

## Installation of FEDs by SEAFDEC/TD

*Yuttana Theparoonrat*

Head, Coastal Small-scale Fisheries Management Division  
SEAFDEC/TD

The SEAFDEC Training Department together with the ASEAN and SEAFDEC member countries, conducted the project on “Resources Enhancement” under the Special Five-year Program on Sustainable Fisheries for Food Security in the ASEAN Region from 2002 to 2005. The first project activities were started on 2003 at the pilot project site in Pathew District, Chumporn Province, Thailand and Pulau Langkawi, Malaysia as case study areas. This project was designed to integrate the installation of artificial habitats in inshore waters after a careful pre-assessment of the environmental and socio-economic impacts. In 2003, the project proposal preparation and planning as well as establishing the core working group were carried out. A review of Existing Artificial Reefs and Resources Enhancement Projects in the ASEAN countries was also conducted.

### **Selection of Site and Suitable Module of Artificial Reefs at Kuala Teriang, Pulau Langkawi**

An observation visit for the Selection of Site and Suitable Module of Artificial Reefs at Kuala Teriang, Pulau Langkawi Island was conducted on 28 July 2003 by Dr. Somboon Siriraksophon of SEAFDEC/TD assisted by an Officer from the DOF of Thailand, Dr. Vicharn Insrisawang, who made the following observations:

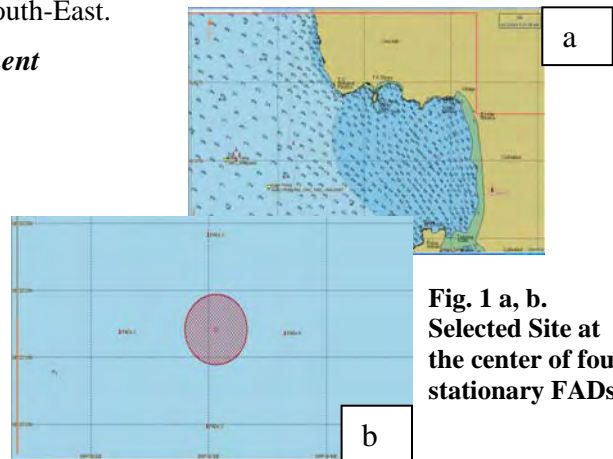
#### ***General Information and Bottom Characteristics***

About 800 Artificial Reefs “cuboid shape” were first deployed in 5.7 nautical miles (Nm) from the Kuala Teriang Fishing Village. Near these artificial reefs (around 400-500 m distance), 4 stationary FADs (Fish Aggregating Devices) made of bamboo pole fixed above the water while the coconut fronds were set below the sea surface were also noted. The depth of the water is about 32-33 m. Bottom sediments was collected using grab, and from the samples it was concluded that the bottom characteristic in this area is muddy-sand of about 81.2% clay and 4.3% silt. The direction of the current at near bottom was also observed by sight while dropping the bottom sediment grab. It was observed that the sea current moves to South or South-East.

#### ***Selecting the Artificial Reef Module for Deployment***

After discussing with the fishermen operating pelagic hand-line fishing at the FAD areas, in addition to the consideration of the bottom characteristics (muddy sand) and depth of water (~32 m), the site for the artificial reefs was selected at the center of the four stationary FADs (Fig. 1a, Fig. 1b). The module of artificial reef was designed to be suitable for the soft bottom like muddy-sand due to its high sinking rate by a pocking-pressure effect. Two module shapes, namely: Leg or Table shape and Cubic shape were selected for this site (Fig. 2a, Fig. 2b).

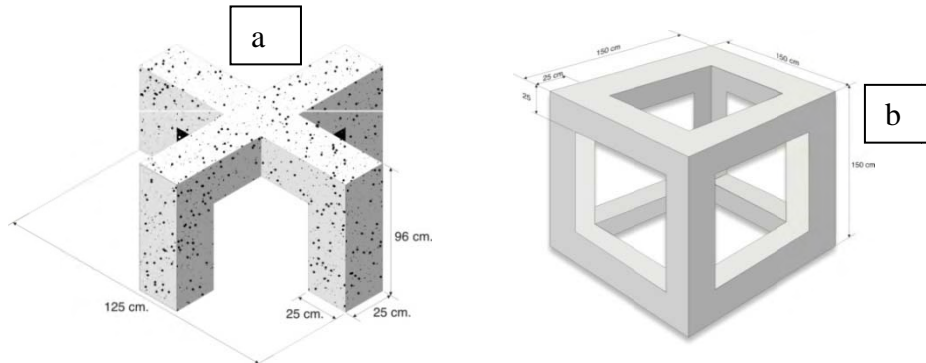
The leg or table shape should be higher than the thickness of the muddy-sand by about 20% (it is suggested that measuring the thickness of the muddy-sand should be done first). For example if the thickness of muddy-sand is 80 cm, then the length of leg or table shape must be ~96 cm. This shape will be deployed first at the bottom before setting the cubic shape above the leg or table shape.



**Fig. 1 a, b.**  
Selected Site at  
the center of four  
stationary FADs

### Volume and Number of Reef Blocks

In order to make the artificial reefs more effective in aggregating fish, Nakamura (1982) reported that the reef volume (concrete volume) should not be less than 2,000 m<sup>3</sup> which means that the number of Cubic shaped concrete block reefs of 1.5x1.5x1.5 must not be less than 879 units, while the number of Leg or Table shaped concrete blocks should not be less than 450 units.



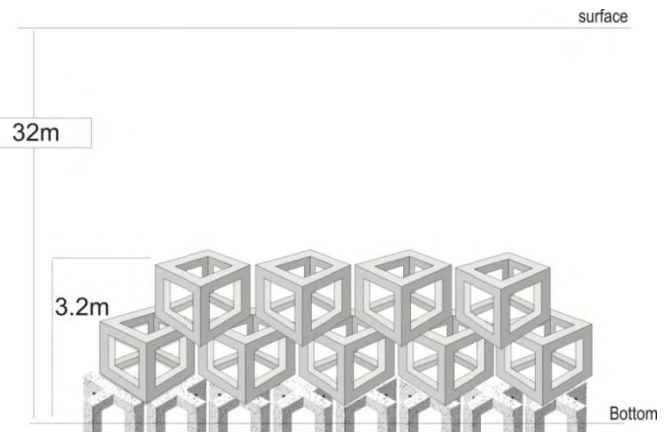
**Fig. 2. Two modules of artificial reef designs for the site at Kuala Teriang:**  
(a) Leg or Table shape, and (b) Cubic shape

The arrangement/setting of these concrete block reefs is shown in Fig. 3. While considering the depth of the water (32 m), it was suggested that the artificial reefs should be set to occupy around 10% of the water depth, therefore after setting the artificial reef its height is expected to be around 3-4 m. This would enhance the fishes, both demersal and pelagic fishes to aggregate/stay in the reef. The SEAFDEC Training Department in cooperation with Department of Fisheries Malaysia through the Fisheries Research Institute (FRI) in Penang and the SEAFDEC Marine Fishery Resources Development and Management Department (MFRDMD) in Terengganu, conducted environmental survey studies at the proposed artificial reef installation site in Pulau Langkawi, Malaysia from 8 to 16 December 2003.

The environmental survey studies were carried out using the K.K. SENANGIN II (Fig. 4). Several fisheries environmental parameters were monitored. Information on the oceanographic parameters including water current and speed/direction were collected. Biological information like benthos, phytoplankton, zooplankton, and fish larvae distribution was also collected. Fishing surveys using various fishing gear including the Trammel net, Squid trap, Crab trap were also carried out. The biological samples were analyzed by FRI.

### Fish Enhancing Device (FED)

The local fishermen in Langkawi, Malaysia have been using the traditional Fish Aggregating Devices



**Fig. 3. Arrangement of two modules of artificial reefs for the site at Kuala Teriang**



**Fig. 4. Environmental survey at the proposed artificial reef installation site at Pulau Langkawi, Malaysia using the K.K. SENANGIN II**

(FADs) or “unjam” in combination with Artificial Reefs (ARs) as auxiliary fishing gear for luring both pelagic and demersal species for their fishing operations. The fisherman installed FADs around the ARs, and using traditional fishing gear such as hand line, gill net and fish trap, they usually operate around the ARs. An “unjam” comprises bamboo poles of approximately 10 m long and float attractors (underwater appendages) made of coconut fronds tied to the whole length of the anchor line, and sandbags as anchor. The damage on the “unjam” could usually occur in the float and the underwater appendages. Another reason contributing to its short endurance period was the anchoring mechanism of the unjam which use sandbags as anchor which can only last for about two months (Ahmad Ali et. al, 2004). Since the local fishermen in Langkawi use the “unjam” permanently as ARs to aggregate fish schools for their fishing, then it is necessary to lengthen the endurance of the “unjam” using long lasting materials and new construction designs.

SEAFDEC/TD under the Resources Enhancement Project, organized a training and installation program for Fish Enhancing Device (FED) using a long lasting endurance synthetic materials with new construction design (Fig. 5-11). The program was conducted for the local fishermen’s group in Kuala Teriang, Langkawi, Malaysia from 19 to 23 December 2004. The training was conducted by introducing the construction and performance of new designed FED to 25 participating local fishermen. Hands-on training for fishermen to construct 4 units of FEDs was also performed. Installation of 4 units of FEDs around the artificial reefs was conducted at Latitude 06° 19’ .009 N Longitude 099° 36’ .136 E. The water depth at the installation area with soft muddy bottom is 31 m.



**Fig. 5. Introduction of FED construction and performance**



**Fig. 6. Preparation of cement anchors**



**Fig. 7. Construction of FED main rope and appendages**



**Fig. 8. Installation of FED main rope and buoy connection**

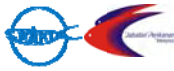


**Fig. 9. Installation of FEDs using local fishing boat**



**Fig. 10. Releasing of FED at marked position**





### Fish Enhancing Device Installation Area

Location : Kuala Teriang, Langkawi, Malaysia (Fig. 12)

Latitude 06° 19'.009 N

Longitude 99° 36'.136'E

( Δ Number 8)

Water Depth : 31 m

Date : 18-24 December 2004



Fig. 11. FED installed around ARs in the project site

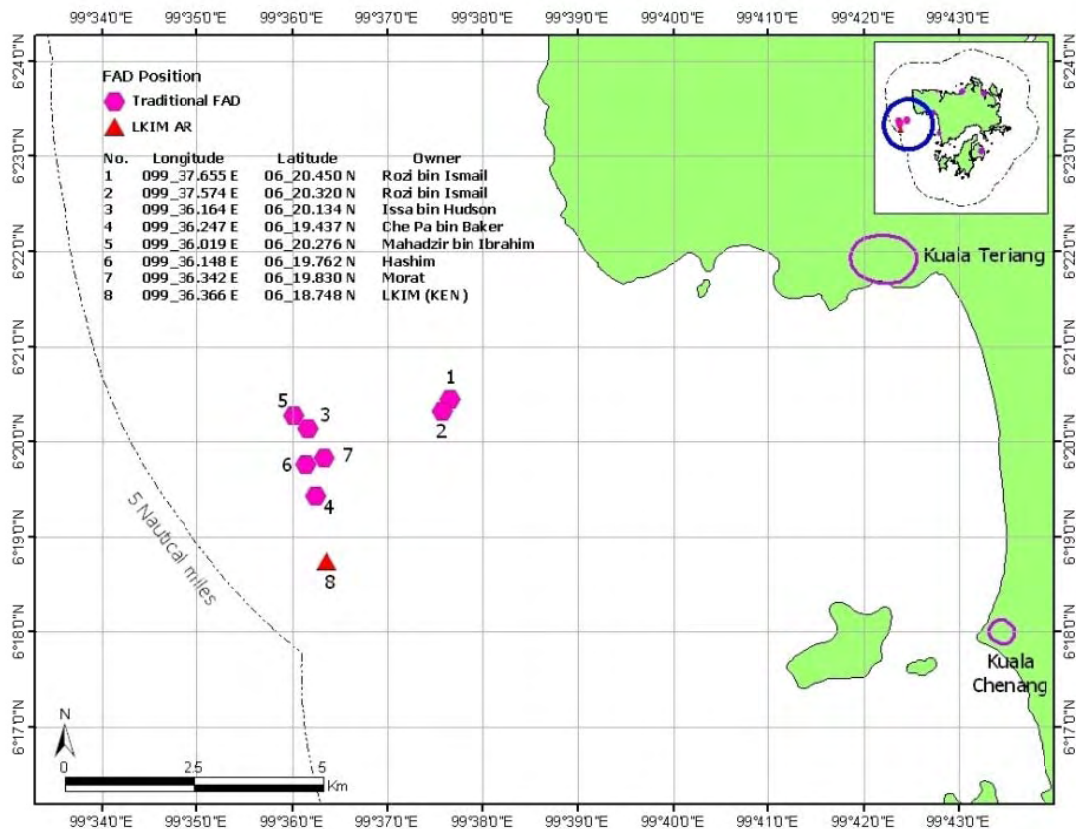


Fig. 12. Chart of installation position of FADs ( Δ Number 8)

### The Fish Enhancing Devices (Fig. 13-14)

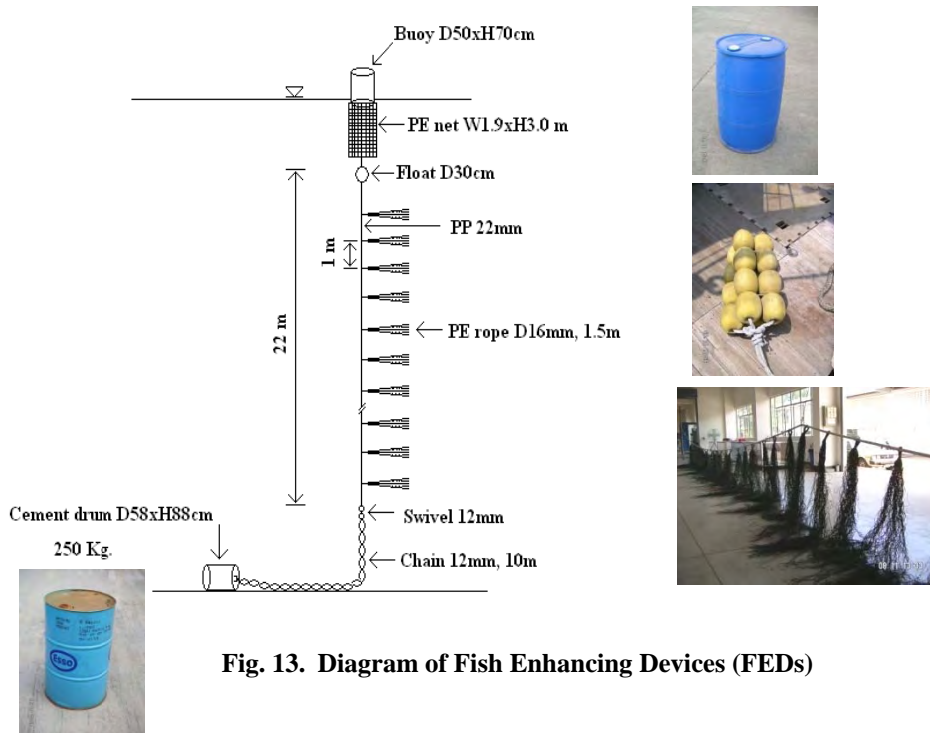
Project : SEAFDEC/TD Resources Enhancement

Location : Langkawi, Malaysia

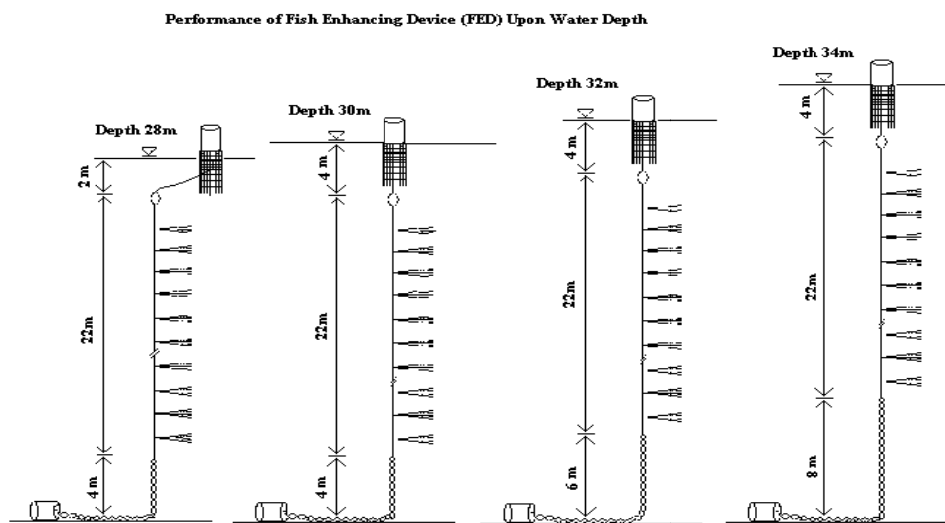
Water Depth : 31 m

Material : Synthetic Fiber - Poly-Propylene (PP)

Poly-Ethylene (PE)



**Fig. 13. Diagram of Fish Enhancing Devices (FEDs)**



**Fig. 14. Mechanism of FEDs allows self-adjustment during low and high tides**

Soon after the installation of FADs in Langkawi, a big natural disaster “Tsunami” hit the Indian Ocean and Andaman Sea on 26 December 2004. Many fishing boats and fishermen’s houses in Kuala Teriang, Langkawi were damaged by the big wave. All fishing activities were suddenly paralyzed as the fishermen stopped their fishing activities to concentrate on rehabilitation. The Relief Programs of the Malaysian Government were focused on re-building the fishing village including the fishing boats and gears. The fishermen in Kuala Teriang, Langkawi only returned to fishing in March 2005. Nonetheless, it was observed that the FEDs set up were not damaged during the Tsunami.

At the beginning of the new fishing season, the fishermen reported that the amount of fish catch around the FEDs was very high. The fishermen said that they could get a lot of benefits from the FEDs. However, in July 2005, the fishermen group of Kuala Teriang reported that all FEDs had disappeared, which was attributed mainly to the encroachment of trawlers in the demarcated zone.

Based on such circumstance, the National Coordinator for Japan commented during The 28<sup>th</sup> Meeting of the Program Committee of SEAFDEC held in Bangkok, Thailand in December 2005, that: **“The use of artificial reefs is based on national interests and capacity. To this end, pilot activities on artificial reefs should be given low priority” (Para 27).**

In connection with such comment by the National Coordinator for Japan, SEAFDEC/TD had to scale down all activities related to artificial reefs under the Resources Enhancement Program in Pathew District in Chumporn Province, Thailand and in Pulau Langkawi, Malaysia.

### Artificial Reefs Installation

The installation of artificial reefs in Langkawi, Malaysia was conducted from 20 to 22 January 2006. The installation observation trip by the TD staff was supported through the project on Locally Based Coastal Fisheries Management: Pulau Langkawi (LBCRM-PL) under the Japanese Trust Fund Program. Since under the Resources Enhancement Program, it had been proposed to conduct studies on the impact of artificial reefs (ARs) installation to fisheries resources in the project site in Malaysia, the Malaysian Government through the LKIM proposed to install 10 units of ARs in Kuala Teriang in Langkawi Malaysia on 21 January 2006.

The environmental survey aimed at monitoring the effect of ARs to the fisheries resources in the installation site before the actual ARs installation was conducted by TD in November 2005. In the ARs installation activities, LKIM requested SEAFDEC/TD to assist the fishermen in the proper installation position and procedure. Thus, SEAFDEC/TD sent one researcher to participate in the installation in collaboration with fisheries officers of DOF and LKIM Malaysia

The Fisheries Development Authority of Malaysia (LKIM) finally installed 10 units of ARs on 21 January 2006. The installation position is Latitude 06° 20.501' N, Longitude 99° 37.658' E with water depth of 21.7 m. The ARs were carried by iron barge with tug boat from the construction site to the installation position. The barge was anchored at the nearest position of installation site using two concrete blocks, 5 tons each, on the fore and aft of the barge. Setting of the ARs was performed by using hydraulic crane with its wire cables laying down the ARs on the sea bottom and the divers guided the release of the cable hook from the ARs. Setting of each AR was conducted at position around the barge as shown in Fig. 15, 16, 17a, 17b, 17c. Each setting point was recorded using handy GPS. The construction and installation costs of the ARs were provided by LKIM, Malaysia.

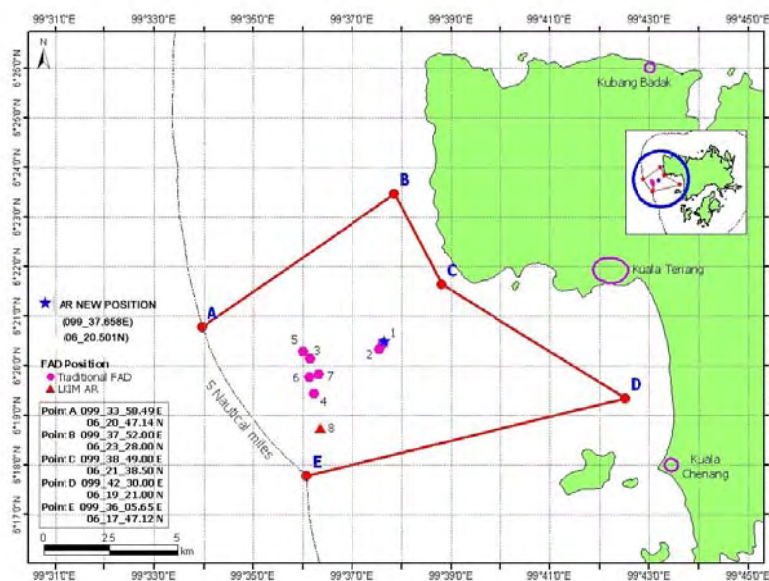


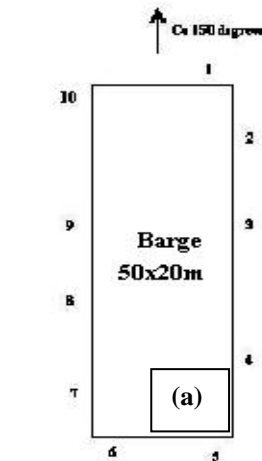
Fig. 15. Position (No.1) of Artificial Reefs installation (star marked)

**Position of Artificial Reefs in Langkawi, Malaysia  
21 January 2006**

No. 1	Lat.	06° 20' .505 N
	Long.	099° 37' .634 E
No. 2	Lat.	06° 20' .506 N
	Long.	099° 37' .642 E
No. 3	Lat.	06° 20' .504 N
	Long.	099° 37' .647 E
No. 4	Lat.	06° 20' .497 N
	Long.	099° 37' .652 E
No. 5	Lat.	06° 20' .501 N
	Long.	099° 37' .661 E
No. 6	Lat.	06° 20' .489 N
	Long.	099° 37' .656 E
No. 7	Lat.	06° 20' .487 N
	Long.	099° 37' .647 E
No. 8	Lat.	06° 20' .492 N
	Long.	099° 37' .645 E
No. 9	Lat.	06° 20' .494 N
	Long.	099° 37' .640 E
No. 10	Lat.	06° 20' .498 N
	Long.	099° 37' .661 E

**Note:** Water depth 21.7 m  
Bottom sediment Muddy sand  
Barge size 50 x 20 m  
Barge direction Co 150°

**Fig. 17 (a,b,c). Position and installation of ARs in Langkawi, Malaysia**



**Fig. 16 Structure of artificial reefs**

**Training and demonstration on the construction of FEDs**

Training and demonstration on the construction of FEDs (Fish Enhancing Devices) and pre-installation marine biological survey for FEDs off Kuala Teriang, Langkawi, Malaysia, 17-22 March 2007 were conducted. Upon the request of KEN Kuala Teriang fisherfolks for the installation of FEDs (Fish Enhancing Devices) in 2006, SEAFDEC/TD under the LBCRM-PL project responded to the request but the installation was however delayed due to an improvement of the design of the FEDs.

The follow-up survey from Chumporn Province, Thailand showed that all of the FEDs installed in June 2006 had some weak points and must be improved for more durability and effectiveness. Many points were considered and improved on its construction such as replacing the steel structures with rust-proof materials such as stainless steel, adding another cement sinker to secure the unit in place and could not be taken away easily, enhancing its attracting performance by providing fine mesh netting panels under the supporting floats and preventing incidental damages by fishing boats, and by using only a pipe to mark its position at the surface (instead of using an expensive foam-inserted buoy as in the previous one).

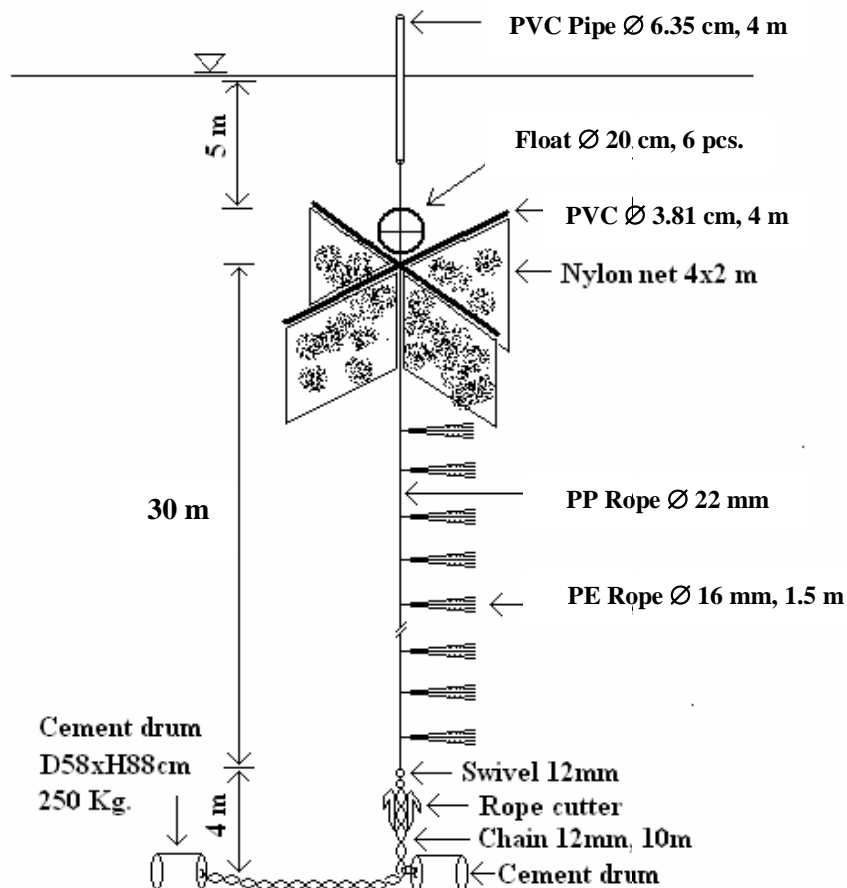
This design will be effective for pelagic species and in shallow waters which was proven to last at least six months in the waters (Fig. 18). All materials were procured, prepared, partly assembled and transported to Kuala Teriang, Langkawi, Malaysia by boat from the Thailand border (Satun Province).

The training and demonstration was conducted on 19 March 2007 for the KEN Kuala Teriang fisherfolks under the technical guidance of the SEAFDEC/TD team and assisted by a local fishery officer for interpretation between English and Malaysian languages. There were around 20 KEN fisherfolks who participated in this activity. Some of them had already experienced similar training and installation in 2004 when the SEAFDEC team first introduced this device to the project site.

**Fish Enhancing Device (FED) Design (Type-II, Improved)**

<b>Project</b>	: SEAFDEC/TD, Resources Enhancement
<b>Location</b>	: Langkawi Island, Malaysia
<b>Water Depth</b>	: 28-34 m
<b>Material</b>	: Synthetic Fiber -Poly-Propylene (PP) -Poly-Ethylene (PE) -Polyvinylchloride (PVC)
<b>Duration</b>	: 17-22 March 2007 (Demonstration)

**Fish Enhancing Device (FED)  
 (Water depth 28-34 m)**



**Fig. 18. FEDs construction design (improved, Second version)**



Partly finished FED has been assembled (except the 2 cement sinkers). The related activities are shown in Fig. 19. It took around 6 hrs to complete a set of FEDs. Then, the fisherfolks were requested to complete all the 10 units of FEDs by themselves within one month and all units were proposed to be installed in the demarcated zone of Kuala Teriang in May 2007 (Fig. 20).



**Fig. 19. Training and Demonstration on the Construction of FED to the fisherfolk of KEN Kuala Teriang, Langkawi, Malaysia, 19 March, 2007**

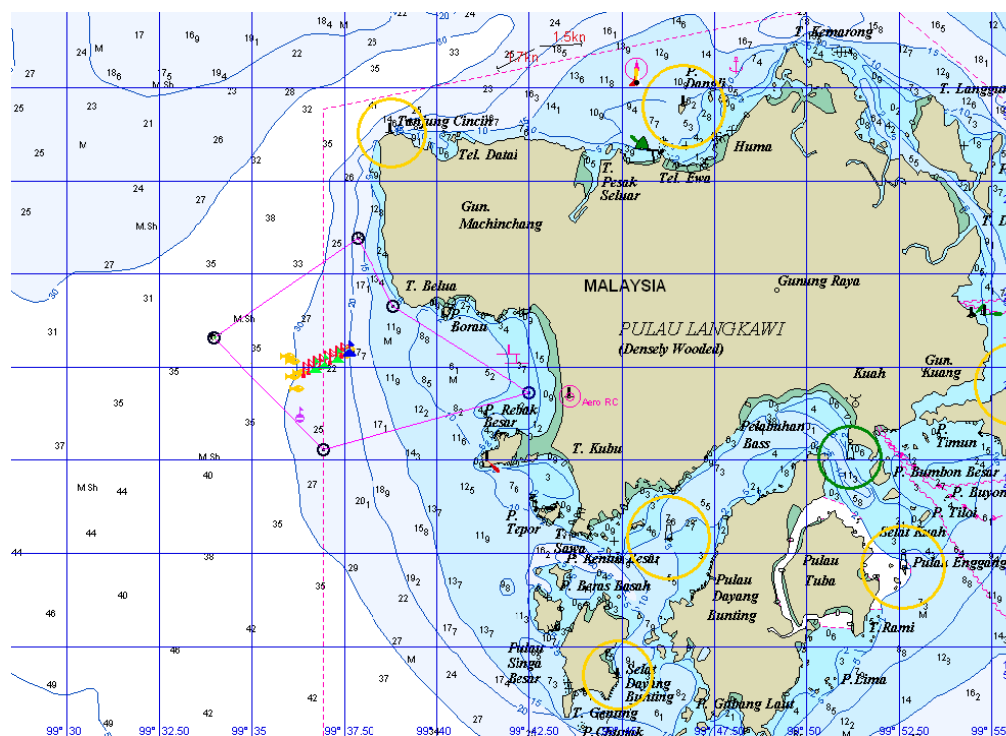


Fig. 20. Chart showing proposed FEDs installation site as requested by the KEN Kuala Teriang fisherfolks in 2007 (indicated by a red circle)

### Pre-installation marine biological and oceanography survey for FEDs

Marine physical and biological survey is one of the essential tools to monitor the effectiveness of the environmental and fisheries habitat changes brought about by the installation of FEDs. Prior to the installation of the FEDs, therefore, an identical survey has to be initiated. This survey was carried out from 20 to 21 March 2007. A small fishing boat was chartered and the following parameters were collected and investigated using available oceanographic equipments prepared by the FRI staff. The summary of the results of the pre-installation survey is shown in Table 1.

#### Water quality

Conventional water quality parameters such as temperature, salinity, turbidity, depth, redox potential, dissolved oxygen and pH, which characterized the conditions existing at the site during sampling, were monitored *in situ* using a Multi Parameter Water Quality Monitor. Nutrients such as  $\text{NO}_2$ ,  $\text{NO}_3$ ,  $\text{NH}_3$  and  $\text{PO}_4$  were periodically monitored within the study site.

#### Plankton

A plankton net was towed horizontally to collect some planktons (zooplankton and phytoplankton) including fish larvae assemblages. The samples collected were preserved in 10% formalin. Identification of the species and abundance were analyzed at the FRI laboratory.

#### Benthos (Benthic fauna)

Benthic fauna is an indicator for the bottom characteristics and productivity of the area. This biological aspect was investigated by collecting bottom sediments using a small grab. Samples were collected twice and preserved before sieving. Abundance, species composition and distribution of the collective organisms living in, on, or near the bottom substrate were analyzed at the FRI laboratory.

### *Catchability of fishes*

For this purpose hand-lining was conducted at the survey site. It effort was measured as kg catch/man/hour and would be conducted both during spring and neap tides. However, the team failed to catch any fishes due to the strong current and the anchor could not make the boat steady in one place. Moreover, the muddy sand bottom could show low productivity rather than a sandy or rocky bottom in terms of fish existence or abundance.

**Table 1. Summary of the Pre-installation marine biological and oceanography survey for FEDs**

<b>Date</b>	<b>Activity</b>
20 March 2007	<p><i>Station 1:</i> N 06°20.5200, E 099°37.6399            Water quality (surface, mid-water, bottom, 20 m)            Water sample (surface and bottom, 20 m)            Benthos (×2)            Plankton net (Horizontal tow)</p> <p><i>Station 2:</i> N 06°20.5004, E 099°37.6194            Plankton net (surface),            Benthos (×2)</p> <p><i>Station 3:</i> N 06°20.476, E 099°37.648            Plankton net (surface)            Benthos (×2)</p> <p>*<i>Stations 1-3</i> are towards the traditional FADs, depth 20 m</p>
21 March 2007	<p><i>Station 4:</i> N 06°18.991, E 099°36.153            Depth 108 ft (36 m)            Water quality (sub-surface, mid-water (15m) and bottom (27 m))            Grab (×2)</p> <p><i>Station 5:</i> N 06°_19.033, E 099°_36.144            Depth 103.1 ft (34.3 m)            Water quality (sub-surface, mid-water (16m) and bottom (28 m))            Grab(×2)            Plankton net (surface)            Hand-line fishing (Station 5)</p> <p>*<i>Stations 4-5</i> are proposed to install FEDs as requested by KEN Kula Teriang Fisherfolk</p>

### *Analysis of data*

All data obtained were compiled and analyzed by FRI and periodically monitored.

### *Working staff*

1. Abdul Razak Bin Latun-Fisheries Research Institute, Penang
2. Hadzley Harith- Fisheries Research Institute, Penang
3. Choong Kah Tung -State Fisheries Department, Penang
4. Taweekiet Amornpiyakrit-SEAFDEC/TD
5. Suchart Kijsumut-SEAFDEC/TD

The time allocated for the fisherfolk to complete the construction of 10 sets of FEDs was unfixed, but it should not be more than 1 month. However, the fisherfolks showed their enthusiasm to install the FEDs as soon as possible in the requested site. Hence, the SEAFDEC team decided to continue the installation in early April 2007. Monitoring survey on its effectiveness was discussed after the installation (Fig. 21).





Fig. 21. Pre-installation marine biological and oceanography survey for FEDs, 20-21 March, 2007 at the requested installation site of FEDs

### Installation of 10 units of FEDs

The SEAFDEC/TD staff introduced a new design of FEDs to the fishermen group of Kuala Teriang, Langkawi, Malaysia on 17-22 March 2007 under the project Integrated Coastal Resources Management in Pulau Langkawi (ICRM-PL). In the wake of the training course on construction of FEDs on 19 March 2007, 10 sets of FEDs were completed by the members of KEN before the end of March 2007. The Steering Committee (SC) meeting held on 22 March 2007 agreed to carry out the installation of the units on 4 April 2007. The positions where these units would be installed in the zoning demarcation were determined during the SC meeting. The two patterns of the proposed installation position of the FEDs are shown in the following diagrams (Table 2, Fig. 22, and Table 3, Fig. 23):

#### Proposed Langkawi FEDs Setting Position by TD

**Pattern A** (along transect line between local FADs and artificial reefs set by LKIM)

Table 2. Proposed position of installation of ARs (Pattern A)

No.	Latitude (N)	Longitude (E)
1	06° 20' .4995	99° 37' .6391
2	06° 20' .4901	99° 37' .6510
3	06° 20' .4245	99° 37' .5051
4	06° 20' .3528	99° 37' .3600
5	06° 20' .2811	99° 37' .2133
6	06° 20' .2095	99° 37' .0670
7	06° 20' .1370	99° 36' .9199
8	06° 20' .0653	99° 36' .7748
9	06° 19' .9928	99° 36' .6289
10	06° 19' .9229	99° 36' .4830

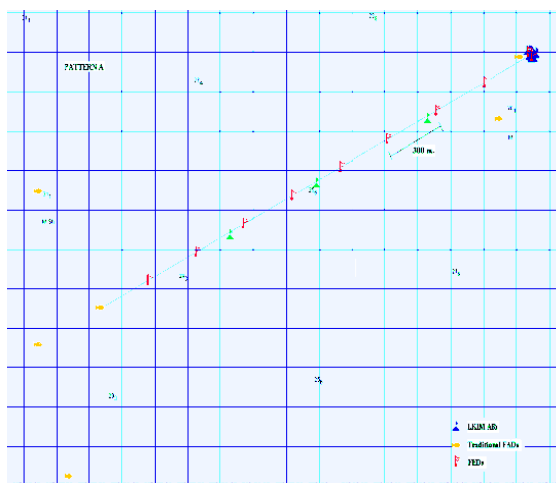


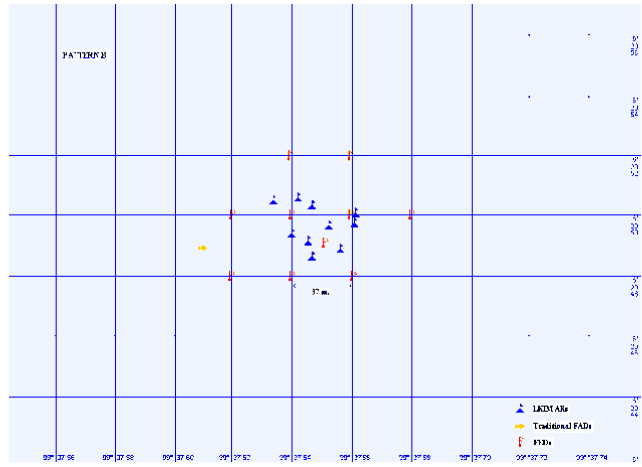
Fig. 22. Proposed position of ARs installation (Pattern A)



**Pattern B** (around artificial reefs set by LKIM, Malaysia 21 January 2006)

**Table 3. Proposed position of installation of ARs (Pattern B)**

No.	Latitude (N)	Longitude (E)
1	06° 20' .5200	99° 37' .6399
2	06° 20' .5200	99° 37' .6604
3	06° 20' .5004	99° 37' .6194
4	06° 20' .5004	99° 37' .6399
5	06° 20' .5004	99° 37' .6600
6	06° 20' .5004	99° 37' .6801
7	06° 20' .4910	99° 37' .6501
8	06° 20' .4799	99° 37' .6198
9	06° 20' .4799	99° 37' .6399
10	06° 20' .4799	99° 37' .6600



**Fig. 23. Proposed position of ARs installation (Pattern B)**

The TD staff accompanied by fisheries officer of DOF Malaysia installed the 10 units of FEDs on 4-5 April 2007. The installation position was proposed by the fishermen group as indicated in Fig. 24-25. About 20 fishermen participated in the installation process (Table 4, Fig. 26), which was conducted using two local fishing boats equipped with GPS and Echo-sounder system.



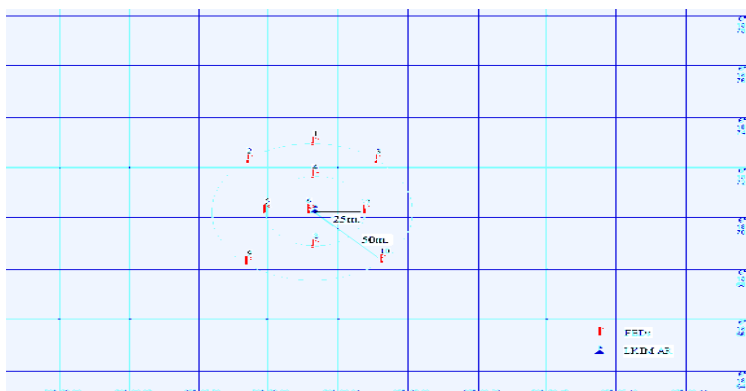
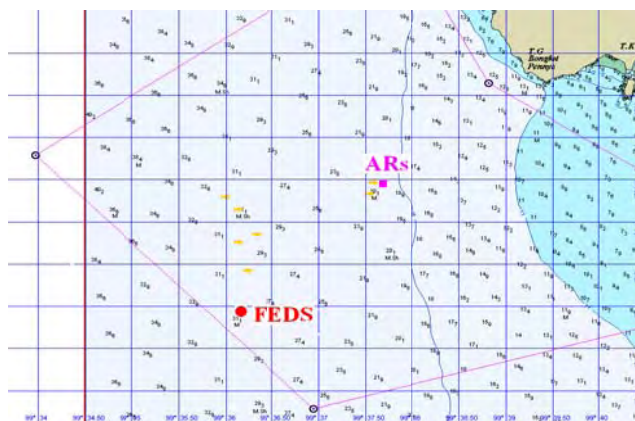
**Fig. 24. Discussion among fishermen group (left), and materials preparation (right)**



**Fig. 25. FED installation at position pre-indicated by fishermen group**

**Table 4. FEDs installation position in demarcated zone of Kuala Teriang on 4 April 2007**

No.	Position	
	Latitude	Longitude
1	6° 19'.025 N	99° 36'.211 E
2	6° 19'.011 N	99° 36'.151 E
3	6° 19'.004 N	99° 36'.202 E
4	6° 18'.999 N	99° 36'.184 E
5	6° 18'.977 N	99° 36'.184 E
6	6° 18'.970 N	99° 36'.170 E
7	6° 18'.954N	99° 36'.151 E
8	6° 18'.935 N	99° 36'.159 E
9	6° 18'.901 N	99° 36'.217 E
10	6° 18'.968 N	99° 36'.209 E



**Fig. 26. Position of FEDs installation in the demarcated zone of Kuala Teriang on 4 April 2007**

### Monitoring of the Fish Enhancing Devices (FEDs) in Kuala Teriang, Langkawi, Malaysia

SEAFDEC/TD staff in cooperation with fisheries officers of FRI, DOF Malaysia conducted monitoring survey on the condition and performance of FEDs as well as survey on marine environmental conditions on 4-5 September 2007. Monitoring of the FEDs was conducted through under-water observation by scuba diving as well as using echo-sounder. The position of the FEDs was searched by GPS. However, no FEDs were found during the survey. Based on reports from the local fishermen, some parts of PVC pipes used as markers and buoyancy float of the FEDs were cut by commercial trawlers (Fig. 27-29).



**Fig. 27. Vessel cruise track (red lines) while searching for FEDs (yellow spots)**



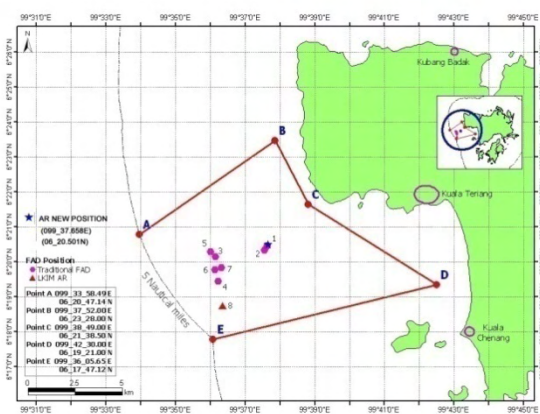
**Fig. 28. PVC pipes as markers and buoyancy floats of the FEDs were cut by commercial trawlers**

**Fig. 29. Commercial fishing boat operation in the project demarcated zone**

**Recommendations**

The installation position of FEDs was proposed by local fishermen group to take place in the demarcated zone of Kuala Teriang. Even through the FEDs position was located in the demarcated zone, lack of intensive patrolling system by fisheries officers may have led to the damage of the FEDs by the intruding commercial trawlers. During the monitoring survey conducted, it was noted that three commercial trawlers were operating inside the area of the demarcated zone. There was no immediate action from the local fishermen to report to the authorities to stop the intruding trawlers. In order to avoid further damages to fishing gear and the resources enhance devices that may be installed later, measures to prevent illegal trawlers from entering the demarcated zone should be re-considered.

For further installation of FEDs by the project in the demarcated zone, it was recommended that the FEDs should be installed near artificial reefs that were installed by LKIM on 20-22 January 2006 (Fig. 30-31). The ARs could serve as protection from further damage of the FEDs by the trawlers.



**Fig. 30. Location of ARs installed by LKIM on 20-22 January 2006**



**Fig. 31. Installation of ARs by LKIM on 20-22 January 2006**

