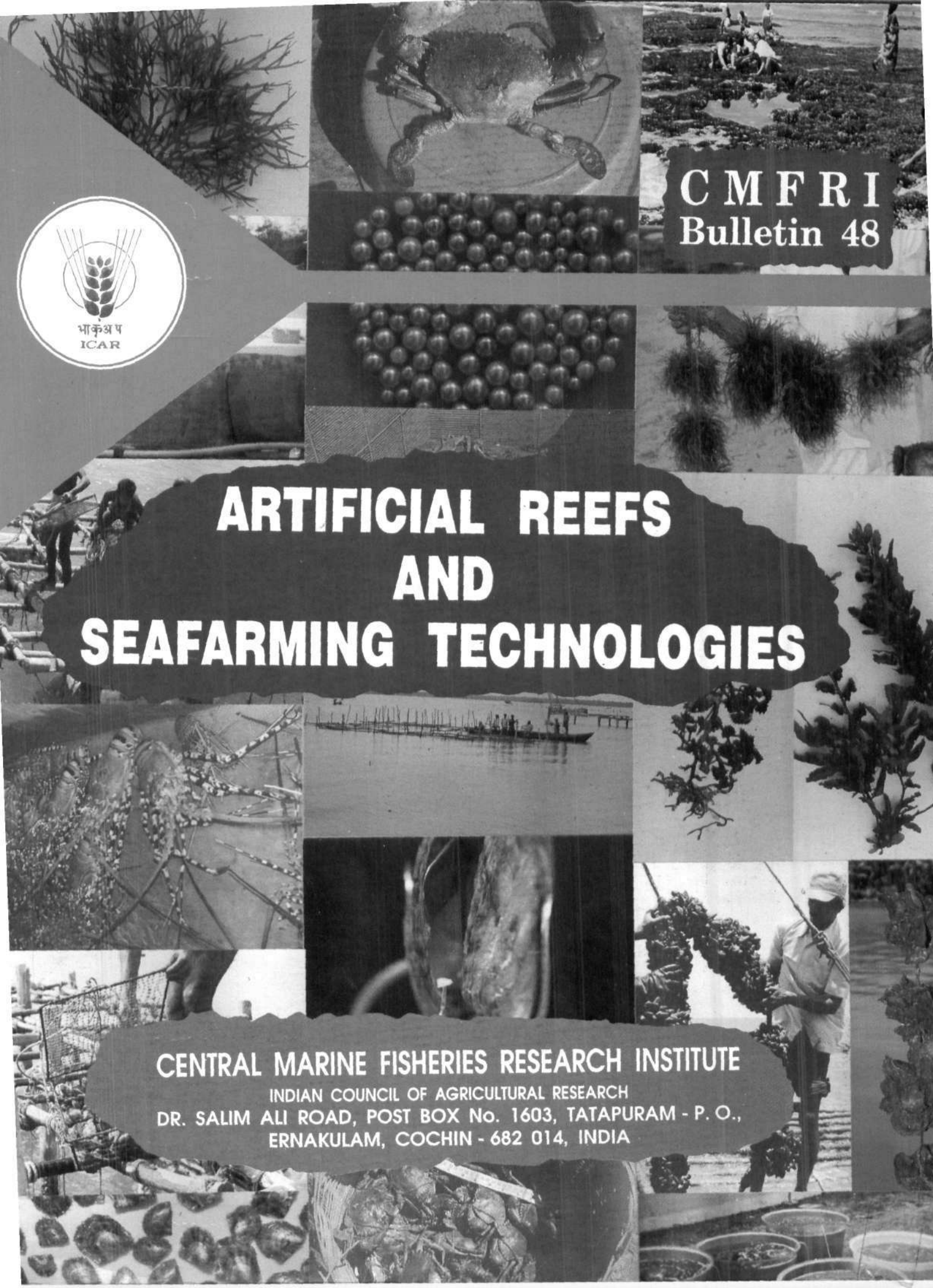

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Dr. K. Rengarajan

Editor

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ARTIFICIAL REEFS HABITAT ENHANCEMENT AND INCREASING FISHERIES POTENTIAL

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Introduction

Artificial reefs are used throughout the world to increase the fisheries potential of barren or relatively unproductive areas. Artificial reefs also act as effective fish attracting devices during certain times of the year. Reefs when properly located and structured not only concentrate fishes, but also increase the biological productivity of the area. Formation of rough rigid bottom habitat with artificial reefs of diverse materials increases the surface area necessary for fish food organisms. The reefs also often serve as spawning habitat and shelter for fishes and shellfishes.

Artificial reefs also act as an ideal tool of rehabilitation or enhancement of areas impacted by overfishing and bottom trawling. The artificial fish habitats established by the traditional fishermen of the Southwest coast of India, particularly off Trivandrum and Kanyakumari Districts, since the beginning of eighties, have been models of regenerative process of depleted fishery wealth in the coastal waters.

Artificial reefs

Artificial reefs are natural or man made external objects or stable structures placed in the sea to provide an artificial fish habitat and thereby to attract, aggregate and regenerate pelagic, demersal, migratory and residential fishes. An artificial reef develops into a fish habitat when barnacles, algae, oysters, mussels and other sessile organisms colonise the reef as they do any firm surface in shallow water. The process by which the organisms invade a previously uninhabited area, is known as Ecological Succession. It begins with an accumulation of bacterial slime. Benthic diatoms and protozoans appear next. They multiply rapidly. Hydroid and multicellular algae follow and then come the planktonic larvae of barnacls, mussels and snails. Eventually the ecosystem reaches a balanced state or climax community, inwhich no further colonisation occurs and ecological succession ceases unless a disturbance of the system causes the process to start afresh.

Origin and development

It was known to the Japanese fishermen since the ancient past that alien objects placed in water cause aggregation of fish and prompt growth of seaweeds. The oldest written records shows that in 1650 reefs were constructed by placing rocks in the water. Later records show that this practice has been used in many areas of Japan. However in the post world war II period artificial reef programme was developed into a long range programme for fishing ground construction and it is reported that presently Japan spends nearly US $ 3 billion on this programme.

The artificial reef programme of United States dates back to 1860 and at present there are about 300 highly productive artificial reefs in US coastal waters supporting from sport fishing to commercial fishing. In most of the western countries Artificial Reef Programme attained significance in the post world war II period only, however, reef building technology gained so much attention these years and presently reefs are increasingly designed for specific resources.

As an age old practice, traditional fishermen of Trivandrum Coast operating shore seines used to dump rocks fastened with coconut fronds into sea bottom to attract fishes closer to the shore. Occurrence of large fish shoals in areas of sunken ships and boats were known to the traditional fishermen for many decades. The sunken ship, off Anjengo fishing village 45 km north of Trivandrum

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at 45 m depth matured into a rich Artificial fish habitat and is a very good fishing ground for perches, carrangids and a number of other fishes. The first recorded artificial fish habitat construction was off Puthiathura in 1953 and subsequently off Eraviputhenthura (Kanyakumari Dist.) in 1957. However, an organised effort to construct artificial fish habitats and artificial reefs was made only from 1980 onwards. The declining trend of the coastal resources and reduction in the catch per effort was the first catalyst to start this programme. The Government of Kerala recently implemented two artificial reefs off Parithiyoor and Kollamkode (Pozhiyoor) using ferro-cement triangular structures and was found to be highly effective in habitat enhancement and fish aggregation.

The recent developments in the Artificial Reef Programme across the world show the increased awareness for habitat regeneration. Purpose built Artificial Reefs are now fairly frequently placed either on damaged reefs or on the sea bed near the natural reefs. By creating additional habitats, they allow a greater number of larvae to settle, seek shelter and survive predation.

Design and construction of Artificial Reefs

The productivity of an Artificial Reef is found to be directly related to the size, shape and height of the reef. As the experience accumulated with time, it was realized that the concept of artificial reefs may be enlarged to a scale sufficient to create new fishing grounds in areas were none had existed.

The first generation reefs were installed utilizing locally available materials such as rocks fastened with coconut fronds, coconut stumps, bundles of coconut and screwpine leaves. These were randomly dumped by the fishermen at selected sites. It was found that coconut leaves, screw pine leaves and coconut stumps when decayed, help plankton and other organisms grow around and on them, which attracts large number of smaller and bigger fishes into the area. However, a basic drawback with this random dump and hope method was that the reef didn't have the desirable shape, size or height. According to fishermen, productivity was very low in these reefs. The next organised effort was at Shanghumugham where the reef was established at 10 m depth with 3 m height. The materials used were rocks fastened with coconut fronds, rocks placed in net bags, concrete well rings, old used tyres, old autoparts, etc. It was found that high structures like well rings provide shade and shelter for fishes and other organisms. This reef was found to be the most productive reef of traditional design. But two problems faced with all these were the sinking of the Artificial Reefs and the unsystematic distribution of the reef components. Another problem was the limited height of the reef structure. It was at this stage that the Intermediate Technology Development Group of London deputed one of their Engineering Consultants to India and after extensive consultation with the users, scientists and representatives of NGO's, a triangular module of 1.5 m size was designed, fabricated and placed underwater. Although a number of designs were experimented the triangular ferrocement modules were selected due to the following advantages.

1. The total weight of the module was only about 150 kg, hence handling and placement was very easy.

2. The width, height and length of the module was all 1.5 m and hence the structure was relatively stable and provided maximum surface area for epifaunal growth.

3. The design of the module helps to function as an effective unit in the Artificial Reef whichever position it reaches the bottom.

4. Because of the low cost, ferro-cement modules were highly economical.

Triangular structures were used exclusively for the Pozhiyoor reefs and the subsequent reefs at Valiathura and Shanghumugham. At Pozhiyoor 50 modules were used in the reef building. Experiments have shown that the size of the fish schools increases with the area and size of the Artificial Reefs. Hence the new reefs are being designed with 2.15 m height, also the number of the modules in the reef is also being increased. The ratio of structural height to water depth has been studied and it was found that a minimum ratio of 1:10 is required for good aggregation of pelagic fishes.

Placement of the reef modules

The placement of the reef modules were done with the active involvement of the local fishermen who have excellent knowledge of the sea bottom. Over the years they have built up a most detailed mental map of the sea bed. The technology for placement of the modules were also developed with the help of ITDG, London. A twin boat arrangement with a guadrupod in between the boats, connecting centrally, and a pulley and rope in the middle was the module handling, and placing structure. The Kattamarams ferried the modules from the shore to the reef site. The Kattamarams were placed underneath the quadrupod, in between the boats, and the modules were lifted off, and after the Kattamaram moved on, lowered to the sea bottom and placed. By adjusting the anchor lines placed at the four ends of the boats, the modules were placed one after the other and also in clusters. Bundles of coconut leaves were placed inside the modules for helping the units to attract fishes and cuttlefishes to the area.

Most of the reefs are established in the east-west direction cutting the water current along the coast, so as to provide shelter and maximum protection to the shelter seeking organisms.

Fish aggregation and fishery in the Artificial Reefs

The fundamental question as to what attracts the fish to the reef remains unanswered. Population dynamics associated with a reef involving intra-species, inter-species and oceanographic interactions also remain unresolved. Yet it may be generally stated that alien objects of virtually and kind placed in the water would cause some form of fish congregation.

Some fishes attracted to a reef throughout their entire life cycle, whereas others seem to exhibit the behaviour only during part of their life. Of the reef related species some may be called "upper fish" or "lower fish" as they respond vertically to a reef, whereas some may be called "migratory" or "residential" fish as the response of these fish is horizontal. Some fish species may only "drop by" or "visit" a reef, whereas others "settle down". Some species would live "off" the reef, some "by" the reef and others "within" the reef.

According to the behaviour pattern, reef attracted fishes can be generally categorised into the following groups.

1. Those species which prefer strong physical contact with their bodies against a hard object *e.g.* Moray eel.
2. Those species which like to remain in physical touch with an object, with pectoral fin or belly. Mostly sedentary fishes *e.g.* reef cods and rock cods.
3. Those species which like to remain in close proximity to a hard object without really touching it *e.g.* most reef dwellers such as parrot bass, snappers, breams and coral fishes.

Once attracted to a reef, the fish tends to assume a particular position relative to the reef depending upon the species. Their behaviour can be classified as follows.

a. Upper- and mid-layer swimmers which exhibit a tendency to congregate over the fishing reefs, remaining in the upper layer as a school. *e.g.* mackerel, big-eye scad, carangids, baracudas and smaller perches.

b. The bottom - layer swimmers which gather around a fishing reef, but without exhibiting a sedentary behaviour. *e.g.* apagonids, coral fishes, butterfly fishes, etc.

c. Sedentary fishes which inhabit crevices and holes in the reef. *e.g.* eels, lobsters, reef cods, etc.

Aggregation of fish in areas of newly established reefs was estimated by the fishermen in terms of the catch they were getting from the reefs. Many of the reefs along the Trivandrum Coast were established by small community groups and is opened to fishing only to the particular group.

Coconut leaves and screwpine leaves are dumped in the reefs mainly to attract cuttle-fishes. Decaying leaves attract large number of cuttle-fishes to the areas and provide ideal environment for the females to lay their eggs and for the juveniles to spend thier early life. According to many fishermen, they start fishing only after the

juveniles are sited in the reefs. Such reefs are locally called as "Kanavamada" meaning cuttlefish habitat. The presence of egg masses and juveniles clearly shows that reefs are not only aggregating cuttlefishes, but also provide excellent nursery grounds for the juveniles.

Most of the 31 Artificial Reefs are reported to be excellent fishing grounds for sepia, loligo, serranids, carangids, Big-eye scad, mackerel, goatfishes, white snappers, red snappers, etc. However, the predominant group caught from the reef is cuttlefish.

An underwater study of the reefs along the Trivandrum Coast by the Oceanography Department of Southampton University and Central Marine Fisheries Research Institute had proved that inspite of the smaller sizes of many of the reefs, they act as excellent habitat enhancement units and aggregates large number of fishes. The underwater video records and photographs showed the large-scale aggregation of ornamental fishes of the families *Apogonidae, Pomacentridae, Chaetodontidae, Caesionidae, Labridae, Callyodontidae, Zanclidae, Acanthuridae* and *Scorpionidae.* Crabs and lobsters are also noticed in the Artificial Reefs.

The epifauna collected from the reef modules revealed the presence of large number of pearl oyster *Pinctade fucata,* the chank *Zancus pyrum* and corals.

The biomass estimation of the Pozhiyoor reefs showed a unit biomass of 2.48 gms per cm^2 over a period of 9 months. Comparable studies showed that this is one of the highest productivity observed. From a study for one year it was found that the seasonal income of a fisherman from fishing in the reefs ranges from Rs. 2785 in Kollamcode to Rs. 4050 in Parithiyoor. On a percentage-wise analysis of the catch, it was found that the reef fishermen's catch was nearly 20% higher than that of non-reef fishermen.

Future prospects for the Artificial Reef Programme

Artificial Reefs are considered to play significant roles in revitalizing the aquatic environments which have been damaged by developmental projects and overfising. Such roles of the artificial reefs are particularly well appreciated by the artisanal fishermen who use traditional hooks and lines, long-lines, etc.

Artificial Reefs can also play a vital role in sea-ranching of groupers, perches, lobsters, etc. Releasing of juveniles of these fishes in reef complexes will help them to survive, flourish and reproduce better. Reefs also help to establish new fishing grounds where none had existed earlier and thereby increases the employment opportunity and income of the traditional fishermen.

Finally it may be noted that in the process of ecological destruction, it is in the tropics that the battle to preserve "Bio-diversity" will be won or lost. Artificial Reefs and Artificial Fish Habitats are great steps forward in the march for 'Eco-technology'.

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