

# ASSESSING THE IMPACT OF ARTIFICIAL REEFS IN MALAYSIA

Gazi Md. Nurul Islam, Kusairi Mohd Noh, Fatimah Mohd Arshad, Aswani Farhana Mohd Noh, Illisriyani Ismail

Institute of Agricultural and Food Policy Studies, Universiti Putra Malaysia, Malaysia

## Introduction

Artificial Reefs (ARs) are used as effective tools to increase the productivity of fish biomass. In Malaysia, the marine fisheries resources have declined considerably over the past decade primarily due to overfishing particularly by using trawls. Commercial fishing gears, i.e. trawl nets and fish purse seines are prohibited from fishing in Zone A (0-5 nautical miles) to reduce fishing effort. This area is reserved for the artisanal fishers using traditional fishing gears. ARs are now increasingly being recognized as important aspect of fisheries management and conservation.

Various floating objects have been used as aggregating devices for fish called *unjam* in the east coast of Peninsular Malaysia since the early 1900s (Hung, 1988). The artisanal fishers have established *unjams* close to the coast to attract small pelagic fish (Anderson and Gates, 1997). The Department of Fisheries (DOF) and the Fisheries Development Authority Malaysia (LKIM) have introduced artificial reefs (ARs) in various locations in the coastal waters since 1987. Recently the structural designs and materials of ARs have been changed. The main purpose of establishing ARs is to protect marine habitats from trawls and to compensate the effects of stock depletion. There is a growing need for the conservation of fisheries resources to enhance the productivity of the fish biomass and to rehabilitate marine habitats to improve the income of artisanal fishers (Islam *et al.* 2009). The LKIM managed ARs are used as fish aggregating devices (FADs) mainly focuses to increase the productivities of fish biomass in the surrounding waters and thereby increasing accessibility to the resources, catches and incomes of the artisanal fishers.

The economic literature on ARs has provided limited empirical evidence on the socio-economic benefits to fishers (Crowder *et al.* 2000). Evidence shows that ARs contribute positive effects on the economy of the local communities, however, the contributions of AR management to fisheries resources and livelihoods of poor fishers have not been studied in Malaysia. Previous research in Malaysia mainly focused on the type of artificial reefs in terms of the design of the modules, how they are placed and the materials used. Study results from Indonesia and the Philippines indicate that fishers can increase income from fish catches as a result of FADs. This paper examines on how the FADs can contribute income for the local fishing communities in Malaysia.

### *ARs and FADs in Malaysia*

In Malaysia ARs (known as “*tukun tukun*”) are managed by the Fisheries Department which aims at promoting long term resource management and conservation, while the LKIM managed FADs (known as *unjam-unjam*) are primarily to enable artisanal fishermen to fish in the water adjacent to the artificial structure. Fishing in the FAD areas are open access and can be used free of charge by any artisanal fishermen. Local Fishermen Association (FA) were informed by LKIM who have participated during the construction of *unjam unjam* and subsequently became the main beneficiaries of the program as presented in Model A in Figure 1. Under this model, the

fishers have unlimited access and uses of *unjam unjam*. The artisanal fishers also construct FADs in the marine waters which are either individually or jointly owned. The fishers have established exclusive use rights over the *unjam unjam*. The *unjam unjam* owners can also hire fishers or rent out their *unjam unjam* to others and take major share of income from fishing in the *unjam unjam*. They use traditional gears such as drift nets, traps, hooks and spear for fishing around *unjam unjam* which means that fishing intensity increases that may pose threat to fisheries resources. The benefits from both *unjam unjam* are to aggregate fish that results in higher and stable catch and reducing time and fuel costs of fishing. The ARs or *tukun tukun* developed by DOF is more towards long term resource enhancement and conservation. Fishing is strictly prohibited in the vicinity of the *tukun tukun* area. The benefits from higher fish productivity are not reserved for artisanal fisher groups are shown in Model B in Figure 1. This model helps to enforce management regulation though preventing the operation of trawls in the near shore waters and protect the coastline.

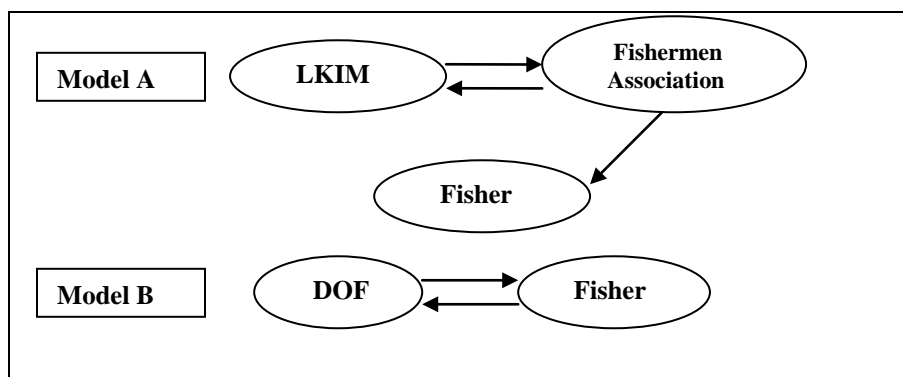


Figure 1: Models of ARs and FADs management in Malaysia

The question remains as to whether the deployment of *unjam unjam* is cost effective to achieve the benefits from catch for the artisanal fishers. Reduced intensity of trawls protects the habitat where fish biomass can be increased. This paper examines the economic impact of *unjam unjam* on the artisanal fishers in the East Coast of Malaysia. The costs of construction and deployment of *unjam unjam* should be lower than the economic benefits derived from them. *Unjam-unjam* have been constructed over 500 locations throughout Malaysia's coastal waters by December 2007 (Azni, 2008). However, about 65% artificial reefs (deployed by LKIM) in Peninsular Malaysia are located in the East Coast. The study was conducted to investigate the impact of *unjam unjam* on the artisanal fishers in the East Coast of Peninsular Malaysia.

## Methodology

The LKIM has conducted a survey to evaluate the impact of *unjam unjam* in the selected areas in the East Coast, Peninsular Malaysia. The LKIM introduced monitoring of catch assessment at the household level and a total 560 boats were selected from monitoring in the four States of East Coast, Peninsular Malaysia. Data used in the study come from 102 boats randomly selected from 560 boats from four districts of East Coast, Peninsular Malaysia: Endau, Nenasi, Setiu and Bachok (Table 1). Household panel dataset for ten months from March to December 2007 were obtained from 102 sampled boats. Two types of survey books were used for the monitoring of

boat: the red book (weekly data collection) and the blue book (monthly data collection). Therefore, each boat has one blue book and ten red books.

Table 1: Number of sampled boats in the East Coast, PM, 2007

State	District	Number of Respondent
Johor	Endau	15
Pahang	Nenasi	28
Terengganu	Setiu	39
Kelantan	Bachok	20
All		102

The data contains fish catch by species, operation costs, and monthly income from fishing in the *unjam unjam* area. Descriptive analysis is used to show the average quantity and value of fisher's landing and operation cost. Data analysis provides revenue and cost of operation of *unjam unjam* before and after development.

## Results and Discussions

The results of the study shows that artisanal fishers were able to increase income from fishing after the installation of *unjam unjam* in the study area. Among the four study areas, fish landing from sampled boats was the highest in Terengganu (32%) followed by Johor (29%), Kelantan (29%) and Pahang (16%). Table 1 shows highest average fish catch (372 Kg) in Setiu district in Terengganu, followed by 273 Kg in the Endau district in Johor, 234 Kg in Bachok district in Kelantan and 228 Kg in Nenasi district in Pahang State. Overall fish catch per boat in the East Coast was 277.28 kg, while catch per trip was 55.79 kg. The higher frequency of fishing in Setiu district indicates that fishing in the *unjam unjam* area has become more competitive. Fishers from outside may be attracted to fish in the open access fishing could be a problem of overfishing in the near shore areas.

Table 2: Fish catch (Kg) and frequency of fishing by districts in the East Coast

State	District	Catch	Frequency	Catch per Trip
Johor	Endau	273.07	4	76.45
Pahang	Nenasi	228.84	3	69.18
Terengganu	Setiu	372.27	12	29.78
Kelantan	Bachok	234.96	9	47.76
East Coast		277.28	7	55.79

Amount of fish catch differs by the design, materials used for FADs and the location of deploying the *unjam unjam*. Other studies found that demersal fish species can be protected by deploying *tukun tukun* or *unjam unjam* because these species are usually caught by trawls. Restriction of trawls operation can protect these species. Figure 2 shows that the catch of demersal species increased similarly with the pelagic species during the study period. Though it is very difficult to understand the catch composition with the small dataset, the most possible reason of increasing the demersal catch is the use of specific gears such as hooks and spears. Future studies can be conducted to investigate in details on the use of fishing gears and the species caught by the fishers in various locations in Malaysia.

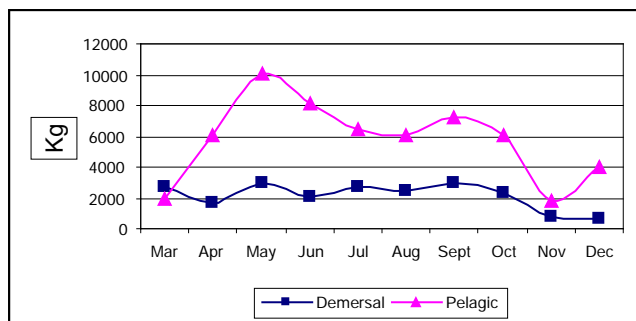


Figure 2: Fish landing by species category in the East Coast, PM

Operation cost of fishing was the highest in Terengganu. The fishers in the Setiu district spent per boat RM 1189 (Table 3). However, the cost per trip was the highest for the fishers in Endau district was the highest (RM 143.39) compared with the fishing cost per trip in Nenasi, Setiu and Bachok districts (RM 92 and RM 77 respectively).

Table 3: Cost of fishing by districts (RM) in 2007

State	District	Operation Cost	Frequency	Cost per trip
Johor	Endau	576.79	4	143.39
Pahang	Nenasi	322.05	3	92.43
Terengganu	Setiu	1,189.60	12	92.15
Kelantan	Bachok	353.48	9	77.67
East Coast		610.48	7	101.41

Table 4 shows the revenue and cost of fishing in the study areas. Most of the *unjam unjam* with concrete structure were deployed in the study areas since 2004. Based on the respondents record of income and costs of fishing shows that the profit from fishing increased by 172% over four years 2003-2007. Total value of fish caught per boat was RM 1,552 in 2003 which was increased to RM 2,108 in 2007. This indicates that revenue from fishing increased by around 36% while the cost of fishing reduced by 31% over the four years period (Table 4).

Table 4: Revenue, costs and income from fishing in the study areas over 2003-2007

Item	2003	2007	Difference	Change (%)
Total Revenue	1,552	2,108	+ 556	+ 35.8
Total Operation Costs	1,040	715	- 325	- 31.3
Total Profit	512	1,393	881	+ 172.2

The total investment for *unjam unjam* in the East Coast areas is around RM 1.6 million. Total profit obtained in the East Coast suggests that the investment in the *unjam unjam* programme is worth. Though the LKIM have introduced expensive *unjam unjam* made of concrete, it reveals that future investment in deploying *unjam unjam* or *tukun tukun* will make considerable income opportunity for the artisanal fishers living in the vast coastal areas of Malaysia. Estimating the investments and returns from *unjam unjam* in the study area has mentioned that the payback

period was about 9 years. However, the payback period for the investments may be different at different locations.

## **Conclusions and Recommendations**

This paper investigated the impact of FADs called *unjam unjam* on the income of artisanal fishers in the East Coast of Peninsular Malaysia. The Fisheries Development Authority Malaysia (LKIM) introduced *unjam unjam* programme to increase productivities of fish biomass in the surrounding waters in order to enhance fishers catch and income. This study analysed fishing income and their costs using monitoring dataset of 102 fishing boats obtained from LKIM in 2007.

The results of the study show that the artisanal fishers were able to increase income from fishing after the installation of *unjam unjam* in the study area. Among the four districts fish catch per boat was the highest (372 Kg) in Terengganu, followed by 273 Kg in Johor, 234 Kg in Kelantan and 228 Kg in Pahang State. However, high frequency of fishing in Setiu district (Terengganu) indicates that fishing in these *unjam unjam* area has become more competitive which could be a problem of overfishing in the near shore areas.

The fishers can install private *unjam* in the near shore areas. They hire fishers for harvesting and sometimes they rent out *unjams* to others. They share their benefits from fishing in these privately owned *unjams* through negotiation. Both open access and private property rights exist in the *unjam* areas. The unclear access rights may be a problem for fisheries management. The allocation problems may create conflicts for the multi-racial nature of the Malaysian fishing communities. The government should assign the access rights to the fishers for sustainable management of marine fisheries in Malaysia.

It was found that the amount of catch for both demersal and pelagic species increased during the study period. The results indicate that the demersal species are not protected by deploying the reefs and the restrictions imposed on trawls operations in these *unjam unjam* area. Future study can be conducted to investigate the use of fishing methods and the species caught in these *unjam unjam* areas.

Study results show that artisanal fishers were able to increase profit after the establishment of *unjam unjam* in the marine fisheries. The profit from fishing has increased by 172% over the four years 2003-2007 suggesting that future investment in deploying *unjam unjam* will make considerable income opportunity for the artisanal fishers living in the vast coastal areas of Malaysia. Sustainable livelihoods of the artisanal fishing communities can be achieved through establishing user based co-management in Malaysia.

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