Establishment and Operation of a Regional System of Fisheries Refugia in the South China Sea and the Gulf of Thailand

FISHERIES REFUGIA PROFILE OF WEST KALIMANTAN PROVINCE

The Agency for Marine Fisheries Research and Human Resources (AMFRHR), MINISTRY OF MARINE AFFAIRS AND FISHERIES (MMAF), Republic of Indonesia

SOUTHEAST ASIAN FISHERIES DEVELOPMENT CENTER
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BACKGROUND

The West Kalimantan waters are part of the South China Sea (SCS) (Fisheries Management Area 711) and have a potential habitat for penaeid shrimp (shrimp from the Penaeidea family). The high economic valuable shrimp species inhabit West Kalimantan marine water including banana shrimp (*Penaeus merguiensis)* and white shrimp (*Penaeus indicus. Penaeid shrimps known as a leading commodity in Indonesian fishery export product.* Around 70% of shrimp production comes from fishing at sea. Around 70% of shrimp production comes from fishing activities at sea. The domestic and export market demand for Penaeid shrimp continues to increase every year, thus encouraging increased fishing efforts. The status of the utilization level of Penaeid shrimp in fisheries management area (FMA) 711 is 0.6 (fully exploited).

The threats to the shrimp fisheries in West Kalimantan are uncontrolled and destructive *fishing* methods and *gears*, the conversion of mangrove land to oil palm plantations, and the utilization of mangrove wood for human activities. Therefore, the effective management efforts are needed to overcome the stocks decline and maintain sustainability in the future.

The shrimp stock recovery can be achieved by applying the concept of fisheries refugia. According to UNEP (2006), this concept is based on a zoning approach in fisheries management through habitat improvement and efforts to minimize the effect of fishing on economically important fish/shrimp stocks in important habitats that play a role in their life cycle. Fisheries refugia is related to the sustainability of the availability of fish/shrimp stocks in certain areas, which is focused on the relationship between the fish/shrimp life cycle and critical habitats in the nursery ground and fishing ground.

The proposed fisheries refugia area of shrimp in West Kalimantan are Padang Tikar Waters (Kubu Raya Regency) and Dusun Besar Waters (North Kayong Regency).

PRODUCTION, SPECIES COMPOSITION, AND POTENTIAL OF SHRIMP RESOURCES

a. Production

Based on statistical data from the Ministry of Marine Affairs and Fisheries of Indonesia, MMAF (2021), the shrimp production of West Kalimantan fluctuated during the 2010-2020 period with an increasing trend. The highest shrimp production in West Kalimantan occurred in 2017 at 37,750 tons and the lowest in 2018 at 7,065 tons (Figure 1). Furthermore, the percentage of shrimp fisheries in West Kalimantan in 2020 contributed 21% of the total shrimp production in FMA 711 (Figure 2).

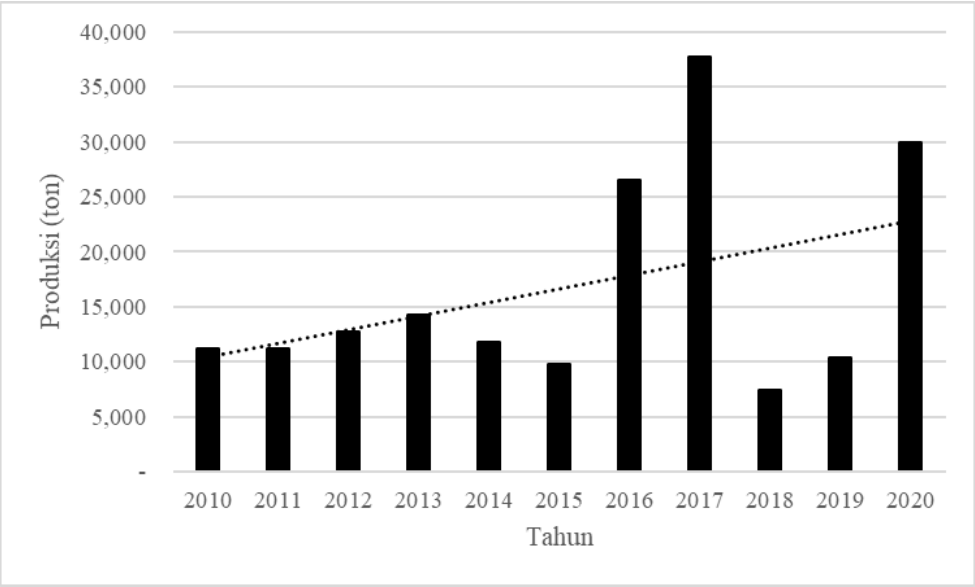


Figure 1.Shrimp production in West Kalimantan Province (MMAF, 2021)

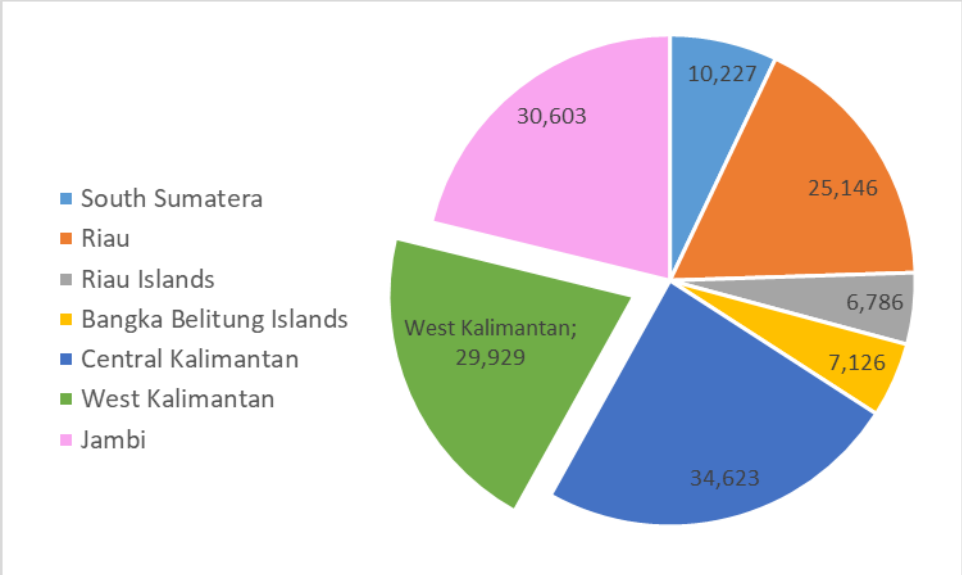


Figure 2. shrimp production in FMA 711 in tons (MMAF, 2021)

b. Species Composition

Penaeid shrimp caught on the west coast of Kalimantan consisted of relatively large and small shrimp species, including *Metapenaopsis toloensis, Metapenaeopsis barbata, Metapenaeopsis stridulans, Metapenaeus tenuipes, Metapenaeus lysianassa, Metapenaeus ensis, Metapenaeus elegans, Metapenaeus ensis, Metapenaeus tenuipes, Metapenaeus dobsoni, Metapenaeus brevicornis, Metapenaeus affinis, Parapenaeopsis hungerfordi, Parapaenaeopsis sculptilis, Parapenaeopsis stylifera, Parapenaeopsis coromandelica, Parapenaeopsis gracillima, Parapenaeopsis cornuta, Parapenaeopsis hardwickii, Parapenaeopsis maxillipedo, Penaeus merguiensis, Penaeus indicus, Penaeus semisulcatus, Penaeus monodon, Solenocea crassicornis,* and *Trachypenaeus granulosus* (Hedianto *et al*., 2014; Hedianto & Mujiyanto, 2016; Suryandari & Wijaya, 2016; BRPSDI, 2021).

There are two types of shrimp that have high economic value and are widely distributed in the waters of West Kalimantan: *Penaeus merguiensis* (common name: banana shrimp; local names: jerbung, wangkang) and *Penaeus indicus* (common name: white shrimp; local names: jerbung, wangkang) (Figures 3).

(a) *Penaeus merguiensis* *(b) Penaeus indicus*

Figure 3.The two species of shrimp with high economic value, (a) *Penaeus merguiensis* and (b) *Penaeus indicus.*

c. Shrimp Resource Potential

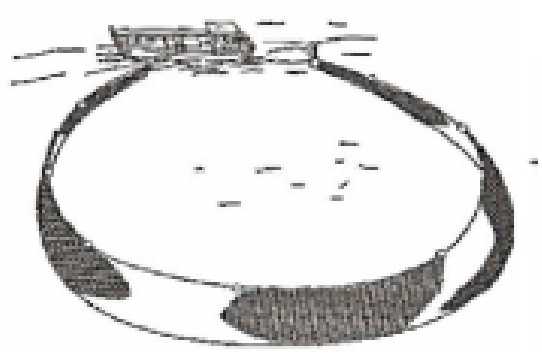
According to the Decree of the Minister of Marine Affairs and Fisheries No. 19, year 2022 concerning Potential Estimation, Total Allowable Catch (TAC), and Levels of Utilization of Fish Resources in the Fisheries Management Area of the Republic of Indonesia, estimation of potential for Penaeid shrimp resources in FMA 711 (Karimata Strait, Natuna Sea, and the South China Sea) is 71,810 tons with a TAC (amount allowed to be caught) of 50,267 tons. The status of the utilization level of Penaeid shrimp in FMA 711 is 0.6 (fully exploited).

THE FISHING TECHNOLOGY, FLEET, AND SEASON

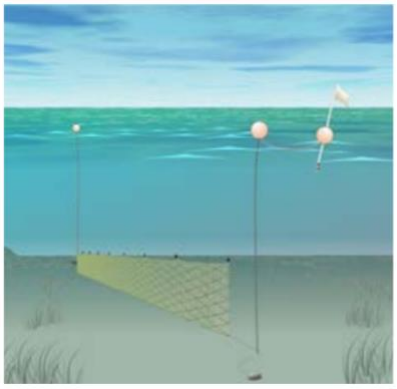
a. The Fishing Technology

Shrimp fishing gear in West Kalimantan Province generally varies depend on the fishing location. There are two types of shrimp fishing gear: active fishing gear and passive fishing gear (Figure 4). The active fishing gear consists of cast nets, gill nets, trammel nets, seine nets, danish seines, otter trawls, beach seines, and handy scoop net. Passive fishing gear consists of stasionary lift nets, trap and guiding barrier (Marine and Fisheries Service of West Kalimantan Province, 2021).

Cash nets[1]



Gill nets[1]



Trammel nets[2]

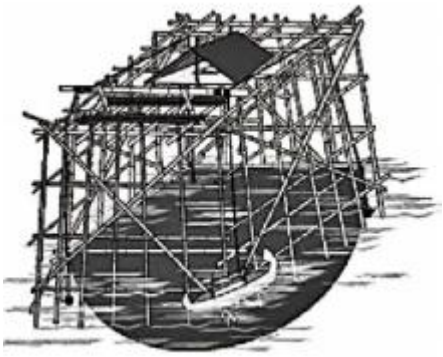
Seine nets[1]

Danish seines[1]

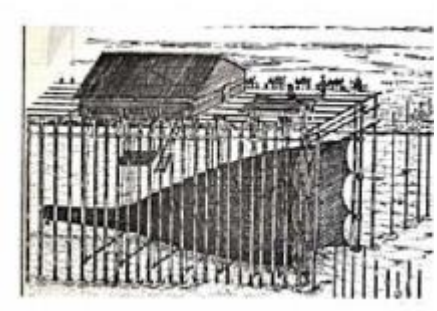
Otter trawls[1]

Beach seines[1]

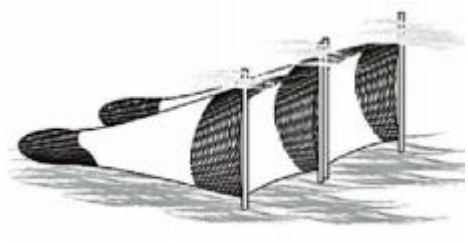
Handy scoop net[1]



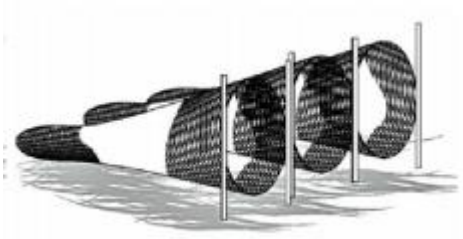
Stationary Lift Nets[1]



Tidal trap (jermal) [1]



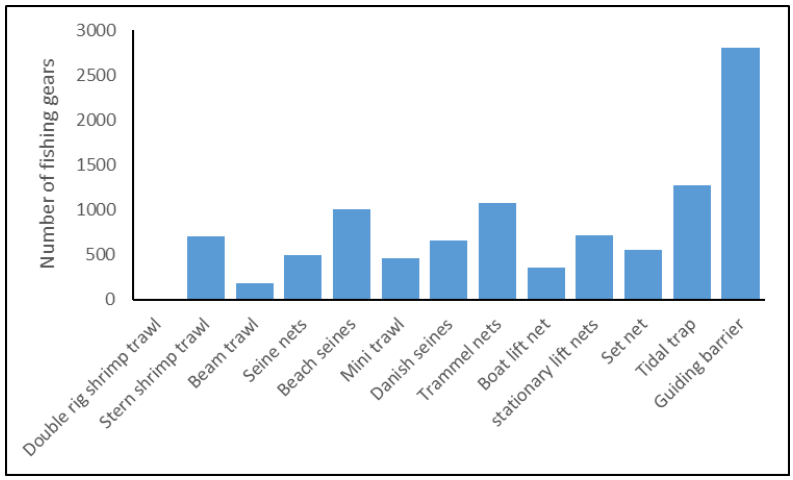
Togo[1]



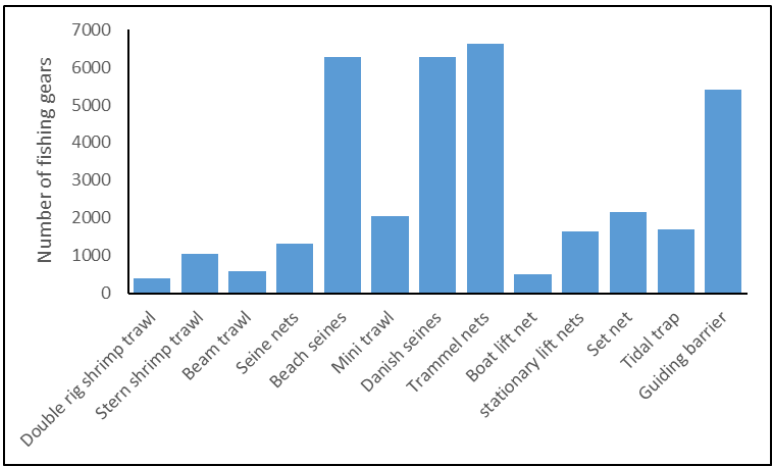
Guiding barrier (Ambai/bubu) [1]

Figure 4.The Fishing Gears around West Kalimantan Waters (photos source: 1. Ministry of Marine Affairs and Fisheries of Indonesia (2017), 2. Gilman et al. (2016)

During 2010-2017 period, the dominant fishing gears in North Kayong Regency were guiding barrier (ambai/bubu) (2,808 units), while beam trawls were the least (178 units). Also during this period, the dominant fishing gear used in Kubu Raya Regency was trammel nets (6,623 units), and Double Rig Shrimp Trawl was the least used (400 units). The fishing gear used in the 2010-2017 period is presented in Figure 5.



(a)



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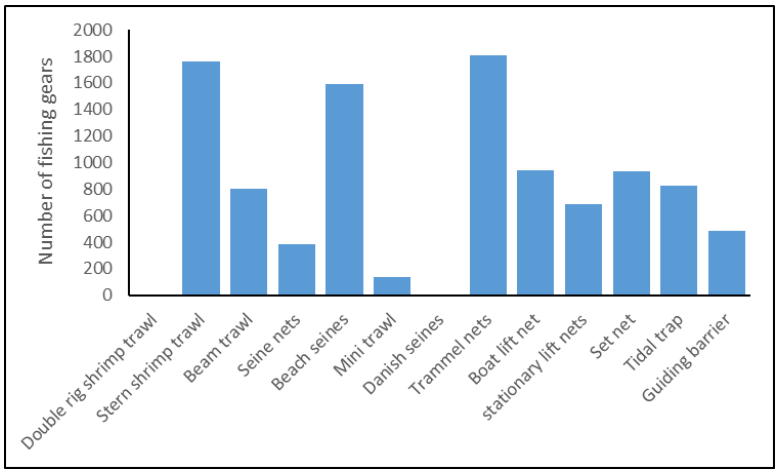
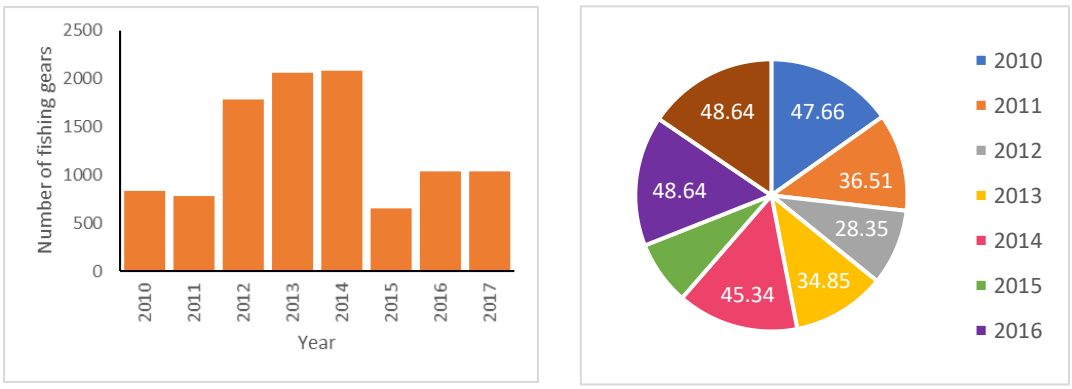


(c)

Figure 5.The shrimp fishing gear in West Kalimantan Waters; (a) North Kayong Regency, (b) Kubu Raya Regency, c. Ketapang Regency period 2010-2017

During 2010-2017, the number of shrimp fishing gear in North Kayong and Kubu Raya Regency 2014 was the highest, and the proportion of shrimp fishing gear to other fishing gear in each regency was 45.34% (North Kayong) and 34.05% (Kubu Raya) (Figure 6). During 2010-2017, the fluctuation of shrimp catch is not directly proportional to the number of shrimp fishing gear (Figure 7).



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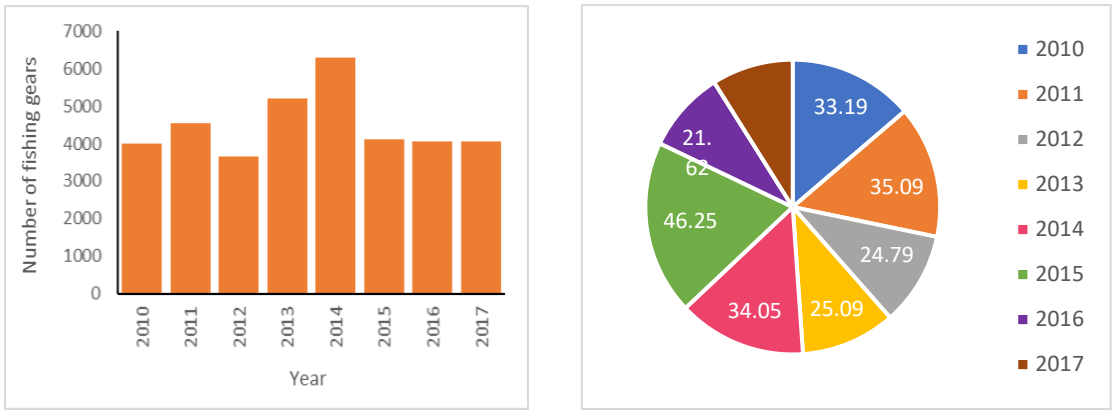

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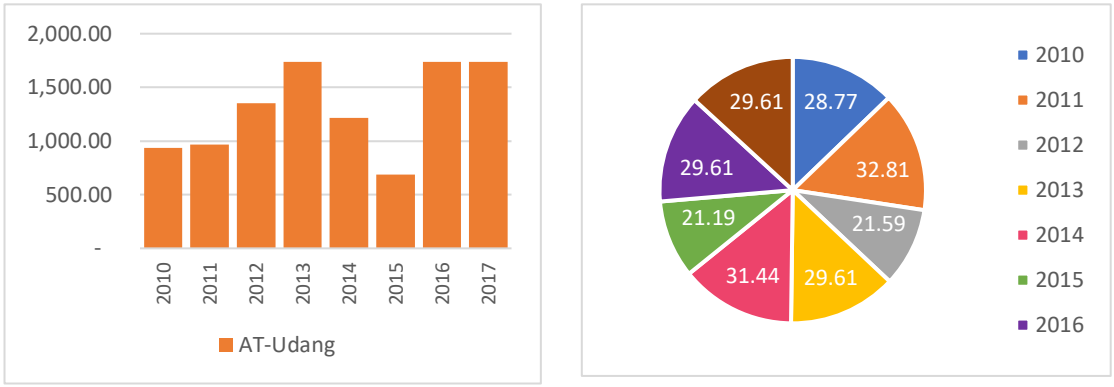
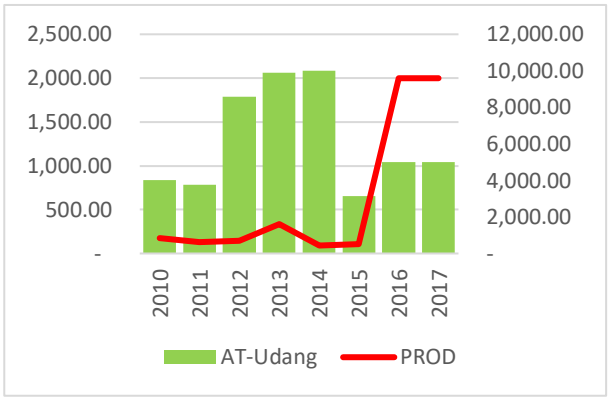


(c)

Figure 6.The total number of shrimp fishing gear and its proportion to other fishing gear in; (a) North Kayong Regency, (b) Kubu Raya Regency, (c) Ketapang Regency.



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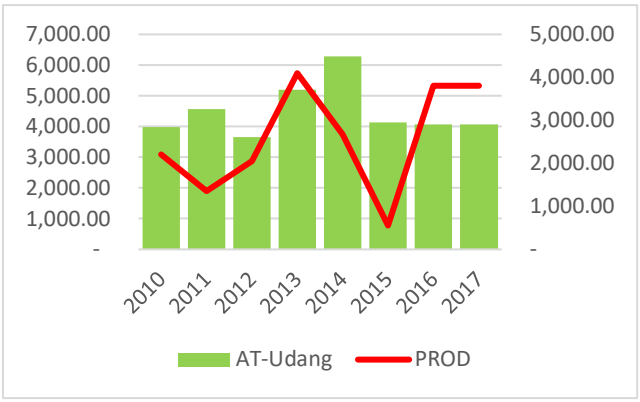

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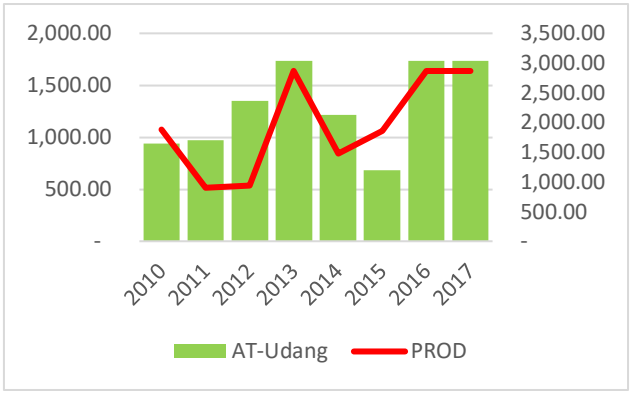


(c)

Figure 7.Overlay of shrimp catches with the total number of fishing gear; (a) North Kayong Regency, (b) Kubu Raya Regency, and (c) Ketapang Regency during 2010-2017 period.

Based on fishing gear ownership, 55% of the total respondents in Padang Tikar II Village use trammel net to catch shrimp, followed by tidal traps (Jermal) about 28% of the existing fishers (Figure 8). The fishers use trammel net because it is not a high cost, is environmentally friendly, saves fuel, and is relatively easy to operate. On the other hand, the tidal traps are high cost and require many workers to manage the gears as well as the catch. Based on the interviews, it is also known that fishers generally use traditional boats and equipment when fishing at sea. Most fishers in Padang Tikar II Village use motorboats with an engine power of 10 GT.

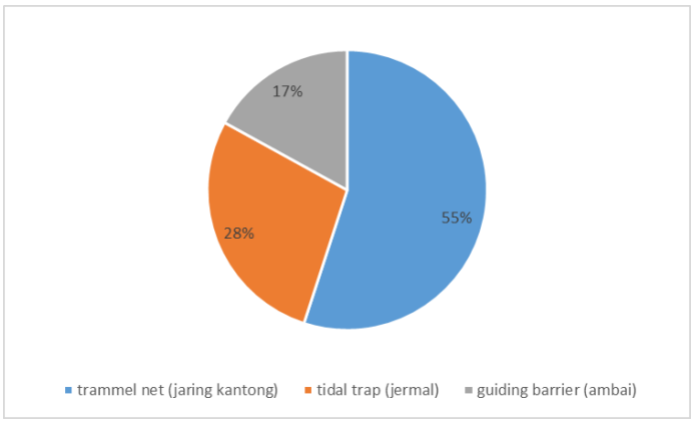


Figure 8. Composition of fishermen by type of fishing gear used in Padang Tikar II Village

Most fishers in Dusun Besar Village use Mini Trawl (Lampara) to catch shrimp, which is 69% of the total respondent (Figure 9). According to fishers, they use mini trawl due to the low cost, save fuel, and is relatively easy to operate. Based on the interviews, it is also stated that fishers generally use boats and traditional equipment when catching shrimp. Most of the fishermen in Dusun Besar Village operate a motorboat with an engine power of 10 GT.

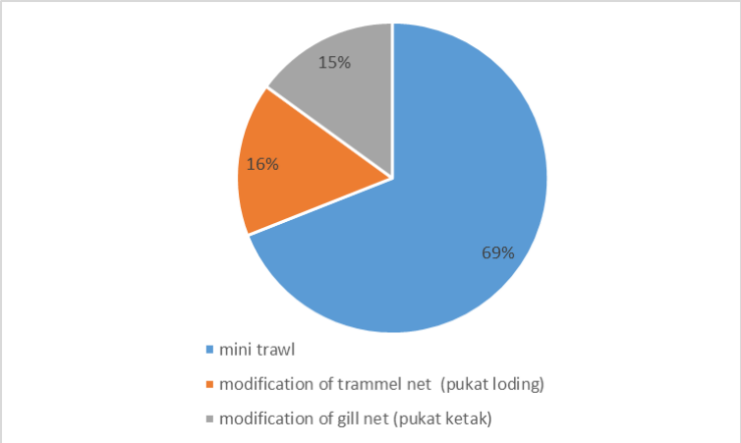


Figure 9.Composition of fishermen by type of fishing gear used in Dusun Besar Village

The higher shrimp catches are during July – October and the lower catch usually in in January – June. Most fishers in both areas do not go fishing from November to January due to bad weather, strong winds, and high sea waves. They have an alternative livelihood during that period, such as farming or working in other sectors, such as construction workers, fishpond workers.

b. The Fishing Fleet

The fishing fleet in the Kayong Utara Regency and Kubu Raya Regency) are dominated by boats < 10 Gross Tonnage/GT (Figure 10). The boats are made of wood with dimensions of length ranging from 5-7 m and a width of approximately 1.5 m and not equipped with adequate navigation equipment. Crew members are 1 to 2 people with one-day fishing trips. The number of boats with 0-5 GT to more than 100 GT operated in West Kalimantan waters between 2007 and 2017 is presented in Figure 11. is presented in Figure 11.

Figure 10.Type of 0-5 GT fleet operated in water areas

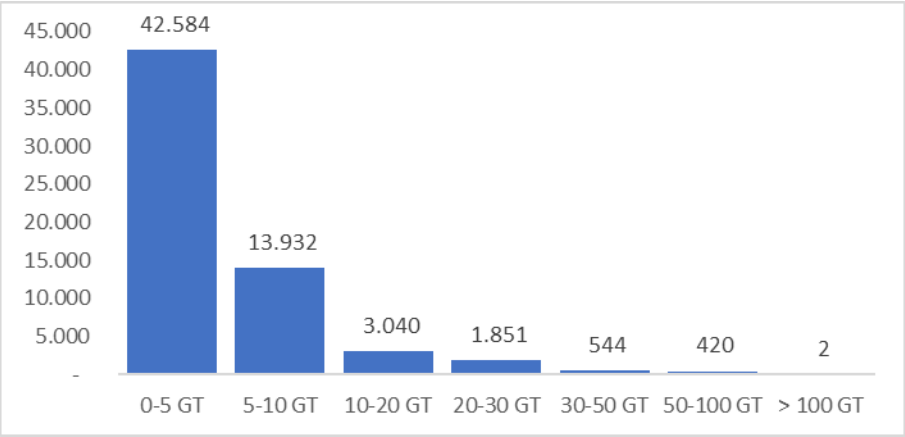


Figure 11.Number of fleet 0-5 GT to >100 GT, period 2007-2017

c. The Fishing Season

Geographically, the waters of West Kalimantan are influenced by two different seasons, the west monsoon and the east monsoon. Fishing activities carry on throughout the year. During the west monsoon (September-February), the fishing activity in the northern part of West Kalimantan decreases, covering the waters from Mempawah, Singkawang to Pemangkat. Meanwhile, in the southern, including the waters of Kubu Raya, Padang Tikar to Ketapang, it is the fishing season for shrimp/fish along with the intensity of active fishing gear (mini trawl/lampara) because the sea conditions are relatively calm. During April-July (east season) is not the fishing season in the southern part; on the other hand, fishing activity increased in the northern area.

NURSERY AREA OF PENAEID SHRIMP

Based on the life cycle, critical habitats for shrimp are estuaries and mangroves ecosystem. The mangrove and estuaries ecosystems are both typical ecosystems in Padang Tikar and Dusun Besar, West Kalimantan. Most fishing activities in both sites are small-scale fisheries, using traps and tidal fishing gears with the dominant target being shrimp. Most of these fishing gears have small mesh sizes; As a result, most of their catch is small shrimp or pre-adult stage. This condition will result in over-fishing recruitment.

The nursery ground for Penaeidae juvenile in Kubu Raya (Padang Tikar) and North Kayong (Teluk Batang and Ketapang) was identified at a depth of 5-10 m as far as 4 miles to the sea and 100 m to landward interact with the mangrove ecosystem.

a. Nursery area of Padang Tikar Water

The composition of juveniles catch from the fishing gears in Padang Tikar consisted of shrimp by 93.8% and non-shrimp by 6.2%, with mostly are Penaeidae. From the study, the catch using experimental gear(mini bottom trawl) in Padang Tikar had a carapace length range of 1.2-3.9 cm with an average of 2.1 cm, meaning that most of the shrimp were juveniles (57.8%) and pre-adult (36.3%) and adult shrimp only 6.9%. Based on the study, it is known that the Padang Tikar waters are an important habitat for Penaeid juveniles and young shrimp as nursery ground.

The abundance of larvae in Padang Tikar waters ranged from 52-132 ind/1000m^3 in the water column 4.93-5.59 m. The nursery area has the characteristics of 40% mangrove cover with 30 species/ha true mangroves, average salinity 27 ppt, water temperature ranging from 31.5 – 32.6 ^{o}C in the surface column, and pH ranging from 7.74- 8.03.

b. Nursery area of North Kayong Water

The catch composition of mini bottom trawl in Teluk Batang, North Kayong is dominated by 58.27% and non-shrimp (fish), 41.73%. Most shrimp species from the Penaeidae were caught by mini bottom trawl

The abundance of larvae in Teluk Batang waters was found from 0-74 ind/1000m^3, the highest abundance of larvae at 74 ind/1000m3 was found in the water column of 5.54-6.79 m. The nursery area has the characteristics: mangrove cover 20.33% consist of 15 species/ha of mangrove, average salinity 29.6 ppt, water temperature ranging from 27.74 – 30.7 ^{o}C in the surface column, and pH ranging from 8, 02-8,13.

c. Nursery area of Ketapang Water

The result of study showed that catch from experimental fishing in the Pawan-Ketapang Delta dominated by shrimp about 70.6%, and non-shrimp only 29.94. Some of the dominant species were *Parapenaeopsis coromandelica, Metapenaeus elegan, Peneaus merquensis, Scylla, Peneaus gracilima, Acetes, Atyopsis*, *M. lysianssa* (Figure 21). Shrimp species caught by mini bottom trawls are mostly Penaeidae shrimp, and other orders are Sergestidae, Palaemonidae, Atydae, and Aquilidae. The dominant Penaeidae found were: *P. coromandelika, P. gracilima*, and *Metapenaeus* sp.

In the waters of the Pawan-Ketapang Delta, the abundance of larvae ranged from 0-74 ind/1000m3, with the highest abundance of 74 ind/1000m3 in the water column from 2.50-5.05 m. The nursery area has the characteristics: mangrove cover is only 3.86%, but true mangrove species is relatively high, about 39 species/ha, average salinity is 34.1 ppt, water temperature ranges from 27.74 – 29.07o C in the surface column, and pH ranged from 7.32-8.32.

SPAWNING AREA OF PENAEID SHRIMP

Fishing experiment of adult shrimp (Figure 12) was carried out at the location indicated by fishers using a modified trammel net, by the term in West Kalimantan; the fishing gear is called “loding”. Loding is a shrimp fishing gear, operationally like a trammel net. Loding net length is about 100-200 m with a net height of 120 cm.

The fishing grounds are 5-10 miles from the coast, with catchment areas in Tanjung Harapan, Ambarawa, Sungai Jawi, Tasik Malaya and Dusun Besar. Each fishing effort takes 2 days. The loding catch is around 100 kg in June, July, August and about 400 kg in April, May, October, and November. Based on the loding catch (Table 1), the shrimp caught were in the adult stage.

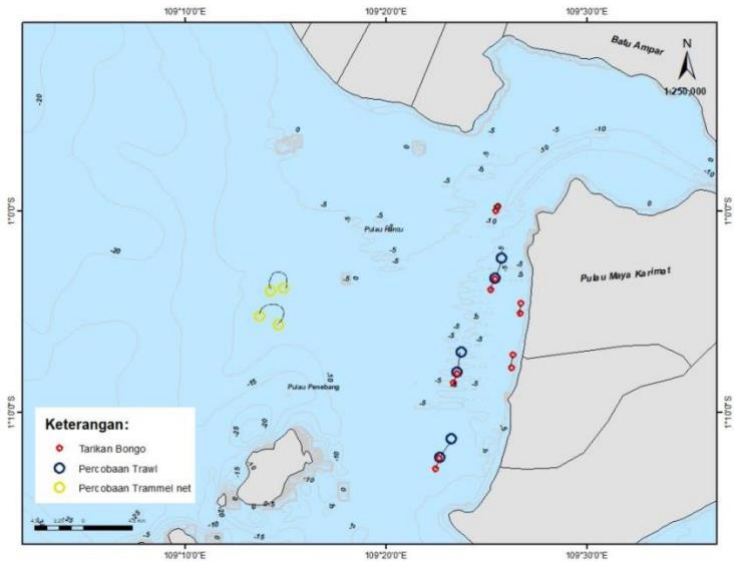


Figure 12.Fishing experiment locations with multiple fishing gear (Trammel net locations represent adult shrimp locations, indicating a spawning area).

BIOLOGICAL PARAMETERS OF PENAEID SHRIMP

a. The population structures

The population structure of *Penaeus merguiensis* shrimp is shown in Figure 13. The total number of *Penaeus merguiensis* shrimp caught was 664, dominated by male shrimp (57%). The length of the male shrimp ranged from 20 - 41 cm and weighed between 6.86 - 45.19 grams, while the female shrimp had a length of 23-54 cm and weighed between 8.57 - 88.71 grams. Male shrimp dominated the carapace length class 29-31 mm, while female shrimp dominated the 38-40 cm carapace length class.

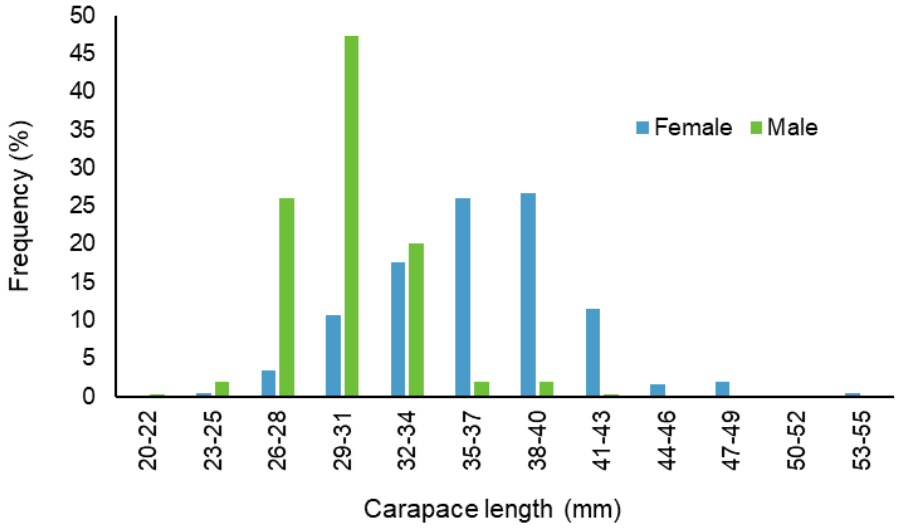


Figure 13.Carapace length class (mm) of *Penaeus mergueiensis* shrimp

About 107 *Penaeus indicus* shrimp were observed at the study site, dominated by male shrimp (57%). The male shrimp caught had a carapace length between 17-35 cm and weight 5.45-38.55 grams, while the female shrimp caught had a carapace length size 23-40 m and a weight 6.87 - 36.45 grams. Male shrimp in 29-31 mm carapace length class dominated with 47.3%, while

female shrimp dominated in class 38-40 mm with a percentage of 26.7%. Figure 14 shows the carapace length class frequency of *Penaeus indicus* shrimp caught at the study site.

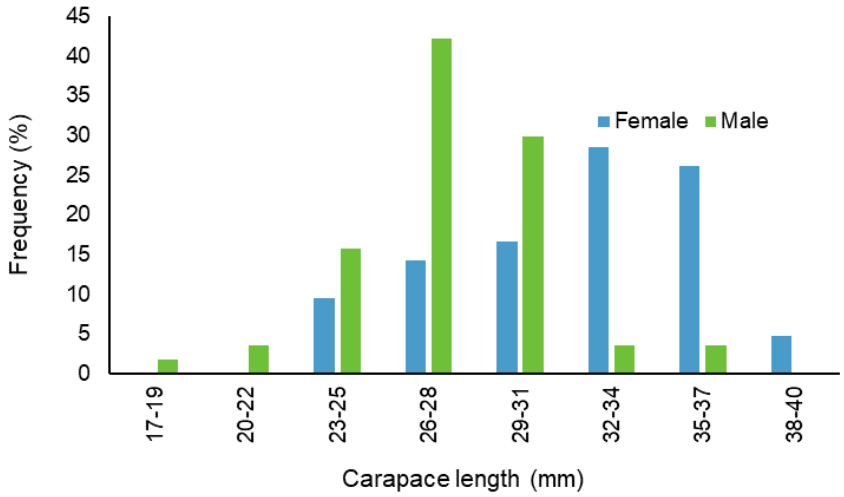
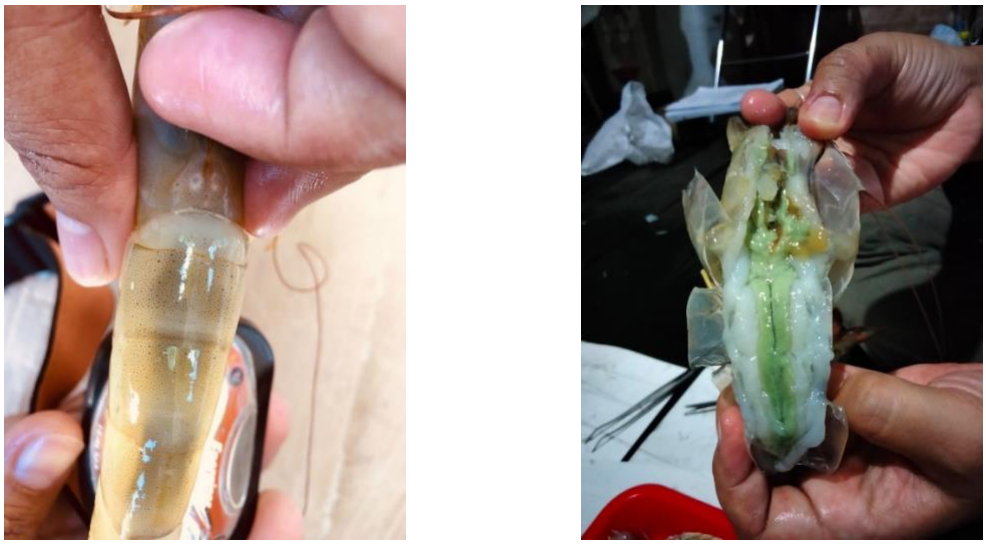


Figure 14.The carapace length class (mm) of Penaeus indicus shrimp

b. Gonad maturity stages

During the study, the team observed gonadal maturity (stage I-V) of female shrimp *P. merguiensis* and *P. indicus*, divided into immature female and mature female shrimp (Figure 15). The survey results revealed that the presence of 262 mature female *P. merguiensis* shrimps (59%) more than the immature shrimp (41%), whereas the mature female *P. indicus* (32 fish, 22%) were less compared to its mature females (78%) from a total of 41 samples. Figure 16 shows the percentage of immature and mature female shrimp from both species of *Penaeus.*

Immature



Mature

Figure 15.Gonad maturity of Penaeus merguiensis

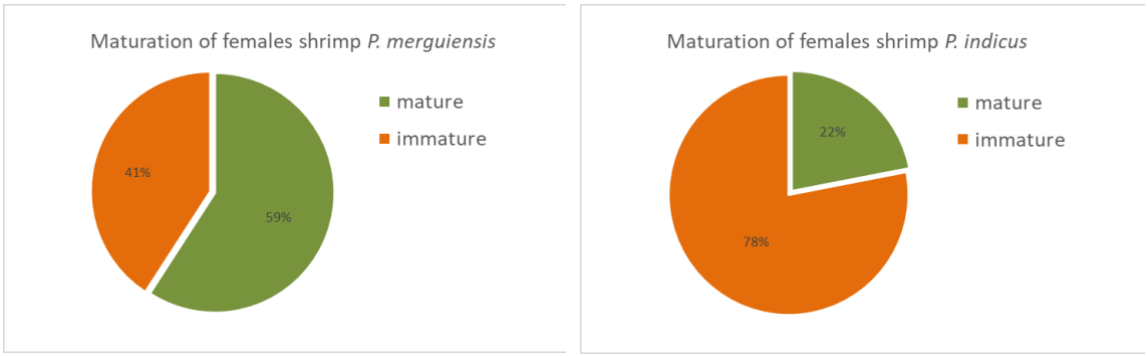
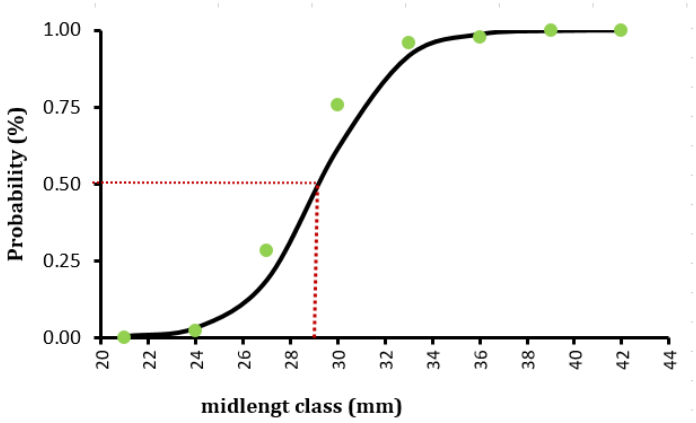


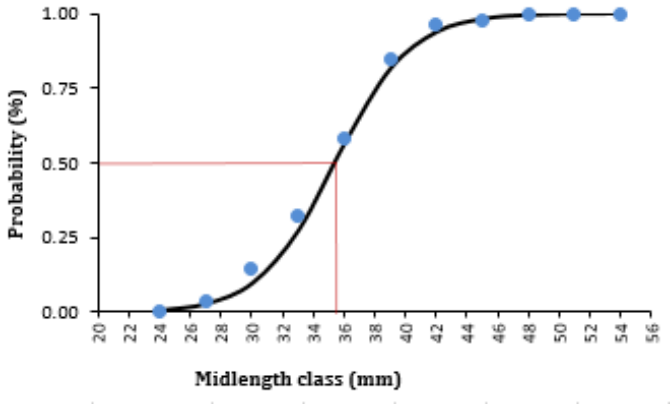
Figure 16.The percentage of mature and immature females of P. merguiensis and P. indicus

c. Carapace length at first capture (Lc) and carapace length at first maturity (Lm)

The different carapace length at first capture (Lc) values between males and females shrimp occurred from Lc analysis for both species *Penaeus* shrimp, where the Lc of females was higher than the males shrimp. The carapace length at first capture (Lc) of *Penaeus merguiensis* males shrimp was 29.27 mm, while the Lc of females' shrimp was 35.34 mm. Overall, the Lc from *Penaeus merguiensis* was 32.85 mm. Figure 17 shows a graph of the estimated Lc of the male *Penaeus merguiensis* shrimp (a) and the female (b).



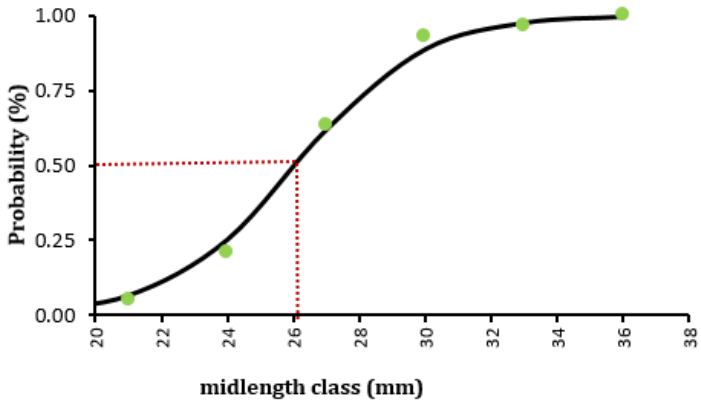
(a)



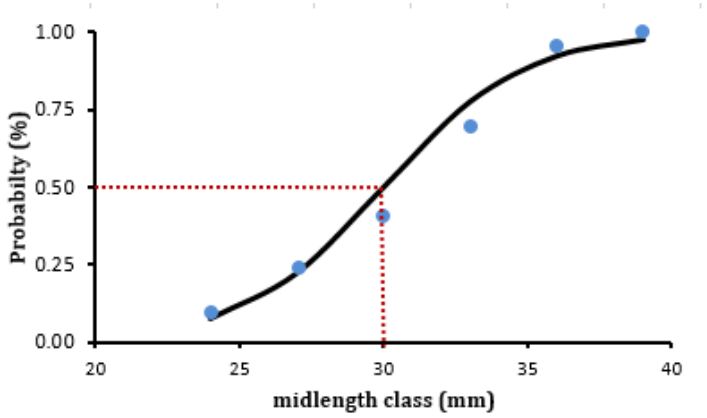
(b)

Figure 17.Length at first capture of (a) males and (b) females Penaeus merguiensis

The Lc value of males *Penaeus indicus* shrimp (26.07 mm) was smaller than of females' shrimp (30 mm), where overall, the Lc caught from *Penaeus indicus* shrimp was 32.85 cm. The graphs for Lc of males and females *Penaeus indicus* shrimp are shown in Figures 18 a and b.



(a)



(b)

Figure 18.Length at first capture of (a) males and (b) females Penaeus indicus

The carapace length at first maturity (Lm) of the females *P. merguiensis* was 34.9 mm (Lm) and 34.2 mm for *P. indicus*. Comparison of Lc and Lm values of *P. merguiensis* shrimp showed a higher Lc value than Lm (Lc = 35.34 mm, Lm = 34.9 mm), while for *P. indicus* shrimp the value of Lc smaller than Lm (Lc = 30 mm, Lm = 34.2 mm). A good fishing condition is when the value of Lc higher than Lm, and indicates that the shrimps caught are big size or mostly mature.

Table 1 shows the catch of economically important shrimp, *Penaeus merguiensis* and *P. indicus* species, based on four types of fishing gear. *P. indicus* was mostly caught using trawl, while *P. merguiensis* was caught more by trammel net loading. Most of the *P. merguiensis* shrimp caught with the trammel net were adult shrimp (149 individuals), when referring to the length at first maturity of female shrimp (*P. merguiensis* = 34.9 mm). Most of the *P. indicus* caught were immature shrimp (26 individuals), with the Lm value of *P. indicus* = 34.2 mm.

Table 1.Shrimp catches by type of fishing gear (primer data, 2021)

Sex of shrimp	Number of shrimps			
	Tidal Traps	Mini trawl	Trammel	Trammel net (loding)
Penaeus indicus				
Immature Female	5	26		2
Mature Female	3	3		3
Male	7	32	14	4
Penaeus merguiensis				
Immature Female	2	16	2	87
Mature Female	4	2		149
Male	11	15	17	306

WATER ENVIRONMENT CONDITIONS

a. Oceangraphic Parameters

Habitat characteristics are one of the important variables to determine the sustainability of the shrimp life cycle and environmental feasibility for the survival of shrimp in nature. The depths of the waters of Padang Tikar and Dusun Besar, West Kalimantan, which are estimated as nursery and foraging areas for Penaeid shrimp, range from 1.5-15 meters, while the waters as spawning areas range from 6-20 meters. Adult

female *Penaeues merguiensis* in the Arafura Sea are found spawning at depths between 13-35 m (Naamin, 1984) and in the waters of the Gulf of Carpentaria, Australia at depths of more than 15 m (Crocos & Kerr, 1983).

The value of the water temperature ranges in Padang Tikar and Dusun Besar ranges from 29.5-32.9 °C. In the adult phase or during spawning, shrimp live in a temperature range between 29-33 °C, while in the larval and juvenile stages can live in a wider temperature range, between 24-32 °C (Staples & Vance, 1979; Tung et al. al., 2002).

The pH concentration in the waters of Padang Tikar and Dusun Besar ranged from 7.5-8.17. The pH concentration in these areas is included in the range category values suitable for the development of shrimp life in the waters. Raharjo (2003) stated that the optimal range of pH for the development of live shrimp is between 7.5-8.3.

The dissolver oxygen (DO) concentration values found during observations ranged between 4.41-8.81 mg/L. According to Tricahyo (1995) and Anggoro (1992) optimal shrimp growth requires a DO range of 4.0-7.0 mg/L. If DO concentration is high, the shrimp respiration rate will increase and vice versa if DO concentration is low.

The salinity concentration value in the estuary area or around the mangrove areas of Padang Tikar and Dusun Besar is known to be less than 20‰, while the salinity concentration of the waters towards the sea ranges from 25-34 ‰. Pratiwi (2008) explained that banana shrimp can grow well in waters with salinity ranging from 15-30 ‰. Also explained by Huynh & Fotedar (2004) & Zulfikar (2016), *Penaeus merguiensis* shrimp still live at a salinity of about 34 ‰.

The turbidity level of the waters of Padang Tikar and Dusun Besar ranges from 0.1-56.6 NTU. The composition of the bottom substrate of the waters in the Padang Tikar and Dusun Besar areas was found to have 3 (three) different compositions of sand, mud, and clay substrates according to their location. The domination of the bottom substrate in the waters of Padang Tikar is dominated by clay, while in the waters of Dusun Besar it is dominated by mud. The *Penaeus merguiensis* and *P. indicus* prefer waters with a bottom of mud and/or sand mixed with mud (Naamin, 1984; Kusrini, 2011; Adyan, 2019).

b. Mangrove Ecosystem

The mangrove ecosystem is a critical habitat in the shrimp life cycle. Some experts suggest that the mangrove ecosystem greatly affects the population of shrimp, crabs, fish, and shellfish that live around the area. Siripong (1988) stated that the high population of Penaeid shrimp in waters has a dependence on the mangrove area. Martosubroto & Naamin (1977) stated that there was a positive correlation between fluctuations in the level of shrimp production and the mangrove area. This shows that the wider mangroves, the higher the production of shrimp produced. If there is degradation that results in the reduction or destruction of the mangrove forest area, over time it will cause a decrease in shrimp production in the surrounding area.

Observations through the interpretation of Landsat-8 Satellite Imagery acquired in March 2015 and ESRI World Imagery Satellite Imagery, the area of mangrove forest on the west coast of Kalimantan is 247,641.6 Ha (Figure 19). There was an increase in mangrove area on the coast of North Kayong Regency from 41,500 Ha in 2015 to 45,087 Ha in 2019 (Figure 20). The structure vegetation of the mangrove ecosystem on the coast of West Kalimantan consists of 17 true mangrove species, 25 associated mangrove species, and 11 coastal vegetation species. True mangrove species include *Acanthus ilicifolius*, *Acrosticum aureum, Avecinnia alba, A. caseolaris, A. marina, Bruguiera gymnorhiza, B. sexangula,*

Bruguiera sp., Ceriop decandra, Excoecaria agallocha, Heritera litoralis, Kandelia candel, *Lumnitzera racemosa*, *Nypa fruticant, Rhizophora mucronata, R. apiculata, Scyphiphora hydrophylacea, Sonneratia caeseolaris, S. alba,* and *Xilocarpus granatum* (Nurfiarini & Kusumawati, 2017).

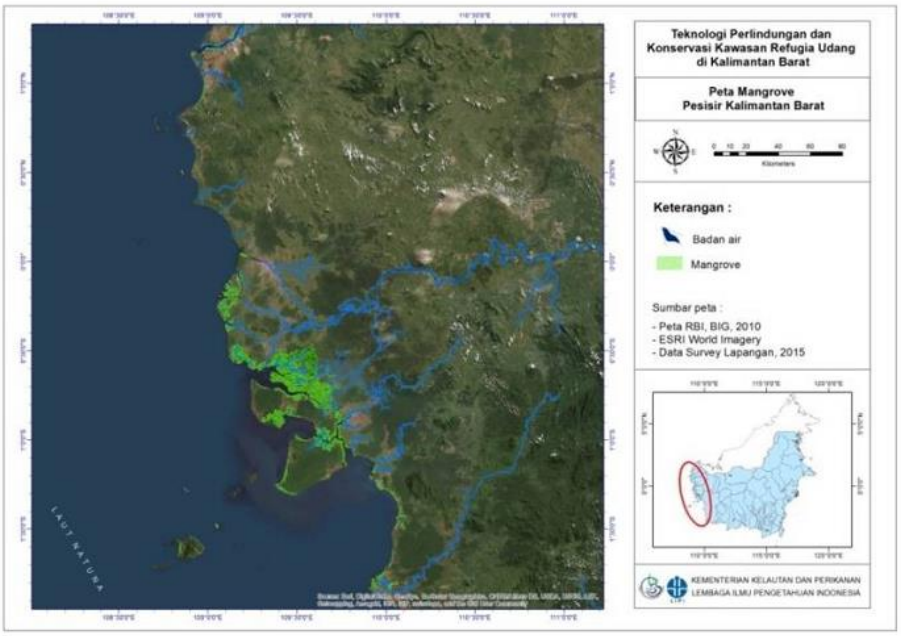


Figure 19.Mangrove Distribution of in West Kalimantan (Source: Nurfiarini & Kusumawati, 2016)

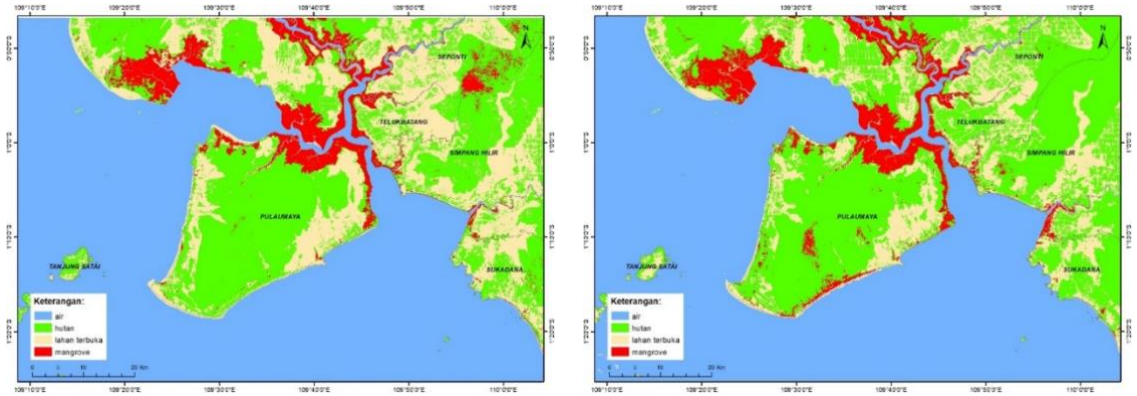


Figure 20.Distribution of mangroves in Dusun Besar, North Kayong Regency

The live stages distribution of shrimp can be predicted based on the fishing experiment at different locations. Shrimp in larval and juvenile stages are mostly caught by mini trawling gear operated around the coast (<5 miles from the shoreline) at a depth of less than two (2) meters. Meanwhile, mature shrimp were caught 5-10 miles from the shoreline at a depth of more than five meters. Based on this, the distribution of shrimp in the waters of Dusun Besar can be described on the map below (Figure 21).

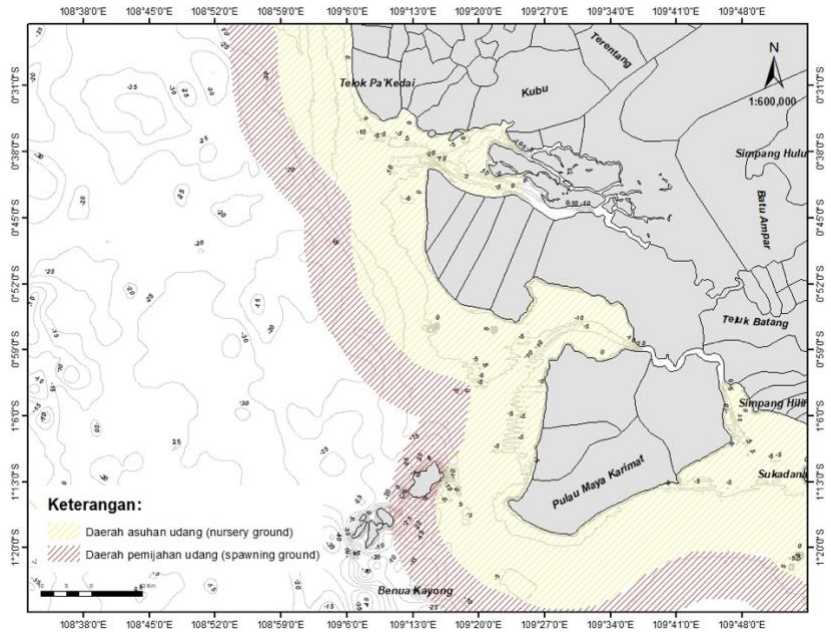


Figure 21.Estimation of Penaeid shrimp nursery and spawning area

SOCIAL ECONOMY CONDITION AND STAKEHOLDERS

a. Social economy condition

The areas of Padang Tikar II Village and Dusun Besar Village are 1318.4 Ha and 244.69 Ha, respectively. Both are coastal villages of West Kalimantan with population characteristics dominated by fishers who depend on marine products. The population of Padang Tikar II Village is 4,163 people with the number of family heads as many as 1,138 families, while the population of Dusun Besar Village is 4,007 people with the number of family heads about 1,119 families. The composition of Padang Tikar II Village population-based on livelihood is shown in Table 2.

Table 2.The composition of the population of Padang Tikar II Village by livelihood

No.	Type of jobs	Padang Tikar II Village		Dusun Besar Village	
		Quantity (individual)	%	Quantity (individual)	%
1	Farmers	540	33.4	652	56.5
2	Farm laborers	437	27.0		
3	Civil servants	46	2.8	6	0.5
4	Craftsmens	15	0.9		
5	Breeders	17	1.1		

6	Fishers	379	23.5	467	40.5
7	Fisher workers	152	9.4		
8	Entrepreneurs	30	1.9	28	2.4

Table 2 shows that the number of fishers in Padang Tikar II Village is 23.5% of the total village population. The fishers of Dusun Besar Village are 40.5% of the total population, the most after the farmers.

In terms of education level, most of the respondents had a low level of education (elementary school): 83% in Padang Tikar II Village, and 77% in Dusun Besar Village (Figures 22 and 23). This condition can affect the acceptance of fishers to innovations or changes. One way to overcome this is through continuous efforts in disseminating and educating fishers on innovations or changes implemented in their environment.

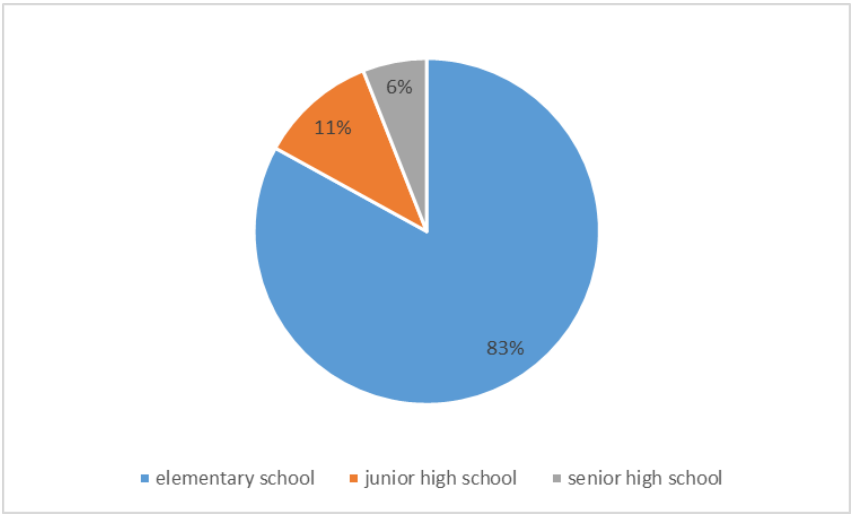


Figure 22.Composition of fishers by education status in Padang Tikar II Village

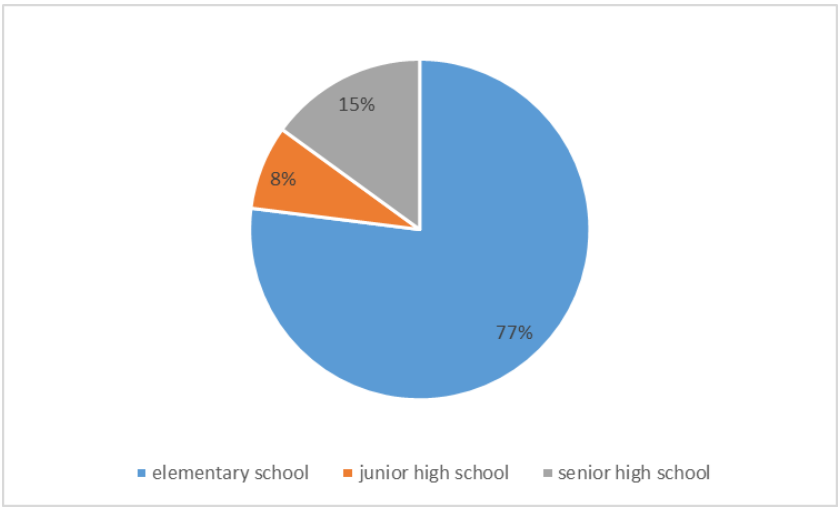
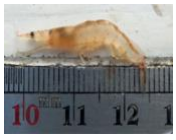


Figure 23.Composition of fishers by education level in Dusun Besar Village

Shrimps are the main catches of fishers in Padang Tikar II Village and Dusun Besar Village. The shrimps were caught using several types of fishing gear such as tidal traps, trammel nets, and mini trawls. Table 3 shows the economic value of various shrimp landed in several collectors in Padang Tikar II Village and Dusun Besar Village.

Table 3.The economic value of various shrimp at the collector level in Padang Tikar II Village and Dusun Besar Village

No.	Shrimp's Scientific name	Shrimp's Local Name	Photo of Shrimps	Shrimp Price (Rp/kg)	
				Padang Tikar II Village	Dusun Besar Village
1.	*Penaeus merguiensis, Penaeus indicus*	Udang wangkang		50,000	55,000
2.	*Metapenaeus tenuipes*	Udang T / sudu		30,000	35,000
3.	*Parapenaeopsis hungerfordi*	Udang merah		6,000	4,000
4.	*Metapenaeus brevicornis*	Udang kuning		15,000	15,000
5.	*Metapenaeus elegans*	Udang dogol		35,000	35,000
6.	*Acetes*	Udang rebon		4,000	-

A fisher usually sells his catch to collectors who live close to his residence in marketing their catch. The yield is directly sold to the collectors fresh or frozen. For certain kinds of shrimp, such as mantis shrimp, the price in a live condition is higher than dead. The flow of shrimp marketing in Padang Tikar II Village and Dusun Besar Village is shown in Figure 24.

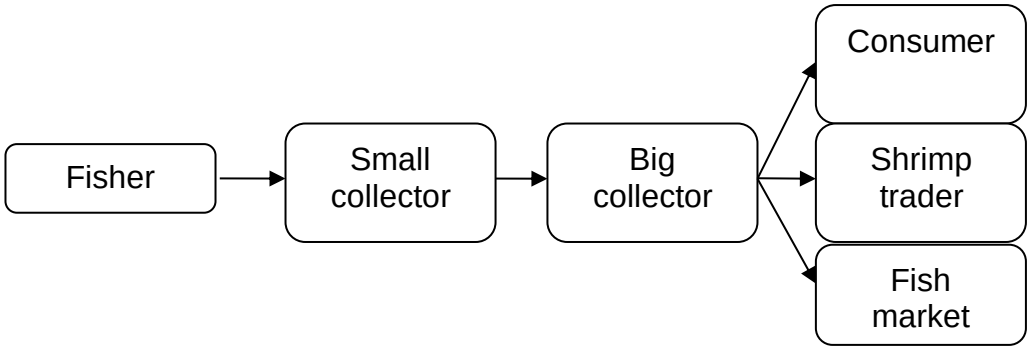


Figure 24.Marketing flow of shrimp catches in Padang Tikar and Dusun Besar

b. Stakeholders

Stakeholders are all parties that influence and are affected by the sustainability of the utilization of shrimp resources, either directly or indirectly. Stakeholder involvement in shrimp fisheries management starts from the planning process to implementing management policies. In general, stakeholders in shrimp fisheries in West Kalimantan consist of Ministries/Institutions, Provincial/Regency/City governments related to fisheries, ministries/institutions, and Provincial/Regency/City governments related to water resource use (e.g. transportation, mining, agriculture, environment and forestry), universities/colleges/research institutes (academics), fishers, collectors, cultivators and other fishery actors.

Based on their authority, shrimp fisheries stakeholders can be divided into primary and secondary groups. The primary group has the authority to utilize and manage shrimp fisheries sustainably. Meanwhile, the secondary group has the authority to set rules, conduct dissemination and guidance, enforce laws, and evaluate sustainable shrimp fisheries management policies, as presented in Table 4.

Table 4.Stakeholders in West Kalimantan Province shrimp fisheries

Group	Stakeholders	Role Description
Primary	Fishers	Utilization of shrimp resources every day
	Collector/city/small agent	Accommodating and buying shrimps caught by fishers
	Collector/city/big agent	Accommodate and buy shrimps from small collectors
	Processor	Accommodating shrimp caught from fishers with certain fishing gears
Secondary	Ministry of Marine Affairs and Fisheries	- Managing the stock of shrimp resources - Ensure the sustainability of shrimp resources

Group	Stakeholders	Role Description
		- Supervise the destructive capture of shrimp resources
	Provincial Marine Affairs and Fisheries Service	- Supervise the destructive capture of shrimp resources - Conduct the guidance of local fishermen and fishing groups - Conduct training to improve the skills of fishers - provide fishing facilities and infrastructure
	Regency/City level of Marine and Fisheries Service	- Empowering local fishers - Conduct training and education to improve the skills of local fishers - Provide fishing facilities and infrastructure
	University or Research Institute	- empowering fishers/fisher groups - apply research results - disseminate the application of effective fisheries management - strengthen fishermen institutions
	NGO	- empowering fishers/fisher groups - building the capacity of fishers/fisher groups

MANAGEMENT MEASURES

a. Issues in Penaeid Shrimp Resource Management

The Penaeid shrimp resources management issues in West Kalimantan are as follows:

I. The Characteristics of Penaeid Shrimp

1. The age of the shrimp is about 1-2 years. Its utilization must be appropriate so that the pre-adult phase are not caught. According to Motoh (1981), an adult Penaeid shrimp can spawn between 200,000 and 1,000,000 eggs in one spawning period.

2. The growth of Penaeid shrimp is fast, especially young shrimp (Garcia & Le Reste, 1981). In addition, it has a high mortality rate.

3. There are many species of shrimp whose territory is evenly distributed. There are pre-adult shrimp mixed with big young shrimp in the same area. Determining the right catching time is very important, so that both types of shrimp can be caught in optimal conditions.

4. Shrimp have a unique life cycle. They usually spawn in the ocean and require a brackish or estuary environment as a nursery ground and feeding ground for young shrimp.

II. Ecological Problems

1. Shrimp habitat degradation due to water pollution

2. A conversion of mangroves into ponds and oil palm plantations

3. Use of destructive and environmentally unfriendly fishing gear, such as mini trawls and tidal traps

III. Social, Cultural and Institutional Issues

1. Ineffective supervision and enforcement of established fisheries laws and regulations.

2. Proper locations for placing passive fishing gear (tidal traps, guiding barrier) in the river and sea shipping lanes.

3. The use of mini trawls is difficult to control.

4. Distribution of subsidized fuel is not timely and uneven.

5. The existence of conservation areas in the Padang Tikar and Dusun Besar areas is still neglected by fishers.

6. Weak or non-functioning fishing groups.

7. Dependence on the dealer/shrimp agent in completing business needs.

8. Lack of guidance from relevant institutions in providing good organizational assistance and training.

b. Recommendations for refugia areas and management measures

Based on studies conducted to identify important habitats for the shrimp life cycle, considering biological, ecological, socio-economic aspects, as well as the results of delineation of established conservation areas in the decree of Ministry of Marine Affairs and Fisheries No. 89 of 2020, the recommended **shrimp refugia area is 4,148.07 km^2 or 414,807 ha** located in Kubu Raya, North Kayong, and Ketapang Regencies. Detailed geographical position delineation can be seen in the Appendix. Figure 25 shows the recommended Penaeid shrimp refugia area in West Kalimantan.

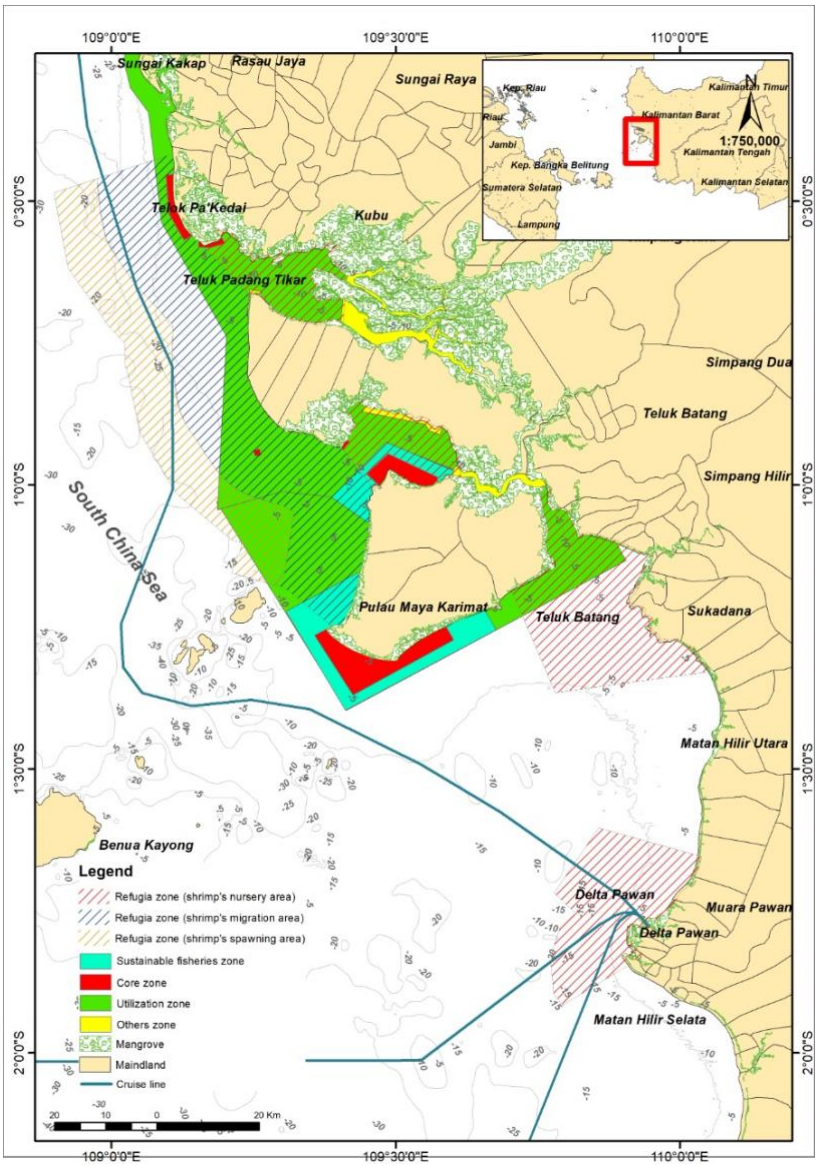


Figure 25.Delineation Map of Penaeid Shrimp Refugia Area in three regencies of West Kalimantan (Supplementing the decree of Ministry of Marine Affairs and Fisheries No. 89 of 2020 concerning Kubu Raya and North Kayong Water Conservation Areas in West Kalimantan Province)

Several management measures in the shrimp fisheries refugia area that can be implemented on the coast of West Kalimantan include:

1. Strengthening local wisdom

   Local wisdom is a social capital that needs to be preserved for better management of natural resources and the environment, such as limiting the fishing period considering the following matters:

   - High waves and bad weather season where most fishers do not go to sea for safety reasons.
   - Most fishermen do not go to sea every Friday and every 1 Muharram every year due to the assumption that these days are “worship days”.

2. Control of fishing effort

    - If the number of fishing boats operating exceeds the specified number and can interfere with the stock-recruitment process, it is possible to schedule fishing boat sailing days so the number of operating fishing vessels can still be controlled and does not interfere with the stock-recruitment process and fishers can plan their sailing day.
    - Reduction and rearrangement of active and passive fishing gears by 20% of the current number of fishing gear.
    - Controlling the mesh size of shrimp fishing gear in mini trawls and trammel nets.

3. Shrimp habitat management

    - Arrangement of sea transportation routes, especially for fisheries refugia areas.
    - Improvement of Penaeid shrimp nursery habitat by replanting mangroves, especially around mangrove areas with decreased environmental quality due to pollution.
    - Management based on community participation. Provide understanding to fishers regarding the sustainability of shrimp resources in their area by environmentally friendly fishing processes and protecting shrimp habitat.

4. Institutional Strengthening

    Intensive and continuous institutional strengthening is needed to implement the arrangement of the shrimp fishing business on the coast of West Kalimantan. Several reasons for consideration, including:

    - The existence of fisherman institutions is extremely needed, especially in supporting the socio-economic activities of fishers,
    - Enlarging and increasing the collective economic scale of the fishers' business,
    - Improve collective bargaining position in accessing capital, markets, technology and policies,
    - Develop the ability to coordinate and cooperate in partnerships, including supervision in the management of fishing business activities,
    - Facilitate the control of shrimp fishing activities responsibly and profitably for fishers.

CONCLUSION AND RECOMMENDATION

a. Conclusion

The recommended areas for Penaeid shrimp refugia (*Penaeus merguiensis* and *Penaeus indicus*, local name: wangkang shrimp) are in Kubu Raya (Padang Tikar), Ketapang (Delta Pawan), and North Kayong (Dusun Besar). The refugia area is determined by considering the biological, ecological, and socio-economic aspects and the results of delineation of the established conservation area in the decree of Ministry of Marine Affairs and Fisheries No. 89 of 2020. The area of the shrimp refugia area is 4,148.07 km^2 or 414,807 ha located in Kubu Raya, Ketapang, and North Kayong Regencies.

b. Recommendation

The preparation of regulations and sanctions needs to be implemented as soon as possible because it is important in maintaining the sustainability of Penaeid shrimp fisheries refugia in Kubu Raya (Padang Tikar), Ketapang (Delta Pawan) and North Kayong (Dusun Besar) by considering several things, including:

1) Strengthening local wisdom

2) Control of fishing effort

3) Shrimp habitat management

4) Institutional strengthening

5) Supervision

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APPENDIX 1.

Geographical position of Penaeidae shrimp refugia zone on the southern coast of West Kalimantan

a. The nursery, migration, and spawning areas of Penaeidae Padang Tikar, Dusun Besar, Kubu Raya Regency

Point	Latitude	Longitude	Point	Latitude	Longitude
Point 1	1° 15' 7.144" S	109° 23' 28.306" E	Point 45	0° 38' 5.581" S	109° 23' 52.120" E
Point 2	1° 10' 52.330" S	109° 18' 19.848" E	Point 46	0° 37' 30.649" S	109° 23' 5.545" E
Point 3	1° 9' 18.452" S	109° 12' 44.567" E	Point 47	0° 37' 7.362" S	109° 21' 39.381" E
Point 4	1° 6' 17.400" S	109° 13' 18.096" E	Point 48	0° 37' 42.293" S	109° 21' 2.121" E
Point 5	1° 0' 55.531" S	109° 6' 49.170" E	Point 49	0° 38' 33.526" S	109° 21' 13.765" E
Point 6	0° 54' 26.605" S	109° 3' 1.179" E	Point 50	0° 39' 10.786" S	109° 21' 53.354" E
Point 7	0° 47' 57.679" S	109° 1' 40.712" E	Point 51	0° 39' 22.429" S	109° 21' 2.121" E
Point 8	0° 42' 29.104" S	108° 59' 13.188" E	Point 52	0° 40' 15.991" S	109° 21' 23.080" E
Point 9	0° 37' 7.235" S	108° 55' 25.197" E	Point 53	0° 40' 29.963" S	109° 22' 28.285" E
Point 10	0° 29' 11.136" S	108° 53' 58.024" E	Point 54	0° 40' 27.635" S	109° 23' 24.175" E
Point 11	0° 24' 56.323" S	109° 6' 35.759" E	Point 55	0° 40' 22.977" S	109° 24' 6.093" E
Point 12	0° 27' 8.782" S	109° 6' 37.605" E	Point 56	0° 40' 25.306" S	109° 24' 43.353" E
Point 13	0° 27' 20.161" S	109° 5' 49.246" E	Point 57	0° 40' 53.251" S	109° 25' 15.956" E
Point 14	0° 28' 59.725" S	109° 5' 52.091" E	Point 58	0° 42' 38.045" S	109° 24' 22.394" E
Point 15	0° 30' 39.289" S	109° 6' 0.625" E	Point 59	0° 42' 28.730" S	109° 23' 33.490" E
Point 16	0° 32' 47.299" S	109° 6' 48.984" E	Point 60	0° 42' 49.689" S	109° 20' 57.464" E
Point 17	0° 34' 6.950" S	109° 7' 43.033" E	Point 61	0° 42' 3.114" S	109° 18' 9.793" E
Point 18	0° 33' 41.348" S	109° 8' 28.548" E	Point 62	0° 40' 41.607" S	109° 16' 34.314" E
Point 19	0° 34' 9.795" S	109° 9' 14.063" E	Point 63	0° 39' 52.703" S	109° 15' 33.766" E
Point 20	0° 34' 55.310" S	109° 9' 14.063" E	Point 64	0° 39' 50.375" S	109° 14' 40.205" E
Point 21	0° 34' 55.310" S	109° 10' 39.403" E	Point 65	0° 42' 15.086" S	109° 14' 22.345" E
Point 22	0° 34' 35.397" S	109° 11' 59.055" E	Point 66	0° 44' 39.400" S	109° 14' 28.904" E
Point 23	0° 33' 49.882" S	109° 11' 36.297" E	Point 67	0° 47' 6.994" S	109° 14' 25.625" E
Point 24	0° 33' 24.280" S	109° 12' 16.123" E	Point 68	0° 48' 42.110" S	109° 14' 22.345" E
Point 25	0° 33' 55.572" S	109° 12' 53.104" E	Point 69	0° 51' 9.705" S	109° 15' 24.662" E
Point 26	0° 34' 46.776" S	109° 13' 27.240" E	Point 70	0° 53' 27.459" S	109° 17' 19.458" E
Point 27	0° 35' 40.825" S	109° 13' 44.308" E	Point 71	0° 54' 29.777" S	109° 19' 40.492" E
Point 28	0° 35' 57.893" S	109° 14' 38.357" E	Point 72	0° 54' 56.016" S	109° 21' 22.168" E
Point 29	0° 36' 34.874" S	109° 15' 12.493" E	Point 73	0° 55' 48.493" S	109° 23' 20.243" E
Point 30	0° 36' 9.272" S	109° 15' 43.785" E	Point 74	0° 56' 7.235" S	109° 23' 53.628" E
Point 31	0° 35' 55.048" S	109° 16' 57.746" E	Point 75	0° 56' 2.813" S	109° 24' 18.689" E
Point 32	0° 36' 43.408" S	109° 16' 46.368" E	Point 76	0° 56' 21.978" S	109° 24' 31.957" E
Point 33	0° 36' 26.340" S	109° 18' 14.553" E	Point 77	0° 55' 28.906" S	109° 25' 5.865" E
Point 34	0° 35' 49.359" S	109° 18' 57.223" E	Point 78	0° 55' 5.318" S	109° 24' 55.545" E
Point 35	0° 35' 40.825" S	109° 20' 2.651" E	Point 79	0° 54' 18.143" S	109° 25' 22.081" E
Point 36	0° 35' 15.223" S	109° 21' 27.991" E	Point 80	0° 53' 37.936" S	109° 25' 52.768" E
Point 37	0° 35' 15.223" S	109° 22' 27.729" E	Point 81	0° 52' 41.374" S	109° 25' 20.021" E
Point 38	0° 34' 55.310" S	109° 22' 59.021" E	Point 82	0° 52' 11.604" S	109° 24' 53.229" E
Point 39	0° 35' 9.533" S	109° 23' 30.312" E	Point 83	0° 51' 18.019" S	109° 26' 7.652" E

Point 40	0° 35' 49.359" S	109° 22' 50.487" E	Point 84	0° 51' 56.720" S	109° 27' 19.099" E
Point 41	0° 36' 40.563" S	109° 23' 16.089" E	Point 85	0° 52' 26.489" S	109° 29' 15.200" E
Point 42	0° 37' 34.612" S	109° 24' 18.672" E	Point 86	0° 52' 35.420" S	109° 30' 59.394" E
Point 43	0° 37' 45.991" S	109° 25' 32.634" E	Point 87	0° 53' 23.051" S	109° 31' 58.933" E
Point 44	0° 38' 38.183" S	109° 25' 11.298" E	Point 88	0° 53' 58.775" S	109° 33' 49.080" E
Point	**Latitude**	**Longitude**	**Point**	**Latitude**	**Longitude**
Point 89	0° 54' 4.728" S	109° 34' 57.550" E	Point 101	1° 0' 0.514" S	109° 27' 35.927" E
Point 90	0° 54' 49.383" S	109° 35' 36.250" E	Point 102	1° 0' 26.965" S	109° 27' 23.718" E
Point 91	0° 56' 6.783" S	109° 35' 54.112" E	Point 103	1° 0' 51.382" S	109° 27' 25.753" E
Point 92	0° 57' 12.276" S	109° 36' 23.881" E	Point 104	1° 1' 42.962" S	109° 27' 2.789" E
Point 93	0° 58' 32.654" S	109° 36' 53.651" E	Point 105	1° 3' 4.284" S	109° 27' 10.534" E
Point 94	0° 59' 8.377" S	109° 36' 50.674" E	Point 106	1° 5' 4.331" S	109° 27' 6.661" E
Point 95	0° 58' 56.470" S	109° 35' 27.319" E	Point 107	1° 7' 0.505" S	109° 26' 51.172" E
Point 96	0° 59' 41.124" S	109° 34' 27.780" E	Point 108	1° 9' 8.296" S	109° 26' 16.319" E
Point 97	0° 59' 5.575" S	109° 34' 28.980" E	Point 109	1° 10' 56.725" S	109° 26' 4.702" E
Point 98	0° 56' 45.178" S	109° 29' 19.699" E	Point 110	1° 12' 56.772" S	109° 25' 33.722" E
Point 99	0° 58' 49.298" S	109° 26' 59.301" E	Point 111	1° 14' 33.584" S	109° 24' 47.253" E
Point 100	0° 59' 54.409" S	109° 28' 8.483" E			

b. The nursery area of Teluk Batang

Point	**Latitude**	**Longitude**	**Point**	**Latitude**	**Longitude**
Point 112	1°21'47.832"S	109°46'51.035"E	Point 124	1°4'5.693"S	109°50'18.137"E
Point 113	1°11'11.732"S	109°42'18.843"E	Point 125	1°5'22.617"S	109°53'6.778"E
Point 114	1°8'5.34"S	109°45'54.822"E	Point 126	1°6'18.83"S	109°56'36.839"E
Point 115	1°4'2.735"S	109°44'46.774"E	Point 127	1°8'2.382"S	109°57'18.259"E
Point 116	1°1'11.135"S	109°44'43.815"E	Point 128	1°11'38.36"S	109°55'37.667"E
Point 117	1°0'23.798"S	109°42'39.554"E	Point 129	1°13'48.538"S	109°57'9.383"E
Point 118	1°1'49.597"S	109°40'56.003"E	Point 130	1°15'29.131"S	109°57'38.97"E
Point 119	0°58'13.619"S	09°41'49.257"E	Point 131	1°16'13.51"S	09°59'52.107"E
Point 120	0°58'10.661"S	109°44'11.27"E	Point 132	1°17'0.848"S	110°1'11.989"E
Point 121	0°59'0.957"S	109°45'51.863"E	Point 132	1°19'43.571"S	110°2'58.499"E
Point 123	1°0'59.301"S	109°46'39.201"E			

c. The nursery area of Teluk Batang

Point	**Latitude**	**Longitude**
Point 133	1°54'58.731"S	109°47'41.121"E
Point 134	1°53'48.973"S	109°46'43.39"E
Point 135	1°51'5.403"S	109°46'19.336"E
Point 136	1°46'55.236"S	109°47'17.066"E
Point 137	1°45'6.991"S	109°49'0.501"E
Point 138	1°43'9.124"S	109°46'45.796"E
Point 139	1°36'22.604"S	109°51'24.827"E
Point 140	1°39'15.796"S	110°2'9.487"E

Point 141	1°40'20.743"S	110°2'4.676"E
Point 142	1°41'42.528"S	110°1'31"E
Point 143	1°46'48.02"S	109°57'11.212"E
Point 144	1°47'16.885"S	109°56'6.265"E
Point 145	1°47'19.291"S	109°54'58.912"E
Point 146	1°48'24.238"S	109°55'3.723"E
Point 147	1°49'48.428"S	109°55'39.805"E

APPENDIX 2

The full version of the profile of the refugia area will be published in Bahasa Indonesia book entitled **THE FISHERIES REFUGIA PROFILE OF WEST KALIMANTAN PROVINCE** (on the process of SUBMISSION to AMAFRAD Press).