

REPORT OF ENVIRONMENTAL SURVEY STUDIES ON ARTIFICIAL REEFS AT CHUMPORN PROVINCE, THAILAND.

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SEAFDEC/TD

TD in collaboration with ASEAN and SEAFDEC member countries conducted Resources Enhancement project in Chumporn 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 conducted an installation of artificial reefs at Chumporn province on March – April 2004. Two group 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.

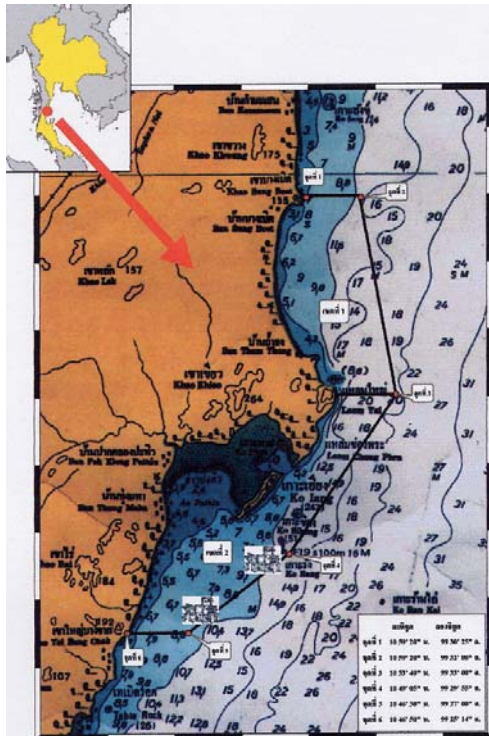


Figure 1. Location of Artificial Reefs project site at Chumporn Province, Thailand

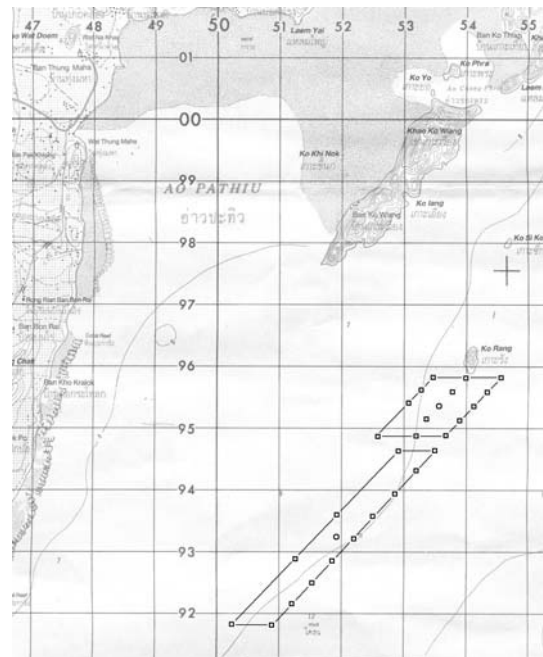
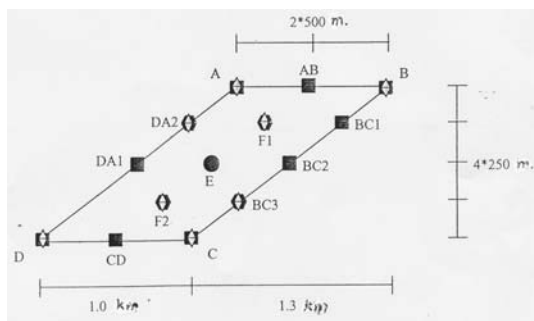


Figure 2. Layout of two group of Artificial Reefs set at project site at Chumporn Province, Thailand

Position:

A. Lat. 10 – 49.00 N,	Long. 99 – 28.85 E	Buoy No. 1	(Height 3 m)
B. Lat. 10 – 49.00 N,	Long. 99 – 29.35 E	Buoy No. 2	
C. Lat. 10 – 48.50 N,	Long. 99 – 28.70 E	Buoy No. 4	
D. Lat. 10 – 48.50 N,	Long. 99 – 28.20 E	Buoy No. 5	
BC3. Lat. 10 – 48.64 N,	Long. 99 – 28.85 E	Buoy No. 3	
DA2. Lat. 10 – 48.85 N,	Long. 99 – 28.68 E	Buoy No. 6	(Height 2 m)
F1. Lat.	Long.	Buoy No. 7	(Height 7 m)
F2. Lat. 10 – 48.64 N,	Long. 99 – 28.63	Buoy No. 8	
E. Lat. 10 – 48.75 N,	Long. 99 – 28.81 N		

Budget: 3,000,000.- Baht



- Group of 40 pieces, Total 360 pieces
- Group of 100 pieces, Total 400 pieces
- Group of 115 pieces, Total 115 pieces
- ◆ Mark Buoy, Total 8 pieces

Figure 3. Layout of artificial reefs setting at area number 46-16-07.

Project Number: 46-16-08

Location: Moo 6, Bonrai, Pakklong Village, Pratew District, Chumporn 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	Buoy No. 1	(Height 3 m)
B. Lat. 10 – 48.20 N,	Long. 99 – 28.30 E	Buoy No. 2	
C. Lat. 10 – 47.20 N,	Long. 99 – 27.00 E	Buoy No. 5	
D. Lat. 10 – 47.20 N,	Long. 99 – 26.75 E	Buoy No. 6	
BC3. Lat.	Long.	Buoy No. 3	(Height 2 m)
DA1. Lat. 10 – 47.57 N,	Long. 99 – 27.25 E	Buoy No. 7	
DA2. Lat. 10 – 47.82 N,	Long. 99 – 27.58 E	Buoy No. 8	(Height 5 m)
E. Lat. 10 – 47.72 N,	Long. 99 – 47.54 E		(Height 4 m)

Budget: 3,000,000.- Baht

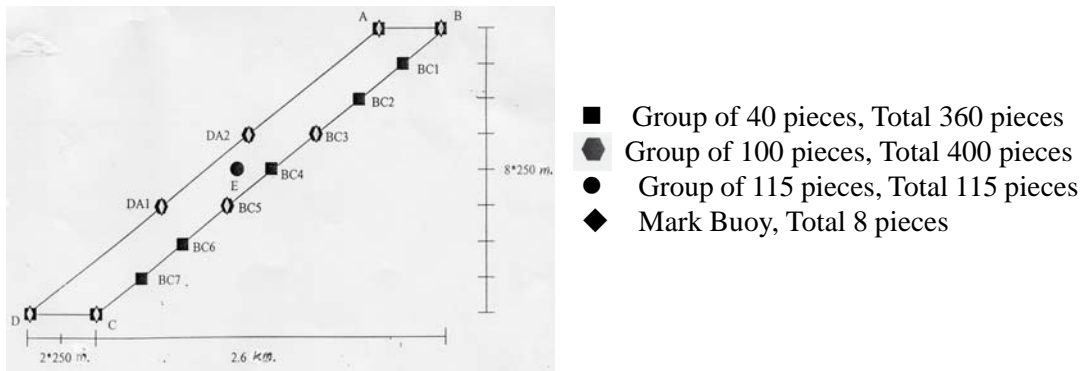


Figure 4. Layout of artificial reefs setting at area number 46-16-07.



Figure 5. M.V. Khaow Khang, carry cubical shape concrete, artificial reefs to install at Pratew dis-



(a).



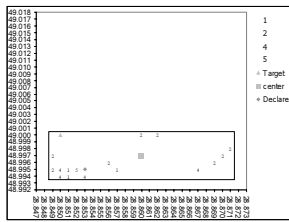
(b).

Figure 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).

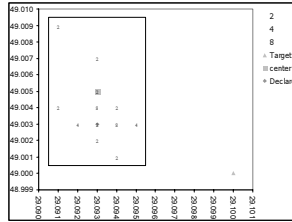
Result of setting position of cubical shape concrete block at artificial reef group.

Project Number: 461607

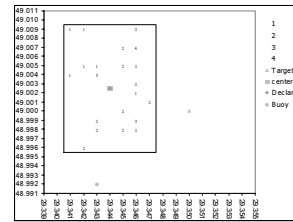
Group A (40 pieces)



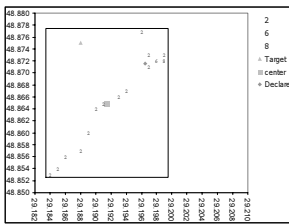
Group AB (40 pieces)



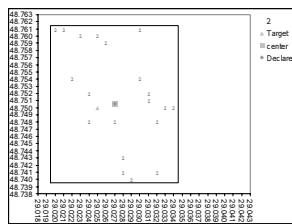
Group B (40 pieces)



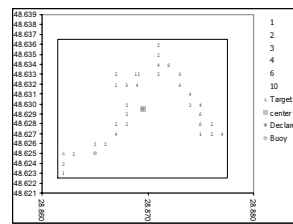
Group BC1 (40 pieces)



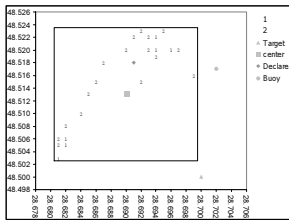
Group BC2 (40 pieces)



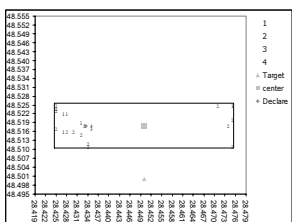
Group BC3 (100 pieces)



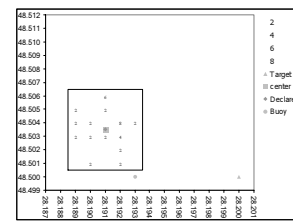
Group C (40 pieces)



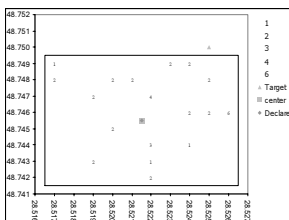
Group CD (40 pieces)



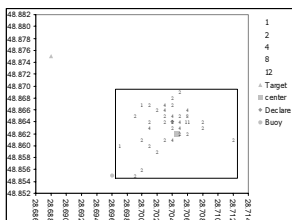
Group D (40 pieces)



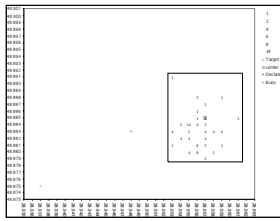
Group DA1 (40 pieces)



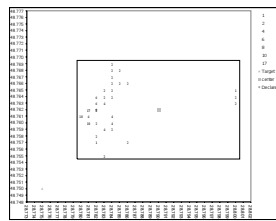
Group DA2 (100 pieces)



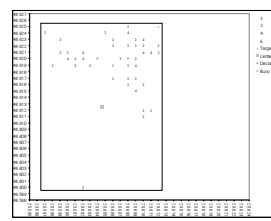
Group F1 (100 pieces)



Group E (115 pieces)

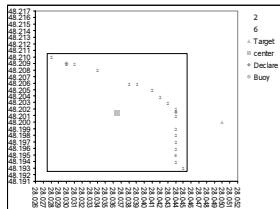


Group F2 (100 pieces)

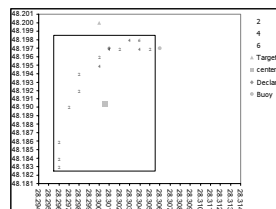


Project Number 46-16-08

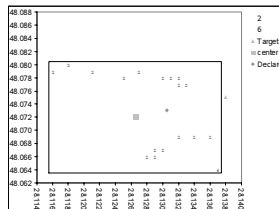
Group A (40 pieces)



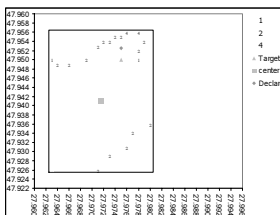
Group B(40 pieces)



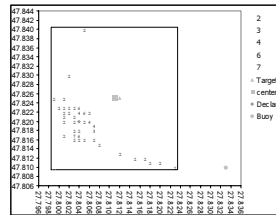
Group BC1 (40 pieces)



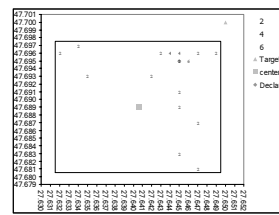
Group BC2 (40 pieces)



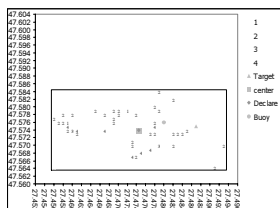
Group BC3 (100 pieces)



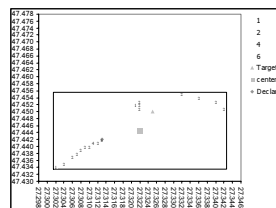
Group BC4 (40 pieces)



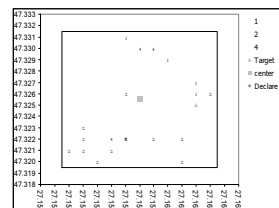
Group BC5 (100 pieces)

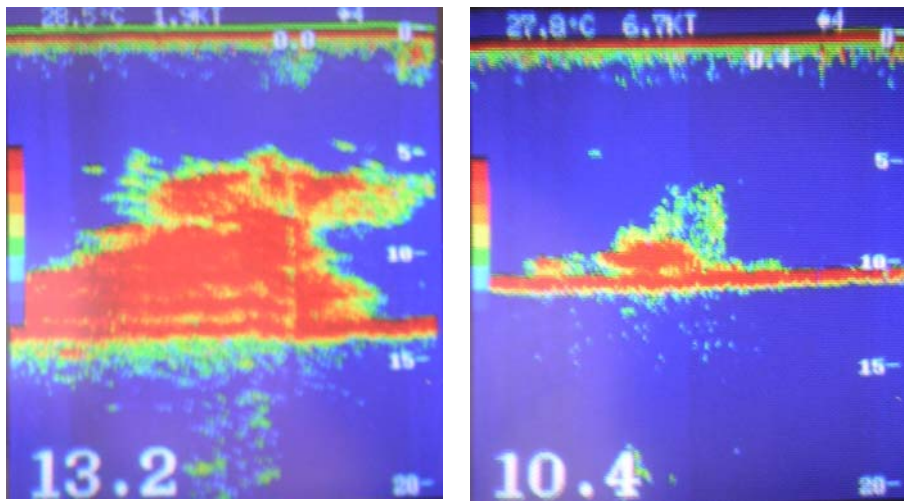
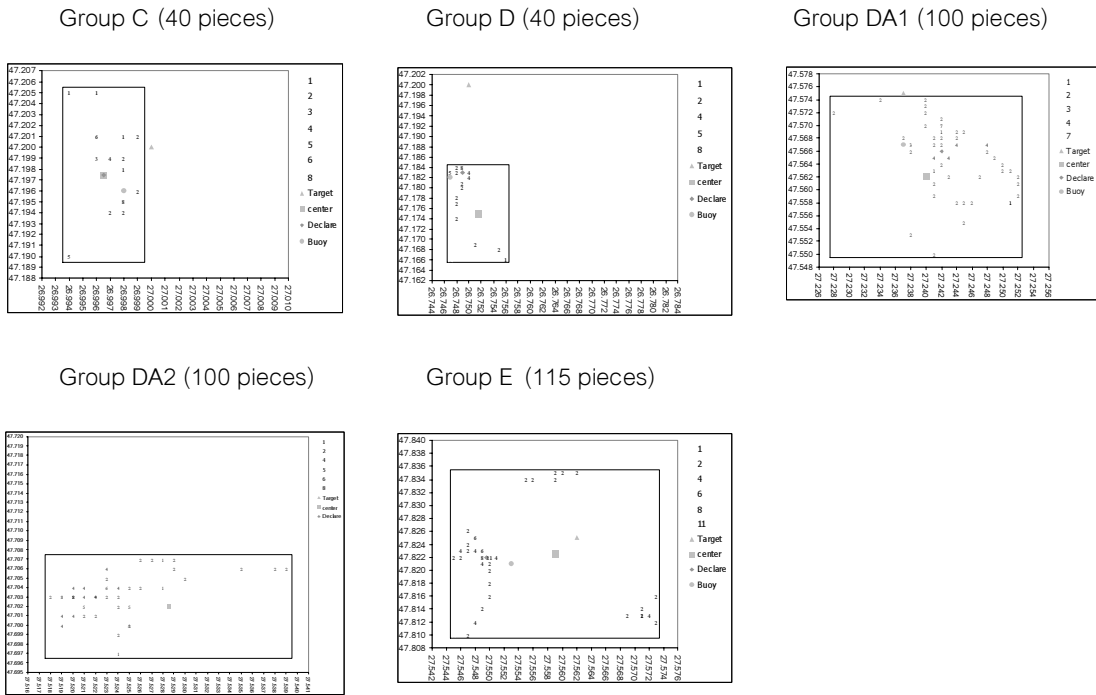


Group BC6 (40 pieces)



Group BC7 (40 pieces)





(a).

(b).

Figure 7. Echo gram of artificial reefs installed in the project site (a) 7 m height, (b) 3 m height

■ FISHING OPERATION SURVEY

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.



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.



(a)



(b)

Figure 9. Squid trap fishing operation (a),(b)

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.

4. Collapsible Crap Trap Fishing Operation

Collapsible crap 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 night time operation. The crab caught were collected, species identification, size and weight measurement were performed.



Figure 11. Collapsible crab trap fishing operation an its catch.

2. Benthos Survey

The survey stations for benthose 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 benthose 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.



Figure 12. Random sampling of benthos by Smith-McIntyre grab and washed through a set of sieves.

3. Fish Larvae Survey

Sampling for fish larvae was carried out using M.V.PLALUNG on 19 November 2003. 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.



Figure13. Fish larvae collection by using bongo net.

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 µm 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.

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.

6. Water Current Measurement

The water current observation was conducted by using Acoustic Doppler Current Profilers (ADCP). The ADCP unit was face-up setting at the sea bottom. The measurement was carried out at the center position of artificial reefs No. 46-16-08 (Group B) setting position. The water depth is 12 m. The current speed and direction were continuous recorded at 10 minutes interval for 24 hours. The recorded data will be analyze for water circulation pattern in the area.



Figure 14. The water current observation was conducted by using Acoustic Doppler Current Profilers (ADCP)

7. Fisheries Resources Survey by Hydro-Acoustic Equipment

The fisheries resources survey in the project site by using scientific echo sounder (FQ-80) on board M.V.SEAFFDEC 2 are performed on 3 August 2004. The transect of parallel cruise tract of 0.5 nautical mile were conducted to cover area of 3x4 square nautical miles of artificial reefs setting area. The scientific echo sounder was equipped with dual frequencies by using two split beam transducer with frequencies of 38 and 120 kHz. The data collected from the echo sounder were recorded into hard disk for further analysis.

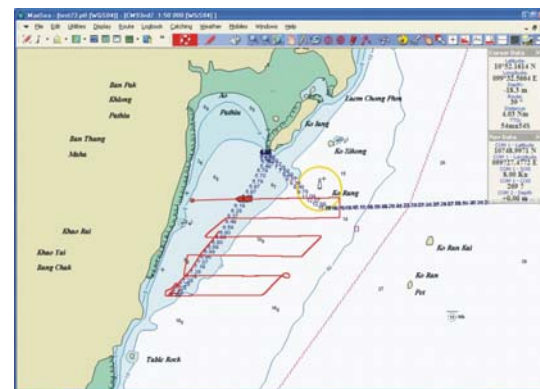


Figure 15. The transect of parallel cruise tract of 0.5 nautical mile were conducted to cover area of

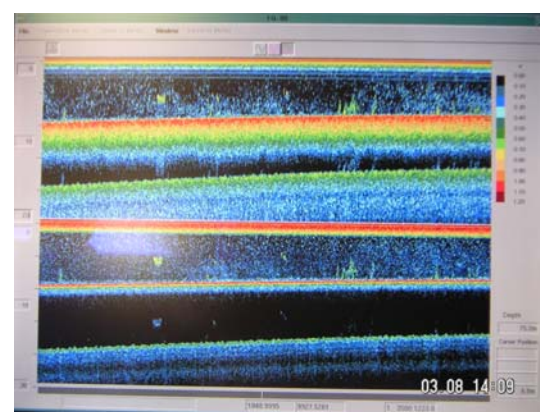


Figure 16. The echo gram of fish detected during the survey.

Results

1) Fishing Operation

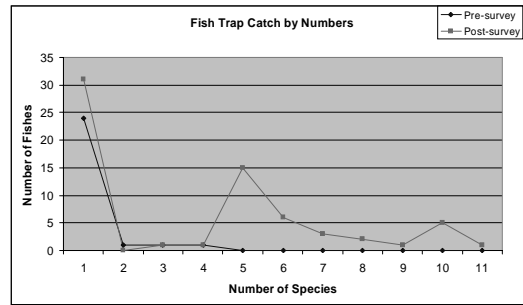
1.1) Fish trap

There are 4 species with total number of 27 fish composed of *Scatophagus argus*, *Plotosus canius*, *Lutjanus sp.*, and *Synanceja horrida* collected during the 1st (Pre.) survey cruise. The number of species collected increasing to 10 species with total number of 66 fish during 2nd (Post.) survey cruise. Spotted butter fish (*Scatophagus argus*), Lactice monocle beam (*Scolosis taeniopterus*), Onespot snapper (*Lutjanus monostigma*) and Blue swimming crab (*Portunus pelagicus*) are the major species collected from fish trap.

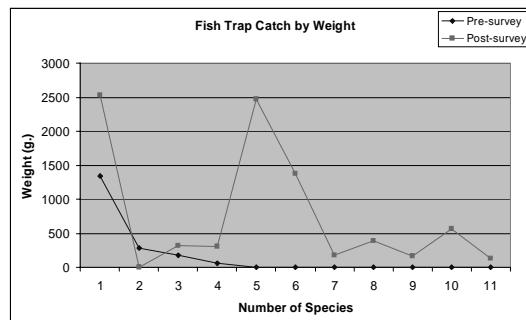
Table 1. Number of species of fish catch by fish trap during the 1st and 2nd survey (November 2003 and August 2004).

No	Common name	Species	Fish Trap 1st Survey		Fish Trap 2nd Survey	
			Number	Weight (g.)	Number	Weight (g.)
1	Spotted butter fish	<i>Scatophagus argus</i>	24	1336	31	2525
2	Canine catfish eel	<i>Plotosus canius</i>	1	280	0	0
3	Snapper	<i>Lutjanus sp.</i>	1	175	1	321
4	Stonefish	<i>Synanceja horrida</i>	1	55	1	300
5	Lactice monocle beam	<i>Scolosis taeniopterus</i>	0	0	15	2470
6	Onespot snapper	<i>Lutjanus monostigma</i>	0	0	6	1380
7	Whitespotted spinefoot	<i>Siganus canaliculatus</i>	0	0	3	180
8	Grouper	<i>Epinephelus sp.</i>	0	0	2	390
9	Two-banded soapfish	<i>Diploprion bifasciatum</i>	0	0	1	160
10	Blue swimming crab	<i>Portunus pelagicus</i>	0	0	5	560
11	Ridged swimming crab	<i>Charybdis natator</i>	0	0	1	130
		TOTAL	27	1846	66	8416

During 2nd (Post.) survey cruise Lactice monocle beam (*Scolosis taeniopterus*), and Onespot snapper (*Lutjanus monostigma*) are showing high capture rate both in term of number and weight (Figure 17).



(a)



(b)

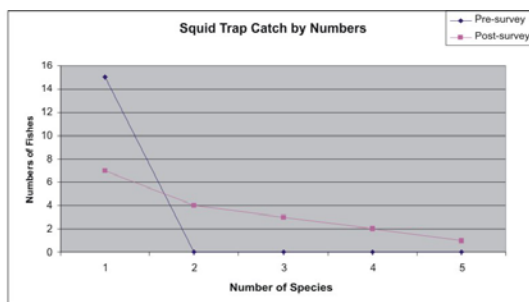
Figure 17. Amount of fish catch by fish trap in Pre. and Post-survey cruise in term of (a) number and (b) weight.

1.2) Squid trap

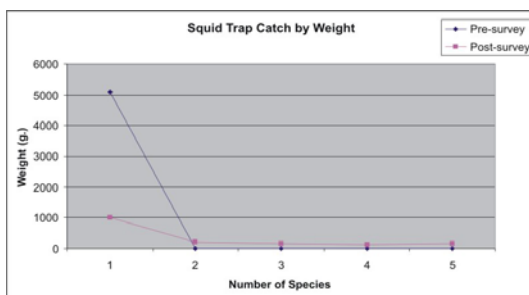
During the pre-survey cruise, only Bigfin reef squid (*Sepioteuthis lessoniana*) was recorded in the amount of 15 individual. The number of species catch increased to 5 species with the total number of 17 individual. However, Bigfin reef squid still the major catch species for post-survey cruise but the size of squid dramatically decrease. The average weight of Bigfin reef squid catch for pre-survey cruise was 339.0 g. and 142.6 g. for post-survey cruise. It was found that the number of squid trap operated by local fisherman in the project area increasing from few number up to more than 200 trap after the artificial reefs were installed.

Table 2. Number of species of fish catch by squid trap during the 1st and 2nd survey (November 2003 and August 2004).

No.	Common name	Species	Squid Trap 1st Survey		Squid Trap 2nd Survey	
			Numbers (cm.)	Weight (g.)	Number	Weight (g.)
1	Bigfin reef squid	<i>Sepioteuthis lessoniana</i>	15	5085	7	998
2	Whitespotted spinefoot	<i>Siganus canaliculatus</i>	0	0	4	215
3	Matted leatherjacket	<i>Acreichthys tomentosus</i>	0	0	3	162
4	Spotted butterfish	<i>Scatophagus argus</i>	0	0	2	140
5	Two-banded soapfish	<i>Diploprion bifasciatum</i>	0	0	1	150
		TOTAL	15	5085	17	1665



(a)



(b)

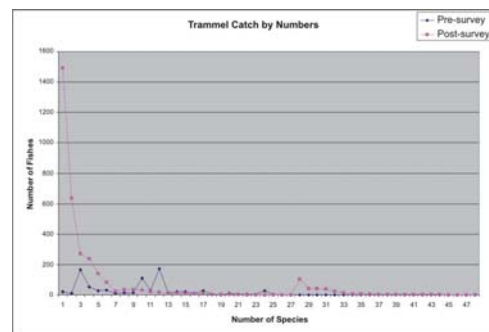
Figure 18. Amount of fish catch by squid trap in Pre. and Post-survey cruise in term of (a) number and (b) weight.

1.3) Bottom gill net

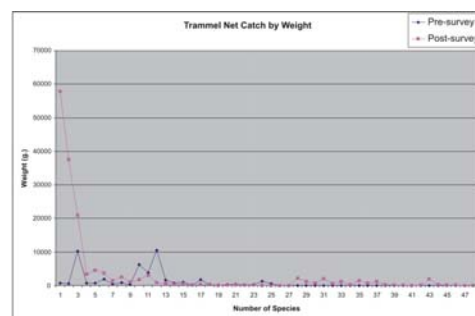
Number of fish species catch during pre-survey by using trammel net was 27 species. The total catch was 809 individual with total weight of 46,264 g. Three major species catch were Croaker (*Johnius sp*) 165 individual, weight 10,242 g. , Pufferfish (*Arothron nigropunctatus*) 171 individual,

weight 10,524 g., and Indo-pacific mackerel (*Rastrelliger brachysoma*) 111 individual, weight 6,296 g.

During post-survey, number of species catch were increasing up to 44 species with consist of 3,403 individual and total weight of 156,542 g. The major species catch were compose of Long tongue sole (*Cynoglossus lingua*), 1,492 individual, weight 57,852 g., Flathead (*Sarsogona tuberculata*) 638 individual, weight 37,531 g., Croaker (*Johnius sp.*) 271 individual, weight 20,918 g., Smooth-tailed trevally (*Selaroides leptolepis*) 141 individual, weight 4,600 g., and False stonefish (*Scorpaenopsis neglecta*) 102 individual, weight 2,205 g. There are 4 species catch during pre-survey but disappear in post-survey catch record. That 4 species were consist of Golden scad (*Caranx kalla*), Canine catfish eel (*Plotosus canius*), Mangrove blue crab (*Scylla serrata*) and Crucifix crab (*Charybdis affinis*).



(a)



(b)

Figure 19. Amount of fish catch by bottom gillnet (Trammel Net) in Pre. and Post-survey cruise in term of (a) number and (b) weight.

Table 3. Number of species of fish catch by bottom gill net during the 1st and 2nd survey (November 2003 and August 2004).

No.	Common name	Species	Trammel Net 1st Survey		Trammel Net 2nd Survey	
			Numbers	Weight (g.)	Number	Weight (g.)
1	Long tongue sole	<i>Cynoglossus lingua</i>	19	712	1492	57852
2	Flathead	<i>Sarsogona tuberculata</i>	11	586	638	37531
3	Croaker	<i>Johnius sp.</i>	165	10242	271	20918
4	Ponyfish	<i>Leiognathus sp.</i>	52	680	239	3362
5	Smooth-tailed trevally	<i>Selaroides leptolepis</i>	28	749	141	4600
6	Threadfin bream	<i>Nemipterus sp.</i>	30	1876	84	3678
7	Terapon	<i>Terapon sp.</i>	12	469	25	1540
8	Blue swimming crab	<i>Portunus pelagicus</i>	13	960	36	2530
9	Mantis shrimp	<i>Hepiosquilla harpax</i>	15	236	33	1040
10	Indo-pacific mackerel	<i>Rastrelliger brachysoma</i>	111	6296	32	1805
11	Cattlefish	<i>Sepia pharaonis</i>	26	3914	20	3115
12	Pufferfish	<i>Arothron nigropunctatus</i>	171	10524	16	835
13	Stingray	<i>Dasyatis sp.</i>	13	1670	12	640
14	Fringescale sardinella	<i>Sardinella fimbriata</i>	22	683	9	265
15	Mullet	<i>Moolgarda sp.</i>	22	1010	8	655
16	Greasyback shrimp	<i>Metapenaeus ensis</i>	11	170	8	175
17	Hairfin anchovy	<i>Setipina sp.</i>	29	1853	6	230
18	Brushtooth lizardfish	<i>Saurida undosquamis</i>	3	299	5	315
19	Western king prawn	<i>Penaeus latissulcatus</i>	1	20	4	100
20	Banana prawn	<i>Penaeus merguensis</i>	10	280	3	105
21	Bigfin reef squid	<i>Teptoteuthis lessoniana</i>	5	490	3	170
22	Indian squid	<i>Photololigo duvoucelli</i>	4	175	1	105
23	Cobia	<i>Rachycentron canadus</i>	2	320	1	100
24	Golden scad	<i>Caranx kalla</i>	28	1390	0	0
25	Canine catfish eel	<i>Plotosus canius</i>	4	584	0	0
26	Mangrove blue crab	<i>Scylla serrata</i>	1	50	0	0
27	Crucifix crab	<i>Charybdis affinis</i>	1	26	0	0

Table 3. (Cont.)

No.	Common name	Species	Trammel Net 1st Survey		Trammel Net 2nd Survey	
			Numbers	Weight (g.)	Number	Weight (g.)
28	False stonefish	<i>Scorpaenopsis neglecta</i>	0	0	102	2205
29	Apogon	<i>Apogon sp.</i>	0	0	43	1130
30	Unicorn leatherjacket	<i>Aluterus monoceros</i>	0	0	42	706
31	Topido scad	<i>Megalaspis corbyla</i>	0	0	38	2145
32	Mantis shrimp	<i>Hepiosquilla harpax</i>	0	0	24	665
33	Flounder	<i>Pseudorhombus sp.</i>	0	0	14	1235
34	Whitfin silver-biddy	<i>Genes filamentosus</i>	0	0	8	325
35	Striped sea catfish	<i>Plotosus lineatus</i>	0	0	6	1510
36	Malabar snapper	<i>Lutjanus malabaricus</i>	0	0	6	725
37	ell	<i>Iyodorontis tile</i>	0	0	5	1140
38	Lactice monocle beam	<i>Scolosis taeniopterus</i>	0	0	5	250
39	Whitespotted spinefoot	<i>Siganus canaliculatus</i>	0	0	4	140
40	Sentinel crab	<i>Pedophilodinus vigil</i>	0	0	4	120
41	Smooth shelled swimming crab	<i>Charybdis affinis</i>	0	0	4	25
42	Green tiger prawn	<i>Penaeus semisulcatus</i>	0	0	3	100
43	Giant johnfish	<i>Sciaenidae albida</i>	0	0	2	1900
44	Baracuda	<i>Sphyraena sp.</i>	0	0	2	320
45	Snapper	<i>Lutjanus sp.</i>	0	0	1	100
46	Mitted leatherjacket	<i>Acreichthys tomentosus</i>	0	0	1	75
47	Longheaded Goby	<i>Pterapercis sepioides</i>	0	0	1	40
48	Sillago	<i>Sillago sp.</i>	0	0	1	20
TOTAL			809	46264	3403	156642

1.4) Collapsible trap

There are 10 species with 94 individual and total weight 7,013 g. recorded during the pre-survey cruise. The major species were Smoothshelled swimming crab (*Charybdis affinis*) 35 individual, weight 473 g, Blue swimming crab (*Portunus pelagicus*), 32 individual, weight 3,335 g., Mud crab (*Pilumnus sp.*) 8 Individual , weight 550 g. and Crucifix crab (*Charybdis affinis*), 6 individual, weight 595 g.

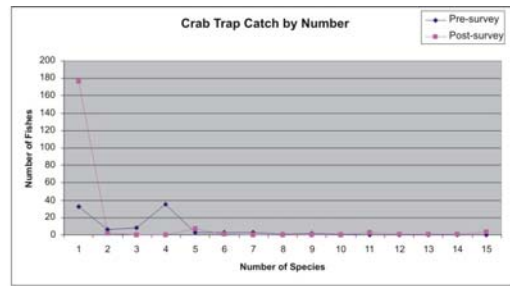
During the post-survey cruise, there are 9 species with 197 individual and total weight of 17,130 g.

Blue swimming crab (*Portunus pelagicus*) was the major species with 177 individual and weight 15,480 g.

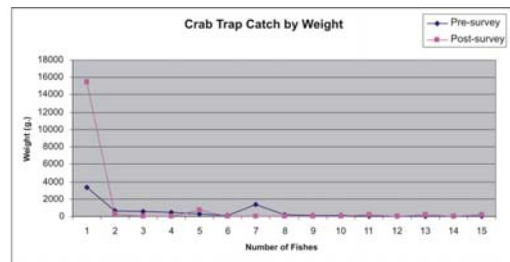
However, the average weight of Blue swimming crab (*Portunus pelagicus*) catch decreasing from 104.2 g. for pre-survey cruise to 87.5 g. for post-survey cruise. There are 6 species recorded in pre-survey cruise not found in post-survey cruise but new 5 species recorded in post-survey cruise. .

Table 4. Number of species of fish catch by collapsible trap during the 1st and 2nd survey (November 2003 and August 2004).

No.	Common name	Species	Crab Trap 1st Survey		Crab Trap 2nd Survey	
			Numbers	Weight (g.)	Number	Weight (g.)
1	Blue swimming crab	<i>Portunus pelagicus</i>	32	3335	177	15480
2	Crucifix crab	<i>Charybdis affinis</i>	6	595	2	280
3	Mud crab	<i>Pilumnus sp.</i>	8	550	0	0
4	Smooth shelled swimming crab	<i>Charybdis affinis</i>	35	473	0	0
5	Spider crab	<i>Dorippe dorsipes</i>	3	260	7	720
6	Mantis shrimp	<i>Hepiosquilla harpax</i>	3	100	1	40
7	ell	<i>lycodontis tile</i>	3	1320	0	0
8	Cattlefish	<i>Sepia pharaonis</i>	1	210	0	0
9	Spottedtail grouper	<i>Epinephelus sp.</i>	2	120	0	0
10	Flathead	<i>Sarsogona tuberculata</i>	1	50	0	0
11	Grouper	<i>Epinephelus sp.</i>	0	0	3	220
12	Smooth-tailed trevally	<i>Selaroides leptolepis</i>	0	0	1	20
13	Striped sea catfish	<i>Plotosus lineatus</i>	0	0	1	200
14	Whitespotted spinefoot	<i>Stiganus canaliculatus</i>	0	0	1	20
15	Threadfin bream	<i>Nemipterus sp.</i>	0	0	4	150
TOTAL			94	7013	197	17130



(a)

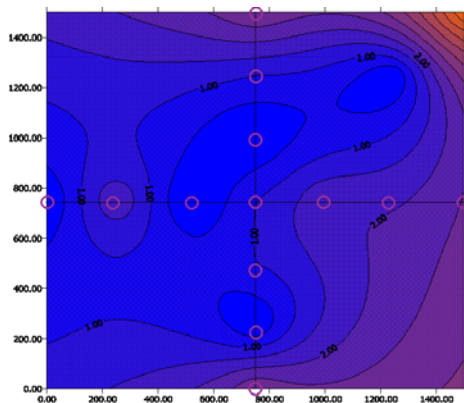


(b)

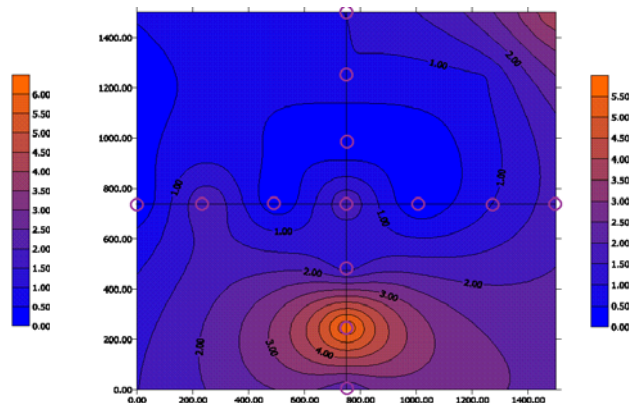
Figure 20. Amount of fish catch by collapsible trap in Pre. and Post-survey cruise in term of (a) number

2) Benthos survey

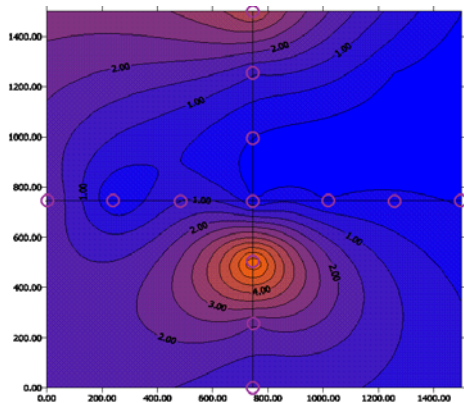
There are 42 species of macro benthos found at the site before artificial reefs installation during November 2003 survey. Among this, 23 species are identify and 19 species could not identify yet. There are 76 individual found at location of artificial reefs group A and 81 individual found at artificial reefs group B. The major species are Family Orbiniidae (36), *Nephtys sp.*(31), Family Maldanidae (13) and *Notomastus sp.*(9). Distribution of Family Orbiniidae in AR Group A does not show any different but its show high concentration at 250 m Southward from center of AR group B. The most concentration of *Nephtys sp.* found at 500 m. Southward from center of AR Group A and at the center of AR Group B.



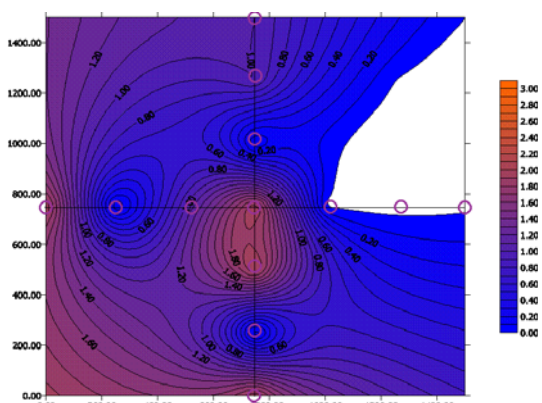
(a)



(a)



(b)



(b)

Figure 21. Distribution of benthos Family Orbiniidae around the center group of artificial reefs during November 2003, (a) artificial reefs group A, (b) artificial reefs group B

Figure 22. 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

Table 5. List of macro benthos found in the site of artificial reefs during the survey on November 2003.

No	Scientific Name	20µm	30µm
		(unit/lit)	(unit/ml)
	MARINE HETEROKONT DIVISION CYANOHYTA (Blue green algae)		
	CLASS CYANOCHLORACEAE		
1	<i>Lyngbya</i> sp	-	5
2	<i>Ocellularia erythroa</i> (Egeberg) Gitter	34	61
3	<i>Rhodella intracellularis</i> Schmid	34	5
4	Unknown Blue green algae	-	20

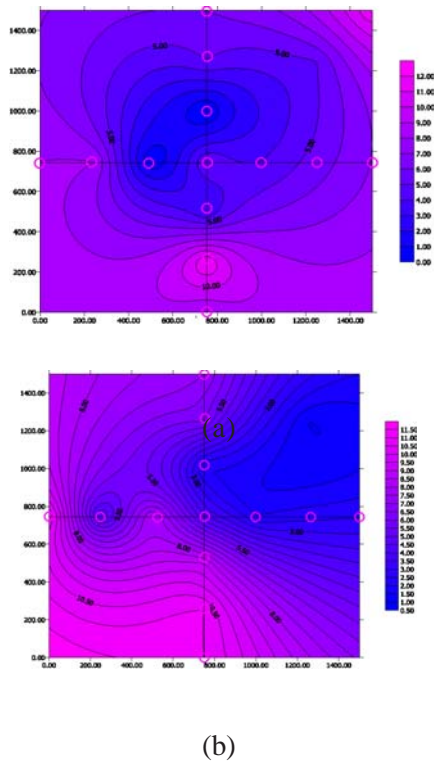


Figure 23. Distribution of benthos all Family around the center group of artificial reefs during November 2003, (a) artificial reefs group A, (b) artificial reefs group B

3) Fish larvae survey

During the pre-survey cruise, it found that fish larvae 5genus composted of *Engraulidae*, *Gobiidae*, *Callinymidae*, *Cynoglossidae* and *Nemipteridae* as well as fish eggs were recorded as shows in Table 6.

Table 6. List of fish larvae found in the site of artificial reefs during the survey on November 2003.

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

4) Phyto-plankton survey

Phyto-Plankton found during pre-survey cruise were composed of 2 Division, 4 Classes, 38 species as followings:

DIVISION CYANOPHYTA (Blue green algae)

CLASS CYANOPHYCEAE

Lyngbya sp.

Oscillatoria erythraea

(Egrenberg) 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)

Table 7. List of phyto-plankton found in the site of artificial reefs during the survey on November 2003.

No.	Scientific Name	20 µm	300 µm
		(unit/lit)	(unit/ml)
MARINE PHYTO-PLANKTON			
DIVISION CYANOPHYTA (Blue green algae)			
CLASS CYANOPHYCEAE			
1	<i>Lyngbya</i> sp.	-	5
2	<i>Oscillatoria erythraea</i> (Egrenberg) Geitler	374	61
3	<i>Richelia intracellularis</i> Schmidt	34	5
4	Unknow Blue-green algae	-	20
DIVISION CHROMOPHYTA			
CLASS BACILLARIOPHYCEAE			
Order Biddulphiales (Centric Diatom)			
5	<i>Asteromphalus</i> sp.	136	2
6	<i>Bacteriastrum delicatulum</i> Cleve	34	-
7	<i>Chaetoceros coarctatus</i> Lauder	306	-
8	<i>C. diversus</i> Cleve	476	2
9	<i>Climacodium biconcavum</i> Cleve	374	-
10	<i>C. frauenfeldianum</i> Grunow	-	8
16	<i>Odontella sinensis</i> (Greville) Grunow	-	5
17	<i>Palmeria hardmaniana</i> Greville	34	2
18	<i>Proboscia alata</i> (Brightwell) Sundström	-	-
19	<i>Pseudosolenia calcar avis</i> (Schultze) Sundström	68	2
20	<i>Rhizosolenia clevei</i> Ostenfeld	34	-3

Table 7. (Cont.)

No.	Scientific Name	20 µm (unit/lit)	300 µm (unit/ml)
21	<i>R. robusta</i> Normann	-	5
22	<i>R. styliformis</i> Brightwell	34	1
23	<i>Thalassiosira</i> sp.	272	52
24	<i>Triceratium favus</i> Ehrenberg fo. <i>quadrata</i> Grunow	34	
Order Bacillariales (Plannet Diatom)			
25	<i>Pseudo-nitzschia</i> sp.	-	25
26	<i>Thalassionema frauenfeldii</i> (Grunow) Hallegraef	272	2,264
27	<i>T. nitzschioides</i> (Grunow) Mereschkowsky	2550	9,823
28	<i>Dictyocha fibula</i> Ehrenberg	68	-
CLASS DINOPHYCEAE (Dinoflaglet)			
29	<i>Ceratium furca</i> (Ehrenberg) Claparède & Lachmann	68	11
30	<i>C. fusus</i> (Ehrenberg) Dujardin	-	5
31	<i>C. trichoceros</i> (Ehrenberg) Kofoid	-	1
32	<i>Dinophysis caudata</i> Saville-Kent	-	2
33	<i>Prorocentrum micans</i> Ehrenberg	-	2
34	<i>P. sigmoides</i> Böhm	34	1
35	<i>Protoperidinium oceanicum</i> (Vanhöffen) Balech	68	-
36	<i>Protoperidinium</i> sp.1	34	-
37	<i>Protoperidinium</i> sp.2	34	-
38	<i>Protoperidinium</i> sp.3	-	15

Remark: Sample 1.20 µm : Number of
sample Unit/Lit
Sample 2.300 µm : Number of
sample Unit/ml (1 bottle 2,400 ml)
(3 Bottles)

5) Zoo-plankton survey

Zoo-plankton found during pre-survey
cruise were composed of 7 Phylums, 8 Classes,
19 species
as followings:

PHYLUM PROTOZOA
CLASS CILIATA
PHYLUM CHAETOGNATHA (ARROW
WORM)
CLASS SAGITTOIDAE
PHYLUM NEMATODA
PHYLUM ARTHROPODA
CLASS CRUSTACEA
PHYLUM MOLLUSCA
CLASS GASTROPODA

CLASS PELECYPODA
PHYLUM ECHINODERMATA
CLASS ECHINOIDEA
CLASS OPHIUROIDEA
PHYLUM CHORDATA
CLASS LARVACEA

Table 8. List of zoo-plankton found in the site
of artificial reefs during the survey on
November 2003.

No.	Scientific Name	20 µm	300 µm
		(unit/lit)	unit/ml
MARINE ZOOPLANKTON			
PHYLUM PROTOZOA			
CLASS CILIATA			
1	<i>Tintinnopsis gracilis</i> Kofoid and Campbell	-	1
PHYLUM CHAETOGNATHA (ARROW WORM)			
CLASS SAGITTOIDAE			
2	<i>Sagitta</i> sp.	-	1
PHYLUM NEMATODA			
3	Free living Nematode	-	5
PHYLUM ARTHROPODA			
CLASS CRUSTACEA			
4	<i>Corycaeus</i> sp.	17	1
5	<i>Oithona</i> sp.	-	5
6	<i>Lucifer</i> sp.	-	49
7	Brachyuran larvae	-	5
8	Nauplius copepod	323	13
9	Unidentified calanoid copepods	17	20
Class Ostracoda			
10	Ostracod		
Family OCYPODIDAE			
11	<i>Macrophthalmus (Mareotis)</i> <i>definitus</i> (Adam and White, 1848)	15	
Family SQUILLIDAE			
12	<i>Oratosquillina soliticans</i> (Manning, 1978)	2	
13	Caridea	7	
PHYLUM MOLLUSCA			
CLASS GASTROPODA			
14	<i>Creseis</i> sp.	-	6
15	Gastropod larvae	-	1

Table 8 (Cont.)

No.	Scientific Name	20 µm (unit/lit)	300 µm unit/ml
	CLASS PELECYPODA		
16	Pelecypod larvae	-	6
	PHYLUM ECHINODERMATA		
	CLASS ECHINOIDEA		
17	Echinopluteus larvae	-	1
	CLASS OPHIUROIDEA		
18	Ophiopluteus larvae	-	5
	PHYLUM CHORDATA		
	CLASS LARVACEA		
19	<i>Oikopleura</i> sp.	-	7

Since, data from post-survey of fish larvae, phyto-plankton, zoo-plankton and benthos could not make a comparison between pre and post-survey yet because of the samples are under analysis. However, the duration of 3 months after artificial installation may not sufficient to observed any effect artificial reefs to fisheries resources yet. Then, it need for more longer period to evaluate the enhancement ability of artificial reefs to fisheries resources.

■ CONCLUSION

There are 35 fish species were recorded during the pre-survey collected by all type of fishing gear. During post-survey 52 species were collected, while 30 species found both pre and post-survey. The average fish size recorded during post-survey show decreasing for some species such as, Threadfin bream (from 62.5 to 43.8 g.), Stingray (from 128.5 to 53.3 g.), Hairfin anchovy (from 63.9 to 38.3 g.), Brushtooth lizardfish (from 99.7 to 36.7 g.) and Bigfin reef squid (from 98.0 to 56.7 g.). The species shows size increasing were Croaker (from 62.1 to 77.2 g.), Terapon (from 39.1 to 61.6 g.), Mantis shrimp (from 15.7 to 31.5 g. and , Mullet (from 45.9 to 81.9 g.). Total species collected from both pre and post-survey were 57 species. It shows clearly that artificial reefs could be induced many fish species both pelagic and demersal fish to feeding around the site. Hopefully, the new artificial fish habitat could be generating the spooning area for some species.

ANNEX IICTD Data

Ship M.V.SEAFFDEC 2 Cruise No. 3-3/2004

Station No. 1 (AR Group A)

Position Lat .10_48.85 N Long. 99_28.66 E

Bottom Depth 12 m

Pressure	Temp.	Salinity	Oxygen	pH	PAR/Irradia	Fluores.		Density	Conduct.	
1	27.7879	33.2082	3.47489	8.101	2.01E+02	2.58 E+00	2.584	21.1166	5.344781	0.00E+00
2	27.8026	33.4487	4.32143	8.11	1.58 E+02	2.35 E+00	2.353	21.2927	5.380766	0.00E+00
3	27.8051	33.45	4.31551	8.11	1.08 E+02	2.56 E+00	2.556	21.2929	5.381253	0.00E+00
4	27.8038	33.4495	4.30755	8.11	7.40 E+01	2.67 E+00	2.667	21.2931	5.381076	0.00E+00
5	27.8006	33.4473	4.29871	8.11	5.25 E+01	2.38 E+00	2.379	21.2926	5.380485	0.00E+00
6	27.8013	33.4542	4.31031	8.11	3.77 E+01	2.41 E+00	2.413	21.2976	5.381585	0.00E+00
7	27.8014	33.4586	4.26406	8.106	2.71 E+01	2.57 E+00	2.567	21.3009	5.382255	0.00E+00
8	27.8001	33.4623	4.23377	8.104	1.95 E+01	2.40 E+00	2.400	21.3042	5.382706	0.00E+00
9	27.7974	33.4677	4.2196	8.102	1.44 E+01	2.51 E+00	2.505	21.3092	5.383248	0.00E+00
10	27.7954	33.4691	4.19644	8.1	1.05 E+01	2.58 E+00	2.583	21.311	5.383275	0.00E+00
11	27.7948	33.4708	4.18447	8.097	7.54 E+00	2.63 E+00	2.626	21.3125	5.383506	0.00E+00
12	27.7934	33.4618	4.18357	8.097	5.24 E+00	3.05 E+00	3.054	21.3063	5.38213	0.00E+00

Ship M.V.SEAFFDEC 2 Cruise No. 3-3/2004

Station No. 2 (AR Group B)

Position Lat .10_48.52 N Long. 99_28.26 E

Bottom Depth 12 m

Pressure	Temp.	Salinity	Oxygen	pH	PAR/Irradia	Fluores.		Density	Conduct.	
1	27.7586	33.2533	3.92102	8.092	4.48E+02	2.66 E+00	2.664	21.16	5.348286	0.00E+00
2	27.7836	33.4437	4.41138	8.102	2.66 E+02	2.69 E+00	2.694	21.2951	5.378127	0.00E+00
3	27.7814	33.4469	4.40268	8.105	1.78 E+02	2.78 E+00	2.783	21.2983	5.37839	0.00E+00
4	27.7866	3.4563	4.37864	8.103	1.20 E+02	2.88 E+00	2.884	21.3038	5.380305	0.00E+00
5	27.7873	33.4575	4.33798	8.1	8.26 E+01	3.01 E+00	3.006	21.3045	5.380587	0.00E+00
6	27.7834	33.4637	4.29968	8.097	5.59 E+01	3.06 E+00	3.056	21.3105	5.381128	0.00E+00
7	27.7818	33.4664	4.25827	8.097	3.94 E+01	3.09 E+00	3.086	21.3131	5.381385	0.00E+00
8	27.7793	33.4659	4.22552	8.095	2.71 E+01	3.16 E+00	3.159	21.3136	5.381097	0.00E+00
9	27.7769	33.4664	4.19841	8.093	1.73 E+01	3.28 E+00	3.276	21.3148	5.380964	0.00E+00
10	27.7767	33.4666	4.1875	8.093	1.19 E+01	2.72 E+00	2.715	21.3152	5.381027	0.00E+00