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The Carrying of Capacity of the Pangkal Babu Mangrove Forest on the Abundance of Fish Resources and the Economy of the People of Tungkal Satu Village, Tanjung Jabung Barat

Daya Dukung Hutan Mangrove Pangkal Babu pada Kelimpahan Sumberdaya Ikan dan Ekonomi Masyarakat Desa Tungkal Satu, Tanjung Jabung Barat

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ABSTRACT
The Pangkal Babu Mangrove Forest has an important role in a fish habitat that is closely related to the livelihoods of fishermen so it has an overall economic relationship. This study aims to analyze the condition of mangrove forests, the triangulation relationship between mangrove forests and fish resources, and the community's economy as well as forms of local wisdom in protecting and preserving mangrove forests. This research was conducted in the Pangkal Babu Mangrove forest area, Tungkal Ilir District, West Tanjung Jabung Regency. The method in this study is a survey method. The sampling technique for the condition of the mangrove forest was using the Line Transect Plot method at 3 different stations. The data analyzed included the density of mangrove forests, fishery resources, the economy, and the local wisdom of the community. The results showed that at station I the condition of mangrove vegetation in Pangkal Babu was in moderate criteria with 1,467 trees/ha, station II was in very dense criteria with 3,367 trees/ha, and station III was in moderate criteria with 1,000 trees/ha. Fishery production for 5 years is 93,221 kg with many trips of 2,115 and a CPUE value of 44.13 kg/trip. Fishery production has exceeded the sustainable potential both biologically (MSY = 82,297 kg) and economically (MEY = 82,296 kg). The value of the coefficient of determination (R2) is 0.82 or 82%, which indicates that the fluctuation in fishery production is caused by the area of mangrove forests by 82%.

Keywords: Pangkal Babu Mangrove, Fishery Production, Economy

ABSTRAK
Hutan Mangrove Pangkal Babu memiliki peran penting untuk habitat ikan yang sangat berhubungan dengan mata pencaharian nelayan, sehingga memiliki hubungan perekonomian secara keseluruhan. Penelitian ini bertujuan untuk menganalisis kondisi hutan mangrove, hubungan triangulasi antara hutan mangrove dengan sumberdaya ikan dan ekonomi masyarakat serta bentuk kearifan lokal masyarakat dalam menjaga dan melestarikan hutan mangrove. Penelitian ini dilakukan di kawasan hutan mangrove Pangkal Babu, Kecamatan Tungkal Ilir Kabupaten Tanjung Jabung Barat. Metode dalam penelitian ini adalah metode survei. Teknik pengambilan sampel kondisi hutan mangrove dengan metode Transek Garis dan Petak (*Line Transect Plot*) di 3 stasiun berbeda. Data yang dianalisis meliputi kerapatan hutan mangrove, sumberdaya perikanan, ekonomi dan kearifan lokal masyarakat. Hasil penelitian menunjukkan bahwa pada stasiun I kondisi vegetasi mangrove Pangkal Babu dalam kriteria sedang dengan 1.467 pohon/ha, stasiun II dalam kriteria sangat padat dengan 3.367pohon/ha dan stasiun III dalam kriteria sedang dengan 1.000 pohon/ha. Produksi perikanan selama 5 tahun yaitu 93.221 kg dengan jumlah trip sebesar 2.115 dan nilai CPUE 44,13 kg/trip. Produksi perikanan telah melebihi potensi lestari penangkapan (*overfishing*) secara biologi (MSY = 82.297 kg) dan ekonomi (MEY = 82.296 kg). Nilai koefisien determinasi (R^2) adalah sebesar 0,82 atau 82%, yang menunjukkan bahwa naik turunnya produksi perikanan disebabkan luas hutan mangrove sebesar 82%.

Kata Kunci: Mangrove Pangkal Babu, Produksi Perikanan, Ekonomi

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INTRODUCTION

Mangrove forests are important natural resources in the coastal environment consisting of ecological and economic aspects. Ecological aspects that have various benefits of environmental protection of terrestrial ecosystems, oceans, and various types of fauna, retaining sea waves or strong winds, controlling seawater intrusion, as a place to find food, spawning, and breeding for fish resources, forming new land through the process of sedimentation and maintaining water quality. The economic aspect consists of sources of income for the community, industry, and also the state such as timber products (construction wood, firewood, charcoal, wood chips for pulp, poles) and associated forest products (Nipah products, medicines, fisheries, environmental health services) (Arief, 2003).

Mangrove forests are included in rare ecosystems because they only cover 2% of the earth's surface, 23% of mangrove ecosystems are in Indonesia, and become the largest country with forest cover around 26-29% of the world's mangrove forest cover, and the rate of forest destruction is around 0.26 - 0.66% per year (Hamilton and Casey, 2016). One of the shrinking mangrove forest areas is in Jambi Province. Mangrove vegetation cover on the east coast of Jambi Province in 2012 was 98%, decreasing to 83% in 2014, while in the Betara River Nature Reserve, the initial vegetation cover of this area was 95% and is now reduced to 78% (Jambi Provincial Government, 2015).

Reduced mangrove forest areas will affect the sustainability of fish resources because mangrove trees produce a lot of natural food for various types of marine life. The roots of mangrove trees are also used by fish as shelter, spawning, and breeding. The sustainability of fish resources is highly dependent on the sustainability of the mangrove ecosystem. The high primary productivity of mangrove tree litter (flowers, twigs, and leaves) is important for fish production in mangrove waters.

Changes that occur in coastal areas and mangrove forests are not only caused by natural factors but also influenced by various human activities. The rate of growth and socio-economic activities of the community is increasing and it is feared that it will affect the state of mangrove forest areas and may cause a decrease in fish resources. In connection with the large role of mangrove forests to maintain fish resources and the economy of the community, further research is needed on the carrying capacity of mangrove forests on the abundance of fish resources and the economy of the community.

This study was conducted to analyze the vegetation condition of the Pangkal Babu Mangrove forest and the triangulation relationship between the Pangkal Babu Mangrove forest with fish resources and the community economy. This research is expected to provide information on the ecological and economic functions of mangrove forests as a guardian of the stability of fish resources and the economy of the community and as a consideration in the management of the Pangkal Babu Mangrove forest.

MATERIALS AND METHOD

Location and Time

This research was conducted in the Pangkal Babu Mangrove forest area, Tungkal Ilir District, Tanjung Jabung Barat Regency with the implementation time in December 2021 - June 2022.

Determination of Mangrove Forest Vegetation

Data collection of mangrove tree density and mangrove species is done by survey, namely to see the general condition of the mangrove ecosystem. Determination of observation stations based on the categories used by Descasari *et al.* (2016), namely: 1) Station I is located in the condition of mangrove vegetation that has been damaged (very sparse) because it is directly related to residential areas. 2) Station II is located in a very dense category of mangrove vegetation conditions because this area is very far from residential areas and leads to the sea. 3) Station III is located in a coastal area exposed to tides so that mangrove conditions are damaged due to abrasion.

The method used to see the condition of mangroves is to use the *Line Transect Plot* Method by placing sample *plots (plots) in the* form of a square with a size of 10 m x 10 m as many as 3 sample *plots with a* distance of 300 m between stations (Agustini *et al.,* 2016). Observed mangroves are tree categories with vegetation size ≥1.5 m and diameter ≥10cm (Figure 1).

Fish Resource Data Collection

The method used in collecting fish resource data is by interviewing fishermen in the Pangkal Babu Mangrove area. Data taken in the form of catch or production data (*Yield*) and fishing effort (*effort) of* all fishing gear taken in a *time series* for the last 5 years.

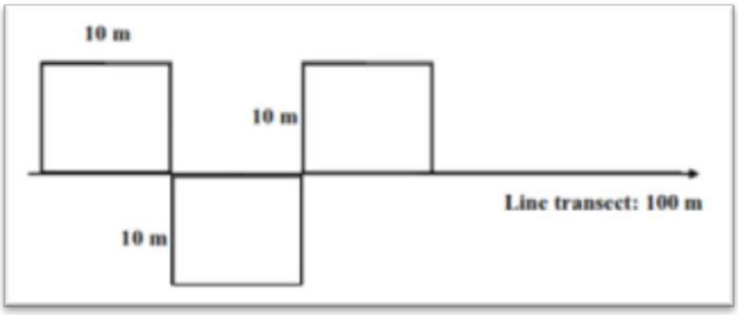

Figure 1. Mangrove Density Measurement Plot Framework (Rahman *et al.,* 2020)

Mangrove Vegetation

Mangrove density and Index of Importance (INP) data are necessary to determine the condition of mangrove forests. Mangrove density and INP are obtained using the following equation (English *et al.,* 1994):

$$Di=\frac{\text{The total number of individuals of a kind (Ni)}}{\text{Total sampling area (A)}}$$

The standard criteria for classifying mangrove forests are listed in Table 1.

Table 1. Mangrove forest damage standard

Criteria	Density (trees/ha)
Very dense	≥ 1500
Medium	≥ 1000 - < 1500
Rare	<1000

Source: Minister of Environment Decree No. 201 the Year 2004

The relative density of species-i (RDi), the ratio between the number of stands of species-I (Ni), and the total stands of all species (∑n) or mathematically:

$$RDi=\frac{\text{Number of individuals (Ni)}}{\text{The Total number of individuals}(\sum n)} \text{ x } 100\%$$

Species relative frequency (RFi), the ratio between the frequency of the i-th species (Fi) and the sum of frequencies for all species or mathematically:

$$RFi=\frac{\text{Type frequency (Fi)}}{\text{The total frequency of all types } (\sum F)} \text{ x } 100\%$$

Species relative dominance or relative species cover (RCi), the ratio between the area of coverage of the i-th species (Ci) and the total area of cover for all species (∑C) or mathematically :

$$RCi=\frac{\text{The dominance of the spesies (Ci)}}{\text{The total area covered by all types } (\sum C)} \text{ x } 100\%$$

Index of Importance (INP), a sum of relative density (Rdi), relative frequency (RFi), and relative closure (RCi):

$$INP=RDi+RFi+RCi$$

The importance value of a species ranges from 0% - 300% which gives an idea of the influence or role of a mangrove plant species in the mangrove community.

Fisheries Resources and Community Economy

The method used to see the abundance of fish resources is by calculating the maximum sustainable yield (MSY) and the community economy by calculating the maximum economic yield (MEY) in the Pangkal Babu Mangrove forest area. The linear regression method was used to obtain the intercept (α) and slope (β) values by using the Schaefer model approach, namely:

Table 2. Description

Analysis	Catch (Q)	Capture effort (E)
MSY	$\frac{\alpha^2}{4\beta}$	$\frac{\alpha}{2\beta}$
MEY	$\frac{\alpha^2}{4\beta} - \frac{c^2}{4\beta p^2}$	$\frac{\alpha}{2\beta} - \frac{c}{2\beta p}$

Before obtaining the MSY value, the CPUE (*Catch per Unit Effort*) calculation was first carried out. The formula used uses the Schaefer (1954) model approach:

$$CPUE = \frac{Catch}{Effort}$$

Description:

CPUE : Catch per fishing effort standardized gear

C : Total catches with gear i

E : Number of the standardized gear capture attempt

RESULT AND DISCUSSION

Research Location

Pangkal Babu Mangrove is located in Tanjung Barat Regency, Tungkal Ilir District, Tungkal I Village. Geographically, Pangkal Babu Mangrove is located at 0^o 49'34.8" LS to 103^o 32'30.7" BT, has western boundaries with Bram Itam District, south bordering Kuala Betara District, east with Berhala Strait, and north with Seberang Kota District (Figure 2).

Figure 2. Research location

The station I is located at coordinates 0^o 49'34.40" LS to 103^o 32'41.50" East which is located in an area close to residential areas that have been used for plantation land and mangrove tree timber for household use. The station I is dominated by mangrove plants such as *Avicennia marina* (Api-api), *Lumnitzera racemosa* (Teruntum), *Bruguiera gymnorriza* (Putut), *Nypa fruticans* (Nipah) and *Xylocarpus granatum* (Niri).

Figure 3. Condition of station I

Station II is located in an area with a high level of mangrove density with little human activity so there are still many types of mangrove plants and many wildlife that are there. Station II is at the coordinate point 0^o 49'30.95 "LS to 103^o 32'51.60" East which is dominated by mangrove plants such as *Avicennia marina* (Api-

api), *Bruguiera cylindrica* (Tumu), *Bruguiera parviflora* (Lenggadai), *Nypa fruticans* (Nipah), *Ceriops Zippeliana* (Tengar), *Rhizopora mucronata* (Bakau kurap), *Sonneratia caseolaris* (Pidada), and *Rhizopora apiculata* (Bakau minyak). Station III is located on the shore that is most affected by tides so abrasion often occurs which causes few types of mangrove plants that can live in this area. Station III is located at coordinates 0^o 49'27.18" LS to 103^o 33'1.48" East where there are only 2 types of mangrove plants namely *Avicennia marina* (Api-api) and *Bruguiera cylindrica* (Tumu).

Mangrove Vegetation of Pangkal Babu

Based on the results of identification that has been done at stations I, II, and III, obtained as many as 175 mangrove trees with 11 different types of mangrove plants (Table 3).

Table 3. Mangrove tree density station I

No	Mangrove type	Number of trees	Di (tree/ha)	RDi (%)	Fi	RFi (%)	Ci	RCi (%)	INP (%)
1	*Avicennia marina* (Api-api)	3	100	6,8	0,3	9,1	0,01	1,2	17,1
2	*Bruguiera gymnorriza* (Putut)	8	267	18,2	0,7	18,2	0,09	9,0	45,3
3	*Lumnitzera racemosa* (Teruntum)	7	233	15,9	0,7	18,2	0,06	5,7	39,8
4	*Nypa fruticans* (Nipah)	14	467	31,8	1,0	27,3	0,40	39,7	98,8
5	*Xylocarpus granatum* (Niri)	12	400	27,3	1,0	27,3	0,45	44,4	99,0
Total		44	1467	0,44	100	3,67	100	1,01	100

Table 3 explains that the highest relative density of mangroves is *Nypa fruticans* (Nipah) at 31.8% and the lowest is *Avicennia marina* (Fire) at 6.8%. The highest relative frequency was *Nypa fruticans* (Nipah) and *Xylocarpus granatum* (Niri) at 27.3% and the lowest was *Avicennia marina* (Api-api) at 9.1%. The relative dominance of the highest species found in this location is *Xylocarpus granatum* (Niri) at 44.4% and the lowest is *Avicennia marina* (Api-api) at 1.2%. The results of the analysis of the highest importance value index are the type of *Xylocarpus granatum* (Niri) by 99% while the lowest is the type of *Avicennia marina* (Api-api) by 17.1%. The difference in the important value index of mangrove vegetation is due to the competition of each type to get nutrients and sunlight, other factors that influence the substrate and tides (Parmadi *et al.*, 2016).

Table 4. Mangrove tree density station I

No	Mangrove type	Number of trees	Di (tree/ha)	RDi (%)	Fi	RFi (%)	Ci	RCi (%)	INP (%)
1	*Avicennia marina*	11	366,7	10,9	1,0	17,6	2,2	7,1	35,6
2	*Bruguiera cylindrica*	9	300,0	8,9	0,3	5,9	1,5	5,0	19,8
3	*Bruguiera parviflora*	11	366,7	10,9	0,7	11,8	1,4	4,5	27,2
4	*Nypa fruticans*	5	166,7	5,0	0,3	5,9	0,6	2,0	12,9
5	*Ceriops zippeliana*	7	233,3	6,9	0,7	11,8	1,8	5,9	24,6
6	*Rhizopora mucronata*	24	800,0	23,8	1,0	17,6	13,2	42,6	84,0
7	*Sonneratia caseolaris*	13	433,3	12,9	0,7	11,8	2,7	8,5	33,2
8	*Rhizopora apiculata*	21	700,0	20,8	1,0	17,6	7,6	24,4	62,8
Total		101	3367	100	5,7	100	31,1	100	300

Table 4 shows that the highest relative density and relative dominance of mangroves in this area is *Rhizopora mucronata* (bakau kurap) and the lowest is *Nypa fruticans* (Nipah). The highest relative frequency consisted of *Avicennia marina*, *Rhizopora mucronata*, and *Rhizopora apiculata* and the lowest consisted of *Bruguiera cylindrica* and Nypa *fruticans*. The result of the highest importance value index is *Rhizopora mucronata* (bakau kurap) at 84% while the lowest is the type of *Nypa fruticans* (Nipah) at 12.9%.

The high value of density, frequency, dominance, and importance value index of mangrove species *Rhizopora mucronata* due to its suitable area with clay substrate texture, still inundated during high tide and not too influenced by sea water so that this species grows a lot at station II.

At station III, only 2 types of mangroves were found, namely *Avicennia marina* and *Bruguiera cylindrica* with the results of the analysis of the important value index of *Avicennia marina* of 228.2% while *Bruguiera cylindrica* of 71.8%. There are many types of mangroves *Avicennia marina* on the beach is inseparable from the carrying capacity of the environment in which this type of mangrove is resistant to seawater and the type of root can help bind the soil so that the land is increasingly towards the sea and prevent abrasion. More details can be seen in Table 6.

Table 5. Mangrove tree density Station I

No	Mangrove type	Number of trees	Di (tree/ha)	RDi (%)	Fi	RFi (%)	Ci	RCi (%)	INP (%)
1	*Avicennia marina* (Api-api)	23	766,7	76,7	1	60	15	91,6	228,2
2	*Bruguiera cylindrica* (Burus)	7	233,3	23,3	0,7	40	1,4	8,4	71,8
Jumlah		30	1000	100	1,7	100	16,4	100	300

Table 6. Mangrove Forest Vegetation Condition

Station	Density (trees/ha)	Criteria
I	1.467	Medium
II	3.367	Very dense
III	1.000	Medium

Fishery Resources of Pangkal Babu

Catch production in the waters of the Pangkal Babu Mangrove forest area was obtained by conducting interviews with local fishermen so that the amount of catch production was within the range obtained. The interview method was carried out because there was no recording of the amount of catch by fishermen and there was no complete data from the relevant agencies (Table 7).

Table 7. The effort, Total Production, and CPUE of fishing

Year	Pangkal Babu Production (kg)	*Effort* (Trip)	CPUE (kg/trip)
2017	89.587,20	1.959	45,73
2018	92.399,75	2.160	42,78
2019	99.789,98	2.185	45,67
2020	91.517,82	2.200	41,60
2021	92.809,02	2.069	44,23
Average	93.220,75	2.115	44,13

Based on Table 7, the average actual production for the last 5 years (2017 - 2021) was 93,220.75 kg and 2,115 trips with a CPUE value of 44.13 kg/trip. Fishermen in the mangrove waters of Pangkal Babu carry out fishing activities using motorized boats and 2 GT boats. Various kinds of fishing gear used by local fishermen are rawai, gill nets, togok, ancang, nets, sondong, anco, and splints. The catch in the mangrove waters of Pangkal Babu consists of fish (sembilang, taji, belanak, kakap putih, malung, betutu, tembilang, grouper) crustaceans (peci shrimp, krosok shrimp, hanging shrimp, udang beras, udang buku) and mollusks (squid and cuttlefish).

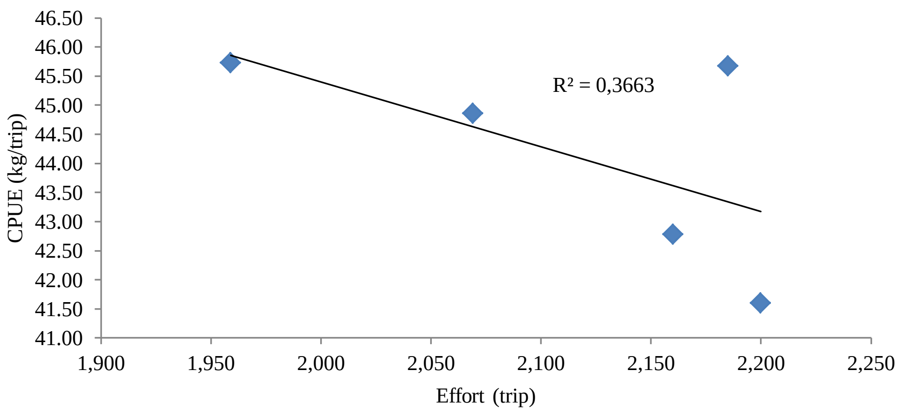

Figure 4. Relationship of Effort and CPUE

Based on the graph of the relationship between *Effort* and CPUE catches in Pangkal Babu in 2017 - 2021, a linear equation y = -0.0111x + 67.635 and R^2 = 0.3663 was obtained. The equation shows that: 1) The regression coefficient (b) of -0.0111 states the negative relationship between production and *effort* that every 1 trip reduction will increase CPUE by 0.0111 kg/trip. 2) The coefficient of determination (R^2) is 0.3663 or 36.63%, this indicates that the rise and fall of CPUE caused by the value of *effort* is 36.63% while 63.37% is caused by other variables. 3) The correlation coefficient (R) obtained is 0.6052, indicating that CPUE and *effort* have a strong relationship. The level of relationship is declared moderate if the correlation coefficient is 0.60 -

0.799 (Sugiyono, 2017).

Maximum Sustainable Yield (MSY)

The MSY value is obtained using the Schaefer model bioeconomic equation as follows:

Table 8. Catch and effort biological parameters (MSY)

Biological Parameters	Catch (kg)	*Effort* (Trip)
MSY	102.871	3.042

Table 8 shows that based on biological parameters, it is known that the sustainable potential catch (MSY) allowed to be caught is 102,871 kg with a total *effort of* 3,042 trips. This shows that during the last 5 years, the catch in the Pangkal Babu mangrove forest area has exceeded the sustainable potential of fishing (*overfishing*) based on the opinion of Deptan (1999) which states that the potential fish allowed to be caught (*Total Allowable Catch / TAC)* is 80% of the sustainable potential (MSY) of 82,297 kg. The average catch is 93,221 kg, while the fishing trip does not exceed its sustainable potential with an average *effort of* 2,115 trips while the sustainable potential is 3,042 trips.

Maximum Economic Yield (MEY)

The results of the MEY analysis using the Schaefer model are presented in Table 9.

Table 9. Catch and effort economic parameters (MEY)

Economic Parameters	Catch (kg)	Effort (Trip)
MEY	102.870	3.032

Based on the economic parameters above, it can be seen that the fishery catch will provide maximum profit if the catch is 102,870 kg with an *effort of* 3,032 trips, based on the potential of fish allowed to be caught, which is 80%, it becomes 82,296 kg. These results show that the economic catch in the waters of the Pangkal Babu forest area exceeds the economic maximum catch, but the effort made does not exceed the maximum effort.

Table 10. Fishermen's costs and income

Year	Cost (IDR)	Revenue
2017	54,444,250	387,000,000
2018	59,620,000	403,000,000
2019	60,263,750	459,000,000
2020	60,650,000	355,000,000
2021	57,276,750	382,000,000
Average	58,450,950	43,777,778

Fishing costs consist of repairs to fishing gear, boats, fuel, and individual needs during fishing while income is obtained from the sale of all types of fish caught each year. Based on the table above, it can be seen that the highest cost occurred in 2020, which was IDR 60,650,000 while the highest income in 2019 was IDR 459,000,000.

Mangrove Forest Support on Fish Resource Abundance

The carrying capacity of mangrove forests for fishermen's catch production in the Pangkal Babu area is presented in Figure 5.

Based on the graph that explains the carrying capacity of mangrove forests to the amount of fish production, the equation y = 99.45x + 79556 is obtained and the R value^2 = 0.82, this equation shows that: 1) The regression coefficient (b) of 99.45 states a positive relationship between fish production and mangrove forest area that every additional 1 hectare of mangrove forest area will increase fish production by 99.45 kg/ha. 2) The coefficient of determination (R^2 is 0.82 or 82%, this indicates that the rise and fall of fish production caused by the value of mangrove forest area is 82% while the remaining 18% is caused by other variables. 3) The correlation coefficient (R) obtained is 0.9056, indicating that fish production and mangrove forest area have a very strong relationship. Low fish production occurred in 2017 and 2020 due to a reduction in the area and density of mangrove forests in the Pangkal Babu area which caused fish catches to decrease and resulted in a reduced *effort* by fishermen.

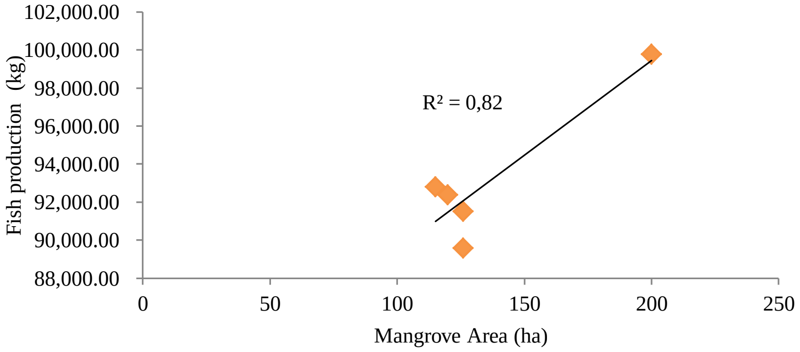

Figure 5. Graph of mangrove support for fish production

CONCLUSION

Based on the results of the study it can be concluded that the highest importance value index is found in station I, namely the type of *Xylocarpus granatum* (Niri), station II, namely the type of *Rhizopora mucronata* (Bakau Kurap), and station III, namely the type of *Avicennia marina* (Api-api). There is a positive relationship between mangrove forest areas and fish production. MSY and MEY calculations show that efforts to utilize fish resources in the Pangkal Babu Mangrove area have occurred with overfishing biologically and economically.

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