



Artificial Reefs for the Enhancement of Biological Resources and Livelihoods of Fishermen

CMFRI's Final Report Presentation : Chennai, 18 May 2009

Central Marine Fisheries Research Institute has conducted the final report presentation meeting for commemorating the completion of the Consultancy project on "Site Selection and Monitoring of Artificial Reefs in Eleven Selected Locations in Tamil Nadu" on 18th May 2009, at 15.00 hrs. by Madras Research Centre of CMFRI at Central Institute of Brackishwater Aquaculture. Dr.G.Mohanraj, Principal Scientist delivered the welcome address. Dr.H.Mohamad Kasim, Principal Scientist & Scientist in charge of Madras Research Centre of CMFRI, presented the project report wherein he highlighted the salient achievements under the project followed by detailed video clipping presentation on the project activities. He described that the

marine artificial reef systems had been observed to enhance the biological resources of the region where they were deployed. This proven technology was used by different countries all over the world for increasing the marine living resources in general and fish production in particular. Tamil Nadu being the premier Indian maritime State in the exploitation of marine fishery resources of India since the long past it now faces depletion of different fishery resources because of their overexploitation by various types of crafts and gears all along the 1,076 km coastline. In order to increase the fishery resources and augment the fish production, Tamil Nadu Fisheries Department came up with a Fishery Development Mission wherein the

deployment of artificial reef along the Tamil Nadu coast was one of the major activities for enhancing the resource potential.

The pioneering work done for the establishment of the artificial reefs was presented in the report of the Mission, a brief summary of which is presented hereunder. Tamil Nadu Government identified 11 locations, two in each of the districts of Thoothukudi, Ramanathapuram, Pudukottai, Thanjavur, Nagapattinam (vide G.O.Ms.No.155, Animal Husbandry and Fisheries Department dated 29.3.2005) and one in Cuddalore, which was added later. Tamil Nadu Fisheries Department approached Central Marine Fisheries Research Institute with a request to undertake the



Fig.1: A series of finished reef fish modules



Fig.2: Reef modules being readied for lowering into the sea



Fig.3: Deployment process of grouper modules with pulleys



Fig.4: Lowering the module into the sea



Fig.5: Boat loaded with reef modules



Fig.6: Deployment of reef fish modules



Fig.7: A series of finished triple ring modules



Fig.8: Fish assemblage in artificial reefs



Fig.9: A view of the audience at the function





Fig.10: Different species of fishes in artificial reefs

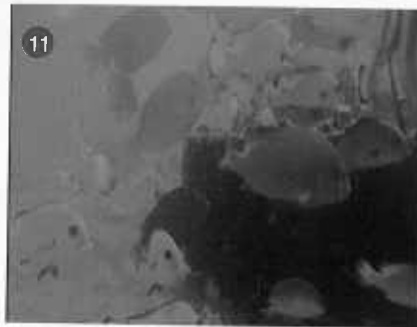


Fig.11: Congregation of school of fishes in artificial reef

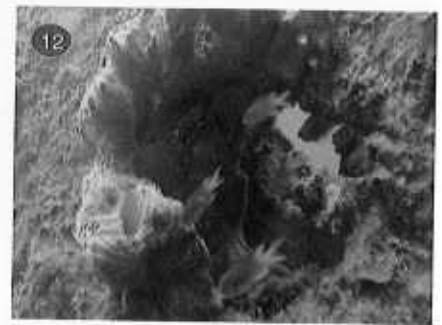


Fig.12: A few ornamental fishes in artificial reef



Fig.13: A group of *Diagramma* spp. In artificial reef



Fig.14: Assemblage of perches in the reef



Fig.15: Reef fishes with heavy settlement of foulers in reef



Fig.16: Dr.G.Syda Rao, Director, CMFRI releasing the report



Fig.17: Mr.Shambu Kallollikar, IAS, Commissioner of Fisheries delivering special address.



Fig.18: The report being received by the Commissioner of Fisheries, T.N.



Fig.19: Dr. A.R.Thirunavukkarasu, Principal Scientist HOD, FCD, CIBA, receiving the report



Fig.20: Dignitaries on the dais



Fig.21: Dr.G.Mohanraj, Principal Scientist, MRC of CMFRI, giving the welcome address

Fig.20: Dignitaries on the dais : (from L to R) Dr.A.R.Thirunavukkarasu, Principal Scientist HOD, FCD, CIBA, Mr. Shambu Kallollikar, IAS, Commissioner of Fisheries, TNFD, Dr.G.Syda Rao, Director, CMFRI and Dr. H.Mohamad Kasim, Principal Scientist & Scientist -in -charge, MRC of CMFRI





site selection for the deployment of artificial reef systems and monitoring the performance of the reefs along Tamil Nadu coast in relation to the change in the socio-economics of the fishermen of the respective beneficiary villages where the artificial reefs are being deployed (vide their letter Rc.No. 45344/C2/2004 dated 29.6.2005) and CMFRI agreed to undertake this work on a consultancy project mode bearing the project code No. 6016000070 for a consultancy fee of Rs.24,26,923 for a period of 3 years by executing a memorandum of understanding as per the Consultancy Processing Cell letter No. 2-9/05-CPC dated 29.12.05. Accordingly, the first phase of work i.e., site selection at 11 different locations along 6 different maritime districts was carried out by an expert team of Scientists, Technical personnel and Field staff of CMFRI. The team consisted of 3 Principal Scientists, 6 Scuba Divers, and 2 field staff. The details on the nature of sea bottom terrain, soil characteristics, basic hydrographic parameters, plankton composition, fauna and locations of the sites with latitude and longitude readings were collected.

The fabrication of the artificial reef structures was carried out at two different places, **one** at Sethubavachathiram where the reef structures meant for 9 locations selected at Thalangudda, Tharangambadi, Eripurakkurai, Kollukadu, Vallavanpattinam, Kodimunai, Gopalanpattinam, Thiruppalakkudi and Villundi were fabricated and the structures meant for Vellpatti and Vembar were fabricated at Tuticorin. The deployment of these artificial reef structures were carried out by professional contractors with the help of crane, lorries and Tuticorin type of cargo vessel at Vellpatti and Vembar and by barge at the other 9 locations.

After the successful deployment of the reefs at all the places, periodical observations of the hydrography, planktonology, maturation process of the artificial reef structures, species succession, fish assemblage and the fishery at the artificial reef sites were made. The impact of the artificial reef on the fishery and socio-economic status of the fisher community was studied by comparing the data collected after the completion of two years in all the eleven villages and other neighbouring villages where the fringe benefits of artificial reef were extended with that of the bench mark survey conducted before the implementation of the project.

Immediately after the deployment of the artificial reef modules, biological fouling, an accumulation process of micro-organisms, algae and diatoms, plants, and animals started taking place on surfaces of the artificial reef structures. Algal succession on artificial reefs comprised filamentous algae as the primary colonisers followed by the fleshy brown algae. The amphipod crustaceans, three caprellids and three tube-building gammatid amphipods, were the earliest and the most abundant settling foulers. The community consisted of representatives of seven phyla and about 38 species, as follows: 8 polychaetous annelids, 9 crustaceans, 7 molluscs, 6 coelenterates, 2 bryozoans and 2 others.

Standing stock biomass of sessile epibenthos from artificial reefs in Vellpatti and Vembar was 2,468 to 3,919 g/m² on horizontal surfaces and 4,218 to 7,726 g/m² on vertical surfaces. An average sessile biomass was estimated to be 1,838 g/m² on the exposed outside surface of concrete reef structures and 3,318 g/m² on the protected interior of the reef structure along the Palk Bay and Bay of Bengal.

Predators, such as crabs, lobsters, starfish and sea urchins, on the inside of the artificial reef grazed on the protected fouling growth and the actual predation rate on the unprotected exposed area was probably higher than that observed in the inside of the reef structures. Standing stock biomass was only a static measurement of the productivity of a reef, and not indicative of all the biomass that was produced over the extended time period before samples were collected.

The following succession stages on artificial reef structures were identified over a two year period: a). Bacteria – Algae, b). Barnacle – Hydroid, c). Mollusc – Polychaete, d). Sponges – Ascidian and e). Anemone – Stony coral. It was further said;

1. During the 24-month study, a total of 137 taxa were identified to be living within the artificial reef habitats.

2. The artificial reef habitats were colonised by an average of 423,948 individual marine life organisms and they had a total mean biomass of 58,358g per m² of sampling unit footprint. Colonial organisms covered 5,835 cm² of surface area/m² footprint.

3. The artificial reef habitats were more complex and had greater surface area than the most actual reef

structures and consequently had a greater density of marine life than would be expected on currently used reef structures of the same profile elsewhere.

4. The biomass/footprint ratio of the experimental reef habitats could be increased by optimising hiding spaces and by increasing both surface area and profile.

5. There were considerable year-to-year fluctuations in total biomass, with the dominant species.

6. The artificial reef habitats provided refuge cover for a large number of small and bigger fish (135.3/m²), crab (3,445.9/m²) and lobster (22.9/m²).

7. In terms of biomass, the forage base to small fish ratio of the artificial reef habitat was 45.5; and

8. On an equivalent area basis, the biomass enhancement ratios of the artificial reef habitats ranged from 123 and 2,195 times, respectively.

Annual total fish catch from the non reef areas was estimated to be 5324.4 t in which gillnets landed 3,634.3 t, hook & line landed 1,161.7 t and trawlers landed 528.4 t. In all 91 genera and 109 species had been landed by these gears, in which 7 species of elasmobranchs comprised 4 species of rays and 3 species of sharks, 39 species of pelagic resources, 44 species of demersal resources, 4 species of crabs, 3 species of lobsters, 5 species of prawns, 6 species of cephalopods and one species of gastropod had been landed indicating a very rich species diversity, it was mentioned, with the addition of the following details.

An estimated total marine fish catch of 1548.1 t was landed from the artificial reef area, to which the contribution of gillnet was 1226.3 t and of hook & line was 321.8 t and this formed 29.1% of the fish catch from both non-artificial reef area and reef area.

As many as 77 species under 65 genera comprised 6 species of elasmobranchs, 27 species of pelagic fishes, 30 species of demersal fishes, 3 species of prawns, 4 species of crabs, 3 species of spiny lobsters, 3 species of cephalopods and 1 species of gastropod were landed from artificial reef area. The species composition from artificial reef area was richer by 2 species than from that of the non-artificial reef area, indicating the availability of better species diversity in the artificial reef area.



A total of 37 species belonging to 35 genera were landed by 1986 units of hook & line from the artificial reef area. Three species of elasmobranchs in which 2 species were rays, 13 species of pelagic fishes, 16 species of demersal fishes, 1 species of prawn and 4 species of cephalopods were landed by the hook & line units.

The hook & line units had landed on an average 70.65 t and gillnets 136.25 t and these two added together to 206.9 t of fish which were landed from a single artificial reef site and a total revenue of Rs.110.45 lakhs had been realised from the sale of these fishes. The net income after deducting the operational cost, opportunistic cost, depreciation cost of craft, gear and the artificial reef structures (11.55 lakhs per annum) from the sale proceeds came to 98.9 lakhs, in the year.

The report mentioned the possibility of realising a higher net income as the resource enhancement in the artificial reef area was reported to be 23 times to as high as 4,000 times at different locations all over the world.

Comparison of the impact of artificial reef on the socio-economic conditions of the fishermen with the bench mark data collected at the beginning of this project indicated that all the fishermen said that the deployment of artificial reef was very useful. 73.6% of the stakeholders stated that the artificial reef had increased the fishery, 15% had told that there was species increase and 7.5% of them had told that the non-mechanised boat catches had gone up. The awareness on the artificial reef structure and their performance had also increased, as told by the respondents (95.6%) who said that the artificial reefs were made by cement concrete structures. All of them gave a vivid account on the occurrence of the **dominant species, their season, abundance etc.** and the types of gears to be operated for different target species. On an average the hook & line was the dominant gear used in artificial reef area, followed by a type of gillnet called salangai valai and piece valai and gillnet & squid thoondil.

The deployment of artificial reefs is not only useful for the fishermen of the target villages but is being used for fishing by the adjacent villages both on the north and south of the target beneficiary villages, the report said. Most of the stakeholders desired that more number of Artificial reefs were needed to be deployed in their villages and they wanted GPS to be provided by the Government at free of cost to locate

the artificial reef site with less difficulty. The cost of the artificial reef may be a prohibitive factor in developing it into individual specific intervention. Therefore this may be worked out initially as common property resource of the whole fishing village. Over a period of time, it may be developed as an individual or family property, if it did not culminate into a social problem within the village. There was very little chance for a social problem as this technology is sure to provide excellent revenue for the traditional fishermen, it was mentioned.

Fishing villages wherein some or all the fishermen own mechanised trawlers, or villages in close proximity to a fleet of mechanised trawlers would hesitate to adopt this technology because of the fear that this would obstruct or damage the trawl net operation and it might lead to or aggravate the existing social conflict.

The present study revealed that the artificial reefs were suitable for diverting the fishermen from their dependence on the natural reef habitat in places like Gulf of Mannar where all the 21 coral reef islands were protected. Fishing villages with natural rocky or coral reefs within their fishing territories also might not opt for artificial reefs, as they would be superfluous and would not make much difference from natural reefs. Present finding should be highlighted to the fishermen of the area and the forest department in encouraging this activity so that their conservation would become easy.

It is well known that the coastal waters are 12 times more productive than the oceanic waters and the fishing is also very intensive and extensive along the coastal waters. The report says that this forced the evolutions of strategy to improve the biological resource and the ecosystem for which the artificial reef worked out to be an excellent option. Promotion of deployment of one artificial reef for each fishing village should be the aim not only to improve the biological resources and also to conserve the shallow coastal waters from incessant sweeping by the trawl operations, it was observed.

Artificial reefs could be thought of as eco-tourism places and could be developed as tourist centres for game-fishing with hook & line, scuba diving, underwater photo and videography and for other eco-friendly aquatic sports, it was mentioned in the report.

Last but not the least, the rich biodiversity of the Indian coastal waters had been devastated by prolonged mechanised trawl operations since the past five decades and this could be revitalised through the systematic establishment of the artificial reefs all along the Indian coastal waters. Mentioning this, it was pointed out that this activity should be considered as one of the prime activities as this not only would lead to recolonisation of the coastal waters at the sites of artificial reefs, but also the breeding or reproductive potential of coastal organisms was enhanced many fold at the reef sites leading to the revival of the coastal fishery stocks and could be restored to their original levels, through this excellent ecological intervention called artificial reef, the report stated.

The Chief Guest Mr. Shambu Kallollikar, IAS Commissioner of Fisheries, Government of Tamilnadu while delivering his special address, emphasised that livelihood improvement activities for the fishermen should be given priority and that the establishment of artificial reefs all along the Tamilnadu coast had produced excellent results in achieving this goal. Dr.G.Syda Rao, Director, CMFRI, Kochi in his presidential address had expressed his **satisfaction at the overall performance of the project which had made an apparent socio-economic impact on the livelihoods of the Tamilnadu fishermen.** Dr. A.R.Thirunavukkarasu, Principal Scientist & Head of Fish Culture Division, CIBA had appreciated the meticulous way in which the project had been implemented and the underwater videography of the maturation process of the artificial reef structures was the first of its kind in India. The function came to an end with proposal of a vote of thanks by Mr. D.Kandasami, Principal Scientist.

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