Policy Report

Massachusetts Division of Marine Fisheries
Policy Report PR – 1

Massachusetts Marine Artificial Reef Plan

M. A. Rousseau

Draft

Massachusetts Division of MarineFisheries
Department of Fish and Game
Executive Office of Environmental Affairs
Commonwealth of Massachusetts

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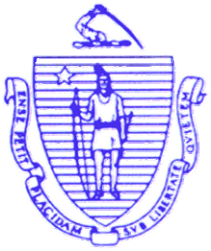

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Executive Summary

In 1984, Congress enacted the National Fishing Enhancement Act (NFEA), authorizing the National Oceanic and Atmospheric Administration (NOAA) to establish national guidelines providing direction for individual states to develop site-specific artificial reef development plans. The National Marine Fisheries Service (NMFS) compiled The National Artificial Reef Plan (NARP) in 1985, providing general guidelines to states for artificial reef siting, materials and design, permitting, monitoring, and management strategies. The Massachusetts Division of Marine Fisheries (*MarineFisheries*) first began formal involvement with reef deployment in the 1970's when technical assistance was provided to the Town of Yarmouth for the siting of a tire reef in Nantucket Sound. Two additional reefs have been deployed in MA waters; however, these projects were developed on an *ad hoc* basis, with no sanctioned state policy to guide the permitting agencies. Interest in artificial reefs continues to increase, resulting in a greater demand for their creation by user groups, conservationists, and governmental agencies. In order to prepare for this demand, this plan has been developed to guide the construction, management, and monitoring of artificial reefs in state waters.

It is important to evaluate the current state of knowledge on artificial reefs and understand how this information relates to an artificial reef program for Massachusetts. Renewable fisheries resources are important to the economy and culture of coastal communities in Massachusetts. Spatial and temporal variability of climate and oceanography along the Massachusetts coast affect species diversity, abundance, and species composition on a localized scale not experienced by other Atlantic coastal states. Additionally, growing urban populations and increased tourism have placed more demands on resource managers to develop innovative techniques to effectively protect and manage marine resources for future generations. Artificial reef sites in the coastal and inland waters of the United States have been used to increase access to marine resources for fishermen and divers for over thirty years. Artificial reefs have also been deployed to provide additional fisheries habitat, and used as mitigation for the loss of existing habitat due to coastal alteration projects. Scientists believe that artificial reefs have the potential to serve as a useful tool in fisheries and habitat management, and can generate significant economic benefits for states with well-established reef programs. However, artificial reefs are not without risks, and resource managers must weigh the biological, physical, and socio-economic advantages and disadvantages of each proposal.

The identification of the intended purpose(s) of an artificial reef is a critical component of the development process. Artificial reefs in the United States have been designed primarily to support and enhance recreational fishing effort. Other, more limited uses for artificial reefs include; commercial fisheries enhancement, subsistence fishing, recreational diving, habitat restoration or

expansion, coastline protection, marine sanctuaries, mitigation for habitat loss, and as fisheries management tools.

Understanding the criteria for siting and permitting an artificial reef project, and recognizing the responsibilities required of the applicant and the agencies involved in the permitting process is essential for proper project development. Optimal reef development locations are identified using a three-step approach: development zone identification, exclusion mapping, and delineating an area of greatest potential benefits. Unique partnerships in artificial reef development between state, federal, and private interest groups have been formed. Generally, the state serves as the lead management agency and the primary entity in artificial reef plan implementation. Most states also participate in regional communication and coordinate essential artificial reef management activities through their respective Interstate Fisheries Management Councils (IFMCs). Through the permitting process, every effort is made by federal, state, and local governments to ensure potential reef sites are selected that minimize the user group conflicts. All preparations, modifications, or special conditions necessary for transport and deployment of materials must meet permit specifications prior to any projects implementation.

To assure compliance with permit conditions and other applicable regulations, artificial reefs should be monitored to assess performance, and to confirm that the goals and objectives of the reef design are being achieved. This information is beneficial for improving existing reefs and for building effective reefs in the future. Biological monitoring of existing reefs helps identify research priorities in order to gain a better understanding of how artificial reefs can be utilized as fisheries management tools. Compliance monitoring is established during the permitting process to assure conformity to conditions or restrictions defined in an artificial reef permit. Performance monitoring evaluates an artificial reef or reef system to assure the established goals and objectives are being met, and may include the collection of preconstruction or site selection background data.

To manage the Massachusetts Artificial Reef Program, *MarineFisheries* has adopted a series of policy statements to direct artificial reef efforts. These statements address the administration of the Massachusetts Artificial Reef Program, the planning and development of new artificial reefs, deployment, monitoring, and maintenance of reefs, and the management and use of artificial reef sites. The Artificial Reef Plan also calls for a five-year review in order for The Plan to reflect most current information and science as it relates to artificial reefs in Massachusetts.

Artificial reefs constructed in the waters under the jurisdiction of this state and the contiguous federal waters should be designed, built, and monitored in accord with the guidelines outlined in this plan. As the state agency responsible for the marine resources of the Commonwealth, *MarineFisheries* is best suited to administer and coordinate all artificial reef-building activities in state waters and be the primary agent for these activities in federal waters.

I. Introduction

In 1984, US Congress enacted the National Fishing Enhancement Act (PL-98-623). Language in this act strongly encourages effective and responsible artificial reef development programs under state management. Section §203 of the act mandated that NOAA, in consultation with other federal, state and intergovernmental agencies, develop and publish the National Artificial Reef Plan (Stone 1985). This plan set national guidelines for reef development and provided direction and guidance for individual states to develop site-specific reef development plans. The Joint Atlantic States Marine Fisheries Commission (ASMFC) and Gulf States Marine Fisheries Commission (GSMFC) Reef Committee updated the National Artificial Reef Plan (NARP) in 1998. A revision draft written in 2002 is presently undergoing federal agency review. This revision provides updated information to address:

- A synopsis of existing information on artificial reefs
- Criteria for siting and constructing artificial reefs
- Methods for monitoring the compliance of artificial reefs to permit requirements
- Methods for managing artificial reef use
- Research needs for artificial reef technology and management strategies
- Alternatives evaluation to facilitate the transfer of artificial reef construction materials to permit holders

Section §205 of this Act requires the Secretary of the Army to determine that all applicants demonstrate financial ability to assume liability for any reef-related damages. This has shifted the emphasis from private, local efforts to state-sponsored programs.

The Division of Marine Fisheries (*MarineFisheries*) is the lead agency in the Commonwealth of Massachusetts for the management and enhancement of marine fisheries resources, and for the promotion and development of the recreational and commercial marine fisheries. Under Massachusetts General Law (MGL) Chapter 130, the director of *MarineFisheries* has the authority to:

- Section 17(3): Investigate questions relating to fish and personally or by assistants, institute and conduct inquiries pertaining to such questions, and conduct such biological research and assist cities and towns in the development of shellfish conservation and management plans as will, in his opinion, tend to conserve, improve, and increase the supply of fish in the coastal waters.

- Section 17(6): Establish and maintain properties at such places within the commonwealth as he may select for the purpose of propagating, rearing and protecting fish.

- Section 17(7): Occupy, use, and control, not exceeding ten ponds and estuaries, creeks or other arms of the sea, within the coastal waters, and the necessary land thereto adjoining, for the propagation and distribution of fish frequenting the coastal waters and for the scientific investigation of their habits, if such occupation and use do not impair the private rights of any person or materially obstruct any navigable waters. Notice of such occupation and use and the purpose thereof shall be conspicuously posted by the director at the nearest points to said ponds and estuaries, creeks or other arms of the sea, and shall be recorded in the registry of deeds in the county or district where they are situated.

Depending upon the location and size of an artificial reef, other federal and state agencies may have an authoritative role during the permitting process. More information detailing the individual local, state, and federal agencies roles are provided in chapter 5.

MarineFisheries supports and participates in enhancement efforts when these activities do not disrupt traditional fishing practices, or adversely affect existing fish populations or the ecosystem. *MarineFisheries* will support artificial reef construction when the following conditions are met:

- An artificial reef will not adversely affect other fisheries
- Substantial natural cover is absent
- Hydrographic and substrate conditions will support reef stability
- Materials used and construction methods will ensure long-term utility

The creation of artificial habitat has been employed by many coastal states as an effective method of increasing fisheries productivity, providing additional recreational and commercial fishing opportunities for hard substrate dependent fisheries, and enhancing the forage base (Ambrose 1994; Ditton et al. 2002; Figley 2004; Myatt and Myatt 1992; Stevens and Pondella 2002). Artificial reefs can enhance the recreational experiences of anglers and divers, augment fisheries habitat, and mitigate the loss of existing habitat from coastal alteration projects. Whether artificial reefs attract fish or produce fish is a debate that U.S. fishery managers have not been able to settle, although the answer to this question may be somewhere in the middle. As interest in artificial reefs increases, so will demand for their creation by user groups, conservationists, and government agencies. In order to prepare for this demand, this artificial reef policy has been developed to guide the construction, management, and monitoring of artificial reefs in commonwealth waters.

1.1 Purpose of MA Artificial Reef Plan

The Artificial Reef Plan (The Plan) is intended to provide Massachusetts with an operational framework for administering the responsible long-term management

of artificial reefs in the marine waters of the Commonwealth. This Plan addresses several fundamental features necessary for establishing an effective artificial reef program including:

- Outlining *MarineFisheries'* management authority for artificial reefs
- Justifying the need for an Artificial Reef plan
- Coordinating and facilitating artificial reef development
- Assessing the feasibility for reef placement
- Recognizing the diversity of localized habitats
- Maintaining a long range focus for reef development and monitoring
- Addressing local and regional needs
- Evaluating existing artificial reefs (successes and failures)
- Summarizing existing standards for artificial reef materials
- Providing guidance for artificial reef permitting
- Advocating criteria for responsible site selection, construction, and maintenance of artificial reefs
- Instituting standards for monitoring artificial reefs in Massachusetts' coastal waters

This Plan utilizes information compiled from current scientific literature, artificial reef programs in other states, guidance documents created by the Interstate Marine Fishery Commissions (IMFCs), the NARP, and current field research. The material contained in this document may be revised as new information becomes available.

1.2 Definition of an Artificial Reef

MarineFisheries defines an artificial reef as:

> *An area within the marine waters of the Commonwealth in which approved structures have intentionally been placed or constructed for the purpose of enhancing benthic relief. Structures may be designed to provide and/or improve opportunities for recreational and commercial fishing, aid in the management or enrichment of fishery resources and ecosystem services, or to achieve a combination of these objectives.*

The primary focus of *MarineFisheries'* definition of artificial reefs is benefits to fishery resources. Other environmental resources and ecological services including but not limited to shoreline protection, sediment transport, and habitat protection where the primary function of benthic relief may serve a different primary purpose may provide secondary benefits to fishery resources. Shellfish aquaculture, is precluded from this definition

1.3 Biological Productivity and Aggregation

Artificial reefs are used as tools by resource managers to enhance desired species, attract fish to more suitable areas, restrict certain gear types, and to partition activity among competing user groups (Sheehy 1985). The fundamental

question in artificial reef science today examines whether artificial structures have the ability to produce new fish biomass or whether reefs merely concentrate existing fish populations (Bohnsack 1989). Several studies demonstrate the attractive properties of artificial reefs by documenting the ability of artificial reefs to yield higher catch rates of targeted fish species when compared to similar fishing over natural reef areas (Turner et al. 1969; Candle 1985). Other studies outline the production properties of artificial reefs by documenting higher densities of mature fish on artificial reefs when compared to nearby natural reefs (Love et al. 2006). The consensus of the 8th Conference on Artificial Reefs and Artificial Habitats (CARAH) was that artificial reefs "are now believed to be more of a continuum, both attracting and enhancing fish populations. Properly constructed, and strategically sited artificial reefs can enhance fish habitat, provide more access to quality fishing grounds, benefit fishermen, divers and the economies of shore communities, increase total biomass in a given area and provide managers with yet another option for conserving, managing and developing fishery resources."

The degree of attraction or production of an artificial reef may be the direct result of many complex variables, including location of the reef, type of reef materials, life history, behavior of fish species, proximity of natural reefs, age of the reef, and numerous environmental factors. Since the majority of artificial reefs have the ability to serve in each capacity, fisheries managers and other reef builders must consider the consequences of production and aggregation of reef fish populations when planning new reefs or establishing management policies for future and existing reefs. The wise use of artificial reefs as a potential tool for fisheries management requires the implementation of sound standards and practices regarding construction, maintenance, and exploitation of all artificial reefs established.

1.4 Goals and Objectives of MA Artificial Reef Program

As the agency responsible for managing the living marine resources and the harvesting of those resources for the Commonwealth, it is the mission of *MarineFisheries* to maintain a diverse number of self-sustaining fish populations at healthy levels of abundance in balance with the ecosystem. The goals and objectives of *MarineFisheries*' Artificial Reef Program emphasize a responsible, consistent, and long-term approach that examines the potential for development and management of artificial reefs. This approach endorses technical assistance and planning which identifies techniques for artificial habitat development that will enhance and/or attract biomass, augment commercial and recreational fishing, and provide tools for long-term fisheries research and management; while ensuring such development does not adversely affect existing fisheries. With this approach, *MarineFisheries* expects to achieve the following overall objectives:

- Ensure future reef development has biological justification to meet fishery management and resource protection needs

- Prevent adverse affects to habitat and fisheries resources through responsible reef planning and development
- Minimize conflicts between competing users of marine resources
- Improve artificial reef monitoring and research
- Increase access for commercial and recreational users
- Utilize artificial reefs as a fisheries management tool
- Enhance fishery resources and fisheries habitat to the maximum practicable extent

This Plan highlights the steps necessary to ensure responsible planning and development of artificial reefs in Massachusetts in accordance with established interstate and national standards. The process is designed to provide the greatest benefit to marine resources while minimizing user group conflicts that may arise with further artificial reef development.

1.5 History of Artificial Reefs in Massachusetts

There are four artificial reef sites in Massachusetts' coastal waters (Figure 1). In 1978, *MarineFisheries* assisted the Town of Yarmouth with the planning and deployment, of an artificial reef in Nantucket Sound. This reef was designed to provide desirable habitat for finfish and lobsters in a relatively featureless area, and to render a constructive means of utilizing old tires. Reef monitoring was undertaken with the aid of SCUBA diving, side scan sonar, and user group surveys from 1978 to 1981. Monitoring results indicated successful structure stabilization, attraction, and colonization of macrobiota, and improved recreational angling (Bugley et al. 1994).

In 1997, *MarineFisheries*, in partnership with the University of Massachusetts at Dartmouth (UMD), planned and developed a more sophisticated artificial reef project. The Dartmouth Artificial Reef project was supported by state funds and implemented at the urging of local state officials. The three and one half acre site is located in Buzzards Bay, southwest of Salter's Point in Dartmouth, and is composed of prefabricated concrete units ("reef balls"). The reef balls occupy a total footprint of approximately 242 square yards, or less than two percent of the total area of the permitted site. Annual inspections revealed that this deployment has remained stable and seasonally supports numerous species of structure-oriented fish such as cunner (*Tautogolabrus adspersus*), tautog (*Tautoga onita*), scup (*Stenotomus chrysops*), and black sea bass (*Centropristis striata*).

In 1999, the Massachusetts Turnpike Authority (MTA), as part of the Massachusetts' Central Artery ("Big Dig") Project, constructed an artificial reef in Boston Harbor. MTA built the reef to provide partial mitigation for the destruction of blue mussel (*Mytilus edulis*) and American lobster (*Homarus americanus*) habitats that were filled during the capping of a landfill on Spectacle Island in Boston Harbor. The northernmost artificial reef system in the United States at the time of its deployment, it was designed to create a new ecosystem in the harbor, primarily as habitat for blue mussels, lobster, and other shellfish. The

reef site consists of 17 terrace-type modules and six cobble/boulder patch reefs (MTA n.d.). *MarineFisheries* has monitored bottom water temperature at this site since 2001 using programmable electronic recorders and has included one of the cobble patches in its annual coast-wide early benthic phase (EBP) lobster sampling efforts.

In 2006,

Continued interest in proposing new reefs reveals the need for development of a formal Massachusetts artificial reef policy. This policy will offer clarified goals and limitations for the introduction of artificial reefs in state waters, identify data gaps and research needs, and serve as a guidance document for the future development of artificial reefs in Massachusetts.

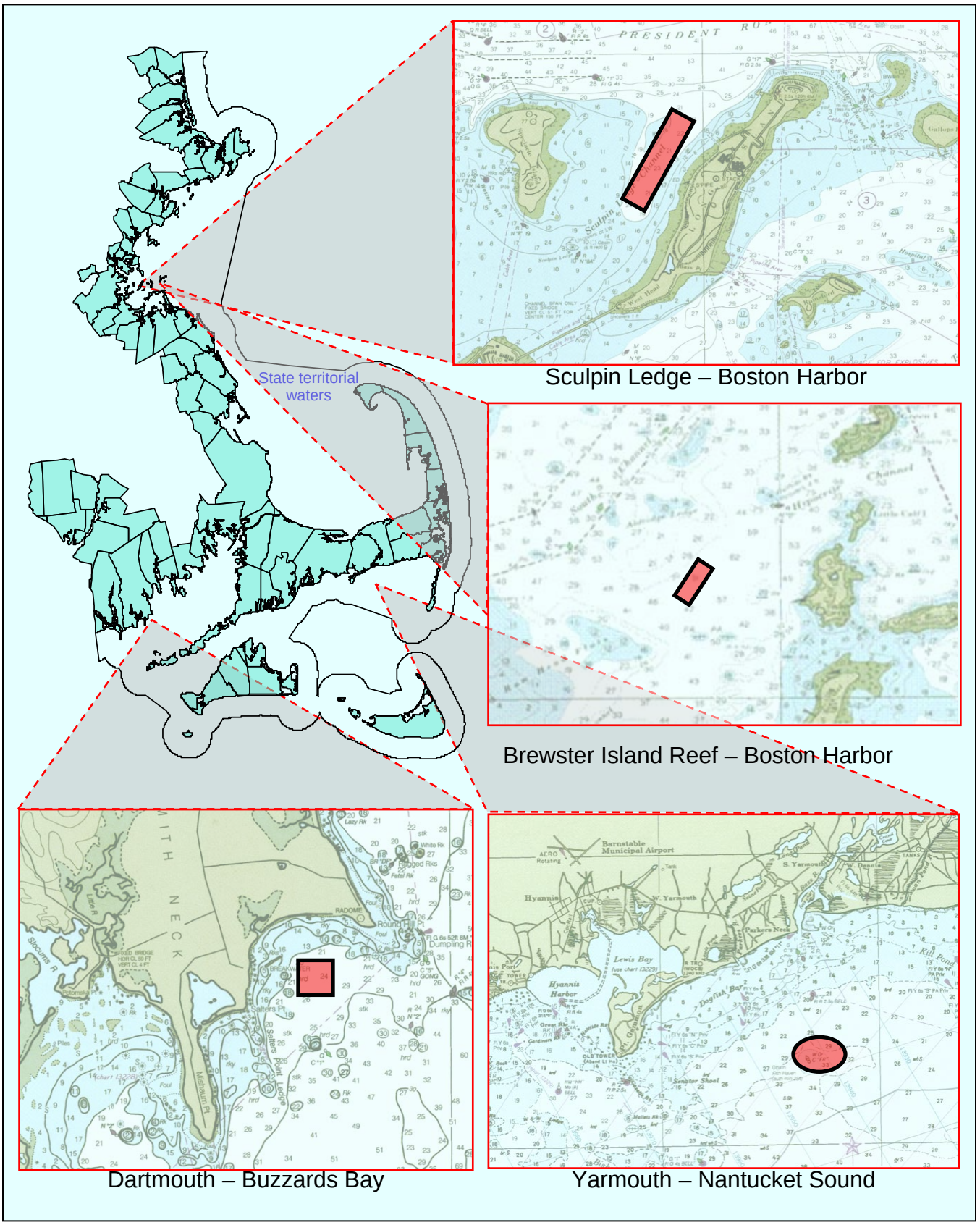


Figure 1. Artificial Reef Locations in Massachusetts.

II. Technical Evaluation

Artificial reefs are designed to intentionally alter the ecological function of benthic habitat in an area determined to be of lesser productive value. Reef designs are employed by coastal resource managers because they can mimic the characteristics of natural reefs (Bohnsack and Sutherland 1985). Planning during reef development can minimize potential problems; however, artificial reefs are not without risks. Successful artificial reef programs vary in their specific intent; from reefs in Japan built to increase commercial fisheries yields, to reefs in Europe constructed to prevent trawling in specific areas (Baine 2001). Fisheries managers and reef builders must consider the consequences of production and aggregation of reef fish populations when planning new reefs or establishing management policies for future and existing reefs. Reef building may pose risks to fisheries resources by increasing fishing effort and catch rates, increasing access to previously unexploited stock segments, and concentrating previously exploited segments of the stock (Grossman et al. 1997). It is important for artificial reef managers to build upon the successes and failures of other artificial reef programs, while recognizing the geographic, oceanographic, and demographic characteristics that make each region unique.

2.1 Benefits and Risks of Artificial Reefs

Artificial reefs have been deployed throughout the world in various forms in attempts to enhance fisheries habitat and increase commercial and recreational fishing opportunities. Official documentation of artificial reef use dates back to the 17th century in Japan (Sata 1985). In the United States, early artificial reef development efforts focused on using reefs to enhance recreational fishing opportunities. Advancements in the science and technology have identified several benefits of artificial reef development including:

- Use as a tool for mitigating habitat loss
- Increasing biodiversity through the use of more complex structure
- Additional opportunities for scientific research
- Water quality improvements from filter feeders
- Increased access for land based fisheries (increased recreational opportunities)

The risks associated with artificial reef development are also well documented. Bohnsack and Sutherland (1985) attributed artificial reef failures to the use of unsuitable materials, inappropriate site selection, and natural forces. These authors also cited biological and socioeconomic failures whereby artificial reefs did not result in increased fish abundance and greater angler success. The Reef Committees of the ASMFC and GSMFC have examined the successes and failures of reef programs from Massachusetts to Texas and have prepared guidelines concerning the appropriateness and preparation of a wide variety of reef-building materials (Lukens and Selberg 2004). The experiences of many

state artificial reef programs have identified many potential risks associated with artificial reef development and have predicated most of the procedures, policies, guidelines and restrictions in this artificial reef plan.

2.1.1 - Biological benefits and risks

The surface area of an artificial reef assists with the development of fast-growing, highly productive fouling communities that feed on plankton and detritus brought to them by ocean currents. Anchored to the firm reef substrate, fouling organisms can better withstand the destructive force of ocean storms. This increase in biomass provides a food source for fish and other marine life, which feed on fouling organisms (Baine 2001). Interstitial spaces and crevices of reef structures provide fish and other marine life shelter to avoid predation. Demersal fish species frequent reef sites to feed on reef-associated species. Waste products shed from reef communities enrich the surrounding sediments and promote the growth of infauna. Invertebrates colonize reef structures and filter algae, organic matter, and bacteria from the water column, improving the water quality of the surrounding area (Svane and Petersen 2001). Large pelagic fish species frequent reefs to feed on reef fish and crustaceans.

The biological risk associated with artificial reef development has been subject to limited scientific study. The NARP and guidance documents created by the various IFMCs have developed standards to eliminate obvious biological hazards such as chemical pollutants and the destruction of existing productive habitat that may occur with the creation of new artificial reefs. These documents draw from problematic or failed artificial reef projects and utilize the permitting process in an effort to avoid repeating these failures. Quality standards have been set for materials. Procedures have been developed for preparing materials and supervising deployment. Monitoring protocols have been implemented to verify the stability of reef materials on the sea floor. Other biological risks may include but are not limited to: species displacement, species over-enhancement, disruption of migratory patterns, overfishing, disease occurrence associated with the concentration of marine populations and the proliferation of non-native species. These risks will require further evaluation on a case-by-case basis by the state. Further biological assessments of artificial reefs and the species they influence may reveal additional biological risks and provide the means to formulate more knowledgeable management decisions and strategies regarding artificial reefs (Figley 2004).

2.1.2 - Physical benefits and risks

The surface area of an artificial reef represents the interface where an animal lives and its exposure to the water column. Three-dimensional reef structures, with more vertical relief, have more living area for the same relative unit of sea floor. The taller and more complicated a structure, the greater available surface area for marine life to colonize and the more productive it can be. The interspersion of reef, natural substrate, and open-water habitats provides greater

environmental complexity, which fosters greater biodiversity than the habitats by themselves.

Artificial reef habitats have physical characteristics that influence the species diversity and abundance of marine life inhabiting them. Their designs are structurally complex, increasing the amount of interstitial space used by fish and motile invertebrates for refuge and foraging, mimicking natural habitats, and providing greater surface area for the colonization of primary producers. Currents diffused by reef structures can provide areas of calm water, and reef inhabitants can better utilize energy that would otherwise be expended swimming against a current for growth (Chang 1985).

Using any tool that alters the environment involves physical risks that relate to the construction, placement, durability, and stability of artificial reefs. These risks include:

- Accidental sinking of artificial reef material off the designated reef site that could result in damage to fishing gear or cause the unintentional creation of an impediment to navigation
- Movement of material by currents or wave forces from designated reef sites into areas where it may conflict with other maritime or coastal interests, such as swimming beaches
- Damage to, or destruction of existing high quality habitats from misplaced or moving materials
- Alterations to the hydrographic characteristics of an area
- Alterations to the sediment transport characteristics of an area
- Dragging of materials off reef sites by anchor lines, commercial trawls or dredges
- Disintegration of reef material causing the habitat to not function as intended
- Siltation or shoaling over of reef materials
- Violation of clearance requirement, thus presenting a threat to navigation
- The permanence of the physical alteration brought about by reef construction and the difficulty of removing reef structures

2.1.3 - Socio-Economic benefits and risks

Artificial reefs in the United States have been designed primarily to support and enhance recreational fishing effort despite the fact that it remains uncertain if they can enhance fisheries or be detrimental to fisheries. In New Jersey, party boat fishing effort on artificial reefs increased from 3 percent in 1970 to 47 percent in 2000 in conjunction with an extensive increase in reef building efforts during that period (Figley 2001). Artificial reefs may also provide benefits for commercial fisheries, subsistence fishing, recreational diving activities, habitat restoration or expansion, marine sanctuaries and mitigation for habitat loss.

Socio-economic risks associated with artificial reefs include:

- User conflicts such as those between anglers and divers or recreational and commercial fishermen, or between fisheries and other competing uses of the ocean such as navigation, sand mining, undersea cables and pipelines
- Increased demands on the existing coastal access facilities
- Contamination of seafood by chemicals leached from reef structures
- Injury or death to a SCUBA diver caused by reef structure
- Lack of public interest in using reefs
- Excessive materials and construction costs that may not bring the expected return on investments
- Excessive travel costs associated with distances from harbors to artificial reef location

The success of any artificial reef is dependent upon location, materials used in reef construction, proximity to natural reefs, age, behavioral and life history characteristics of targeted marine species, and numerous other environmental parameters. Other advantages of properly designed and maintained artificial reefs include:

- Reefs sited in close proximity to ports reduce fuel consumption and boat travel time
- Reefs increase the total amount of habitat available for recreational activities
- Locations can be publicized to provide easily locatable recreational opportunities
- Multiple users utilizing reefs simultaneously provide an additional element of safety

2.2 Comparative Differences of MA to Other Coastal States

Artificial reefs are utilized in the offshore environment of almost every coastal state. McGurrin et al. (1989) found that 76% of permitted artificial reefs along the Atlantic coast were located in offshore waters, with the remaining 24% located in estuarine waters. What is known about the biology of marine artificial reefs is based on years of research and observations conducted primarily on offshore reefs.

The location of Massachusetts along the eastern seaboard is unique. Current and historical geologic and oceanographic forces have shaped the distinctive habitats and species compositions that occur today. Massachusetts' South Shore delineates the northern edge of the Mid-Atlantic Bight. The warmer water of the Gulf Stream influences this region. Cape Cod Bay and the North Shore of Massachusetts are located in the western Gulf of Maine (GOM) and are influenced by the colder waters of the Labrador Current. During the summer, water temperatures are an average of 5° C warmer in Buzzards Bay and southern Cape Cod compared to Massachusetts Bay and the north shore. This

spatial and temporal variability in climate and oceanography also affects species diversity, abundance, and composition on a localized scale not experienced by other Atlantic coastal states. Seasonal temperature fluctuations also limit or inhibit primary productivity and colonization. Shorter seasonal migration patterns of marine species and larger fluctuations in annual temperature ranges further limit the length of the recreational season. Natural, hard substrate habitat is more common in Massachusetts marine waters compared to most states along the Atlantic seaboard. These natural bedrock outcroppings, cobble shoals, and other substrate types provide important locales for refuge, spawning, and foraging of fish (Gannon et al. 1986).

2.2.1 - Geography

Glacial ice migrating across the region 10,000 to 20,000 years ago carved out basins, ridges, and valleys, and deposited sediments and debris throughout the GOM region (Oldale et al. 1994). Changes to the shoreline during this period were affected by the rise and fall of sea level and the compression of the landmass from the massive weight of the glacier. Initial expansion of the glacier froze massive volumes of seawater, causing a global reduction in sea level and depressed the land mass beneath it. Glacial deposits, including large boulders, gravel, and fine silts and mud created an assorted array of geologic assemblages amongst large areas of exposed bedrock outcroppings (Knebel 1993). This heterogeneous mixture of materials deposited as the glacier retreated created habitat niches that are populated by distinctive biotic assemblages unique to the northeast region of the United States (Wahle 2000). The frequency of rocky outcroppings north of Cape Cod and the prevalence of glacial depositional areas in southeastern Massachusetts exemplifies the geological diversity along the Massachusetts' coast. Cape Cod, Nantucket, and Martha's Vineyard were formed from terminal moraines during various stages of glacial expansion and retreat (Wahle 2000). Salt marshes, barrier beaches, sea grass beds, estuaries, tidal mud flats, salt ponds, coastal embayments, open coastal waters, and rocky shores are common marine, estuarine, and coastal habitats found along the Massachusetts coast (Tyrell 2005).

2.2.2 - Oceanography

Massachusetts is located between two large marine systems, the GOM system (part of the Acadian province), and southern New England system (part of the Virginian province). The coastline of northern Massachusetts is bordered by the GOM, where the prevailing currents rotate in a counterclockwise direction, with some seasonal variability. Southern Massachusetts is located along the northern edge of the Mid-Atlantic Bight. The Gulf Stream brings warm water from the south, initially from the coast of Florida, moving east off the North Carolina coast and then northeast across the Atlantic Ocean.

Massachusetts is influenced by physical, chemical, and biological oceanographic processes that act on regional and local scales. The North Atlantic Oscillation, for example, is a large global climatic pattern that influences the oceanography of

the North Atlantic Ocean (including Massachusetts). Atmospheric pressure drives surface winds and wintertime storms from west to east across the North Atlantic affecting climate from New England to Western Europe. Individual rivers entering Massachusetts coastal waters affect oceanographic conditions, such as current, salinity, and temperature. These small and large features interact to influence the oceanography and ecological function of Massachusetts (Geyer 1992).

Spatial and temporal variability of oceanographic conditions affects species diversity, species composition, and other natural resource parameters. Bathymetry, climate, and tides create complex mixing regimes that enhance nutrient cycling and primary productivity over Georges Bank and northeast GOM. The steep north-south thermal gradient along the coast makes it a faunal transition zone. The glacially influenced coast and seabed create a unique benthic habitat along the US east coast that serves as a nursery to lobsters and cod, two of the regions most valuable fisheries (Wahle 2000).

2.2.3 – Ecology

Ipswich Bay
Mass Bay
Boston Harbor
CC Bay
Buzzards Bay
Nantucket / Vineyard Sound

How reef may effect local resources

2.2.4 - Demography

2.2.4.1 Massachusetts

Over the past four centuries, humans have contributed to dramatic shifts in the composition of New England's marine biotic communities through harvesting, species introductions, pollution, and coastal development. Geographic and oceanographic conditions have played an important role in the colonization and population of coastal communities in New England. Massachusetts' 2533 miles of coastline, defined as the length of coast influenced by the tide, contains 2.2 million people in 78 communities, or 35 percent of the total population of the state.

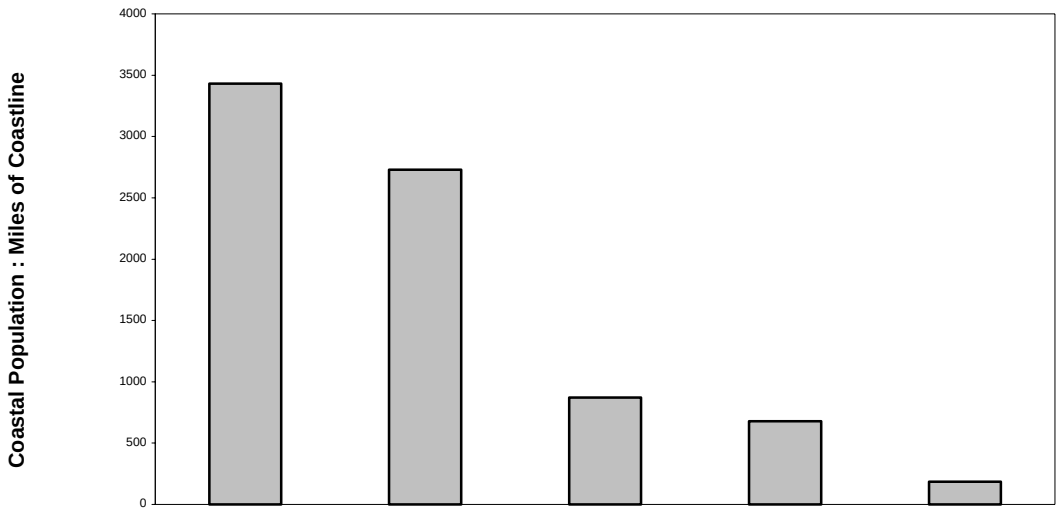
The 2003 US Census data ranks Massachusetts coastal communities as the most populous when compared with the coastal communities of all New England states. Yet, a ratio of coastal population to the number of miles of tidal influenced coastline ranks Massachusetts third among New England states; with ratios declining from the south to the north along the Atlantic coast (Figure 2).

2.2.4.2 South Coast Massachusetts

Communities from the Rhode Island border to the southeastern tip of Cape Cod and the Islands is 1065 miles in length, with a total coastal population of 503,

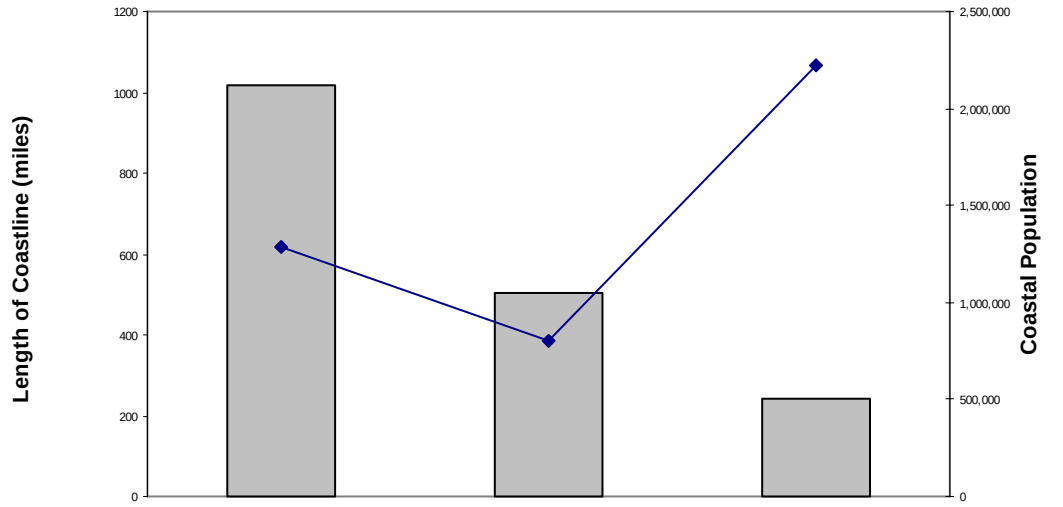
084. This region represents 42 percent of the entire coastline length, with 23% of the total year round coastal population (Figure 3).

The 472:1 ratio of coastal population to the number of miles of coastline along southern Massachusetts is lower than all New England states except Maine. The coastal area of southern Massachusetts serves as an important tourism destination, and the coastal population increases substantially during the summer season.



	CT	RI	MA	NH	ME
Coast Pop / Mile of Coastline	3432	2730	871	679	184
Coastal Population	2,120,734	1,048,319	2,206,909	161,574	641,198
Miles of Coastline	618	384	2533	238	3478

Figure 2. Ratio of Coastal Community Population to Miles of Coastline for New England States (Population data source: US Census 2003. Miles of coastline: ASFPM floodplain management program 2004).

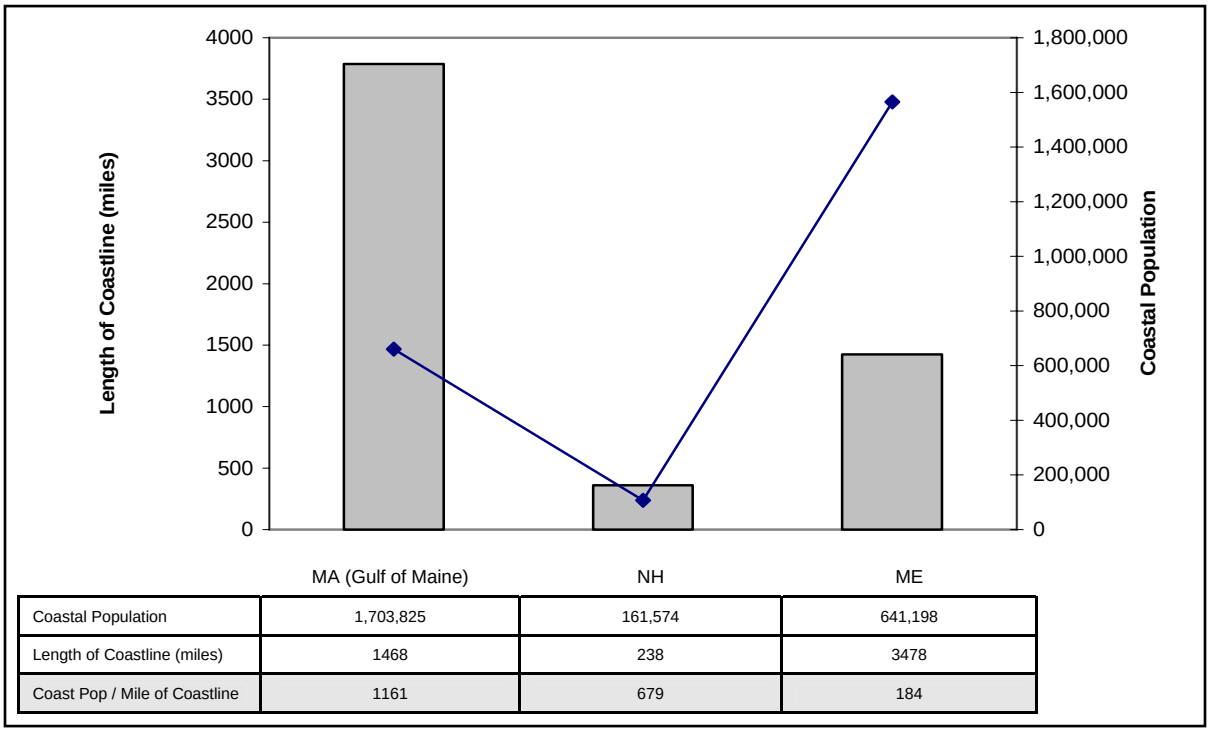


	CT	RI	MA (South Coast)
Coastal Population	2,120,734	1,048,319	503,084
Length of Coastline (miles)	618	384	1065
Coast Pop / Mile of Coast	3432	2730	472

Figure 3. Coastal Community Population and Length of Coastline for Southern New England by State (Population data source: US Census 2003. Miles of coastline: ASFPM floodplain management program 2004).

2.2.4.3 Gulf of Maine Region of Massachusetts

The GOM region of Massachusetts consists of 49 coastal communities from outer Cape Cod to the Massachusetts - New Hampshire border. The 1468 miles of Massachusetts coastline in this region contains 1.7 million people. The urban characteristics of this region are evident, as 58% of the entire coastal length contains 77% of the total coastal population (Figure 4). By contrast, the state of Maine has six hundred and forty thousand coastal community residents spread over 3478 miles of coastline for a ratio of 184:1. The 1158:1 ratio of Massachusetts' coastal population to the number of miles of coastline is six times higher than Maine, and 1.7 times higher than New Hampshire.



	MA (Gulf of Maine)	NH	ME
Coastal Population	1,703,825	161,574	641,198
Length of Coastline (miles)	1468	238	3478
Coast Pop / Mile of Coastline	1161	679	184

Figure 4. Coastal Community Population and Length of Coastline for the Gulf of Maine by State (Population data source: US Census 2003. Miles of coastline: ASFPM floodplain management program 2004).

2.2.4.4 Regional Summary

Population predictions by NOAA estimate a continued increase in coastal populations over the next few decades (Crossett 2004). The environmental

impacts resulting from this growth are not well understood. Coastal areas that attract development are very fragile and development can disturb coastal ecosystems and damage economic and ecologic values. Additionally, newer development has expanded to previously undeveloped coastal areas, putting dynamic coastal habitats at a greater risk. As coastal populations increase, there will be increased demands on resource managers to develop innovative techniques, including the potential use of artificial reefs, to effectively protect and manage the greater demands placed on marine resources for future generations.

III. Artificial Reef Applications

A difficult problem facing artificial reef management is mediating conflicts between the different user groups impacted by the creation of new artificial reefs. Conflicts associated with competing uses of public resources (i.e. fish species and fish habitat) exist in artificial reef development despite the best efforts of resource managers. The environmental permitting process attempts to address resource and resource user concerns prior to approval and implementation of any project. This process is designed to allow for input on several levels to ensure resource uses are in the best interest of the public. User group input can shape a proposal to meet the goals and objectives of the artificial reef program. During the permitting process, monitoring guidelines are established, engineering design and materials are reviewed, the biological aspects and target location of a proposal are assessed, user conflicts are addressed, and future research needs are identified. Each component is critical in the proper management and overall success of the reef program in accomplishing its intended goals. Despite this process, user conflicts often occur after a project has been implemented.

Potential user conflicts may increase with an increase in reef development (Stephan et al. 1990). Management of artificial reefs in Massachusetts is contingent upon balancing the potential benefits to reef users while ensuring the viability of fisheries resources. The approach of reef management must include:

- Designing regulations to allow the highest probability of achieving the goals and objectives established for reef development
- Addressing reef and fisheries management concerns or questions
- Providing guidance that will assist in the design and implementation of reef research activities
- Collecting quantifiable data that can address the physical stability, biological health, and overall effectiveness of permitted reefs
- Directing research efforts towards management related problems, questions or concerns involving the present and future use of marine artificial reefs
- Increasing public awareness on the benefits and risks of artificial reefs

3.1 Commercial Fisheries

The enhancement of commercial fishing activities is a primary function of artificial reefs in the Western Pacific (Sheehy and Vic 1982). Italy and France have experimented with a number of reef designs used in support of commercial harvesting of finfish and shellfish species (Bombace 1989). In the United States, most utilization of artificial reefs by commercial fishermen is restricted to benthic artificial reefs constructed primarily for use by recreational fishermen and sport divers. Except in certain states in which some artificial reefs have been protected by federal or state fisheries regulations, commercial fishermen have free access to all artificial reefs in existence.

Massachusetts has a well-established and deeply rooted commercial fishing industry, with efforts directed toward a wide range of species including both inshore and offshore finfish, lobster, and various species of shellfish. Massachusetts ranks second among Atlantic coast states in poundage landed (295.4 million pounds) and number one in landings value (NMFS 2003). The 292.6 million dollars contributed by the commercial fishing industry to the economy in 2003 employed several thousand coastal residents with full or part time work (NMFS 2003).

The success of the state's various commercial fisheries can be linked to the present health and future viability of the fisheries resources. Extensive management measures establishing size limits and catch limits on some species have been taken by both state and federal resource managers to protect certain stocks from overfishing. Loss of access due to coastal development, competition with recreational users, and changes to the natural environment continue to present commercial fishermen with additional economic pressures. Fisheries managers are challenged with determining the equitable allocation of marine resources and must consider all user groups when making decisions, as well as the marine resources themselves.

Commercial fishing practices may not be the most beneficial way to utilize existing small-scale artificial reefs intended for recreational use. Such reefs, with their limited fisheries resources can be quickly over-exploited, leaving them less than effective for use by recreational anglers. In order to avoid or minimize conflicts with users of different gear types, it is important to consider these uses during the initial stages of reef design, site selection, and permitting.

Despite the potential problems facing fisheries managers in developing successful artificial reefs for commercial purposes, artificial reefs represent an option for improving the status of certain commercially important marine species such as lobster. Artificial reef technology has been applied to the creation of kelp beds, mariculture of shellfish such as oysters and mussels, enhancement of lobster survival, and harvest of pelagic species (Stone 1985). The concept of artificial reefs as a potential method to enhancing commercial fishing activity may be appropriate for species of shellfish, lobster, and finfish, but more research is necessary before commercial reefs can be implemented on a larger scale.

3.2 Recreational Fisheries

Massachusetts' 2500-mile coastline offers an array of recreational uses to citizens and visitors to the Commonwealth. Marine recreational fishing activities are extremely popular in both inshore and offshore waters. The types and degree of saltwater fishing activities that take place are linked to the quality of the marine resources, and to the physical resources available to marine anglers in pursuit of these activities. Boat-based fishing activities require the availability of

access facilities for both small and large private boats, and the availability of charter boats and head boats for anglers not using a private boat. Fishing effort conducted from these boats can be linked to the number of productive fishing locations offshore including natural structures, shipwrecks, and artificial reefs.

Steinback and Gentner (2001) estimate the total direct and indirect economic activity generated by marine recreational fisheries in Massachusetts was $880 million in 1998. They found that about 800,000 anglers participate in marine recreational fishing, and this number continues to grow. Over 70 different species are landed recreationally in Massachusetts' waters. Striped bass, tautog, black sea bass, scup, summer and winter flounder, cod, haddock, bluefish and tuna are common recreationally targeted finfish species, as well as American lobster and several shellfish species. Any future artificial reef development efforts must focus on understanding the degree of fishing effort exerted in different regions, by different user groups, and on different marine resource populations.

Distinct bathymetric features available for recreational uses are a relatively fixed quantity. In fact, available recreational areas may be diminishing as many old shipwrecks utilized by recreational users disappear over time from erosion, storms, or burial from sediment shifting. More stringent maritime safety regulations and better boat building techniques have facilitated a reduction in the frequency of new shipwrecks replenishing available recreational areas as older shipwrecks disappear.

User conflicts and overcrowding of existing fishing locations cannot be easily addressed except through the implementation of strict and potentially unpopular regulations and restrictions. The presence of artificial reefs can result in an increase in fishing activities and generate expenditures that may not occur if the reefs were absent (Bell 1991). Increased expenditures by marine recreational anglers generate additional sales of goods and services provided by the local communities and supporting industries. Artificial reef utilization by recreational anglers may result in significant economic benefits, which extend beyond those associated with the direct benefits of improved fishing opportunities for the anglers themselves.

3.3 Sport Diving

Recreational diving is a popular sport in Massachusetts, and our coastal waters provide unique conditions that will drive its future development. Since divers prefer to conduct most of their diving activities on relatively shallow (usually less than 100 feet) habitat, artificial reefs can provide relief to popular recreational dive sites subject to overcrowding during periods of peak use.

In comparison with some other regions of the country in which offshore recreational diving is a much more common activity, Massachusetts' waters have

a set of unique conditions that will be of continued importance in shaping the future development of marine sport diving in the coastal waters of this state. Massachusetts benefits from an abundance of productive "hard bottom" sites that are accessible from the shoreline or by boat. Popular dive locations along the North Shore allow divers access to water depths of 60 to 90 feet. Sport diving activities in the state's waters include wreck diving, shellfish and lobster collecting, underwater photography, spearfishing, and observing the rich diversity of marine life and the variety of habitat types. In states with extensive artificial reef programs, such as Florida and South Carolina, exploration of artificial reefs are popular activities undertaken by divers utilizing private vessels and charter boats. In southern Florida, artificial reefs have been developed with divers as the intended primary user group (Myatt and Myatt 1992). While most of the dive charter trips in Massachusetts are completed from boats with generally six or less divers, several operations exist which carry larger numbers of divers on bigger boats.

The seasonal climate of Massachusetts does not serve to attract divers on a global scale as is seen in states such as Florida, but the diversity of ocean habitats, advances to navigation and boating, and the improvement and affordability of exposure equipment for divers help to make Massachusetts more attractive and accessible to serious divers. Most diving activity occurs from May through October when water temperatures and sea conditions are the most suitable. The growing frequency of sport diving signifies the importance of this user group and its participation in artificial reef development for the future conservation, allocation and regulation of the state's marine resources. Economic benefits similar to those derived from recreational fishing will increase because of expanded sport diving participation.

As recreational diving continues to increase in popularity, dive sites face overcrowding and additional conflicts with other user groups, creating more demand for accessible recreational dive sites. As this demand increases, the direct and indirect economic benefits of the recreational diving industry will be of significantly greater value to the state in the future.

3.4 Subsistence Fishing

Populations of urban coastal communities include economically disadvantaged individuals that rely on subsistence fishing as a means of nourishment. Shore-based infrastructure such as bridges, jetties, and pilings provide structural benthic relief utilized by commercially and recreationally important shellfish and finfish species. The strategic placement of artificial reefs near waterfront infrastructure has the potential to enhance shore-based fishing opportunities (Buckley 1982).

Legislative actions such as stringent National Pollutant Discharge Elimination System (NPDES) requirements and other provisions of the Clean Water Act

(CWA) are proving to be effective methods of cleaning polluted urban waters. The Clean Vessel Act (CVA) Pumpout program and the Environmental Protection Agency's (EPA) No Discharge Area (NDA) Implementation Plan have been established by the federal government to work with state and local governments to eliminate the discharge of sewage from vessels in the states' marine waters. As the quality of the marine environment in urban areas improves to meet more stringent water quality standards, consideration should be given to urban artificial reefs in harbors and ports as a potential method for enhancing fishing opportunities.

3.5 Mitigation

The National Artificial Reef Plan (Stone 2002) states:

> "In using artificial reefs to mitigate development-related habitat loss, project sponsors should use reef technology to simulate the type of habitat which has been lost (e.g., offshore reef development for the loss of offshore reef habitat). Artificial reefs should not be constructed as appropriate replacement for dissimilar habitat types such as shallow-water estuarine habitat, submerged grass flats, or mud flats."

Mitigation remains a controversial issue for the potential use of artificial reefs. The construction of marine artificial reefs has been used to mitigate for the loss of various types of marine habitat in a number of coastal states. Mitigation can be successful in areas where the artificial reefs are properly placed, and closely resemble the type of habitat substrate lost (Reed et al. 2006). Ambrose and Swarbrick (1989) found that artificial reefs designed to compensate for environmental impacts to natural reefs in California need to be built substantially larger then the impacted area of the natural reef. In Massachusetts, an artificial reef was constructed in Boston Harbor in 1999 as mitigation for the destruction of shellfish beds and subtidal habitat during a coastal construction project. Due to limited effort and a lack of funding available for monitoring, this project has not been able to demonstrate that the value of habitat that was destroyed has been replaced by habitat the reef was designed to create. Establishing strict monitoring protocols is necessary to document the habitat values generated as a result of required compensatory mitigation monitoring.

3.6 Marine Sanctuaries and Nurseries

The concept of marine sanctuaries has been applied to areas of naturally occurring reefs along both the Atlantic and Pacific coasts of the United States (Wilson 1987). Sanctuaries have been established to protect and preserve natural resources. "No harvest" artificial reefs can be established for the purpose of non-consumptive utilization, providing a safe haven for fisheries stocks and other exploitable marine resources. Alternatively, creating artificial reefs in areas nearby or adjacent to closed sanctuary areas may also be used to offset the loss of traditional fishing grounds.

The same concept can be applied for utilizing artificial reef habitat to augment existing nursery grounds for certain marine species. In cases where existing nursery grounds are decreasing or threatened, specifically designed habitat structures could be located in areas to increase the chances for successful recruitment of targeted marine species. These areas can be designated as prohibited zones, or areas in which limited harvesting of other targeted and non-targeted species could take place.

3.7 Special Management Zones

A Special Management Zone (SMZ) designation has been used by several states to control and manage user activity on and around artificial reefs built in federal waters (Bell 1991). Use of artificial reefs as a fishery management tool within the Exclusive Economic Zone (EEZ) requires coordination with the New England Fishery Management council (NEFMC). Artificial reefs designated as SMZ's offer fishery resource managers the ability to utilize artificial reefs as a potential tool for the conservation or the restoration of marine habitats by providing a degree of regulatory control which otherwise would not exist. Reefs can be planned, designed and developed with specific management objectives in mind, be supported by the regulatory language for an SMZ, and allow artificial reefs to be used as non-traditional fishery management tools (Stone 2002). Designation of an artificial reef or the area surrounding the reef as an SMZ can prohibit or control certain uses in order to ensure the reef use complies with the established management goals. The SMZ designation has been used to reduce user conflicts, prohibit certain types of fishing gear or activity, or to attempt to maximize biological production through conservation.

MarineFisheries will consider the use of SMZ status for artificial reefs located in federal waters as a possible tool for managing the state's system of marine artificial reefs. All such requests for the establishment of SMZ's will be to achieve regulatory capabilities on artificial reefs, which are in accordance with the policies, goals and objectives established in this document. Recommendations for the establishment of SMZ's or for the implementation of new regulations or restrictions applicable to established SMZ's will be made by *MarineFisheries* based on thorough documentation of all available data. SMZ status or regulations will not be sought merely at the request of one user group in attempting to regulate the ban of a potentially competitive group or groups.

3.8 Research

Research priorities have been evaluated for the Atlantic coast by the ASMFC's Artificial Reef Advisory Committee (Steimle et al. 1990). These priorities include:

- Research activities need to focus on best ways of developing artificial reefs

- Research opportunities should coordinate artificial reef research efforts on a regional or national scale when feasible

Research should be established to correspond to the management and information needs required for the continued development of artificial reefs. With few reefs along the coast of Massachusetts, there are limited research opportunities and significant data gaps when compared to other states with active artificial reef programs. While much can be learned about the biology, fisheries potential, socio-economics, and overall effectiveness of marine artificial reefs from other states' programs, more information is critical for fisheries managers to gain a more thorough understanding of artificial reefs. Effective research efforts should attempt to answer pertinent questions regarding the utilization of marine artificial reefs.

3.9 Regulation

Regulation of the development and utilization of artificial reefs is an important component in guiding the overall direction of an artificial reef program. As coastal populations increase, more demand is placed on habitat and biota. Increased emphasis will be placed on regulating traditional natural fisheries resources and on the fisheries resources associated specifically with marine artificial reefs. Conflicts between competing user groups will increase with the continued demand on artificial reef utilization and development in both coastal and offshore waters. Artificial reef development will be regulated in accordance with the guidelines, goals and objectives established in this plan and other pertinent federal or state regulations. *MarineFisheries* will maintain responsibility for providing direction in this development, and will ensure that all reef development is in the best interest of the citizens of this state as well as all marine resources.

3.10 Artificial Reefs vs. Ocean Disposal

Under the pretext of creating reefs to improve fishing for coastal anglers, solid waste materials have been disposed of in the ocean. Due to a lack of funding for reef materials available for construction activities, many less than desirable items were accepted for use on artificial reefs, resulting in less than effective reef design, stability, and long-term usefulness. This situation has created problems when inadequate scrap materials naturally moved off permitted locations and into trawl fishing areas or onto public or private beaches. Many artificial reef programs are dependent on the use of scrap materials to carry out reef construction projects. Care must be taken to ensure that materials used are safe and effective in providing long-term reef habitat substrate and will meet the goals and objectives of an artificial reef program. Artificial reefs should never be created for the primary purpose of disposing of solid waste materials. Breakwaters, erosion control devices, physical barriers to impede illegal trawling, waste disposal sites, and many other structures have been constructed under the

title of marine artificial reefs (Lukens and Selberg 2004). Unless intended to function primarily as potential enhancement for marine habitat, construction of coastal infrastructure should be described for their actual purpose and not viewed as true marine artificial reefs.

3.11 Non-traditional Uses

In addition to the more established reef uses listed above, there are limited examples of artificial reefs designed for alternative or non-traditional purposes. Several states have permitted reef sites where designed modules known as “Eternal Reefs” utilize cremated remains to build memorials that also serve to enhance marine habitat. In the Dominican Republic, prefabricated concrete reef units form a submerged breakwater for shoreline stabilization (Harris 2001). In Australia and New Zealand, artificial reefs enhance existing surf breaks to increase the number of suitable surfing locations (Pattiaratchi 1999). In the Mediterranean Sea, multipurpose mechanical structures prevent illegal near-shore bottom trawling; provide refuge for marine species, and structure for mariculture of suspended mussels in unsheltered, soft bottom areas of high primary productivity (Bombace 1989). In Florida, experimental nursery reefs enhance post larval stone crab habitat (Calinski 1981). Other non-traditional uses include reefs designed for seaweed cultivation, habitat protection, and shellfish mariculture.

IV. Artificial Reef Design Guidelines

The ASMFC Program and Policy Guidelines for Comprehensive Statewide Planning and Management lists five fundamental steps necessary for the development and implementation of formal marine artificial reef plans (Gordon 1993). These steps include:

- Identifying needs
- Information and data collection
- Plan development
- Implementation
- Evaluation

Initial planning for an artificial reef requires well defined goals and objectives in place prior to project development. Artificial reef planning requires the examination of the different reef types, materials, and designs while developing the specific goals and objectives of a proposal. The goal and/or objectives of the project, and environmental and biological concerns must be identified early in the planning stages. Reefs that are improperly sited will result in wasted time, money, and effort and will not fully realize the objectives.

4.1 Reef Types

All artificial reefs can be classified into three main categories; benthic, mid-water, and estuarine. The advantages of each reef type depend on a project's objectives, location, size, and resource availability. The majority of reefs built in the United States coastal marine waters have focused on benthic reefs as a means to enhance recreational use. However, all reef types contribute to the common purpose of enhancing marine habitat for fish and other marine life.

4.1.1 - Benthic Reefs

Benthic artificial reefs are constructed by placing solid material on the sea floor, providing suitable substrate for the attachment of marine fouling organisms and vertical relief for motile invertebrates and fishes. Durable materials placed in the marine environment are colonized by a variety of sessile organisms. In time, these primary and secondary producers become the foundation of the entire reef community, and are critical to the eventual success of the reef. Material type, location of the reef, physical oceanographic conditions, time of deployment of the materials, and soak time are important factors affecting species diversity, percentage of cover and the overall stage of benthic invertebrate community development (Carter et al. 1985).

Motile invertebrates such as crabs, shrimp, lobsters, mollusks, amphipods, and echinoderms may also be found on benthic reefs in large numbers. Successful

larval recruitment from surrounding waters and the benefit of abundant food and shelter are essential to the long-term success of many of these organisms. Juvenile fishes take advantage of the food and shelter artificial reefs can provide. Some of these fish remain on the reefs for some or all of their life stages, while others may only utilize reefs during specific periods of development (Tupper and Boutilier 1997).

Finfish, shellfish, or other species of recreational or commercial interest utilize artificial reefs in numbers usually equal to or exceeding the equivalent area of natural reefs (Stone 1985). The reasons for the presence of large quantities of adult and sub-adult fish on and around benthic artificial reefs are complex and not completely understood. Possible explanations include the abundance of food, protection from predators, shelter, suitable spawning habitat, enhanced survival of juveniles, and the presence of a physical orientation point. Regardless of the exact mechanisms, the construction of benthic artificial reefs has proven to be a reliable means of increasing access to demersal and pelagic marine fish populations (Bell 1991).

4.1.2 - Mid-water reefs

Mid-water artificial reefs are suspended in the water column rather than placed entirely on the ocean bottom. Also known as fish aggregation devices (FAD), the concept of using floating or suspended structures to attract harvestable quantities of fish have been used extensively in the Mediterranean and Western Pacific. Unlike benthic reefs, FAD's function as a point of attraction for targeted pelagic fish species.

Large quantities of baitfish are often found congregating around FAD's (Rountree 1989). Larger pelagic predators may aggregate around FAD's to take advantage of the baitfish as a food source. Pelagic fish may also be drawn to FAD's for the fixed reference point they provide in the open ocean. Attraction to sound, the creation of vortices in the water, attraction to shade under the FAD's and other explanations have also been suggested as potential reasons for their success. The actual mechanisms that dictate the abilities of floating or suspended structures in aggregating large quantities of fish are not well understood (Bell 1991).

4.1.3 - Estuarine Reefs

Estuarine reefs are accessible to a larger number of users and provide an alternative to fishing offshore when weather or sea conditions are unsuitable. The majority of the successfully established estuarine reefs are found in the more temperate waters of the mid-Atlantic and Pacific coast states. The biological dynamics of estuarine artificial reefs remain one of the least studied areas of artificial reef development. While suitable materials placed in estuarine waters can result in the development of a diverse community of fouling organisms,

targeted fish species in these areas do not seem to utilize reef structures in the same manner as species utilizing offshore reefs. Estuarine fish species do not appear to associate with solid structure like offshore species (Buckley 1982); however, properly designed estuarine reefs could provide optimal habitat for the juvenile stages of many finfish and invertebrate species. The relative abundance of food and suitable habitat provided in the estuaries themselves may be the reason for this. The true value of estuarine reefs may be in their utilization for shellfish aquaculture, as a method to enhance shore-based fishing activities, or to mitigate habitat loss from development, pollution, or environmental damage. Proximity to staging areas, shallower depths, and protection from harsh weather conditions makes estuarine artificial reef development more cost effective when compared to offshore reef development.

4.2 Materials

Note: Information contained in this section was selected from the *Coastal Artificial Reef Planning Guide* prepared by the Joint Artificial Reef Technical Committee of the Atlantic and Gulf States Marine Fisheries Commissions (1998) and modified, where necessary, to correspond to the goals and objectives of the Massachusetts Artificial Reef Policy. This section provides a broad description of the criteria for materials and design, as well as a brief description of suitable material types commonly utilized in artificial reef construction. For a more detailed description of materials suitable for artificial reef construction, please refer to the *Guidelines for Marine Artificial Reef Materials, second addition*, published by the Gulf and Atlantic States MarineFisheries Commissions (Lukens and Selberg 2004). Copies of both documents are available on the GSMFC website.

4.2.1 - 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. These criteria, together with siting and management considerations, will determine the success or failure of an artificial reef project.

4.2.1.1 - 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.

4.2.1.2 - Compatibility

To maximize potential benefits to fisheries, 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 the materials will not encroach on the natural reef.

4.2.1.3 - Stability and Placement

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 must be stable on their own, since structures may break apart over time. For example, the bond between concrete and steel in a certain structure may break, but it is unlikely that either material will be moved individually.

4.2.1.4 - Durability

Limited options are available for maintenance of underwater facilities like artificial reefs. Anything beyond the most rudimentary maintenance of a large-scale ocean reef is impractical and limited by expense. Artificial reef materials, therefore, must be resistant to deterioration and break-up, and have a guaranteed lifespan of at least 20 years. Durable materials will retain the desired structure and configuration, have low maintenance costs, and have long life expectancy in the marine environment.

4.2.2 - Material Types

Artificial reefs have been built from a wide variety of materials over the years. The majority of artificial reef development activities in the US over the past fifty years have employed construction materials that were previously used or intended for other purposes. Some of these used materials have been more suitable for constructing artificial reefs than others. “Materials of opportunity” are defined as manufactured substances that are no longer useful for their primary purpose. Many artificial reef programs have become dependent on such “materials of opportunity” 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. Material and design studies would help move artificial reef programs away from dependence on materials of opportunity and toward a focus of designs and materials that can augment habitat (Noble 1998).

Artificial reef programs employ a number of specifically engineered reef habitat structures. Such structures have become a more viable option for future artificial reef development projects, and may decrease the total dependency of reef development on the availability of scrap materials, and improve the overall effectiveness and safety of fabricated reefs. The use of engineered materials has evolved with improved financial support, and willingness within the private industry to develop new and affordable reef materials.

Regardless of the nature of materials utilized to construct artificial reefs, *MarineFisheries* will identify the particular materials that are deemed acceptable for use as reef structures in Massachusetts' coastal and adjacent offshore waters. Materials will only be considered for use if they possess characteristics that 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. The "*Guidelines for Marine Artificial Reef Materials*" provides detailed information based on the experiences, benefits, and drawbacks of past uses of a variety of materials by resource management agencies.

4.2.2.1 - Secondary Use and Natural Materials

Due to their unpredictable availability, most scrap materials used in reef construction can be classified as "secondary use" materials, also known as "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 to reef managers and developers is to implement site-specific reef plans and individual projects by balancing cost effectiveness with project effectiveness in achieving objectives. Planners must consider transportation, preparation, potential deployment, maintenance, and possible enhancement costs in assessing which materials meet reef development goals. Existing artificial structures such as shipwrecks and gas and oil structures may already be in suitable locations. In such cases, they may only need to be located, enhanced, 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 with transportation, preparation, and deployment costs, especially if confronted with an expensive disposal alternative for these materials. Although past artificial reef development has been directly tied to the availability of these materials, this may not be the most desirable situation for continued planning and development of reef construction efforts in the future. 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 they may no longer be desired. In these cases, they should 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 the most suitable material available to create the intended habitat. *MarineFisheries* will carefully inspect the materials and ensure that they are environmentally safe, structurally and physically stable, and can be deployed in a cost-effective and safe manner. A thorough inspection of potential materials should be conducted early in the proposed reef construction effort to determine and ensure suitability.

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, and light gauge metal items, such as refrigerators, washing machines, and clothes dryers. Some materials may be used if specific design features can be employed to provide durability and stability. For instance, plastics and fiberglass are durable and can be designed with sufficient density to ensure stability. Vehicle tires also are problematic. However, there have been limited cases, including the Yarmouth tire reef, where they have been used without documented negative impact. In particular, tires that have been imbedded in concrete and fully encased have enough ballast to ensure stability. The Plan recommends that tires should be used as artificial reef materials only with great caution. In addition to the "*Guidelines for Marine Artificial Reef Materials*," documentation of the use of materials has been compiled through the experiences of artificial reef program managers, and should be consulted prior to consideration of using any secondary use material in a reef development project.

4.2.2.2 - Manufactured Reef Structures

A reliance on the availability of secondary use materials for development of artificial reefs presents several problems. If the program is to function in a manner conducive to effective long-term planning and development goals and objectives, it cannot base reef construction solely on the unpredictable availability of acceptable scrap materials. One solution is the incorporation of manufactured reef structures into planned reef development activities. Manufactured structures can be developed to posses the characteristics desired of a reef substrate for a specific environment, application, or result. Although the initial costs in procuring materials may be higher than the cost of obtaining many scrap materials, the transportation, handling, and deployment costs are similar. Furthermore, manufactured reef structures do not have to be cleaned prior to deployment as an artificial reef. Specific qualities of stability, durability, structural integrity, transportability, and biological effectiveness can be engineered into a reef design, giving manufactured reef structures an advantage over scrap materials that are limited in how they can be modified or deployed. Manufactured reef units can be deployed in any quantity, profile, and pattern required, providing for maximum efficiency of the materials used in achieving the desired results. Materials of opportunity such as ships must be deployed as a single unit, often with a great deal of the total material volume being taken up by the vertical profile. The same volume of designed reef materials that would be found in a

sunken vessel can be spread over a much larger area of ocean bottom, allowing for better access to a larger number of reef users.

Another advantage 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, 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 long-term planning is rarely possible.

4.2.3 - 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 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. Programs using donated materials that are acceptable for artificial reef use can significantly reduce the overall construction costs of artificial reef.

4.2.3.1 - 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 otherwise be very expensive to construct and deploy. Some form of incentive, such as modified tax obligations, could be considered to encourage future donations of secondary use materials where the cost to the donor exceeds normal disposal costs.

4.2.3.2 - Tax Incentives

Donations to an artificial reef project through *MarineFisheries* may be viewed as a charitable contribution, and may qualify for some degree of tax deduction on both federal and Commonwealth of Massachusetts taxes. Although this has not been a major incentive to stimulate the donation of goods or services, it may help to persuade individuals to donate reef construction materials such as barges, ships, and boats. *MarineFisheries* Artificial Reef Program will work with companies and private citizens on artificial reef projects that propose to use donated materials.

4.2.3.3 - Alternatives

The value of donated materials may be used as match for financial assistance where appropriate (Federal Aid in Sport Fish Restoration Act). This can serve to facilitate the transfer of materials to the reef builder for reef development.

4.3 Design

The concept of "designing" artificial reef systems as well as individual reefs, or even specific reef structures, is one that has been widely used, and is best documented in Japan (Sheehy and Vik 1982). The "design" of most artificial reefs in the US traditionally has been left to chance when using the most readily available and cost effective materials. Nevertheless, attempts have been made to construct these reefs in such a way that their overall design incorporates the factors required to achieve the most effective and efficient reef possible. In an effort to improve the manner in which artificial reefs are built, many states are now considering a number of key design criteria. These criteria are employed to develop reefs that will produce the maximum benefit possible for the biological community, the scientific community, and reef users.

The overall design of the reef, as well as individual reef materials used should be chosen with an achievable goal in mind. Reef structures must be easy to acquire or manufacture, and their handling, transportation, preparation, and placement on the reef must be realistically accomplished within safe, low-risk, cost-effective limits. Reefs intended for a specific purpose (e.g. trolling, bottom fishing, SCUBA diving, nursery grounds, etc.) should be constructed with this in mind. Some materials used in reef construction may be more suited for a specific use while other materials may be better suited for general or multiple uses. Artificial reef planners and developers should incorporate reef design criteria to ensure the overall design of the reef, including any individual reef structures achieve the intended goals and objectives of the artificial reef.

4.3.1 - Configuration and Orientation

The overall configuration of the materials on a reef will play an important role in determining how the reef works and how effectively it can be utilized. Orientation of reef materials to prevailing currents can affect densities of sessile communities and fish aggregations on the reef (Lindquist and Pietrafesa 1989). Placement of different types of structures at separate locations of the permitted area can provide increased diversity of reef fish assemblages, and allow concurrent multiple uses of the reef site (Lindberg 1996).

4.3.2 - Profile

The vertical profile of a reef structure may be important in determining the overall fish species composition and biomass of the reef. Low profile reefs are thought to be more successful in providing a suitable habitat for more demersal species, while high profile reefs appear to work better for many pelagic fishes (Kellison and Sedberry 1998; Baine 2001). Additionally, shading caused by a reef profile can influence epibiotic assemblages (Glasby 1999). 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.

4.3.3 - 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 increase the potential for a more diverse community than 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 (Spanier 1993).

4.3.4 - Total Surface Area

In most cases, the total biomass that can be supported on an artificial reef will be related to the total surface area. 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 fouling organisms, the more significant the food source available to other levels of the reef community.

4.3.5 - Openness of reef materials

Reef materials should be selected which offer suitable openness to allow adequate water circulation and prevent the stagnation of water, which could minimize the effectiveness of the overall reef. Openness of 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. Any movement, separation, or deterioration of reef materials is not favorable when establishing a permanent reef.

4.3.6 - Proximity to natural or artificial habitats

Artificial reefs may harbor high densities of fish and often resemble natural reefs (Bohnsack and Sutherland 1985). Therefore, reefs may be utilized to redirect harmful human activities away from sensitive, natural reefs. However, there may be management risks associated with increasing the harvest ability of fish. The concentration of fishing pressure on or near artificial reefs may disproportionately affect the relative abundance and distributions of fish species that utilize reef habitats. Changes to the surrounding ecology may also include tropic cascades via the disruption of important predator prey relationships and changes to fish migration patterns. Ecological relationships of adjacent natural reefs to artificial reefs are not well understood and require further study. The potential of

introduced habitat to change production and aggregation functions in an area are important factors for considering the potential of artificial reef technology for fishery enhancement.

4.4 Siting

The primary focus for siting an artificial reef is to enhance or create viable habitat that will benefit fisheries. Improperly sited reefs can result in negative impacts including hazards to navigation, damage to naturally productive bottom, and environmental clean-up problems. Artificial reef siting criteria was extensively examined during the 1980's by the Sport Fishing Institute's Artificial Reef Development Center for the purposes of enhancing recreational fishing opportunities (Ditton and Burke 1985). In order to determine optimal siting requirements, a three-step outline was developed for identifying reef sites. The first step identifies potential development zones using geographic, oceanographic, socioeconomic, and environmental information (Myatt and Ditton 1986). The second step, commonly referred to as "exclusion mapping", identifies and eliminates areas within the development zone that are unsuitable for reef development. Elimination criteria can include, but not be limited to, regulatory prohibitions or user conflicts (Stone 2002). Finally, the areas determined to have the greatest potential benefits for an artificial reef are targeted for development. This process has been successful in the development of recreational reefs by states with artificial reef programs, and can serve as a guide for additional reef development when interest in utilizing reefs for restoration, mitigation, recruitment, and juvenile survival purposes exists.

In selecting locations for proposed marine artificial reef development, sites need to receive a high degree of public support. Reef sites for public use must be within reasonable distances of boat landings, marinas, fixed navigational aids, and major inlets in order to be accessible to as many users as possible. An artificial reef site selected for development must not unintentionally create a public benefit for one or more user groups at an expense to other user groups. User conflicts between recreational anglers and commercial fishermen over use of the ocean bottom are often the most common problems encountered in this area. Additional consideration should be given to boat size and navigational abilities.

Potential artificial reef sites must possess the physical, biological, and oceanographic conditions suitable for the type, design, and purpose of the proposed reef. Factors such as depth, bottom type and stability, magnitude and direction of prevailing currents, water quality, potential degree of wave energy, nature, extent of existing biota, and nature of surrounding habitat must be taken into consideration in deeming a particular site acceptable for addition of a reef. The suitability of each site must be evaluated independently. The nature of reef materials, design of the reef and intended purpose can vary significantly between individual reefs.

Natural reefs are important for artificial reef colonization and interaction of marine species. Grove and Sonu (1985) recommended that the distance between natural and artificial reefs range between 600 and 1000 meters to avoid competition. Artificial reefs are beneficial when they establish new productive sites on relatively unproductive bottom. The site selection process must ensure that artificial reef development does not take place on naturally productive "live bottom" areas. The creation of these new sites can help to disperse reef users, lessen pressure on existing live bottom areas, and minimize crowding on other established sites.

Artificial reefs cannot create a hazard to safe navigation, create a potentially unsafe situation for reef users, or interfere with existing or potential uses of the site that would directly conflict with the intended purpose of the reef. Reefs cannot be located in shipping channels, designated anchorages, or in areas of heavy shipping traffic where the reduced depth of water will create a potentially hazardous situation. Artificial reefs should also be located away from military exercise areas, areas of extremely shallow water (shoals, banks, shallow wrecks, etc.) and away from the mouths of inlets. Reefs should also not be built on or near identified sites of potential archaeological significance, dredge spoil areas, or too close to existing special purpose or navigational buoys.

Artificial reefs should not interfere with or restrict the ability to continue established traditional commercial fishing activities. In some cases, it may not be possible to find a location that is not utilized for some facet of commercial fishing. In this case, attempts should be made to locate a more suitable site for artificial reefs development, such as where existing "hangs" or obstructions are known to occur. If this proves impractical, a reef design resulting in as minimal an area as possible should be considered.

4.5 Deployment

Prior to the initiation of actual construction activities, all necessary permits to conduct proposed work must be in hand. All preparations, modifications, or special conditions necessary to ready materials for transport and deployment must be complete according to permit specifications. If materials of opportunity are being utilized, a thorough inspection of proposed reef materials must be conducted prior to deployment. Additional inspections by state or federal agencies or other groups may also be required. All construction activity will require coordination with all participating parties (which may include marine contractors, United States Coast Guard (USCG) representatives, law enforcement agencies, *MarineFisheries* staff, other Department employees, media, etc.), and contingency plans for bad weather, communication difficulties or emergencies must be clearly established and disseminated.

4.5.1 - Marking of Reefs

Artificial reef buoys, while maintained by the state, may be required by the USCG Aids to Navigation Branch. Buoys must be designed in compliance with all USCG standards. Missing or damaged buoys must be replaced in accordance with the conditions of the federal permits.

There are a number of difficulties in maintaining buoys on coastal and offshore reefs. These include:

- Lost or severely damaged buoys due to storms, ice, collisions with ships, deliberate sabotage, failure of the mooring system from corrosion and / or damage from boaters tying to the buoys
- High cost of replacement buoys and mooring systems, and inadequate funding available to replace missing or damaged buoys
- Inability to replace missing buoys in a timely manner due to a lack of buoy and chain reserves or a lack of a suitable vessel capable of doing the work and responding to short lead times in scheduling the job
- Inability to enforce USCG or state regulations which would prevent individuals from tying to buoys while using the reefs, resulting in damage to buoys and prematurely shortened life-spans

Marking requirements for each reef complex will be determined by USCG on a case-by-case basis. Marking requirements may be waived if:

- The entire reef complex is adequately marked and charted on a navigational chart
- There is sufficient water clearance over the reef
- The reef structure is over 2 miles from fairways, channels, and anchorages
- The individual reef structure is part of an overall existing reef
- There is no history of deep-draft traffic through the area

The USCG District Commander, upon receiving an application from the reef sponsor, will make the decision on when and if navigation aid is mandatory. Site specific considerations will determine actual requirements (Atlantic 1998).

4.6 Liability

There are a number of risks associated with the development and deployment of artificial reefs. These risks may include:

- Personal injury during reef development or deployment
- Damage to private or public property during the transportation and handling of reef materials
- Hazards to navigation created during transportation or deployment
- Environmental hazards caused by improper or incomplete cleaning of materials
- Damage to naturally productive bottom due to improper site selection or placement

- Damage to fishing gear, resulting from improper placement of reef materials
- Damage to equipment, injury to personnel, the unintended creation of hazards to navigation, or unintended changes to ocean bottom or habitat due to the decomposition or movement of materials after they have been put in place
- Injury to recreational divers occurring on improperly prepared materials, structurally deteriorated materials or other inherent hazards found on and around submerged reef structures (Bell 1991)

The National Fishing Enhancement Act of 1984 (P.L. 98-623, Title II), Section 205 C addresses the legal liability of the artificial reef permittee, the materials donor, and the federal government. These liability considerations can be summarized as follows:

- A 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 National Fishing Enhancement Act of 1984 (NFEA) have been satisfied
- A donor of materials for reef construction, once title has transferred to the permittee, is immune from liability if materials meet the requirements of the NARP
- The NFEA does not address the transporting of reef materials. All maritime accidents, injury to crew, grounding, premature discharge, collision, or sinking would have a liability situation similar to any other maritime context
- While the permittee is liable for failure to place and mark reefs (PL 998-633 Section 205 (C) (2), strict adherence to the requirements of the permit will protect the permittee from liability for injuries resulting from those activities required in the permit
- Once properly located, marked, and periodically monitored by the permittee as required by permit, there is little potential for liability, and it is each vessel owner's responsibility to avoid collision
- The liability of the permittee in cases of diving accidents associated with artificial reefs is similar to a municipality's liability for accidents in a public park. Liability in each case would involve determination of comparative negligence of the diver and the permittee (Tinsman 1998)

The NFEA prohibits the Army Corps of Engineers (ACOE) from issuing a permit for reef construction to anyone who cannot demonstrate the ability to assume liability for all damages that may arise with respect to the construction and maintenance of an artificial reef. This has had the effect of slowing down artificial reef development by most private groups or individuals, and once the ACOE establishes the actual extent of this liability, all reef development in this country will likely be managed at the state government level (Bell 1991).

V. Artificial Reef Permitting Guidelines

Note: Information contained in this section was selected from the *Environmental Permitting in Massachusetts Guide* prepared by the Massachusetts Office of Coastal Zone Management (CZM) and modified, where necessary, to correspond to the goals and objectives of the Massachusetts Artificial Reef Plan (MARP). This section provides a broad description of the criteria for federal, state, and local permit requirements as they may relate to artificial reef development in Massachusetts. In some circumstances there may be additional permitting requirements not detailed in this document. A complete description of permitting requirements can be found in the *Environmental Permitting in Massachusetts Guide*, written by CZM (MACZM 2003). Copies are available on the CZM website (http://www.mass.gov/czm).

The roles of all parties involved in artificial reef development, management, and regulation have evolved significantly since the release of the original National Artificial Reef Plan in 1985. 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 Atlantic and all Gulf of Mexico states also participate in regional communication and coordination concerning essential artificial reef management activities through their respective IFMCs. The consensus of reef program managers is that artificial reefs may be utilized as fisheries management tools, and as such, their use constitutes a fisheries issue that must be addressed accordingly. Unique partnerships in artificial reef development between state, federal, and private interest groups have been formed with the states as the lead fishery management agencies and primary entities in implementation of the national plan. Close interaction between the GSMFC, ASMFC, and NMFS facilitated the current revision of the national plan.

5.1 Federal Role

The federal role is to provide technical assistance, guidance, and regulations for the proper use of artificial reefs. Such assistance must be compatible with other long-term needs, and should improve coordination and communication between the federal agencies, states, IFMCs, commercial and recreational fishing interests, diving communities, and other interested parties. Generally, the federal role is carried through the permit process, and federal agencies provide guidelines, services, information, financial aid, and in-kind support for projects. Federal fisheries agencies may provide some regulatory functions regarding fishing practices on specially designated artificial reefs (e.g., “Special Management Zone” designation in the South Atlantic and Gulf of Mexico FMC Fishery Management Plan (FMP) for snappers and groupers, and reef fish, respectively). The federal government has been involved in artificial reef activities for several decades, through research and developments sponsored by

individual agencies, as well as in reviewing and commenting on reef permit applications (see Act section 205). There is no overall federally coordinated program to guide artificial reef activities except through the permit program of the ACOE. The President's Proclamation of an EEZ on March 10, 1983 declared a national interest in living and non-living resources found within 200 nautical miles from shore. In addition, the National Recreational Fisheries Conservation Plan of 1996, developed pursuant to Executive Order 12962 - Recreational Fisheries, directs specific federal activities to utilize artificial reefs in implementation of a national recreational fisheries resources conservation plan. The Atlantic Coastal Fisheries Cooperative Management Act (Atlantic Coastal Fisheries Act) (PL 103-206) 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 there will be interest in the use of artificial reefs in the EEZ to enhance the resources and the habitats that are essential to fisheries proliferation.

Six federal entities – the ACOE, the US 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.

5.1.1 - U.S. Army Corps of Engineers

On July 26, 1985, the ACOE published proposed regulations to implement a portion of their responsibility pursuant to the National Fishing Enhancement Act (NFEA). The ACOE regulations closely mirror the evaluation standards established by NFEA and guidance provided in the National Artificial Reef Plan (NARP) that was developed pursuant to section 204 (Stone 2002).

A permit from the ACOE is the primary certificate of federal approval. A permit to site a structure to be used as an artificial fishing reef is granted by the ACOE under Section 10 of the Rivers and Harbors Act of 1899 (33 U.S.C. 403). Section 10 authorizes the ACOE to regulate construction in, or alteration of, any navigable waters of the United States. Section 4 of the Outer Continental Shelf lands Act of 1953 (43 U.S.C. 1333(f)) extends this authority to the continental shelf. The ACOE has authority under Section 404 of the Clean Water Act of 1972 (PL 92-500) to regulate any materials placed within waters of the United States and stipulates state certification of projects involving the discharge of dredge or fill material.

The term artificial reef, as defined in ACOE regulations and the NFEA, means:

> " a structure which is constructed or placed in the navigable waters of the United States or in the waters overlying the outer continental shelf for the purpose of enhancing fishery resources and commercial and recreational fishing opportunities."

The ACOE is required to review the applicant's objectives for artificial reef construction as well as the applicant's provisions for siting, constructing, monitoring, and managing the proposed reefs. Clear evidence of title and responsibility for maintenance is also required as is information on the financial ability of the applicant to assume liability for future damages resulting from the reef or associated activities. The ACOE permits are required to specify the design and location of the reef and the types and quantities of material to be deployed. All permits must include terms and conditions for the construction, operation, maintenance, monitoring, and managing the reef to ensure compliance with applicable provisions of law as well as conditions that may be necessary for the protection of the environment and human safety and property. The liability of the United States government, the applicant, and reef material donors is also addressed. The NFEA provides for a civil penalty of up to $10,000 for each violation considering the nature, extent, circumstances, and gravity of the violation.

The following regulations are administered together by the ACOE Regulatory Division through a single permit application.

- Rivers and Harbors Act of 1899 (Section 10)
- Clean Water Act (Section 404)
- Marine Protection, Research and Sanctuaries Act, (Section 103)

A Section 10 permit is required for all work, including structures, seaward of the annual high water line in navigable waters of the United States, defined as waters subject to the ebb and flow of the tide, as well as a few of the major rivers used to transport interstate or foreign commerce. A Section 404 permit is required for activities that involve the discharge of dredged or fill material into waters of the United States including not only navigable waters, but also coastal waters, inland rivers, lakes, streams, and wetlands. A Section 103 permit is required to transport dredged material for the purpose of disposal in the ocean. The ACOE, New England District has issued a Programmatic General Permit (PGP) for minor work in Massachusetts. Any project that does not comply with the terms and conditions of the PGP will require an Individual (Standard) Permit. The PGP provides for three levels of regulatory review (Table 1):

- Category I - Non-reporting. Eligible without screening (provided required local and State permits and required State certifications are received), or

- Category II - Reporting. Require screening and a written determination of eligibility under the general permit by the ACOE after coordination with the U.S. Fish and Wildlife Service, U.S. Environmental Protection Agency and National Marine Fisheries Service, and the CZM Office

- Individual Permit - The PGP does not affect the ACOE Individual Permit review process or activities exempt from ACOE jurisdiction

Applications must include a brief project description, a vicinity map, a site plan, and a plan view of the proposed structure. Federal and state resource agencies meet every three weeks to review applications. A PGP is usually issued, with or without special conditions, within 60 days of a complete application.

For Individual Permits, within 15 days of receiving the required application material, the ACOE issues a Public Notice seeking comments from abutters, regulatory agencies, and the public. The comment period is typically 30 days. The ACOE evaluates comments received, compliance with section 404(b) (1) of the Federal Clean Water Act if applicable, public interest factors and issues a permit if the project is not contrary to the public interest.. If denied, the applicant is informed of the reason(s) through the Environmental Assessment/Statement of Findings.

No ACOE permit is valid until the applicant has obtained all the required state approvals. For more information, please visit the ACOE website (www.nae.usace.army.mil).

Table 1: Examples of the activities and categories of the PGP (ACOE 2003).

Activity	Category I	Category II	Individual Permit
Fill in Navigable Waters (most reefs qualify as fill)	Fills authorized by Ch.91 Amnesty program (e.g., seawalls or bulkheads). No provisions for new or previously unauthorized fills in Category 1, other than those authorized under the MA Chapter 91 Amnesty program.	Up to 1 acre fill and\or waterway and wetland impacts (e.g., areas drained or flooded). Fill includes temporary and permanent waterway. Temporary fill and excavation up to 1 acre in special aquatic sites. No permanent fill and/or excavation in special aquatic sites except when associated with a proactive restoration project. Proactive restoration projects with any amount of impact can be reviewed under Cat. 2. The ACOE, in consultation with State & Federal agencies, must determine that net adverse effects are not more than minimal.	Greater than 1 acre waterway fill and\or secondary waterways or wetland impacts (e.g., areas drained or flooded). Fill includes temporary and permanent waterway fill. Temporary fill and excavation up to 1 acre in special aquatic sites. Permanent fill or excavation, any amount, in special aquatic sites, other than specified in Cat. 2. EIS required by the ACOE.
Dredging	Maintenance dredging less than 1,000 cy with upland disposal, provided proper siltation controls are used. Provided: • Dredging and disposal operation limited to November 1 to January 15. • No impacts to special aquatic sites	Maintenance dredging greater than 1,000 cy, new dredging up to 25,000 cy, or projects that don't meet Cat. 1. Provided: • No impacts to special aquatic sites. • Disposal includes upland, beach nourishment, and open water, only if ACOE, in consultation with federal and state agencies, finds the materials suitable	Maintenance dredging and/or disposal (any amount) in or affecting a special aquatic site, new dredging greater than 25,000 cy., or any amount in or affecting a special aquatic site,
Pile-Supported Structures and Floats	Piers /structures licensed by Ch. 91 through the Amnesty program. Private, bottom-anchored floats up to 400 SF. in size. Private, pile-supported structures for navigational access to the waterway, <400 SF in size, with attached floats totaling <200 SF. Provided (for all of the above): •Floats supported off substrate at low tide. •Pile-supported structures &floats are not positioned over vegetated shallows and moored vessels are not positioned over special aquatic sites. •Pile-supported structures that are <4' wide have at least a 1:1height:width ratio10. •Ch. 91 license issued. •Not associated with a boating facility. •Not located within the horizontal limits of a ACOE Federal Navigation Project (See Appendix B).	Private piers and floats that don't meet the terms in Cat. 1, and don't require an Individual Permit. Pile-supported structures or floats located such that they, and/or vessels docked or moored at them, are within the buffer zone of the horizontal limits of a ACOE Federal Navigation Project (FNP). (See Appendix B.) The buffer zone is equal to three times the authorized depth of that FNP. Note: Federal Navigation Projects include both Federal Channels and Federal Anchorages. Expansions to existing boating facilities.	Pile-supported structures and floats associated with a new or previously unauthorized boating facility . Pile-supported structures or floats located such that they and/or vessels docked or moored at them, are within the horizontal limits of a ACOE Federal Navigation Project (See Appendix B). Note: Federal Navigation Projects include both Federal Channels and Federal Anchorages. Any work in the area of the Cape Cod Canal located west of the vertical lift railroad bridge as noted in Appendix C and specified at Endnote 11 of the MA PGP (ACOE 2003).

Miscellaneous	Temporary buoys, markers, floats, and similar structures for recreational use during specific events, provided they are removed with 30 days after use is discontinued. Coast Guard-approved aids to navigation. Oil spill clean-up temporary structures & fill. Fish and wildlife harvesting structures and fill (as defined by 33 CFR 330, APP. A-4). Scientific measurement devices and survey activities such as exploratory drilling, surveying, and sampling activities. Does not include oil and gas exploration and fill for roads or construction pads.	Structures or work in or affecting tidal or navigable waters that are not defined under any of the previous headings listed above. Includes, but is not limited to, utility lines, aerial transmission lines, pipelines, outfalls, boat ramps, and bridges. Shellfish aquaculture facilities in compliance with the Aquaculture Guidelines.	EIS required by the ACOE. Shellfish aquaculture facilities in compliance with the Aquaculture Guidelines. Shellfish aquaculture facilities not in compliance with guidelines, including those facilities within 25 feet of eelgrass beds.

5.1.2 - 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 (PL 98-369, USC 777c). This act provides federal financial assistance to the states for approved studies and projects directed at enhancement of recreational fisheries resources.

5.1.3 - The US Fish and Wildlife Service

The US Fish and Wildlife Service (USFWS) administers the Federal Aid in Sport Fish Restoration Program, which provides matching grants to states to undertake sport fish restoration and boating projects. Money for this program is collected from excise taxes on fishing tackle and motor boat 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 increases in financial assistance for such projects. Consequently, this funding has influenced the direction of artificial reef programs nationwide with a greater focus on enhancement of recreational fisheries and increased fishing opportunities through better access to the fisheries resources. The USFWS is required to consult with the ACOE under the Fish and Wildlife Coordination Act (FWCA) whenever the waters or channels of a body of water are modified by a department or agency of the U.S., with a view to conserve wildlife resources. In addition, the USFWS participates in the cooperative Interstate Fishery Management Program (ISFMP) of the ASMFC to develop and implement fishery management provisions of the Atlantic Coastal Fisheries Act.

The USFWS also provides a critical function in co-chairing the National Recreational Fisheries Resources Conservation Council with the NMFS.

5.1.4 - The Minerals Management Service

The Minerals Management Service (MMS) is responsible under the OCSLA for leasing federal lands on the US outer continental shelf (OCS) and regulating the development of oil, gas, and sulfur resources in an orderly manner while properly safeguarding the environment. The MMS supports the appropriate conversion of retired oil and gas 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 (Wilson 1987).

5.1.5 – National Marine Fisheries Service

The National Marine Fisheries Service (NMFS), a branch of NOAA, carries out responsibilities of the Department of Commerce (DOC) for the marine fisheries of the country. The DOC has responsibility under the Magnuson Act as amended by the Sustainable Fisheries Act of 1996, to restore, maintain, and enhance fishery resources in the EEZ. Also under this act, the DOC must develop and provide to FMC's guidelines on essential fish habitat (EFH) which will assist in amending Fishery Management Plans (FMP) developed by the FMC's. Under these new provisions, artificial reefs may be designated as EFH. Under the Endangered Species Act of 1973 (ESA), Section 7 requires NMFS to consult with other agencies to ensure that any action authorized, funded, or carried out is not likely to jeopardize the continued existence of any listed endangered species or threatened species, or result in the destruction or adverse modification of designated critical habitat of such species. The DOC also has general authority under the FWCA and the Inter-Jurisdictional Fisheries Act of 1989 (PL 99-659) to cooperate with the states to conserve and manage 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...". The Maritime Programs Appropriations/Authorizations Act of 1972 (PL 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 the Maritime Administration'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. The National Fishing Enhancement Act amends this act to transfer authority for vessels available for artificial reefs to the Department of Transportation. However, some constraints may exist on availability or suitability of military vessels for artificial reef use. The NMFS also

plays an obvious part in artificial reef development, management, and regulation through its role as the lead agency in the development of the NARP. Additionally, the NMFS has been involved in a general oversight capacity in such activities as providing comments on artificial reef permits, reviewing potential impacts to EFH, research, establishment of acceptable standards for the transfer, cleaning and preparation of certain reef materials, and in establishment of fishery regulations pertaining specifically to development of artificial reef sites.

5.1.6 - The National Ocean Service

The National Ocean Service (NOS), another branch of NOAA, is responsible for mapping the locations of artificial reef sites and other bottom obstructions. Due to the advent of affordable differentially correct Global Positioning Systems (GPS), many coordinates of previously marked artificial reef sites have been found to be inaccurate. During the ACOE permit process, the NOS must be notified of reef locations to ensure that reef sites are accurately plotted. Cooperative programs with fishermen and/or divers may be of great value as part of the monitoring of permitted reef sites by assisting in detection of any movement or deterioration of reef structures and components.

5.1.7 - Department of Defense

The Department of Defense (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 several branches of the DOD to facilitate transfer
of demilitarized combat vehicles to state artificial reef programs along the Gulf and Atlantic coasts. Although the program is now inactive, the intent was to make other suitable materials available in future programs.

5.1.8 - United States Coast Guard

The U.S. Coast Guard (USCG) is responsible for protecting the public, the environment, and the U.S. economic interests in the nation's ports and waterways, along the coast, on international waters, or in any maritime region. The USCG has authority to:

- Promulgate regulations dealing with lights, warning devices, and other public and private aids to navigation on offshore installations
- Establish safety fairways and traffic separation schemes for safe movement of vessel traffic under the Ports and Waterways Safety Act
- Establish safety zones around offshore facilities
- Enforce fishery laws
- Monitor and enforce compliance with international conventions and statutes on environmental protection

The USCG manages the Private Aids to Navigation Program to ensure that aids to navigation are being maintained to conform to certain minimum standards, and to promote the accuracy of information available to mariners. In some cases, aids are required because an artificial reef may pose some hazard to navigation. 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.

When an artificial reef is not considered an obstruction to navigation, aids established for indicating the presence of a reef to users may be discontinued when reef 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 navigation aid is no longer mandatory. Site specific considerations will determine actual requirements (Atlantic 1998).

5.1.9 - Maritime Administration

Within the Department of Transportation (DOT), the Maritime Administration (MARAD) has been involved in numerous artificial reef construction projects over the past three decades through the donation of surplus ships for reef construction material. Under amendments to PL 98-402 in Section 207 of the National Fishing Enhancement Act, the Secretary of Transportation has authority to designate any “obsolete” vessel as being available for transfer to state artificial reef programs.

5.1.10 - The Environmental Protection Agency

The EPA has responsibility under the Marine Protection, Research, and Sanctuaries Act of 1972 (MPRSA) and the Clean Water Act of 1977 (CWA) to regulate ocean dumping and point source pollution. All permits issued under these two Acts must comply with environmental guidelines promulgated by the EPA. Under the MPRSA, the EPA also has the authority to designate ocean dumping sites for all discharges into ocean waters. However, such activities have been segregated in the EPA permits from artificial reef construction activities. Under the CWA, the EPA co-administers the Section 404 program with the ACOE. Among other responsibilities, the EPA may prohibit or restrict discharges of dredged or fill material at sites where the discharge would have unacceptable effects on fish, shellfish, wildlife, recreation, or municipal water supplies.

As part of their involvement in REEFEX, an interagency technical working group consisting of representatives from the EPA, U.S. Navy, and the South Carolina Department of Natural Resources, the EPA developed criteria for preparation of demilitarized combat vehicles prior to their use in reef construction. Although specific to this particular material, this marks the first time since passage of the

National Fishing Enhancement Act of 1984 that some guidelines have been developed for materials used in the construction of artificial reefs.

5.1.11 - National Environmental Policy Act

The National Environmental Policy Act (NEPA) established environmental protection as a national policy goal and directed all federal agencies to consider the environmental consequences of their projects and permitting actions. The NEPA review provides opportunities for integration of national environmental policy into project planning; public and agency review of potential environmental effects of federal actions (including issuance of federal permits) and programs; coordinated and inter-disciplinary program planning; and resolution of disputes among agencies. Most federal agencies have promulgated regulations governing the incorporation of NEPA's reviews into their programs.

There are three levels of analysis in the NEPA review system. The first level, a categorical exclusion determination may exclude an undertaking from a detailed environmental analysis if it meets certain criteria that have previously been determined as having no significant environmental impact. The next level is the environmental assessment (EA), with one federal agency designated as the lead agency for preparing the EA. Following publication of the EA in the *Federal Register* and a public comment period, the agency will issue a Finding of No Significant Impact (FONSI) or will decide to prepare an environmental impact statement (EIS) to examine alternatives, impacts, and mitigation. Other federal and state agencies may play an official role in preparation by becoming "cooperating" agencies with the lead agency. At the completion of the EIS process, the lead agency issues a Record of Decision making environmental findings.

5.1.12 - Federal Consistency Review Procedures

Federal Consistency Review is required for any project undertaken by a federal agency, requiring a federal permit, requiring a federal offshore oil and gas lease, or receiving federal funding that is in or may affect the land or water resources or uses of the Massachusetts coastal zone. The Massachusetts coastal zone is the area bounded by the seaward limit of the state’s territorial sea (generally 3 miles from shore) to 100 feet landward of specified major roads, railroads, or other visible right-of-way (generally the first major transportation corridor inland of the shoreline, see Figure 1). Any project proposal that exceeds MEPA thresholds and that requires a federal license or permit must be found to be consistent with CZM coastal policies.

CZM's federal consistency review ensures that any federal activities in or affecting Massachusetts’ coastal resources are consistent with state coastal policies. These policies are enforceable, and are based on existing Massachusetts statutes and regulations and offer policy guidance on

management of water quality, marine habitat, protected areas, coastal hazards, port and harbor infrastructure, public access, energy, ocean resources, and growth management. The project-specific federal activity cannot take place until CZM concurs that the project is consistent with state coastal policies. Specific application requirements and review timetables for the various federal actions that make a project proposal subject to CZM's review are contained in regulations at the CZM federal consistency review website (http://www.mass.gov/czm/fcrczmregs.pdf).

Upon receipt of a complete application, the federal consistency review can begin. The following steps then occur:

- A project review schedule is sent to the applicant or his or her agent
- The project is assigned to a CZM technical reviewer, who will be responsible for evaluating the materials provided and for making a recommendation to the Director of CZM as to whether or not the project is consistent with CZM's enforceable program policies
- A public notice of the proposed project is published in the next available *Environmental Monitor*, a publication of the MEPA Unit in the Executive Office of Environmental Affairs (EOEA). A 21-day comment period begins on the day that the *Environmental Monitor* is published
- When all technical and public policy questions raised by the project have been resolved, and all other state licenses and permits have been obtained, CZM may concur with or object to the applicant's Federal consistency certification. This may occur any time from immediately following the close of the public comment period to the end of a period defined by federal regulation. CZM makes every effort to render a decision at the earliest possible time

Massachusetts chose to develop and implement a "networking" coastal management program. Under this approach, CZM has entered into Memoranda of Understanding (MOU) with the state agencies that issue environmental licenses, permits, and certifications to implement CZM's enforceable program policies through their regulatory processes. A Federal consistency review cannot be completed until copies of all relevant state environmental licenses and certifications have been received by CZM.

An applicant may also request mediation from the NOAA Office of Coast and Ocean Resource Management (OCRM) or appeal CZM's denial of Federal consistency to the U.S. Secretary of Commerce by filing a notice with the Secretary within 30 days of receipt of CZM's denial. Copies of the appeal and any accompanying information must also be filed with all of the state and federal agencies involved with the proposed project. Complete information on the appeal process may be found in federal regulation 15 CFR 930 Subpart H. CZM must be notified of any modification to a project that has previously been reviewed and approved. Based on the significance of the proposed modification, CZM may determine that no further review is required, or may require the proponent to reopen the federal consistency process.

When a project is below CZM's thresholds for Federal consistency review or is otherwise outside the jurisdiction of the federal consistency process, the federal agency issuing the final license for a proposed project may require the applicant to obtain a statement to that effect from CZM. The applicant may send a request for a waiver with a copy of the appropriate federal license application to the CZM Project Review Coordinator. If CZM determines a project is not subject to federal consistency review, applicants can expect confirmation within a week of receipt of their request.

Following a catastrophic event, such as a hurricane, there may be repairs that require emergency certification from local, state, and federal agencies to mitigate damage in an accelerated period. The Federal consistency process recognizes such situations and provides for emergency certifications. The action proposed for emergency certification must be one that is necessary to avoid or eliminate imminent threat to public health and safety, and is limited to what is necessary to abate the emergency. Full compliance with all pertinent state licensing procedures, including CZM Federal consistency review, is required when the immediate need for undertaking the emergency action no longer exists.

For more information detailing the CZM Federal Consistency Review process, please see the CZM website at www.mass.gov/czm.

5.2 State Role

There is consensus among state agencies that artificial reef projects must be considered as fishery management issues. As more fish species become subject to IMFC FMP regulations, it is important that state artificial reef programs become more closely linked organizationally with state fishery programs. It is imperative that appropriate state agencies play a major role in the development of national and site-specific guidelines for artificial reefs and their use.

Because of the potential long-term effects of altering the environment through artificial reef development, and the potential impacts of artificial reefs on finfish and shellfish stocks, eligibility to hold a permit to develop an artificial reef should be restricted to the appropriate state fishery management agency. *MarineFisheries* holds the public trust in managing fisheries resources and is the principal entity that can demonstrate long-term accountability for liability required in artificial reef permits.

5.2.1 - Massachusetts Environmental Policy Act

The MEPA Unit within the Massachusetts Executive Office of Environmental Affairs (EOEA) administers the MEPA Review. This process provides opportunities for public review of the potential environmental impacts of projects for which state agency action is required. The MEPA review helps state

agencies satisfy their obligation to avoid damage to the environment, or if damage to the environment cannot be avoided, to minimize and mitigate the damage to the maximum extent practicable. State agency action includes activities that are undertaken, permitted, and/or funded by agencies of the Commonwealth, and the transfer of lands owned or controlled by the Commonwealth. The intent of the MEPA review is to inform project proponents and state agencies of potential adverse environmental impacts while a proposal is still in the planning stage. The proponent, through the preparation of one or more review documents, identifies required state agency actions and describes the means by which the proposal complies with applicable regulatory standards and requirements. All relevant state agencies are required to identify any aspects of the proposal that require additional description or analysis prior to completion of the agency action, which is usually the issuance of an environmental permit. Proponents of projects that require state action and that meets or exceeds MEPA review thresholds must file an Environmental Notification Form (ENF) and may be required to file an Environmental Impact Report (EIR).

Proposed projects are subject to a MEPA review if they equal or exceed the MEPA thresholds. Examples of threshold activities include:

- Alteration of 25 or more acres of land
- Alteration of designated significant habitat, and/or taking of endangered or threatened species or species of special concern
- Alteration of coastal dunes, barrier beaches, or coastal banks; alteration of 500 ft. of fish run or inland bank; alteration of 1,000 square feet of salt marsh or outstanding resource waters; alteration of 5,000 square feet of bordering or isolated vegetated wetlands; new or expanded fill or structure in a velocity zone or regulatory floodway; alteration of one-half acre of other wetlands
- Projects proposed within an Area of Critical Environmental Concern (ACEC)

It is important to review the complete list of MEPA thresholds for applicability to a particular proposal. No state permits can be issued until the Secretary certifies that the project's environmental impacts have been fully described and all necessary plans to avoid, minimize, and mitigate adverse effects are in place. The MEPA regulations also provide mechanisms to review proposals that are below MEPA thresholds but may have adverse environmental impacts, project changes and time lapses, and for waivers of certain provisions of the regulations.

5.2.2 - Massachusetts Wetlands Protection Act and Rivers Protection Act

Any construction in or near a wetland resource, including intertidal and subtidal habitat, is subject to the provisions of the Wetlands Protection Act (WPA). Local conservation commissions and the Department of Environmental Protection (DEP) Wetlands Program administer the WPA. The purpose of the WPA is to

protect Massachusetts wetlands resources and to ensure that the beneficial functions of these resources are maintained. A wetland is defined as:

- Any bank, freshwater wetland, coastal wetland, beach, dune, tidal flat, marsh or swamp bordering on the ocean, any estuary, creek, river, stream, pond, lake, or certified vernal pool
- Land under any of the water bodies listed
- Land subject to tidal action, coastal storm flowage, or flooding
- Riverfront areas in the Commonwealth of Massachusetts

Projects in wetlands resource areas, or in the buffer zone around them, must obtain a local Order of Conditions through DEP. The wetland resources identified are protected because they fulfill the public interest to protect public and private water supply, protect fisheries, protect groundwater supply, provide flood control, protect land containing shellfish, prevent storm damage, protect wildlife habitat, and prevent pollution. These interests are protected by a "no net loss of wetlands" policy. Projects that affect wetlands are required to avoid impacts where possible, minimize unavoidable impacts, and mitigate for unavoidable impacts. In addition to the requirements of the WPA, project proponents should check with local conservation commission officials to determine if there are any local wetlands by-laws applicable to the project.

5.2.3 - Public Waterfront Act (Chapter 91)

Any project in, under, or over flowed or filled tidelands or great ponds will require a Chapter 91 license or permit. The Division of Wetlands and Waterways in the DEP administers the Chapter 91 Waterways Program. Chapter 91 is the Massachusetts public trust statute that protects the public's rights to fish, fowl, and navigate below the current or historic high water line, and in great ponds and navigable rivers and streams in Massachusetts. Waterways regulations promote the preservation of tidelands for water-dependent uses that require direct access to the water. In addition, the regulations seek to ensure that areas in jurisdiction are maintained for public use and enjoyment when privately developed. Dredging, placement of structures, change in use of existing structures, placement of fill, and alteration of existing structures in any of the following coastal areas falls under Chapter 91 (recognizing that MGL Ch. 91 applies more broadly than to coastal areas) including:

- Flowed tidelands - projects in, on, over, or under tidal areas between the mean high water (MHW) line and the limit of state territorial waters (generally 3 miles from shore)
- Filled tidelands outside Designated Port Areas (DPAs) - projects up to the first public way or 250 feet from MHW, whichever extends farther inland
- Filled tidelands inside DPAs - projects between the present and historic MHW (i.e. all filled areas inside DPAs)

Projects are reviewed to ensure that they: (1) do not unreasonably interfere with navigation, (2) are structurally sound, (3) provide a proper public purpose, (4) do

not interfere with public rights or rights of adjacent property owners, (5) will not adversely affect natural resources, and (6) preserve DPAs for maritime industrial use. The applicant must provide DEP with the proposed project location, type of project, project plans, information about other applicable state permits, a certification that the project does not violate municipal zoning, and notification of the municipal planning board. Projects are subject to a 30-day public comment period advertised in a newspaper of general circulation.

5.2.4 - 401 Water Quality Certification

Any activity that would result in a discharge of dredged material, dredging, or dredged material disposal greater than 100 cubic yards that is also subject to federal regulation must obtain a 401 Water Quality Certification. The Division of Wetlands and Waterways in the DEP administer the 401 Water Quality Certification Program. The 401 review ensures that a proposed dredge and/or fill project that can result in the discharge of pollutants complies with Massachusetts Surface Water Quality Standards, the WPA, and otherwise avoids or minimizes individual and cumulative impacts to Massachusetts waters and wetlands. As the authority to administer the 401 Water Quality Certification is derived from the Federal Water Pollution Control Act, only projects that require a federal permit are subject to 401 reviews. Reviews are divided into Major Projects (5,000 cubic yards of dredging or more) and Minor Projects (less than 5,000 cubic yards of dredging). The 401 application must include a description and plans of the proposed dredging area, method of dredging, a description of the material to be dredged, and the proposed disposal site. If the proposed dredging is in an Outstanding Resource Water (314 CMR 4.00) the applicant must publish a public notice in the *Environmental Monitor*. Copies of the public notice must be sent to the local conservation commission and to the DEP. Written comments on the application are accepted by the DEP for 21 days. The DEP may condition the certification to ensure that state surface waters are not harmed by the project.

5.2.5 - State Fisheries Regulations

The Division of Marine Fisheries (*MarineFisheries*) is the lead agency in the Commonwealth for the protection, management, and enhancement of marine fisheries resources and habitats, and the promotion and development of the recreational and commercial marine fisheries, for resident species, and those that spend a portion of their lifecycle in the state's tidal waters. Responsibilities also include:

- Administering marine fisheries laws
- Licensing and overseeing fin fisheries and shellfisheries in waters important to the Commonwealth of Massachusetts
- Cooperating with state, federal and international agencies to accomplish these goals

Coastal projects and projects in waterways must minimize impacts to finfish and shellfish and their habitat. Regulatory activities are conducted in coordination with NMFS.

MADEP will contact *MarineFisheries* as part of its Water Quality Certification, Chapter 91, and Wetland Protection Act permit reviews. *MarineFisheries* will recommend time-of-year restrictions on construction to protect spawning fish or will recommend mitigation for damage to shellfish beds or areas of Submerged Aquatic Vegetation (SAV). *MarineFisheries* also works cooperatively with other federal, state, and local agencies to:

- seek to avoid impacts to fisheries resources
- minimize impacts through project modifications, sequencing, and time-of-year-restrictions
- seek restoration of habitat for direct short-term impacts
- recommend options for compensatory mitigation

MarineFisheries' recommendations are incorporated into permit conditions.

5.2.6 - Areas of Critical Environmental Concern

The purpose of the ACEC Program is to preserve, restore, and enhance environmental resources and resource areas of statewide significance. To accomplish this, the program, (1) identifies and designates critical resources and resource areas; (2) increases the level of resource protection in designated ACECs by working through the existing state environmental regulatory framework; and (3) engages municipalities, state agencies, non-governmental organizations, and individuals in ACEC stewardship activities including resource management planning. MEPA review thresholds are reduced in ACEC's. The DEP Wetlands (and Chapter 91 Waterways Programs also include provisions in their regulatory reviews that protect the resources of ACECs.

The following reviews are required for a project proposed in an ACEC:

- MEPA - Projects proposed in ACECs are given scrutiny under MEPA if they need certain state permits, use state funding, or involve state agency actions. The project review thresholds (size or type) that require filing of an Environmental Notification Form (ENF) are reduced for proposals in ACECs (301 CMR 11.03: Review Thresholds). Once an ENF is filed, the review process proceeds as described in the MEPA regulations (301 CMR 11.05: ENF Preparation and Filing).

- Waterways - Chapter 91 regulations do not allow new fill in ACECs and place limits on new structures (310 CMR 9.32). Improvement dredging is permissible only for fishery and wildlife enhancement. Dredged material disposal is prohibited except for beach nourishment, dune construction or stabilization, or enhancement of fishery or wildlife resources (310 CMR 40.00).

- Wetlands - The performance standard is raised to "no adverse effects" except for maintenance dredging for navigational purposes of "Land under the Ocean" (310 CMR 10.24).

5.2.7 - Underwater Archaeological Resources

The Massachusetts Board of Underwater Archaeological Resources is responsible for managing underwater historical and archaeological resources. Proponents of projects in jurisdictional waters must contact the Board of Underwater Archaeological Resources to find out if the proposed activity will disturb underwater archaeological resources. The Board oversees the discovery, reporting, protection, and preservation of resources such as abandoned properties, artifacts, treasure trove, and sunken ships that have remained unclaimed for 100 years or more, or which are valued at $5,000 or more. The exact location of archaeological sites is not made public, in order to protect the resources from unauthorized excavation.

5.2.8 - Ocean Sanctuaries Act

There are five Ocean Sanctuaries in Massachusetts waters including the Cape Cod, Cape Cod Bay, Cape and Islands, North Shore, and South Essex Ocean Sanctuaries. These include most state waters with the major exception of an area east of Boston Harbor. The landward boundary of the sanctuaries is the mean low water mark and the seaward boundary is the limit of state waters, generally three miles offshore. Jurisdiction is over any activity that would seriously alter or endanger the ecology or appearance of ocean sanctuaries or the Cape Cod National Seashore.

Structures and activities that significantly alter the ecology of the ocean sanctuaries are prohibited except as they may be allowed under section 302 CMR 5.08 of the ocean sanctuaries regulations. The Department of Conservation and Recreation (DCR) administers the Ocean Sanctuaries Program. The Ocean Sanctuaries Act prohibits activities that may significantly alter or endanger the ecology or appearance of the ocean, seabed, or subsoil of sanctuaries or the Cape Cod National Seashore. To accomplish this goal the Act may prohibit:

- Building structures on or under the seabed
- Construction or operation of offshore or floating electrical generating stations
- Drilling or removal of sand, gravel (except for the purposes of beach nourishment), other minerals, gases, or oils
- Dumping or discharge of commercial, municipal, domestic or industrial wastes
- Commercial advertising
- Incineration of solid waste or refuse on vessels within sanctuary boundaries

These prohibitions may be waived if a finding of "public necessity and convenience" can be made for the proposed project or activity. Under the Ocean Sanctuaries Act, DCR does not issue any licenses or permits but acts through the regulatory process of other agencies, particularly the Chapter 91 Waterways Program. There is no separate ocean sanctuaries review process. Ocean sanctuaries staff comment on MEPA filings and on DEP Chapter 91 license applications during the respective public comment periods. Proposals that are below MEPA thresholds are presumed to comply with the Ocean Sanctuaries Act. A project that receives a Chapter 91 License is presumed to comply with the Ocean Sanctuaries Act.

5.2.9 - Designated Port Areas

The state has designated areas in developed ports for the purposes of promoting and protecting marine industrial activities and certain supporting uses. DPA's have been set aside in Gloucester Inner Harbor, Beverly Harbor, Salem Harbor, Lynn, Mystic River, East Boston, Chelsea Creek, South Boston, Weymouth Fore River, New Bedford-Fairhaven, and Fall River. Project proposals are reviewed through the MADEP Chapter 91 and MACZM Federal Consistency Review processes to ensure compliance.

5.3 Local Role

The role of local government agencies includes:

- Coordinating programs to provide materials for reef construction
- Providing technical support or supervision for community efforts
- Conducting reef programs, including financial support
- Obtaining state monies for local reef efforts
- Publicizing local reef efforts

These efforts are conducted with the oversight of state fishery management agencies to ensure compatibility with established state, regional, and national fishery management goals. Local governments can also assist state artificial reef programs in the collection of relevant social and economic information. Such information is extremely important in developing goals and objectives for reefs (Atlantic 1998).

Local conservation commissions and the DEP Wetlands Program administer the WPA. In addition to the requirements of the WPA, project proponents should check with local conservation commission officials to determine if there are any local wetlands by-laws applicable to the project.

5.3.1 - Zoning By-Laws

Applicants must contact local officials (usually the Planning or Zoning Board) to ensure that the proposed project is consistent with local zoning by-laws. The

Zoning Act sets up the structure by which cities and towns adopt zoning by-laws to regulate uses of land, buildings, and other structures for the purpose of protecting the health, safety, and general welfare of present and future inhabitants. Most often zoning is accomplished by designation of zoning districts in which specific types of uses and/or structures are encouraged or prohibited. To protect environmental resources, a number of municipalities have adopted wetlands and floodplain overlay districts, and watershed and aquifer overlay districts.

5.4 Interstate Marine Fisheries Commissions

Coordination of state efforts through the IFMCs has facilitated the efforts of the National Artificial Reef Plan. The role of the IFMCs is to provide an open forum for discussion and debate on issues facing artificial reef program managers, respective federal agencies, and affected fisheries interests. States along the coasts of the Atlantic Ocean and the Gulf of Mexico established technical advisory committees for marine artificial reef development within their respective IFMCs. These committees are composed of state marine artificial reef program managers, representatives from the NMFS, the US Fish and Wildlife Service, the MMS, the EPA, and the FMCs, and provide critical advice to the IFMCs relative to development of marine artificial reefs.

The Artificial Reef Technical Committees of the ASMFC and GSMFC meet periodically to exchange information and to coordinate activities relevant to common areas of interest. Joint committee activities have served to consolidate individual state efforts along the Atlantic and Gulf coasts. The committees have worked cooperatively to identify and resolve national issues such as standardized criteria for materials used to build artificial reefs. The joint committee forum also has assisted member states in development and implementation of individual state plans and policies responsive to local, regional, and national needs (Atlantic 1998).

VI. Artificial Reef Assessment and Monitoring Guidelines

Artificial reefs must be monitored to assure compliance with permit conditions and other applicable regulations, and to assess performance to confirm that the goals and objectives of the reef design are being achieved. The specific monitoring strategies will depend on the degree of compliance required and the objectives and resources of the permittee. The information obtained is beneficial for improving existing reefs and for building effective reefs in the future.

Compliance monitoring is established during the permitting process in accordance with the NARP, to assure continued conformity to conditions or restrictions defined in an artificial reef permit. Performance monitoring evaluates an artificial reef or reef system to assure the established goals and objectives are being met. Performance monitoring criteria may include the collection of preconstruction, or site selection background data. The type of monitoring will depend on the permit requirement, but should provide enough information to establish statistically valid conclusions. Documentation of all monitoring will be recorded by the *MarineFisheries'* Artificial Reef program, and a permanent record of all monitoring activities will be maintained on file.

Not enough money to operate a reef-monitoring program. Further justification for the need for an artificial reef plan

6.1 Assessment Guidelines

6.1.1 - Biological assessment

Evaluation of reefs requires a detailed biological assessment of reef impacts. Underwater observations and reef monitoring dives can provide information about reef community development, and the success or failure of a reef in enhancing fish and/or invertebrate populations. Data collected may examine important ecological aspects of the reef, including invertebrate fouling community development, degree of interaction between fish communities and invertebrate communities, target marine species with certain reef designs, or location and long-term changes that may take place in reef community structures over time. An advantage of this type of assessment includes the ability to detect and document potential negative consequences from reef construction or reef use. Biological monitoring of existing artificial reefs is also critical in identifying research priorities for further characterizing the ecological characteristics and habitat functions of artificial reefs.

6.1.2 - Fisheries Assessment

A reliable measurement of the reef success involves evaluating quantifiable impacts of the reef on fisheries. Information on marine species commonly landed, catch per unit of effort, total catch, effectiveness of individual gear types or fishing methods, and seasonal harvest rates may be obtained on fisheries resources throughout the effective life span of a reef. Performance monitoring activities will assist reef managers in determining the impact to individual marine species populations and the effectiveness of certain fishing practices or gear types. This information is critical for fisheries resource managers in determining the need for new regulations, changes to fishing practices, public education, and additional data collection. Data needs for fisheries assessment may require fishing survey queries to determine the type and extent of fishing activities around reefs.

Artificial reefs designated as Marine Protected Areas (MPA's) can help to mitigate the depletion of fishery stocks from over harvest and habitat degradation. In order to achieve this objective, it is essential that artificial reefs be protected as no-take areas, be large in size, and are extensively evaluated and monitored (Pitcher and Seaman 2000).

6.1.3 - Socio-Economic Assessment

Social and economic factors must be considered when measuring the overall success of any artificial reef or reef system. In order to document the social benefits and overall cost effectiveness of reef development, monitoring needs to examine a variety of different factors. Socioeconomic assessments are conducted using specifically designed surveys that target certain user groups. Direct and indirect economic benefits, quality of fishing, fuel consumption per trip, user conflicts, and changes in fishing patterns or techniques, can be examined to determine the overall impact of the reefs.

6.2 Monitoring guidelines

6.2.1 - Compliance Monitoring

Compliance monitoring begins upon completion of all construction and post construction monitoring. Requirements will vary based on reef design, materials, age, and location of the reef, and in response to severe weather events that may alter or destroy reef materials. The first component of the monitoring involves the documentation of material stability or structural integrity, and may often be conducted through the use of simple bathymetric surveying instrumentation such as hull mounted depth recorders, towed side-scan sonar, or SCUBA. Cable controlled cameras and (ROV's) with cameras may also be used when practical or available. In situations where compliance monitoring has detected problems with a particular reef or reef structure, all pertinent agencies must be notified as soon as possible (normally the ACOE and the USCG).

6.2.2 - Performance Monitoring

The assessment of physical, biological and socio-economic factors is essential in documenting the degree of success and impacts of a given artificial reef or reef system. Performance monitoring involves the on-going evaluation of an artificial reef (or system of reefs) to determine if the reef is meeting the defined goals and objectives. A properly designed performance monitoring strategy will help to:

- Detect any unexpected negative consequences
- Evaluate alternative management strategies
- Improve future artificial reef construction techniques
- Identify additional research priorities

Case Study: Massachusetts Bottom Sediment Enhancement Project

To determine the most appropriate location for the proposed reef, MADMF performed a comprehensive pre-installation evaluation and survey of Salem Sound and Boston Harbor. We developed a simple model to select potential sites for habitat enhancement using ESRI's ArcGIS 9.0 mapping software. We chose three parameters for use in our model: substrate, bathymetry, and proximity to the pipeline. These data layers were coded to represent prime, potential, and unsuitable areas for habitat enhancement and multiplied together to create a single layer map. The results of this model allowed us to identify four prime locations for potential reef sites (29.6 acres total); within these areas we selected 24 sites (and 5 alternate sites) within 1000 ft. of the Hubline pathway. Through the use of GIS, we were able to eliminate 80% of potential reef area prior to field assessments. After this initial selection, MADMF collected bathymetry data in the field at each of these 24 potential sites. These data were used to verify the GIS model and calculate slope. Upon completion of this task, 8 sites were eliminated and the remaining 16 sites were ranked according to their slope. All remaining potential sites have a flat to 5º slope. After careful consideration of these 16 sites, three more sites were eliminated due to known poor larval settlement in the area, high siltation rates, and concern for safety of employees due to boat traffic.

All 13 remaining potential sites were within 6.8 miles to the nearest harbor, and in the 20 to 50 ft. MLLW depth range. Therefore, all potential sites are considered accessible to recreational and commercial fisherman, scientists, recreational SCUBA divers, and other interested user groups. No sites were located within shipping channels marked on NOAA charts. Additionally, MADMF discussed the habitat enhancement project with the Massachusetts Lobstermen's Association and we do not anticipate any adverse reactions from commercial lobstermen. No other commercial fishing activities are expected to occur within potential site areas due to shellfish closures and shallow, undesirable depths for large-scale fishing practices such as trawling. It is important to note that no submerged aquatic vegetation (SAV) will be affected by the reef due to the targeted reef depth and substrate type.

Underwater transect surveys were then conducted to determine the stability of the substrate at each site, as well as to classify and quantify the substrate at a smaller scale. Additional biological and physical data was collected including: species abundance and diversity, and current direction. These data allowed us to avoid placing the reef on pre-existing productive habitat and ensured that the reef would be placed on substrate that we expect will be strong enough to prevent reef sinking.

Upon completion of these transect dives, 1 more site was eliminated and one of the alternative sites was utilized. Primary, secondary, and underlying substrate data at each site were then numerically ranked into three categories "prime, potential and poor." Each sediment proportion was multiplied by the assigned category rating. These values were then summed to provide a final sediment rating for that site. In addition to substrate, we also included wave action, proximity to the Hubline, and proximity to fill points on the Hubline in the ranking analysis. We assumed that the presence of sand ripples on a site indicated areas of high wave energy which may be detrimental to reef placement. Therefore, sites were classified as either good, average, or poor according to this physical attribute. Sites that were closer to the Hubline were also preferred. Thus, sites were classified as either adjacent to the Hubline pathway, near the Hubline, or far from the Hubline (i.e. no more than 1000 ft.). Sites that were closer to fill points were preferred. Fill points along the Hubline were assumed to be areas that were highly disturbed by the installation of the Hubline, and also represent areas where we could compare our installed reef with a hard bottom area along the Hubline pathway. Sites were classified as either adjacent to a fill point, near a fill point, or far from a fill point.

Each variable described above was weighted on a percentage scale according to their importance in the site selection process. The final weighted scores were summed for each site. The sites with the highest scores were generally considered the best for reef placement, although species presence and abundance was not taken into account here. Species abundance and diversity was taken into account when we determined the final three sites.

The ranking analysis provided us with six top choices for the habitat enhancement area: 2 sites in Marblehead, 2 sites near the Hypocrite Channel in Boston Harbor, and 2 sites near the Brewster Spit in Boston Harbor. MADMF than proceeded to conduct video surveys of each of these six sites. Additional transect surveys were conducted with the goal to cover as much ground as possible in the 1.7 acre footprint. This allowed MADMF to assess the site's overall potential and species abundance and diversity. Upon the completion of these dives three final sites were selected: 6, 20, and 23.

When these site locations were sent to the MA Board of Underwater Archaeological Resources (BUAR), we were informed that Site 20 was located

within a buffer zone of an area of archeological concern. Therefore, Site 29 (an alternative site) was selected rather than the highest ranking site, Site 20. Site 29 still meets our site selection criteria, although it contains more cobble than Site 20, and it is outside of the BUAR's recommended 250-300m buffer zone to avoid placing the reef in close proximity to an area of archeological significance. Therefore, the three final sites considered for the habitat enhancement project were Sites 6, 23, and 29 (Figure 3). General descriptions of each of these sites are below.

After selecting these three sites, we set out to determine if these sites would have the presence of a natural larval supply. We accomplished this through two different methods: (1) suction sampling both the potential reefs as well as nearby natural reefs and (2) using settlement collectors.

The suction sampling device consisted of a PVC lift tube supplied with air from a SCUBA tank. Samples were air-lifted into a mesh nylon bag attached to the upper end of the suction tube. We suction sampled six sites for comparisons: the three potential reef sites, natural reef sites near these reefs, and the Hubline fill point near Site 29 (Figure 7). At each site, 0.5 m^2 quadrats were haphazardly placed on the substratum at least 2 meters apart until a total of 12 replicates were complete at each site (Figure 8).

We designed larval settlement collectors to essentially create micro-prime habitats in areas that are devoid of prime settling habitat (Figure 9). Each collector had Astroturf placed on the bottom of the collector (for "substrate") and was filled with cobble and small boulders. We placed 10 collectors on each site and let them remain on the bottom for at least 2 months before retrieving the collectors. Collectors were placed in July before larval lobster settling season in Massachusetts Bay and retrieved at the end of September, which was close to the end of the recruitment season. Once this part of our data collection was finished, we had also completed the site selection process.

We found that at Site 23 there was a high degree of siltation in the collectors. This made the habitat more preferential for larvae, however, it also indicated that if we placed an artificial reef at this site there was high potential for siltation and reef burial. Site 29 and Site 6 did not experience these high siltation rates. All the sites had larval crustacean settlement (early benthic phase crustaceans) present in the collectors. Site 23 was the only site that had larval lobster settlement in the collectors. We hypothesize that this was due to the high sedimentation rates. This siltation immediately made the habitat more preferential to settling invertebrates because they could dig a shelter into the silt underneath the rocks. Site 6 and 29 collectors did not have this type of habitat without siltation, and invertebrates could not burrow in the collectors like they could in Site 23 collectors. However, we expect that once the reef is actually installed, the natural underlying substrate will provide the necessary habitat for

settling invertebrates that the collectors and Astroturf could not provide in a two-month timeframe.

Due to the high siltation rates, we eliminated Site 23. This left Site 29 in Boston Harbor and Site 6 in Marblehead as the final sites considered for the reef. Both sites had no larval lobster settlement in their collectors, however, we did suction sample natural reefs in the same vicinity as these two reefs. Both of these natural reefs had the presence of larval lobsters in addition to many other newly settled larval species. Additionally, Site 29 was within 50m or less from a Hubline fill point area. We also suction sampled this Hubline fill point and found the presence of larval lobsters (Figure 7). Thus, we concluded that although larval lobsters were not present in the settlement collectors, we would expect to record larval lobster settlement on either of these sites (Figure 10). Although both of these sites were equal in terms of larval settlement, we still wanted to consider overall species abundance and diversity at these two sites. We graphed species counts on each of the sites that were suction sampled (Figure 11). From this it was clear to us that Site 6, although it had lower abundance of species, had higher species diversity than Site 29. We ran species abundance and diversity analyses on the suction sampling data in order to confirm our observations from the graph. Based on these results, Site 6 provided the highest measure of species richness. The Marblehead natural reef provided the highest measure of heterogeneity followed by the Boston natural reef. The lowest species richness occurred at site 29.

At this point, we went back to the ranking analysis and considered all other site selection criteria to make our final decision. Site 29 clearly met the majority of the site selection criteria, as opposed to Site 6. Site 29 was the closest to the Hubline (Figure 12), the closest to a Hubline fill point, received little wave action, had low species diversity and abundance, had a natural larval supply, and would be more cost effective than Site 6.

5.0 Monitoring

To evaluate the success of this project, we propose a structured monitoring program designed to characterize and track juvenile settlement and development of invertebrate and finfish populations on the reef. We will also compare lobster size-distribution and settlement on the reef to adjacent areas in Massachusetts Bay, including sites on disturbed areas of the Hubline pathway. The elements of the monitoring program will include (but are not limited to):

1) Visual Dive Surveys - Currently, divers have established permanent transects at a number of the potential reef and control areas within the footprint of Site 29, a natural rocky reef near Site 29, and the Hubline fill point. This permanent sampling methodology will allow us to repeatedly sample the same transects over time. When divers are not working on the transect, no transect line is actually left down on the seafloor. Rather, we mark the start and end points of

the transect and use a known bearing to set the transect tape down on the same area each time we resample the area. We use the same 2m long "swath" bars (that were used in substrate sampling for the site selection process) to quantify macroinvertebrates and fish along the transect. We use 1m^2 quadrats with a 1/4 m^2 inset quadrat to sample smaller invertebrates typically found in higher densities (e.g. *Modiolus sp*.), substrate type, algal coverage, and encrusting or sessile invertebrate coverage (e.g. colonial tunicates or sponges). These methods allow us to actually quantify changes in species abundance and diversity through time. We hope to sample the permanent transects 4 times a year, while we have funding, in order to make comparisons across seasons.

2) Optical/Acoustical Surveys – These surveys will be conducted with a towing sled fitted with a camera and sonar equipment. The surveys will assist in monitoring changes in vegetation and assure stability of the reef over time. These surveys will begin immediately following reef installation.

3) EBP Suction Sampling - Airlift sampling of young-of-year (YOY) lobsters will be conducted at each plot in the late summer of each year. Three 1/2 m^2 quadrats will be sampled per reef plot on three different substrate sizes using standard MADMF airlift sampling procedures. This sample size will minimize impacts on reef fauna due to the destructive nature of airlift sampling. Suction sampling will also be conducted on impact control plots to compare lobster settlement between the reef and the sediment the reef was installed on. All crustaceans and finfish will be enumerated and classified to the lowest taxonomic level practical. Lobsters will be measured to the nearest mm and sexed. These data will also be compared to naturally occurring cobble habitat and to disturbed areas along the Hubline pathway.

4) Ventless Trap Survey - Two pairs (1 vented /1 ventless) of traps will be deployed on each reef and control plot, totaling 9 trap pairs. Commercial lobstermen will be contracted to haul the experimental traps once per week from the period of May through November each year. MADMF will send field technicians out on each trip to measure and record the contents of each trap using standard MADMF lobster trap sampling protocol.

The MADMF project leader will produce annual progress reports summarizing activities, monitoring, and preliminary data. At the conclusion of the project a comprehensive completion report will be written that will provide a detailed description of the program including analyses and an evaluation of the project's relative success at meeting the objectives. Reports will be sent to any permitting agencies requesting review of project status upon completion of reef construction.

A successful artificial reef will remain in place and continue to provide durable, safe, and effective habitat necessary to provide the foundation of the reef community itself (Bell 1991). The varieties of materials used in reef construction

require continuous evaluation. Reef material stability and structural integrity are critical components for the success of a reef material type. Although some monitoring of material stability can be accomplished through remote sensing, diving is the most reliable and cost effective method of evaluating the condition of artificial reef structures. Divers can detect and measure a number of factors of interest in documenting reef material designs. Observations on lateral movement, subsidence, burial, scouring, structural deformations, corrosion, and material destruction can be made on most artificial reefs (Bell 1991). Construction materials that demonstrate undesirable qualities not in keeping with established standards should not be considered for use. The direction of any reef program is incumbent upon learning from past failures and successes, and documentation of this information is critical.

VII. Policy

Artificial reefs constructed in the waters under the jurisdiction of the state and contiguous federal waters should be designed and built in accord with this policy. As the state agency responsible for the marine resources of the Commonwealth, *MarineFisheries* is best suited to coordinate all artificial reef-building activities in state waters and be the primary agent for these activities in contiguous federal waters.

7.1 Artificial Reef Program Administration

As the coordinator for the Massachusetts Artificial Reef Program, *MarineFisheries* will adopt the following administrative policies:

- *MarineFisheries* will maintain accurate records on all artificial reef activities it conducts
- *MarineFisheries* will keep copies of all permits on file as part of an artificial reefs permanent record
- *MarineFisheries* will maintain accurate and current maps of all artificial reef locations
- *MarineFisheries* will act as the point of contact for donors of reef materials
- *MarineFisheries* will coordinate public involvement and volunteer efforts
- *MarineFisheries* will collect and disseminate artificial reef information to the public
- *MarineFisheries* will participate in regional and national artificial reef planning and management activities
- *MarineFisheries* will oversee artificial reef research and monitoring efforts

7.2 Planning and Development

As the agency with regulatory authority over the marine resources of the state, artificial reefs will be planned, designed, sited, constructed, and monitored under the auspices of *MarineFisheries.* This would ensure that all artificial reefs constructed in state waters are consistent with the goals, objectives, and guidelines outlined in the MARP. During the planning and development of artificial reefs in state and contiguous federal waters, *MarineFisheries* will adopt the following policies:

- *MarineFisheries* will (or will require the proponent to) ensure that all permits required to carry out any aspect of artificial reef construction or program management are obtained prior to beginning any work
- No entity, other than *MarineFisheries* should be issued permits for artificial reef construction by federal or state regulatory agencies including, but not limited to the ACOE or DEP

- *MarineFisheries* will (or will require the proponent to) adhere to all conditions of any permit issued by federal or state regulatory agencies including, but not limited to the ACOE or DEP
- *MarineFisheries* will (or will require the proponent to) evaluate, assess, and seek public input on the demand for artificial reefs and potential user conflicts when siting artificial reefs
- *MarineFisheries* will participate in the process of evaluating, assessing, and selecting a suitable site(s) for artificial reef development
- *MarineFisheries* will (or will require the proponent to) solicit and facilitate citizen participation during the planning and development of artificial reefs
- *MarineFisheries* will continue to participate on the ASMFC artificial reef technical committee, and seek to strengthen communication with federal agencies involved with permitting artificial reefs
- *MarineFisheries* will allow the use of materials listed as acceptable under the "Guidelines for Marine Artificial Reef Materials". Other materials may be considered on a case-by-case basis
- *MarineFisheries* will not allow the use of: 1) white goods (household appliances); 2) automobile and truck bodies; 3) asphalt materials; and 4) tires for constructing an artificial reef
- *MarineFisheries* will require that all phases of artificial reef planning, development and maintenance are carried out in accordance with the guidelines, policies and procedures established in the MARP and all pertinent regulations
- *MarineFisheries* will require that a contingency plan be developed during the planning stages of artificial reef development and in place prior to permitting. A contingency plan will include feasible, timely, and cost-effective options for the removal of a reef or for the mitigation of unanticipated impacts, resulting from improper placement, unsuitable materials, or movement of materials off the permitted site, as determined during monitoring.
- When artificial reefs are proposed as mitigation, the first priority for *MarineFisheries* will be to avoid impacts. Artificial reefs as mitigation should only be used as a last resort. The value of productive habitat generated as a result of a mitigation project must meet or exceed the value of the habitat lost
- When artificial reefs are proposed as mitigation, *MarineFisheries* will consider artificial reefs only when proposed habitat loss or degradation is on artificial or natural reef habitat

7.3 Deployment

MarineFisheries personnel must be present during the placement of all materials on any marine artificial reefs constructed in Massachusetts. During the deployment of artificial reef materials, *MarineFisheries* will adopt the following policies:

- *MarineFisheries* will (or will require the proponent to) require all artificial reef construction activities be carried out with safety as the primary concern

- *MarineFisheries* will (or will require the proponent to) ensure that the actual deployment of the reef materials takes place in the location designated in the permit
- *MarineFisheries* will confirm all aspects of construction activities that take place are in compliance with construction permits
- *MarineFisheries* will require any potential problems or discrepancies to be documented and reported
- *MarineFisheries* will require marine contractors to assume full responsibility and liability for all donated materials being transported until properly deployed on permitted sites in accordance with permit specifications. The marine contractor will also assume responsibility for the safety of his personnel and equipment and have insurance appropriate to cover this liability
- *MarineFisheries,* or other parties designated as the final permit holder, will not assume ownership of an artificial reef until the reef is properly placed on the ocean floor

Following the completion of any marine artificial reef construction activities, *MarineFisheries* personnel will adopt the following policies:

- *MarineFisheries* will (or will require the proponent to) record and document accurate positions and conditions of all reef materials deployed
- *MarineFisheries* will (or will require the proponent to) conduct in-water inspections of reef construction activities
- *MarineFisheries* will (or will require the proponent to) document and record all construction activities and make necessary reports to permitting authorities
- Vessels or material used for artificial reefs will be the responsibility of the donor until materials are placed on the permitted reef site
- *MarineFisheries* will (or will require the proponent to)work with personnel in disseminating information to the public regarding the completion of reef construction activities

7.4 Monitoring and Maintenance

During and subsequent to construction of an artificial reef, monitoring for compliance with ACOE permits and the assessment of artificial reef performance relative to the reefs objectives is required. Section 203 of the National Fishing Enhancement Act states that artificial reefs “shall be sited and constructed, and subsequently monitored and managed” (to) enhance fishery resources, facilitate access to users, minimize liability and risk, and be consistent with international law. In order to effectively monitor and maintain artificial reefs in accord with the NFEA, *MarineFisheries* will:

- *MarineFisheries* will (or will require the proponent to) interact with research institutions in developing research and monitoring objectives
- *MarineFisheries* will (or will require the proponent to)conduct compliance monitoring

- *MarineFisheries* will (or will require the proponent to) perform maintenance on artificial reef sites under its control, based upon an evaluation of the information obtained in its monitoring program
- *MarineFisheries* will establish guidelines for monitoring artificial reef stability. These guidelines will be developed on a case-by-case basis and include minimal annual frequency, duration, and other acceptable methods, criteria, and standards necessary to establish statistically valid conclusions
- *MarineFisheries* will establish guidelines for monitoring artificial reef structural integrity. These guidelines will be developed on a case-by-case basis and include minimal annual frequency, duration, and other acceptable methods, criteria, and standards necessary to establish statistically valid conclusions
- *MarineFisheries* will establish guidelines for monitoring artificial reef colonization. These guidelines will be developed on a case-by-case basis and include minimal annual frequency, duration, and other acceptable methods, criteria, and standards necessary to establish statistically valid conclusions
- *MarineFisheries* will establish guidelines for monitoring artificial reef aggregations. These guidelines will be developed on a case-by-case basis and include minimal annual frequency, duration, and other acceptable methods, criteria, and standards necessary to establish statistically valid conclusions

7.5 Management

The MARP recommends that *MarineFisheries* work towards the development of enforceable policies for the management of artificial reefs. Development may include establishing future policies for the management of artificial reefs in the EEZ, or for including the use of SMZ's. In order to manage the artificial reef program in accordance with the recommendations of this plan, *MarineFisheries* will adopt the following policies:

- *MarineFisheries* will oppose any proposed artificial reef development by another agency or entity whose goals and objectives for artificial reef development are contrary to the goals and objectives outlined in this Plan
- *MarineFisheries* will provide information to the public that exposes illegal reef building as a violation of law and highlights the potential harm to the resource from this activity
- *MarineFisheries* will research the need for legislation that outlaws destructive techniques on artificial reefs under its control
- *MarineFisheries* may(or may require the proponent to) site artificial reefs to reduce encounters with competing user groups
- *MarineFisheries* may adopt additional policies or propose legislation to manage artificial reef use on a case-by-case basis

7.6 Use

Conflicts associated with competing uses of public resources (i.e. fish species and fish habitat) exist in artificial reef development despite the best efforts of resource managers. In order to manage the use of artificial reefs in accordance with the recommendations of this plan, *MarineFisheries* will adopt the following policies:

- *MarineFisheries* will advise artificial reef users through public announcements that they may use a state artificial reef at their own risk
- *MarineFisheries* may provide outreach on reef use ethics and courtesy
- *MarineFisheries* may establish restrictions for specific reefs (i.e. no harvest reefs for divers) to designate access for certain user groups to the exclusion of others
- *MarineFisheries* may establish fisheries management measures – size/bag limits, gear restrictions or seasonal closures
- *MarineFisheries* may establish SMZ designations for reefs in Federal waters

7.7 Plan review

This Plan is written as a guide to be used in the planning and construction of artificial reefs in Massachusetts, and to act as a framework for future artificial reef regulations. As artificial reef technology advances, this Plan will be amended to reflect current knowledge. In order to provide the best available information, MarineFisheries will ensure the following:

- The MA Artificial Reef Plan will be reviewed every five (5) years and amended as appropriate
- *MarineFisheries* will prepare supplemental material when proposed changes to the Plan are required as a result of unforeseen potential environmental impacts which have not been adequately addressed. Such material will be made available for interagency and public review

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Appendix A. Acronyms and Glossary of Key Terms

ACEC	Area of Critical Environmental Concern
ACOE	Army Corps of Engineers
aggregate	(adj.) to gather into a mass or whole
angler	(n.) a fisherman using hook and line gear to catch fish
artificial reef	(n.) An area within the marine waters of the Commonwealth in which approved structures have intentionally been placed or constructed for the purpose of enhancing benthic relief. Structures may be designed to provide and/or improve opportunities for recreational and commercial fishing, aid in the management or enrichment of fishery resources, or to achieve a combination of these objectives
ASMFC	Atlantic States Marine Fisheries Commission. A compact of fifteen Atlantic Coast states created to promote better utilization of the fisheries of the Atlantic seaboard. The ASMFC develops management plans for the various fishery resources within state and federal waters
attraction	(n.) the force by which one object attracts another
BUAR	Board of Underwater Archeological Resources
benthic	(adj.) relating to the ocean bottom
CFR	Code of Federal Regulations
CMR	Code of Massachusetts Regulation
coast	(n.) land next to the sea; the seashore
coastal	(adj.) located on or near or bordering on a coast
compliance monitoring	Ongoing investigations conducted to determine if an artificial reef conforms to the constitutions mandated by permits
CWA	Clean Water Act
CVA	Clean Vessel Act
CZM	Coastal Zone Management
DGPS	Differentially corrected Global Positioning System - an electronic navigation device that operates off satellite signals

discharge of dredged material (ACOE definition)	any addition of dredged material into U.S. waters. The term includes, without limitation, the addition of dredged material to a specified discharge site located in U. S. waters and the runoff or overflow from a contained land or water disposal area. Discharges of pollutants into U. S. waters resulting from the onshore subsequent processing of dredged material that is extracted for any commercial use (other than fill) are not included within this term and are subject to section 402 of the Clean water Act even though the extraction and deposit of such material may require a DA permit. The term does not include plowing, cultivating, seeding and harvesting for the production of food, fiber, and forest products. The term does not include *de minimis*, incidental soil movement occurring during normal dredging operations
discharge of fill material (ACOE definition)	the addition of fill material into U. S. waters. The term does not include plowing, cultivating, seeding and harvesting for the production of food, fiber, and forest products. The term generally includes, without limitation, the following activities: a) placement of fill that is necessary for the construction of any structure in U. S. waters; b) building any structure or impoundment requiring rock, sand, dirt, or other material for construction; c) site-development fills for recreational, industrial, commercial, residential, and other uses; d) causeways or road fills; e) dams and dikes; f) artificial islands; g) property protection or reclamation devices such as riprap, groins, seawalls, breakwaters, revetments; h) beach nourishment; i) levees; j) artificial reefs; k) fill for structures such as sewage treatment facilities, intake and outfall pipes associated with power plants and subaqueous utility lines
DOC	Department of Commerce
DOD	Department of Defense
DOI	Department of the Interior
DOT	Department of Transportation
DPA	Designated Port Area
dredging (DEP definition)	the removal of materials including, but not limited to, rocks, bottom sediments, debris, sand, refuse, plant or animal matter in any excavating, cleaning, deepening, widening, or lengthening, either permanently or temporarily, of any fl owed tidelands, rivers, streams, ponds, or other waters of the commonwealth
EA	Environmental Assessment
EBP	Early Benthic Phase
EEZ	Exclusive Economic Zone

EFH	Essential Fish Habitat - areas of the marine environment essential for various life stages of federally managed fish and shellfish species
EIR	Environmental Impact Report
EIS	Environmental Impact Statement
EOEA	Massachusetts Executive Office of Environmental Affairs
EPA	United States Environmental Protection Agency
estuary	(n.) a semi-enclosed coastal body of water which has a free connection with the open sea
FAD	Fish Aggregating Device
fill (DEP definition)	(n.) any unconsolidated material that is confined or expected to remain in place in a waterway. This does not include: material placed by natural processes, material placed on a beach for beach nourishment purposes, and dredged material placed below the low water mark for purposes of subaqueous disposal.
FMC	Fishery Management Council
FMP	Fisheries Management Plan - developed by fisheries councils to manage and regulate specific fisheries
footprint	(n.) the area of sea floor covered by artificial reef structures
FONSI	Finding of No Significant Impact
FWCA	Fish and Wildlife Coordination Act
GIS	Geographic Information Systems
GOM	Gulf of Maine
GPS	Global Positioning System
GSMFC	Gulf States Marine Fisheries Commission
HAPC	Habitat Areas of Particular Concern
hard-substrate habitat	(n.) a firm, stable substrate, such as rock, or concrete, on the sea floor, which is commonly referred to as reef habitat
IFMC	Interstate Fisheries Management Council
IMFC	Interstate Marine Fisheries Commissions
intertidal	(adj.) the area between the high water and low water marks.
land under the ocean (DEP definition)	land extending from the mean low water line seaward to the boundary of the municipality's jurisdiction and includes land under estuaries.
MACZM	Massachusetts Office of Costal Zone Management
MADEM	Massachusetts Department of Environmental Management
MADEP	Massachusetts Department of Environmental Protection
MADFA	Massachusetts Department of Food and Agriculture
MARAD	Maritime Administration

MARP	Massachusetts Artificial Reef Plan
Massachusetts coastal zone (CZM definition)	the area bounded by the seaward limit of the state's territorial sea (generally 3 miles from shore) to 100 feet landward of specified major roads, railroads, or other visible right-of-way (generally the first major transportation corridor inland of the shoreline)
MEPA	Massachusetts Environmental Policy Act
MGL	Massachusetts General Law
MHW	Mean High Water
mitigation	(n.) actions taken to make the impact of other actions, conditions or occurrences less severe
MMS	Minerals Management Service (United States DOI)
monitor	(v.) to test, observe, or sample on an ongoing basis
MOU	Memorandum of Understanding
MPA	Marine Protected Area. An ocean sanctuary where fishing is prohibited
MPRSA	Marine Protection, Research, and Sanctuaries Act of 1972
MTA	Massachusetts Turnpike Authority
NARP	National Artificial Reef Plan
NDA	No Discharge Area
NEFMC	New England Fisheries Management Council
NFEA	National Fishing Enhancement Act of 1984
NEPA	National Environmental Policy Act
NHESP	National Heritage and Endangered Species Program
NMFS	National Marine Fisheries Service
NOI	Notice of Intent
NOAA	National Oceanic and Atmospheric Administration
NOS	National Ocean Service
NPDES	National Pollutant Discharge Elimination System
OCSLA	Outer Continental Shelf Lands Act
outstanding resource water (DEP definition)	used to denote those waters, other than Public Water Supplies, designated for protection as Outstanding Resource Waters under 314 CMR 4.04. These waters constitute an outstanding resource as determined by their outstanding socio-economic, recreational, ecological and/or aesthetic values. The quality of these waters shall be protected and maintained
patch reef	(n.) a several-square yard to several-acre reef constructed by either placing a single structure, such as a ship, or a barge load of material on the sea floor
performance monitoring	Investigations conducted to determine if a reef meets the biological and socio-economic goals of the program

PGP	Massachusetts Programmatic General Permit
production	(n.) the act of creating something within a given period of time
profile	(n.) the height or relief of a reef structure above the sea floor
reef site	(n.) a large area of the sea floor that is permitted by the ACOE to a permittee for the purpose of building reefs
reef unit	(n.) a single, fabricated reef structure, such as a concrete-ballasted tire unit or a reef ball
REEFEX	The creation of artificial reefs by sinking ex-Navy vessels
SAV	Submerged Aquatic Vegetation
SMZ	a designation for a reef site granted to a reef permittee by a federal fisheries management council to restrict specified types of fishing gear on that reef site
Special aquatic site (ACOE definition)	includes wetlands and salt marshes, mudflats, riffles and pools, and vegetated shallows
structure (DEP definition)	(n.) any man-made object which is intended to remain in place in, on, over, or under tidelands, great ponds, or other waterways. Structures do not include any mooring, float or raft which has been authorized by annual permit of the local harbormaster
UMD	University of Massachusetts at Dartmouth
uplands	non-wetlands
USCG	United States Coast Guard
USGS	United States Geological Survey
water-dependent uses (DEP definition)	uses and facilities which require direct access to, or location in, waterways and therefore cannot be located inland, including but not limited to: marinas, recreational uses, navigational and commercial fishing and boating facilities, water-based recreational uses, navigation aids, basins, and channels.
wetland (DEP definition)	(1) any bank, freshwater wetland, coastal wetland, beach, dune, tidal flat, marsh or swamp bordering on the ocean, any estuary, creek, river, stream, pond, lake, or certified vernal pool. (2) land under any of the water bodies listed. (3) land subject to tidal action, coastal storm flowage, or flooding. (4) riverfront areas in the Commonwealth of Massachusetts
WPA	Wetlands Protection Act

Appendix B. Permit Guidance

Note: Information contained in this section was selected from the *Massachusetts Aquaculture Permits Guidance Document* (MADFA 1998) compiled by the Massachusetts Department of Food and Agriculture, and modified, where necessary to correspond to permitting requirements for artificial reefs in Massachusetts. A complete description of all permitting requirements can be found in the *Environmental Permitting in Massachusetts Guide*, (MACZM 2003).

Permit Guidance

DISCHARGE

If question is applicable to your project please refer to the corresponding permit.

1. Will your activity involve the discharge of dredge or fill material into the waters of the U.S., including wetlands?
   Surface Water Discharge Permit

2. Do you plan to r discharge dredge or fill material into any waterway or wetland? ***Programmatic General Permit or Individual Permit (IP)***

	Surface Water Discharge Permit	**Programmatic General Permit(PGP) / IP**
Issuing Agency:	Dept. of Environmental Protection Division of Watershed Management 627 Main Street Worcester, MA 01608 (508) 792-7470	U.S. Army Corps of Engineers 696 Virginia Road Concord, MA 01742 (978) 318-8491
Statutory	Clean Water Act	Section 401-CWA Water Quality; Section 404 CWA
Reference:		33 CFR Part 320
Activities Covered:	Surface water discharge. Surface waters include rivers, streams, seaward lakes, ponds, springs, wetlands, downward impoundments, estuaries and coastal waters.	Discharge of dredge or fill materials in waters of the U.S.; including waters seaward of the High Tide Line (HTL), streams from ordinary high water, and all wetland impacts. Wetland impacts fewer than 5,000 sq. ft. are permitted under the MA PGP, but must still meet the conditions. Water Quality Certificate or Order of Conditions may also be required. Impacts between 5,000-1 acre require a written authorization and consultation with NMFS, EPA and USFWS.
Process:	Application kit for water pollution and surface water discharge. Applicant must apply to MADEP as well as file the appropriate Federal NPDES permit application forms to the United States EPA.	Applicants must inform the Historic Preservation Officer of their intent by submitting a copy of the application materials to the Massachusetts Historical Commission (phone: 617-727-8470). An application and an 8.5" x 11" plan view of the entire property and project limits with existing and proposed conditions (i.e. a navigational chart) should be forwarded to the ACOE. The proposal should include the amount, type and source of fill material to be discharged.
Fees:	$500-$1,600	No fee for PGP. Up to $100 for IP.
Other Information:	USEPA - One Congress St. Suite 1100 Boston, MA 02114 - 2023	

STRUCTURE

If question is applicable to your activity please refer to all corresponding permit(s).

1. Will your facility have structures within 200 feet of water or filled tide lands or on land under water?
   Waterways License - BRPWW02

2. Will your facility have any structures, dredging, or other work seaward of the MHW? ***ACOE Permit; PGP or Individual Permits***

3. Will your project operate within the Massachusetts coastal zone and/or require Federal action (e.g. permits, licensing, grants, etc.)?
   Federal Consistency Determination – CZM Consistency *(next page)*

4. Will your activity alter any inland (including riverfront protection area) or coastal wetland resource areas?
   Wetlands Permit – Wetlands Protection Act *(next page)*

	Waterways License, BRPWW02	**ACOE Permit; PGP or Individual Permits**
Statutory Reference:	MGL Ch. 91	Section 10 of the Rivers and Harbors Act 1899
Regulatory Reference:		33 CFR Part 320
Activities Covered:	Structures within 200 feet of water; filled tide lands	Structures placed seaward of MHW or work in navigable waters including dredging.
Process:	Order of Conditions as determined by local Conservation Commission of public interest factors, including a 30 day public comment period announced in a newspaper. Approval by local Planning Board, MEPA if applicable.	The ACOE will review with consideration to obstructions to navigation and other public interest factors, and compliance with other Federal laws such as the Endangered Species Act and National Historic Preservation Act.
Fees:	Dependent on project type	$0-$100
Other Information:	Copy of NOI needed. Copy of application form to Conservation Commission and accompanying transmittal fees to be determined at time of application. Copy of public notice of Order of Conditions. May require review under MEPA (301CMR 11.04 (9)	Conditions and restrictions on the permit may result from consultation with resource agencies: NMFS, EPA and USFWS.

	Federal Consistency Determination- CZM Consistency	Wetlands Permit Wetlands Protection Act
Issuing Agency:	Executive Office of Environmental Affairs Coastal Zone Management Office 100 Cambridge Street (617) 727-9530	Local Conservation Commission or MADEP-Office of Watershed Management Wetlands Program One Winter Street Boston, MA 02018 (617) 292-5695
Statutory Reference	G.L. C. 21 A, ss.4A	MGL Ch. 131 Sec. 40
Regulatory Reference	301 CMR 21.00	310 CMR 10.00
Activities Covered:	Any activity that may affect the land and water resources of Massachusetts; including riverfront areas i.e., within 200 ft of riverfront. 2) Requires a federal license or permit, or is federally funded or a direct activity of a federal agency; 3) Is generally above the thresholds established by the MEPA.	All activity in or near any resource areas
Process:	There are no specific application forms. A letter requesting an initiation of CZM consistency should be submitted at the beginning of the process. The process will not be completed until all state and federal permits have been issued.	Local Conservation Commission review, approval or rejection, appeals heard by MADEP documents to CZM; this is triggered through a determination by a federal agency or through a MEPA review process. The application requirements and review timetables vary depending on project type, but always require a federal consistency certification letter describing project impact on the CZM's enforceable policies and copies of relevant permits and approvals. Upon request, the CZM office will make a determination of the CZM's jurisdiction over specific activities. Once application materials are complete, CZM publishes a public notice of the project in the Environmental Monitor to initiate a 21 day public comment period, CZM has varying amounts of time to review application.
Fees:	None	
Other Information:	Project Review coordinator / Consistency contact - Office of Coastal Zone Management, 251 Causeway St. Suite 800 Boston, MA 02114-2136 (617) 626-1219	Filing fee dependent on project. Examples of artificial reef projects that require a consistency determination include: ACOE or EPA NPDES permits and/or are supported (in whole or part) by federal grants or loans i.e., Saltonstall-Kennedy Grants or Economic Agency Fisheries Assistance Grants.

WATER SOURCE

1. Will your facility be located in an Area of Critical Environmental Concern (ACEC), a Rare Species Habitat, or exceed MEPA review thresholds ? ***MEPA Environmental Notification form***

	MEPA Environmental Notification Form
Issuing Agency:	MA Environ. Policy Act Office 100 Cambridge Street, Suite 900 Boston, MA 02202 (617) 626-1020
Statutory Reference:	MEPA MGL Ch. 30, Secs. 61 and 62
Regulatory Reference:	301 CMR 11.00
Activities Covered:	1) Any activity in an ACEC requiring a state permit or funding, 2) Activities requiring state permits or funding that exceed the review thresholds at 301 CMR 11.03 and 11.04. 3) Activities that exceed the thresholds are covered under CZM consistency review (see301 CMR 11.03 and 11.04 below).
Process:	An Environmental Notification Form is filed with the MEPA office and a public notice is published. Following a 30 day public comment and review process, an EIR is prepared addressing the alternatives and comments received from the ENF review.
Fees:	None
Other Information:	This review is not actually a permit however, it is a review process which must be completed successfully before State agencies can issue any permits.

Appendix C. Artificial Reef Description Form

The Commonwealth Of Massachusetts
Division of Marine Fisheries
251 Causeway Street, Suite 400
Boston, Massachusetts 02114-2152

ARTIFICIAL REEF DESCRIPTION FORM

PLEASE TYPE OR PRINT INFORMATION CLEARLY

Contact Information:

Proponents Name:	Date:
Name of Contact Person:	
Address:	Tel Number:
City:	Cell Number:
Zip Code:	Fax Number:
Mailing Address (if different from above)	
Street:	Email Address:
City:	
Zip Code:	

Site Location Information:

Location (City or Town):	GPS Coordinates:
Nearest Port:	Latitude:
Approximate Depth (MLW):	Longitude:
	NOAA Chart ID#:
Additional information :	

Reef Material Information:

Please check all that apply:					
	Natural material		Prefabricated artificial reef unit		Materials of opportunity
Please provide specific information about the materials being proposed for use:					

Monitoring information:

Describe monitoring plan. Include details of pre and post construction monitoring activities.

Return completed form to: **Division of Marine Fisheries Artificial Reef Program**
C/0 **Mark Rousseau, 30 Emerson Avenue, Gloucester, MA 01930**
Phone: 978-282-0308 x162. Fax: 617-727-3337. Email: mark.rousseau@state.ma.us