

Global practices in artificial reefs

Shoba Joe Kizhakudan, Joe K Kizhakudan and Remya L.

Global strides in artificial reef R&D and deployment

Historically, it was well understood by the coastal communities and fisher's world over that the rock patches, sunken ships and vessels and submerged coastal dwellings and reefs supported more life in the coastal waters, and they supported good fisheries. The floating tree trunks, leaves, floating islands in flash floods carried huge sheltering populations of fishes and fauna. The traditional fishers of Kerala and Tamil Nadu in India deployed huge palm trees and thick bushy trees with foliage as anchors in the sea bottom with boulders and sandbags which harboured larger predatory fishes and thus improving catch rates and returns.

The first artificial reefs were inadvertently created in the Mediterranean Sea in the 1500s, when rocks used to anchor tuna fishing nets left on the seabed at the end of each fishing season accumulated over time and created new rocky habitats, inhabited by fish which were subsequently exploited by local fishermen between the tuna fishing seasons (Riggio et al., 2000). Similar practices were employed by artisanal fishermen across the world (Simard, 1995). The modern concept of "artificial reef" evolved in Japan in the 20th century after World War II, and was adopted in the Mediterranean Sea in the second half of 1900s.

The Japanese are the world leaders in artificial reef technology for commercial fishery enhancement and have been creating artificial reefs since the 18th century; the materials used are of high quality like concrete, steel and glass-reinforced plastic. In the USA, the artificial reef programs of many maritime states are run for the benefit of recreational sports fishing, (SCUBA) diving, commercial fishing, waste disposal, and environmental mitigation; the materials used are mostly waste, including concrete, rock, construction rubble, scrap tires, cars, railway carriages and ships. Only Japan and the USA have a national development plan. Malaysia and the Philippines use waste tires to build many of their artificial reefs. The central Visayan Islands of the Philippines have been known to use 1600 pyramid bamboo modules. Australian reefs have been built from materials of opportunity such as tires and redundant ships; these reefs are used primarily as a focus for recreational angling, and SCUBA diving. In Taiwan, many fishing vessels (made obsolete by government policy to reduce the size of the fishing fleet) were sunk to provide new habitats. In Europe, artificial reefs were pioneered along the Mediterranean coast in the late 1960's. At present, most reefs are still associated with scientific research. Italy, France, and Spain have been the most active reef-building countries since 1970. Spain is placing more artificial reefs into its coastal waters than other EU countries. In

1991, Italian artificial reef scientists for the first time formed an inter-European reef group to encourage liaison between research groups and other associations of the Mediterranean.

The main purposes of these deployments were to enhance fisheries and improve fisheries management. The increasing interest in artificial reefs has given rise to the organising of the first International Conference on Artificial Reef and Related Aquatic Habitats in Texas, USA in 1974, and subsequently in Brisbane, Australia (1977), California (1983), Florida (1987), California (1991), Tokyo, Japan (1995), San Remo (1999), Mississippi (2005), Curitiba (2009), Turkey (2013), and Malaysia (2017). Several management guidelines have been developed over the last twenty years to support managers and scientists in the placement of artificial reefs in the European seas (OSPAR, 1999; UNEP-MAP, 2005; London Convention and Protocol/UNEP, 2009; OSPAR, 2009). The London Convention 1972, UNCLOS and Basel Convention 1989, Mediterranean Action Plan and the Barcelona Convention 1995 lead to the development of guidelines for the placement of materials at sea other than for mere disposal (construction of artificial reefs) (UNEP-MAP, 2005, 2009). In 2006, the Protocol entered into enforcement. In 2008 specific guidelines for the placement of artificial reefs were within the context of the London Convention and Protocol (London Convention and Protocol/UNEP 2009). No placement of matter in the maritime area for a purpose other than that for which it was originally designed or constructed shall take place without authorisation or regulation by the competent authority of the relevant Contracting Party. OSPAR (O'Sullivan, 2018).

In 2009, FAO General Fisheries Commission for the Mediterranean (GFCM) initiated a debate on the use of artificial reefs in the Mediterranean and Black Seas, especially to enhance and manage fisheries and fishing resources (GFCM, 2010). This issue has been addressed during the annual meetings of the Sub-Committee on the Marine Environment and Ecosystem (SCMEE) that led to an ad hoc workshop in January 2011 (GFCM, 2011, 2012) for developing the guidelines and management practices for artificial reef siting, use, construction, and anchoring in Southeast Florida (Lindberg and Seaman, 2011). These guidelines provide resource users, managers and planners with essential information and guidance on the most effective methods for enhancing and protecting natural resources as well as improving fisheries and aquaculture opportunities.

The objectives of these guidelines were:

- 1) to update the information reported in the previously prepared guidelines;
- 2) to assist the countries in the planning and deployment of artificial reefs based on scientific criteria;
- 3) to avoid pollution or degradation of the aquatic ecosystem due to the deployment of unsuitable materials as well as the dumping of waste;
- 4) to prevent negative impacts due to the deployment of artificial reefs;
- 5) to provide information on the different scopes and types of artificial reefs, as well as on their potential effects;

- 6) to provide technical information on the deployment, monitoring, ongoing management and socio-economic effects of artificial reefs.
- 7) To provide actual biological advantages in biodiversity improvement, recruitment and fisheries
- 8) To extend coastal protection against sea bottom surges and swells
- 9) To provide alternative livelihood options for coastal traditional fishers
- 10) To extend habitat restoration, reproductive refugia, nursery grounds and protected areas under vulnerable or threatened stages.
- 11) To extend impetus to sustainability in fishing and improve fisheries governance.

European Programs in the Mediterranean Sea: The Mediterranean region is one of the world's richest biodiversity spots hosting 7.5% of the world's animal taxa of which nearly 28% of them are endemic. Nearly 150 million people live bordering these coastal regions and areas. Historically, the practice of deploying reefs could be dated back to 3000 years in some of the Mediterranean countries. The more recent European Programs in the Mediterranean Sea in countries like Cyprus, France, Greece, Israel, Italy, Spain, Tunisia, Malta, Monaco, and Turkey introduced over the past 50 years were aimed at promoting small-scale fisheries using gill nets, trammels, and traps (Bombace et al., 2000; Pelini et al., 2008; Gianna Fabi et al., 2011) and to deter illegal trawling in coastal areas and other sensitive habitats. As multiple countries are involved in the area, conflict and resolutions led to the evolution of legal frameworks and protocols in the programs. In Monaco, growing corals was the objective while in Malta it was diving. In France alone, nearly 90,000 m³ of artificial reefs (concrete) have been deployed in 20 sites. Since 2000, ten reefs (concrete) have been developed around the islands of Greece, each covering 8-10 sq.km. Israel deployed reefs basically to promote professional fisheries and recreational activities. Italy has the program developed in over 70 sites with protection, production and a combination purpose to impede trawling as a primary objective. Spain is the leader in the group with over 103 sites completed following "Methodological guidelines for Artificial Reefs Placements" - protection, production and impeding trawling. Tunisia developed programs with the support of the JICA funds for impeding trawling and protecting sea grass beds.

Sustainability of Artisanal fisheries in Portugal in the Gibraltar Strait: The Portuguese Fisheries and Marine Science Lab - IPIMAR deployed artificial reefs in the Southern Portugal-Algarve. Initially, they were deployed for protection in 1990 with tall structures and later production reef modules in smaller sizes were introduced. Nearly 21,500 units in 45 sq.km with an area of influence of 70 sq km. During the 1980's the fishing fleets had drastically reduced by 50% and since the introduction of artificial reefs, traditional fishing and livelihoods were revived. This is perhaps the largest reef deployed in Europe - 8.2 km long and 1.5 km wide. The fish production from the region rose continuously for 15 years.

Mexico -Yucatan Peninsula started artificial reef programs in the seventies with sunken ships and then barrages. Later in Campeche in 1985, modules for fish production were

introduced. The fish production rates increased by 10 folds and the species abundance improved from 23 to 49 species.

The Japanese experience: The initial deployments using stones in 1952 saw improved aggregations and ease of fishing in littoral and intertidal zones. In 1974 the Coastal Fishing Ground Improvement and Development Law was introduced and by 2001 they had covered 20,000 sites of deployments with a variety of objectives, which include protection, conservation, production, seaweeds, nursery, littoral marine species, breeding, aquaculture, upwelling, ranching.

Artificial reefs in Virginia Beach, USA: In a recent turn of events, the Chesapeake Bay Foundation was ordered in July 2022, to remove all artificial reef materials from several sites in the Lynnhaven River in Virginia Beach after the reefs were found with prohibited items, such as asphalt and metal wire, sticking out of the water, when the Virginia Marine Resource Commission found that the materials used were in substantial violation of state code. This incident exemplifies the need for caution in the use of the right materials for reef construction, and the need to ascertain that the artificial reef will not have any negative impacts on the ecosystem it is placed in.



Fig.7. Types of reefs deployed in different countries for different purposes.

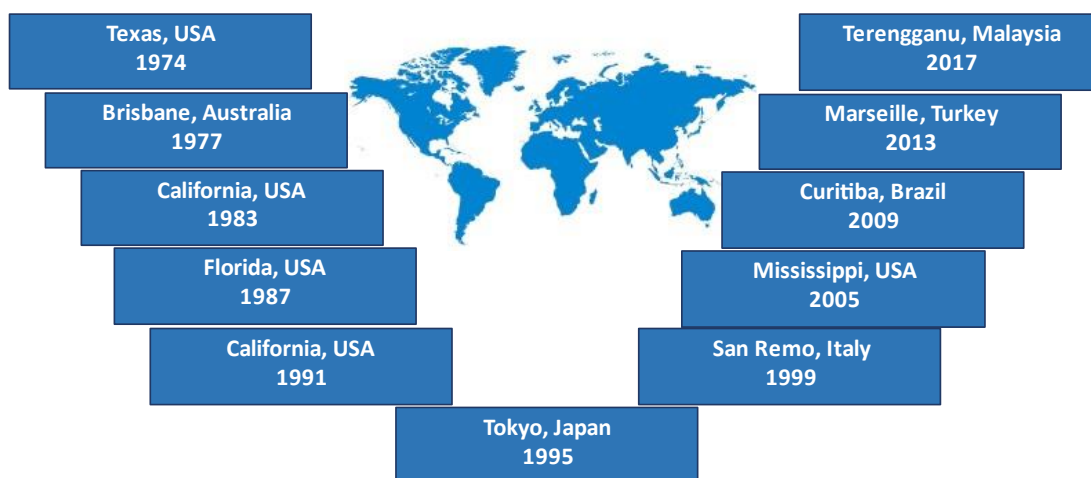


Fig.8. CARAH conferences around the world on Artificial reefs and Related Aquatic Habitats