Artificial reefs

Artificial reefs are established for a range of purposes including fisheries enhancement and management, coastal protection, reef rehabilitation and recreational diving, but can be controversial. Different materials and structures have been used with variable success. This sheet provides an overview of their advantages and disadvantages and indicates under what circumstances they can assist with the management of MCPAs.

An artificial reef (AR) is a structure that is deliberately or accidentally introduced to the seabed and is performing the function of attracting marine life. The creation of man made structures to enhance marine resources is the basis of a specialised branch of marine technology known as 'artificial reef development' and is widely considered as a tool for protecting the natural ecosystem and enhancing fisheries production (also refer to H6 for more on coral reef rehabilitation). An AR provides shelter from predation and surfaces for larvae to settle on; the organisms that are attracted create new food sources and attract other species, thus a matured AR site (3-5 years) may also play a role in increasing biodiversity in and around the AR site. Coastal communities in some countries have traditionally used ARs to increase their catches. They are now established with the involvement of governments, the private sector and NGOs for various reasons, using a diverse range of materials from disused oilrigs, ships, vehicles and railway tracks, to purpose made concrete blocks and bamboo structures. AR construction has different purposes in different countries, for example, in the United States ARs are constructed mainly to improve recreational fisheries; in Japan, to benefit commercial fisheries; and in some European countries, to control inshore trawling and to increase fish production for rural fishing communities.

The purpose of an AR, the ecology of the targeted species, as well as the main chemical and physical parameters, determine how it is installed, the materials to be used, and whether it is an appropriate activity. Some AR may fulfill more than one purpose, but all ARs do not serve all purposes. Although they can be beneficial, there are potential negative effects, including intensification of overfishing and damage to benthic habitat through movement of the structure in storms, which must be evaluated.

ARs are usually installed for the reasons described below.

FISHERIES ENHANCEMENT

The main purpose of AR construction is often focused on the aggregation effect of different fish species attracted to the AR by the provision of shelter and an increased food supply. But despite much research, the role of ARs in fisheries enhancement is controversial. Some studies indicate that production is enhanced, but others suggest that ARs act more as Fish Aggregating Devices (FADs) (see sheet I4), concentrating fish but not increasing overall population. An AR can very quickly display high fish densities and attract heavy fishing, but the surrounding area may experience a reduction in fish populations. ARs thus potentially contribute to overfishing unless carefully managed, in which case it may be appropriate to designate the structure as a no-take area.

Ultimately there may be an overall increase in fish density due to the increase in available habitat, but this could take a long time if fishing pressure is high. Ideally an AR should develop to have similar species diversity and population densities as natural reefs nearby.

In South East Asia, artisanal fishing communities traditionally used natural materials such as bundles of brushwood, boxes of leaves and coconut palm fronds to attract fish. Now ranges of materials, including tyres, are used. The topography and height of the structure are believed to be important in attracting certain fish species.

ARs can also be used to create obstacles for trawlers and other large fishing vessels to prevent them using inshore fishing grounds. However, this should not be necessary in an MCPA and should only be attempted in close consultation with all involved. ARs can, however, reduce pressure on natural reefs by redirecting fishing and tourism elsewhere (see case study).

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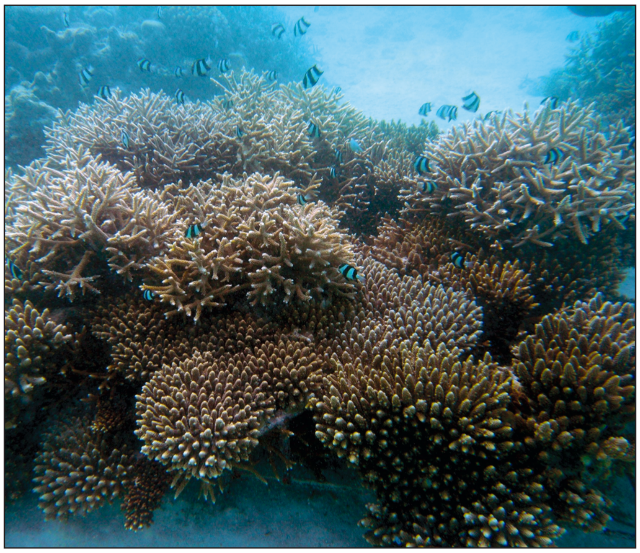
Coral transplants are fixed to a metal frame structure as an artificial reef creation technique in Maldives



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After 3 years the growth of the corals can be seen to be significant

RECREATIONAL DIVING

For dive sites, an interesting structure is important. Preferred materials include various kinds of plastics, perhaps reinforced with fibreglass, concrete and steel, but decommissioned ships are popular because of the aesthetic value of wrecks for divers. Scrap materials however are often less durable than reefs made from new materials. The materials should be stable, non-corrosive or non-polluting and able to withstand extreme weather conditions. Wrecks must be thoroughly cleaned and materials that might result in pollution (e.g. cables, oil, paints and alloys that might contain heavy metals, and anti-biofouling coatings) or that are loose (e.g. plastics, cabling, and oil residue) removed. The vessel is then transported to the site and sunk, which can be expensive. For dive sites, ARs should be placed at the appropriate depth, usually at 20-40m, preferably on a featureless seabed, in order not to disturb the living reef.

When the artificial structure is a dive site, installation and monitoring can be carried out in partnership with dive operators. Monitoring should cover diver usage as well as ecological aspects. Photography can be used for monitoring, and provides an educational tool to demonstrate reef development (see sheet G3).

COASTAL PROTECTION

Specially designed modular ARs can be used as submerged breakwaters to protect coastal areas from erosion. This should only be considered if expert advice is available and conducted in close consultation with all stakeholders (see sheet K1).

REEF REHABILITATION

This may be necessary after impacts such as bleaching, ship groundings, and dynamite fishing and is described in sheet H6.

KEY POINTS FOR THE MCPA

- Before installing any AR, clearly define the purposes for which it is needed. MCPAs with a shortage of interesting, accessible dive sites might benefit, but a careful cost-benefit analysis is needed; if the proposed purpose is fishery enhancement, the potential role of the AR in relation to other fisheries management mechanisms must be considered. Refer to the ICRI guidelines for Artificial Coral Reef Restoration and Rehabilitation for guidance (see Sources of further information).
- An EIA may be a legal requirement (see sheet A6) but if not, a full assessment of the environmental and socioeconomic impact of the proposed AR should be undertaken.
- If coral transplantation is used in AR development, transplants must be taken with care not to negatively impact on donor sites (see sheet H6).
- If the installation of an AR is for recreation, consider partnering with a hotel or dive operator who wants to make their diving sites more interesting for tourists, and is willing to cover the costs, but lacks the scientific expertise. If the purpose is for fishery management or coastal protection, partnership with scientific institutions is essential.
- Consultation with stakeholders is essential from the start to avoid conflict with fishers and other users of the area. Relevant authorities (e.g. port) should be consulted to ensure that there is no conflict with existing or proposed shipping routes.
- The reef sites should be regularly monitored to collect scientific data in order to record any positive or negative impacts, and to clean/remove unwanted materials such as torn nets and other wastes.

CASE STUDY

Artificial Reefs in India

In India, communities have a history of constructing ARs to enhance local fisheries. During the Second World War, a ship was sunk off Anjengo fishing village, 45km north of Trivandrum (Kerala), and lies in 45m of water. The wreck, along with a wartime wreckage from the nearby Indian Space Research Organisation (ISRO) and Vikram Sarabai Space Centre (VSSC), matured into a rich artificial fish habitat that attracted many local hook and line fishermen, who benefited from the enhanced catches in these areas.

The 1960s saw the introduction of new fishing technology such as intensive bottom trawling, which degraded the productivity of local fishing grounds, and had negative impacts on dependant communities. Following this, the concept of Artificial Fish Habitats (AFH) resumed, attracting interest from the government, national and international funding agencies, and non-governmental organisations, which advanced the planning and development of ARs along the Trivandrum coast.

In May 2002, the Suganthi Devadason Marine Research Institute (SDMRI), in collaboration with the Coastal Zone Management Centre and The Netherlands, deployed ARs in the Tuticorin coast of the Gulf of Mannar with support from the local community. The deployment of the triangular ferro-cement AR modules was part of the 'India-Netherlands Water and Coastal Cooperation Programme' for the enhancement and management of biodiversity and socioeconomics of fisher folk. Careful planning using baseline data on the ecological and biological parameters and socioeconomic status of the target population was undertaken in advance, and continuous monitoring was carried out to study the succession of biodiversity. Monthly monitoring included the collection of data on water quality parameters, plankton and productivity, sediment analysis, benthos, fishes and macro invertebrates, and daily fish landings.

The outcomes of the research demonstrated that the ARs were highly efficient in attracting and aggregating biological resources. Fish diversity in AR sites was 90.8% higher than the control site without AR modules. The presence of invertebrates also increased by 87%. When compared with control sites, catch per unit effort analysis proved that there was a high aggregation of fish (70%) and molluscs (65%) in AR sites. The AR modules also served as good substrate for coral larval settlement, featuring both branching and massive corals.

Contact SDMRI (**http://www.sdmri.org/**) for the final progress report of the AR project, 30 pp.

Sources of further information

(See also sheet H6)

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Seaman, W. Jr. (ed.) 2000. Artificial Reef Evaluation with Application to Natural Marine Habitats. CRC Press. 246pp.

In the proceedings of the sixth international conference on Aquatic Habitat Enhancement, 1995, the following papers may be of particular interest:

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Jensen, A & Collins, K. 1995. Artificial reef research in European union: A review. pp. 824 – 829.

Lazarus, S. 1995. Artificial fish habitats in traditional fisheries of southwest coast of India. pp. 732 – 737.

Websites:

Resource page on prefabricated artificial reef units - **www.artificialreefs.org**

Reef Ball: a US-based organisation promoting prefabricated concrete artificial reefs: Reef Ball Foundation Services Division - **www.reefball.com**

Reef Ball Foundation Charity Division, an associated non-profit charity that provides grants - **www.reefball.org**

Practical Action: Technology Challenging Poverty. Website for technical assistance - **www.practicalaction.org**

NOAA Coral Health and Monitoring Programme: Information on artificial reefs - **www.coris.noaa.gov and www.coral.noaa.gov**

ICRI resolution on Artificial Coral Reef Restoration and Rehabilitation - **www.icriforum.org/library/ICRI_resolution_Restoration.pdf**