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Mangrove Conservation Awareness amongst Shrimp Culturist in Malaysia

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ABSTRACT

Shrimp farming is an important industry in Malaysian agriculture. The growing domestic and export demands for the commodity have made shrimp farming expand over the years. However, intensive shrimp farming in Malaysia may result in substantial mangrove forest destruction as shrimp farms are mainly established in coastal mangrove forests. Thus, the objective of this paper is to ascertain the awareness of shrimp culturists in Peninsular Malaysia on the importance of mangroves conservation. Questionnaires were prepared using a 5-likert scale response option designed for a series of statements pertaining to the hypothetical environment and mangrove expected conditions in order to examine the understanding and perspective of the respondents toward environment issues. The data were analysed by exploratory factor analysis. The analysis uncovered four underlying environmental issues that are related to aquaculture production perceived by shrimp culturists. The shrimp culturists showed consistent attitude pertaining to the needs of conserving natural resources. Data on responses to this issue illustrated higher percentage on the importance of safeguarding the natural environment. The shrimp culturists, however, believed that aquaculture farming would not destruct mangrove area. The majority of shrimp culturists perceived that the introduction of new species into wild population would not harm natural food chain. As expected, farm waste was perceived to pollute areas surrounding the aquaculture farms. The study finds that, in general, the awareness among shrimp culturists on environment conservation issues is still low.

Keywords: Shrimp, mangrove, conservation, environment, factor analysis

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INTRODUCTION

Shrimp farming is an important industry in the Malaysian agricultural sector. The growing domestic and export demands for the commodity have made shrimp farming expand over the years. The growth of the industry is also due to the government's promotion and support programmes in view of the vast market potential for the commodity. However, the intensity of shrimp farming in Malaysia might result in the destruction of mangrove forest as shrimp farms are mainly established in coastal mangrove forests. Thus, the objectives of this paper are to highlight the interaction between shrimp farming activities with mangroves in Malaysia, and to ascertain the awareness of shrimp culturists in Peninsular Malaysia on the importance of mangroves conservation.

This paper discusses the importance of mangrove forests to the coastal ecosystem, and also farmed shrimp to the agricultural sector as well as the economy. The study also discusses the status of the establishment of Malaysian shrimp farms in brackish water environment. The primary data collection process is outlined in the methodology section. The awareness on the importance of mangrove forests among shrimp culturists and factors affecting their perceptions towards environmental issues in aquaculture production are interpreted in the following section. Finally, the paper discusses the relevant policies needed to maintain the productivity of the shrimp farming sector and also to minimize the mangrove forest destruction.

MANGROVE FOREST IN MALAYSIA

Mitsch and Gosselink (1993) defined a mangrove forest as an association of halophytic trees, shrubs, palms, ferns and other plants growing in brackish to saline tidal waters on mudflats, riverbanks and coastlines in tropical and subtropical regions. The United Nations Environment Programme (UNEP) (2006) outlined that a 400 square kilometre managed mangrove forest in Matang, Perak, supports a fishery worth USD 100 million a year. Hence, removing the mangrove species would lead to economic loss .

World Resource Institute (1996) shows the loss of Malaysian original mangrove area once recorded at 32% in 1996. The recent statistics show that there is about 225 thousand hectares of mangrove area left in 2009 (Peninsular Malaysia, 2010; Sabah, 2010; STIDC PERKASA, 2009) as compared to about 446 thousand hectares of mangrove area recorded in 1997 (Spalding *et al*, 1997). Thus, the loss of Malaysian original mangrove area has increased to about 50% in 2009. Destruction of the mangrove forest is mainly due to the development of various economic activities, such as logging and aquaculture.

Continuous destruction of mangrove forests will bring adverse externalities to the ecosystems. This is so as there is approximately 70 species of plants recognized as mangrove species and the greatest diversity of mangrove species to be found in Southeast Asia (Spalding *et al*., 1997), where the high biodiversity of mangrove forests serve as nursery grounds

for many aquatic organisms (Massaut, 1999). As such the preservation of such mangrove forests is inevitable. Besides, mangrove forests also tend to stabilize coastlines against erosion, acting to reduce the energy of wind, waves, and storm surges, filtering runoff entering coastal waters from rivers, and to protect coastlines from floods and tsunami (Claude, 2002; Massaut, 1999) .

Removal or restriction of access to mangrove forests also will lead to occurrence of social issues. Some local communities are depending on mangrove for food, charcoal, construction materials and employment. For instance, certain brackish wild species of fish, shrimp, mud crab and shellfish captured from mangrove forests are important aquatic species for human consumption. Besides, *Rhizophora* is one of the important trees found in mangrove forest and particularly sought for charcoal. In fact, certain types of charcoal produced in Malaysia have pharmaceuticals value and highly demanded in Japan. Thus, if mangrove areas were lost without reforestation, the socioeconomic conditions for the communities along the coast are expected to be worse off.

THE IMPORTANCE OF SHRIMP FARMING IN MALAYSIA

Shrimp is one of the most prominent fishery commodities in Malaysia as it is a high value fishery commodity which registered a trade surplus over the years. This is evidenced by the Balance of Trade figures that showed positive values across the years and Revealed Comparative Advantage coefficients that show improving levels of trade surpluses and competitiveness for shrimp commodities in Malaysia, particularly for fresh shrimp product (Ng *et. al.*, 2010a).

Increase of farmed shrimp output might be one of the factors that improve the trade competitiveness of the shrimp commodity in the global market due to consistent stocking, monitoring, harvesting, and supplying. Unlike the shrimp supply from marine capture where the production is frequently constrained by external factors, such as limited stock in a wild population, over-fishing, and seasonal capture. Thus, the ability to supply shrimp in a more consistent trend is one of the factors affecting competitive advantages for Malaysia in the global shrimp trade.

Realizing the great potential for the current and future shrimp industry, the Malaysian government, in 2007, had allocated 5,300 ha of land through the Aquaculture Industrial Zone programme that specifically alienated land for shrimp farming activities. Furthermore, Fatimah *et al.* (2008) and Malaysia (2009) outlined that the contribution of farmed shrimp towards total aquaculture production in Malaysia has exceeded farmed fish production since 1995.

As shown in Table 1, marine capture shrimp output increased in decreasing trend while farmed shrimp production increased in increasing trend. Moreover, the Malaysian farmed shrimp production increased from 28% of the total shrimp production in 2004 to 43% in 2009. Thus, it can be concluded that the 44% of the growth rate in shrimp production from 2004 to 2009

Table 1
Malaysian Shrimp Production by Source, 2004 – 2009 (MT)

Year	Inland	Marine	Aquaculture	Total	Growth Rate (%)
2004	285 (*0.3%*)	80287 (*72%*)	31155 (*28%*)	111,727	-
2005	306 (*0.3%*)	54651 (*62%*)	33878 (*38%*)	88,835	-20.49
2006	NA	63089 (*64%*)	35806 (*36%*)	98,895	11.32
2007	303 (*0.3%*)	72639 (*63%*)	43198 (*37%*)	116,140	17.44
2008	NA	82120 (*62%*)	51403 (*38%*)	133,523	14.97
2009	389 (*0.2%*)	91064 (*56%*)	69798 (*43%*)	161,251	20.77

Source: Annual Fisheries Statistics (various issues)

is derived mainly from improvements in the aquaculture production. From the increasing trend found in the shrimp culture output, it is evidenced that farmed shrimp production has great potential to outperform marine captured shrimp production in the future.

ESTABLISHMENT OF BRACKISH WATER SHRIMP FARMS IN MALAYSIA

Farmed shrimp in Malaysia is produced by pond systems in both freshwater and brackish water environments. Nevertheless, the majority of shrimp is produced in the brackish water environment as production technology used in this environment is more efficient compared to technology adopted in freshwater shrimp production. In 2008 and 2009, 99% of the total farmed shrimp produced was from brackish water environment (Malaysia, various issues). The major brackish water shrimp species for commercial purpose are banana shrimp (*Penaeus vanamei*) and tiger shrimp (*Penaeus monodon*). However, of late the former is preferred because of more resistant to diseases.

The shrimp farms in Malaysia are generally established along the coastal mangrove areas. Since mangroves grow on a very wide range of soil types, including clays soil with acceptable higher salinity level it is very suitable for aquaculture farming system especially shrimp culture (Clough, 1992). According to FAO (1987), clayey soil stabilises the bed of the pond and absorbs large quantities of nutrients while releasing them slowly over a long time period to the overlying water. Furthermore, FAO (1987) stated that clayey soil normally holds higher amounts of organic matter than light textured soils and thereby increases the productivity of the pond. Thus, clayey soil is an important factor in contributing to the productivity of shrimp farming which is easily found in the coastal mangrove forests.

However, studies have shown that a high concentration of shrimp farming in one area will result in high levels of pollution in the surrounding area (Vandergeest, 2007). A large scale shrimp farming activity requires a large scale of inputs to support its operations. Hence, resources in the surrounding area will be exploited more

significantly. For instance, the destruction of mangrove swamps in Southeast Asia occurred at an alarming rate, and this was mainly due to the development of shrimp farming activity (Gujja & Finger-Stich, 1996; Iwama, 1991). As a result, the destruction of mangrove forests will bring a certain level of economic loss directly and indirectly to the coastal community, and also the total cost of recovering the forest would be very high.

Furthermore, the Consumer Association of Penang (CAP) (2010) also stated that the establishment of farmed marine shrimp ponds has led to the destruction of thousands of hectares of mangroves in Malaysia. This association have objected to the development and expansion of shrimp farming in Malaysia as it has adverse impacts to the environment and socio-economy of the coastal habitat especially the fishing community.

However, issues raised in the discussion are mainly from other producing countries, which Malaysia could learn from their experience in handling the adverse conditions. In fact, Othman (2008) has outlined that the establishment of shrimp farms in Malaysia has slowly shifting to less critical areas, such as coastal land and abandoned coconut estates or paddy fields which are close to infrastructure and facilities. Othman (2008) also reported that the total shrimp farming acreage has increased from 2,600 ha in 1995 to 7,500 ha in 2004.

In 2009, the total acreage for shrimp farming is estimated to utilize about 7,300 hectares of the total production area in the brackish water environment (Malaysia, 2009). The acreage of shrimp farm was slightly decreased in 2009 as compared to the previous year because code of practice for marine shrimp farming is implemented in Malaysia in order to conserve environment and reduce adverse socio-economic impact. Proper selection of shrimp farming area is emphasised in this code where the establishment of shrimp farm on mangrove forest is discouraged.

In fact, the establishment of Aquaculture Industrial Zone also has gone through the environmental impact studies prior to its implementation. For instance, a Detailed Environmental Impact Assessment (DEIA) study had been conducted before the establishment of the Integrated Shrimp Aquaculture Park (i-SHARP) in Terengganu. In fact, shrimp ponds constitute only 38% of the total land allocation under this project; this pond acreage is relatively low as compared to traditional shrimp culture method, where the pond area would be 80% to 85% of total shrimp farming area (Cheang, 2010). The other 62% of the land is used to ensure that the farm is run in ecologically sound practices.

METHODOLOGY

A field survey was conducted on the shrimp culturists that consisted of farm owners, managers, and supervisors in selected States of Peninsular Malaysia. This survey was conducted under consultation and assistance from the Department of Fisheries (DOF) at federal, state, and district levels.

The study areas covered Manjung districts in Perak, and several areas surrounding the Kota Tinggi district in Johor. The shrimp farms in these two states were chosen due to the higher concentration of shrimp farms operating in these regions. This is evidenced from Ng *et al.* (2010b) who found that Selangor, Sabah, Perak and Johor are the major States producing farmed shrimp. However, the reason for not choosing Selangor and Sabah in this study was due to budget and time constraints.

Prior to the survey the questionnaire was presented to the DOF officers at district levels and was thoroughly discussed. The purpose was to ensure that the questionnaire was well-designed to suit the objectives of the study and also to make adjustments to questions and statements in order to ease respondents' understanding and eventually providing rational responses.

In order to obtain the perspectives of the shrimp culturist on conserving mangroves, a set of questionnaire was designed that contained demographic and perspective sections. In fact, all statements listed in the perspective section were positive statements. Thus, any disagree or strongly disagree of any of the statement illustrates certain level of perception towards the environmental issue(s).

In the demographic section, respondents had to fill in the details regarding to their age, educational background, working experience in aquaculture sector, and experience in aquaculture trainings. In the perspective section, a series of statements regarding to the hypothetical environment and mangroves expected conditions with 5-likert scale responses were designed in order to examine the understanding and perspective of the respondents towards environment issues. The data were first analyzed by descriptive analysis and then, followed by exploratory factor analysis.

Awareness on the Importance of Mangrove Forests among Shrimp Culturists in Peninsular Malaysia

This study involved 45 respondents and the survey was assisted by the Department of Fisheries (DOF) officers . The results of responses on the ecosystem statements are presented in Table 2. As far as the demographic information is concerned, the age of respondents is ranged from 23 to 65 years old, with the mean age 41 and a standard deviation of 11. The education level in terms of number of years of schooling is ranged from three to 16 years; the average education level is ten years with a standard deviation of two years. Aquaculture experience is ranged from two to 26 years with the mean of nine years and a standard deviation of five years. There are 20 out of 45 respondents have gone through formal trainings, of which nine out of the 20 trainings were organized by DOF and the rest were organized by private sectors. The result is consistence where we can conclude that younger operators need more training.

As shown in Table 2, there are more than 50% of total respondents agreed with half of the given statements. The results indicate that more than half of the respondents understood with the basic

TABLE 2
The Shrimp Culturist's Response on Statements regarding the Mangroves and Environmental Issues, Peninsular Malaysia (%)

No.	Statement	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly disagree	Total
1	Aquaculture run-off affects wild population.	4	49	2	31	13	100
2	Introduction of new species to wild population damages the natural food chain.	2	16	29	53	0	100
3	Introduction of exotic species into coastal water damages the natural food chain.	2	13	42	42	0	100
4	Natural food chain in wild populations is important for environmental sustainability.	24	67	7	0	2	100
5	Natural resource is an important input for production of goods and services.	22	51	18	7	2	100
6	Shrimp farming will result in mangrove conversion.	4	13	18	49	16	100
7	Shrimp farming will result in large-scale degradation of mangrove.	0	31	22	33	13	100
8	Shrimp farming affects mangrove flora and fauna.	0	20	20	47	13	100
9	Mangrove flora and fauna is important for environmental sustainability.	20	67	11	2	0	100
10	Abandonment of shrimp ponds will affect environmental sustainability.	16	78	4	2	0	100
11	Most of the mangrove flora and fauna hardly survive in shrimp pond area.	0	13	9	64	13	100
12	The establishment of shrimp farm causes depletion of tidal wetlands.	0	7	13	64	16	100
13	Water discharge from shrimp farms will pollute the surrounding area.	18	56	7	20	0	100
14	High concentration of shrimp farms in a one area will result in high level of water pollution in the surrounding area.	16	44	9	31	0	100

environmental issues and the importance of mangrove to the ecosystems. About 53% of the respondents agreed with the statement that aquaculture run-off affects wild population. Similar responses were obtained from statements 13 and 14. It shows that more than half of them were aware of the potential pollution caused by aquaculture activities. In contrast, 53% of the respondents disagreed with the negative impacts from the introduction of new species to wild population on the natural food chain. Again, the shrimp culturists had high regard toward the natural resources as indicated by responses to statements 4, 5 and 9.

The respondents did not believe that shrimp farming would destroy mangrove and its flora and fauna as well as causing

depletion of tidal wetlands. The high percentage on disagreement to statements 6, 7, 8, 11 and 12 illustrates their attitudes toward these constructs. The attitude is developed due the fact that most of the shrimp farms are built in the approved coastal mangrove area with tides. In fact, the establishment of shrimp farms in mangrove is also monitored by the Department of Environment. Therefore, most of the respondents believed that the mangrove destruction issues due to shrimp farming activities were actually exaggerated.

The DOF officers informed researchers that most of the shrimp culturists were applying organic inputs in their daily operations as chemicals were prohibited by the Malaysian government and also rejected by major shrimp importers, such as EU (European Union), USA, and Japan. Furthermore, the farms are mainly built on the areas with tides so that, the wastage discharged from shrimp farms is harmless to the environment since it will be washed away during the high tide. With the necessary precautions taken, most of the respondents had denied that their shrimp farms were harmful to mangrove flora and fauna.

Findings from Factor Analysis

The factor analysis was performed to uncover the underlying environmental issues that were related to aquaculture activities perceived by shrimp culturists. The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy (Kaiser, 1970, 1974) is an indicator of factorability.

Table 3 shows the result of KMO and Bartlett's Test of Sphericity. The KMO test was 0.727 indicating that the degree of common variance among the 18 variables on the respondents' perceptions towards environmental issues was middling. The probability associated with the Bartlett test is <0.001, which satisfies the requirement for appropriateness factor analysis.

As shown in Table 4, there are four eigenvalues greater than 1.0 and considered significant. The factor analysis yielded four factors explaining 65.32% of the total variance (Table 4). Table 5 shows the rotated component matrix for 15 items of the four factors. Issue one is labeled as "conservation of natural resources" by the following items: natural resource is an important input for production of goods and services; diseases prevention improves productivity; natural food chain in wild populations is important for environmental sustainability; mangrove flora and fauna is important for environmental sustainability; and food safety is important for human health. The variance explained by this factor is 21.34% with the highest factor loading of 0.854 (Table 5).

Second issue is labeled as "intrusion of aquaculture". Three variables are identified in factor two which explained 16.60% of the variance. The highest factor loading is 0.855. The items identified are shrimp farming affects mangrove flora and fauna; shrimp farming will result in large-scale degradation of mangrove; and the establishment of aquaculture farm causes depletion of tidal wetlands.

TABLE 3
KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.727
Bartlett's Test of Sphericity	Approx. Chi-Square	905.266
	df	120
	Sig.	.000

TABLE 4
Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	3.906	24.412	24.412	3.906	24.412	24.412	3.415	21.343	21.343
2	3.380	21.126	45.537	3.380	21.126	45.537	2.656	16.598	37.940
3	1.755	10.970	56.508	1.755	10.970	56.508	2.532	15.822	53.763
4	1.409	8.808	65.316	1.409	8.808	65.316	1.848	11.553	65.316
5	.985	6.159	71.474						
6	.860	5.376	76.850						
7	.770	4.815	81.666						
8	.512	3.197	84.863						
9	.488	3.051	87.914						
10	.416	2.598	90.512						
11	.364	2.276	92.788						
12	.335	2.091	94.879						
13	.255	1.595	96.474						
14	.218	1.363	97.838						
15	.208	1.297	99.135						
16	.138	.865	100.000						

Extraction Method: Principal Component Analysis.

TABLE 5
Rotated Component Matrix

Item	Component			
	Conservation of natural resources	Intrusion of aquaculture	Intrusion of foreign species and chemical	Farm waste
Natural resource is an important input for production of goods and services	.854			
Diseases prevention improves productivity	.813			
Natural food chain in wild populations is important for environmental sustainability	.730			
Mangrove flora and fauna is important for environmental sustainability	.680			
Food safety is important for human health	.668			
Shrimp farming affects mangrove flora and fauna		.855		
Shrimp farming will result in large-scale degradation of mangrove		.814		
The establishment of aquaculture farm causes depletion of tidal wetlands		.809		
Introduction of exotic species into coastal water damages the natural food chain			.814	
Introduction of new species to wild population damages the natural food chain			.774	
The use of antibiotics affects food safety			.655	
Most of the mangrove flora and fauna hardly survive in shrimp pond area			.574	
Aquaculture run-off affects wild population			.516	
High concentration of shrimp farms in a one area will result in high level of water pollution in the surrounding area				.806
Water discharge from farms will pollute the surrounding area				.762

"Intrusion of foreign species and chemical" is the third issue obtained from the analysis. This issue has five items with the highest factor loading of 0.814. The variance explained was 15.82%. The items in the third issue are: introduction of exotic species into coastal water damages the natural food chain; introduction of new species to wild population damages the natural food chain; the use of antibiotics affects food safety; most of the mangrove flora and fauna hardly survive in shrimp pond area and aquaculture run-off affects wild population.

The last issue is "farm waste". This factor explained 11.55% of the variance. The items in the last factor are high concentration of shrimp farms in a one area will result in high level of water pollution in the surrounding area has the highest factor loading of 0.806 and water discharge from farms will pollute the surrounding area.

Before any conclusive discussion on the latent factors that have been generated by the factor analysis, reliability test need to be conducted. Reliability analysis was conducted for the remaining items in each factor. From the analysis, the internal reliability for the factor analysis has been tested and the alpha scores for each factor are presented in Table 6. The final alpha score range for the factor analysis is 0.726 to 0.834. It meets Peter (1979) and Churchill *et.al.* (1984) where those reliability levels that are less than 0.5 might be acceptable in social sciences which means that those items should be retain in the scale.

The exploratory factor analysis uncovered four underlying environmental issues that are related to aquaculture production perceived by shrimp culturists. The shrimp culturists have shown consistent attitude pertaining to the needs of conserving natural resources. Data of responses to this issue illustrate higher percentage is for the importance of safeguarding the natural environment. The shrimp culturists, however have different perceptions pertaining to the second issue which is the intrusion of aquaculture will destruct mangrove area. Evidence from data indicates that aquaculture farming will not destruct mangrove area. As far as the third issue is concerned, it is worth noted that the majority shrimp culturists perceived that the introduction of new species into wild population will not harm natural food chain. A consistent finding with researchers' expectation, farm waste is perceived to

TABLE 6
Internal Reliability Analysis on Factors Affecting Aquaculture Entrepreneurs' Perceptions towards Environmental Issues in Aquaculture Production

Factor	Alpha Scores	Number of Item
Conservation of natural resources	0.834	5
Intrusion of aquaculture	0.821	3
Intrusion of foreign species and chemical	0.726	5
Farm waste	0.794	2

pollute areas surround the aquaculture farms. From this analysis, it can be inferred that the issues immerged are the resultant of shrimp culturists current level of knowledge of sustainable aquaculture production.

Policy Implications

This study discovered various levels of attitudes and perceptions of shrimp culturists toward environmental impacts or potential impacts from aquaculture farming and development. The majority shrimp culturists were fully aware and agreed with pollution caused by aquaculture farming. However, they lagged in knowledge in a more complex situation such as the possible damage to natural food chain if a new or exotic species were introduced. By the same token, the encroachment of aquaculture farming in mangrove area, to them, was not very critical, although statistics show otherwise.

Undoubtedly, shrimp industry is gaining ground for it market potential and value. Albeit good export demand, international market such as the EU has imposed stringent conditions, among others on environment concerns, on shrimp products which are to be imported. As such, to be competitive via cost efficiency is inadequate as conformance to market requirements is inevitable in current and future settings. Hence, shrimp culturists need to acquire and equip themselves with sustainable production knowledge and skills to be competitive and sustainable.

The shrimp culturists have to be educated to enhance their understanding and awareness on the adverse environmental impacts that might occur from their farms to the nature habitat and mangroves ecosystems. This program can be conducted by distributing posters or magazines that contain the current information on environment and mangrove destruction to shrimp culturists. Besides, the organizers can increase the frequency of running aquaculture trainings in order to provide advanced techniques and technologies to develop sustainable shrimp farmers.

Alternative lands for shrimp farming are necessary to reduce mangrove forest destruction in establishment of shrimp farms in Malaysia. The change has to be encouraged and promoted by the government, such as introducing subsidies on basic water supply equipment to those farms established in the alternative areas. As water source is supplied by mean of pumps or connected by canals, commercial farms integrate reservoir and sediment ponds to cater for their operation in ensuring good quality water supply.

In order to expedite the growth of the industry at a sustainable rate, a specific area should be identified by the government as a one stop centre for shrimp aquaculture. Ng *et al.* (2010b) highlighted that farmed shrimp in Malaysia are mainly concentrated in Perak, Selangor, Johor, and Sabah; thus, one of these states is proposed to become as a Target Area of Concentration (TAC) for shrimp farming. Within the TAC, policy makers could promote shrimp culturists to adopt sustainable practices as listed in the responsible code of practice for marine shrimp aquaculture and also to monitor their behaviour more efficiently. Hence,

the shrimp aquaculture activities can be operated in sustainable way and minimized the alleged negative impact on mangrove areas.

According to Malaysia (1999), responsible code of practice for marine shrimp aquaculture contains a series of comprehensive methods to ensure that shrimp farms are productive and also environmentally sustainable. Thus, it is worthwhile to make the code mandatory instead of voluntarily. Moreover, it covers the precaution criteria as below:

i. Farm base selection. One of the objectives is to conserve mangrove forest and natural conservation area from shrimp farming activities. Hence, shrimp farms are encourage to build on the zone proposed by the state governments, which is the Aquaculture Development Area.

ii. Farm building. The objectives are to establish the lower cost farm in order to minimize the adverse externalities to the environment. Minimize chopping trees in the farm area is one of the main approach in order to achieve the objectives.

iii. Farm management. Recycling and treating waste water before water is discharged to natural environment is encouraged under the code.

iv. Harvesting. The objective is to ensure that farmed shrimps produced in Malaysia are safe for human consumption.

v. Exotic species. Fish/Shrimp Health Certification is necessary for imported foreign shrimp species to Malaysia. Approval from DOF is also needed in order to transport exotic shrimp species even across states.

vi. Recording aquaculture data. Shrimp culturists are encouraged to keep farm records systematically.

CONCLUSION

The shrimp farming is a potential economic activity in Malaysia, yet if not controlled could possibly produce negative impact to the environment; in particular the mangrove forests. In fact, mangrove forests in Malaysia have reduced significantly in the past decades but not solely due to shrimp farming. The introduction of Shrimp Farming Code is expected to lessen the cutting down of mangrove trees, and hence, promoting sustainable and environmental friendly shrimp aquaculture farming systems. The study found that the awareness of the environmental issues among shrimp culturists is still low. There are several policy implications that brought to the discussion to possibly increase the environmental awareness among the culturist and also to conserve the mangrove forest. Education is one of the best ways to increase environmental awareness and understanding of the importance of mangroves to coastal ecosystems. On a positive note, the recent study has found that the establishment of shrimp farms have slowly shifting to less critical areas. Besides,

shrimp aquaculture practices can be monitor more effectively once the TAC for shrimp farming is introduced.

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