DISCUSSION

The numbers of small white shrimp (*Metapenaeus lyssianassa*) caught by setnet

The individual numbers of small white shrimp caught by setnet in this site showed different results. According to sampling position the shrimp caught were high at stations close to the mangrove forest while shrimp caught away from the mangrove forest in the river and in the outer of estuary were low. Mangrove forest contributes to increase the amount of nutrient by falling leaf (Primavera, 1997). In fact the mangrove forest is supposed to influence the abundance of shrimp in the water and the roots of mangrove forest give shelter for shrimp from predator. The most abundance of mangrove forest in this estuary are nipah (*Nypa frutican*) and berembang (*Sonneratia caseolaris*). The mangrove forest area in this estuary is more than 40 ha. However, in several places mangrove forest is cut by local community for house construction and setnet. According to Castaneda and Defeo (2003) vegetated habitats are important in determining the distribution of penaeids in estuary, because they provide food and refuge from predators. Mangrove ecosystem is a suitable feeding, breeding, and nursery ground for various marine, estuarine and freshwater fishery resources (Hossain 2001).

Based on the salinity, the number of shrimp caught in Sungai Kakap estuary can be grouped into three. The first group was caught in the water salinity between 1 – 2‰, the second group was caught in the water salinity between 5 – 7‰ and the third group was caught in the water salinity 20‰. From this study small white shrimp is estimated to prefer staying in the water salinity between 5 – 7‰. According to Suseelan (1978) salinity is a limiting factor in the growth of most marine prawn species both directly and indirectly. Suseelan (1978) give example that *Penaeus indicus* prefers the minimum of salinity 4‰, *Penaeus semisulcatus* prefers the minimum of salinity 19‰, *Metapenaeus affinis* and *Metapenaeus dobsoni* prefer the minimum of salinity 14‰, *Parapenaeus stylifera* prefers the minimum of salinity 25‰, *Penaeus aztecus* prefers the minimum of salinity 8.5‰.

The salinity distribution in the estuary and in the river influences to the distribution of small white shrimp (*Metapenaeus lyssianassa*). In this study small white shrimp (*Metapenaeus lyssianassa*) was found in around 4 km from coastal water to the river. This fact is supported by study of Azis (1979) that *M. bennettae* was found in the distance 50 km from coastal water in Brisbane River with salinity
interval 0.4 – 10.7‰. Furthermore Munro in the year 1975 found *P. merguiensis* in Norman River with salinity 0.46‰ in the distance 80 km from coastal water (Azis *et al* 1983).

The carapace length of small white shrimp caught was analyzed by ANOVA. The F statistic result is $1.09 < F$ critical value 5.14 (*Appendix 6*). This indicates that the sizes of shrimp caught have no different. Range sizes of small white shrimp caught by setnet were from carapace length 0.8 cm – 2.1 cm. The most of shrimp caught were from carapace length 1.3 – 1.5 cm. The fact found that the bigger sizes of shrimp are not in abundance. According to Berachi (2003) one of overfishing symptom could be learned from a tendency to catch smaller sizes of shrimp individually over the year. Learning from range sizes of the shrimp caught by setnet which was composed from smaller sizes of the shrimp, it might warn that small white shrimp population in this estuary is declining.

**Sizes distribution of small white shrimp caught by setnet**

During the study the bigger sizes of shrimp caught were found in higher salinity in deeper water. While smaller sizes of the shrimp caught were from the lower salinity area. The factor might influence to distribution of smaller sizes of shrimp is water current. According to Macia (2004) one factor that may contribute largely to the pattern of distribution of smaller sizes in near proximity to mangroves could also be the water current.

The correlation analysis between salinity and small white shrimp is positive. The result of correlation analysis showed that $r$ statistic of shrimp sizes – water salinity 0.89** and $r$ statistic of shrimp sizes – water dept 0.86** (*Appendix 8*). It means that water salinity and water dept have positive correlation with the sizes distribution of small white shrimp in this estuary. There is an indication that adult small white shrimp prefer to inhabit in deeper water with salinity interval 10 – 20‰ in front of the mouth of estuary or in coastal water. Water spaces with salinity interval 10 – 20‰ generally is used by artisanal fishermen using setnet for fish and gillnet.

According to fisherman the dominant shrimp species caught by trawlers in the surrounding of Sungai Kakap marine waters with salinity more than 20‰ are yellow shrimp (*Metapenaeus brevicornis*), greasbaek shrimp (*Metapenaeus ensis*), red shrimp (*Solenocera subnuda*) and white shrimp (*Penaeus indicus*). But in several cases trawlers sometime enter in coastal water with salinity 10 – 20‰ primary at the
night found small white shrimp (Metapenaeus lysianassa) in the limited numbers. Penaeid shrimp production from trawlers with tonnage from 5 – 20 gross tones landed in catch landing base of Sungai Kakap in the year 2005 were yellow shrimp (Metapenaeus brevicornis) 273610 kg, greasbaek shrimp (Metapenaeus ensis) 264830 kg, red shrimp (Solenocera subnuda) 226812 kg, and white shrimp (Penaeus indicus) 180720 kg (Marine and fisheries agency of Sungai Kakap 2005).

The dominant bottom sediment of Sungai Kakap estuary is silt and clay. The percentage of sand content is increasing according to the distance of shore line. From the distribution of shrimp caught, it is supposed that silt and clay is preferred by small white shrimp (Metapenaeus lysianassa). The abundance of small white shrimp (Metapenaeus lysianassa) in silt and clay sediment might be influenced by their behavior to burry inside the estuary sediment beside there is enough availability of nutrient for shrimp. According to Ruello in Aziz (1983) the sizes of sediment texture less than 63 micron content high organic material (13.2%).

The study conducted by Aziz et al (1983) in Banten Bay showed that small white shrimp also was abundance in silt and clay sediment area. Furthermore Azis et al (1983) noted that other penaeid shrimps were found in different abundances in different sediment textures. P. monodon was not caught in sand and silt sediment but it was found in abundances in smooth silt and mud sediment. P. merguiensis was found in similar abundances in sand and silt sediment and it was found in silt and mud sediment. In addition Macia (2004) also noted that Fenneropenaeus indicus was found in abundance in sandy mud sediment but it was scarce found in mud sediment and Metapenaeus monoceros was found in abundance in mud sediment but it was scarce found in sandy mud sediment.

The sedimentation process in this estuary can threat the existence of small white shrimp habitat. It may be caused by mangrove cutting and the upland activities. The sedimentation might increase the water turbidity. At the moment the average of water transparency in the estuary is around 20 cm. The water transparency decreases along the river. The decreasing of water transparency might be caused by increasing of suspended material in the water column such as clay, sand, organic material and the others. Indirectly water transparency influences to water productivity. Decreasing of water transparency might decrease sunlight penetration to water column. Sunlight is needed by phytoplankton and water vegetation for photosynthesis process. Therefore water productivity could be decreased by sedimentation. For example from field investigation that the numbers of wood trap deployed in estuary water for
trapping giant fresh water shrimp (*Macrobacium rosenbergii*) are 200 units. Most of wood traps are from mangrove plant. The requirement of mangrove plant for one unit wood trap is in about 600 stick or equal with two of mangrove plants per unit or 400 of mangrove plants for the total of wood traps deployed in this estuary for one season or six months operation. The threat of mangrove cutting in this site could cause land erosion and it might change sediment texture and harm aquatic organism in the estuary.

**Setnet distribution**

To manage the setnet in this estuary it is important to have map. In the moment there is no spatial planning for setnet in this estuary. Map of setnet distribution is look like unmanaged and there is not sit line for water transportation. Therefore, the position of setnet should be regulated.

**Catch per unit effort (CPUE) of small white shrimp fishery**

The CPUE of small white shrimp tends to decrease from year to year. Decreasing of CPUE might be influenced by the increasing of fishing efforts. The result of correlation analysis between CPUE and effort shows that r statistic (- 0.82**) was bigger than r table, this means that the increasing of effort numbers has high negative correlation to CPUE values (**Appendix 12**).

According to Berachi (2003) the decreasing of CPUE, a tendency to catch more small sized individuals, a change in catch composition can be used to see overfishing symptom. However decreasing CPUE of small white shrimp caught by setnet in Sungai Kakap estuary might be important information to manage small white fishery.

The factors might decrease CPUE of small white shrimp in Sungai Kakap estuary estimated from several factors such as:

1) The increasing of effort numbers to catch small white shrimp and employment in higher levels in line with the increasing coastal population, poorness, lack skill and education and also lack mechanization to exploit the offshore fisheries resources have triggered overexploitation of fisheries resources in inshore fisheries which relatively has cheaper infestation and cheaper operational cost. The regulation on the limitation of effort numbers might become one factor to recover sustainability of small white shrimp in this estuary.
2) According to the fisheries commodity type, shrimp commodity relatively has higher prices in the market than fish therefore most of fishermen prefers to catch shrimp than fish. This tendency can be seen from the types of fishing gear deployment in this estuary, most of them are used to catch shrimp. This phenomenon also occurs in offshore fishery, most of fishing vessels are trawlers.

3) The utilization of small mesh sizes (0.5 inches) might cause smaller sizes of the shrimp caught by setnet. This case might decline CPUE of small white shrimp.

4) Due to heavy ship traffic inside the estuary, the threat of oil spills could be one factor to destroy marine habitat in this estuary.

Economic analysis of small white shrimp (Metapenaeus lysianassa) fishery

The average of fisherman income per trip from small white shrimp fishery in Sungai Kakap estuary is Rp. 25600. Fisherman income is usually used to fulfill the basic of family need. According to Pusdatinaker (2006) the minimum of regional pay for West Kalimantan province 2006 is Rp.512000 per month or Rp.17000 per day per person. Most of fisherman has more than two family members or fisherman income at the moment is not enough to fulfill the basic of family need because it is lower the minimum of regional pay values. Therefore, they still remain in poorness condition. To fulfill the basic of family need and to release from poorness condition, at least fisherman should have an income equal or higher than the minimum of regional pay. For example fisherman should have income Rp.51000 per day for three people in family and Rp.68000 per day for four people in family. One way might be able to increase fisherman income is a shrimp processing. The fisherman ought be encouraged to process small white shrimp (Metapenaeus lysianassa) to dry shrimp (udang ebi) which has higher price in the market still is not utilised fully. The processing of drying shrimp undertaken by fisherman or his family might increase the income.

However, to handle fisherman poorness government has responsibility. The improvement of fisherman skill, capability, capital and alternative livelihood are some solution to handle the fisherman poornes. The economic activities in coastal area which might be offered are fish processing (drying shrimp and drying fish processing), fish culturing and fish trading. Providing of alternative livelihood which is emphasized on fish commodity might be more reasonable and it could attract the fisherman enthusiasm to work harder to reach higher income.
Management implications

At the moment, Sungai Kakap estuary still has no regulation for fishery activities. Management measure using input control and output control still is not applied optimally to sustain fishery resources. According to King (1997) the objectives of fishery management are additional economic, social and environmental objectives, such as fishermen welfare, economic efficiency, the allocation of resources and environment protection. Concerning to the setnet fishery that has beneficial role for artisanal fishermen, fishery regulation should be developed to avoid overexploitation of fishery resources and environment degradation.

Management objectives of small white shrimp fishery can be achieved effectively using input control and output control such as:

1) It is predicted that adult small white shrimp (M. lysianassa) prefers to inhabit in water salinity 10 – 20‰. More time for adult small white shrimp (M.lysianassa) for spawning may protect them from overexploitation. Closure of water area at salinity 10 – 20‰ from trawlers might be a method to sustain small white shrimp fishery. According to Ruzafa. et al (2005) marine preservation is intended to protect critical spawning stock biomass, intraspecific genetic diversity, population age structure, recruitment supply and ecosystem balance while maintaining fishery.

2) Regulation of fishing ground primary for stationary fishing gears (setnet and wood trap) at settled water spaces might reduce social conflict among fishermen. At present setnet and wood trap deployment in Sungai Kakap estuary still is not regulated optimally. Coordination between fishermen organization and marine and fishery agency of Kabupaten Pontianak is suggested to regulate fishing gears deployment.

3) Minimum mesh sizes regulation for setnet can reduce smaller sizes of small white shrimps caught by setnet. At the moment mesh sizes of setnet in the end of the pocket is 0.5 inch. It is recommended that minimum mesh sizes in the end of the pocket should be bigger than 0.5 inch. When considering that most of small white shrimp caught by setnet were composed from smaller sizes. The choice of optimum mesh sizes for setnet need further investigation. According to Heikinheimo et al (2006) enlargement of the mesh size is an excellent measure to increase the sustainability of the fishery.
4) Limiting of setnet units in Sungai Kakap estuary could be one option to raise productivity and to maximize fishermen income. However, it will also result in the unemployment of fishermen who will be eased out fisheries. Diversification of fishermen skill could be done to make them more suitable for non fishing sector.

5) Mangrove cutting in Sungai Kakap estuary occurs along the year. To reduce water turbidity and estuary destruction from land erosion, preservation of mangrove vegetation from deforestation should be done. It suggested that fishermen do not use mangrove plants for their fishing gear construction. According to Nickerson (1999) mangrove ecosystems are important in trapping sediment and organic material from land sources interacting with seagrass and coral reef ecosystems by maintaining water quality.

6) Enforcement of regulations could be undertaken to ensure that management objectives will be achieved optimally. However, the first and most important aspect of enforcement is education. Education can be used to change local community attitudes toward overexploitation and environmental damaging practices. Local community education can use several media such as public meeting, radio talk, press article and posters (King 1997). Furthermore according to Walmsley and White (2003) effective education and awareness programs can increase the awareness of the communities about environmental issues and they can become much more proactive about their natural resource management.

7) Alternative livelihood such as; fish processing, fish culturing and fish trading are some solution to handle fisherman poorness.