish can live 100% in fresh water because they are tolerant to low salinity and at high tide they often go up to rivers in which the waters tend to be fresh. *Argyrosomus amoyensis* can indeed adapt to waters with high environmental factor changes such as in river mouths. They can live and have habitats on shallow beaches, estuaries or in rivers.

The *Lates calcarifer*, *Eleutheronema tetradactylum* and *Pampus argenteus* were found with low percentage due to environmental conditions that tend to be inconsistent with the optimum conditions, so that they were found with a low percentage or also caused by the abundance of the fish in which these fish species migrate frequently in the waters. The discovery of these fish species at the Maro Estuary is thought to be caused by the estuary waters being the entry point for fish that have a tolerance level on environmental factors. [7] that environmental parameters determine the presence of *Eleutheronema tetradactylum* fish in the waters becomes the fishing destination. [6] the species of brackish water fish are very diverse because the fish in the area come from the sea and also the rivers that have tolerance to moderate salt levels. Furthermore, [8] estuary is the entrance/exit for fish from coastal waters into/out from a river body.

From the composition of the catches, it is suspected that the existence of fish in the area of the Maro Estuary is a type of migratory fish which in certain seasons enter estuary waters and in certain seasons will come out then move to move to find the suitability of the desired environmental factors. [9] the fish in estuary waters in certain months, both for freshwater and seawater fish. Both estuary and migratory fish are very tolerant towards changes in salinity and other factors such as temperature, pH and so on.

B. The Effect of Environmental Factors on the Presence of Fish

The environmental factors analyzed in this study were the physical (temperature) and chemical (salinity and pH) factors.

1. Temperature

One of the environmental parameters analyzed to justify the effect of environmental factors on catches in the Maro Estuary was temperature. Figure 3, shows the relationship between temperature and fish catches in Maro Estuary.
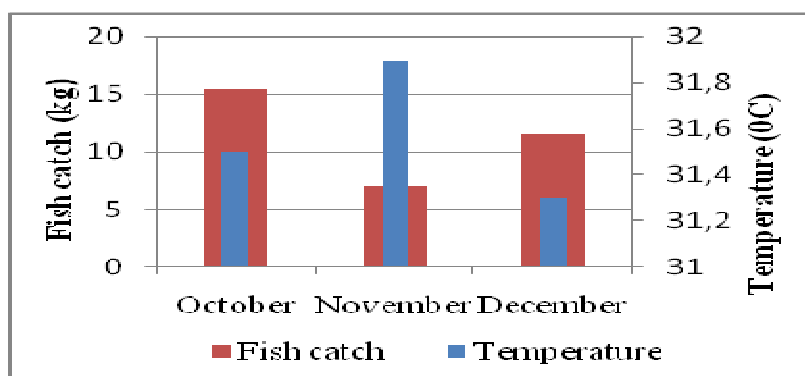

Figure 3. The relationship between temperature and fish catches

As shown in Figure 3, it can be seen that the average temperature in October was 31.5 °C with an average catch of 15.5 kg and the average temperature in November was 31.9 °C with an average catch of 7 kg. The average temperature in December was 31.3 °C with an average catch of 11.6 kg. This shows that, in October with an average temperature of 31.5 °C and an average catch of 15.5 kg, and in November with an average temperature of 31.9 °C, there was an increase of 0.4 °C in temperature from the previous month then the catch also decreased by an average of 7 kg. Then, in December with a temperature of 31.3 °C or a decrease of 0.6 °C from the temperature in November, there was an increase in catch with an average of 11.6 kg.

In relation to environmental factors, namely temperature, the increase in temperature in the period of data collection was caused by changes in the season, namely the dry season which was longer than usual, as in November and December, which should have been marked by the incentive to start the rain but this has not happened, so it was suspected that the increase in the temperature of the water was caused by the intense sunlight that illuminated the body of water so that the temperature of the waters in the Maro Estuary increased.

To determine the effect of environmental factors, namely temperature on catches, a statistical test was conducted using the T test. The test results showed a significant value of 0.066 and the value was greater than the probability value of 0.05 (0.066 > 0.05), then H1 is rejected and Ho is accepted. Thus, the temperature has no effect on fish catches in the Maro Estuary. It was caused by the inability to achieve optimum conditions, namely temperature as an environmental parameter that determines the existence of fish in waters as a fishing destination. According to the results, the average temperature was in the range of 31.3 – 31.9 °C and the temperature is higher than the ideal value for fish in the estuary of the river. [9] who conducted a study at Pami Estuary in Manokwari, shows that the temperature was thought to have an effect on the composition of fish species at 28 – 30 °C. From this comparison, it is shown that if there is an increase in temperature about 1.3 °C, the response would be different to fish in the waters to move to find more suitable environmental conditions and this would have an effect on the catches. [11] the fish will live well in temperatures ranging from 25–29 °C, while the minimum temperature limit ranges from 16–17 °C. Extreme temperature changes will have adverse effect on fish resulting in stress and various other physiological disorders. If the water temperature decreases, it will result in low oxygen uptake caused by a decrease in heart rate. [12] temperature also has an effect on the growth rate of fish. The low temperature will inhibit he growth rate of fish as a result of low temperatures which disrupt the metabolic processes in the fish's body where the metabolic process will take place slowly. The temperature must be suitable with an optimum range of 25-30 °C. High water temperature causes fish to move actively and metabolism increases and oxygen demand increases but oxygen availability decreases, causing fish to be deprived of oxygen in the blood resulting in stress.

2. Salinity

One factor that is thought to influence the presence of fish in the Maro Estuary is salinity. To see the relationship between salinity and fish catches, it can be seen in Figure 4 below.
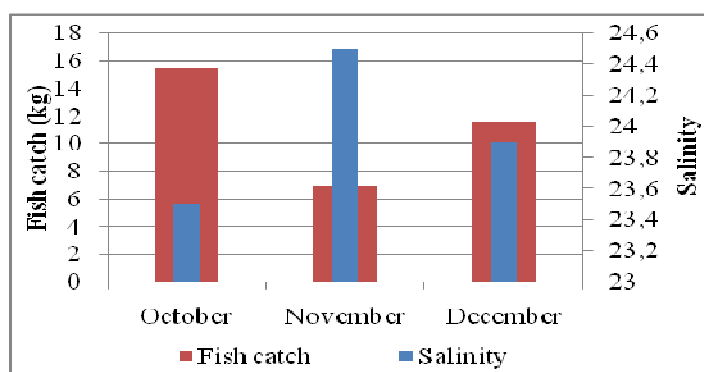

Figure 4. The Relationship between salinity and fish catches

As shown in Figure 4, it is known that the average salinity in October was 23.5 ppt with an average catch of 15.5 kg. In November, the average salinity was 24.5 ppt with an average catch of 7 kg, and in December the average salinity was 23.9 ppt with an average catch of 11.6 kg. From the data, it shows that in October – December, the salinity that dominates the Maro River Estuary is coastal salinity with a salinity of less than 32 ppt. [13] salinity less than 32.0 ppt is coastal water. The low salinity in the Maro Estuary was caused by the still high water debit of the Maro River entering the estuary, although in that month was marked by the dry season, but the water intensity was

still high and carried fresh water mass resulting in dilution and this was thought to result in a decrease in salinity value.

To determine the effect of environmental factors, namely salinity, on catches, a statistical test was conducted. The T test results showed a significant value of 0.001. This significant value is lower than the probability value of 0.05, that is $0.001 < 0.05$, then H1 is accepted and H0 is rejected, thus, salinity has an effect on fish catches in the Maro Estuary.

From the results of statistical tests the effect of salinity was caused by the achievement of optimum conditions for fish in the waters of the Maro Estuary which supported their presence in the waters. From the average data on salinity, it shows that the average salinity was 23.5 - 24.5 ppt. The value is still suitable for tolerable salinity for fish that live in river mouths. [10] the salinity of 18-27 ppt is thought to have an effect on the composition of fish species. The decrease in salinity in the waters will change the composition and dynamics of the organism's population. The response of organisms to salinity is different for each species.

3. Acidity (pH)

To find out the relationship between pH and fish catches in relation to the effect of environmental factors on the existence of fish, it can be seen in Figure 5 below.
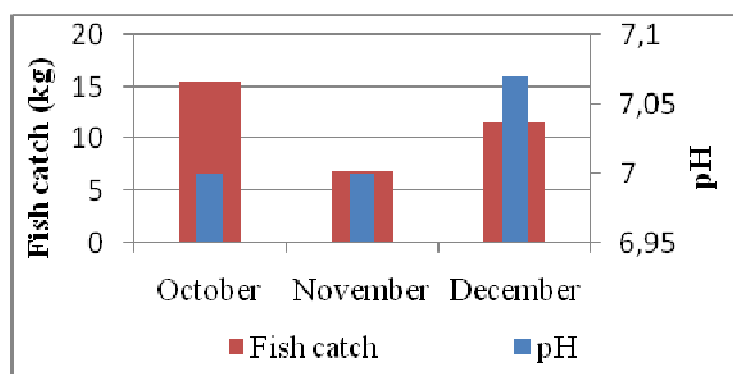

Figure 5. The Relationship between pH and fish catches

In Figure 5, it can be seen that the average pH in October was 7 with an average catch of 15.5 kg, in November, the average pH was 7 with an average catch of 7 kg, and in December the average pH was 7.07 with an average catch of 11.6 kg. According to these data, the pH in October – December wasin the normal pH range and supported the existence of living organisms within. The pH condition at the normal range is thought to be caused by the confluence of water from the river with slightly acidic conditions but when it enters the river mouth as it will mix with sea water in the river mouth as a strong base, resulting in pH levels in the normal direction.

The T test results to determine the effect of environmental factors, namely pH, on the catches, showed a significant value of 0.000. This significant value was lower than the probability value of 0.05 $(0.000 < 0.05)$, then H1 is accepted and H0 is rejected. Thus, pH has an effect on the catches in the Maro Estuary.

From the results of statistical tests the effect of pH was caused by the achievement of optimum conditions for organisms in the waters. Thus, the effect of pH was caused by pH value in accordance with field data with an average value of 7 - 7.07 and was referred to as normal pH. [9] that a pH value ranging 6-7 is thought to have an effect on the composition of the species of fish caught at the Pami Estuary in Manokwari.

Based on the results of statistical tests of all variables, namely temperature, salinity and pH, it is known that the relationship value is 0.784. This value can be interpreted that the relationship between the two research variables on the correlation is very strong. [14] the correlation with a value of 0.75-1 is categorized as strong. Whereas R *square* or coefficient of determination which shows how good the regression model is formed by the interaction between the independent and dependent variables. The value of R *square* obtained was 0.615 and the so-called coefficient of determination means that the independent variables such as temperature, salinity and pH (X) have a contribution of 61.5% to the Y variable, namely the catches, while the rest can be explained by other factors than the X variables.

Basically, the value of R *square* is in the range of 0-1 with the sense that the smaller the number of R *square*, the weaker the influence of the two variables. From the results of the R *square* above, it is shown that the contribution of variable X is 61.5% and given that this study was conducted in nature with various variables that were difficult to control and manage such as season, time of fishing, number of trips and various other factors, then the value is considered capable of explaining the effect of the two variables namely the X variables (temperature, salinity, pH) on Y variable (catches).

While the regression equation of statistical test results produces a formulation model for all variables such as temperature, salinity, and pH, as follows:

$$Y = b0 + b_1X_1 + b_2X_2 + b_3X_3$$
$$Y = 0,922 + 0,526X_1 + 1,380X_2 + 8,094X_3$$

Furthermore, the results of the analysis using the analysis of variance or F test obtained the F hit of 14,535 with a significance level of 0,000. Since the probability of 0,000 is still below 0.05, it means that this regression model can be used to predict fish catches in the Maro Estuary. Thus, all independent variables, namely temperature, salinity, and pH, have an effect on the dependent variable, namely catches.

CONCLUSIONS

Based on the results, it can be concluded as follows:
1. The composition of fish catch species in the Maro Estuary in October - December 2015 consisted of *Polydactylus plebeius*, *Mugil cephalus*, *Argyrosomus amoyensis*, *Cinetodus froggatti*, *Lates calcarifer*, *Eleutheronema tetradactylum* and *Pampus argenteus*.
2. The environmental factors that have an effect and support the existence of fish in Maro Estuary were salinity and pH.

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