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Evolution of Marine Artificial Reef Development—A Philosophical Review of Management Strategies

RICHARD CHRISTIAN, FRANK STEIMLE, AND RICHARD STONE

Artificial reefs are a common fishery and aquatic habitat management tool, used in all U.S. coastal states and elsewhere worldwide. Although support for their use is strong among managers and resource users, there is still inadequate scientific information available on their performance in meeting program goals; performance and ecological function information is also weak on many types of natural reefs and fishery-valuable shipwrecks. The wise and responsible use of artificial reefs or habitats by habitat or fishery managers depends on knowing how well they are meeting application objectives; these objectives can be singular or multiple and can involve compliance with laws and regulations. Noncompliance monitoring provides good feedback information to managers and artificial reef designers and planners for continued support and improvement of their efforts. Artificial reef development in the U.S.A. has perhaps reached a state in which an equal effort is needed for construction and for monitoring, assessment, and program fine-tuning for optimum beneficial results. Support for this shift in emphasis can be found in the fact that the continued expansion of artificial reef development has not stopped the decline of many reef fishery resources, such as black sea bass, groupers, snappers, and tautog, or caused many user conflicts. If the artificial reefs and habitats are not completely meeting program expectations, then managers will want to know this and what might be the causes of the shortfall. This paper discusses how monitoring is an essential part of any artificial reef program, just as it is a part of most other fishery and natural resource management efforts, and that there are a range of artificial reef habitat or reef fishery variables that can or should be monitored that provide critical performance information for aquatic resource managers.

The earliest artificial reef structures placed in marine waters were developed without management concerns in mind. This development was a response by fishermen to declines in fishing success in previously productive fishing areas. This was the case in the late 1700s and early 1800s off the coast of Awaji Island, south of Kobe, Japan, when Japanese fishermen made large wooden frames, added bamboo and wooden sticks, and sunk them with sandbags in 20 fathoms of water to replace a sunken ship that had provided productive fishing until it deteriorated (Ino, 1974). Similar responses occurred in the U.S.A., where the earliest documented example seems to be the use of logs in the 1830s to construct wooden shelters that were floated to the desired locations and weighted down with rocks or other heavy material. These structures were used to replace trees that had fallen into coastal South Carolina waters and had been productive fishing grounds for sheepshead (*Archosargus probatocephalus*) until the trees decomposed (Stone, 1974).

While Japanese artificial-reef-building efforts have had some government involvement since

about 1930 (Ino, 1974), it was not until the mid- to late 1950s that Alabama, Hawaii, California, Texas, and several other states started planning and supervising artificial reef construction and research activities in the U.S.A. The U.S. government's marine fisheries research agency began efforts on artificial reef research and management in 1966 (Stone, 1985a). These early state and federal efforts were the first attempts in the U.S.A. to manage artificial reef development (having specific objectives and allocating some staff and fiscal resources to accomplish the objective). Waste materials were often used, as they could be obtained at low cost at a time when there was very little state or federal funding for reef construction or research. California tested materials such as quarry rock and concrete shelters beginning in 1960 (Carlisle et al., 1964). Subsequent limited state and federal studies showed that many of the scrap materials used initially were physically unsuitable for the marine environment. Researchers, managers, and environmentalists were also sensitive to the potential for these materials to contaminate the marine environment; studies were initiated to test

for leaching of toxic substances from such reef materials.

From research efforts in the 1960s through the 1980s, useful information on both the biological and physical aspects of artificial reefs and artificial reef material became available. Researchers and managers quickly recognized the need to communicate and exchange information with others in the field regarding the complex questions concerning the use of artificial reefs to enhance fishery resources or fishing activities. Numerous local or regional workshops addressed these issues; leading to six consecutive international artificial habitat meetings. The first of these was held in Houston, TX, in 1974.

The late 1970s and early 1980s was a period of growing interest in artificial reef development and management to enhance fisheries and fish habitat. There was also a growing concern about ocean dumping; an artificial reef should be used to maximize fishery and natural-resource benefits and as a guise for ocean dumping. The realization of the enthusiasm and concern over these important issues resulted in Congressional hearings in 1981 and 1983 leading to the National Fishing Enhancement Act (Act) of 1984. This Act called for the Secretary of Commerce to develop and publish a long-term National Artificial Reef Plan (Plan) to promote and facilitate responsible and effective artificial reef use based on the best scientific information available. The Plan was developed with input from federal and state agencies, the Interstate Marine Fisheries Commissions, the Regional Fishery Management Councils, state, federal, and private artificial reef authorities, and the general public. More than 50 individuals worked on the Plan and it was published in 1985 (Stone, 1985b). It provided useful guidance on all phases of artificial reef development based on the best available scientific information and promoted site-specific state artificial reef plans. One of the more important things that came out of this effort, the recognition of the need to clearly define the purpose of the reef, acknowledged that artificial reef activities had moved into an era in which management strategies should be developed before the reefs were put into place. No longer was an attempt to improve angler catch-per-unit-effort the only management option considered. Artificial reefs had new management goals, such as to improve recruitment, juvenile survival, and growth of reef associated species and to serve as marine sanctuaries. Since publication of the Plan, about one-half of the coastal states have

developed state site-specific marine artificial reef plans.

Coincident with passage of the Act, the Wallop-Breaux Amendment (contained in the Deficit Reduction Act: PL 98-369) to the Federal Aid in Sport Fishing Act of 1950 (the Dingell-Johnson Act, a.k.a. D-J) became law in 1984. This amendment significantly expanded the amount of federal aid money states receive to assist in development of sport fish restoration projects. A key provision of the Wallop-Breaux Amendment was that new money collected was to be dedicated to new projects and split equitably between fresh- and saltwater projects within the state agencies. This provision led to dramatic increases in funds available for construction of artificial reefs. Since development of the Plan, Wallop-Breaux funding has provided and continues to provide the financial support for nearly all of the marine artificial reef development in the U.S.A. under the auspices of state and interstate programs. In addition, this funding source has facilitated the establishment of technical advisory committees of the Gulf and Atlantic States Marine Fisheries Commissions. These committees function to coordinate reef development activities in the Gulf of Mexico and the Atlantic Ocean within state and federal waters. Managers of the state marine artificial reef programs participate in joint meetings of the committees to exchange ideas and experiences and coordinate development of coastwide policies. Through communication with the Pacific States Marine Fisheries Commission on related activities, these groups provide the basis for a national approach to effective management of marine artificial reef development. In this manner, the coastal states have assumed the responsibility of implementing specific provisions of the National Fishing Enhancement Act.

Even with the federal and state plans in place and a more managed approach to artificial reef development through the states and the commissions, there has been a stigma carried over in some people's minds concerning the use of materials of opportunity and the fear of ocean dumping associated with artificial reef sites. Artificial reef managers are well aware of this. Consequently, artificial reef programs have evolved in the last 2 decades or so to be extremely sensitive to the use of materials that might have any detrimental environmental effects and have developed monitoring programs to track reef effectiveness. The California Department of Fish and Game has had a particularly effective monitoring program in place since about 1960 (Wilson et al., 1990).

Monitoring programs have been established along the Atlantic coast and in the Gulf of Mexico as well. Currently, programs in Florida, Georgia, Louisiana, New Jersey, North Carolina, and South Carolina focus on biological and physical performances of various materials, structures, and placements. Experiments on sanctuary reefs are underway in at least two of these states. Other states, universities, and federal agencies have also conducted effective monitoring, although the monitoring has not always been as long-term or as thorough as desired because of the lack of adequate funding. Researchers, however, continue to monitor biological and physical conditions on artificial reefs in many areas, and the results of these studies have been passed on in numerous publications (e.g., several issues of the *Bulletin of Marine Science*, books, and *Fisheries*) and at local, regional, and national workshops to help managers make their programs more effective. The Atlantic and Gulf States Marine Fishery Commissions have had artificial reef committees for more than 10 yr that have addressed environmental concerns thoroughly. They have worked closely with the Environmental Protection Agency and others to define toxic/hazardous substances that might occur on present or potential artificial reef materials and to develop protocols for removing potential hazards or to disallow the use of certain materials of opportunity. The two commissions have developed specific guidelines on types of materials that are acceptable (Lukens, 1997) and have queried artificial reef researchers and managers for additional information and research needs (Steimle and Figley, 1990). Federal and state programs and policies decry the building of artificial reefs with the intent of waste disposal and seek to prevent the use of environmentally hazardous materials on artificial reef sites.

There continue to be problem areas and issues that need more attention. For example, inadequate monitoring of materials used by private contractors or fishermen to construct reefs could result in the use of inappropriate materials. However, continuing experiments and monitoring by state artificial reef managers and federal, state, and university scientists have definitely resulted in better managed programs from the standpoint of the more effective use of materials designed to meet program objectives. Gear and user conflicts have also caused problems in managing stocks and user groups frequenting the limited space on and around artificial reefs. One method employed by two of the regional fishery management

councils [responsible for management of fisheries resources in the Federal Exclusive Economic Zone (EEZ)] has been designation of Special Management Zones (SMZs) in pertinent fishery management plans (FMPs). The South Atlantic and Gulf Fishery Management Councils have developed and incorporated such language in their snapper-grouper and reef fish FMPs, respectively. The SMZ designation establishes a mechanism for user groups to participate with the councils in the development of restrictions on certain gear types used on artificial reefs in the EEZ. As a result, the use of SMZs by the state of South Carolina has become routine. When the state applies for a permit from the Army Corps of Engineers to build a reef, they simultaneously apply to the South Atlantic Council for SMZ status on the proposed site. Many artificial reef managers believe this SMZ protocol provides a necessary framework for effective management of species associated with artificial reefs. For this reason, the Atlantic States Commission's Artificial Reef Committee requested that similar language be included in the FMP for black sea bass. Acting on this request, the commission and the Mid-Atlantic Fishery Management Council have included this protocol in their respective plans for black sea bass.

There are still many questions that require further study, and many states have not always been able to sustain assessment and monitoring activities because of a lack of adequate funding. Available funding has been used to construct reefs with secondary-use materials with the experience and knowledge of state reef programs and limited university and federally funded research. Programs operating under such "shoestring" budgets often rekindle old fears and stigmas associated with artificial reef construction. However, artificial reef development in the U.S.A. is not a veiled waste disposal program, and it is not an effort to attract and harvest the last reef fish. It is not pursued in ignorance. Current artificial reef development in the U.S.A. is a well-managed function, for the most part, with specific artificial reef programs under state purview. The state program managers take their responsibility very seriously and view these efforts as a means to assist state and federal fishery managers in providing sustained and enhanced fishing opportunities for the public and to enhance resource habitat when possible. The programs have evolved from ones that initially used available recycled materials to a much more sophisticated approach that uses mainly specifically tested and designed materials, in-

cluding prefabricated units and limited materials of opportunity such as concrete rubble, ships, and obsolete gas and oil structures. All of the state artificial reef program managers use the latest biological information available on the habitat needs of target species to plan for the design and deployment of the units. Also, in their state site-specific plans or databases, they use socioeconomic, geologic, and oceanographic data to select sites that will meet resource user demands and accommodate materials for the long term.

Two states, Louisiana and Texas, have effective artificial reef programs that use obsolete gas and oil structures almost exclusively. Their state artificial reef plans reflect this (Wilson et al., 1987; Stephan et al., 1990). They have found these structures to be stable, durable, and compatible with the marine environment, and thousands of these structures in the Gulf of Mexico are readily available (Kasprzak, pers. comm.). Another advantage of the rigs-to-reefs program is that the funding used by these states to pay for management of the program and monitoring and maintenance of the reef sites comes from cost savings to the gas and oil companies. Upon removal of the structure once it becomes obsolete, part of the saving in donation to the state instead of onshore scraping is passed on to the state artificial reef program. The funding aspects of these programs are particularly important, because funding allows scientists opportunities for long-term studies on reefs deployed for resource management on structures that have been in place long enough to develop climax communities. These sites can provide long-term performance and temporal variability estimates, including reef-user effects. Such information is needed to improve the way artificial reefs are used and our understanding of how they can function as part of living marine/estuarine resource management.

In conclusion, we believe that the quest for knowledge about how artificial habitats function over time and under extremes of use and exposure to oceanographic conditions must continue. Long-term monitoring and a stable source of program funding is essential for improved management. There are new technologies becoming available now that may cut costs for monitoring and help to improve the physical, biological, and socioeconomic databases, as well as to improve efficacy of artificial reefs as a fishery and habitat management tool and their ability to enhance essential fish habitat for certain stressed fish populations.

Marine artificial reef construction and man-

agement in the U.S.A. have been driven by three critical elements: the lack of adequate reef fish habitat to accommodate growing fishing pressure (the most important factor); availability of suitable, affordable materials; and availability of a steady funding source for research, development, and management. Due in part to the limited funding for development of artificial reefs, the priority for most of these efforts has been heavily biased toward enhancing fishing opportunities for recreational fishermen who have been willing to put up or obtain funds to support these efforts. The full potential for application of artificial reefs to a variety of fishery management and habitat enhancement issues has not been achieved yet. The use of artificial reefs as fishing reserves may be one way to achieve more of that potential in the near future.

The coincidence of passage of the National Fishing Enhancement Act and that of the Wallop-Breaux Amendment established a new era in artificial reef development. These pieces of legislation have encouraged development of a cooperative national program among the coastal states, the National Marine Fisheries Service, and the Fish and Wildlife Service, with the coastal states and the interstate commissions now taking the lead. The developing policy on essential fish habitat as a new mandate of the Magnuson-Stevens Act may serve to enhance the role of artificial reefs in future fishery management actions.

State artificial reef programs have evolved more quickly in the last 10 yr through the coordinative bodies of the interstate commissions. States from Texas to Rhode Island currently have active reef programs and participate as members in the Artificial Reef Technical Committees of the Gulf and Atlantic Commissions. Working through the commissions' technical committees, the states have coordinated activities and learned from their shared experiences. California and Washington have had excellent programs that operate independent of the Pacific Commission.

The hands-on experience of the states and the marine fishery commissions over the past decade have served to provide much useful information to the state and federal agencies responsible for the National Plan mandate. It is important for the commissions to assist the states in bringing this information forward, to continue to meet the legislative mandate, and to develop the full potential of artificial reefs as fishery management and habitat enhancement tools as envisioned by those who drafted the original Plan.

Artificial reef research and management have come a long way since we first started doing research in this field more than 30 yr ago. We think that with the continued interest of federal, state, university, and other researchers in seeking answers about the processes that occur on artificial reefs in the marine environment, as this additional information becomes available to artificial reef program managers, the use of this fishery and habitat management tool will be more effective in helping to positively resolve complex fishery resource management issues. In addition, there should be better integration of habitat enhancement with effective resource management for sustained healthy populations and use of the resources by fishery interests.

LITERATURE CITED

- CARLISLE, J. G., JR., C. H. TURNER, AND E. E. EBERT. 1964. Artificial habitat in the marine environment. Calif. Dept. Fish and Game, Fish Bull. 124:1-93.
- INO, T. 1974. Historical review of artificial reef activities in Japan, p. 21-23. *In*: Proc. Art. Reef Conf., Texas A&M Univ., TAMU-SG-74-103. L. Colunga and R. Stone (eds.).
- LUKENS, R. (coordinator). 1997. Guidelines for marine artificial reef materials. GSMFC Report 38, Ocean Springs, MS.
- STEIMLE, F., AND W. FIGLEY. 1990. A review of artificial reef research needs. ASMFC Rec. Fish. Rept. 7, Washington, D. C.
- STEPHAN, D., B. G. DANSBY, H. R. OSBURN, G. C. MATLOCK, R. K. RIECHERS, AND R. RAYBURN. 1990. Texas artificial reef fishery management plan. Fishery Management Plan Series, Number 3, Texas Parks and Wildlife Department, Coastal Fisheries Branch, Austin, TX.
- STONE, R. B. 1974. A brief history of artificial reef activities in the United States, p. 24-27. *In*: Proc. Art. Reef Conf., Texas A&M Univ. TAMU-SG-74-103. L. Colunga and R. Stone (eds.).
- . 1985a. History of artificial reef use in the U.S., p. 34-41. *In*: Artificial reefs, marine and freshwater applications. F. D'Itri (ed). Lewis, Chelsea, MI.
- (compiler). 1985b. National artificial reef plan. NOAA Tech. Mem. NMFS OF-6, Silver Spring, MD.
- WILSON, C. A., V. R. VAN SICKLE, AND D. POPE. 1987. LA artificial reef plan. Louisiana Dept. of Wildlife and Fisheries Tech. Bull. 41.
- WILSON, K. C., R. D. LEWIS, AND H. A. TOGSTAD. 1990. Artificial reef plan for sport fish enhancement. Calif. Dept. Fish and Game, Admin. Rpt. No. 90-15.
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