Environmental Survey Studies on Artificial Reefs in Rayong Province, Thailand: Technical Assistance in a Pilot Site for Suitable Designs of Resource Enhancement Practices

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Abstract

The series of environmental survey studies on artificial reefs carried out in Rayong Province, Thailand by SEAFDEC Training Department was part of the pilot project and capacity building on rehabilitation of fisheries resources and habitats and fishing grounds implemented during 2010 to 2014. Selected onsite study and evaluation of enhancement practices including impacts of artificial reefs to fisheries resources and environment were conducted in order to provide technical assistance to the Member Countries in their efforts to identify pilot project sites and capacity building activities on rehabilitation of fishery resources and habitats/fishing grounds. The survey studies were carried out based on fishing gear used in order to determine the species composition and abundance, while underwater observation was carried out to inspect the conditions of the artificial reefs "Rayong No. 2" installed at the eastern part of Samed Island, Rayong Province in December 2009 by the Department of Fisheries (DOF) of Thailand. The G-18 position of the artificial reefs (Lat. N 12° 31.085, Long. E 101° 30.830), was selected and referred to as a major site for the study as it comprised large amount of concrete block ARs (35 pieces of ARs 1.5 m^3) and probably has the most abundant species diversity in the ARs area. The fishing gears and equipment used for the species composition survey were fish trap, bottom gill-net, hand line, juvenile fish trap, Smith-McIntyre grab, and underwater observation. Results of the survey from fish trap operation before the ARs installation (February – March 2009) indicated the abundance of 18 fish species, and total catch was 52,658 g inside the ARs area. The major species caught were *Lutjanus vitta, Diagramma pictum, Scolopsis monogramma* and *Monacanthus chinensis* at 1863.3, 1520.8, 348.3, and 162.5 g/trap/time, respectively. Meanwhile, one year after ARs installation (March 2011), the fish trap operation indicated 12 fish species were found inside ARs area, and total catch was 22,520 g. The major species caught were *Siganus javas, Lutjanus lyjanus, Lutjanus russelli, Siganus canaliculatus* and *Diagramma pictum* at 202.5, 1360.0, 500.0, and 500.0 g/trap/time, respectively. Results from fish trap operations showed that the number of species and amount of catch decreased one year after ARs installation.

Results from benthos survey in August 2011 showed that there were 26 species of macro benthos found around the G-18 ARs position. There were 531 individuals found at the distance of 50 m to the west (W-50) yet in the most concentrated position there were 8 species. The major species found belong to Family Capitellidae, Family Pectinariidae and Family Maldanidae. Results of benthos survey in October 2012 found that there were 31 species around the G-18 ARs position, where 968 individuals were found at the distance 50 m to the south (S-50) yet the most concentrated position there were 10 species. The major species found belong to Family Capetellidae, Family Nereididae, Family Onuphidae, and Family Maldanida.

Results from interview with local fishers around Ban Phe Bay indicated that the major fishing gear used were fish trap, squid trap, bottom gill-net, hand line, and towing-line. Most of the fishers occasionally operated their fishing gear around ARs because the abundance of fish was not rich. The accident where about 50,000 liters of crude oil leaked from the PTT Global Chemical pipeline around 20 km off the coast of Rayong on 27 July 2013 had caused massive impact to the environmental condition and ARs around Ban Phe Bay. This accident led to severe reduction of the fishery resources around Rayong Bay for a year. However, the results from a study on water circulation around Rayong Bay and Samed Island during September 2013 showed that water circulation around ARs area was less due to a blockage along the shore where tidal current flow eastward Samed Island. Less current which flowed through the ARs structures could be the cause of less biological growth in the ARs areas.

Keywords: artificial reefs, resources enhancement, Rayong

Introduction

A series of environmental survey studies on artificial reefs has been being carried out in Rayong Province, Thailand since 2010 by the Coastal and Small-scale Fisheries Management Division of SEAFDEC Training Department. This is part of the five-year pilot project on Rehabilitation of Fisheries Resources and Habitats/Fishing Grounds implemented during 2010 to 2014 and aimed at seeking suitable designs of resources enhancement practices for the SEAFDEC Member Countries in the future. Under this project, selected onsite study and evaluation of enhancement practices including impacts of artificial reefs to fisheries resources and environment were carried out in Rayong Province, Thailand (**Fig. 1**) to be able to provide technical assistance to M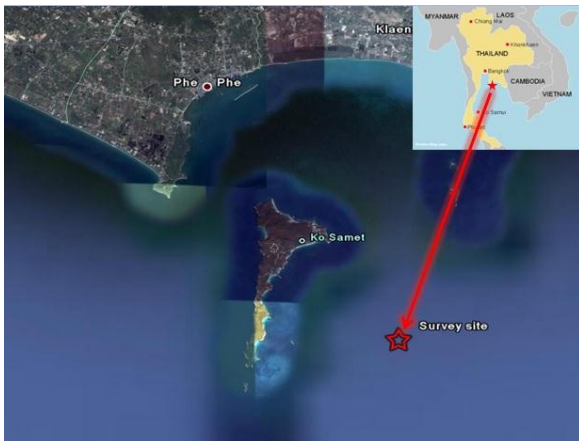ember Countries wishing to establish pilot project sites and capacity building on rehabilitation of fisheries resources and habitats/fishing grounds. Large-scale artificial reefs (ARs) known as "Rayong 2 ARs", was selected for the study which was conducted from December 2009 to February 2010. Covering an area of 1.86 x 4.16 km^2, the Rayong 2 ARs were installed at Suanson Beach Ko Kudee in Klang District, Rayong Province (**Fig. 2**). The survey analyzed the catch from fishing gears for species composition and abundance, and conducted underwater observation to inspect the conditions of the ARs previously installed in December 2009 by the Department of Fisheries (DoF) of Thailand. The study intended to determine the resources rehabilitation processes by ARs and to establish appropriate methodology for ARs evaluation.
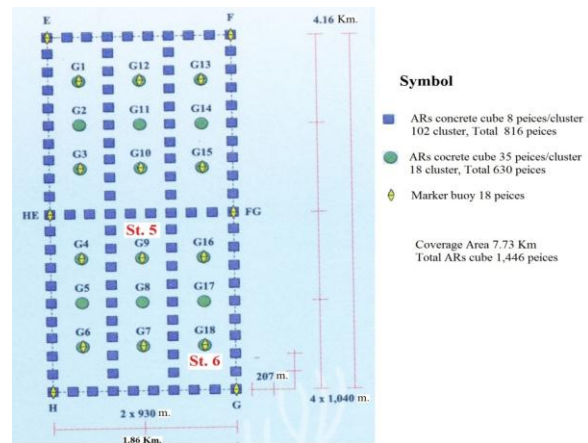

Fig. 1. Survey site in Rayong Province, eastern coast of the Gulf of Thailand

Fig. 2. Layout of ARs installation in survey site

Results

During the survey, fishing gears and devices were used to investigate the species composition and abundance of the fisheries resources near the selected ARs at G-18 position (Lat. N 12° 31.085, Long. E 101° 30.830) and referred as major site for the study as it comprised large concrete blocks (each measuring 1.5 m^3) and probably with the most abundant species diversity in the area off Rayong Province. Fish length and weight were recorded and species were identified and classified by types of fishing gear used. Juvenile fishes were identified, preserved and recorded. Benthic fauna specimens were identified and their distribution and abundance in the sampling area were estimated.

Fish Trap Operation

Data on fish species composition were collected from fishing operations using fish trap made of rectangular wooden frame 1.0 x 2.0 x 0.5 m covered with 2 cm mesh size wire and the narrowest entrance of opening funnel is 5 cm. Without bait, the fish trap was set for 10 days per operation, and positioned in station No. 5, 6, 9 and 10 inside and outside the installed ARs.

Three fish trap fishing operations were conducted during February-March 2009 (before ARs installation), February-April 2010 (2 months after ARs installation), and March 2011 (1 year after ARs installation). The fish caught by the fish trap operations are shown in **Table 1** while the average catch per operation is shown in **Fig. 3**.

Table 1. Number of species caught by fish trap operations inside and outside Rayong 2 ARs

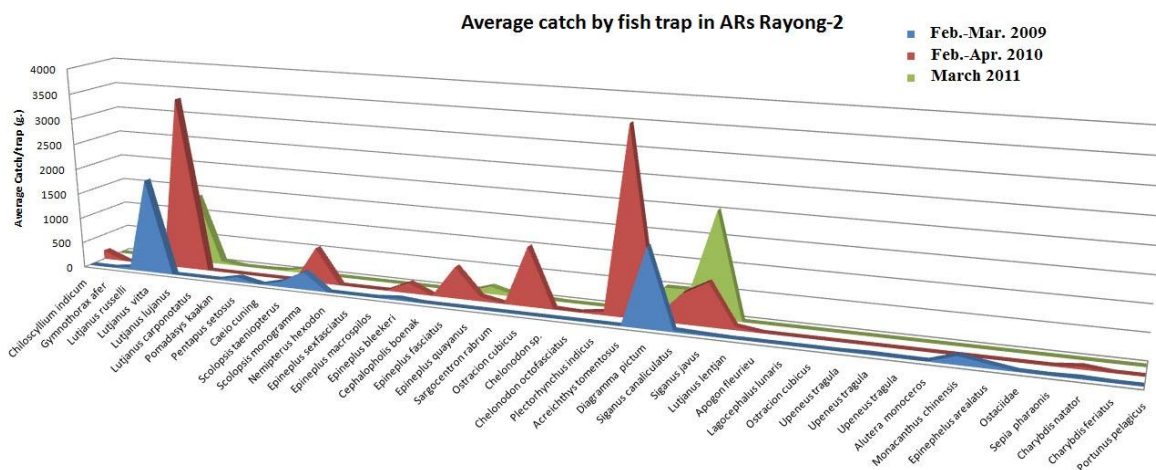| Area	Number	Feb.-Mar. 2009 (before ARs Installation)	Feb. – Apr. 2010 (2 month after ARs installation)	Mar. 2011 (1 year after ARs installation)
Inside ARs	species(sp), (quantity)	18 sp, (17,552.7 g)	16 sp, (47,440.0 g)	12 sp, (22,520.0 g)
Outside ARs	species(sp), (quantity)	20 sp, (26,177.7 g)	18 sp, (53,950.0 g)	14 sp, (13,060.0 g)
TOTAL	species(sp), (quantity)	26 sp, (43,730.4 g)	26 sp, (101,390.0 g)	14 sp, (35,580.0 g)

Fig. 3. Average catch by fish trap in Rayong 2 ARs during Feb.-Mar. 2009, Feb.-Apr. 2010 and Mar. 2011

As shown in **Fig. 3**, 18 species were caught before ARs installation (February-March 2009) and total catch was 17,552.7 g inside ARs area. The major species caught comprised *Lutjanus vitta, Diagramma pictum, Scolopsis monogramma* and *Monacanthus chinensis* at 621.1, 506.9, 116.1, and 54.2 g/trap/time, respectively. One year after the ARs installation (March 2011), 12 fish species were caught with total catch of 22,520 g inside ARs area dominated by *Siganus javas, Lutjanus lyjanus, Lutjanus russelli, Siganus canaliculatus* and *Diagramma pictum* at 2025.0, 1360.0, 500.0, and 500.0 g/trap/time, respectively. Results indicated that number of species in ARs area from fish trap operations slightly differed and decreased, while the amount of catch increased a little one year after ARs installation.

Bottom Gill Net Fishing Operation

A custom-made vertical extension pieces of trammel net (2.3 m high × 30 m long, 15.0 cm outer mesh size, 4.0 cm inner mesh size, nylon multi-filament, 110d/2) was used in the investigation. Five pieces of nets were sewn together horizontally to attain a length of 150 m and installed near Position G-18 to sample the catch of both demersal and pelagic fishes. The net was immersed underwater near the ARs for over 12 hours and retrieved the next morning. Three gill net fishing operations were conducted on December 2010, October 2011 and June 2012. During the survey, the bottom gill net caught 37 fish species while the other 25 were non-fish species (crabs, shrimps and cuttlefish), and were classified by groups, *i.e.* fish, crab, squid, and shrimp. The major fish species caught were therapon, yellow-striped scad, pony fish, threadfin bream, and rabbitfish with long-armed crab dominating the catch for non-fish species in all operations. Results indicated that the number of catch of therapon and pony fish increased from 2010 to 2012 from 5 to 61 individuals and 18 to 30 individuals, respectively. Catch of threadfin bream was stable at 9 to 11 individuals from 2010 to 2012, while catch of yellow-striped scad and long-armed crab decreased from 2010 to 2012, from 11 individuals to 0 and 35 individuals to 0, respectively (**Fig. 4**). From 2010 to 2012, fish species (by percentage weight) contributed 64%, 64% and 76% to the total, respectively, while crabs contributed 33% in 2010 and 12% in 2012 (**Fig. 5**), suggesting that the species composition around Rayong 2 ARs must have changed with the age of ARs deployed.
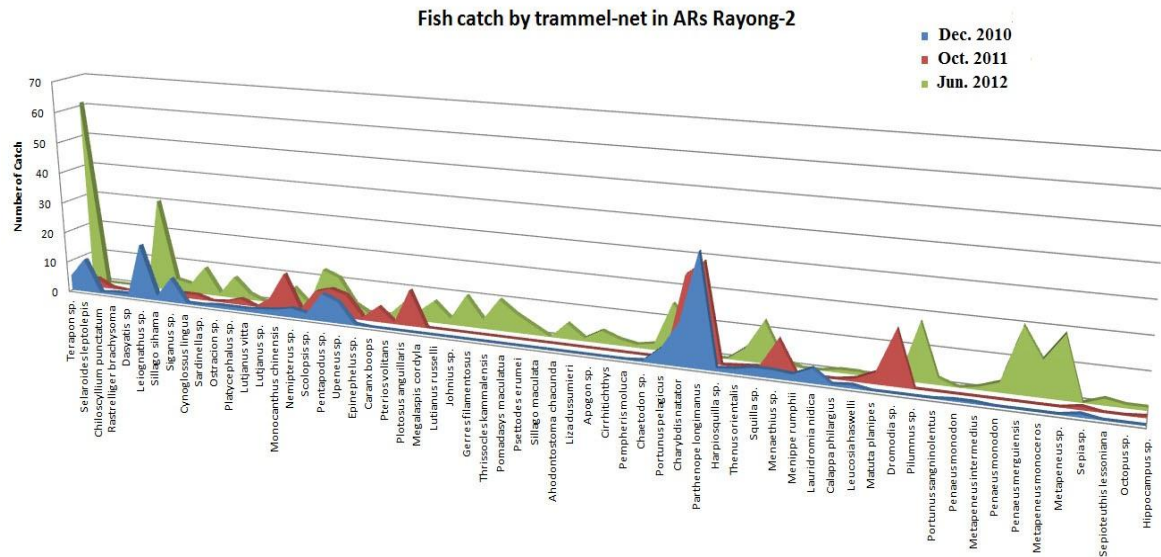
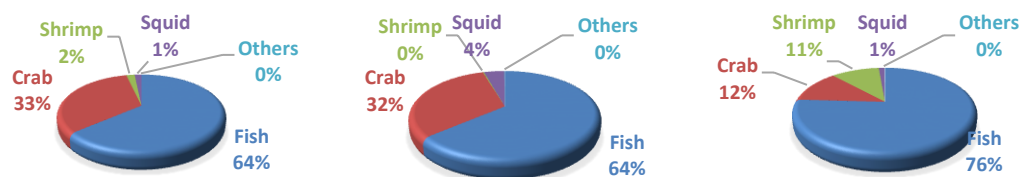**Fig. 4.** Fish caught by trammel net in Rayong 2 ARs

Fig. 5. Catch composition classified by percentage (weight) from trammel net in 2010 (*left*), 2011 (*center*) and 2012 (*right*)

Juvenile Fish Traps Operation

Two cylindrical-shaped juvenile fish traps made of steel frame (100.0 cm high and 90.0 cm in diameter) covered with fine-mesh net with an under entrance (diameter 26.0 cm) and two sided-entrances (inner diameter 15.0 cm, 22.5 cm long funnel from the outer entrance) attached with 2 luring lights (**Fig. 6**), were deployed near Position G-18 to collect data on juvenile fishes in the ARs area. The traps were suspended vertically at 1.0 m interval and 1.0-2.0 m above the sea bottom. Immersion time of the traps was over 12 hrs at night, and hauling operation was done the following day.

Results indicated that approximately 7 fish species and 2 non-fish species were caught by the juvenile fish traps. Among these species was one demersal species, *Upeneus* sp. (goat fish) while the others were pelagic (Engraulidae) or mid-water species, and the other 2 non-fish species (loliginid squid and polychaete) were classified as bottom dwellers.

The juvenile fish species comprised *Upeneus* sp., *Alepes* sp*., Gnathanodon* sp*., Encrasichoiina heteroloba, Encrasicholina* sp*., Archamia* sp*., Secutor ruconius,* Loliginid squid, and Nereididae*.* These results confirmed that 7 species of early stage juvenile fishes are using ARs as nursery ground or probably spawning ground.

Fig. 6. Cylindrical-shaped juvenile fish traps

Benthos Survey

Benthic fauna survey was carried out using a Smith McIntyre's grab at sampling stations near the G-18 position in the N-S and E-W directions at an interval of 25 m from the center (**Fig. 7**). Samples from 17 stations for benthic fauna sampling were collected and preserved and then identified by specialists. Results of the benthos survey in August 2011 indicated that there were 26 species of macrobenthos found in the sampling sites around the G-18 ARs position, and 531 individuals were found at a distance of 50 m to the west (W-50) yet at the most concentrated position only 8 species found. The major species found belong to Family Capitellidae, Family Pectinariidae and Family Maldanidae (**Fig. 8**). Results of the benthos survey in October 2012 indicated that there were 31 species around the G-18 ARs position, 968 individuals were found
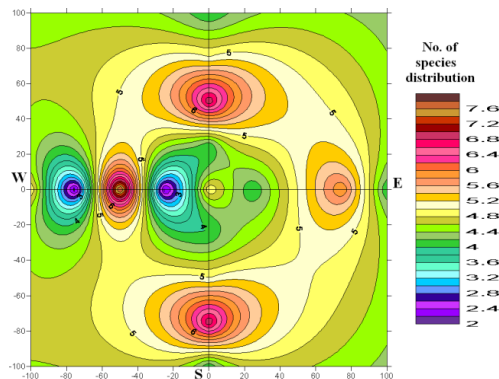
at a distance of 50 m to the south (S-50) yet the most concentrated position had only 10 species. The major species found belong to Family Capetellidae, Family Nereididae, Family Onuphidae and Family Maldanidae (**Fig. 9**).
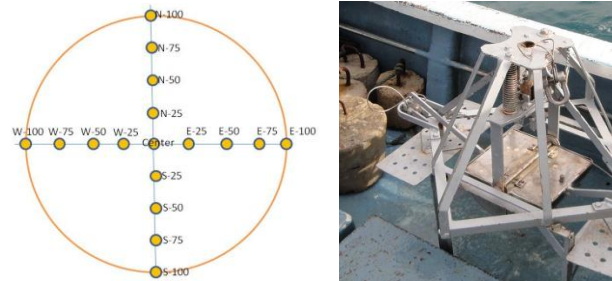

Fig. 7. Benthos survey sampling stations neat G-18 position in the N-S and E-W direction at interval of 25 m from the center (*left*) and Smith McIntyre's grab used for the sampling (*right*)
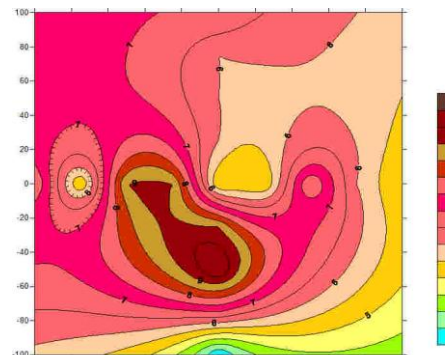

Fig. 8. Species distribution of benthic fauna at an interval of 25 m away from the G-18 position in North, East, South and West directions (100 m range) in August 2011

Fig. 9. Species distribution of benthic fauna at an interval of 25 m away from the G-18 position in North, East, South and West directions (100 m range) in October 2012

Conclusion

The socio-economic status of fishers fishing around ARs was determined through a questionnaire survey. Results of interview with local fishers around Ban Phe Bay indicated that their major fishing gears used were fish trap, squid trap, bottom gill-net, hand line, and towing-line. Most of the fishers occasionally operate their fishing gear around ARs because fish around ARs was no longer abubdant. This might have been due to the massive impact to the environmental conditions and ARs around Ban Phe Bay brought about by an incident where about 50,000 liters of crude oil leaked from PTT

Global Chemical pipeline about 20 km off the coast of Rayong on 27 July 2013. This led to reduction of the fisheries resources around Rayong Bay for a year. Moreover, results of the study on water circulation around Rayong Bay and Samet Island in September 2013 conducted by the Marine Meteorological Center indicated that water circulation around the ARs area was less due to a blockage along the shore where tidal current flows eastward of the waters of Samet Island. Minimal water current flowing through the ARs structures had caused low biological growth in the ARs area.

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