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# The Correlation between Mangrove and the Increasing Capture Fisheries and Sea Farming Products in Coastal Waters (The Case Study in Sinjai Regency Coastal Waters)

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***Abstract:*** *The study is carried out in Sinjai Regency coastal waters. The study aims to analyze correlation and regression between mangrove ecosystem width gain and fishing and sea farming rising catch in Sinjai Regency coastal waters involving: (1) fishing catch, (2) sea farming product, (3) milkfish catch, and (4) shrimp catch. The findings found the coastal fishing and sea farming product as follows: (1) capture fisheries products correlate positively 0.886 with value $R^2$ = 0.979, and it forms regression equation Y=19037+4.755X, (2) sea farming products correlate positively 0.981 with value $R^2$ = 0.959, and it forms regression equation Y=10201-1.125X, (3) milkfish catch products correlate positively 0.756 with value $R^2$ = 0.555, and it forms regression equation Y=2E+06-2.216X, and (4) shrimp catch products correlate positively 0.656with value $R^2$ = 0.444, and it forms regression equation Y=39445-4.917X.*

***Keywords:*** *Correlation of mangrove, capture fisheries and sea farming products*.

## I. Introduction

### 1.1. Background of the Study

Mangrove ecosystem belongs to one of coastal ecosystem having use for coastal and surrounding community welfare escalation if it is managed in optimal and continuous ways. Mangrove ecosystem is the primary producer of nutrients for both internal and external mangrove ecosystem. Therefore, mangrove ecosystem has various potential power to increase fisheries products from both capture fisheries and aquaculture, including: fish catch, milkfish catch and shrimp catch, estuarine pond fisheries and sea farming in coastal areas[1].

Mangrove ecosystem as the primary producer of nutrients for coastal and surrounding waters shall be protected from natural or human activity destruction. One of mangrove ecosystem management models to make the mangrove optimal and continues is silvofishery model. The model combines utilization and preservation aspects in order to ensure ecological and economic sustainability. In social aspect, social welfare increases as the effect of mangrove ecosystem maintenance, and it will directly affect fishing and sea farming catches from coastal waters as stated that[2]:

Mangrove ecosystem functions as not only the primary producer of nutrients for coastal waters, but also has several ecological functions; it is a place where milkfish and shrimp are foraging, growing up and sheltering from predators. Mangrove ecosystem also functions as the center of biodiversity for freshwater, brackishwater and marine organisms. Even if the ecosystem is dominated by brackishwater organisms, it is also frequently inhabited by freshwater and marine organisms both caused by their life cycle and seasonal factors[3].

Some previous findings[4] and[5] state that the presence of mangrove ecosystem in coastal areas can not only increase fish farmer and fisherman income from fishing and coastal sea farming activities, but also public opportunity to have fresh air and life. The purity of environment is protected when it is protected from sea breeze, whirlwind, abrasion and salt water intrusion to the land. Steadily, coastal communities can utilize ground water from their well for daily needs.

### 1.2. Research Objectives

The study aims to analyze correlation of mangrove ecosystem width gain and coastal fisheries products including: (1) fishing catch, (2) sea farming products, (3) milkfish catch, and (4) shrimp catch.

## II. Research Method

### 2.1.Research Time and Site

The study takes place for four months from July to December, 2014. The research sites are in North Sinjai, West Sinjai and Pulau-pulau Sembilan Districts, Sinjai Regency.

**2.2. The Areas of Research**

The areas of research are in coastal areas of Sinjai Regency by selecting three coastal districts: North Sinjai District, West Sinjai District and Pulau-pulau Sembilan District in Sinjai Regency. This location selection is based on a consideration that the three locations can represent characteristic of coastal areas in Sinjai Regency.

**1.3. Data Source**

Data sources used in the study are primary data and secondary data. Primary data covers characteristic data on fisherman and fish farmer. Secondary data includes data from fishing catch quantity, sea farming products, milkfish fishing catch, shrimp fishing catch. General overview of Sinjai Regency coastal waters is collected from references like previous researches and Central Bureau of Statistics workbook of Sinjai Regency.

**2.4. Data Collection Technique**

Primary data collection technique is carried out by direct interview with fisherman and fish farmer. Determination of respondents is done by selecting them on purpose based on their involvement to the required data. Secondary data is collected by utilizing various references from the previous researches and the reports published by district office, department of fisheries and the Central Statistics Body.

**2.5. Data Analysis**

Data analysis applied in this study are (1) analyzing correlation between mangrove ecosystem width gain and capture fisheries products gain in coastal waters and sea farming in coastal waters, and (2) analyzing regression between mangrove ecosystem width gain and capture fisheries and coastal sea farming products by applying equation 1 and 2 below:

**2.5.1. Correlation Analysis**

To analyze the correlation between mangrove ecosystem width gain and capture fisheries and coastal sea farming products escalation, it uses equation [6] as follows:

$$r = \frac{\sum(x - \bar{x}) - (y - \bar{y})}{\sqrt{\sum(x - \bar{x})^2 \sqrt{\sum(y - \bar{y})^2}}} \quad \text{..... 1}$$

**2.5.2. Regression Analysis**

Furthermore, to analyze the value of regression equation between mangrove ecosystem width gain and capture fisheries and sea farming products from coastal waters, it uses the equation[6] as follows:

$$Y = a + bx \quad \text{..... 2}$$

Information:
Y = Fishery production
X = Mangrove ecosystem area

## III. Discussion

**3.1. General Overview**

Sinjai Regency is on the Southern Peninsula in the western part of South Sulawesi Province with Balangnipa as the provincial capital city. It has south latitude of $5^{o}$ 19'30'' to $5^{o}$ 36' 47'' and longitude east of $119^{o}$ 48' 30'' to $120^{o}$ 20' 00''. Sinjai Regency borders on Bone Regency at north side, Bone bay at east side, Bulukumba Regency at south side, and Bulukumba and Gowa regencies at west side.

The width of Sinjai Regency is 819.96 $km^2$ (1.29%) of the total width of South Sulawesi Province. Population census 2010 in Sinjai Regency counted 198,111 people consisting of 92,202 males and 102,909 females, then sex ratio is 46.54%: 53.46%. According to the administration, Sinjai Regency is divided into 9 (nine) districts: (1) West Sinjai, (2) Sinjai Borong, (3) South Sinjai, (4) East Sinjai, (5) Central Sinjai, (6) North Sinjai, (7) Pulau Pulau Sembilan, (8) Bulupoddo, and (9) Tellulimpoe. There are 75 areas which are administratively designated as sub-districts and villages, and nine among them are coastal villages.

**3.2. The Potential of Coastal Waters**

Coastline of Sinjai Regency is around 31 km; 17 km outlines the mainland and another 14 km outlines the island. Along the 17 km coastline on the mainland, it has potential brackishwater pond by 1,030 ha and

mangrove ecosystem by 1,356.50 ha. The potential resources are scattered to all nine coastal sub-districts and villages. The potential brackishwater ponds are not managed well yet. Until 2011, the ponds are still 716.50 ha utilized, or it is around 69.56% of the total existing potential ponds [7]. In addition to the existence of mangrove ecosystem, coastal waters of Sinjai Regency has five big rivers. The rivers have double advantages for the brackishwater pond as the nutrients carrier and source of fresh water.

Other than the potential of brackishwater fish farming throughout 17 km coastal waters in Sinjai Regency, the regency has potential of sea farming throughout 14 km coastal waters in Pulau-pulau Sembilan. The nine small islands have a prospect for sea farming development that can increase the social welfare of Pulau Sembilan community, but the potential is not managed well yet. Minor management is caused by low human resources quality on sea farming technique in addition to the financing problems faced by the fish farmer.

### 3.3. The Observed Parameter

The parameters focused in the study consist of: (1) capture fisheries products from the coastal waters, (2) sea farming products from the coastal waters, (3) milkfish catch, and (4) shrimp catch. The findings will be used as a reference to convince the coastal community that the existence of mangrove ecosystem may increase fishing and sea farming products from the coastal waters. Further, the correlation and regression equation between mangrove ecosystem width gain and catch quantity and sea farming products of the coastal waters are explained below:

#### 3.3.1. The Production of Capture Fisheries

The production of coastal capture fisheries in Sinjai Regency from year to year is increasing along with the mangrove ecosystem width gain. Presumably, it is triggered by the existence of mangrove ecosystem as the nutrients provider for coastal waters that it directly affects natural food availability for organisms in coastal waters, Sinjai Regency. The result of observation between the mangrove ecosystem width gain and the production increase of coastal capture fisheries from 2000 to 2012 is presented in the Table 1 below.

**Table 1. The mangrove ecosystem width gain and the production increase of coastal capture fisheries, Sinjai Regency (2000–2012)**

| No. | Year | Area (ha) | Production (ton) |
|---|---|---|---|
| 1 | 2000 | 897.50 | 22.074.15 |
| 2 | 2001 | 897.50 | 22.871.51 |
| 3 | 2003 | 897.50 | 22.931.00 |
| 4 | 2004 | 898.50 | 22.989.90 |
| 5 | 2005 | 898.50 | 23.290.50 |
| 6 | 2006 | 898.50 | 23.904.80 |
| 7 | 2007 | 963.50 | 24.423.70 |
| 8 | 2008 | 1.269.50 | 24.577.00 |
| 9 | 2009 | 1.351.50 | 24.682.00 |
| 10 | 2010 | 1.351.50 | 25.861.78 |
| 11 | 2011 | 1.351.50 | 25.755.11 |
| 12 | 2012 | 1.356.50 | 25.806.00 |

Sourcesr: Staticalof .Sinjai, 2000-2012.

Analysis result on the correlation between mangrove width gain and the production increase of coastal capture fisheries indicates that there is positive correlation by 0.886 at significance level of 0.000. Analysis result on the mangrove ecosystem width gain and the production increase of coastal capture fisheries in Sinjai Regency indicates that the wider mangrove width, the higher amount of coastal capture fisheries catch that it generally forms an equation of $Y = 19037 + 4.755X$.

It affirms the findings of Yulianda, et al. (2010) [8] stating that the presence of mangrove ecosystem in coastal waters has some advantages, in direct and indirectly ways. The ecosystem can directly increase the production of coastal fisheries, while indirect advantages are as retaining wall from abrasion and salt water intrusion, settlement defensive wall from whirlwind, and nutrients provider for coastal biota. Then, the regression value between mangrove ecosystem width gain and production increase of coastal capture fisheries is illustrated in the Figure 1.

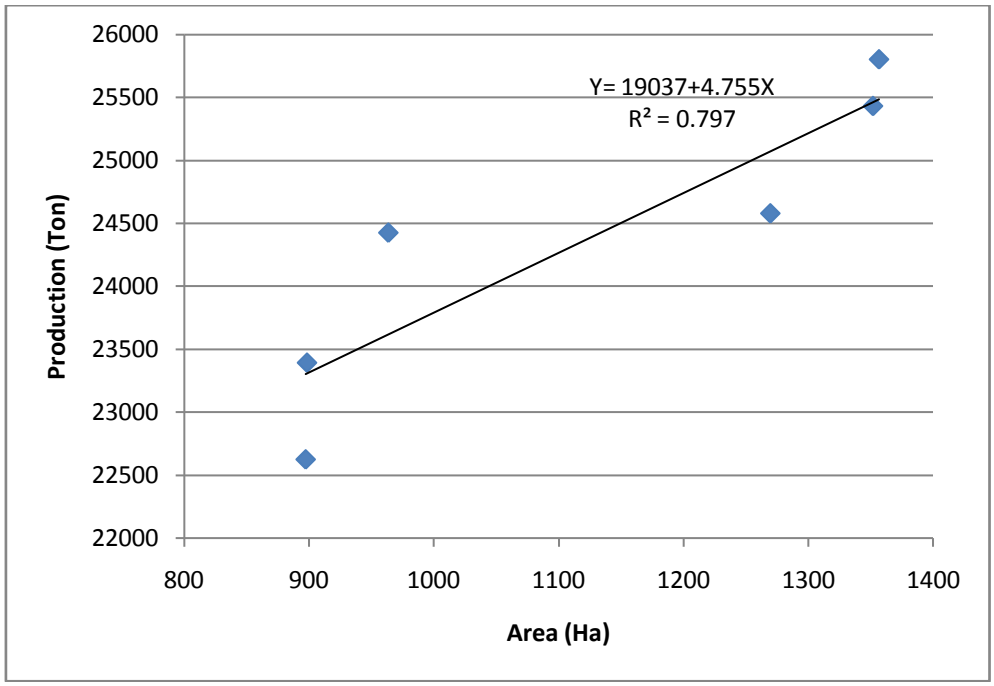


**Figure 1.** The correlation between mangrove ecosystem width gain and production increase of coastal capture fisheries in Sinjai Regency.

The regression analysis result between mangrove ecosystem width gain and production increase of coastal capture fisheries indicates that every mangrove ecosystem width gain by 1 ha, it may increase the production of coastal capture fisheries by 4.755 ton year$^{-1}$, with value $R^2$ Square 0.797. It means that 79% of coastal capture fisheries production associates with the mangrove width gain, and the other 21% of coastal capture fisheries production in Sinjai Regency is affected by other factors.

### 3.3.2. The Production of Sea Farming

The production of sea farming in Sinjai Regency coastal waters from year to year is increasing along with the mangrove ecosystem width gain. It is likely that the presence of mangrove ecosystem is as the nutrients provider and a filter from some coastal waters pollution. The mangrove directly has an influence on natural food availability for coastal waters organisms in Sinjai Regency. The result of observation between mangrove ecosystem width gain and production increase of sea farming in coastal waters from 2000 to 2012 is presented in the Table 2.

**Table 2. The mangrove ecosystem width gain and production increase of sea farming in Sinjai Regency coastal waters (2000–2012)**

| No. | Year | Area(ha) | Marineculture (ton) |
|---|---|---|---|
| 1 | 2000 | 897.50 | 98.04 |
| 2 | 2001 | 897.50 | 99.01 |
| 3 | 2003 | 897.50 | 112.00 |
| 4 | 2004 | 898.50 | 147.00 |
| 5 | 2005 | 898.50 | 157.00 |
| 6 | 2006 | 898.50 | 169.80 |
| 7 | 2007 | 963.50 | 184.30 |
| 8 | 2008 | 1.269.50 | 3.889.50 |
| 9 | 2009 | 1.351.50 | 4.271.50 |
| 10 | 2010 | 1.351.50 | 4.042.40 |
| 11 | 2011 | 1.351.50 | 4.975.81 |
| 12 | 2012 | 1.356.50 | 5.882.00 |
| Sources: Statistical of Sinjai (2000-2012) | | | |

The correlation analysis between mangrove ecosystem width gain and production increase of sea farming indicates that there is positive correlation between mangrove area and production of sea farming in coastal waters at correlation level 0.981 and significance level 0.000. The analysis result on mangrove ecosystem width gain and production increase of sea farming in Sinjai Regency coastal waters indicates that the wider mangrove ecosystem area, the higher production of sea farming that it generally makes equation Y =10201-1.125X.

It affirms the findings of [9] and[10] stating that the existence of mangro ecosystem in coastal waters has some advantages directly and indirectly. Direct advantage is the production increase of brackishwater fish farming, while the indirect ones are the function of mangrove as retaining wall from abrasion and salt water intrusion, settlement defensive wall from whirlwind and nutrients provider for coastal biota. The regression value between mangrove ecosystem width gain and production increase of sea farming in coastal waters is illustrated in the Figure 2.

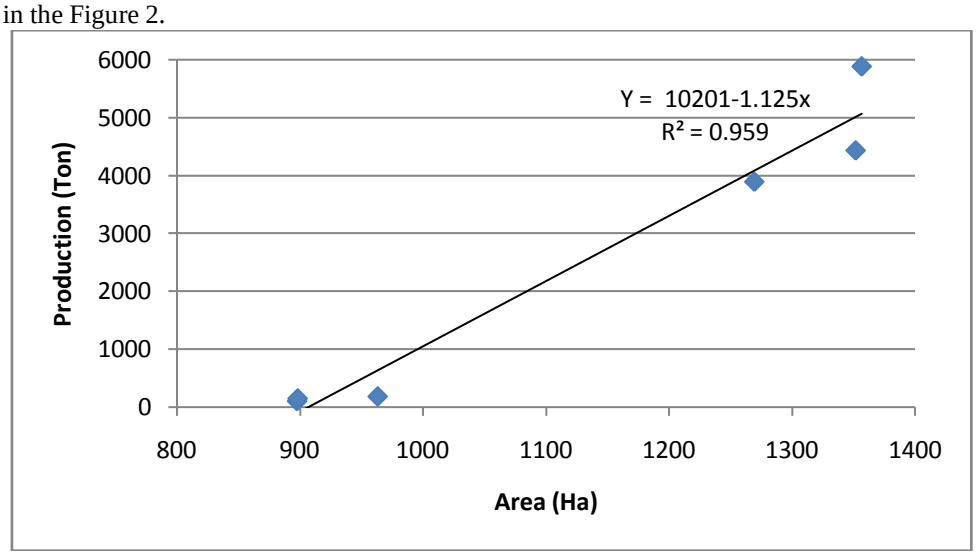


**Figure 2.** The correlation between mangrove ecosystem width gain and production of sea farming in Sinjai Regency coastal waters.

The result of regression analysis between mangrove ecosystem width gain and production increase of sea farming indicates that every mangrove ecosystem width gain by 1 ha, it can increase the production of sea farming up to 1,125 ton year$^{-1}$, with value $R^2$ Square 0.959. It means that 95.9% of sea farming production from coastal waters can explain the correlation between production and mangrove ecosystem width gain.The other 4.1% of sea farming production from Sinjai Regency coastal waters is explained by other factors.

### 3.3.3. The Milkfish Catch

The milkfish catch in Sinjai Regency coastal waters from year to year is increasing along with mangrove ecosystem width gain. It is likely triggered by the existence of mangrove ecosystem as the nutrients provider, a shelter from the ocean current and predators, and as a place where the milkfish lays the eggs. The result of observation between mangrove ecosystem width gain and production increase of milkfish catch quantity from 2000 to 2012 is presented in the Table 3.

**Table 3. Mangrove ecosystem width gain and production increase of milkfish catch quantity in Sinjai Regency coastal waters (2000–2012)**

| No. | Year | Area (ha) | Cathquntity (species) |
|---|---|---|---|
| 1 | 2000 | 897.50 | 56.011 |
| 2 | 2001 | 897.50 | 59.045 |
| 3 | 2003 | 897.50 | 73.703 |
| 4 | 2004 | 898.50 | 121.416 |
| 5 | 2005 | 898.50 | 245.713 |
| 6 | 2006 | 898.50 | 391.807 |
| 7 | 2007 | 963.50 | 437.910 |
| 8 | 2008 | 1.269.50 | 403.750 |
| 9 | 2009 | 1.351.50 | 580.730 |
| 10 | 2010 | 1.351.50 | 676.000 |
| 11 | 2011 | 1.351.50 | 1.353.600 |
| 12 | 2012 | 1.356.50 | 1.914.500 |
| Sources: Statistical of .Sinjai (2000-2012) | | | |

Based on the correlation analysis between mangrove ecosystem width gain and milkfish catch quantity increase, there is positive correlation between the mangrove ecosystem area and milkfish catch quantity at correlation level 0.756 and significance level 0.004. Based on the analysis on mangrove ecosystem width gain and milkfish catch quantity in coastal waters, it indicates that the wider mangrove size area, the higher catch quantity that it generally makes equation Y =2E+06- 2.216X

It agrees the findings of[11] and[12]. They state that the presence of mangrove ecosystem in coastal waters has some advantages in direct and indirect ways. Directly, the ecosystem may increase brackishwater fish farming production, while indirect advantages are as retaining wall from abrasion and salt water intrusion, settlement defensive wall from whirlwind and nutrients provider for coastal biota. Regression value between mangrove ecosystem width gain and milkfish catch quantity increase in coastal waters is presented in the Figure 3.

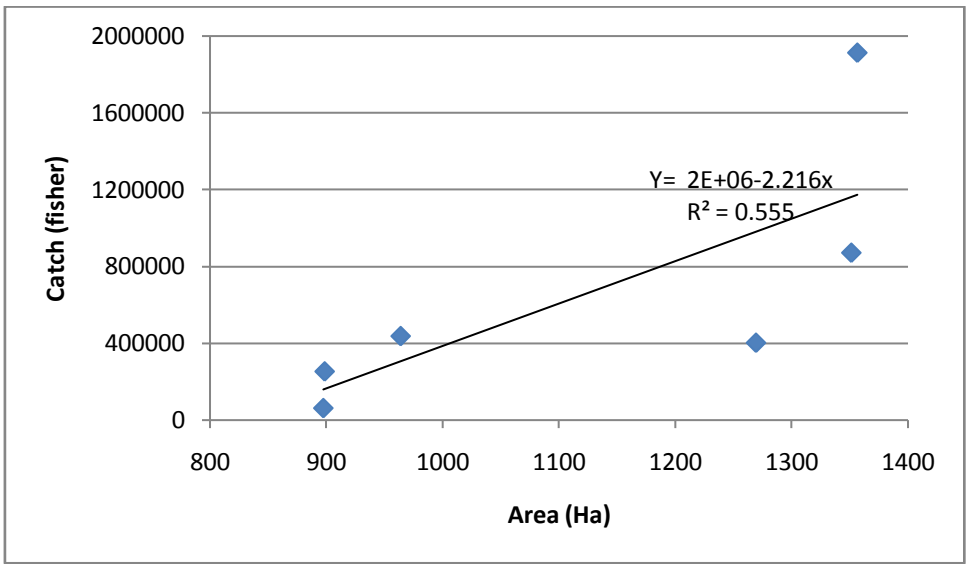


**Figure 3.** The correlation between mangrove ecosystem width gain and milkfish catch quantity increase in Sinjai Regency coastal waters

The result of regression analysis between mangrove ecosystem width gain and milkfish catch quantity increase indicates that every 1 ha mangrove ecosystem width gain will increase the catch number of milkfish by 2.216 fishes with value $R^2$ Square 0.555. It means that 55.5% of milkfish catch quantity from coastal waters may explain this correlation with mangrove width gain, while the other 44.5% of milkfish catch quantity in Sinjai Regency coastal waters correlates with other factors.

### 3.3.4. The Shrimp Catch

The shrimp catch in Sinjai Regency coastal waters year after year is increasing along with mangrove ecosystem width gain. It is likely that the presence of mangrove ecosystem functions to provide nutrients, as a place to hide from ocean current and predators, and a place to lay the eggs. The result of observation between mangrove ecosystem width gain and shrimp catch quantity increase in coastal waters from 2000 to 2012 is presented in the Table 4.

**Table 4. Mangrove ecosystem width gain and shrimp catch increase in Sinjai Regency coastal waters (2000–2012)**

| No. | Year | Area (ha) | Cathquntity (species) |
|---|---|---|---|
| 1 | 2000 | 897.50 | 25.279 |
| 2 | 2001 | 897.50 | 37.431 |
| 3 | 2003 | 897.50 | 49.983 |
| 4 | 2004 | 898.50 | 65.730 |
| 5 | 2005 | 898.50 | 71.452 |
| 6 | 2006 | 898.50 | 86.754 |
| 7 | 2007 | 963.50 | 90.138 |
| 8 | 2008 | 1.269.50 | 92.943 |
| 9 | 2009 | 1.351.50 | 120.731 |
| 10 | 2010 | 1.351.50 | 125.000 |
| 11 | 2011 | 1.351.50 | 246.095 |
| 12 | 2012 | 1.356.50 | 487.000 |

Sources Statistical of . Sinjai (2000–2012)

The correlation analysis between mangrove ecosystem width gain and shrimp catch increase indicates that there is positive correlation between mangrove area and shrimp catch quantity at correlation level 0.656 with significance level 0.004. Based on the analysis result between mangrove ecosystem width gain and shrimp catch quantity increase, it indicates that the wider mangrove ecosystem area, the higher fishing catch quantity that it generally makes equation Y=39445-4.917X.

It agrees with the findings of[13],[14] and[15] stating that the presence of mangrove ecosystem in coastal waters has several advantages, in direct and indirect ways. The ecosystem directly increases the production of brackishwater fish farming, and it indirectly functions as a retaining wall from abrasion and salt water intrusion, settlement defensive wall from whirlwind, and as a nutrients provider for coastal biota. The regression value between mangrove ecosystem width gain and shrimp catch quantity increase is illustrated in the Figure 4.

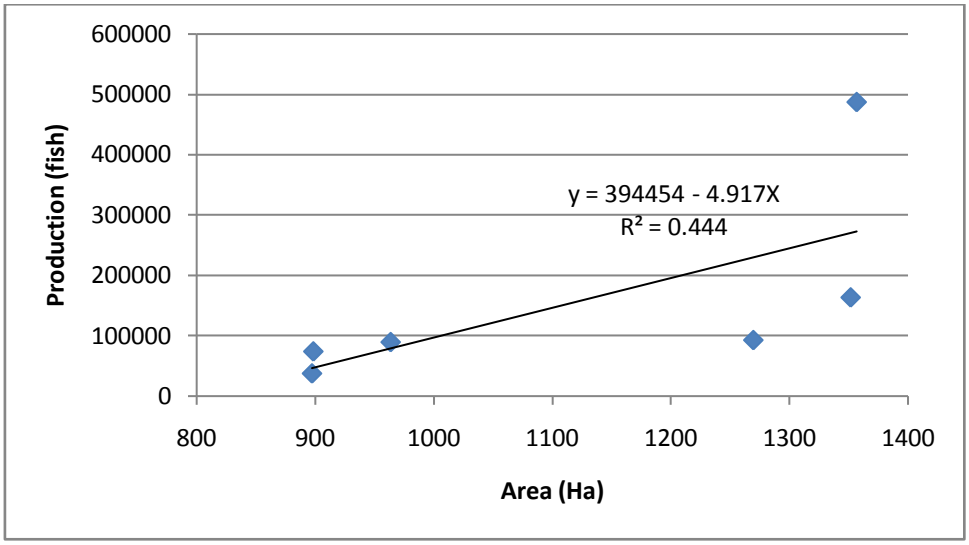


**Figure 4.** The correlation between mangrove ecosystem width gain and shrimp catch quantity in Sinjai Regency coastal waters

The result of regression analysis between mangrove ecosystem width gain and shrimp catch quantity increase indicates that every 1 ha mangrove ecosystem width gain, it may increase shrimp catch quantity by 4,917 fishes with value $R^2$ Square 0.444. It means that 44.4% of shrimp catch quanity from coastal waters can explain this correlation with mangrove ecosystem width gain, while the other 55.6% of shrimp catch is affected by other factors.

## IV. Closure

### 4.1. Conclusion

The findings conclude some points as follows: (1) the capture fisheries catch correlates positively with the regression equation for every 1 ha mangrove ecosystem width gain, and it will be tailed by the catch quantity by 4,755 kg $year^{-1}$, (2) the production of sea farming correlates positively with the regression equation for every 1 ha mangrove ecosystem width gain, and it will increase the production of sea farming by 1,125 kg $year^{-1}$, (3) the milkfish catch quantity correlates positively with the regression equation that every 1 ha mangrove ecosystem width gain will be followed by the milkfish catch quantity by 2,216 fishes $year^{-1}$, and (4) the shrimp catch quantity correlates positively with the regression equation when the mangrove ecosystem is widened by 1 ha, it will increase the shrimp catch quantity by 4,917 fishes $year^{-1}$.

### 4.2. Suggestion

Based on the research conclusion, here are the suggestion: (1) the mangrove ecosystem management shall be integrated with the ecological relevance rather than administrative limitation; sectoral relevance means all related department shall be invited into the mangrove ecosystem management, and also scientific relevance, (2) the rehabilitation system of mangrove ecosystem shall refer to natural ecological system from both the biodiversity and the mangrove forest planting, i.e. by mangrove planting spacing that allows the formation of waterways between trees; this will form water zones as an assembly point for coastal biota during the ebb tide, and (3) in order to arrange a continuous mangrove ecosystem management, there must be any institutional framework as the legal umbrella.

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