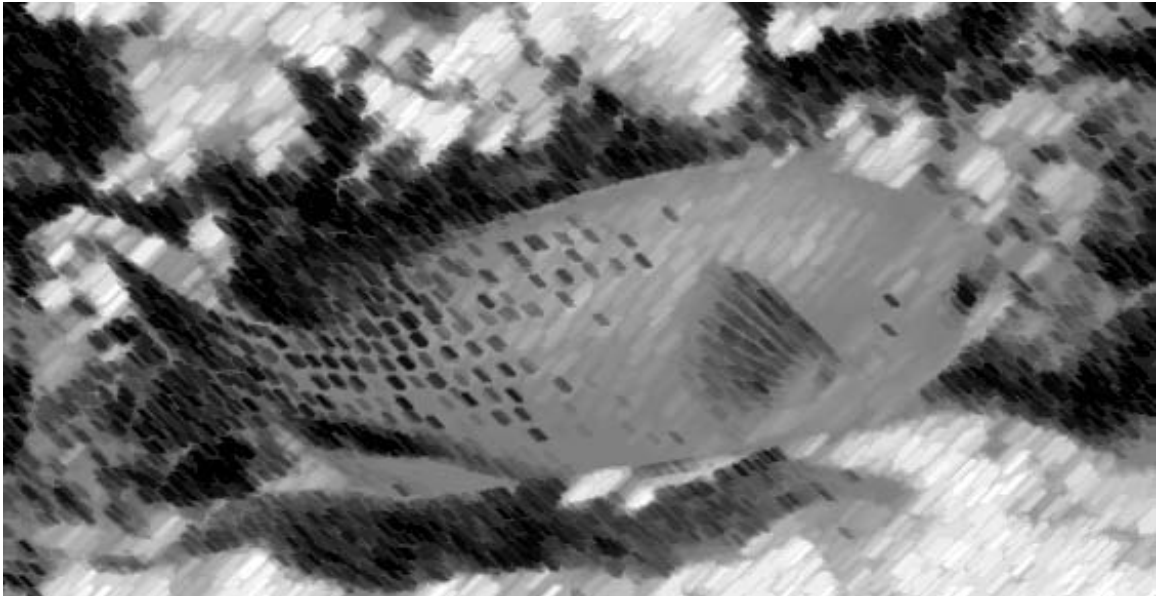


**National Artificial Reef Plan**  
**(as Amended):**  
**Guidelines for Siting, Construction,**  
**Development, and Assessment of**  
**Artificial Reefs**



**United States Department of Commerce**  
**National Oceanic and Atmospheric Administration**  
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## ACKNOWLEDGMENTS

While the National Artificial Reef Plan of 1985 (Plan) was compiled by a small team of devoted National Marine Fisheries Service scientists, namely Richard Stone, Ron Schmied, and Frank Steimle, the revision of the Plan has been a formidable effort, incorporating the combined knowledge of literally dozens of scientists, program managers and users from the federal, state, local, and private sectors. Though the Plan forms the genesis, this revision has grown out of a series of workshops and meetings which were sponsored by the Atlantic States (ASMFC) and Gulf States Marine Fisheries Commissions (GSMFC) with funding support from the National Marine Fisheries Service's Office of Intergovernmental and Recreational Fisheries. The workshops were developed to meet an expressed priority need on the part of artificial reef program managers for updated information. While this was a drafting effort to which many people contributed, Jessie Thomas of the ASMFC, Richard Christian, formerly of the ASMFC and currently with the U.S. Fish and Wildlife Service, Ron Lukens and Nancy Marcellus of the GSMFC, members of the respective Artificial Reef Technical Committees, and the National Marine Fisheries Service Artificial Reef Team provided invaluable assistance in this endeavor. Sincere gratitude is given to the three interstate marine fisheries commissions and their member states for working cooperatively with the National Marine Fisheries Service to revise the National Artificial Reef Plan. Bill Price, Virginia Fay, and Michael Bailey of the National Marine Fisheries Service contributed considerably to the initial revision of this document. Finally, thanks are given to the many contributors to the document, represented by many hours of research and writing.

## PREFACE

The original National Artificial Reef Plan (Plan) was published in 1985. On page 1 of that document, in the Introduction, the last sentence of the first paragraph states, “The Plan is intended as a dynamic, working document that will change as new information becomes available.” By letter to the National Marine Fisheries Service (NMFS) in the spring of 1996, the three interstate marine fisheries commissions requested that the NMFS authorize them to engage in revising the Plan. In December 1996, NMFS responded, providing the commissions the authority to develop draft recommendations for full plan revision. The commissions conducted a number of meetings which involved representatives from nearly every state artificial reef program, staff members from the three commissions, staff of the Minerals Management Service, and NMFS staff. During the course of this extensive series of meetings draft language was formulated and compiled into the document “Coastal Artificial Reef Planning Guide” which was then jointly published by the three commissions in December 1998, and submitted to NMFS as the basis for revision of the Plan.

The rationale for the interstate marine fisheries commissions to assume a lead role in revising the Plan was that state artificial reef management programs, which typically interact through the interstate marine fisheries commissions, have been the most visible in artificial reef development, and, therefore, their programs are more integrally tied to the guidance provided in the Plan. It was in the spirit of regional and national cooperation and coordination of activities that the state artificial reef programs worked in conjunction with the National Oceanic and Atmospheric Administration (NOAA) to apply their knowledge and experience in revising the Plan.

## EXECUTIVE SUMMARY

The National Artificial Reef Plan (Plan) (NOAA Technical Memorandum, NMFS OF-6, 1985) is not meant to be a textbook or a policy manual, but rather a guide for artificial reef program managers and policy makers regarding how to access and understand the many facets of artificial reef development and use. The Plan was developed by the Secretary of Commerce under direction of the National Fishing Enhancement Act of 1984 (Act). The Plan was designed to be a dynamic working document that would be updated as new information became available. Prior to 1984, many coastal states had well-developed programs directed at enhancing fisheries and fish habitat with artificial reef structures. Following approval of the Plan in 1985, these states were joined with others in implementing its recommendations. Many have pursued aggressive construction programs under guidance of the Plan and according to specific requirements in the Act. In addition, some state agencies have been less active in constructing reefs, but rather have made financial and technical resources available to local governments, private interests, and universities to encourage responsible reef development and research.

Approximately half of the coastal state natural resources agencies in the United States have approved plans for construction of artificial fish habitats based on the guidance of the Plan. In developing these plans and implementing individual state programs, these agencies have taken advantage of the coordination function for their respective interstate marine fisheries commissions to share experiences and technologies. The interstate commissions have served to assist coordination of information exchange and development of coastal and national policies for responsible stewardship of the fisheries affected by artificial reef development activities.

The Act designates the Secretaries of Commerce and the Army with lead responsibilities to encourage, regulate, and monitor development of artificial reefs in the navigable waters and waters overlying the outer continental shelf of the United States. The Secretary of Commerce is responsible for the Plan, which provides guidance on reef development. Under the Act, the Secretary of the Army, when issuing a permit for artificial reefs, shall consult with and consider the views of appropriate local, state, and federal agencies and other interested parties; ensure that the provisions for siting, constructing, monitoring, and managing artificial reefs are consistent with established criteria and standards; and ensure that the title to the artificial reef construction material is unambiguous and that responsibility for maintenance and the financial ability to assume liability is clearly established. The coastal states have aggressively pursued implementation of the Act under the Army Corps of Engineers (Corps) regulatory oversight. The natural resource agencies in two-thirds of the coastal United States hold more than 90 percent of the permits for artificial reef structures. The Corps is a highly decentralized agency that has delegated to its district offices, the authority provided by Federal law for administering the regulatory program. The Act establishes the procedures to be followed by the Corps in issuing permits for artificial reefs. Given the discretion allowed by law, there is no inherent assurance that only responsible reef development will be permitted. Responsible state agencies have assisted the Corps and other affected agencies in keeping irresponsible activities to a minimum and preserving long-term benefits to associated fisheries and marine habitat.

This document follows the format of the 1985 Plan incorporating changes to original text in key areas. A few significant deviations from the format of the Plan of 1985 are contained in this report. The most significant occurs in the section dealing with materials. Materials used to construct artificial reefs are under continuous examination and evaluation by reef developers and environmental regulators. This is especially true for those materials that were originally intended for another purpose. These materials are referred to throughout as “secondary use” materials. This document changes prior nomenclature for such materials previously referred to as “materials of opportunity.” Currently, no federal agency provides any form of certification of material against established environmental standards. This document does not explore this issue in detail. Executive agencies will interpret and clarify such roles under existing statutes. Therefore, relevant statutes are cited in applicable sections.

Several critical issues of national importance provide the focus for much of the debate regarding artificial reef activities. These include the permit programs of the Corps, materials criteria, liability, research and evaluation, site location, and the roles of affected federal agencies and the regional fishery management councils. Fishery management councils (FMCs) established under the Magnuson-Stevens Fishery Conservation and Management Act have additional responsibilities not addressed herein that may result from their role in conserving essential fish habitat.

One of the main areas of emphasis was to include language to reiterate the importance of artificial reefs as a fisheries management tool. The basic precept to employ reefs as management tools is for state natural resource agencies to be involved in all artificial reef construction in their waters, and also be consulted on artificial reef development in adjacent federal waters. Such governmental fisheries management agencies can demonstrate long-term commitment and responsibility to the resource and resource users. These agencies are critical to establishing and maintaining compatibility with fishery management objectives for affected species. The states also can demonstrate an ability to assume liability for the projected life of the structure not just for the duration of the permit.

There has been growing interest in the use of artificial reefs in mitigation projects. Although some mitigation projects have successfully incorporated artificial reef structures into project objectives, caution should be exercised in such instances. There is no general acceptance of the utility or effectiveness of artificial structures in mitigation projects.

Establishment of baseline evaluation and monitoring programs remains an issue. Recommendations for evaluation and monitoring should include assessments of physical attributes of the reef structure as well as biological attributes of species assemblages by life history stage, among others. Such assessments should be measured against the objectives established for building the reef and may require that such objectives be included in permits.



## INTRODUCTION

The National Fishing Enhancement Act (Act) of 1984 (33 U.S.C. §2101 et seq.) directs the Secretary of Commerce to develop and publish a long-term National Artificial Reef Plan (Plan) (NOAA Technical Memorandum, NMFS OF-6, 1985) to promote and facilitate responsible and effective artificial reef use based on the best scientific information available. As defined in Section 206 of the Act, the term “artificial reef” refers to “. . . a structure which is constructed or placed in waters covered under this title for the purpose of enhancing fishery resources and commercial and recreational fishing opportunities.” The term “waters” covered under this chapter is defined as “. . . the navigable waters of the United States and the waters superjacent to the outer continental shelf as defined in Section 2 of the Outer Continental Shelf Lands Act . . . to the extent such waters exist in or are adjacent to any State.”

The Plan that was implemented in 1985 provided guidance on various aspects of artificial reef use, including types of construction materials and planning, siting, designing, and managing of artificial reefs. It included a review of information sources and discussed research needs that had been identified at that time. Other issues, such as liability and mitigation, also were introduced. These issues were to be addressed in more detail by groups of knowledgeable individuals from the federal, state, local, university, and private sectors. As such, the Plan is intended to serve as a dynamic, working document to be revised and updated periodically.

This revision of the Plan incorporates new language developed from input received from relevant federal and state agencies, the interstate marine fisheries commissions (IMFCs), regional fishery management councils (FMCs), recreational and commercial fishing interests, and the general public. Much of the original text and format has been maintained where appropriate and pertinent to current issues, as well as to the current state of marine artificial reef development, management, and regulation in the United States. While this revision provides general guidelines for artificial reef development, states that have not already done so are strongly encouraged to develop specific protocols or guidelines for the use of artificial reefs in their locations.

The 1985 document was general in scope and provided a framework for regional, state, and local planners to develop more detailed, site-specific artificial reef plans sensitive to highly variable local needs and conditions. Coastal states have used the Plan to develop state-specific plans under the cooperative leadership of state agencies and IMFCs that are responsible for fisheries management and development. Those plans focus on specific criteria for reef development and management in their geographic areas.

Increasing demands on fish stocks by both commercial and recreational fishermen and losses of benthic habitat due to development, fishing pressure, and pollution, have had substantial effects on many reef-associated fish species. Properly constructed, and strategically sited artificial reefs can enhance fish habitat, provide more access to quality fishing grounds, benefit fishermen and the economies of shore communities, increase total fish biomass within a given area, and provide managers with another option for the conservation and management of fishery resources.

Artificial reefs have been used for centuries to enhance fishery resources and fishing

opportunities. However, the United States has not systematically developed the potential of this fishery management technique for fishery resource and habitat enhancement. Since development of the Plan in 1985, most efforts in the United States have been focused on enhancing access to fishery resources. Prior to 1985, reef development projects used natural or scrap materials almost exclusively because of the relatively low cost and availability. With increased funding assistance through expansion of the U.S. Fish and Wildlife Service Federal Aid in Sport Fish Restoration Program, and with increased support from state resource management agencies, most coastal states have been able to plan and execute more effective marine artificial reef development activities. Many coastal states now are taking advantage of more advanced technologies and methodologies to design materials and structures for specific fisheries management objectives.

Since adoption of the Plan in 1985, the majority of marine artificial reef development has come under the auspices of individual state programs. During this time, many states and the U.S. Army Corps of Engineers (Corps) have established effective local working relationships resulting in better implementation of the provisions of the Act under the guidance of the Plan. In this regard, the Plan has functioned well and generally has been deemed a success. However, growing concerns over the adequacy of the Plan to meet the increased demands being placed on reef developers and fisheries managers mandates revisions based on current information. Development of marine artificial reefs outside of approved state programs or plans, or other approved governmental programs, or without the supervision of experienced state developers or state and federal fishery managers, still poses a concern. Of particular concern are reef deployments in or adjacent to waters that are not covered by an approved state-specific artificial reef management plan or other approved governmental program, or where inadequately staffed and/or trained state or local coastal governments manage reef programs. Improperly located reefs, built out of inappropriate materials or built under inadequately reviewed permits, can pose long-term problems. These are critical factors, which continually need to be revisited in the Plan to clarify the roles for proper state and federal involvement in this national activity and to assure optimal use for artificial reefs in the United States.

Although artificial reefs can enhance recreational and commercial fishing opportunities, creating a successful reef entails more than placing miscellaneous materials in ocean, estuarine, or other aquatic environments. Planning, long-term monitoring, and evaluation are necessary in each project to ensure that the anticipated benefits are derived from artificial reefs. Improperly planned, constructed, or managed reefs may be ineffective, may cause conflict among competing user groups at the reef site, may increase the potential to overharvest targeted species, or may damage natural habitats. In such cases the benefits from the planned objectives of these structures may be negated. The disposal of materials in the marine environment without the proper permits may be detrimental to living marine resources. Such activities are illegal and prohibited under the Marine Protection, Research, and Sanctuaries Act (codified as 33 U.S.C. §§1401-1445, 16 U.S.C. §§1431-1447f, 33 U.S.C. §§2801-2805).

The Plan provides guidance emphasizing the use of the most recent and best information available. It is intended to address the needs of a wide variety of users, including reef regulators, fishery and environmental managers, prospective donors of reef material, government officials, and the general public. The Plan both addresses criteria specified in Section 204 of the Act, and unspecified criteria considered important by the working groups

providing input to this Plan. The consideration and use of these guidelines and criteria will assist reef developers, managers, and regulators in focusing their activities on effective artificial reef programs and performance monitoring. It establishes standard terminology to improve communication between parties interested in reefs, and assists in developing more uniform permitting procedures and clear guidance on materials acceptable for construction of marine artificial reefs.

Artificial reef development and management protocols and guidelines contained in the Plan are designed to enhance the use of artificial reefs as fishery management tools. In this regard, artificial reefs should, at a minimum, cause no harm to existing living marine resources and habitats. Optimally, artificial reefs should be developed such that aquatic resources and habitats are enhanced. Decision makers must be cautious when attempting to enhance existing habitats, however, as adding to an existing habitat may alter the ecosystem by changing the biology, population dynamics, distribution, or species composition. The ecological benefit of placing artificial structures within or near a functional hard bottom or sea grass community is sometimes questionable, although there may be instances where ecological benefits could be realized by such placement. Areas of bare substrate and sand scattered throughout hard bottom communities are a natural phenomenon that contribute primary productivity to adjacent habitats. Objectives of the artificial reef project should match or compliment objectives of state, interstate, and federal fisheries management plans (FMPs) for affected species, and be compatible with other management tools contained in such FMPs (e.g., gear restrictions and area closures).

Again, the Plan is intended to serve as a dynamic, working document to be revised and updated periodically. It is critical that the Plan be revisited periodically so that the Plan remains relevant and useful in the future, and future revisions can address developments in technology, relevant scientific research, and any changes in living marine resource management policy.

## **NATIONAL STANDARDS FOR ARTIFICIAL REEF PROGRAMS**

The purpose of the National Fishing Enhancement Act is to promote and facilitate responsible and effective efforts to establish artificial reefs in the navigable waters of the United States and waters superjacent to the outer continental shelf (as defined in 43 USC, Section 1331) to the extent such waters exist in or are adjacent to any state. Section 203 of the Act establishes the following standards for artificial reef development. Based on the best scientific information available, artificial reefs in waters covered under the Act "... shall be sited and constructed, and subsequently monitored and managed in a manner which will:

- 1) enhance fishery resources to the maximum extent practicable;
- 2) facilitate access and use by US recreational and commercial fishermen;
- 3) minimize conflicts among competing uses of waters covered under this title and the resources in such waters;
- 4) minimize environmental risks and risks to personal health and property; and
- 5) be consistent with generally accepted principles of international law and shall not create any unreasonable obstruction to navigation."

## **ROLES**

The roles of all parties involved in artificial reef development, management, and regulation outlined in the original Plan have evolved significantly since 1985. The Corps has formalized their involvement through regulations promulgated pursuant to the Act (see Regulatory Requirements section). Involvement on a state level varies, with most coastal states having some degree of control or oversight of artificial reef development in their waters and adjacent federal waters. Most coastal states also participate in regional communication and coordination concerning artificial reef management activities through their respective IMFCs. Partnerships in artificial reef development between state, federal, and private interests have formed over the ensuing years with the states as the lead fishery management agencies and the primary entities in implementation of the Plan. The general consensus of state reef program managers is that artificial reefs are fisheries management tools, and that their use should be addressed accordingly.

### **Federal**

The current Federal role is to provide technical assistance, guidance, permitting and regulations for the proper use of artificial reefs. Such assistance should be compatible with other long-term needs, and should improve coordination and communication between the Federal agencies, states, FMCs, IMFCs, commercial and recreational fishing interests, diving communities and other interested parties. Generally, the Federal role is carried out through the permit process and this National Plan. Additionally, Federal agencies may provide guidelines, services, information, financial aid, and in-kind support for some projects. Federal fisheries agencies may provide some regulatory functions regarding fishing practices on specially designated artificial reefs (e.g., Special Management Zone (SMZ) designation in the South Atlantic and Gulf of Mexico FMP for the snapper-grouper complex and reef fish, respectively).

The Federal government has been involved in artificial reef activities for several decades. Specifically, the Federal government has been involved in the research and development sponsored by individual agencies and the review of reef permit applications. Currently, however, there is no federally coordinated program to regulate artificial reef activities except through the Clean Water Act Section 404 permit program administered by the Corps, with environmental oversight by EPA.

The President's Proclamation of an Exclusive Economic Zone (EEZ) on March 10, 1983 declared a national interest in living and non-living resources found within 200 nautical miles from shore. The Atlantic Coastal Fisheries Cooperative Management Act (Atlantic Coastal Fisheries Act) (16 U.S.C. §5101 et seq.) of 1993, finds that: "...increasing pressure, environmental pollution, and the loss and alteration of habitat have reduced severely, certain Atlantic coastal fishery resources... and... It is the responsibility of the Federal government to support... cooperative interstate management of coastal fisheries." Increased use of fisheries resources is expected in the EEZ, and, undoubtedly, there will be more interest in the use of artificial reefs to enhance these resources and the habitats essential to their proliferation.

Five federal entities, the U.S. Departments of the Interior (DOI), Commerce (DOC), Defense (DOD), and Transportation (DOT), and the Environmental Protection Agency (EPA), have

varying degrees of interest in, and responsibility for, artificial reefs.

### ***Department of Interior***

The DOI has broad authority under the Outer Continental Shelf Lands Act (OCSLA) to protect natural resources. They have specific responsibility to enhance recreational fishery resources under the Federal Aid in Sport Fish Restoration Act of 1950 (Dingell-Johnson Act) as amended by the Wallop-Breaux Amendment, through the Deficit Reduction Act of 1984 (16 U.S.C. §777c). This act provides federal financial assistance to the states for approved studies and projects directed at enhancement of recreational fisheries resources.

#### ***U.S. Fish and Wildlife Service (USFWS)***

The U.S. Fish and Wildlife Service (USFWS) administers the Federal Aid in Sport Fish Restoration Program, which provides matching grants to the states to undertake sport fish restoration and boating projects. Money for this program is collected from excise taxes on fishing tackle and motorboat fuels in a user-pays/user-benefits program. The 1984 Wallop-Breaux Amendment to the Sport Fish Restoration Act significantly enhanced the states' abilities to undertake artificial reef programs through increased financial assistance for such projects. Consequently, this funding has influenced the direction of artificial reef programs nationwide towards a greater focus on enhancement of recreational fisheries and increased fishing opportunities by improving access to the fisheries resources.

In addition, the USFWS participates in the cooperative Interstate Fishery Management Program of the Atlantic States Marine Fisheries Commission (ASMFC) to develop and implement fishery management plans under the Atlantic Coastal Fisheries Act. The USFWS has responsibility to provide technical assistance in various consultation processes under the Endangered Species Act, the National Environmental Policy Act, the Coastal Zone Management Act, and Section 404 of the Clean Water Act. The USFWS also provides a critical function in co-chairing, with NMFS, the National Recreational Fisheries Resources Conservation Council. Through its participation in these programs and consultation process, the USFWS has the potential to influence artificial reef development.

#### ***Minerals Management Service (MMS)***

The Minerals Management Service (MMS) responsible under the OCSLA for leasing federal lands on the United States outer continental shelf (OCS) and regulating the development of oil, gas, and other mineral resources in an orderly manner while properly safeguarding the environment. The Energy Policy Act of 2005 (P.L. 109-58) amended the OCSLA to authorize MMS to oversee renewable energy and alternative uses on the OCS. Current MMS regulations allow the appropriate conversion of retired platforms for reefs when such platforms are permitted and designated for use by a state artificial reef program and within areas established for receipt of platforms for the enhancement of habitat for fish and other aquatic life.

### ***Department of Commerce***

DOC has authority under a number of statutes to protect natural resources and their habitats. This authority is generally delegated to the National Oceanic and Atmospheric Administration (NOAA), which houses several line offices responsible for implementing various statutory and regulatory mandates. Relative to artificial reefs, the National Fishing Enhancement Act of 1984

(33 U.S.C. §2101 et seq.) directs the Secretary of Commerce to develop and publish a long-term National Artificial Reef Plan to promote and facilitate responsible and effective artificial reef use based on the best scientific information available.

### **National Marine Fisheries Service (NMFS)**

NMFS carries out responsibilities of the DOC related to conservation and management of living marine resources and their habitats. NMFS' authority to conserve and manage fishery and living marine resources is established by a suite of Federal laws, including the Magnuson-Stevens Fishery Conservation and Management Act (16 U.S.C. §1801 et seq.), the Endangered Species Act (16 U.S.C. §§1531-1543), the Fish and Wildlife Coordination Act (16 U.S.C. §§661-666c), and others (see Regulatory Requirements section).

NMFS plays an obvious part in artificial reef development, management, and regulation through its role as the lead agency in the development of the NOAA *National Artificial Reef Plan as Amended: Guidelines for Siting, Construction, and Development of Artificial Reefs*.

Additionally, NMFS is involved in a general oversight capacity in such activities as providing comments on artificial reef permits; research; establishment of acceptable standards for the transfer, cleaning, and preparation of certain reef materials; and in establishment of fishery regulations pertaining specifically to the development of artificial reef sites. NMFS also provides scientific input and conducts research that affects many of the biological considerations in the creation and siting of artificial reefs, as well as the study of feasibility of using artificial reefs to gather information about habitat requirements of marine organisms.

In addition to its regulatory and policy development responsibilities, the Restoration Center (housed with the NMFS Office of Habitat Conservation) also plays a role in artificial reef development. The Restoration Center (RC) has authority to respond to the recommendations from the Office of Response and Restoration (ORR) Program within the National Oceans Service (NOS) to use funds available from responsible parties involved in a release or spill of hazardous materials into estuarine-marine waters to construct artificial reefs. These artificial reefs are used to restore lost or injured reef-like habitat, or reef-related fisheries resources, or to compensate for a loss of public access to recreational fishery resources because of the release or spill or from physical damage to natural reef habitat, such as by vessel groundings. The RC also offers funding for voluntary habitat restoration projects, which can include artificial reef construction.

### **Regional Fishery Management Councils**

The Magnuson-Stevens Fishery Conservation and Management Act (16 U.S.C. §1801 et seq.) established eight Regional Fishery Management Councils (FMCs) that have the authority to develop federal fishery management plans and amendments intended to conserve and manage fish and fishery resources in their respective jurisdictions. In addition, each FMC's fishery management plan must describe and identify essential fish habitat (EFH) for the fishery under its jurisdiction, minimize, to the extent practicable, adverse effects on such habitat caused by fishing, and identify other actions to encourage the conservation and enhancement of such habitat. For example, the South Atlantic Fishery Management Council has recommended, and NMFS has established, special management zones (SMZs) around artificial reefs and designated SMZs as habitat areas of particular concern (HAPCs) within essential fish habitat (EFH) (see 50 CFR 600.815(a)(8)). The FMCs may recommend whether new or existing artificial reefs should be considered EFH by NMFS. The FMCs also play a role in the EFH consultation process by

reviewing specific project proposals and providing comments to state and/or federal agencies whose actions may adversely affect EFH.

### *National Ocean Service (NOS)*

The NOS Office of Coast Survey plays a role in charting the locations of artificial reef sites. With the advent of affordable and spatially accurate global positioning system (GPS) receivers, many latitude/longitude coordinates of previously charted artificial reef sites have been found to be inaccurate. To ensure that reef sites are accurately plotted, the Corps permit process should unilaterally require the use of differential GPS coordinates that should be forwarded to NOS when artificial reefs are constructed. Reef site selection should avoid creating hazards to navigation.

Within NOS, the Office of Response and Restoration (ORR) encompasses the full suite of DOC's capabilities for responding to all types of hazardous events in coastal areas, including oil spills. ORR's mission is to mitigate the negative environmental effects that may be associated with these hazardous events, and to pursue compensation to restore natural resources when they are harmed. ORR has been delegated trustee responsibilities assigned to the Secretary of Commerce under the Clean Water Act, the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), and the Oil Pollution Act (OPA) of 1990. As noted above, the ORR provides recommendations to NMFS on the use of funds from responsible parties to restore lost or injured reef-like habitat or reef related fisheries resources.

The National Marine Sanctuary Program (NMSP) manages a system of National Marine Sanctuaries that protect special, nationally significant, areas of the marine environment under the authority of the National Marine Sanctuaries Act (16 U.S.C. §1431 et seq.). The NMSP has jurisdiction in coastal and federal waters that are within designated National Marine Sanctuaries. Pursuant to the authority under the NMSA, most sanctuaries have regulations that prohibit seabed disturbance and placement of objects on the seabed. Since NMSP regulations generally prohibit placing structures on the seafloor, any individual who wishes to establish an artificial reef within a National Marine Sanctuary must first get approval from the NMSP through the onsite sanctuary manager. Each Sanctuary has regulatory authority within its boundaries pursuant to Subparts F through R of 15 CFR Part 922.

To ensure that applications to establish artificial reefs in National Marine Sanctuaries are reviewed consistently and in a manner that adheres to the National Marine Sanctuaries Act and the National Marine Sanctuary Program regulations, the NMSP has developed a policy statement and artificial reef permitting guidelines to address how the NMSP will consider proposals to establish artificial reefs within National Marine Sanctuaries. This document complements the guidance contained in the NOAA *National Artificial Reef Plan as Amended: Guidelines for Siting, Construction, and Development of Artificial Reefs* to guide the NMSP and applicants through the process of evaluating proposals for artificial reef development within sanctuaries.

NOS' Office of Ocean and Coastal Resource Management (OCRM) has responsibility within the Department of Commerce pertaining to the Coastal Zone Management Act, as amended (16 U.S.C. §1451 et seq.). This act establishes a state-federal partnership in the planning, development, and conservation of coastal resources. OCRM provides national leadership, strategic direction, and guidance to state and territory coastal programs and estuarine research reserves. The Office further works with state and territory coastal resource managers to develop



a scientifically-based, comprehensive national system of marine protected areas (MPAs) and supports effective management and sound science to protect, sustain and restore coral reef ecosystems. These activities are mandated by the Coastal Zone Management Act (16 U.S.C. §1456), the MPA Executive Order (Executive Order 13158), and the Coral Reef Conservation Act (16 U.S.C. §6401 et seq.). State CZMA programs, approved by NOAA, review artificial reef proposals through state programs as well as through the “federal consistency” provision of the CZMA (see Regulatory Requirements section).

### ***Department of Defense***

The DOD is responsible for preserving national security, maintaining navigation, and protecting the public interest in multiple uses of the Nation's waters. The DOD has worked with the states in several programs to provide materials for reef construction. More recently, the ReefEX initiative was developed within the DOD to facilitate transfer of demilitarized combat vehicles to state artificial reef programs. Although the program is now inactive, the intent was to make other suitable materials available in future program elements.

#### ***U.S. Army Corps of Engineers (Corps)***

In addition to the Corps’ responsibilities for permitting the construction of artificial reefs under the NFEA, the Corps is responsible for regulating certain activities in waters of the United States under Sections 9, 10, 11, 13, and 14 of the Rivers and Harbors Act of 1899 (RHA) (33 U.S.C. §401 et seq.). The Corps also has permit authority under Section 404 of the Clean Water Act (CWA) (33 U.S.C. §1344), and Section 103 of the Marine Protection, Research and Sanctuaries Act (MPRSA) (33 U.S.C. §1413). The Corps regulates work on structures under the RHA and the transport of dredged material under the MPRSA. The Corps has very specific regulatory authorities under the CWA and retains responsibility for processing and issuing permits under Section 404 of the CWA except where regulatory authority has been delegated to the states. Specifically, the Corps is the lead federal agency responsible for permitting artificial reef development under authority of the National Fishing Enhancement Act of 1984. Pursuant to Section 203 of the Act, the Corps promulgated rules for permitting artificial reef development activities in 33 CFR, Parts 320 through 330, November 13, 1986.

The Corps has responsibility for the protection of submerged archaeological resources. One key piece of protective legislation for archaeological resources is the National Historic Preservation Act (NHPA) (16 U.S.C. §470 et seq.). The Corps is responsible for assessing potential reef sites for possible impacts to submerged archaeological resources under section 106 of the NHPA.

#### ***Navy***

Under the National Defense Authorization Act for Fiscal Year 2004 (P. L. 108-136), the Navy was granted authority to transfer obsolete warships to states for artificial reef purposes. See also 10 U.S.C. §7306(b) (authorizes transfer of vessels as gifts or otherwise as artificial reefs by the Secretary of the Navy). In 2004, the Navy joined MARAD in a cooperative effort for making suitable obsolete warships and MARAD merchant-type vessels available for use as artificial reefs. Under this cooperative effort, the Navy agreed to transfer the former aircraft carrier ex-Oriskany to the State of Florida for use as an artificial reef. Before transfer of the ex-Oriskany occurred, the Navy’s contractor performed work necessary to environmentally prepare the ship for sinking as an artificial reef.

## ***Department of Transportation***

The mission of the DOT is to serve the United States by ensuring a fast, safe, efficient, accessible and convenient transportation system that meets the vital national interests and enhances the quality of life of the American people, today and into the future. The Maritime Administration (MARAD) promotes development and maintenance of an adequate, well-balanced, United States merchant marine, sufficient to carry the Nation's domestic waterborne commerce and a substantial portion of its waterborne foreign commerce, and capable of serving as a naval and military auxiliary in time of war or national emergency. MARAD also seeks to ensure that the United States enjoys adequate shipbuilding and repair service, efficient ports, effective intermodal water and land transportation systems, and reserve shipping capacity in time of national emergency.

### **Maritime Administration (MARAD)**

MARAD has been involved in numerous artificial reef construction projects over the past three decades through the transfer of surplus ships for reef construction material. The Maritime Programs Appropriations/Authorizations Act of 1972 (P.L. 98-402) authorized the transfer of surplus World War II Liberty class war vessels designated by the Secretary of Commerce to coastal states as scrap if states would utilize them to construct artificial reefs. Provisions of this act established a formal protocol to remove derelict vessels from MARAD's inactive fleet and transfer them directly to state artificial reef programs. Such vessels have been utilized by many state marine artificial reef programs over the years, and have provided excellent fishing and diving sites.

## ***Department of Homeland Security***

### **U.S. Coast Guard**

The Coast Guard has authority to: 1) promulgate regulations dealing with lights, warning devices, and other public and private aids to navigation on offshore installations; 2) establish safety fairways and traffic separation schemes for safe movement of vessel traffic under the Ports and Waterways Safety Act; 3) establish safety zones around offshore facilities; 4) enforce fishery laws; and 5) monitor and enforce compliance with international conventions and statutes on environmental protection.

### ***Environmental Protection Agency (EPA)***

Placement of fill material or structures, such as those used to create artificial reefs, is subject to Corps permitting authority under Section 404 of the Clean Water Act (CWA). CWA Section 404 applies to "waters of the United States," which as a general matter include most inland waterbodies as well as the territorial seas (which for CWA purposes extend three miles from the baseline). In issuing CWA Section 404 permits, the Corps applies the Section 404(b)(1) guidelines, which were developed by EPA in conjunction with the Corps. The guidelines (which can be found at 40 C.F.R. Part 230) prohibit issuance of 404 permits that would cause or contribute to violations of applicable water quality standards and also generally preclude discharges that would cause or contribute to significant degradation of waters of the United States. In addition, CWA Section 404(c) authorizes EPA to prohibit, withdraw, or restrict the use of defined areas as a dredged or fill material disposal site in any waters of the U.S., including the Territorial Sea, if EPA determines that the discharge will have unacceptable adverse effects

on municipal water supplies, shellfish beds and fishery areas, wildlife, or recreational areas. Artificial reef creations beyond the Territorial Sea are regulated under Section 10 of the Rivers and Harbors Act of 1899.

Under the Liberty Ship Act, which allows states to apply to the Secretary of the DOT for use of obsolete vessels to create artificial reefs, the state application to the DOT must include a certification from EPA that the proposed use of the vessel will be compatible with “applicable water quality standards and other appropriate environmental protection requirements” (16 U.S.C. §1220(b)).

Although the EPA has not developed guidelines for materials used for artificial reef construction, the CWA Section 404(b)(1) guidelines and ocean dumping criteria (promulgated under the MPRSA) can be used to as guidance to determine the acceptability of certain artificial reef materials in waters of the United States. While these guidelines do not supercede the guidelines outlined in this document, they can be used in conjunction. The placement of materials for the purpose of creating an artificial reef is not regulated as ocean dumping under the MPRSA. As part of its involvement in ReefEX, EPA also developed specific criteria for preparation of de-militarized combat vehicles prior to their use for reef construction in the Gulf of Mexico.

## **State**

### ***State Natural Resource Agencies***

Virtually all state natural resource agencies with active marine fisheries management and enhancement programs are involved in artificial reef activities. Since implementation of the original Plan in 1985, most state marine fisheries agencies have assumed the lead in acquiring permits, maintaining liability, financing, constructing, researching, and monitoring marine artificial reefs through state supported programs. The level and type of state involvement in an artificial reef program are usually governed by the following factors:

- 1) the need to offset fishery or habitat stress with habitat enhancement;
- 2) the degree of public support;
- 3) constituency pressures to enhance access to fisheries; and
- 4) the availability of a stable funding source to support reef construction.

Many coastal states have adopted their own plans based on the Plan’s guidance. In effect, the states have been responsible for implementing the Plan, in cooperation with the Corps, and collecting information necessary for updating guidance in the Plan, and for strengthening provisions of the National Fishing Enhancement Act of 1984.

State resource managers recognize that benthic artificial reef construction involves long-term alteration of bottom habitat. Potential effects on natural resources and the environment should be considered prior to construction. Some past artificial reef construction projects which were used largely to justify solid waste disposal, were not well researched, did not have specific fisheries management objectives, and would not be acceptable under present artificial reef development policies. There is general consensus among state agencies that artificial reef projects must be considered within the context of fishery management. As more species become subject to FMP regulations, it is important that state artificial reef programs become more closely linked organizationally with state fishery management programs.

The states have a strong interest in activities that may affect EFH. States have considerable ability to ensure that EFH concerns are addressed fully before any action potentially affecting such habitat may proceed. A state program for artificial reef construction is an integral part of any comprehensive state/federal effort to protect, restore or enhance habitats that are essential to valuable commercial and recreational fisheries.

Because of the potential long-term effects of artificial reef development on the environment and on finfish and shellfish stocks, eligibility to hold a permit to develop an artificial reef in state waters, or in federal waters where an adjacent state has adopted an existing artificial reef program that extends to federal waters, should be restricted to the appropriate state fishery management agency. The states' natural resource agencies hold the public trust in managing resources associated with artificial reefs and are the principal entities that can demonstrate long-term accountability for liability required in artificial reef permits. If a state wishes to extend its permit authority to other entities, it should do so in writing to the appropriate Corps office. However, the state agency should be a key authority for artificial reef development and management activities in state waters and coordinate with appropriate fishery management councils and NMFS. States without artificial reef programs should direct development of artificial reefs in state waters through the state marine fisheries resource agency to assure consistency with fishery management objectives. In addition, state CZMA programs have review authority under the CZMA federal consistency provision and should be consulted on artificial reef plans and construction process.

The states' role in the artificial reef construction process is to develop or participate in developing statewide and site-specific plans. Such plans should be designed to maintain regulatory and quality control that ensures all artificial reefs in state waters (and adjacent federal waters covered by state artificial reef programs):

- 1) have a specific objective for fisheries management or other purpose stated in the goal of the statewide, or site-specific plan;
- 2) have biological justification relating to present and future fishery management needs;
- 3) will have minimal negative effects on existing fisheries, and/or conflicts with other uses;

- 4) will have minimal negative effects on other natural resources and their future use;
- 5) use materials that have long-term compatibility with the aquatic environment; and
- 6) are monitored during and after construction to determine whether reefs meet permit terms and conditions and are functioning as anticipated.

State natural resource agencies should be involved in all artificial reef construction in their waters, and should also be consulted on artificial reef development in adjacent federal waters. When artificial reef construction projects go beyond state government financial limitations, state natural resource agencies should, at a minimum, provide guidelines, policies, and acceptable procedures to assist other organizations undertaking artificial reef projects.

### ***Interstate Marine Fisheries Commissions***

Coastal states have coordinated artificial reef activities through their respective IMFCs. State reef developers have progressed beyond focusing solely on creating access to fisheries utilizing secondary use materials. The states have been innovative in utilizing the tools available to them to validate methodologies in reef research on such topics as construction and siting, fishery management, regulatory requirements, and reef biology (including production and aggregation issues).

One role of the IMFCs is to provide an open forum for discussion and debate on issues facing state artificial reef program managers, respective federal agencies, and affected fisheries interests. Most IMFCs have established technical advisory committees for marine artificial reef development. These committees are composed of the coordinators of the state marine artificial reef programs within the respective state agencies responsible for marine and coastal resources management. Committee membership also includes representatives from NMFS, USFWS, MMS, EPA, and FMCs. These committees provide critical advice to the IMFCs relative to development of marine artificial reefs, and have served to increase responsiveness and efficiency of coastal artificial reef programs.

Joint IMFC committee activities have served to consolidate individual state efforts along the coasts, thus assisting in the promotion and facilitation of responsible and effective efforts to establish artificial reefs. The committees have worked cooperatively to identify and resolve national issues, such as developing standardized criteria for materials used to build artificial reefs. Coastal states should continue such coordination through the relevant bodies of their respective IMFCs.

### **Local Governments (County and Municipal)**

Local government agencies have been involved in directing or coordinating artificial reef programs. Their role has included coordinating programs to provide materials for reef construction, providing technical support or supervision for community efforts, conducting and

financially supporting reef programs, obtaining state monies for local reef efforts, and publicizing local reef efforts. These efforts should be conducted under the oversight of state fishery management agencies to ensure compatibility with established state, regional, and national fishery management goals and permit requirements. As part of the economic development activities of local chambers of commerce, local governments should assist state artificial reef programs in collection of relevant social and economic information. Such information is extremely important in developing goals and objectives for reefs.

## **Private**

In the years prior to enactment of the National Fishing Enhancement Act of 1984, individuals, sport fishing clubs, local artificial reef committees, and diving clubs initiated the construction of many artificial reefs. Private groups and organizations played an important role in artificial reef development during this time. They communicated the needs of fishermen, lobbied for the development of local and state artificial reef programs, and undertook fund-raising activities. In addition, private individuals and clubs often provided volunteer services for the cleaning, modification, construction, transportation, and deployment phases of artificial reef projects. Under the supervision of biologists, local divers have contributed to monitoring and evaluation studies. Such activities have encouraged entrepreneurial ventures by private interests in development of artificial reef materials and designs.

Although these groups have traditionally played an important role in development of artificial reefs in many states, they should coordinate their activities with state artificial reef programs, or state and federal marine fishery resources agencies, to ensure such reefs are used properly and in compliance with all pertinent regulations and management goals. Local and academic expertise should also be sought to achieve the most successful reef projects.

Recent developments in the private sector should help resolve some of the problems reef builders have had in initiating programs. Several companies now provide expertise in artificial reef development, as well as effective materials for construction of artificial reefs. Some private reef developers have been innovative in working with state artificial reef programs by not only providing innovative materials and designs for reef construction, but also locating financial assistance and volunteer labor for deployment activities and monitoring. Nonprofit organizations, universities, and consortiums may add expertise in this area as well.

## GUIDELINES

### Siting

Proper siting is vital to the success of an artificial reef. The initial focus should be to enhance or create habitat and a diversity of fishery resources, while not impeding or interfering with navigation. The goals of the artificial reef project, social and economic considerations, and environmental and biological concerns should be identified early in the planning stages. Reefs that are improperly sited can result in a number of negative impacts, including hazards to navigation, damage to bottom habitat, and environmental clean-up problems. Hazards to navigation pose potential hazards to fishing vessels. On occasion, commercial and recreational fishing vessels have become entangled in artificial reef structures only to lose gear and entrap marine life. Such ill-conceived projects should not be permitted. The following guidelines are provided to assist reef builders in the critical site selection stage of artificial reef development.

### *Purpose*

Artificial reefs provide new or enhanced hardbottom habitat to areas that may or may not be habitat limited (an important consideration). Artificial habitat provides space that is quickly colonized by sessile organisms and provides new food sources, greater protection of juveniles by providing more space to be used as refuge, and a possible focal point for aggregating adults to spawn. Properly sited, constructed and managed reef sites, particularly multiple-site complexes, can be used to meet a variety of objectives. Traditionally, the majority of artificial reefs in United States coastal marine waters have been sited and built to enhance recreational fishing. However, there appears to be an increased emphasis in recent years on benefits derived from non-extractive activities. Artificial reefs can provide enhanced (1) recreational diving opportunities; (2) socio-economic benefits to local coastal communities; (3) increase habitat to reduce user pressure on nearby natural reefs; (4) reduce user conflicts (e.g., diving in a heavily fished area may be inappropriate, so reefs may provide an alternative location for this activity); and (5) provide mitigation or restoration to habitat loss for commercial activities (e.g., beach renourishment, dredging). In 2002, for example, the 510-foot *USS Spiegel Grove* was sunk off the coast of Key Largo, Florida, which provided one of the largest artificial reefs in the world, was placed primarily for the purpose of enhancing recreational diving opportunities.

All of these uses ultimately share the common purpose of enhancing or increasing the marine habitat available for associated fishes and other organisms. By fulfilling this purpose, enhanced fishing and diving opportunities (and the economic benefits generated from this) will follow. The fundamental issues dictating the design and location of an artificial reef are the intended purposes or objectives. Failure to clearly identify the objectives at the outset can detract significantly from overall reef effectiveness and utility, and compromise public confidence in artificial reef programs.

For the most part, state and federal fishery management agencies, FMCs, and other natural resource management entities have established protocols for siting artificial reefs that can be found within state artificial reef plans. Although these plans differ in their scope, breadth, and depth, most plans contain several common elements. These elements include proper reef siting, design, and materials, permitting, regulation and management, monitoring, proposed uses of

reefs, biological function and productivity, liability and other legal considerations, funding, and research. (Note: The only anomaly is the artificial reef plan for the State of Florida, which provides general information on artificial reefs with an emphasis on programmatic goals for artificial reef development. Since most counties in the State of Florida have their own artificial reef programs, many county plans provide a greater level of specificity in their requirements relative to the state artificial reef plan.) Those outside of these entities with an interest in building artificial reefs should contact the relevant state agency to obtain pertinent background information, (i.e., biological, socioeconomic, and regulatory) to identify the best procedure for advancing a proposed reef-building project. These agencies should work together to identify commercial and recreational fishing interests that should be considered in the planning process from the outset. Also, they should ensure open lines of communications exist to avoid potential conflicts among user groups.

While the majority of reefs have been built to support and enhance recreational fishing, interest is growing in using artificial reefs to restore, mitigate, or create habitat, to improve recruitment, and enhance juvenile survival and growth of reef-associated species.

#### **Habitat Enhancement for Increased Fishery Production**

Prospective reef builders should have an understanding of the limiting factors involving the fauna and flora that will utilize an artificial reef site. Builders should identify the habitat type and/or species targeted for enhancement and determine which biological, physical, and chemical site conditions will be most conducive to meeting the objectives. Once these siting criteria are determined, they should be used in identifying potential construction sites and materials to be used. Infaunal communities in the area where the reef is to be built should be considered prior to placement.

Artificial reefs should not be constructed on many types of natural habitats, or in such a manner that would threaten the integrity of natural habitats, such as:

- 1) existing coral reefs;
- 2) beds of aquatic grasses or macroalgae;
- 3) oyster reefs (except for shell stock replenishment);
- 4) scallop, mussel, or clam beds; or
- 5) existing live bottom (marine areas supporting growth of sponges, sea fans, corals, and other sessile invertebrates generally associated with rock outcrops).

In some cases, however, it may make sense to construct artificial reefs in areas with sparse live assemblages or on barren bottoms in proximity to biologically productive areas. This can be



done to enhance the area and/or to divert user pressure from fragile natural areas.

### **Recreational Fishing Enhancement**

Prospective reef builders should assess the relative importance of, and demand for, shore-based and boat-based fishing activity. The National Marine Recreational Fishery Statistics Survey (MRFSS) or similar state surveys could provide such information. Other factors that should be considered include:

- 1) location of shoreline access points (e.g., ramps, piers, marinas, bridges, and charter and party boat docks);
- 2) general fishing methods and use patterns (e.g., trolling versus bottom fishing, vessel sizes, distances traveled offshore, skin and SCUBA diving); and
- 3) potential conflicts with other users (e.g., commercial fishermen, divers, shipping, general navigation, military, mineral and energy extraction, historic wrecks and sites, etc.).

State and local government-sponsored artificial reef programs should attempt to accommodate the full range of recreational fishing needs. In addition to providing for the needs of boat-based anglers in offshore and inshore waters, artificial reefs may be considered to enhance or maintain recreational fishing from bridges, piers, jetties, and other shoreline locations. State and local cooperation is vital to assure the stability of materials used and to avoid potential conflicts. Enhancement of shore-based angling can have particular social and economic significance to coastal communities with heavy tourist traffic and can help to expand public support for artificial reef development. Caution should be exercised when developing artificial reefs in nearshore areas due to the increased potential for spatial and use conflict. Careful project planning will minimize these conflicts.

Recreational reefs are generally used more when they are properly charted and mapped, and are adequately marked by buoys. (However, there may be instances when buoying is not practical.) These types of reefs are also used more frequently when they are located fairly close to shore; are accessible by running simple compass headings and known distances from permanently marked buoys at the mouths of major rivers, inlets, or passes; and have published coordinates. If recreational reefs are located fairly close to shore and are not buoyed, reef sponsors should provide visual lineups with shoreline reference points (e.g., water tanks, buildings, antenna towers) to allow boaters who do not have electronic navigation equipment to find the reefs easily.

Sponsors of artificial reefs should develop and distribute public information brochures and/or flyers describing reef locations, fishing conditions at each site, applicable fishing regulations, or use restrictions. Such restrictions would include observance of diving flags, anchoring guidelines, fishing gear restrictions, catch limitations, and courtesies which should be extended to other reef users. Accurate reef information is critical to public use and benefits.

### **Sport Diver Enhancement and Access**

Sport divers represent a growing number of artificial reef users. The development of new technology and the increased availability of diver training and access have led to a tremendous increase in the number of sport divers in the United States. The economic impact of sport divers frequenting artificial reefs rivals that of recreational fishing activities in some regions.

Reefs proposed for divers should be sited and constructed at depths that will provide reasonable bottom time and minimize the decompression hazard. Factors such as water clarity, proximity to other popular dive areas, average current velocities, depth, and possible conflicts with other user groups (e.g., recreational hook and line and/or commercial fishing, navigation, etc.) should be considered.

### **Commercial Fishing Enhancement**

The use of commercial fishing reefs could prove beneficial by providing specially designated sites for commercial fishing only. This could reduce conflicts with recreational anglers and divers. To effectively accomplish this approach, SMZ status through state and federal regulatory processes would be required. Another approach to this objective would be to site artificial reefs for commercial fishing activity far enough offshore or from shore-based access sites that recreational anglers and divers would not be likely to travel there.

As in any other application of artificial reefs, it is useful to consider the issue of habitat limitation when siting reefs for commercial purposes. The distribution of reef and reef-like habitats is sporadic, leaving large expanses of sea bottom covered by silt, mud, and sand. Such areas are typically devoid of species that are known to associate with reef habitats, including snappers, groupers, triggerfish, porgies, black seabass, tautog, and Pacific rockfish, among others. However, many commercially important species may not be limited by habitat. Instead they may be limited by impacts of fishing activities or negative environmental parameters, such as poor water quality. In these cases, artificial reefs may not enhance the net gain in catch, and may actually contribute to a decline in the total biomass.

Along with the historic practice of shell (cultch) planting to create or enhance oyster reefs, artificial reef technology may also be applied to the following:

- 1) creating and/or expanding kelp beds;
- 2) oysters and mussel culture;
- 3) enhancing the yield and survival of spiny and American lobster;
- 4) concentrating pelagic species to enhance harvest;
- 5) live rock culture;

6) providing essential habitat for associated reef fishes; and

7) culture of organisms for biomedical use.

### **Marine Protected Areas**

The use of artificial reefs as marine protected areas (either for a certain stock or for protection against all consumptive uses) has been applied in very few areas to date. However, this may be one of the most underutilized applications for artificial reefs. The idea of marine protected areas covering large amounts of natural live bottom areas has been debated by fisheries management agencies for several years. This idea has little support among recreational and commercial fishing interests. The use of newly sited and constructed artificial reefs to create marine protected areas could ease some of these concerns, providing hard substrate and habitat while leaving traditional fishing areas open.

Artificial reef managers involved in siting and constructing reefs for marine protected areas should, as with all reef planning, clearly identify the goals of the reef. Proper siting should take the following factors into consideration:

- 1) proximity to natural live bottom;
- 2) primary target species and associated prey species;
- 3) life history stages of affected species;
- 4) hydrological and geophysical factors;
- 5) enforcement;
- 6) traditional uses of the proposed site;
- 7) paths of ingress and egress to and from the site for target species; and
- 8) material design best suited to meet the reef objectives.

### **Mitigation**

Artificial reefs have been employed to mitigate the destruction or degradation of various marine habitats due to coastal development or catastrophic loss. In some instances, the application has been in-kind, on-site mitigation. For example, a coral reef in Biscayne National Park, damaged

by the impact of a large vessel, was successfully repaired using state-of-the-art technology that simulated natural coral. In other instances, reefs have been built a distance from the damaged area to substitute for non-reef habitat. For example, the Corps built an artificial reef in Delaware Bay as mitigation for loss of brackish water river bottom.

When mitigation is undertaken to offset the loss of aquatic resources permitted under the Clean Water Act or Rivers and Harbors Act of 1899, additional guidance is relevant. In the interest of achieving functional replacement, in-kind compensation of aquatic resource impacts is generally required. However, the agencies' preference for in-kind mitigation, as indicated in the 1990 Memorandum of Agreement on mitigation between the U.S. Environmental Protection Agency and the Department of the Army (1990 MOA), should not preclude the use of out-of-kind mitigation if it is practicable and environmentally preferable to in-kind compensation (e.g., of greater ecological value to a particular region). There may be circumstances warranting a combination of in-kind and out-of-kind as well as on-site and off-site mitigation to compensate for losses.

The use of artificial reefs to mitigate the loss or damage of marine habitats is a complex issue that involves more than substituting one type of habitat for another. The benefits gained from creating an artificial reef may not be the same as those derived from the natural system it is intended to replace. Whenever possible, the area in which the environmental damage might occur should be studied beforehand to discover the ecological functions provided by the existing system. Then, artificial reef technology, which will simulate those functions to the greatest degree possible, should be utilized.

When artificial reefs are proposed for non-reef related mitigation, often it is the only way to attempt to compensate for the loss of such habitat or fishery access. When faced with this situation, resource managers have two primary considerations:

- 1) can artificial reef technology be used to repair or replace the damaged habitat; and
- 2) if not, how can artificial reef technology be used to replenish specific elements of the overall resources of the area.

### ***Social and Economic Considerations***

It is likely that the majority of artificial reefs will continue to be built to support fishing and diving activities, and artificial reefs constructed for recreational use normally will be near major population centers. Occasional reef construction in less populated areas may be appropriate to stimulate local economies and alleviate fishing pressure on more congested sites. Reef builders can use census reports, together with fishing license, boat registration, and landings data to delineate recreational fishing demand centers. For commercial fishing reefs, demand centers may be more sparsely populated, but should be recognized fishing communities with the appropriate infrastructure. Artificial reefs built for divers should focus on population centers with dive charter availability or potential. Artificial reefs built for research, reserves, culture of aquatic organisms, and other less user-oriented purposes will require siting criteria more specific to those uses. Further, it may be appropriate to avoid population centers for these types of reefs for best results.

Within each of the user demand centers identified, land and water access systems should be evaluated. Reefs should be planned in areas with adequate public access facilities and infrastructure support. Recreational reefs should be located for safe access by prudent anglers and divers, and in locations easily supported and maintained by reef managers. Studies of recreational use patterns can be particularly useful in this endeavor. Reefs for commercial fishing can be sited farther from harbors and inlets, but energy conservation should remain an important consideration. Reefs installed as reserves, nursery areas, or spawning habitats should be located or managed to minimize fishing pressure, yet allow for adequate enforcement.

Before beginning the site selection process, reef planners should determine existing fishing patterns and conditions offshore of each identified demand center in question. Such information should include:

- 1) an estimate of reef use;
- 2) preferred target species and life history stage;
- 3) distances from nearest navigable inlet or harbor;
- 4) traditional fishing areas and methods; and
- 5) existing or future fishery management issues which may affect the reef site or users (e.g., stock status problems, user conflicts, closures, etc.).

Analysis of this information should enable prospective reef builders to delineate broad geographical areas adjacent to identified demand centers within which to begin a more detailed site selection process and should help determine reef size and management needs. The size (areal extent) of a reef can be important, depending on the type and quantity of material to be used and the number of boats expected on a reef at any one time.

The goals and priorities of the reef managers should direct overall site selection. Within the identified target area, existing artificial reefs and known bottom obstructions should be identified. Exclusion areas should include, but are not limited to:

- 1) shipping lanes;
- 2) restricted military areas;
- 3) areas of poor water quality (e.g., low dissolved oxygen, dredge spoil sites etc.);

- 4) traditional trawling grounds;
- 5) unstable bottoms, existing rights-of-way (e.g., oil and gas pipelines and telecommunication cables); and
- 6) sites for other purposes that are incompatible with artificial reef development.

In certain circumstances, “Special Aquatic Sites” may need to be excluded from artificial reef development, consistent with CWA Section 404(b)(1) guidelines. “Special Aquatic Sites” are geographic areas, large or small, possessing special ecological characteristics of productivity, habitat, wildlife protection, or other important and easily disrupted ecological values. Examples of Special Aquatic Sites include coral reefs, sanctuaries and refuges, and vegetated shallows.

### ***Environmental Considerations***

When the intended artificial reef construction purpose is clearly established, the following should be established and addressed:

- 1) evaluation of social and economic siting concerns;
- 2) definition of a general reef construction target area;
- 3) delineation of known exclusion areas; and
- 4) assessment of proposed site geology, hydrology, water quality and fishery resources.

Information and assistance useful to these assessments can be obtained from federal, state, and local natural resource management agencies, academic institutions, private consulting firms, not-for-profit organizations, and local residents. Specific attention should be given to the points covered below.

### **Bottom Geology**

The bottom composition and character at an artificial reef site affects reef stability and longevity and should be carefully evaluated in the site selection process. In most cases, soft sediments such as clays, silts, and loosely packed sands should be avoided. Over time, reef materials may sink into these sediments or become partially covered. Benthic geology may also give a clue about siting and possible benefits from artificial reefs. Areas depauperate of cover such as rocks, aquatic plant or mud/sand bottoms may already have insufficient habitat to support an aquatic community, therefore reef developers may avoid lengthy surveys and ecosystems analysis of such areas.

Bottom areas consisting of hard rock or hardpan with a veneer of sand cover provide excellent substrate for most types of reef construction. Dense materials, such as concrete, cannot settle or scour excessively on these types of substrate. Reef planners should be aware however, that bottom sediments shift and may change radically during storms, hurricanes, and geologic events. Materials that present large amounts of surface area may scour deeply into almost any bottom type, depending upon storm events, current, or wave.

Estimations of depth and bottom type using NOS charts are recommended only in the planning stages for a new reef site. Detailed information about bottom type and water depth should be obtained before a site is actually permitted for development of artificial reef construction. Excessive silt and sand may cover the epibenthic organisms associated with artificial reef structures. Water column sediment loads may reduce light penetration.

### **Hydrography**

Principal hydrographic factors to be considered in selecting sites for artificial reef construction include water depth, potential wave height, currents and tides. Water depth is significant as a criterion for siting, for several reasons. First, reefs should be built in water sufficiently deep to avoid creating a hazard to navigation. Minimum clearance above the reef should accommodate the draft of the vessels expected to operate in the vicinity. The USCG and the Corps will review the merits of each reef construction proposal in light of local circumstances (see Regulatory Requirements section). Factors considered in these cases include water depths at and near the site, type of construction materials to be used, reef clearance, nature and extent of vessel traffic in the area and proposed marking methods.

Second, water depth has implications for reef users. In many coastal areas, water depth is a function of the distance offshore. This relationship should be considered when making tradeoffs between reef stability, clearance requirements, target species, and reef accessibility to various user groups (e.g., small versus large boat fishermen, commercial versus recreational fishermen, fishermen versus divers).

Third, water depth affects the composition of species at the reef, including all sessile and motile invertebrates associated with the reef as well as plant life and fish assemblages. Reef materials placed in clear or shallow water with good light penetration generally will provide the best results in meeting the typical biological objectives of most artificial reef projects. Water depth is a key factor in determining the likely presence of desired life history stages of target fish species. Also, water depth at the reef site may critically affect reef material stability and long-term structural integrity. In this case, average wave energy in large, open bodies of water as a function of water depth is the major concern.

Wave interaction with a reef can be destructive, but its magnitude is difficult to predict. It is primarily dependent on wave height, wave speed, depth of the reef, and density and shape of the reef material. This force can resuspend bottom sediments causing sedimentation on the reef or destabilization of reef materials that are capable of moving short distances or entirely off the site. Reef materials and designs should be properly matched to water depths and predicted wave conditions to ensure their stability. Planning for worst-case storms may need to be considered on sites where movement of materials would be detrimental or hazardous.

Predicted currents (tidal or wave-generated) for a possible reef site can greatly influence reef effectiveness and can necessitate inclusion of certain critical design parameters in the selection of reef materials. Reefs should be designed to resist breakup, movement or burial that might result from the effects of currents. Detailed engineering studies may be required in some cases to ensure reef success in some areas.

Currents also influence the number of boats that can fish a reef at one time. Fishing reefs constructed across prevailing currents will allow the maximum flow of nutrient/food-laden, well-oxygenated water through the reef and the increased availability of food for reef organisms may improve hatching success of adhesive egg masses. This design orientation also helps create nutrient upwelling over the reef which, if large enough, attracts and concentrates baitfish and their predators, which are often targeted by fishermen. In spite of the possible advantages of orienting reefs perpendicular to general current directions, there are cases (exceptionally strong currents or predictable storm surge) where restrictions to water flow should be minimized. In these cases, structures might function better if oriented parallel to or at shallow angles to the predominant current flow.

### **Water Quality**

General water quality is another important consideration. Water turbidity, salinity (in estuarine and coastal areas), dissolved oxygen, biological oxygen demand, water temperature, nutrient loads, pollution levels, and other water quality factors affect both the biological productivity and use value of artificial reefs. For example, benthic reefs built in areas with low dissolved oxygen levels (generally below 3 mg/l) or where anoxic (oxygen-depleted) conditions periodically occur will not achieve desired biological productivity levels and will probably not achieve management goals (Lenihan and Peterson 1998; Lenihan 1999). Similarly, reefs built in highly turbid water would have limited value to the diving community due to decreased visibility, but may be valuable as fish habitat. Polluted areas and areas affected by treated sewage effluent should be avoided to minimize resource exposure and possible human health risk.

In site planning, information and assistance can be obtained from federal, state, and local resource management, environmental quality, and scientific research agencies (see Sources of Information section). If sufficient background information does not exist to permit an adequate water quality assessment, prospective reef builders should ensure that this information is obtained through whatever means necessary, especially if some questions exist as to the suitability of a site based on water quality factors.

### ***Biological Considerations***

Artificial reef effectiveness is largely determined by the biological processes that enhance habitat for associated invertebrate and fish species, or the ability of the reef to improve recreational or commercial fishing. This discussion focuses on general procedure that should be used in isolating and accommodating key biological siting factors.

State and federal fishery management agencies, and other knowledgeable parties, have the capability to determine the nature of fishery resources and fishing activities in the geographical areas targeted for reef construction. Objectives of the proposed reef should be compatible with fisheries conservation and management programs of the pertinent fishery management entities. Clear objectives for the proposed reef should be based on an assessment of public need, existing



shore-based infrastructure, and the best available science. The scientific information that is used in decision-making should be relevant, inclusive, objective, transparent, timely, and peer reviewed. In addition, reef builders should select the target species or species groups, and consider life stages that they wish to enhance or rebuild. Critical habitat and environmental requirements of those species also should be identified. If selected target species are particularly sensitive to water temperature, salinity, dissolved oxygen levels, water turbidity, and contaminants, or if they have stringent habitat or food requirements, these parameters should be used as artificial reef site selection and design criteria. For example, in building reefs for snapper, grouper, black seabass, rockfish, and other marine demersal species, low and medium profile reefs should be constructed from different sized materials, which will create numerous holes and crevices of varying sizes, providing shelter for juveniles and adults (Anderson et al. 1989; Gorham et al. 1989; Lindberg 1991; Bortone 1994; Bortone et al. 1997; Ecklund 1996; Ecklund 1997; Strelcheck et al. 2005; Lindberg et al. 2006).

Prospective reef builders should be aware of existing and proposed fishery management plans and regulations for the species that may be significantly affected. They should site or construct artificial reefs that would complement fishery management goals. Consideration should be given to the impact on the target species.

## **Artificial Reef Materials and Design**

### ***Materials Criteria***

When planning artificial reef development, certain general characteristics can be useful in evaluating specific materials and design regardless of the specific purpose or location (marine or estuarine). Listed below are four major criteria that should be considered in evaluating the use of any artificial reef materials. Reef builders are now fortunate to have the experience of nearly 40 years of state-sponsored artificial reef development to draw upon.

#### **Function**

Selection of materials that are known to be effective in stimulating desired growth of organisms and providing habitat for the target species is critically important in developing artificial reefs. Proper design or configuration of selected materials on the reef site will contribute significantly to artificial reef function. Surface area, profile, shape, orientation, open (interstitial) spaces, rugosity and size are major design features that affect the function of artificial reefs and species that encounter those reefs.

#### **Compatibility**

To maximize fishing and fisheries benefits, artificial reef materials and selected designs should minimize environmental risks and user conflicts. While some risks and tradeoffs are inevitable, knowledge of a site's physical and biological characteristics and the possible uses of a reef can help planners design reefs that will avoid major problems. For example, reefs designed for divers should have materials that are attractive and minimize safety risks. Artificial reefs placed near natural reefs can be designed to ensure that materials will not encroach on the natural reef.

### **Stability**

The movement of reef materials off reef sites not only violates permit requirements, but also can threaten navigation, foul commercial fishing grounds and litter beaches. This situation can be a significant threat to continued public support of artificial reef programs. All materials used in reef construction should be of proven stable design. In addition, the individual materials in composite structures should be stable on their own, since structures may break apart over time. The primary danger to unstable designs is that as structures break apart or shift, they may encroach upon and damage natural resources outside of the reef area. For example, the bond between concrete and steel in a certain structure may break, but it is unlikely that either material will be moved.

### **Durability**

Artificial reef materials should be resistant to deterioration and breakup. Durable materials will retain the desired structure and configuration in the marine environment.

## ***Types of Materials***

Artificial reefs have been built from a wide variety of materials over the years. The majority of artificial reef development activities in the United States over the past fifty years have employed construction materials that were previously used or intended for other purposes. Some of these previously used materials have been more suitable than others for constructing artificial reefs. Many artificial reef programs have become dependent on such scrap materials due to their low cost and ready availability. However, it has become evident that a total reliance upon scrap materials may hinder the ability to reach reef development goals and objectives.

Many artificial reef programs employed a number of specifically engineered reef habitat structures. Such structures have become a more viable option for artificial reef development projects because of improved financial support, and a willingness within private industry to develop new and affordable reef materials.

Individual state agencies, in consultation with NOAA and other federal agencies, should be able to define the particular materials that are deemed acceptable for use as reef structures in their coastal and adjacent offshore waters. The decision to allow or disallow the use of particular materials should be based on state and federal regulations and other guidelines, as well as the policies and procedures established by each state. Materials should only be considered if they possess characteristics that allow them to safely meet the established goals and objectives for the artificial reef project under consideration, and present no risk to the environment in which they are being placed. Much of the experience gained by reef programs across the country has been documented. The Atlantic and Gulf States Marine Fisheries Commissions have developed a comprehensive manual entitled, *Guidelines for Marine Artificial Reef Material*, which is based on the experiences of reef programs throughout the country (GSMFC and ASMFC 2004). This document is an excellent source of information on reef materials and has been widely endorsed by researchers, fisheries managers and reef developers as an essential guide for marine artificial reef development, and should be considered when selecting artificial reef material. *Guidelines for Marine Artificial Reef Material* provides detailed information on the benefits and drawbacks

of a variety of materials used in the past by state resource management agencies. The document may be obtained from the Gulf States Marine Fisheries Commission and may be accessed at:

[http://www.gsmfc.org/pubs/SFRP/Guidelines\\_for\\_Marine\\_Artificial\\_Reef\\_Materials\\_January\\_2004.pdf](http://www.gsmfc.org/pubs/SFRP/Guidelines_for_Marine_Artificial_Reef_Materials_January_2004.pdf)

### **Secondary Use and Natural Materials**

Due to their unpredictable availability, most scrap materials used in reef construction can be classified as secondary use materials, or materials of opportunity. Effective artificial reefs have been constructed from secondary use and natural materials. A combination of various materials may provide for the greatest diversity in terms of both biological communities and users. The challenge is to implement state or regional site-specific projects in as cost effective a way as is feasible. Planners should consider transportation, cleaning or other preparation, potential deployment, maintenance, and possible enhancement costs in assessing which materials meet reef development goals. Many *de facto* artificial reefs such as shipwrecks, and gas and oil structures may already be appropriately sited. In such cases, they may only need to be located, enhanced, cleaned or otherwise prepared, and publicized. Other excellent materials may already be at or near suitable development sites. Besides donation or sale of materials, a corporate sponsor, donor, or provider of materials may be willing to assist in transportation, preparation, and deployment needs, especially if confronted with an expensive disposal alternative for these materials.

Although past artificial reef development in most states has been directly tied to the availability of these materials due to budgetary constraints, this may not be the most desirable situation for continued planning and development of reef construction efforts in the future. While a total dependency on scrap materials is not the most effective means of managing reef development activities, some forms of scrap, when available in the proper condition, are very desirable as reef construction materials and should continue to be utilized.

In some instances, natural materials such as quarry rock, limestone, or even shell have been utilized to construct artificial reefs. While these are not by definition scrap materials, their availability is sometimes dictated by a desire to move them from an existing site where for some reason they may no longer be needed. In these cases, they could be classified as secondary use materials. In other cases, as in the intent to build a reef to provide a rocky bottom substrate, material such as quarry rock is obviously the most suitable material for creating the intended habitat.

Individual state artificial reef programs or state and federal resource management agencies, or other approved reef programs, should always serve as the central contact and coordination point for evaluating, approving, distributing, and deploying reef materials on a given state's system of artificial reefs. Before agreeing to approve any materials for use in reef construction, NOAA recommends that the managing or oversight agency should carefully inspect the materials and ensure that they are environmentally safe, structurally and physically stable, needed, practical, and can be deployed in a cost-effective and safe manner. A thorough inspection of potentially suitable materials should be conducted as early in the proposed reef construction effort as possible to minimize wasting time or effort on unsuitable materials.

A detailed discussion of the benefits, limitations and problems encountered in using the almost

limitless list of reef materials that have been employed over the years in the construction of artificial reefs is beyond the scope of this document. The collective experience of the state artificial reef managers over the past several decades has revealed that a number of secondary use materials are unsuitable as artificial reef material. Among those that have been found to be persistently problematic are: wood; fiberglass; plastic; light vehicle bodies; fiberglass boats and boat molds; railroad boxcars; and light gauge metal items, such as refrigerators, washing machines, and clothes dryers. These materials should not be used in artificial reef development, unless specific design features can be employed to provide durability and stability. For instance, plastics and fiberglass can be durable when they are designed with sufficient density to ensure stability. Vehicle tires, although they are problematic, have been used in some limited cases without documented negative impact. In particular, vehicle tires have been embedded in concrete that both encases the tires and may provide enough ballast to ensure stability. However, the Plan recommends that tires not be used as artificial reef materials.

### **Manufactured Reef Structures**

Relying on the availability of suitable secondary use materials for development of a productive system of artificial reefs presents several problems. If an artificial reef program is to function in a manner that is conducive to effective long-term planning, it should not continue to base reef construction solely on the unpredictable availability and diminished quantity of acceptable scrap materials. The only practical solution is to consider the incorporation of manufactured reef structures into planned reef development activities.

Artificial reef structures can be developed which possess the characteristics desired of a reef substrate for a specific purpose. Although the initial costs in procuring these reef materials may be higher than those involved in obtaining many scrap materials, the transportation, handling and deployment costs are typically about the same. Also, the lack of expense in having to clean or otherwise prepare these structures can often balance out this difference completely. Specific qualities of stability, durability, structural integrity, transportability, and biological effectiveness can be engineered into a reef material design, which gives manufactured reef structures a great advantage over most scrap materials, which are limited in how they can be modified or deployed.

Manufactured reef units can be deployed in any quantity, profile, and pattern required. Secondary use materials such as ships should be deployed in a single unit, often with a great deal of the total material volume being taken up in vertical profile. The same volume of designed reef materials that would be found in a vessel can be spread over a much larger area of ocean bottom, allowing for better access to a larger number of reef users.

One of the most significant advantages offered by the use of designed reef structures is the ability to procure them in any quantity as needed. This allows reef managers to plan ahead, make the best use of available funding, and predict costs required for accomplishing specific reef construction objectives. When depending on secondary use materials for reef development, this type of short and long-term planning is rarely possible.

## ***Transfer of Construction Materials***

Donation of materials for reef construction represents an opportunity for both the donor and the program receiving the materials. Such donations have allowed the development of many artificial reefs that otherwise would not have been possible. In most cases, the costs to the donor for providing the reef material have been offset by reduced removal or disposal costs, treatment of the transfer as a charitable donation (to government agencies), and favorable publicity.

### **Incentives**

Potential donors of reef material often face large salvage or disposal costs for retired or surplus materials. These materials could serve as effective reef materials, but additional costs to relocate them on an artificial reef site may be much higher than normal disposal costs. Innovative thinking is needed to identify possible incentives for donors that would allow reef builders to obtain donated reef material that, if fabricated from raw materials, would be very expensive to construct and deploy. This donated reef material, once on site, could increase fishery resources, enhance habitat, and contribute to coastal economies for many years.

### **Alternatives**

The value of donated materials can be used for matching fund requirements in financial assistance where appropriate (e.g., Federal Aid in Sport Fish Restoration Act). This can serve to facilitate transfer of materials to the reef builder and for reef development.

## ***Design Criteria***

The concept of designing artificial reef systems or specific reef structures is one that has been widely used in Japan for a number of years (Sheehy 1983). It has been demonstrated that proper design techniques can greatly affect factors such as biological effectiveness, long-term cost effectiveness, and general performance of the reef or reef system. The design of most artificial reefs in the United States traditionally has been left to chance with the most readily available and cost effective materials being used.

In an effort to improve the manner in which artificial reefs are built, many states are now taking into consideration a number of key design criteria. These criteria are employed in developing reefs that will produce the maximum amount of benefit possible for the biological reef community itself, as well as the users of the reef. Artificial reefs should be constructed, to the extent possible, so that the overall design of the reef, as well as individual reef structures, are tailored specifically to allow the best chance of achieving the intended purpose of the reef.

In furthering the development of effective marine artificial reefs in the United States, artificial reef planners and developers should make every attempt to incorporate the reef design criteria listed below into all artificial reef construction activities.

### **Practicality**

The overall design of the reef, as well as individual reef materials used, should be chosen with an achievable goal in mind. Reef structures utilized should be easy to acquire or manufacture, and their handling, transportation, preparation, and placement on the sea floor should be realistically accomplished within safe and relatively low-risk, cost-effective limits.

### **Effectiveness in achieving reef objective**

The reef layout and materials used should be designed to provide the users of the reef the best possible chance of receiving its desired benefits. Reefs intended for a specific purpose (e.g., trolling, bottom-fishing, SCUBA diving, nursery grounds, etc.) should be constructed with this in mind. Certain materials used in reef construction are more suited for narrowly defined purposes while others are better for general or multiple uses.

### **Reef configuration**

The overall configuration of the materials on a reef will play an important role in determining the reef's utility. Placement of different types of structures on separate parts of the permitted area will provide increased diversity of reef fish assemblages, and also allow multiple uses of the reef site. Divers and fishermen can be separated in this manner, as can troll fishermen and fishermen wishing to anchor over the structure.

### **Reef profile**

The vertical profile of a reef structure may be important in determining the overall fish species composition and biomass of a given reef. Low profile reefs are thought to be most successful in providing a suitable habitat for more demersal species, while high profile reefs appear to work better for many pelagic fishes (Bortone 1994). A combination of high and low profile construction materials can often be utilized within one permitted location to create a reef targeting a potentially more diverse fish assemblage.

### **Interstitial space**

The quantity and nature of interstitial spaces in reef structures are important in determining the degree and complexity of the biological community developing on and around the reef. Numerous holes, crevices, walls and overhangs in a reef structure allow for a much more diverse community in general than that which would develop on a reef material with less structural complexity. Adequate interstitial spaces are necessary to establish a rich diversity of motile invertebrates as well as numerous cryptic fish species. Interstitial spaces may also be a factor in enhancing desired behavior such as increased reproduction, molting, or predator avoidance (Ecklund 1996; Sherman et al. 2001).

### **Total surface area**

In some cases, the total biomass that can be supported on an artificial reef will be directly related to the quantity and quality of effective surface area available. This is particularly true of low profile benthic reefs in which the fouling community of sessile marine organisms achieved on the reef may be important to the subsequent development of the demersal fish community established on and around the reef materials. Many sessile and motile invertebrates are important food items for many of the fish species inhabiting the reefs. The greater the surface area available to these organisms, the more significant the food source available to other levels of the reef community.

### **Circulation patterns surrounding reef materials**

Reef materials should be selected which allow adequate water circulation. This should prevent the stagnation of water in some parts of the reef, which could diminish the productivity of the overall reef. Sufficient water circulation surrounding the reef also allows for better utilization of all surfaces of structures for the establishment of sessile invertebrates, as well as the potential for improved access to fish and motile invertebrates that may be more cryptic in nature.

## **REGULATORY REQUIREMENTS**

### ***Corps of Engineers***

The Corps, in accordance with Section 10 of the RHA of 1899 and Section 404 of the CWA, is responsible for regulating certain construction activities that take place in the waters of the United States. Prior to approval of a permit, other concerned Federal or state agencies and other groups are given the opportunity to review the proposed work to ensure that it complies with existing regulations. This review also helps prevent the approval of projects that might negatively impact other existing or planned activities. It should be noted that the Corps must consult under section 106 of the National Historic Preservation Act (16 U.S.C. §470 et seq.) if it determines that an action may affect cultural resources.

Placement of fill material or structures, such as those used to create artificial reefs, is subject to Corps permitting authority under Section 404 of the Clean Water Act (CWA). When evaluating a CWA Section 404 permit application, the Corps applies the Section 404(b)(1) guidelines, which were developed by EPA in conjunction with the Corps. These guidelines prohibit issuance of Section 404 permits that would cause or contribute to significant degradation of waters of the United States (see Environmental Protection Agency section below for more details on CWA Section 404 and Section 404(b)(1) guidelines). Although “waters of the U.S.” generally extends only three miles from the baseline, the Outer Continental Shelf Lands Act (OCSLA) provides the Corps specific authority under the RHA to permit artificial reefs to the seaward edge of the continental shelf (43 U.S.C. §1331).

### ***Coast Guard***

Often, it is desirable or necessary to mark artificial reefs with buoys as aids to navigation. The USCG manages the private aids to navigation program to ensure that aids conform to certain minimum standards, and to promote the accuracy of information available to mariners. In some cases, aids are required because the artificial reef poses some hazard to navigation. If, for example, an offshore oil or gas structure, which normally must be removed, was left standing as artificial reef material and as a convenient landmark for users of the artificial reef site, it would be a hazard to navigation and need a continuously maintained navigation aid. In other cases, the responsible party may prefer to have a navigational aid for the convenience of those who use the reef, even if it is not required. In either case, it is necessary to submit an application to the commander of the USCG district having jurisdiction.

Some districts have prepared written descriptions of factors they consider critical in evaluating a private aid application for an artificial reef. Reference to these criteria should help reef builders select specific aids for the reef. Prospective reef builders may be able to contract with a local company to install and maintain aids at the site; however, the permittee is responsible for the aid.

As part of the planning process for an artificial reef, the sponsor should be aware that a significant cost might be involved in buying and maintaining the appropriate aids to navigation. Also, reef management should include a mechanism by which the aid is monitored for compliance with the USCG authorization for color and signal characteristics and to ensure that

the aid stays on station.

When an artificial reef is not considered to be an obstruction to navigation, aids established only for the purpose of indicating the presence of a reef to users may be discontinued when construction is completed, if authorized by the USCG District Commander. The USCG District Commander, upon receiving an application from the reef sponsor, will make the decision on when navigational aid is no longer mandatory. Generally, site-specific considerations determine requirements.

### ***Environmental Protection Agency***

Placement of fill material or structures such as those used to create artificial reefs is subject to Corps permitting authority under Section 404 of the Clean Water Act (CWA). CWA Section 404 applies to “waters of the United States,” which as a general matter include most inland waterbodies as well as the territorial seas (which for CWA purposes extend three miles from the baseline). In issuing CWA Section 404 permits, the Corps applies the Section 404(b)(1) guidelines that were developed by EPA in conjunction with the Corps. Those guidelines appear at 40 C.F.R. Part 230 and prohibit issuance of 404 permits that would cause or contribute to violations of applicable water quality standards. Section 404(b)(1) guidelines also generally preclude discharges that would cause or contribute to significant degradation of waters of the United States. In addition, CWA Section 404(c) authorizes EPA to prohibit, withdraw, or restrict the use of defined areas as a dredged or fill material disposal site in any waters of the U.S., including the Territorial Sea, if EPA determines that the discharge will have unacceptable adverse effects on municipal water supplies, shellfish beds and fishery areas, wildlife, or recreational areas. Artificial reef creations beyond the Territorial Sea are regulated under Section 10 of the Rivers and Harbors Act of 1899.

Under the Liberty Ship Act, which allows states to apply to the Secretary of the Department of Transportation (DOT) for use of obsolete vessels to create artificial reefs, the state application to the DOT must include a certification from EPA that the proposed use of the vessel will be compatible with “applicable water quality standards and other appropriate environmental protection requirements” (16 U.S.C. §1220(b)).

### ***National Oceanic and Atmospheric Administration***

#### ***National Marine Fisheries Service***

#### **Magnuson-Stevens Fishery Conservation and Management Act**

NMFS, in cooperation with the FMCs, has responsibility under the Magnuson-Stevens Fishery Conservation and Management Act to rebuild, restore, and maintain fishery resources in the EEZ. Also under this act, NMFS must develop guidelines on essential fish habitat (EFH) in order to assist the FMCs in amending fishery management plans. These guidelines have been developed and EFH has been incorporated in FMC fishery management plans. Under these provisions, artificial reefs may be designated as EFH.

The Magnuson-Stevens Fishery Conservation and Management Act provides that federal agencies must consult with the Secretary of Commerce on all actions, or proposed actions,



authorized, funded, or undertaken by the agency, that may adversely affect Essential Fish Habitat (EFH). The Secretary must provide recommendations to conserve EFH (which may include measures to avoid, minimize, mitigate, or otherwise offset adverse effects on EFH) to federal or state agencies for activities that would adversely affect these habitats. EFH regulations encourage the FMCs and NMFS to cooperatively identify actions that may adversely affect EFH. The FMCs are required to comment and, when appropriate, make recommendations to the Secretary of Commerce or any federal or state agency whose action is likely to substantially affect habitat of an anadromous fishery resource. Regulations for implementing the EFH coordination and consultation provisions of the Magnuson Stevens Act are at 50 CFR 600.905-930. These regulations provide definitions, guidelines, and requirements on performing EFH consultations and incorporating them into existing agency procedures, and alternatives to individual EFH consultation.

### **Endangered Species Act**

The Endangered Species Act (ESA) (16 U.S.C. §§1531-1543) provides a means whereby the ecosystems upon which endangered or threatened species depend may be conserved, and to provide a program for the conservation of such endangered and threatened species. If a Federal action may affect ESA-listed species, the action agency must initiate consultation with NMFS under section 7 of the ESA. In the context of artificial reefs, a consultation's effects analysis would consider materials, contaminants, or physical/mechanical characteristics that may affect listed species.

### **Fish and Wildlife Coordination Act**

The Fish and Wildlife Coordination Act (FWCA) (16 U.S.C. §§661-666c) requires that wildlife, including fish, receive equal consideration and be coordinated with other aspects of water resource development. This is accomplished by requiring consultation with the U.S. Fish and Wildlife Service, NMFS, and appropriate state agencies, whenever any body of water is proposed to be modified in any way and a Federal permit or license is required. These agencies determine: (1) the possible harm to fish and wildlife resources; (2) the measures needed to both prevent the damage to and loss of these resources; and (3) the measures needed to develop and improve the resources, in connection with water resource development. NMFS submits comments to Federal licensing and permitting agencies on the potential harm to living marine resources caused by the proposed water development project, and recommendations to prevent harm.

### **Marine Mammal Protection Act**

The Marine Mammal Protection Act of 1972 (MMPA) (16 U.S.C. §§1361-1421h) establishes a federal responsibility to conserve marine mammals, with management vested in the Department of Commerce for cetaceans and pinnipeds other than walrus. The Department of the Interior is responsible for all other marine mammals, including sea otter, walrus, polar bear, dugong and manatee. The MMPA generally assigns identical responsibilities to the Secretaries of the two departments.

The MMPA also provides that the Secretaries shall allow the incidental, but not intentional, taking, by U.S. citizens engaged in activities other than commercial fishing (e.g., offshore oil and gas development). NOAA may issue two types of authorizations pursuant to section 101 of the MMPA (implementing regulations at 50 CFR 216.101-108). Incidental Harassment

Authorizations (IHA) are for activities with no potential for mortality or serious injury while utilizing required mitigation measures. Letters of Authorization (LOA) are for activities that may result in injury or mortality despite utilizing required mitigation measures.

### **Other Pertinent Laws**

NMFS also has general authority under the Fish and Wildlife Act of 1956 (16 U.S.C. §§742a-742j), the Anadromous Fish Conservation Act of 1965 (16 U.S.C. §§ 757a-757g) and the Interjurisdictional Fisheries Act 1989 (16 U.S.C. §§ 4101-4107) to cooperate with the states in conserving and managing fishery resources in the Territorial Sea. Further, under Section 804 of the Atlantic Coastal Fisheries Act, the Secretary of Commerce, in consultation with the Secretary of Interior, "...shall implement a program to support interstate fisheries management efforts ... [which] ... shall include habitat conservation ..." (16 U.S.C. §5101 et seq.).

### **National Ocean Service**

#### **National Marine Sanctuaries Act**

The National Marine Sanctuaries Act (Title III of the Marine Protection, Research, and Sanctuaries Act, 16 U.S.C. §§ 1431-1445c-1) (NMSA) provides NOAA with the authority to protect and manage the resources of significant marine areas of the United States. NOAA's administration of the marine sanctuary program involves designating marine sanctuaries and adopting management practices to protect the conservation, recreational, ecological, educational, and aesthetic values of these areas. The NMSA requires any federal agency action inside or outside the boundaries of a National Marine Sanctuary (sanctuary), including issuance of a license or permit, that is likely to injure the resources of a sanctuary to provide the Secretary of Commerce with a written statement describing the action and its potential effect on sanctuary resources. This statement of sanctuary resource impacts must be prepared at the earliest practicable time before final approval of the federal action or federal permit. In no case shall the statement be provided to the Secretary later than 45 days prior to the approval of the federal action. If the Secretary finds that the federal action or permit is likely to injure sanctuary resources, the Secretary will recommend reasonable and prudent alternatives to the proposed action which may include choosing an alternative location for the federal activity or federally permitted activity. The federal agency must promptly consult with the Secretary of Commerce on the recommended alternatives and provide a written explanation if the federal agency chooses not to follow the recommended alternatives provided by the Secretary of Commerce. In addition, the NMSA prohibits the destruction, loss of, or injury to any sanctuary resource and any violation of the Act, any regulations, or permits issued pursuant to the NMSA. NOAA is required to conduct such enforcement activities as are necessary and reasonable to carry out the Act. The NMSA also establishes liability for response costs and natural resource damages for injury to sanctuary natural resources. Under the Act, NOAA may undertake or authorize all necessary actions to prevent or minimize the destruction or loss of, or injury to, sanctuary resources, or to minimize the imminent risk of such destruction, loss, or injury. Furthermore, NOAA must assess damages to sanctuary resources. NOAA is required to use recovered response costs and damages to finance response actions and damage assessments to restore, replace or acquire the equivalent of the injured sanctuary resource, and to manage and improve national marine sanctuaries. NOAA is also required to conduct research monitoring, evaluation,

and education programs as are necessary and reasonable to carry out the purposes and policies of the NMSA.

### **Coastal Zone Management Act**

Section 307 of the Coastal Zone Management Act (CZMA) (16 U.S.C. § 1456), called the federal consistency provision, requires federal agencies proposing activities, including artificial reef planning and construction, that have reasonably foreseeable effects on any land or water use or natural resource of a state's coastal zone (also referred to as coastal uses or resources and coastal effects) to conduct their activities in a manner consistent to the maximum extent practicable with the enforceable policies of a coastal state's federally approved coastal management program. (Federal agency activities are activities and development projects performed by a federal agency, or a contractor for the benefit of a federal agency.) *See* 16 U.S.C. §§ 1456(c)(1) and (c)(2) and NOAA's regulations at 15 C.F.R. part 930, subpart C for federal consistency procedures for federal agency activities. Federal license or permit activities, e.g., an Army Corps of Engineers permit to a non-federal entity to construct an artificial reef, and federal financial assistance activities that have reasonably foreseeable coastal effects must be fully consistent with the enforceable policies of state coastal management programs. (Federal license or permit activities are activities proposed by a non-federal applicant requiring federal authorization, and federal financial assistance activities are proposed by state agencies or local governments applying for federal funds for activities with coastal effects.) In most cases, artificial reef construction permits to be issued by the Army Corp will likely be subject to state CZMA review. *See* 16 U.S.C. § 1456(c)(3)(A) and NOAA's regulations at 15 C.F.R. part 930, subpart D for federal consistency procedures for federal license or permit activities, and 16 U.S.C. § 1456(d) and NOAA's regulations at 15 C.F.R. part 930, subpart F for federal consistency procedures for federal financial assistance activities.

### ***Minerals Management Service***

Current MMS regulations (30 C.F.R. §1730) allow the appropriate conversion of retired platforms for reefs when such platforms are permitted and designated for use by a state artificial reef program and within areas established for receipt of platforms for the enhancement of habitat for fish and other aquatic life.

### ***States and Local Governments***

Coastal states have the authority to regulate artificial reef development activities and the disposal of solid materials into coastal waters under their jurisdictions. Many states have adopted artificial reef plans that contain guidelines and regulatory provisions to control artificial reef development activities. The Coastal Zone Management Act (16 U.S.C. §1450 et seq.) provides that any federal activities that are likely to affect any land or water use or natural resource of the coastal zone must be consistent, to the maximum extent practicable, with the enforceable policies of the coastal state's CMP.

It is strongly recommended that states, if they have not already done so, establish penalties for illegal disposal of solid materials in coastal waters, and for violating artificial reef regulations. Such penalties should be substantial enough to deter those illegal activities, and should at least

be compatible with any penalties established for similar violations in federal waters.

In some cases, a survey to locate possible archeological sites may be required by a state before approval of a permit. Other state and/or local permits may be required. Many Corps districts have working agreements with state agencies for joint processing of permits. Where available, this arrangement will streamline the overall permitting process.

## **Construction**

Successful artificial reef construction is ultimately determined by the ability of managers to predict and plan on-site deployment of materials. This process should begin well before field operations with pre-site surveys, decisions on material options, deployment techniques, design choices, and permitting. Throughout the planning process, managers and permitting agencies should assess the possible effects of major storms, especially the effect on material stability and structural integrity.

Another important pre-placement consideration is the selection of an accessible material staging site that will allow safe and efficient construction, storing, and loading of materials. Equipment and personnel needed to handle the materials should be readily available at the site to: 1) allow construction of the reef during favorable weather conditions; 2) coordinate with donated or contracted services such as towing and other volunteer or contracted assistance; and 3) reduce unnecessary delays.

Preplanning among involved agencies not only clarifies mission objectives, but also ensures that all participants are aware of planned reef material configurations and orientations. Careful attention to planning details can assure the final success of the project. For example, reef planners should:

- 1) acquire an adequate environmental and biological database of the site;
- 2) select safe weather and water conditions appropriate to the type of transportation and construction technique;
- 3) employ reputable and competent personnel;
- 4) coordinate with any biologists, oceanographers, or engineers studying the reef;
- 5) coordinate with USCG or local marine police;
- 6) assure that all equipment is tested, sufficient for the task to be performed;
- 7) obtain liability insurance, if needed, to protect all involved (see Liability section);

- 8) assure that all pre-surveyed sites can be successfully relocated and are clearly marked by project coordinators prior to arrival of materials;
- 9) maintain staging area(s) to be compatible with the surrounding neighborhood and to avoid potential conflicts at the staging area(s);
- 10) stage and deploy primary or emergency navigational aids, as required;
- 11) manage the flow of raw materials to the staging area and the movement of completed units to the reef site;
- 12) assess daylight and other operational constraints;
- 13) supervise any required clean-up after placing reef materials on the site (e.g., overlooked floatables);
- 14) be prepared to cancel operations if necessary to ensure the safety of participants and the proper placement of materials; and
- 15) secure funding and other support to complete construction.

## **Management**

### ***General***

Artificial reefs may be used to help promote the management and conservation of fishery resources. To be most effective, artificial reefs should be developed using clear, specific, realistic, and measurable objectives. With specific objectives in mind, reef developers/managers should choose and plan strategies and reef characteristics that will best meet their goals. Reef management should begin with the objective(s) for a reef and continue for the life of that reef. Once an artificial reef has been constructed, another important phase of reef management begins - monitoring and maintenance.

Specific management strategies will depend on the objective(s) of the reef and compliance with existing regulations or resource management programs. Generally, the FMCs develop and recommend management strategies in the Exclusive Economic Zone for fishery resources and users through specific FMPs. Coastal fishery resources that migrate between jurisdictions also may be regulated through interstate FMPs developed and implemented by the member states of

the respective IFMC. There are also statutory and regulatory requirements that must be followed when designating EFH in the management of the species covered under a specific FMP. NOAA, FMCs, and IFMCs should be consulted at the earliest possible time in the artificial reef construction process, as they are a major source of information about the fisheries resources and can help identify potential conflicts or issues of compatibility of a proposed reef project.

SMZ designation is one alternative for maintaining compatibility of reef development with fisheries management objectives. The FMPs for groupers and snappers in the Gulf of Mexico and the South Atlantic, as well the Atlantic black seabass FMP, contain SMZ language specific to artificial reef development and use in these fisheries. The State of New York also has implemented new reef-use rules that include SMZ-type authority over natural and artificial reefs and wrecks. Artificial reefs designated as SMZs offer reef managers much more flexibility to effectively utilize reefs as fishery management tools by providing a degree of regulatory control that otherwise would not exist. Reefs can be planned, designed and developed with specific management objectives in mind (e.g., stock enhancement of a group of fish species in a particular environment) and be supported by the regulatory language for an SMZ. SMZs or similar regulatory measures allow artificial reefs to be used as non-traditional fishery management tools.

States should be the primary source of management advice pertaining to artificial reefs in their coastal waters. For any artificial reef in the EEZ, any fishery management measures should be coordinated with the appropriate fishery management council and NMFS regional office. Since publication of the 1985 Plan, about half of the coastal states in the United States have developed marine artificial reef plans. States with artificial reef programs are encouraged to update their plans periodically, and the remaining states are encouraged to develop site-specific artificial reef plans for areas within their jurisdiction and in adjacent waters. These plans facilitate development and management of artificial reefs in a responsible manner, based on user needs and the best technical or scientific information available. Such plans also can deter haphazard development by non-state entities. In the event private individuals or organizations seek to construct artificial reefs, NOAA encourages these entities to work closely with state and federal agencies to ensure compliance with all applicable laws, regulations, permit conditions and artificial reef guidelines. NOAA recommends that reef builders, sponsors, scientific advisors, or management entities involved in artificial reef development identify and apply criteria to assist in determining whether reef objectives are being met. These standards could include a measure of the following:

- 1) increase in any number or combination of resource variables (number of fish per unit area or biomass per unit area);
- 2) increases in harvest (catch per unit of effort) or an increase in the average size of fish caught;
- 3) increases in the number of fishermen using an area; or

- 4) reduction in user conflicts or changes in other socioeconomic factors affecting the specific purpose of the artificial reef.

Information gathered from monitoring can be used to test predictions made in the planning phase about the designs, materials, or total structure of an artificial reef. The results of these tests can be used to:

- 1) improve or refine siting or design;
- 2) evaluate benefits/costs;
- 3) effect regulations to protect stocks from overharvesting or to resolve user conflict; and
- 4) propose alternative management strategies or options.

Management should provide:

- 1) public or administrative awareness about the effectiveness of the artificial reef programs;
- 2) assurance of adequate long-term funding for the program;
- 3) encouragement of research on artificial reefs; and
- 4) documentation of reef development and effects.

Availability of information to reef users is critical. Whenever possible, artificial reef builders should develop and distribute public information brochures and flyers describing:

- 1) reef locations;
- 2) fishing conditions at each site;
- 3) applicable fishing regulations or site restrictions (e.g., observance of diving flags, anchoring guidelines, fishing gear restrictions, and catch limitations); and
- 4) tips on courtesies that should be extended to other reef users.

Reef design and the effective use of buoys can be important parts of artificial reef management. Reefs with numerous clumps of material can provide more anglers with better fishing and fewer conflicts than a single clump reef. Buoys can be used to place anglers over productive fishing areas of the reef. For example, the State of Washington has constructed reef structures in different areas within the permitted reef site to direct fishing effort by buoy placement. The state places some reef site structure away from the reef buoy(s) to minimize the chance of anglers locating the material. This creates small reserves, or less heavily fished areas, which could be buoyed later if overharvest occurs on the areas buoyed initially.

### ***Monitoring***

There are two primary reasons for establishing monitoring programs as part of reef management, including compliance and performance monitoring. The first is to assure compliance with the conditions defined in any authorizing permits or other applicable laws or regulations (see Act, Section 205b). The second is to provide an assessment of the predicted performance of reefs and assure that the reefs meet the general standards established in Section 203 of the Act.

The specific monitoring strategies will depend on the degree of compliance required and the objectives and resources of the reef builder. The information obtained should be useful for improving existing reefs and for building effective reefs in the future.

#### **Compliance Monitoring**

Specific compliance monitoring requirements will be determined by governing law, regulations, and conditions for approval of the various required permits (e.g., USCG permits, Corps permits, state permits, and conditions of consistency concurrence for Coastal Zone Management purposes). The degree to which federal, state, or local agencies will carry out compliance inspections of an artificial reef also will be governed by applicable law, regulations, and the conditions of approval for the permit(s) under which the artificial reef is authorized. Generally, for compliance monitoring, recording and reporting requirements should meet the conditions of the governing permit.

Compliance monitoring should involve the documentation of material stability and structural integrity throughout the life of the reef, and may be conducted through the use of simple bathymetric surveying instrumentation, such as hull mounted depth recorders. When available, more sophisticated gear such as side-scan sonars or magnetometers may be useful in mapping out the positions of artificial reef materials when deployed over a large area. Accurate and repeatable navigational data establishing reef material positions are essential. Compliance monitoring surveys often may require the use of visual confirmation of reef material obtained through observations provided by SCUBA divers. Cable-controlled cameras, as well as remotely operated vehicles with cameras, also may be used when practical or available, especially when water depth or sea conditions preclude the use of divers.

#### **Performance Monitoring**

Performance monitoring assesses the physical, biological and socioeconomic factors essential in documenting the degree of success as well as all impacts of a given artificial reef or reef system



(Bohnsack and Sutherland 1985; Seaman 2000). Performance monitoring involves the on-going evaluation of an artificial reef to determine whether or not the reef is accomplishing the purpose(s) for which it was established. This type of monitoring also can detect whether the reef is having any unexpected negative consequences, as well as provide a great deal of insight into the need for future modifications to construction techniques, identifying research priorities and documenting the need for alternative management strategies or new regulations.

### **Engineering Assessment**

The long-term success of artificial reefs ultimately is dependent upon the reef materials remaining in place and continuing to provide a durable, safe and effective substrate for the foundation of the reef community itself. Continued performance monitoring of artificial reefs over the years provides a mechanism by which to evaluate and learn from the efforts of both past and present reef construction activities, thus allowing for improvements in future reef development techniques.

Stability and structural integrity are critical factors involved in evaluating the success of a particular type of reef material from an engineering standpoint. Remote sensing can be used to monitor compliance with regulations on reef structure movement. The information gained through the *in situ* engineering evaluation of artificial reef materials should be well documented and used carefully in considering future reef design. Certain materials will be better suited for applications in specific reef environments (offshore versus nearshore versus estuarine) and some will be found which do not meet acceptable standards for continued use under almost any conditions.

### **Biological Assessment**

Many marine artificial reefs are constructed for the purpose of improving local ecology (Bohnsack and Sutherland 1985; Lindberg and Relini 2000; Seaman and Jensen 2000). With this in mind, a detailed biological assessment of the positive and negative impacts of the reef should be conducted as required by law. In most cases, this can be done through underwater observations and through data collected during routine reef monitoring activities. Monitoring can provide a great deal of information regarding the degree of development of the reef community, and indicate the success of the reef in producing both short-term and long-term results in enhancing desired finfish populations. Additional quantifiable data also may be collected regarding many other important ecological aspects of an artificial reef, and include the following:

- 1) an accounting of development of sessile invertebrate communities on different types of structures;
- 2) the degree of interaction between motile reef species and the surrounding sediment communities;
- 3) importance and degree of interaction between fish communities and invertebrate communities associated with the reefs; and
- 4) association of key target fish species by life history stage with certain reef designs or

locations and long-term changes which may take place in reef community structures as reefs age.

One obvious advantage of this type of monitoring program is the ability to detect and quickly document any negative consequences from reef construction or utilization practices. Managers can then respond in a timely manner to modify existing policies, practices or regulations. Biological monitoring of existing reefs is also critical in identifying research priorities for gaining a better understanding of how artificial reefs work and how they can be best used to meet fisheries management objectives.

### **Fisheries Assessment**

While marine artificial reefs can be constructed for various reasons, the most commonly encountered use of reefs is to enhance various fishing activities (Ditton and Graefe 1978; Myatt 1985; Polovina 1991; Rhodes et al. 1994). Any reliable measurement of the success of a given reef or system of reefs in these cases would naturally involve evaluating quantifiable changes in the fishery it was designed to enhance. It is recommended that routine collection of data, such as species commonly caught, catch per unit of effort, total catch, effectiveness of individual gear types or fishing methods, use patterns, and seasonal harvest rates be maintained throughout the life span of a reef. This information provides a baseline for evaluation of the effectiveness of the reef.

Monitoring activities designed to obtain information such as this will greatly assist reef managers in determining potential impacts on individual fish populations as well as the effects of individual fishing practices or gear types. Information obtained will be essential in allowing fisheries resource managers to make logical decisions regarding the need for new regulations, changes in fishing practices, specific needs in public education, and the need for additional detailed data, obtainable through directed research activities.

### **Socioeconomic Assessment**

The impact of the reef(s) on a variety of social and economic factors within a given region of interest (state, county, municipal, etc.) is a key element in measuring the overall success of any artificial reef or system of reefs, and provides a basic measurement in cost/benefit analyses. Monitoring should be conducted on a relatively frequent basis to accurately document any measurable benefits that could be used to determine the overall cost-effectiveness of reef development, construction and maintenance efforts. Such factors as direct and indirect economic benefits, improved quality of fishing, increased fishing safety, decreased fuel consumption per trip, lessened or increased user conflicts, changes in fishing patterns or techniques, as well as others, should be routinely examined to determine the overall impact of the reefs.

### ***Maintenance***

Maintenance also should be part of a reef program. Certain maintenance may be necessary to comply with permit conditions (buoys, materials scattering, etc.). Additional maintenance, to the extent authorized by law, can enhance reef effectiveness (e.g., removing entangled fishing gear, repositioning buoys, and adding materials).

### **Maintenance to Comply with Permit Requirements**

When buoys are utilized, they must be maintained to comply with USCG permit requirements. This may involve painting, repair, or complete replacement of badly deteriorated buoys or mooring systems. If monitoring reveals that a buoy does not mark the actual location of the reef, either because it was deployed inaccurately, or because the materials or the buoy have moved, the buoy may need to be repositioned or the permit modified.

### **Maintaining Reef Effectiveness**

If monitoring reveals that the reef materials were inappropriate for the substrate, resulting in sunken or covered material, then maintenance might include deploying additional materials more suited to the site conditions. This maintenance also may be the answer to more complex biological problems, such as failure to attract the target species. Additional higher or lower profile material might provide the missing habitat.

### **Maintaining Documentation**

Accurate documentation of a reef's developmental stages, especially the addition of materials, is important for determining reef effectiveness and long-term costs. Documentation should include the types of reef materials, deployment dates, locations of various materials on the reef, and fish species present. Whenever possible, information should be recorded on fishermen and diver use of the artificial reef.

## **Liability**

Improper artificial reef placement can potentially injure persons, property, and natural resources. Risks include, but are not limited to:

- 1) injuries to personnel handling the reef materials;
- 2) damage to vessels transporting reef materials;
- 3) improper location causing damage to fishing gear;
- 4) damage to vessels in transit over the reef;
- 5) damage to buried pipelines and cable;
- 6) injury to recreational divers;
- 7) decomposition or movement of the reef material to an unauthorized location;

8) environmental hazards caused by incomplete cleaning of hulls or holds containing toxic residues; or

9) damages to existing natural resources such as crushing live coral reefs.

Section 205(c) of the Act addresses the liability issue from the perspectives of: 1) the reef permittee; 2) the materials donor; and 3) the Federal government. Issues of liability that are not addressed by the statute will require reference to maritime law, sovereign immunity, and traditional tort concepts.

Described below is a typical process that culminates in the actual placement of reef materials in navigable waters of the United States and waters superjacent to the outer-continental shelf. There are several stages in this process.

### ***Plan and Permit Stage***

The Act requires the Secretary of Commerce to publish a long-term plan that will establish criteria for design, construction, and siting of artificial reefs. This Plan and the statutory standards of Section 203 of the Act and the Corps regulations at 33 C.F.R. §322 guide the Corps in its decision to issue the permit required to begin construction. According to Section 203, the materials to be used for the reef must minimize environmental risks, and the placement of the reef must not create an unreasonable obstruction to navigation.

The Act creates no liability on the part of the United States. The Suits in Admiralty Act (46 U.S.C. Appx §741 et seq.) is the basic remedy for injuries or damage resulting from maritime actions of the Federal government. Under this statute, if the Corps negligently authorized placement of a reef on top of a pipeline or undersea cable or in shallower water than intended, the United States might be sued for any damages that resulted from that negligence. In this respect federal sovereign immunity has not been waived. As a result, an intentional Federal government decision to permit a reef in a particular place, or to require certain materials for construction, would not create liability even if there were some risks involved, assuming that the explicit requirements of the Act had been satisfied.

### ***Construction Stage***

When a permit has been obtained, the materials should be transported to the reef site and properly located, anchored, and marked. The Act does not address the transportation phase. Maritime accidents or injury to crew, grounding, premature discharge, collision, and/or sinking could occur.

The Act states that: “Any person who has transferred title to artificial reef construction materials to a person to whom a permit is issued in accordance with subsection (a) of this section shall not be liable for damages arising from the use of such materials in an artificial reef, if such materials meet applicable requirements of the plan . . . and are not otherwise defective at the time title is transferred.” It would therefore be in any donor's interest to verify that the materials meet the Plan guidelines and to document title transfer.

The actual placement of materials in the water will usually involve private parties, either volunteers to, or contractors of, the permit holder. Since the permit will specify the location and procedures for placing and marking, the permit holder could be liable for any damages resulting from a failure to follow those specifications (see Act, Section 205(c)(2)). Conversely, strict adherence to these requirements of the permit may immunize the permit holder from liability for injuries resulting from those required activities (see Act, Section 205(c)(1)).

### ***Monitoring Stage***

When a reef has been properly located, marked on navigation charts if necessary, and any required surface markers affixed, liability may be minimized. Unless the reef breaks up or moves to a different location, or the marker buoys become detached, sink, or are otherwise destroyed, it would be each vessel owner's responsibility to avoid collision. The Plan suggests, and each permit may contain, requirements for systematic monitoring of each new artificial reef. To diminish liability, permit holders should follow these requirements, and other provisions required by relevant federal, state and local authorities.

Diving accidents may occur with use by recreational divers. In this respect, an artificial reef is like a public park. There are dangers in most parks, guardrails and fences cannot be placed everywhere, and everyone who visits the park assumes some risk of injury. Consideration should be given to a warning being placed on nautical charts and posted in local dive shops to alert people of these dangers.

## **SOURCES OF INFORMATION AND RESEARCH NEEDS**

### **Synopsis of Information Sources**

In recent years, the amount of information available on the design, construction, use, ecology, and effectiveness of artificial reefs has increased dramatically. Academic institutions, state and federal fishery management agencies, IMFCs, and in some cases, county or local groups, have studied or sponsored studies on multiple aspects of artificial reefs and their use as fishery management, habitat management, or ecological research tools. These studies have resulted in a rapidly expanding body of information that is available from a variety of sources, including electronic databases, published papers, and reports. Some of the most comprehensive individual sources of artificial reef information are the papers published as proceedings of international artificial reef and habitat conferences and from other conferences or workshops. While information on artificial reefs has increased, resource managers still require more and better fishery science and information to enable artificial reef programs to have maximum sustained beneficial results at lowest costs, and to avoid situations where reefs are found to be detrimental to resources or users. The process to improve dialogue among reef managers, those engaged in or considering reef research, and the agencies capable of, or responsible for, providing support to reduce information gaps should continue.

### **Research Needs**

Most coastal states, and some territories, such as Puerto Rico and Pacific Islands, have artificial reef programs. Many have, or are developing, their own statewide artificial reef plans to define objectives and guide long-term construction and evaluation efforts, as recommended in the original Plan. These state plans can be examined as sources of local or regional information on the use of artificial reefs and are readily available from marine fisheries agencies in the specific state. Other artificial reef information, such as location of each artificial reef and the types of material used, may be available from these agencies.

Most state artificial reef programs use Federal Aid in Sport Fish Restoration funds to construct and monitor their artificial reefs. The National Sea Grant Program also supports some artificial reef studies. This type of funding usually requires progress or completion reports on the specific activities being funded. These reports can provide additional technical information on artificial reefs. The reports often cover angler use surveys, construction methods, design/materials assessment, and programmatic evaluations.

A compilation of the results of a worldwide survey of artificial reef research needs conducted by the ASMFC was reported in 1990 (Steimle et al. 1990). The survey queried resource managers on major research or information needs to plan, construct, maintain, and manage marine and estuarine artificial reefs for fisheries. Even though knowledge of artificial reefs has increased, many of the information needs identified were practical, reflecting a need to be more effective and efficient in developing reefs and documenting benefits. There also was a concern for the role that reefs have on sustainable fishery populations. In brief, artificial reef program managers and fishery managers believe more research and information is required in the following areas, listed in order of priority.

### ***Estuarine Applications***

The highest level of interest expressed by reef managers was on the use of artificial reefs in estuaries. The need to know if artificial reefs would support the various life stages of estuarine-dependent fishery resources in the highly variable estuarine environment is of great interest. Also, it is necessary to determine what level of use such reefs can support.

### ***Understanding Reef Community Ecology***

The second leading concern is how physical aspects of artificial reef habitat can limit or enhance reef resource abundance and productivity. Managers need to define relationships and possible effective limits or thresholds among reef characteristics, such as area/size, edge habitat, aspect ratio, cubic volume, etc., and ecosystem functions. There also is interest in the ways reefs are used by species, such as temporal abundance patterns and interactions among species on artificial and natural reefs.

### ***Reef Population Life Histories***

Reef program managers need to know how artificial reefs support various life stages of reef species, especially juvenile, and the mechanisms involved. Do artificial reefs enhance prey fields and availability, and the growth rates of reef population cohorts? What are the resource migration ranges and pathways? While resources are using artificial reefs, is there a difference in natural and fishing mortalities as compared to other habitats?

### ***Bioengineering and Design***

Increasingly, artificial reef managers want to know how artificial reefs can be designed or used to address the needs of specific life stages of reef resources, such as juveniles. This requires an understanding of specific habitat functions and the needs of these life stages.

### ***Harvest Analysis***

Artificial reef program managers need data on rates of sustained harvest for various reef resources. Fishery managers need data defining the fishing effort on reefs by various users to assess the potential to control harvests of associated resources. They are also interested in knowing if artificial reefs can be resource conservation refuges without costly enforcement. The prolonged effects to fish populations of different types of artificial reefs and associated special management zones are also of interest.

### ***Reef Population Dynamics***

Reef program managers feel that a definition of the structure and dynamics of reef populations is needed to understand stock/fishery interactions. They also want to know how spacing of reefs, reef materials and condition (height, complexity, overall size, epifaunal state, etc.) affect resource recruitment and stock structure and size. Do artificial reef populations differ from those of the rest of the population in a region and does this difference change with time as artificial reefs mature?

### ***Socioeconomics***

This aspect of fishery science is often overlooked or under-utilized by reef resource managers. Managers generally want the public benefit of their programs documented. They want to know who uses the reefs and to what extent. Managers need to know the cost-benefit relationships among reef types, materials, designs, and deployment methods, and how these relate to fishery productivity or other factors, such as user accessibility.

### ***Community Production***

Managers want to define any relationships between reef size, configuration and location, and productivity, in terms of standing stocks, yield to fisheries, and resource growth and survival rates. Does the law of diminishing returns apply to reef productivity, especially fishery resources, after a certain reef size or density threshold is reached? There is a need for real-world data. Results from a standing stock or production study of a few cubic yards of experimental reef structure may not apply to programs that use acres and thousands of tons of reef material, and to fish that require larger habitats. Food webs and food chains need to be defined and quantified and trophodynamic models developed to understand how much and what kinds of food must be produced to support sustained reef resource populations. Managers also want quantitative data on productivity of reef fish, invertebrates, and plant communities to enable comparisons within and among reefs and other habitats.

### ***Reef Data Acquisition and Distribution***

Artificial reef managers need better databases to develop predictive models of the effectiveness of reef designs and deployments. Cost effective, standardized data acquisition methods must be formulated to reduce high labor costs and produce comparable data. A national mapping and tracking component would facilitate information exchange and aid in determining management objectives and future locations of artificial reefs.

### ***Mitigation***

The use of artificial reefs as mitigation for loss of dissimilar habitat has been and will continue to be a controversial topic. Attempting to replace like-for-like habitat is difficult enough, especially functionally. This problem is compounded when reef habitat is used to compensate for losses of other habitat types, even when there are no feasible alternatives. The use of artificial reefs continues to be proposed as habitat loss mitigation, and fishery habitat managers need information on the ability of reefs to replace other habitats.



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## **ABBREVIATIONS**

Act - National Fishing Enhancement Act of 1984 (Title II of PL 98-623)  
Atlantic Coastal Fisheries Act - Atlantic Coastal Fisheries Cooperative Management Act (PL 103-206) of 1993  
ASMFC - Atlantic States Marine Fisheries Commission  
CERCLA - Comprehensive Environmental Response, Compensation and Liability Act  
CFR - Code of Federal Regulations  
Corps - U.S. Army Corps of Engineers  
CWA - Clean Water Act  
DO - dissolved oxygen  
DOC - U.S. Department of Commerce  
DOD - U.S. Department of Defense  
DOI - U.S. Department of the Interior  
DOT - U.S. Department of Transportation  
EEZ - Exclusive Economic Zone  
EFH - essential fish habitat  
EPA - Environmental Protection Agency  
FMCs - regional fishery management councils  
FMPs - fisheries management plans  
GPS - global positioning systems  
GSMFC - Gulf States Marine Fisheries Commission  
HAPC - Habitat Areas of Particular Concern  
IMFCs - interstate marine fisheries commissions  
MARAD - Maritime Administration  
MMS - Minerals Management Service  
MPRSA - Marine Protection, Research and Sanctuaries Act  
MRFSS - Marine Recreational Fishery Statistics Survey  
NMFS - National Marine Fisheries Service  
NOS - National Ocean Service  
OCS - outer continental shelf  
OCSLA - Outer Continental Shelf Lands Act  
OPA - Oil Pollution Act of 1990  
ORR - Office of Response and Restoration  
PSMFC - Pacific States Marine Fisheries Commission  
Plan - National Artificial Reef Plan  
RHA - Rivers and Harbors Act of 1899  
SMZ - Special Management Zone  
USCG - U.S. Coast Guard  
USFWS - U.S. Fish and Wildlife Service

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