

RESOURCES ENHANCEMENT PROJECT ACHIEVEMENT

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I. INSTALLATION OF ARTIFICIAL REEFS AT CHUMPHON PROVINCE, THAILAND

TD in collaboration with ASEAN and SEAFDEC member countries conducted Resources Enhancement project in Pathew Distric, Chumphon province, Thailand as a case study. This project is designed to integrated installation of artificial habitats in inshore waters with careful pre-assessment of environmental and socio-economic impact.

Department of Fisheries, Thailand propose to install artificial reefs at Chumphon province on March 2004. Two groups of cubic shape concrete type, 1.5x1.5x1.5m, total 1750 pieces, are set on the project area number 46-16-07 and 46-16-08 (Fig.1). The artificial reefs settle at 12m depth with area cover is 2 km².

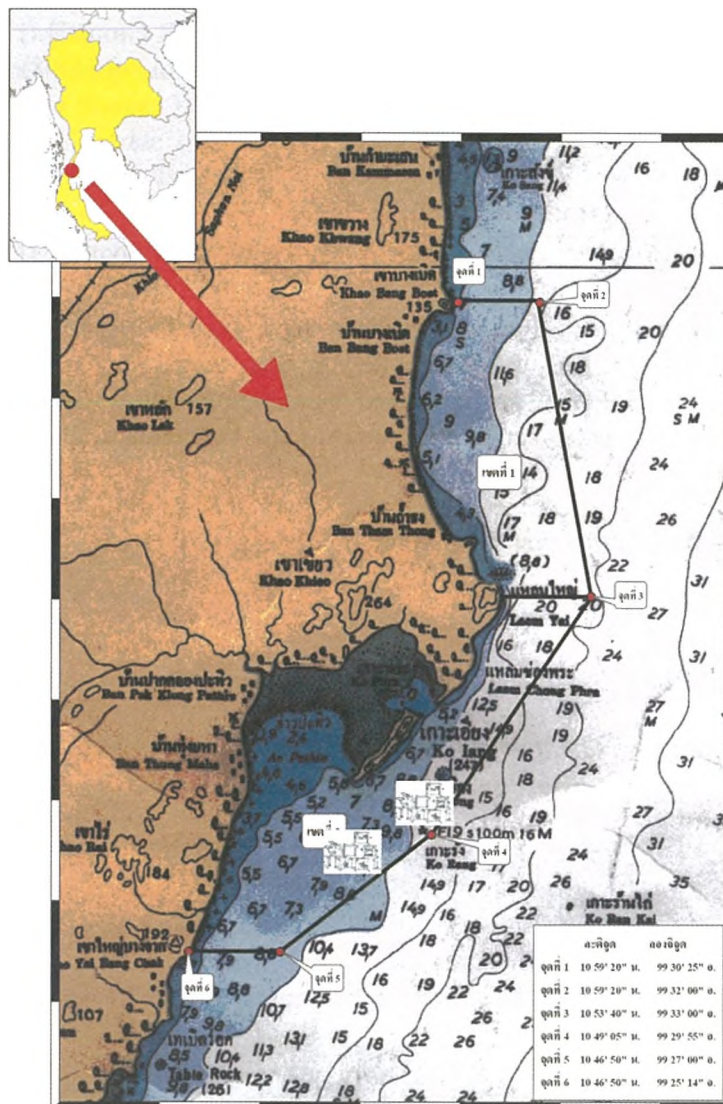


Fig. 1 Location of Artificial Reefs at Pakklong Sub-District, Chumphon Province, Thailand

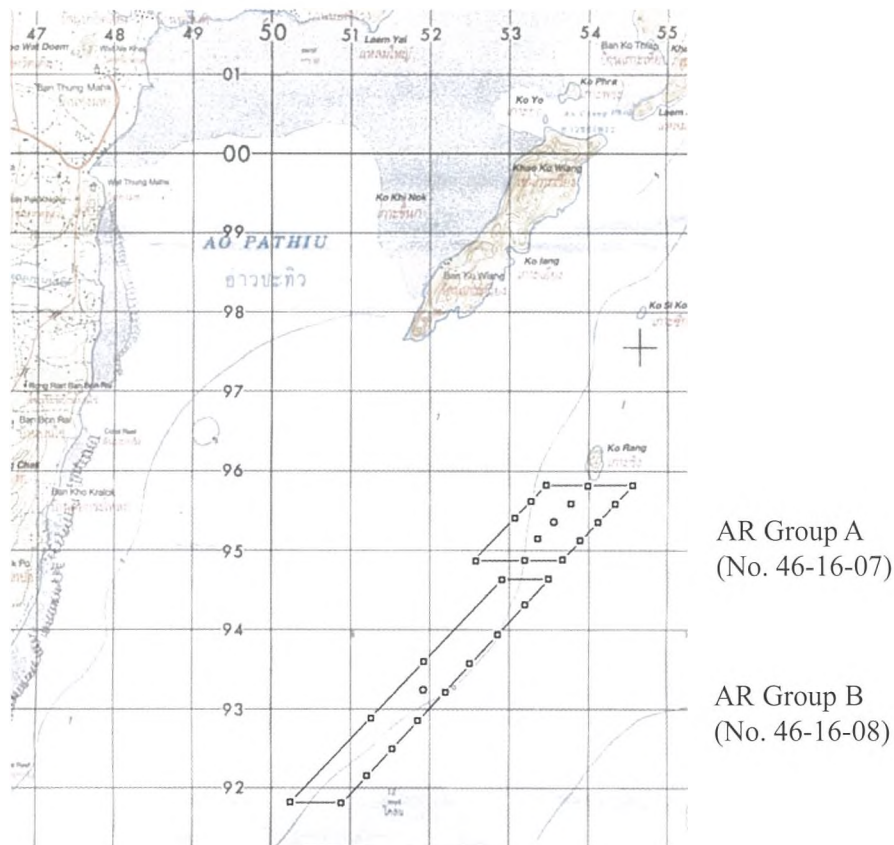


Fig. 2 Layout of two group of Artificial Reefs at project site, Chumphon Province, Thailand

SEAFDEC/TD staff in cooperated with Fisheries Officer, Department of Fisheries to conducted the installation of artificial reefs by M.V. Khaow Khang at Pathew District, Chumphon Province, during 10 – 31 March 2004. The installation method are performed by dumping cubical shape concrete from the vessel at marked position. The position and number of cubical shape concrete installing in the project site are shows as following;

Department of Fisheries, Thailand , Artificial Reefs Project for 2003

Project Number: 46-16-07

- Locaton:** Moo 2, Banborsamrong, Pakklong, Pathew District, Chumphon Province
- Area:** 1.0 x 1.0 kilometer
- Water Depth:** 11.0 – 16.0 meter
- Bottom:** Muddy sand
- Dist. From Shore:** 4.9 – 5.8 kilometer
- Material:** Concrete 1.5 x 1.5 x 1.5 meter, 875 pieces
- Position:**
 - A. Lat. 10 – 49.00 N, Long. 99 – 28.85 E
 - B. Lat. 10 – 49.00 N, Long. 99 – 29.35 E
 - C. Lat. 10 – 48.50 N, Long. 99 – 28.70 E
 - D. Lat. 10 – 48.50 N, Long. 99 – 28.20 E
- Budget:** 3,000,000.- Baht

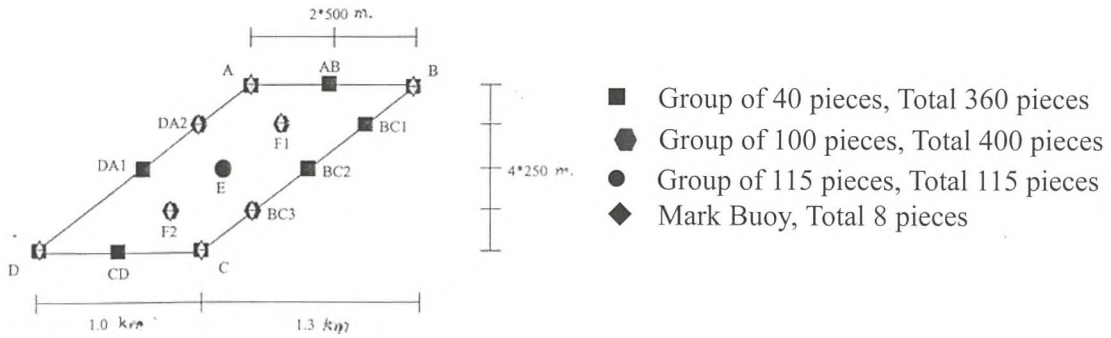


Fig. 3 Layout of Artificial Reefs setting at area number 46-16-07

Project Number: 46-16-08

Location: Moo 6, Banbonrai, Pakklong, Pathew District, Chumphon Province

Area: 0.5 x 2.0 kilometer

Water Depth: 9.5 – 11.0 meter

Bottom: Muddy sand

Dist. From Shore: 3.0 – 4.5 kilometer

Material: Concrete 1.5 x 1.5 x 1.5 meter, 875 pieces

Position: A. Lat. 10 – 48.20 N, Long. 99 – 28.05 E

C. Lat. 10 – 47.20 N, Long. 99 – 27.00 E

D. Lat. 10 – 47.20 N, Long. 99 – 26.75 E

Budget: 3,000,000.- Baht

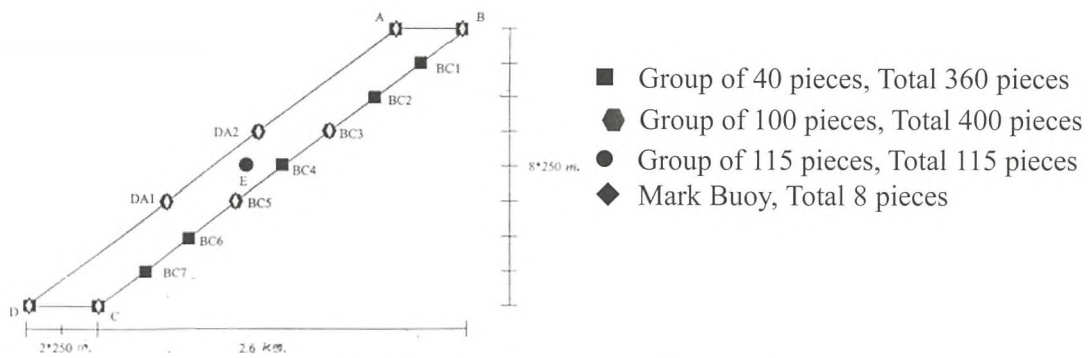


Fig. 4 Layout of Artificial Reefs setting at area number 46-16-08



Fig. 5 M.V. Khaow Khang, carry cubical shape concrete, artificial reefs to install at Pathew District, Chumphon Province

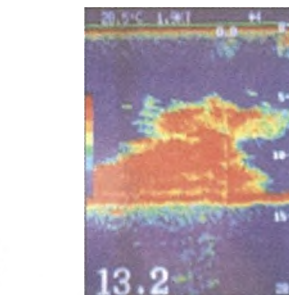


Fig. 6 Fork lift using for convey the cubical shape concrete dumping on the project site (a) the dumping position are marked by anchor flag buoy (b)

Fig. 7 An Echo-gram of Artificial reefs after installation

II. SURVEY AND DATA COLLECTION ON ENVIRONMENTAL STUDIES ON ARTIFICIAL REEFS, SET NETS AND MARINE CAGE CULTURE PROJECT SITES

The SEAFDEC Training Department in cooperation with Department of Fisheries Thailand conducted environmental survey studies at the artificial reef installation site at Pathew District, Chumphon province, Thailand. The environmental survey studies was carried out by M.V.Plalung 1, 35 gross tons. The three survey cruise were conducted as followings; 16-24 November 2003 (pre-survey), 24 July- 4 August 2004, and 21-31 March 2005 (post –survey). Several fisheries environmental parameters were studies. 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, Fish trap, Squid trap, Crab trap were also carried out. In addition, a fish stock assessment by hydro-acoustic survey at the project site was performed. Several fisheries environmental parameters were studies as followings,

1. Fishing Operation Survey

1.1 Fish Trap Fishing Operation

Fish traps with dimension of 90Wx190Lx60H cm, PE net webbing mesh size 6.5 cm, wooden frame diameter 3.5 cm, entrance wire mesh #3.5 cm, were individual setting around the artificial reefs project site where water depth is 12 m. The 8 pieces of fish trap were setting fixed at bottom near by artificial reefs Project No. 46-16-07 A, DA2, E and F1, and for Project No. 46-16-08 BC3, BC5, DA2 and E. The fish caught were collected for species identification after 6 days of fishing operation.



Fig. 8 Fish trap fishing operation

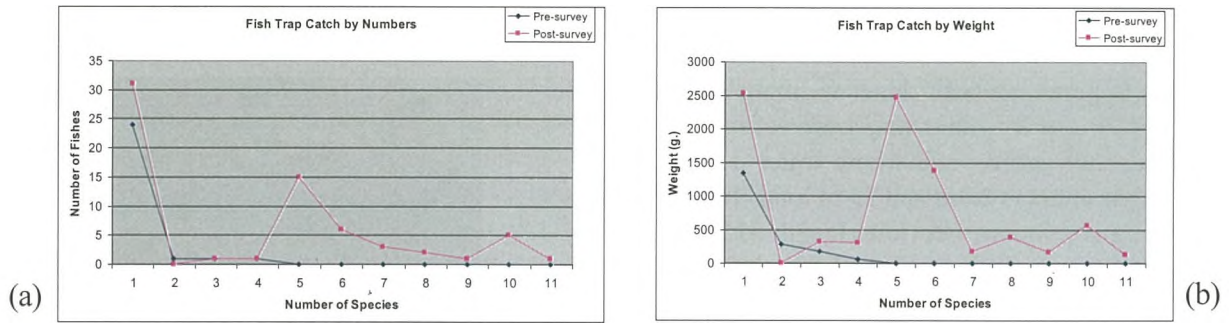


Fig. 9 Amount of fish catch by fish trap in Pre. and Post-survey cruise in term of (a) number and (b) weight.

1.2 Squid Trap Fishing Operation

Squid traps with dimension of 85Wx110Lx70H cm, PE net webbing mesh size 5.5 cm, wooden frame diameter 2.5 cm, were individual setting around the artificial reefs project site where water depth is 12 m. The 12 pieces of squid trap were hang on the buoy line at 3 meter below water surface. The squid caught were collected daily in the morning time for 4 days for species identification and size composition study.

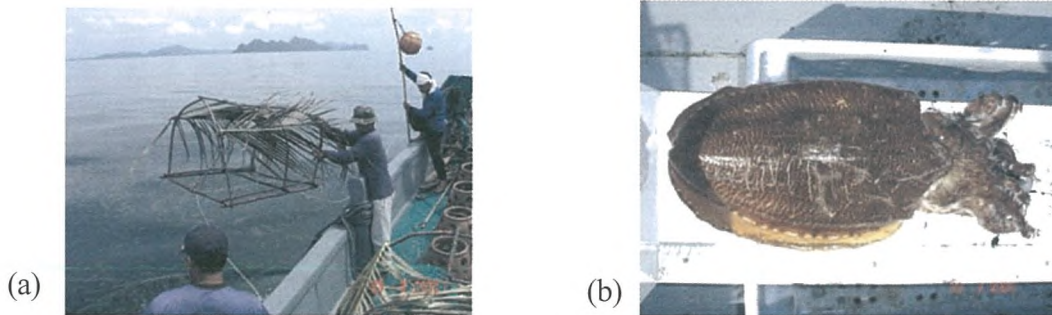


Fig. 10 Squid trap fishing operation, (a) and (b)

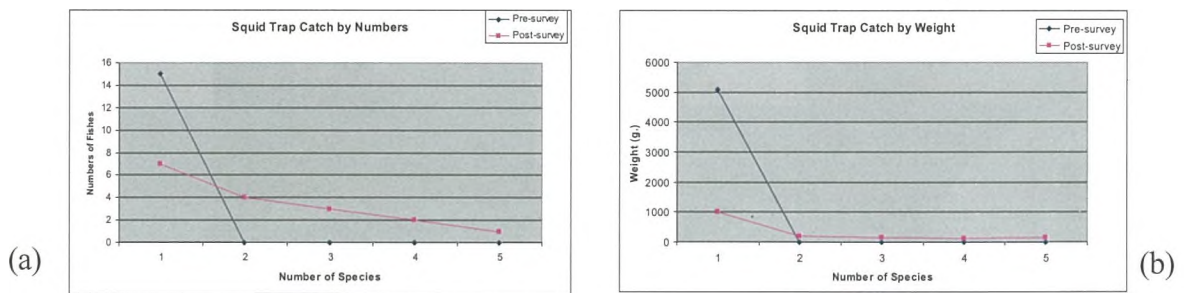


Fig. 11 Amount of fish catch by squid trap in Pre. and Post-survey cruise in term of (a) number and (b) weight

1.3 Bottom Gill net (Trammel net) Fishing Operation

Bottom trammel net with inner webbing mesh size 4.5 cm, and 26 cm for outer net, were setting around the artificial reefs project site where water depth is 12 m. The height of net is 2.4m and 35 m long. Total 15 pieces of joining continuous net (total length 525 m) were set fixing at bottom by anchor at both end. The fishing operation are conducted for 3 days with net soaking period of 15 hours from the evening to next day morning time. The fish caught were collected, species identification, size and weight measurement were performed.



Fig. 12 Bottom trammel net fishing operation

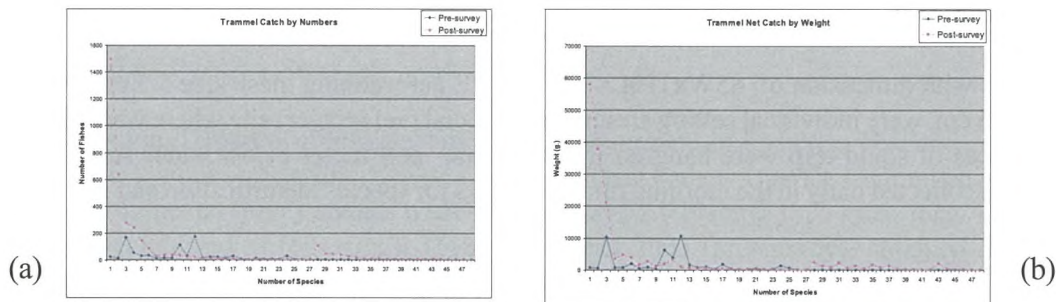


Fig. 13 Amount of fish catch by bottom gillnet (Trammel Net) in Pre. and Post-survey cruise in term of (a) number and (b) weight.

1.4 Collapsible Crab Trap Fishing Operation

Collapsible crab trap with dimension of 38Wx54Lx18H cm, PE net webbing mesh size 3 cm, iron frame diameter 4mm, were joining continuous setting around the artificial reefs project site where water depth is 12 m. The 80 pieces of crab trap were setting by long-line fishing operation pattern fixed at bottom for 3 days of operation. The traps soaking period is 15 hours cover on the nigh time operation. The crab caught were collected, species identification, size and weight measurement were performed.



Fig. 14 Collapsible crab trap fishing operation an its catch

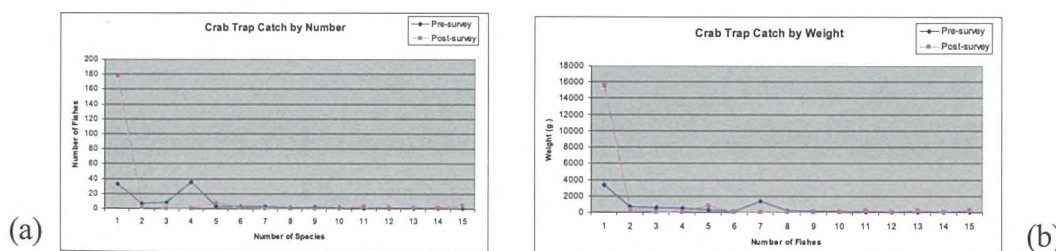


Fig. 15 Amount of fish catch by collapsible trap in Pre. and Post-survey cruise in term of (a) number and (b) weight.

2. Benthos Survey

The survey stations for benthos were set at 0m, 250m, 500m, and 750m, in the direction of N,S,E, and W, away from the center position of each group of Artificial Reefs setting position. Total benthos sampling are 22 stations. At each station a random samplings of bottom sediment was collected using a Smith-McIntyre grab (area coverage 0.05 m²). The sediment was washed through a set of sieves, the smallest one with a mesh size of 0.5 mm. Benthic animal were collected and fixed in 10% formaldehyde solution in sea water on board. The preserved macrobenthic fauna were brought to laboratory for further identify.

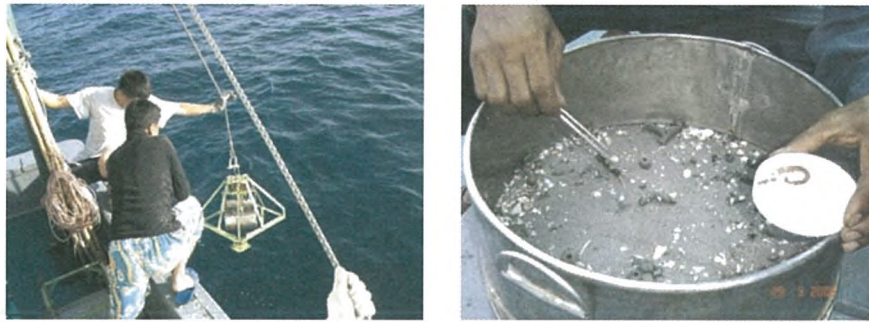


Fig. 16 Random sampling of benthos by Smith-McIntyre grab and washed through a set of three different mesh size sieves

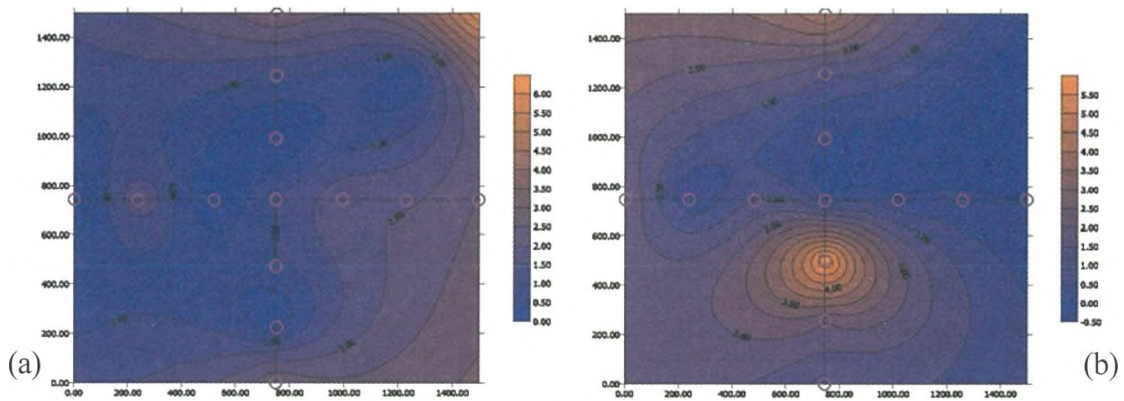


Fig. 17 Distribution of benthos Family Orbinidae around the center group of artificial reefs during November 2003, (a) artificial reefs group A, (b) artificial reefs group B

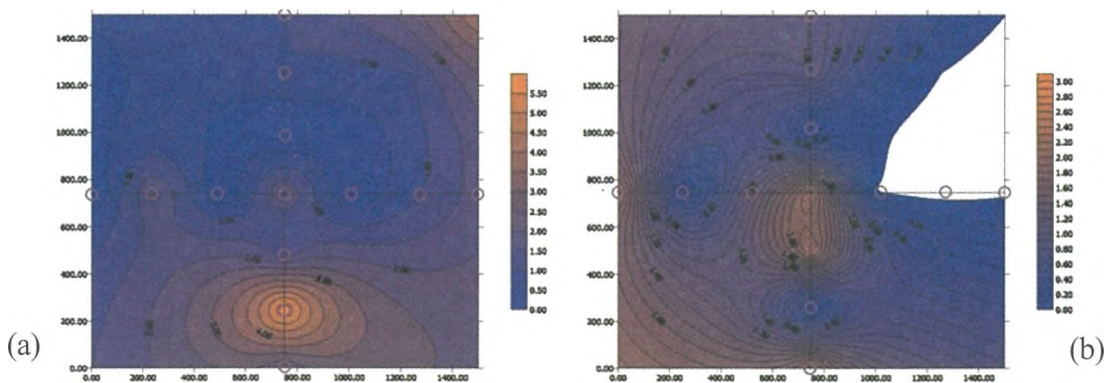


Fig. 18 Distribution of benthos *Nephtys sp.* around the center group of artificial reefs during November 2003, (a) artificial reefs group A, (b) artificial reefs group B

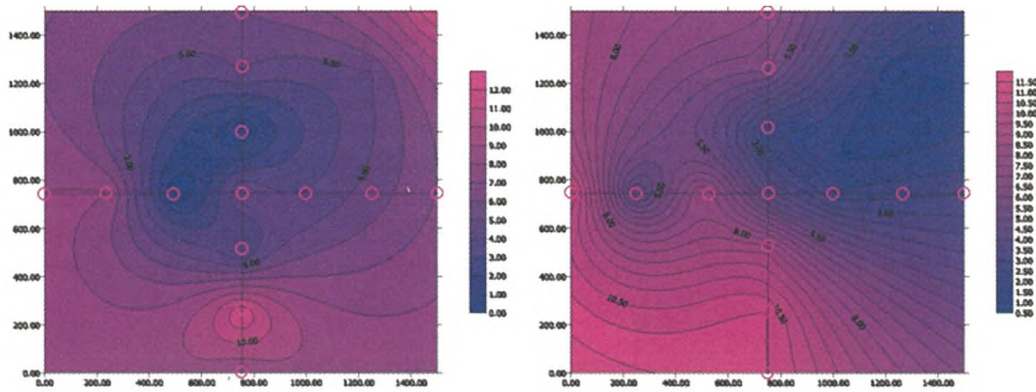


Fig. 19 Distribution of benthos all Family around the center group of artificial reefs during November 2003, (a) Artificial Reefs group A, (b) Artificial Reefs group B

3. Fish Larvae Survey

Sampling for fish larvae was carried out using M.V.PLALUNG 1. The bongo net, 60 cm. in diameter with mesh size 500 micron at the mouth part and 330 micron at the cod end, was employed for the horizontal haul. The net was towing at 1 meter below the surface with speed of 2 knots for 30 min. A flow meter was attached to the mouth of the net. Specimens were preserved in 10% formalin/sea water mixture immediately after a haul completed. Sorting and identification was done at the laboratory.



Fig. 20 Fish larvae collection by using bongo net

List of fish larvae found in the site of artificial reefs during the survey on November 2003.

Phylum CHORDATA	
Number	27
Fish larvae	
<i>Engraulidae</i>	5
<i>Cobiidae</i>	7
<i>Callinymidae</i>	2
<i>Cynoglossidae</i>	1
<i>Nemipteridae</i>	1

4. Phyto-Plankton Survey

The phyto-plankton samples was collected from water sampler at 1 m below the sea surface. Fifty liters of water samples were filtered through a phyto-plankton net (20 μ m mesh size) and preserved in a 10% formalin/sea water mixture. The samples were concentrated by sedimentation. Cell count and identification were conducted in laboratory.

DIVISION CYANOPHYTA (Blue green algae)

CLASS CYANOPHYCEAE

Lyngbya sp.

Oscillatoria erythraea (Eggenberg) Geitler

Richelia intracellularis Schmidt

Unknow Blue-green algae

DIVISION CHROMOPHYTA
 CLASS BACILLARIOPHYCEAE
 Order Biddulphiales (Centric Diatom)
 Order Bacillariales (Plannet Diatom)

 CLASS DICTYOCHOPHYCEAE

 CLASS DINOPHYCEAE (Dinoflaglet)



Fig. 21 Phyto-Plankton bloom

5. Zoo Plankton survey

Sampling for zoo-plankton was carried out using bongo net, 60 cm. in diameter with mesh size 300 micron with employed in the horizontal haul. The net was towing at 1 meter below the surface with speed of 2 knots for 30 min. A flow meter was attached to the mouth of the net. Specimens were preserved in 10% formalin/sea water mix immediately after a haul completed. Sorting and identification was done at the laboratory.

PHYLUM PROTOZOA
 PHYLUM ECHINODERMATA
 CLASS CILIATA
 CLASS ECHINOIDEA
 PHYLUM CHAETOGNATHA (ARROW WORM)
 CLASS OPHIUROIDEA
 CLASS SAGITTOIDAE
 PHYLUM CHORDATA
 PHYLUM NEMATODA
 CLASS PELECYPODA
 CLASS LARVACEA
 PHYLUM ARTHROPODA
 CLASS CRUSTACEA
 PHYLUM MOLLUSCA
 CLASS GASTROPODA

III. INSTALLATION OF FISH SHELTER MODEL FOR PARTICULAR SPECIES ON ARTIFICIAL REEFS AREAS

The installation of three type of fish shelter model were conducted by M.V.Plalung 1 during 23-26 March 2005. Three type of fish shelter are Vertical concrete tube (diameter 20cm, 60 cm long), Horizontal concrete tube (diameter 20cm, 60 cm long) and Oval ball shape earthenware (diameter 60 cm, 80 cm high).

The installation site are on two heap of artificial reefs at location of Latitude 10° 48'.88N, Longitude 99° 28'.94E and Latitude 10° 47'.56 N, Longitude 99° 27'.47 E. At each locati on, there are 18 units of each fish shelter type installed on artificial reefs. This experiment will conduct the observation diving to monitoring species and number of fish living inside the fish shelter. The collected information will using for design the shape of artificial reef with suitable for target fish species.



Fig. 22 Circular ball shape earthenware (diameter 60 cm, 80 cm high)

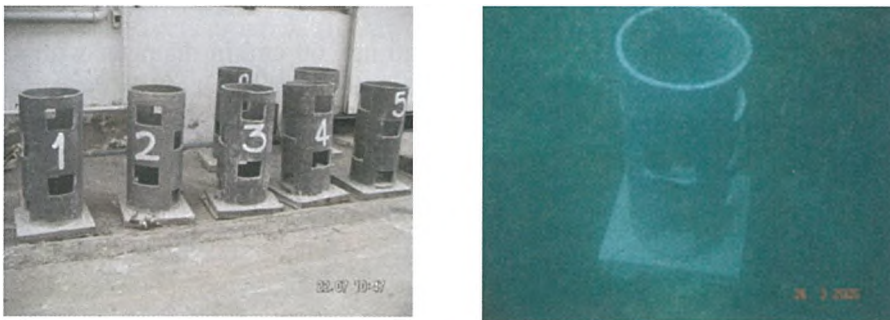


Fig. 23 Vertical cylinder concrete tube (diameter 20cm, 60 cm long)



Fig. 24 Horizontal cylinder concrete tube (diameter 20cm, 60 cm long)

IV. TRANSPLANTING OF SEA WEED (SAGASSUM) ON ARTIFICIAL REEFS AREAS

Since artificial reefs installation size at Pak-klong Chumporn Province are located on soft muddy bottom with water depth of 13 m. There are only barnacle and green mussel could be growth on the concrete structure of artificial reefs after one year of installation. The environmental condition around artificial reefs on soft muddy bottom are the major limitation factors for marine ranching selective species and monitoring activity.

In order to improve the environmental condition around artificial reefs, transplanting of sea weed experiment on artificial reefs were conducted. Sagassum (*Sargassum polycystum*) were collected from Banphe Rayong province and planting on artificial reefs with supported by concrete bars. The transplantation experiment conducted on 24-26 March 2005. Growth up sagassum could be create a marine forest habitat to support a feeding and nursing ground for some fish species. The experiment need to further monitoring of effect of growth up sea weeds the fish behavior in the experiment site.

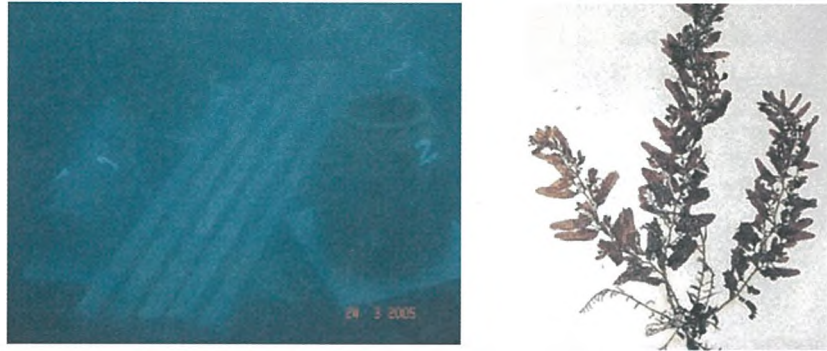


Fig. 25 Supported concrete bars for Sagassum (*Sargassum polycystum*) transplantation

Since, the Twenty-eight Meeting of the Program Committee of the Southeast Asian Fisheries Development Center (SEAFDEC) was held in Bangkok, Thailand from 7 to 9 December 2005. The national Coordinator for Japan commented that use of artificial reefs is based on national interests and capacity. To this end, pilot activities on artificial reefs should be given low priority. Then project activities concern on artificial reefs were scale down and terminated from second phase of Project on Rehabilitation of Fisheries Resources and Habitats/Fishing Grounds through Resources Enhancement 2006-2010.

V. FISH ENHANCEING DEVICE (FED) TRAINING PROGRAM

SEAFDEC/TD under Resources Enhancement Project organized a training and installation program for a permanent Fish Enhancing Device (FED) by using a last long endurance synthetic material with new construction designed. The program was conducted for local fishermen group in Prathew district Chumphon province Thailand during 22-24 August 2005. The training was performed by introduction of the construction and performance of new designed FED to 50 participated local fishermen. The hand on training for fishermen to construction of 10 units of FED were performed. The installation of FED around the artificial reefs were conducted at water depth of 13-15 m. with soft muddy bottom.

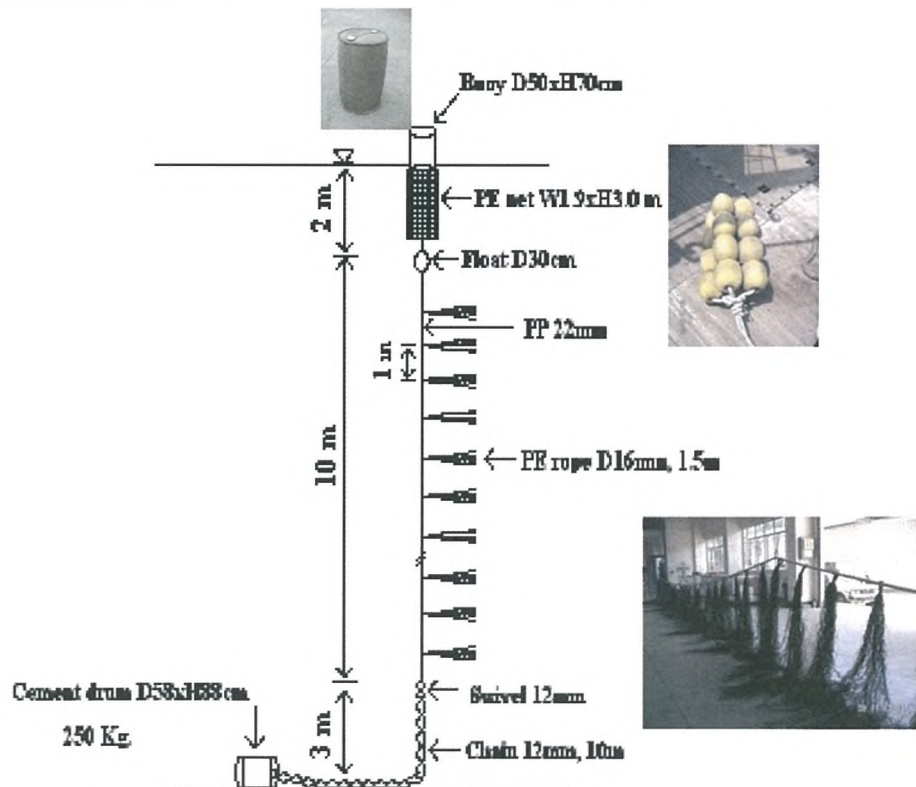


Fig. 26 FEDs design construction using at Pathew District, Chumphon Province, Thailand



Fig. 27 FED main rope, appendages and buoy construction



Fig. 28 FED installation by local fishing boat

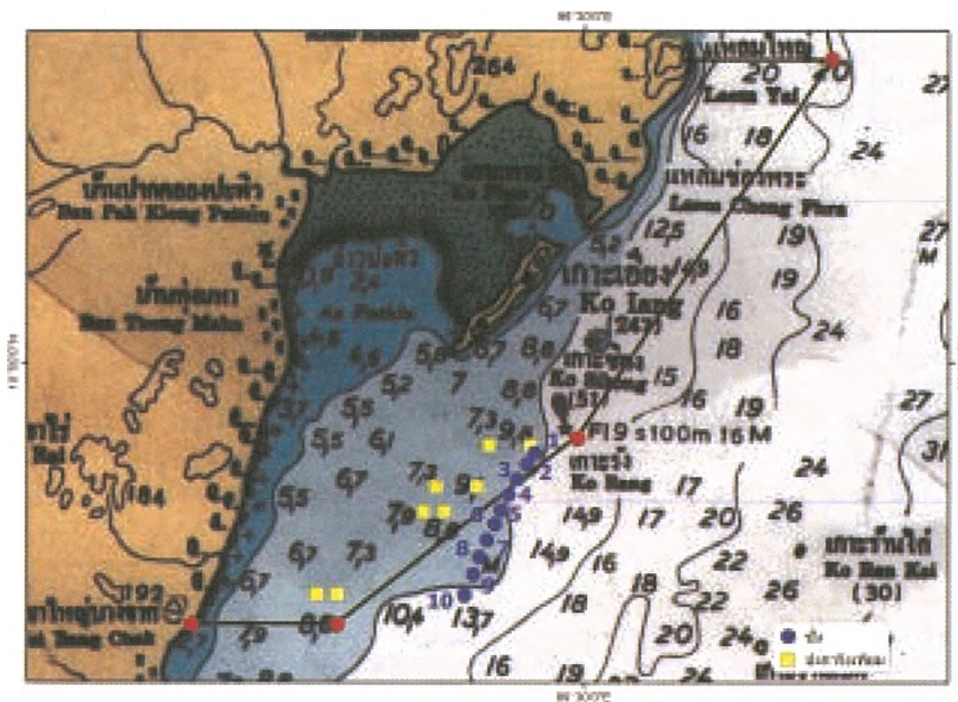


Fig. 29 Installation position (blue dot) of FEDs around artificial reefs (yellow dot) in Pathew District, Chumphon Province, Thailand

Ten unit of FEDs were installed by local fishing boat. The installation position was designed under consultation with the fishermen group of Prathew district. FEDs installation method was conducted along the cross eye bearing direction from Ko Rang to Ko Khai in direction of 115 degrees. FEDs were setting along the bearing direction in the interval of 400 meter. When the FEDs position were plotted on the chart, it found that some part of FEDs were located out of the boundary line of project area as shown in Figure 29. Observation of FEDs performance by underwater SCUBA diving by Chumporn Marine Fisheries Development Center (CMDEC) staffs was conducted on four months after installation. Result of underwater survey found that most of FEDs synthetic material were attached by marine growth such as oyster, green-muscle, barnacle, and coral. Fingering and juvenile of some pelagic species were found around FEDs.

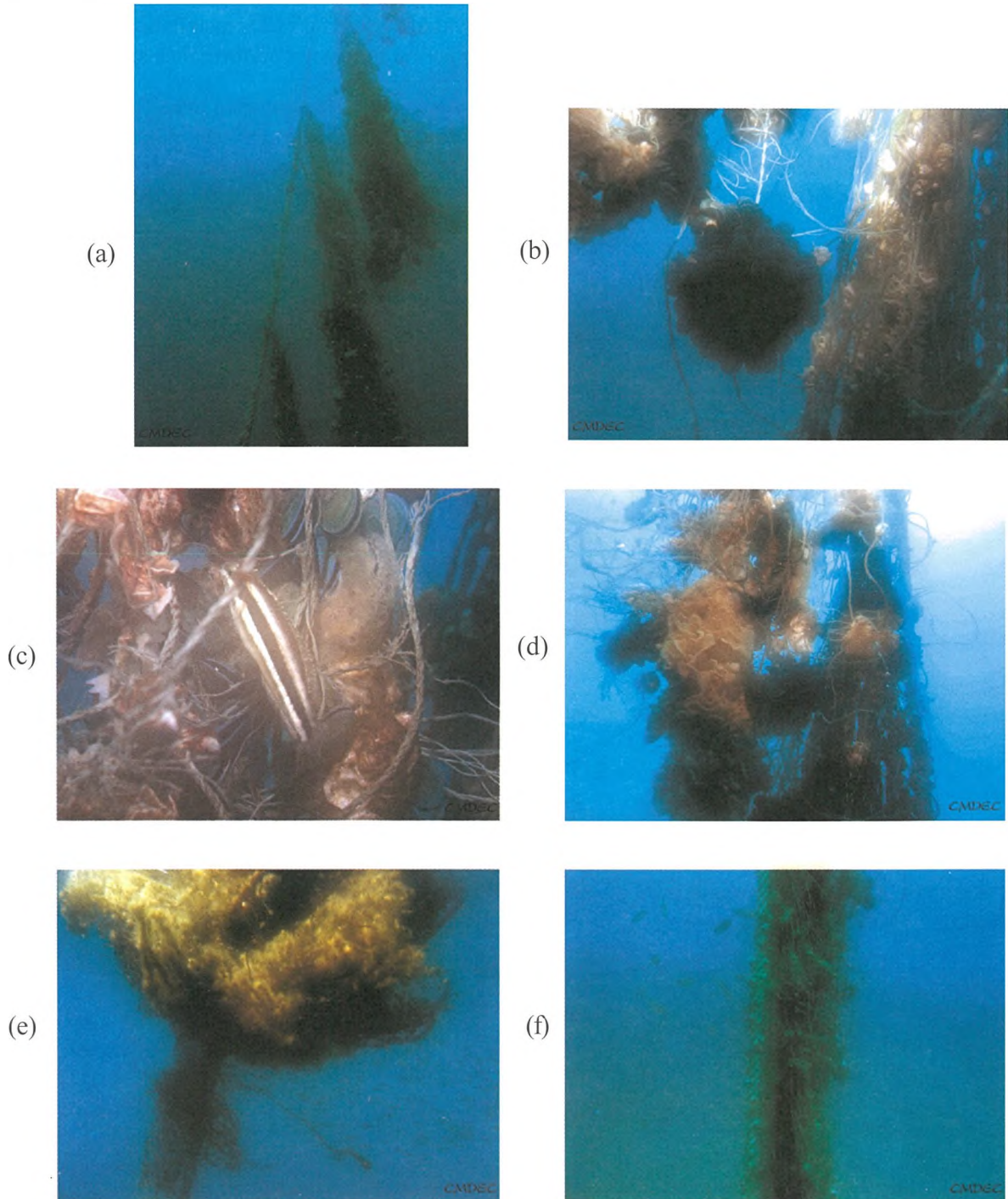


Fig. 30 FEDs synthetic material were attached by marine growth; Oyster, Green-muscle, Barnacle, and Coral (a-d). Fingering and juvenile of some pelagic species were found around FEDs (e-f)

However, it found that six months after installation, FEDs were lost due to plastic container buoy were cut off by several reason such as stolen of plastic buoy, buoy line were cut off by commercial fishing boat use as anchor, and break down of iron swivel part, etc.

Installation of new design FEDs in PathewDdistrict Chumphon Province, Thailand

In order to receive support from Local Administrative Authority (Ao Bo Tor) for additional installation of 60 units of FEDs in the project area of Prathew district. The experiment on new designed of FEDs were conducted. The installation of 10 unit s of FEDs were carried out at Phrathew district Chumphon province during 27-29 June 2006. The installation areas are located around artificial reefs installation site. The objective for installation of FEDs were testing on the design performance and durability as well as an effectiveness of resources enhancement. In order to approval of additional FEDs installation, Ao Bo Tor of Prathew district required for 6 months criteria of testing period for design performance and durability.

Fish Enhancing Dvice (FED)

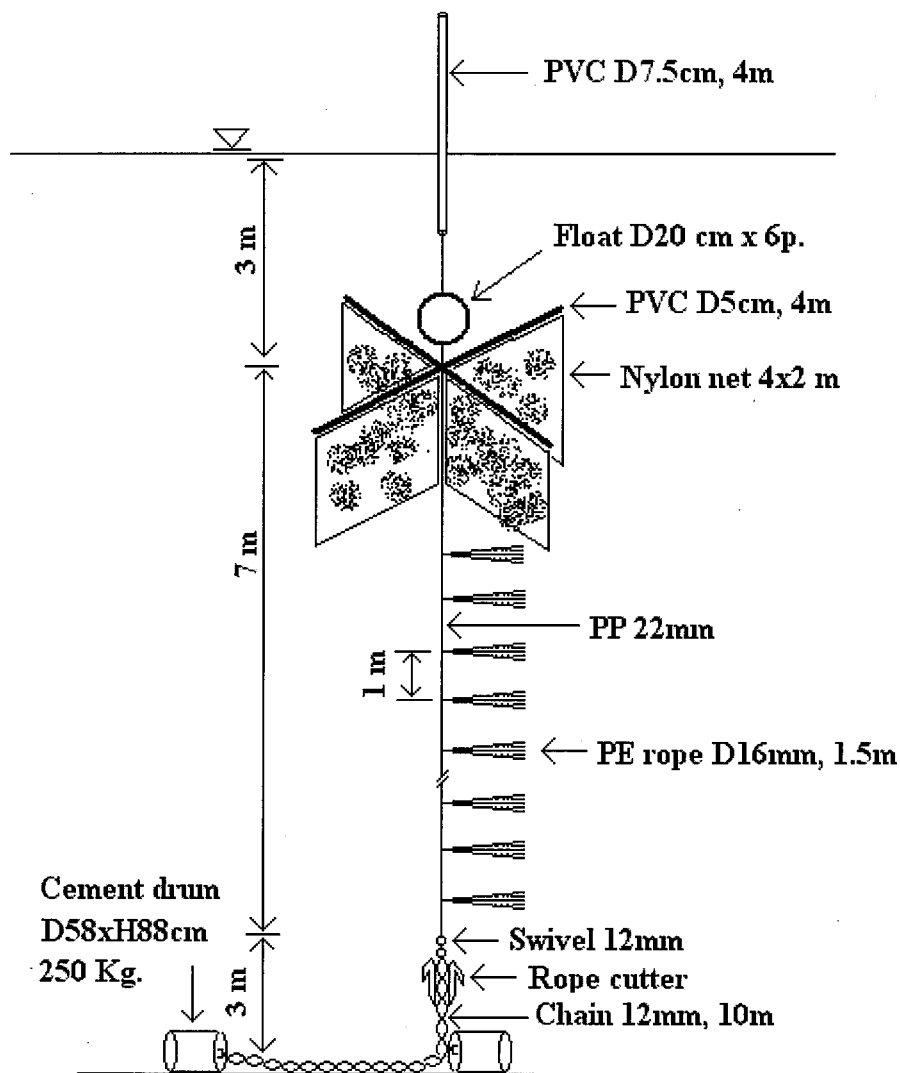


Fig. 31 Second designed FEDs using in Pathew District, Chumphon Province

The second designed of FEDs was modified for some weak points and must be improved for more durability and effectiveness. Many points were considered and improved on its construction such as replacing steel structures with rust-proof material as stainless steel, adding another cement sinker to secure the unit in place not to be taken away easily, enhancing its attracting performance by providing fine mesh netting panels under the supporting floats and avoiding from incidental damages by the fishing boat by using only a PVC pipe to mark its position at the surface (instead of using an expensive foam-inserted buoy as the previous one).

FEDs were installed in demarcated zone of artificial reef setting with water depth of 13-15 meter. In order to avoiding damage from surface passage boat, the Poly-propylene, 22 mm, standing rope, 7 meter, was hang on 6 pieces of plastic floats, 20 cm, at 3 meter under water surface. Appendage ropes, untwisted PE 16 mm, 1.5 meter long, were attached at 1 meter interval along standing rope. Lower part of standing rope attached with 12 mm, 10 meter long, galvanize chain. Two concrete weight, 250 kg., were attached at the losses end of galvanize chain and at 3 meter apart from other end. Buoyancy of 6 plastic floats are sufficient to lift up galvanize chain on vertical standing at 3 meter from the bottom. A stainless steel rope cutter was attached at the upper part of standing chain at 3 meter above bottom. Top of standing rope was connected with two perpendicular PVC pipe, 5 cm, 4 meter long, with hanging net for shelter providing. A closeted ends PVC pipe, 7.5 mm, 4 meter long, was tie with under water plastic float by 16mm PE rope for indicated of FEDs position.



Fig. 32 FEDs construction and installation by fishermen group of Prathew district during 27-29 June 2006

The first investigation of FEDs condition after two months installation were conducted on 29 August 2006. Inspection performed by check position of FEDs by GPS and observation on the growth up of marine organism and fish aggregated around FEDs by under-water photography.

The result of investigation on 29 August 2006, found that 6 units of FEDs still remain and 4 unit are lost. Among the remain, one unit was relocated to a deeper place out off project area. The new position is Latitude $10^{\circ} 48'.090$ N Longitude $99^{\circ} 28'.713$ E. Since, information collection by interview local fishermen that there are 4 -5 bottom trawler operated trawl net inside the artificial reefs areas during 7-18 August 2006, just two week before the FEDs inspection are conducted.

The remain FEDs are in good condition. There are marine growth attached on the PE appendix. Most of marine growth are barnacle, green mussel, oyster and corral. Part of the vertical main rope was attached by lump of squid egg hang on waiting for hatching. Many pelagic school of various species were gathering around FEDs. Young fingerling of some fish species were found around the FEDs for nursling and hiding from predator and strong current. Some demersal fish also found feeding on the FEDs appendage. In general, FEDs could be generated a new habitat for spawning, nursling and feeding environment for bivalve, fish and squid.

Table 1 Position of FEDs installed on 29 June 2006

No.	Latitude	Longitude	Remark
1	10° 48' .937 N	99° 29' .144 E	lost
2	10° 48' .840 N	99° 29' .101 E	lose
3	10° 48' .688 N	99° 28' .852 E	lose
4	10° 48' .588 N	99° 28' .690 E	remain but change position to Lat 10° 48' .090 N Long 99° 28' .713 E.
5	10° 49' .074 N	99° 28' .978 E	remain
6	10° 48' .928 N	99° 28' .900 E	remain
7	10° 48' .929 N	99° 28' .769 E	lose
8	10° 48' .797 N	99° 28' .655 E	remain
9	10° 48' .720 N	99° 28' .692 E	remain
10	10° 48' .683 N	99° 28' .485 E	remain

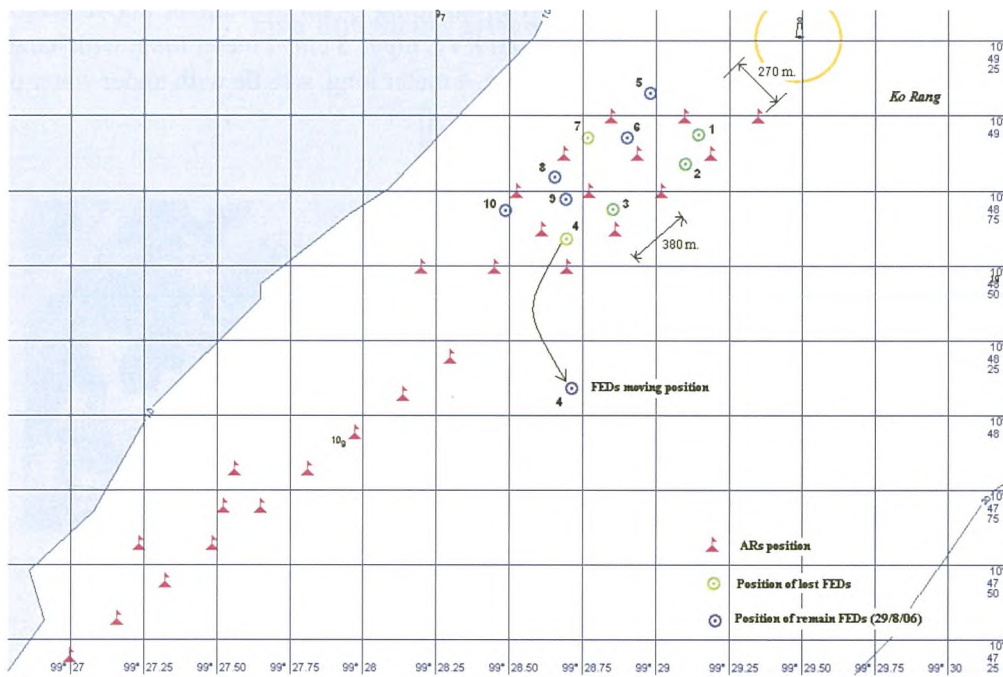


Fig. 33 The FEDs setting position (circle) around artificial reefs areas



Fig. 34 Marked buoy of FEDs on the surface and underwater net spreading pipes



Fig. 35 Marine growth attached on FEDs appendage two month after installation

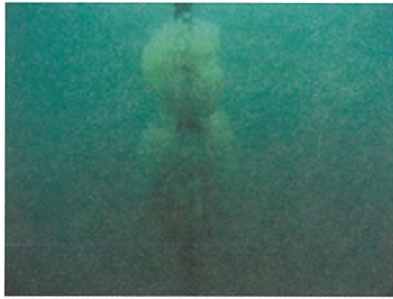


Fig. 36 Squid egg hang on vertical main rope waiting for hatching

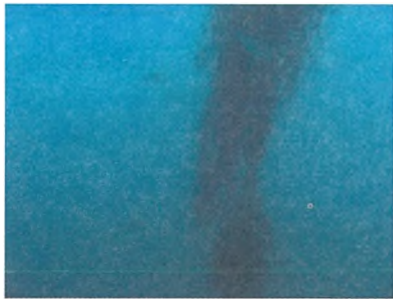


Fig. 37 Young fingerling of some fish species were found around the FEDs for nursing and hiding from predator and strong current.

During inspection of FEDs, an information from interview to local fisherman found that there are bottom trawl net from others province operated in and around ARs installation site. The trawl net operation in side ARs installation areas would directed destroy some part of FEDs. Trawler could be conducted bottom trawl net fishing operation pass through the ARs installation site by using GPS navigation system to avoiding damage of net from ARs.

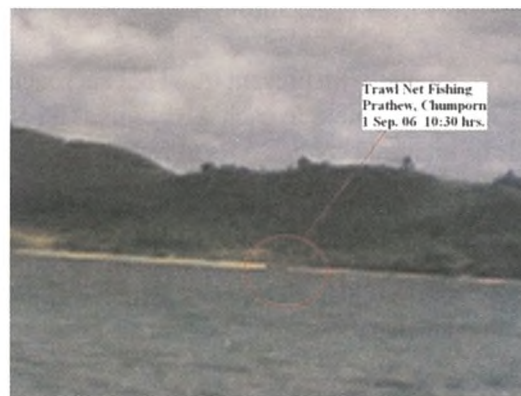
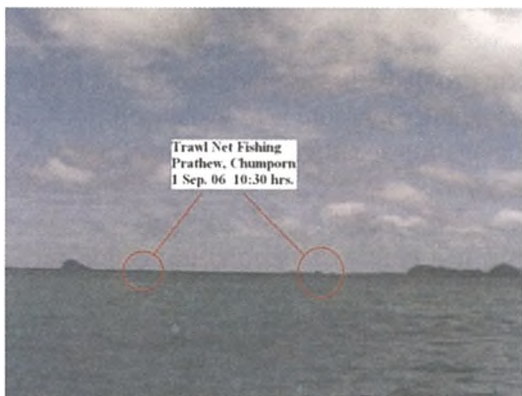


Fig. 38 An evident showing bottom trawl net operated along the coast line of Prathew district. Photo recorded on 1 September 2006, time 10:30 hours

The second investigation of FEDs condition were conducted on 1 December 2006. Inspection performed by Chumporn Marine Fisheries Research and Development Center staffs by observation of FEDs position and growth of marine organism and fish aggregated around FEDs by under-water photography. However, it found that all of FEDs are lose from the installation area. The information from interviewed to local; fishermen found that during their fishing operation on 20 November 2006, all of remain FEDs still can be observed by visual. Since, Starting the end of November, the effect from Northeast monsoon strong wind spreading cover the Southern part of Thailand. Most of the trawl net could not operated in the offshore area because of strong wind and high wave. Some of trawl net intruding into the coastal shore for illegal fishing inside 3 kilometer nursing zone, as well as around FEDs installation area at Prathew district. This is the main reason caused of damage and lost of FEDs by trawl net.



Fig. 39 Strong wind and high wave hit along coastal zone of Chumpon Province during November – December 2006

VI. CONCLUSION AND RECOMMENDATION

From the result of first inspection of FEDs, two months after installation, found that designed construction of FEDs make it well working performance. Some marine organism start to attached and grow up on FEDs appendage. There are both juvenile and mature fish found during under water inspection and photographing. There are 4 units lose and 1 unit re-located caused by bottom trawl net operation in the installation areas. Even through, FEDs were equipped with rope cutter on anchor chain at 3 meter above the bottom. The rope could be cut off the trawl net head rope but could not cut its ground rope with iron chain. However, the encroachments trawl net head rope could be damage by rope cutter. Normally, illegal encroachments trawl net are operating in the night time. They navigate the boat by using GPS along the channel inside ARs. This technique could be avoided from net stuck with ARs. Since, spacing between ARs in SE-NW direction around 380 meter and 270 meters in NE-SW direction. While trawl net otter board spreading distance was around 100 meter. Then spacing between ARs are wide enough for bottom trawl net to pass through.

In order to encounter with present trawl net encroachment problem, the installation of FEDs in the future should be install very near to each ARs units. The others counter measure is to install additional ARs in the middle of interval between ARs to reduce the boat navigation spacing. More often of patrol by DOF enforcement officer are also necessary.

However, with in the period of nearly 6 months just before the second inspection survey are performed, it showed that the second designed and construction of FEDs are function well. FEDs could be using longer than haft year durability. This result could be satisfied to the criteria of Local Administrative Authority (Ao Bo Tor) of Prathew district.

Since, limitation of program budget, then the investigation of the effective of FEDs on biology information aspect by TD staff could not be carry out properly. However, the survey were conducted by scientist of Chumporn Marine Fisheries Research and Development Center by using visual observation methodology. Unfortunately, FEDs were destroy by trawl net before further information were collected. The local fishermen in Prathew district who are directly benefit from the FEDs are fish trap, hand line and bottom gill net operator. This group of fishermen are strongly requested for continuous of the further FEDs installation in appropriated management measure for utilize and study on the efficiency of this kind of resources enhancement tools.