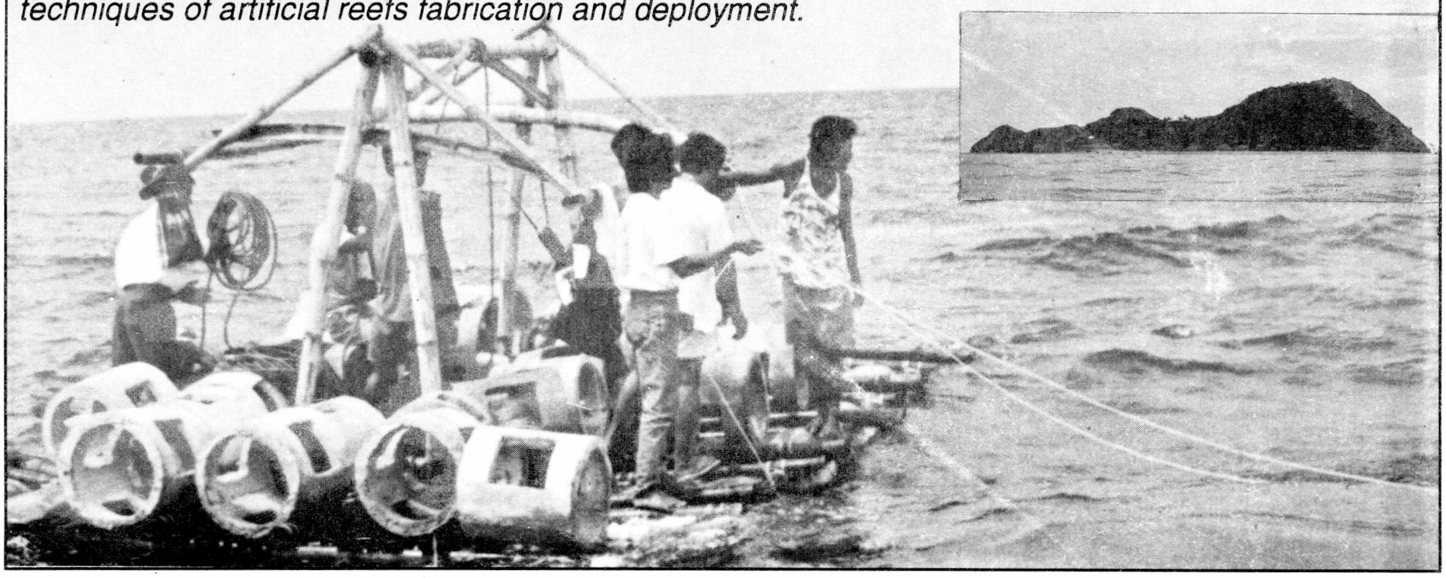
Technology for the community: SEAFDEC-designed Artificial Reefs

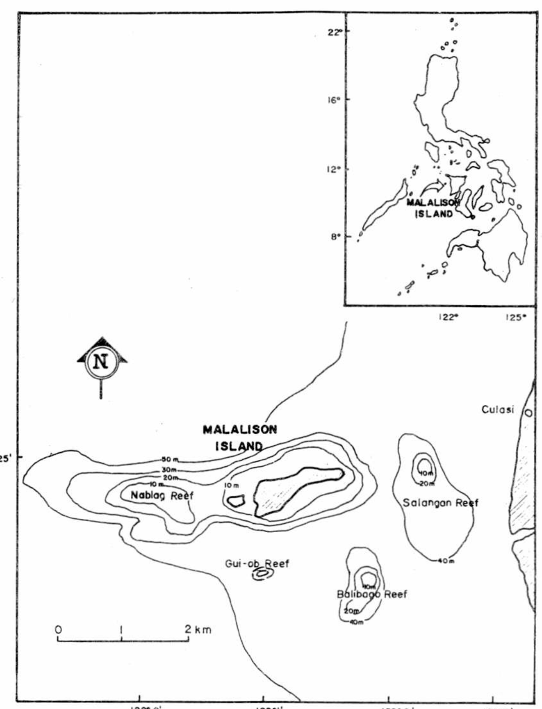
Malalison Island at the background, site of SEAFDEC/AQD's community-based techniques of artificial reefs fabrication and deployment.



SEAFDEC/AQD's Community Fishery Resource Management (CFRM) project, a development-oriented research, is focused on Malalison Island located in west central Philippines. CFRM aims at applying community-based techniques of fishery resource management through the collaboration of community organizations, biologists and social scientists. A major stage of the project was the fabrication and deployment of artificial reefs (ARs) which called for engineering expertise.

Engineer Reynaldo A. Tenedero of SEAFDEC/AQD designed the ARs which utilized the capability of the community to fabricate and deploy. In determining the configuration, form, size and weight, the limitations of the fisherfolk were taken into account.

The fishermen in the area who were organized into the Fishermen's Association of Malalison Island or FAMI were consulted on the water current, underwater topography and substrate. Their information supplemented the data gathered by SEAFDEC/AQD staff who made a hydrographic survey and actual dives to determine the AR site.



Map of Malalison Island, west central Philippines. Inset map: Philippines.

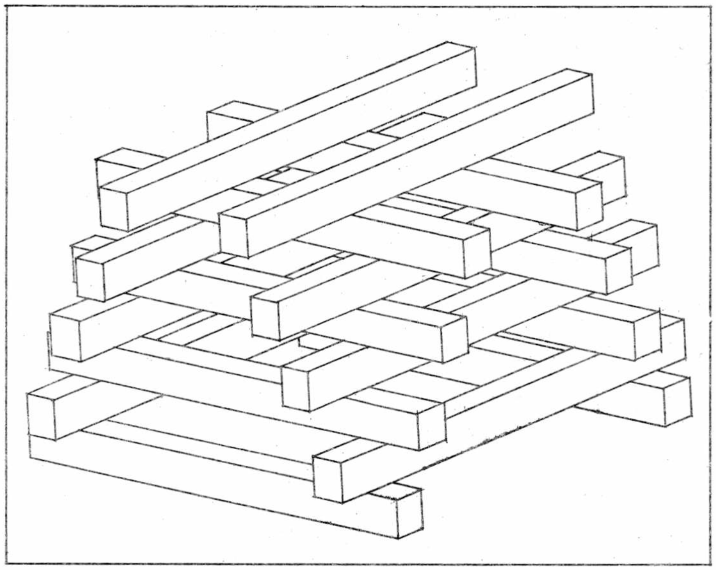


Fig. 1. Unit reef I, building block

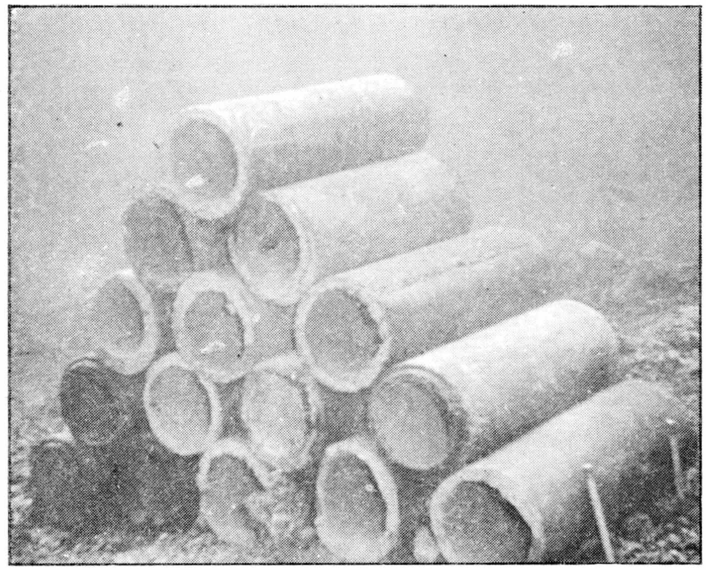


Fig. 2. Unit reef II, concrete pipe culverts.

AR designs

The main considerations in choosing materials for the ARs were availability, cost, and ease of installation. Concrete and stone were used for AR construction because of their density, durability, and low cost. The ARs were steel-reinforced concrete fabricated in segments at least 1.47 kilo Newton (KN) per block to avoid the use of heavy lifting and transport equipment. When concrete was poured, the sides in contact with the formwork were left as is to produce a smooth to rough finish, but the exposed sides were deliberately made rough to provide a varied surface texture which may allow a diversity of organisms to settle.

Three types of unit reef were fabricated. Unit reef I was a building-block type consisting of ten 150x200x2000 mm long concrete block arranged two blocks per layer with unit size of 2x2x1.6 m high (Fig. 1).

Unit reef II consisted of fifteen 300(ID)x1200 mm concrete pipe culvert blocks arranged in pyramidal configuration of 5,4,3,2, and 1 layers to a unit reef size estimated at 1.2x2.5x2 m high. However, the height depended on the spaces in between each block when the unit reef was set (Fig. 2).

Unit reef III consisted of thirty 499(ID)x500 mm modified concrete pipe culverts with three 250x250 mm openings on the sides (Fig. 3). The unit reef size was estimated at 2.5x2.5x1.5 m arranged at random.

Unit reef I was fabricated on the island using locally available materials. Manpower was provided by fishermen and FAMI members who were not really skilled construction workers. Skilled labor was not necessary since the units were of rough finish.

Ready-made concrete pipe culverts for unit reef II were fabricated by a concrete product dealer in Culasi, 20 minutes by motorized banca from the island. Unit reef III culverts were also made-to-order at Culasi, but modified to provide three openings on the sides. The costs of fabrication and deployment of ARs appear in Table 1.

To instill a sense of responsibility for the project, FAMI gave a counterpart of P5,000.00 to cover part of the deployment cost. The amount was taken from the barangay (village) internal revenue allotment fund.

Deployment site

In May 1994, prototype prefabricated AR reef units I & II were deployed to determine transport and deployment problems. Gui-ob reef was identified through a consultative process among the fisherfolk, biologists, and engineer. Prior to deployment, fishermen and AQD staff surveyed the sea bottom and identified the exact location of deployment. Following the criteria in site selection, FAMI and the local government of Culasi approved the AR site as a fish sanctuary where fishing is prohibited. Enforcement of fishery laws were to be implemented by both FAMI and local (village) government unit.

Table 1. AR fabrication and deployment costs[1]

Unit Reef	Description	Block/ Unit	Cost (Peso)	
			Fabrication	Deploy-ment
I.	Building block	16	4,624[2]	995[4]
II.	Concrete pipe culvert	15	4,060[3]	995[4]
III	Modified concrete pipe culvert	30	3,600[3]	995[4]

[1] Direct labor and material cost
[2] Based on estimate
[3] Actual cost
[4] With community counterpart
Conversion rate: US$ 1=₱26.00

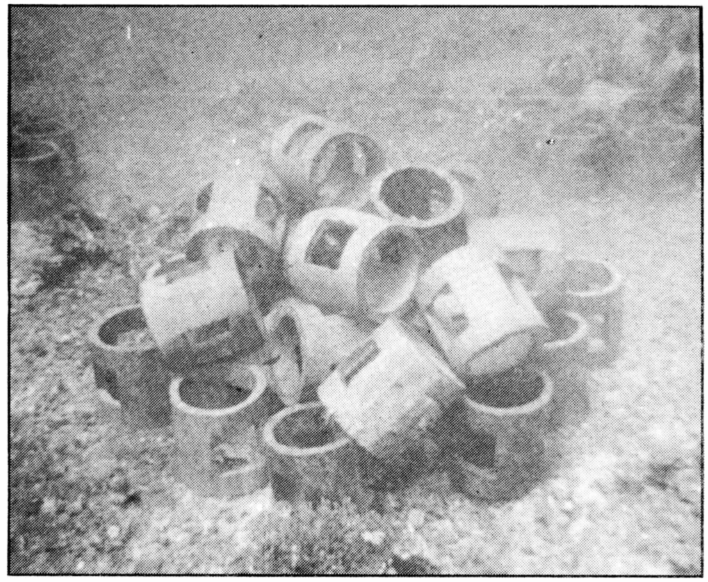


Fig. 3. Unit reef III, modified concrete pipe culverts.

Deployment procedure

The final deployment was done in April and May 1995. A total of 3 reef groups, each consisting of 9 reef units for each type have been deployed at Gui-ob reef covering an area of less than 1 ha.

The three types of AR unit basically followed the same method of deployment. Unit reef III was easiest to deploy because of its lesser weight. Although, unit reef II had the heaviest reef blocks (1.47 KN), it was easy to maneuver because the blocks could be rolled. Small-sized blocks of unit reef I were difficult to maneuver during transport and deployment because of their cornered forms.

After attaining their concrete strength in 28 days, the reef blocks were manually hauled from the fabrication site near the seashore to bamboo raft and towed by motorized banca to the deployment site. The 3.5x7 m bamboo raft had a rectangular opening of 0.7x2.5 m at the middle where the reef blocks were manually lowered one at a time. (Fig. 4). The raft were buoyed by 30 empty sealed plastic drums (0.15 m^3).

During deployment, four motorized bancas were used in hauling the units, towing the bamboo raft, and transporting the divers to the site. The biggest banca could load one set of unit reef. Upon reaching the deployment site, the bancas were anchored to the previously installed surface buoys, which also served as markers for the exact location of ARs. Each

...to page 7

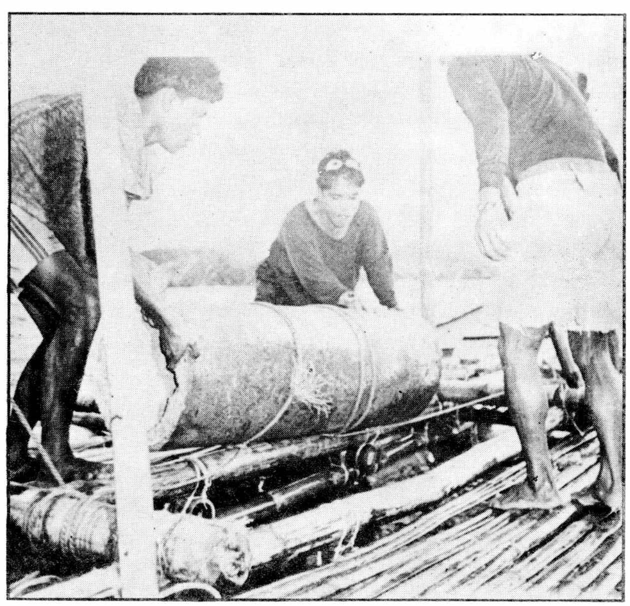


Fig. 4. Lowering reef blocks from the bamboo raft.

The best growth in terms of mean total length (15.05±0.93 mm) and wet body weight (42.89±6.37 mg) was attained by sea bass larvae fed *Brachionus* plus *Artemia* (treatment 1). Fish in treatments 1 (*Brachionus* + *Artemia*) and 3 (*Moina*-fed) had similar growth rates. However, the percent survival ranged from 47.8% (treatment 3) to 65.95% (treatment 2) and did not vary significantly among the fish groups. Survival of fish fed *Moina* (treatment 3) was largely affected by cannibalism by "shooters" (mean total length 41.0 mm). However, growth of fish in this treatment was fast during the last five days of rearing (day 22-26). This confirmed the report of A.C. Fermin (SEAFDEC/AQD) in 1991 that 15-day old sea bass fed *Moina* had faster growth rates compared to larvae fed *Artemia*. *Moina* proved to be an excellent alternative live food to *Artemia*. *Moina* has been found to be a better source of highly unsaturated fatty acids. *Moina* has also the advantage of having a larger body size than *Artemia* which complements the size of zooplankton food required by the fast growing sea bass larvae.

The present study therefore recommends that feeding brine shrimp to sea bass larvae should not be delayed until day 15 so as not to adversely affect fish growth. Feeding *Moina* to sea bass starting on day 17 in place of *Artemia* could be encouraged in order to economize on feed costs in the hatchery.

*Technology for the Community...**from page 5*

block was tied with ropes, then lowered manually into the water. FAMI divers using surface-supplied air compressors assembled the modules in pre-designated areas. When AR units were lowered into the bottom they dispersed far from the designated area. The divers then hauled each block manually underwater and assembled them in the exact position and location (Fig. 5). The clear water transparency from the banca to the sea bottom was advantageous during the deployment as the units could be seen while being lowered. In this situation, the units were lowered directly to the exact site. However, when the loading raft or bancas were anchored far away from the site, the mooring ropes were adjusted for the raft or banca to be directly above or near the designated sites.

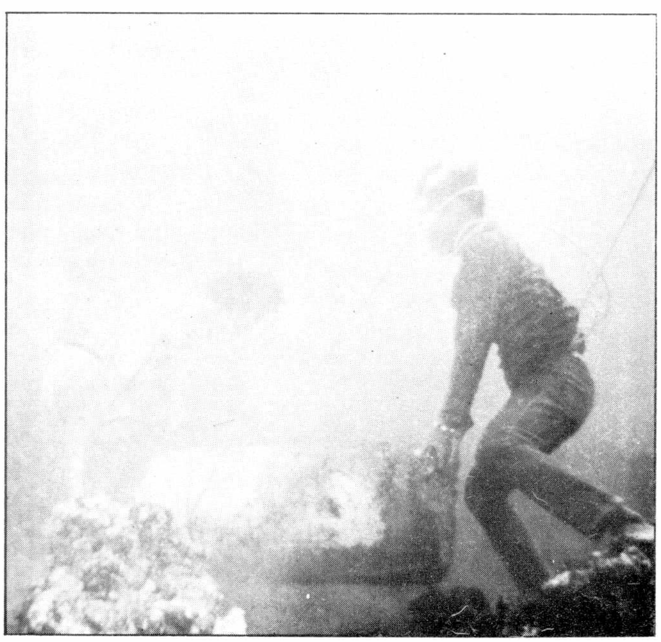


Fig. 5. Divers manually hauling the reef block.

The fisherfolk grouped themselves into two teams. Each team was composed of 6-8 persons. The team loaded unit reef II and III in less than 1 hr and 2 hrs for unit reef I. Transporting ARs from the shore to the deployment site took 45 minutes for the towed raft and 10 minutes for the motorized bancas. The team completely set up unit reef II and III in an average of 3 hrs and 4 hrs for unit reef I. Each team could set up at least 2 to 3 reef units per day. The 25 reef units were deployed in 10 days.

The experience of deploying ARs in 1994 made the following deployment more efficient. Lesser time was involved and the techniques of transporting, hauling and deployment, and assembling the unit reef were improved. A year after, prototype ARs are still completely intact and stable.

The people, the local government unit, the concerned agencies handling the project were the social agents that contributed to the success of setting up the ARs.