Artificial reefs are established for a range of purposes including fisheries enhancement, 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 MPAs.

An artificial reef is a structure that is deliberately or accidentally introduced to the seabed and that attracts marine life. It provides shelter from predation and surfaces for larvae to settle on; the organisms that are attracted create new food sources and thus attract other species. Coastal communities in some countries have traditionally used artificial reefs to increase their catches. They are now established with the involvement of governments, the private sector and NGOs for many reasons, using a diverse range of materials from discarded oilrigs, ships, vehicles and railway tracks, to purpose made concrete blocks and bamboo structures; in the US and Japan, artificial reef construction is a major commercial activity.

The purpose of an artificial reef determines how it is installed, the materials to be used, and whether it is an appropriate activity. Some artificial reefs may fulfil more than one purpose, but all artificial reefs 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.

Artificial reefs are usually installed for the following reasons:

**FISHERIES ENHANCEMENT**

Despite much research, the role of artificial reefs in fisheries enhancement is controversial. Some studies indicate that production is enhanced, but others suggest that artificial reefs act more as a Fish Aggregating Devices (FADs) (see sheet I4), concentrating fish but not increasing overall population. An artificial reef can very quickly display high fish densities and attract heavy fishing, but the surrounding area may experience a reduction in fish populations. Artificial reefs thus potentially contribute to overfishing unless carefully managed, and 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 artificial reef should develop to have similar species diversity and population densities as natural reefs nearby.

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

Artificial reefs 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 MPA and should only be attempted in close consultation with all involved. Artificial reefs can, however, reduce pressure on natural reefs by redirecting fishing and tourism elsewhere (see case study).

**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 polluting and able to withstand extreme weather conditions. Wrecks must be thoroughly cleaned and materials that might result in pollution (e.g. cables, 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, artificial reefs should be placed in 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).

The sinking of the *Dania* (above) off the Kenya coast has provided a site for recreational diving and scientific research, and has attracted large shoals of fish (below).
COASTAL PROTECTION
Specially designed modular artificial reefs can be used as submerged breakwaters to protect coastal areas from erosion. This should only be considered if expert advice is available (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 MPA
- Before installing any artificial reef, clearly define the purposes for which it is needed. MPAs 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 artificial reef in relation to other fisheries management mechanisms must be considered.
- An EIA may be a legal requirement (see sheet A6) but if not, a full assessment of the environmental and socio-economic impact of the proposed artificial reef should be undertaken.
- If installing an artificial reef, consider doing so in partnership 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.
- 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.
- A baseline survey of the seabed is required before installation, and the development of the artificial reef should be monitored.

Sources of further information
(see also sheet H6 Coral reef rehabilitation)
www.artificialreefs.org - resource page on prefabricated artificial reef units.
Reef Ball: a US-based organisation promoting prefabricated concrete artificial reefs: www.reefball.com - Reef Ball Foundation Services Division: www.reefball.org - Reef Ball Foundation Charity Division, an associated non-profit charity that provides grants.

NOAA Coral Health and Monitoring Programme:

CASE STUDY
Artificial reefs in Mauritius
Since 1981, fourteen ships have been sunk by the Mauritius Marine Conservation Society (MMCS) in association with relevant authorities such as the Ministries of Fisheries and Environment and the Port Authority. The aim was to create artificial reefs for marine biodiversity conservation, as MMCS was concerned about the lack of MPAs set aside for this. The six Fishing Reserves in Mauritius receive little active management, having been established primarily to protect fish breeding and nursery areas. Pelagic fish were attracted within weeks of the sinking of each vessel, and all now have benthic fish populations and are covered with soft corals and algal growth.

However, the early reefs became a major attraction for fishers and were quickly over-exploited. Subsequently, awareness-raising by MMCS and the demonstrated benefits from the increased diving industry (fishers provide boat services for tourists) has led to an acceptance of their value in many parts of the island, with less fishing (despite no legal protection) and some fishers are involved in their installation. On other parts of the island, fishing communities are opposed to them fearing that they will cause a navigation hazard. Overall, the wrecks are considered to benefit the tourism industry, and have a conservation benefit by reducing diver pressure on natural reefs, enhancing biodiversity, and providing an education opportunity. They have also stimulated awareness of the need for MPAs, and two Marine Parks have been designated, one of which includes an artificial reef.

The location for each artificial reef is carefully selected (usually a bare area so that no damage is done to marine life, and near a natural reef to facilitate recruitment). One of the first lessons learned was the difficulty of ensuring that the ships settle at the chosen spot. The first wreck was sunk with dynamite which caused much damage to its superstructure. Vessels are now sunk more slowly by allowing water into their hulls but this means that they may drift away from the planned site while sinking. One ship sank so slowly that it was lost and not found for 10 years, a mile from the planned location and at 70m depth, beyond the range of normal SCUBA diving. The wrecks also tend to get damaged and moved by cyclones and heavy swells. Costs are reduced by using voluntary assistance from the MMCS, and by using old barges, fishing boats and ships abandoned in the port.