



Evaluating and Enhancing the Performance of Reefs Constructed from Military Armored Vehicles

Description of Geographic Setting:

This project reviewed 60 constructed reef sites along the coasts of the Atlantic Ocean and the Gulf of Mexico, from New York through Louisiana. Most of the fieldwork was completed off the coasts of Florida, Georgia, and South Carolina. The majority of the reefs were located in shallow water coastal sites, although some were over 90 feet deep. These sites included sand covered hard bottom, sand, and silt-sand substrates.

Abstract:

Constructed reefs have been used for hundreds of years to improve local fishing and diving opportunities. A wide variety of reef construction materials have been used; however, the performance of these reefs is highly variable depending on the materials and sites selected. Since 1994, more than 1,200 military armored vehicles (MAVs) were placed at over 60 reef sites along the Atlantic and Gulf of Mexico coasts, extending from New York to Louisiana. MAV reef performance was evaluated by visual fish censusing and stakeholder surveys. The three types of experimental sites included bare unenhanced bottom (Bare), MAV reefs, and MAV reefs enhanced with Fish Attraction Devices (MAVFAD). MAV reefs dramatically increased target bottom fish abundance compared to nearby unenhanced seabed. Compared to other materials, MAVs generally had significantly greater numbers of key target species, especially snapper and grouper, but these differences were highly variable and depended on the reef materials as well as differential fishing pressure. MAV reefs provided effective habitat for many target recreational species including snapper, grouper, sea bass, hogfish, and sheephead. Most managers found MAV reefs to be effective and stable, and most would like to receive more MAVs under the same type of DoD subsidized program. MAV reefs were generally very popular with fishers and divers.

Partners:

Department of Defense Legacy Resource Management Program; Aquabio, Inc.; state, county, and local groups supported part of the work, including preparation and placement of military armored vehicles; special help with monitoring was provided by Pinellas, Hernando, Pasco, Sarasota, and Bay counties in Florida; and state programs in Georgia, South Carolina, and Delaware. The College of Marine Science, University of South Florida, also provided special assistance.

Service Branch: Defense Logistics Agency

Project Location: Reef sites extended from New York to Louisiana. The bulk of fieldwork was off the coasts of Florida, Georgia, and South Carolina.

Installation Size: N/A

Installation Primary Mission: N/A

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Fish aren't the only life forms that use armor vehicle reefs. The main barrel of a tank provides excellent habitat for the epibenthic community.

Purpose/Need:

During the last ten years, constructed reefs have increasingly been used for habitat mitigation and restoration as well as natural resource conservation. Reefs have been used to compensate for adverse impacts of proposed coastal development, restore habitats damaged because of physical injury or the release of pollutants, or to reduce pressure on natural reefs and create refuges to help conserve fish or shellfish stocks. These applications may prove useful for DoD activities that have either historic or ongoing coastal impacts. For many mitigation, restoration, or conservation projects, prefabricated units designed specifically for marine enhancement have been introduced. Due to inherent design flexibility, this technology can provide greater stability and effectiveness per unit bottom area than most scrap material reefs. However, properly selected, prepared, and configured obsolete DoD materials, such as Military Armored Vehicles or ships, may also be appropriate for these purposes depending on the sites, target species or life stages, and life-cycle cost.

Mitigation—Constructed reefs have been used to mitigate impacts associated with power plant outfalls, port and harbor development, airport construction, highway construction, etc. In some cases, these reefs have been specified as mitigation under the National Environmental Policy Act (NEPA). This mitigation technology may have application in areas where DoD training, operations, ranges, or other activities have unavoidable impacts on coastal natural resources or associated recreational fishing/diving activities. They may also be used as part of mitigation banking programs.

Restoration—Constructed reefs are also being used for restoring habitat damaged due to past physical impacts and chemical or oil contamination. Recently, as part of

- Natural Resource Damage Assessment (NRDA) projects,
- prefabricated reef modules have been used to structurally restore coral reefs injured due to vessel grounding and have been proposed as part of the restoration for NRDA injuries due to contaminated sediments in California and Massachusetts. They have also been proposed for other grounding sites or sites where contaminated bottom sediment impacts the food webs for fish, birds, and marine mammals. As the pace of military littoral operations and training increases, unavoidable vessel grounding and petroleum releases may be more frequent. Constructed reefs are potential tools for restoring injured natural resources.
- Conservation—Constructed reefs can help take the user pressure off natural reefs and thus aid in their conservation. When constructed reefs are integrated with the creation of special management areas that restrict fish take or certain types of gear, they can also assist in the recovery of over fished stocks or threatened or endangered species. At least two of the fish species encountered in this study are considered "at risk" by the American Fisheries Society. The use of special management areas or harvest refuges for conservation management may be especially important to the snapper-grouper reef fish complex identified as target species throughout much of the south Atlantic and Gulf of Mexico coasts. Existing military restricted zones, which are de facto special management areas, may provide some unique opportunities for this type of integrated conservation management. Reef-enhanced restricted or special management areas may provide collateral long-term benefits to fish populations and off-site fisheries that far outweigh direct adverse impacts.



Dr. Dan Sheehy inspecting an M-60 tank turret shortly after placement in the Gulf of Mexico.

Approach:

- MAV reef performance was evaluated by: 1) visual census of fish occupying reef and reference areas, 2) visual assessment and Multibeam survey of reef



Retired Navy ships such as this old aircraft carrier can be sunk in favorable locations to become constructed reefs. Imagine the amount of physical habitat an entire ship will provide!

structural conditions, 3) survey of state, county, and city reef program managers and researchers, and 4) interviews (mail, in-person, or telephone) with selected end users identified through fishing and diving points of contact. These four approaches were designed to assess biological performance, fishery management utility, potential failure modes, and general user responses.

Based on initial surveys, Fish Attraction Devices (FADs) were added to some existing MAVs to determine their potential value in improving fish abundance and forage. The FADs tested were temporary and inexpensive structures used in an attempt to increase the abundance of mid-water fish. MAV units with the FAD enhancements were monitored along with unenhanced units at each test site to evaluate whether or not the enhancements significantly altered fish abundance and/or species composition.

To augment direct field observations, reef program managers and end users were surveyed to obtain their opinions and observations. Managers from all states and all but one Florida county (Dade) responded to a detailed written survey form and provided considerable information about local placement and performance of MAV reefs. End users were interviewed on site, at local boat ramps and docks, and in local fishing and dive shops in areas where field surveys were conducted. End user mail surveys using postcards were also conducted throughout the range of reef placements.

Recommendations/Lessons Learned:

MAV reefs dramatically increased target bottom fish abundance compared to nearby unenhanced seabed. When compared to other scrap materials, MAVs

- generally had significantly greater numbers of key target species, especially snapper and grouper, but these differences were highly variable and depended on the nature and dispersion of the reef materials as well as differential fishing pressure. MAV reefs provided effective habitat for many target recreational species, including snapper, grouper, sea bass, hogfish, and sheepshead. Differences between MAV and Bare bottom and MAVFAD and Bare bottom were highly significant for both bottom and midwater target species. Differences between MAV and MAVFAD were highly significant for midwater species and significant for grouper, but not for total bottom fish.

- Results demonstrate that MAV reefs were stable and effective. Abundance and biomass of target species was significantly greater than nearby featureless bottom, better than most traditional scrap material reefs, and often equivalent to designed and prefabricated reefs. Reefs were exceptionally stable and can be effectively used in high-energy shallow areas not suitable for other types of reef materials.

- The primary performance problems that were observed were mainly due to how the armored vehicles were placed rather than their inherent properties. Their performance as reefs could be enhanced by improving unit spacing and orientation and by securing accurate location data. Future site selection should avoid soft sediment areas and consider high-energy sites where other types of reef materials are not appropriate.

- This project can be duplicated on installations with appropriate obsolete property, such as armored vehicles, ships or boats, aircraft, concrete precast items or structural steel configurations. This could result in opportunities for constructive reuse of material, can assist local natural resource agencies, and promote recreational fishing and diving.



Large goliath grouper (est. 400 lbs) finds habitat under the belly of an M-60 Tank

In most cases it is important to work with local groups and technical experts to select sites and obtain the appropriate permits. Permits should be acquired by and in the name of state or local cooperators. In general, responses to the survey of managers indicated that they found the MAV reefs to be effective and stable, and most would be more than willing to receive more MAVs under the same type of DoD-subsidized program. However, it is clear that the REEF-EX program would not continue without the current government subsidy, which covered materials, preparation, and placement.

It is important to know that not all materials are cost effective and that material preparation and placement procedures are critical to reef construction.

Project Publicity:

Aquabio, Inc. did not directly seek publicity as part of this study. Technical and general presentations were made at conferences to inform the DoD community and as part of efforts to gain local cooperation.

Technical Reports Produced:

None