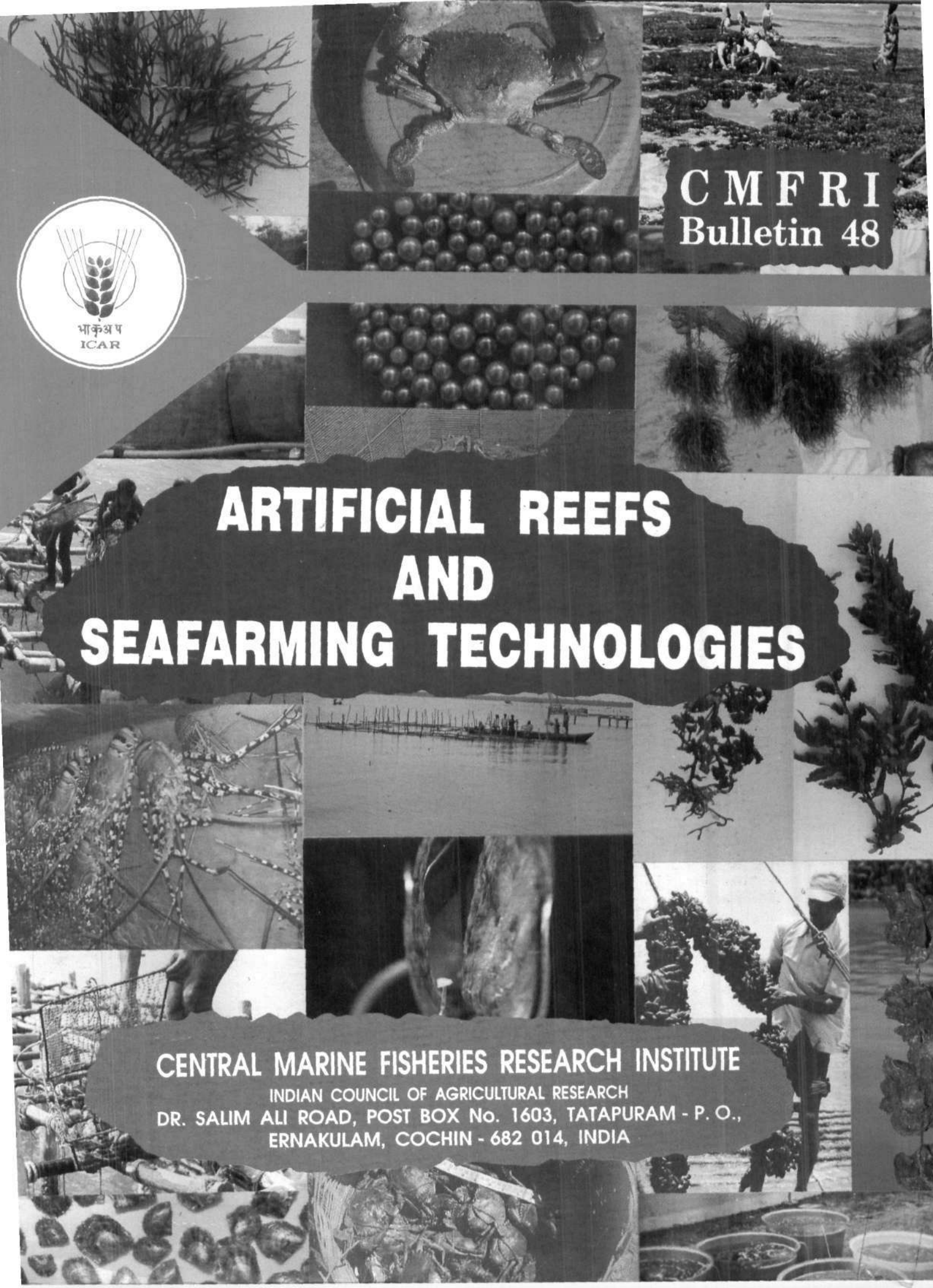

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CENTRAL MARINE FISHERIES RESEARCH INSTITUTE
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Dr. K. Rengarajan

Editor

January 1996

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ARTIFICIAL REEFS FOR A SUSTAINABLE COASTAL ECOSYSTEM IN INDIA INVOLVING FISHERFOLK PARTICIPATION

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Introduction

Forty countries on six continents, are using the artificial reef technology today. Artificial reefs are reported to increase fish catches by 20 to 4000%, prevent overfishing and "with greater awareness of the world's deteriorating marine environments, there is increasing reliance on artificial aquatic habitats in the world" (Grove and Sonu, 1991). When natural reefs like coral reefs and rocky reefs in tropical coastal waters are known for their high biological and fishery productivity and diversity, why not artificial reefs accomplish the same? Artificial fish habitats are of two types, benthic Artificial Reefs (ARs) to attract demersal fish and Fish Aggregating Devices (FADs) to attract column as well as pelagic fish.

Experiments with artificial reef technology

Traditional artificial fish habitats in India

Traditional artificial fish habitats on the Coromandel Coast were first described by Hornell (1924). Bergstrom (1983) reviewed the fish aggregating devices of India and the Southeast Asia. Some of these traditional practices are still in vogue even today. Branches of trees, weighted with rocks as anchors, are dumped into the sea by artisanal fishermen on the coast of Tamil Nadu. They serve as artificial reefs (ARs) called *Mullom* in Tamil and are fished with a hook and line. Similarly, coconut fronds, tied at 1 m intervals along a rope, like a bottle-brush, are suspended from a float and anchored to the seabed with a weight, are called *Kambi* in Tamil and they serve as a Fish Aggregating Devices (FADs). They are fished by four catamarans from four corners, using a square lift-net (bag net) *Mada valai* or *Ida valai* in Tamil.

Traditional knowledge and experience of fishermen is amazing concerning these artificial reefs and fish aggregating devices. Specified areas of the coastal waters are traditionally used, for installing artificial fish habitats, by specified fishing families of the nearest village, through a traditional system called *Seppaadu*, approved by the village panchayat. The species of tree preferred for its trunk or branches as reef material is the Tiger bean *Delonix elata* (Family Ceasalpinaceae) called *Konnu maram* or *Vaadanaaraayana maram* in Tamil. Fishermen believe empirically that the bark of this tree when it rots in seawater, emits a foul stench which acts as a fish-attractant. Chemical analysis of this bark yields the aminoacid L-asparagine, aspartic acid and sucrose acetate, which are known to be fish-attractants (Hariharan, 1969). Through long experience, fishermen know that rocky reefs called *Paarai* in Tamil, and slushy or muddy areas called *Cheru* in coaster waters are biologically and fisheries-wise more productive than barren sandy areas called *Tharai* in Tamil. They are also aware of the fact that these artificial fish habitats, using green vegetation are bio-degradable and hence eco-friendly, although they are short-lived, warranting recurring costs for the poor fishermen.

Modernising the traditional artificial reefs

In order to experiment with modernising these traditional artificial reefs, used extensively by the fishermen of the Periya Neelangarai Kuppam, a fishing village about 25 km south of Madras, on the Madras-Mahabalipuram Road, first of all, the author to obtain the unanimous consent of the village panchayat. Then the technology of the modern artificial reefs (*Naveena mullom*) as the fishermen call it, was explained to

the fishermen, through the Participatory Rural Appraisal (PRA) technique.

Seventeen fishermen volunteered to experiment with the modern artificial reef technology. First the author worked with traditional reef technology itself, in order to obtain baseline data on the fishing potential and composition at a reef on the coast, as well as to gain a good rapport with these traditional fishermen. Seven different species of locally available trees or their branches were used as reef material, but found that their traditionally preferred one, namely the Tiger bean yields the best fish catches (Sanjeeva Raj, 1989).

Then it was got the volunteering team of fishermen, through the PRA technique to draw a map of the floor of the sea, against their village, upto 4.5 km (Sanjeeva Raj, 1990) to choose the right sites for installing artificial reefs on the seabed.

In order that these artificial reefs are rendered more durable and less destructive to green trees, as in the traditional technology, concrete well rings as reef materials were substituted. In February 1988, about 150 concrete well rings, each about 60 cm in diameter and 30 cm in height, were skillfully let down along two polythene ropes, as beads on strings, to a depth of about 20 to 25 m and about 2 km away from the shore. They formed a rough pyramid, with a circular base of about 4 m in diameter, and about 1.5 m in height at the apex (Sanjeeva Raj, 1989, 1991). This reef is surviving intact even to this day, seven years after its installation, yielding heavy catches, and proving that the older the reef the more productive it would be.

Ecological, economic and social benefits

Ecological benefits

Using hook and line, during the day time, with prawn as bait, 25 species of teleosts belonging to 18 families, were caught at this reef, during the first three years from March 1988 to February 1991 as per the data maintained by the participating fishermen themselves. At any one time, four to six species of fish could be fished at the reef. Species composition and dominant species varied according to the season. Catch per unit effort (CPUE) and income per unit effort were calculated. Ecological succession at the reef was studied. Species like *Alepes (Selar) mate* (Vari Paarai in Tamil) and *Carangoides malabaricus* (Kuzum Paarai) were dominant during the premonsoon months, but large (1 m long) *Rachycentron canadus* (Kadal Veraal) were dominant during the summer months. Today, after seven years of habituation, an amazing variety of large fishes such as the rabbitfish, parrotfish and large croakers, which were earlier available only at the submarine mountain (*Paniyur Malai*), opposite the fishing village Paniyur Kuppam, have now migrated to this artificial reef, having accepted it as a natural rocky reef. Six to eight of these 25 species recorded at this reef might be breeding right at the reef, as their fry and fingerlings were collected in large numbers from amidst the coconut fronds of the column and surface fish aggregating devices (FADs), supplemented at this reef.

Artificial reefs are eco-friendly technologies. Ecologically, a rich succession of marine life, not only as encrusting biofoulers on the concrete substratum takes place, but also a succession of fish fry, fingerlings and adult fish colonise this reef for shelter, feeding and breeding. New food-chains are formed at this reef. Cuttlefish and squids deposit voluminous egg-masses amidst these concrete modules, and crabs and lobsters crawl on their surfaces. Algae, bivalves and barnacles literally choke the hollow of these concrete rings, and from a catamaran, one can even hear the snapping of the valves of the Giant Barnacle *Balanus tintinabulum* so abundant characteristically on the Mahabalipuram Coast. Such is the rich biodiversity promoted by these artificial reefs. Indian coastal waters which are so much devastated by mechanised trawlers since the past four decades, can thus be revitalised through these artificial reefs.

Not only such recolonisation of the coastal waters at the artificial reefs, but also the breeding or reproductive potential of coastal organisms can be enhanced at the reef, and thus coastal fishery stocks can be restored to their original levels, through artificial reefs.

Economic benefits

Artificial reefs are low-cost or appropriate technologies, so that even the poorest of the poor

artisanal fishermen who cannot afford a net, can easily afford a hook and line, to earn his daily bread. Artificial reefs of concrete modules are one-time investments, with no recurring costs for fishermen. Cost-benefit-wise, artificial reefs are incredibly remunerative.

Artisanal fishermen can be trained to contribute and share the cost of artificial reefs, for the village cooperative.

Social benefits

Artificial reefs are best operated only as common properties of the whole fishing village community. Since the whole community participates in installing them, the whole community has the right fish at the reefs. This incidentally helps to build up the solidarity of the fishing village community, without any disparity between the richer and poorer fishermen, within the village.

Artificial reefs may help to prevent the entry of mechanised trawlers into the coastal waters and would thus minimise the long-standing feuds between artisanal and trawler fishermen.

Constraints

Artificial reefs would work well only as common property resources of the whole fishing village, but not as individual or family properties, lest there are fights within the village itself, for fishing rights at the reef.

Fishing villages wherein some or all of the fishermen own mechanised trawlers, or villages in close proximity to a fleet of mechanised trawlers, will not opt for artificial reefs, as they would obstruct or damage the trawler nets.

Fishing villages with natural rocky or coral reefs within their fishing territories also may not opt for artificial reefs, as they would be superfluous and would not make much difference from natural reefs.

Close to fishing harbours or to passenger or cargo harbours, adjacent to coastal jetties, oil-rigs and pipe lines, intake sumps of power plants and along navigation routes, artificial reefs would not be allowed.

Future prospects

Lot of basic research still needs to be done at artificial reefs, through scuba-diving and underwater photography, to study the reef profile, ecological succession, biodiversity of the reef communities, carrying capacity for each species, breeding potentials and population structures, maximum sustainable yields, detoxification and cleaning of coastal waters from its pollutants and alternate reef material out of wastes, etc.

Fishing regulations to avoid over-fishing, and fishing of breeders during their breeding season, fishing within the norms of the Maximum Sustainable Yields (MSY) and periodic renovation and regular maintenance of the reef should be enforced among the participating fishermen, as their joint responsibility.

Artificial reefs could be developed as tourist centres also, for game-fishing with hook and line, scuba-diving, underwater photography and for other eco-friendly aquatic sports.

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