Chapter 9: Other Future Uses

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Section 900. Introduction

1. It has been recognized globally that there is a need to conserve ocean ecosystems and use ocean space as efficiently as possible, thus requiring planning for multiple uses of compatible activities, and the development of strategies to promote, enhance, and optimize the multiple uses in order to protect ocean ecosystems and conserve ocean space (Mee 2006). Rhode Island has used SAMPs as innovative, ecosystem-based planning frameworks, each of which have unique policy drivers (Figure 9.1). Policy drivers will change over time and inform implementation actions for the future as multiple uses of ocean space and additional human interventions are considered. Adding new uses will continue changes to the natural, marine, and social ecosystems. The trajectory of these changes could result in a more vibrant, innovative, marine economy with compatible uses. This chapter is unlike others in the Ocean SAMP, as it not simply a compilation of and considerations of findings of fact about the Ocean SAMP region. Rather, this chapter explores opportunities for the future uses and conservation of the Ocean SAMP area—the inner shelf—of Block Island and Rhode Island Sounds, and discusses the potential of these to help develop and protect Rhode Island's ocean ecosystems and green economies. These possible future uses of the Ocean SAMP region are summarized in Table 9.1.

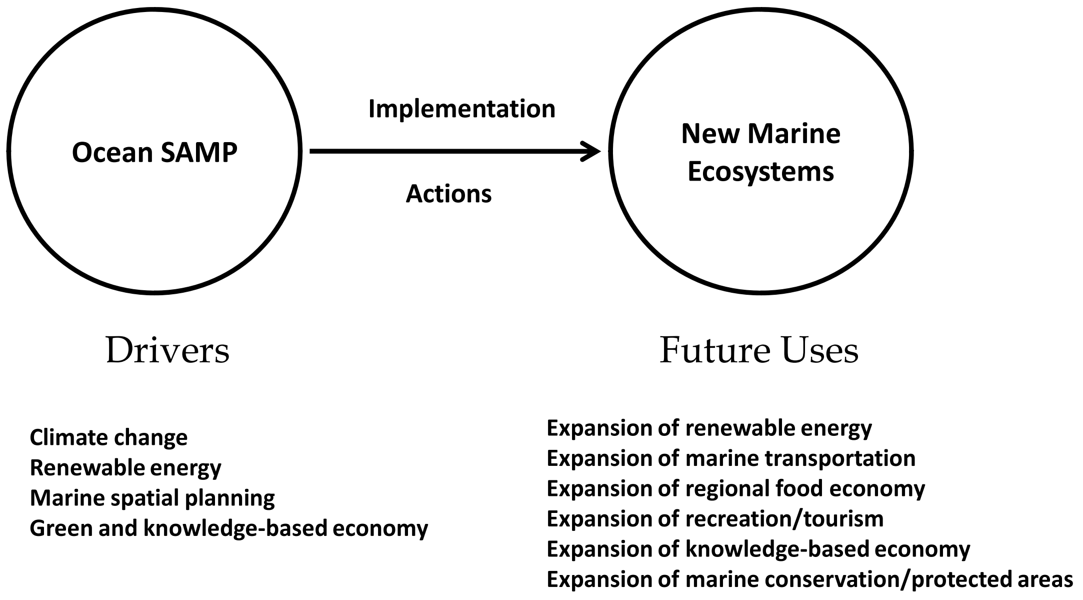

Figure 9.1. Policy drivers for the Ocean SAMP that will lead to implementation of future uses and result in "new" marine ecosystems.

2. The principles and practices of ecological engineering (Mitsch and Jorgesen 2004) could be helpful as an overall design and implementation pedagogy to determine compatible, multiple uses of similar ocean space. Industrial ecology is another important idea as an organizing framework for the analysis of potential multiple uses, and includes life cycle assessments and material flow accounting, as well as ecological economics. Engineering and ecological knowledge of processes occurring in the Ocean SAMP region will not be enough to move forward with social and policy changes for future uses. Stakeholder

interest will remain high throughout the implementation of any future uses. A participatory framework for the engagement of stakeholders, such as the one implemented during this Ocean SAMP process (Dalton 2005), will need to be continued throughout implementation of the Ocean SAMP in order to ensure social, economic, and environmental compatibility. There will be a rapid turnover of ideas associated with new opportunities for future uses of the Ocean SAMP area. This will require a continuation of an organized, participatory stakeholder process as new uses are explored so that information can be shared constructively and systematically, and, over the longer term, informed decisions can be made, and potentially significant benefits for all stakeholders could be realized.

Table 9.1. Possible benefits and management issues that need to be considered for possible future uses of the Ocean SAMP region as reviewed in this chapter.

Future Uses	**Potential Benefits**	**Management Considerations**
Use for Mining	Local sources for aggregates; decreased mining and transportation costs.	Economic viability vs. future alternatives questionable; environmental conflicts due to habitat destruction.
Use for LNG	Favorable economics; well developed infrastructure in place; offshore development viewed as safer.	Environmental, safety and regulatory concerns; increased ship traffic; increased underwater sound affecting marine mammals and fisheries; conflicts with increased recreational uses; increased security risks; increased ecological risks from the spread of invasive species.
Short Sea Shipping	Favorable economics and more efficient than land-based transportation; avoids land-based gridlock; new investments for R.I. ports.	Increased sea vessel traffic; increased underwater sound affecting marine mammals and fisheries; conflicts with increased recreational uses; increased security risks; increased ecological risks from the spread of invasive species.
Marine Reserves for Conservation	Ecosystem restoration; enhanced biodiversity; enhanced recreational opportunities; increased education/research values.	Space removed from extractive uses; conflicts with fisheries interests.
Marine Reserves for Fisheries Enhancement.	Fisheries restoration and localized biodiversity increases; enhanced recreational and education/research values.	Space removed from extractive uses; conflicts with fisheries interests.
Placement of Artificial Reefs for	Localized biodiversity increases; can create	Controversy over values to fisheries; replacement costs high;

Fisheries Enhancement	upwellings and possible fisheries enhancement; increased education/research values.	New permitting and regulatory issues; use conflicts.
Shellfish Biofouling Control	Removes drag on offshore structures/towers; new sources of local seafood production; new marine economic development.	Safety concerns due to the use of divers; seafood safety and regulatory issues; additional vessels present use conflicts.
Submerged Shellfish Aquaculture	Local seafood production; ecosystem benefits from improved habitats and water quality; most economically viable form of aquaculture in R.I.; replaces Canadian imports; new marine economic development.	Conflicts with industrial use of alternative energy structures; new lease and regulatory issues arise in offshore areas; regulatory changes needed due to scale of developments; increased use conflicts, especially vessel traffic.
Submerged Finfish Aquaculture	Local seafood production; new marine economic development.	Future competition with restored marine fisheries products; regulatory changes needed; no finfish aquaculture infrastructure in R.I. or Southern New England; concerns regarding environmental impacts; use conflicts.
Submerged Algae Aquaculture	Local seafood production; new developments of biotechnologies and bioactive compounds production; new marine economic development.	Existing technologies untested; ocean environment may be unsuitable; economics unfavorable; new regulatory regime needs to be put into place.
Enhanced Ecotourism	Recreation economy enhanced.	Increased vessel traffic; conflicts with commercial uses.
Burials and Cemeteries	Land saved; new economic/tourism development.	Displacement of benthic habitats; space removed from extractive uses; new regulations and changes to existing regulations needed; use conflicts.
Desalinization	Buffer droughts; conserve surface waters.	Currently only economically feasible in desert areas; discharges could impact marine ecosystems.

Research and Education Center	Builds the innovation and knowledge-based economy; attracts international/national cooperation and funding.	Space removed from commercial uses; sustainability of funding questionable; new institutional cooperation, coordination, logistics needed.

Section 910. Use for Mining

1. Demands for sand and gravels for beach nourishment and construction (concrete) are increasing, especially from marine resources on the continental shelf as traditional, land-based sources of these materials have been reduced. This shift to the use of offshore resources will expand, especially in marine areas having large concentrations of glacial deposits (Johnson et al. 2008).

2. Aggregates in Rhode Island are largely locked up by the needs for subdivisions, or these resources are held in R.I. Department of Environmental Management parks or open spaces. Much of the sand on Rhode Island beaches currently comes from glacial materials found in upland sources and coastal lagoons. With sea level rise there will be a greater need for aggregates for coastal armoring projects, which could outstrip supply. However, other “soft” shoreline solutions could be alternatives to armoring which can compound shoreline erosion downstream.

3. There is currently no information concerning the amount of usable sand or gravel deposits, or other aggregated material, located within the Ocean SAMP study area. Efforts are being made to conduct sub-bottom profiling and monitoring of Block Island’s inner shelf to investigate the geological structure and mineral distribution within the area (Boothroyd pers. comm.).

4. Potential impacts from offshore mineral mining include removal of substrates that serve as important habitats for fish and invertebrates, creation of less productive marine benthic sites due to anoxia, release of harmful or toxic materials associated directly or indirectly with the mining process, burial of productive habitats during beach nourishment or other shoreline stabilization activities, and creation of harmful suspended sediment levels upon mineral extraction that can potentially have secondary and indirect adverse effects on fishery habitats at the mining sites and surrounding areas (Johnson et al. 2008).

Section 920. Use for Liquefied Natural Gas (LNG) Facilities

1. Natural gas is the fastest growing source of energy for consumption worldwide. Natural gas makes up about a quarter of all energy consumed in the United States every year (Foss 2007a, 2007b), with LNG accounting for approximately 2% of U.S. natural gas supply (Foss 2007a, 2007b). Demand for natural gas in the United States has accelerated due to environmental concerns about other energy resources, rising natural gas prices, and the possibility of domestic shortages (Parfomak et al. 2004).

2. Natural gas is used in homes for heating and cooking, and can also be used to generate electricity. In locations where pipeline capacity from supply areas is expensive and use is highly seasonal, LNG storage can help reduce pipeline capacity commitments, and can be an important fuel during peak power periods (Energy Information Administration 2003).

3. The physical properties of LNG allow for long-distance transport by ship and for local distribution by truck onshore. Liquefaction of natural gas also provides the opportunity to store it for use during high consumption periods close to demand centers, as well as in areas where geologic conditions are not suitable for developing underground storage facilities. In New England, underground storage is lacking, and LNG is a critical part of the region's supply during winter (Energy Information Administration 2003). To meet these needs, new onshore and offshore LNG plants have been proposed for southern New England. Rhode Island receives all of its LNG from shore-based pipelines; there is one existing jurisdictional peak shaving site in Providence operated by Keyspan LNG, Inc.

4. Current projects are expanding the capacity of existing pipelines into the Northeast (Gaul 2009). This report indicates there are multiple recent projects in the Northeast during 2008 to bring regasified natural gas to market from LNG import terminals, suggesting that domestic sources of natural gas supplies may now be able to meet projected future demands.

5. The U.S. has the largest number of LNG facilities in the world – 113 active facilities spread across the country, with a higher concentration of the peak shaving and satellite facilities in the Northeast. Peak shaving is the most common use of LNG in the U.S. It is a way local electric power and gas companies or utilities store gas for peak demand that cannot be met via typical pipeline sources; this can occur during the winter heating season or for air conditioning during the summer months (Foss 2007a). LNG is a hazardous liquid that, since 1959, has increasingly been transported by sea using specially designed ships (Spaulding et al. 2007). Ships are double-hulled and insulated to prevent leakage or rupture in an accident; a typical carrier measures 900' in length, 140' in width and 36' draft, and costs $160 million to build - similar in size to an aircraft carrier (Foss 2007a).

6. The U.S. uses more energy than it produces. There are currently nine operating receiving LNG terminals throughout the country (Center for LNG n.d.). One of these is an offshore terminal located in Massachusetts Bay, 13 miles offshore from Boston – Northeast Gateway Deepwater Port, Excelerate Energy's second buoy-based offshore receiving terminal, which received its first shipment in May 2008. The physical infrastructure of Northeast Gateway consists of a dual submerged turret loading buoy (STL Buoy) system

and an approximately 16 mile-long pipeline connecting into the existing HubLine pipeline (Excelerate Energy n.d.). LNG tankers unload their cargo at dedicated marine terminals which store and regasify the LNG for distribution to domestic markets. Offshore terminals regasify and pump the LNG directly into offshore natural gas pipelines (Figure 9.2), or may store LNG in undersea salt caverns for later injection into offshore pipelines.

7. There are currently no existing or proposed offshore LNG terminals in Rhode Island. Import terminals have been proposed in coastal regions throughout the United States, including Mt. Hope Bay in Fall River, Mass. and Long Island Sound, New York, which would present various impacts within the Ocean SAMP study area around Block Island and in Rhode Island Sound.

8. Rhode Island waters could be affected by increased traffic from LNG tankers through Narragansett Bay and Rhode Island Sound, through the Ocean SAMP study area, by proposed offshore LNG facilities in Mount Hope Bay, Fall River, Mass. and in Long Island Sound, New York/Connecticut. Weaver's Cove Energy has proposed to build an offshore berth in coastal waters of Mount Hope Bay to serve as an offshore unloading dock and buried LNG transfer pipelines. The proposed LNG terminal location is one mile southwest of Brayton Point, Somerset, MA and one mile from shore; the channel would be dredged to accommodate LNG vessel berthing and turning; four-mile LNG transfer lines would transfer imported fuel to storage tanks at the FERC-approved terminal site (Kirkland 2008).

9. There are safety concerns with offshore LNG. Spaulding et al. (2007) examined a partial spill due to an accident or a deliberate attack for an LNG tanker in Block island Sound, with the LNG spreading along the water, gradually evaporating, mixing with air until it could, potentially, catch fire. Depending on the direction of the wind and the size of the spill, they found harm could be substantial. Given these concerns, Spaulding has come up with a hypothetical new LNG terminal plan, for an offshore site in Block Island Sound, completing simulations and gathering information on similar proposals nationwide.

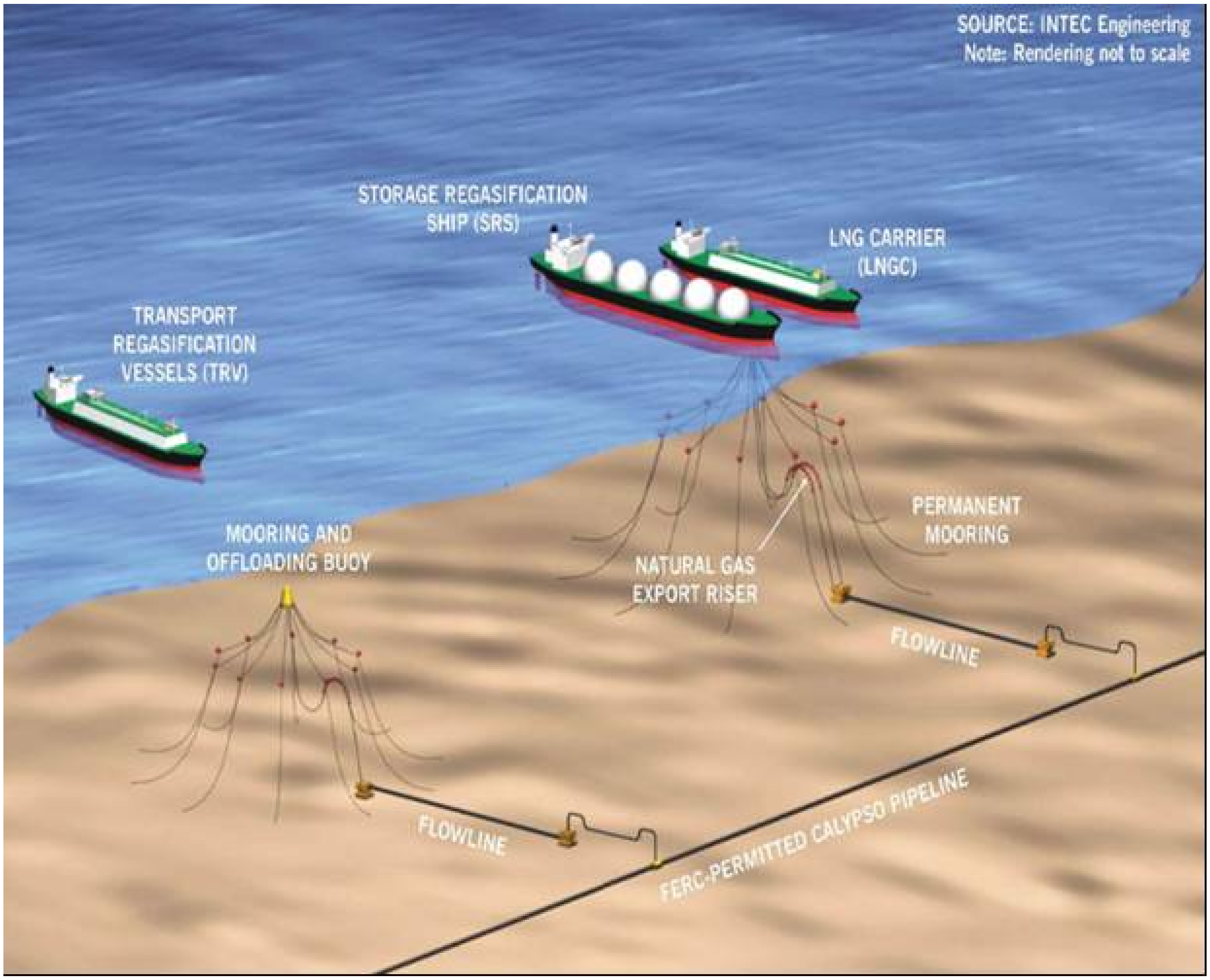

Figure 9.2. Example of an offshore LNG facility proposed eight to 10 miles off the coast of Florida by Suez Energy International (McGinnis 2008).

10. Existing and proposed facilities in the Northeast region are described in Table 9.2 below:

Table 9.2. Existing and proposed offshore LNG facilities in the Northeast region.

Places	**Projects**	**Descriptions**
Boston Harbor, Mass.	AES Battery Rock LNG, AES Corp (proposed)	11 million cubic meters per day facility in Boston Harbor.
Gloucester, Mass.	Neptune LNG, the GDF Suez S.A. (Euronext: GSZ, GSZB)	Currently building an LNG facility off the coast of Gloucester, Mass. that would handle 11 million cubic meters per day.

Cape Ann, Mass.	Northeast Gateway Project	Excelerate Energy owned terminal in Cape Ann, Mass. Received its first shipment in May 2008; capacity of 22.6 million cubic meters per day
Fall River, Mass.	Weaver's Cove LNG, Weaver's Cover Energy (proposed)	proposed 22.6 million cu m terminal in Mt. Hope Bay

11. Potential impacts of offshore LNG are: (a) increased marine traffic through Rhode Island Sound and around Block Island, (b) ecological disruption to fish populations, and whale migratory patterns, (c) decreased fisheries from the entrainment of fish eggs and larvae, and (d) habitat losses due to dredging and disposal for construction (Gallaway et al. 2007). In addition, there would be a limitation of use of waterways during ship transit due to the need for security zones.

12. In Massachusetts, Excelerate is operating a closed-loop system, where the water is recycled, mostly because North Atlantic waters are too cold most of the time to vaporize the LNG. Each ship in this system will suck in less than five million gallons a day. Closed-loop systems might have impacts on fish eggs and larvae and impact overall production of the ecosystem because other species feed on the larvae and eggs. In addition, fishermen have opposed the terminal location on the grounds that the site is located in prime lobster and ground fishing areas.

Section 930. Short Sea Shipping

1. Widely used in Europe, short sea shipping is the movement of goods domestically, usually containerized, aboard small vessels and barges, with the goal of reducing truck traffic on congested highways. Short sea shipping relies on small vessels rather than deep draft container ships. Instead of offloading containers at a large port and having them trucked along I-95, international shipments would instead arrive into a major port such as the Port of New York/New Jersey; then goods would be parceled out to smaller vessels and barges that would travel along the coast. Vessels would have roll-on-roll-off, 53-foot trailers. Smaller vessels and barges could carry hundreds of trailers and not require dredging for deep draft container ships.

2. There is great interest in short sea shipping (Institute for Global Maritime Studies 2008) because: (a) marine transportation systems are less expensive, and short sea ships could be powered by LNG; (b) the I-95 corridor faces gridlock by 2035 since no new upgrades for the highway system are planned over the next 20 years, and without any further improvements to the corridor, projected average daily traffic would be over 133,000, including over 20,000 trucks. Virtually 100% of the highway's urban segments would be congested and congestion for non-urban corridors would increase from the current 26% to over 55%; (c) with the prediction of future cap and trade systems, short sea shipping would be more efficient, profitable and environmentally friendly (Institute for Global Maritime Studies 2008); and (d) hurricanes may become more frequent due to climate warming globally, especially in the Northeast (see Chapter 3, Global Climate Change). A Category 3 northeast hurricane would cut off segments of both I-95 and Amtrak rail systems for substantial periods of time. In short, expansion of short sea shipping would create a redundant, more resilient, intermodal cargo transportation system.

3. Total tonnage of cargo processed by the Port of New York and New Jersey, the major gateway for southern New England, has grown rapidly from 2004 to 2007 (USACE 2004, 2007). The corridor between Boston, New York, and Washington DC has been proposed as an attractive region in which to develop short sea shipping routes due to the present and future projections of traffic congestion, the region's population density, and the availability of port facilities (Rhode Island Economic Monitoring Collaborative 2007). Providence could serve as a central hub for short sea shipping (Rhode Island Economic Monitoring Collaborative 2007; National Ports and Waterways Institute 2004). The Quonset Business Park was awarded $22.3 million in federal stimulus funds in 2010 to improve piers, roads, and rails, plus funds to install a crane in preparation for offshore wind development. Funds will allow the Port of Davisville to be developed as a short-sea shipping port that will accommodate shallow-draft barges loaded with containers from larger ports on the East Coast. The port's vision is to expand into the short sea shipping industry, and produce renewable energy. State officials estimate that new operations at the port could inject $120 million into the RI economy and create up to 1,000 long-term jobs. Of course, commercial ocean traffic in the Ocean SAMP area may increase in the future if a short sea shipping industry develops in Rhode Island (RIEDC 2009). For further information on ship traffic in the Ocean SAMP area see Chapter 7, Marine Transportation, Navigation, and Infrastructure.

4. Potential impacts of short sea shipping are: (a) increased sea vessel traffic, (b) increased underwater sound affecting marine mammals and fisheries, (c) conflicts with increased recreational uses, (d) increased security risks, and (e) increased ecological risks from the spread of invasive species.

Section 940. Marine Conservation and Fisheries Enhancement

1. The Ocean SAMP region could, as a whole, or in part, contain designated areas for single use, multiple uses, or the entire area could be designated as a closed, no use area, or any number of mixtures of these options. Figure 9.3 shows the wide range of options available and reviewed here. The Ocean SAMP region could as a whole, or in part, be allocated into a range of completely no take areas (marine reserves), an area of completely open access, or a mixture of these two with and without placement of additional structures (artificial reefs) which could have benefits for both marine conservation and marine fisheries. Reserves have also been used in combination with artificial reefs in a designed approach to enhance both marine ecosystems and fisheries.

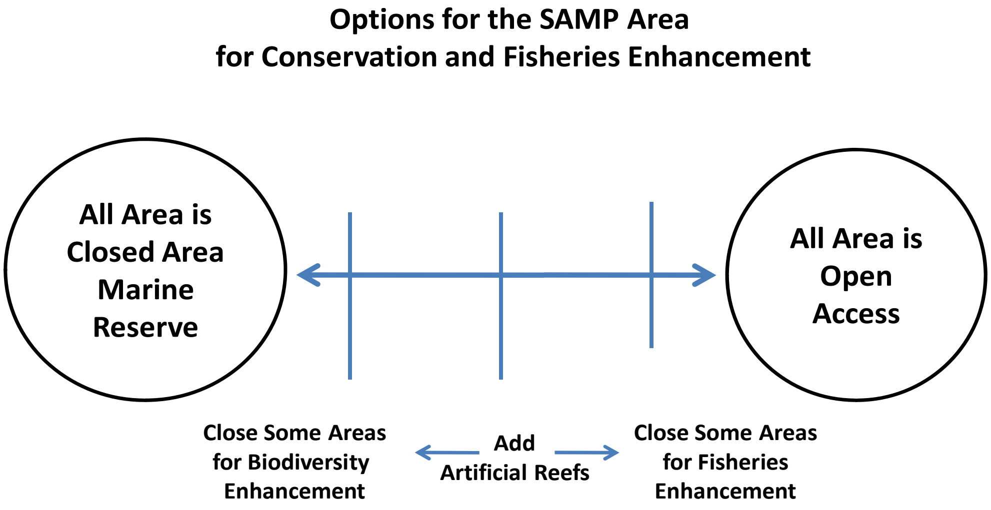

Figure 9.3. Options for the Ocean SAMP area for conservation and fisheries enhancement.
A range of marine area management options exist for the Ocean SAMP area for biodiversity and fisheries enhancement. Options span the gamut from complete to partial closures, plus adding artificial reefs for biodiversity, recreation and commercial benefits.

940.1 Enhancing Marine Conservation

1. According to the World Conservation Union (IUCN), an MPA is “a clearly defined geographical space, recognized, dedicated and managed, through legal or other effective means, to achieve the long-term conservation of nature with associated ecosystem services and cultural values” (Laffoley 2008, 7). There are different types of MPAs: (a) reserves, (b) conservation areas, (c) parks, and (d) recreational management areas.

2. Marine reserves prohibit all extractive activities (removal of animals and plants and actions that alter habitats), except as needed for scientific monitoring. Examples of prohibited activities in marine reserves are fishing, aquaculture, dredging, and mining. In contrast, activities such as swimming, boating, and scuba diving are usually allowed (Sanchirico 2000). Marine conservation areas prohibit damage, take, or possession of living or non-living marine resources for commercial or recreational purposes. Agencies

may permit research, education, and recreational activities, and limited commercial and recreational harvests. Marine parks prohibit damage, take, or possession of living or non-living marine resources for commercial purposes. All other uses are allowed, including scientific collection, monitoring, public recreation, and recreational fishing, unless otherwise restricted. Marine parks prohibit commercial fishing but allow most recreational fishing. Marine parks allow restoration of indigenous ecological communities, improving ecosystem health and resilience with potential benefits for the larger marine ecosystems. Most coastal areas near population centers have been impacted anthropogenically to the point where the indigenous state of ecosystems is poorly understood. Designation of the Ocean SAMP area as a marine park would enable development of a novel understanding of the natural resilience and recovery potential of coastal ecosystems. In 2000, President Clinton issued an executive order calling for a national system of MPAs (Exec. Order No. 13,158, 65 Fed. Reg. 34909 (May 26, 2000)) and the establishment of a federal advisory committee on MPAs. The National Academy of Sciences (2001), the Pew Oceans Commission (2003), and a broad spectrum of scientists and conservation organizations have recommended designation of networks of protected areas as one of the essential tools for the preservation of threatened marine ecosystems, including no-take marine reserves.

940.2 Enhancing Marine Fisheries

1. MPAs have potential costs, benefits, and risks to marine fisheries, which have been summarized by Sanchirico (2000). Potential benefits are habitat improvement, increased numbers of larger, older, and more valuable fish, and larger fish stocks which could increase in harvests. Improvements to the environment and fisheries communities are thought to be a useful tool in the recovery of overfished stocks and may enhance the long-run sustainability of fisheries. MPAs have also been documented to produce beneficial "spillover effects" into non-protected areas. Rodwell et al. (2003) constructed predictive models based on habitat requirements of individual fish species and demonstrated specific contributions of habitat improvements to fisheries. They were able to show that improvements in habitat quality can increase biomass and catch levels, with the greatest benefits accruing to catch. Best results were achieved when locating the reserve where habitat can recover quickly once protected and where the area is not subject to other stresses such as pollution or sedimentation.

2. Most economic studies have failed to consider habitat quality improvement as an economic benefit of marine reserves (Sanchirico 2000). Costs are related directly to the reduction in the area of fishable waters and the resulting displacement of fishing efforts. Risks of MPAs to fisheries have been identified. The main risk is that MPAs are fixed in space while fish stocks are mobile and the ocean environment is susceptible to major environmental changes and human impacts (e.g., climate shifts due to North Atlantic Oscillation [NAO] and El Nino-Southern Oscillation [ENSO] events, or human perturbations such as pollution, oil spills, etc.). For example, if an area is selected for closure due to its unique role in the life cycle of a fish stock, there is no guarantee that this habitat will continue to provide the necessary ecological services if affected by pollution or environmental change (Sanchirico 2000).

3. The New England Fishery Management Council (NEFMC) is working to identify ocean areas in New England vulnerable to fishing gear. Browns Ledge in the Ocean SAMP planning area is one of seven areas that have been identified by the NEFMC habitat science team as an area vulnerable to mobile fishing gears (NEFMC 2010).

4. Fisheries interests are concerned worldwide about the designation of MPAs. Changes in fishing operations following siting of an MPA poses risk to fishing interests. For example, in response to area closures, boat captains might alter the configuration or design of their vessels to employ multiple gear types or might increase the number of trawls. In this example, increased effort or more detrimental practices could drive non-protected area fish stocks lower. MPAs could potentially affect one user group disproportionately (Holland 2000). For example, if an MPA is sited nearshore, the inshore fleet could potentially incur the highest cost (i.e., direct loss of fishable waters), while the offshore fleet could receive most of the benefits. Approximately, 60% of the case studies and empirical analyses on the impacts of protected areas found them to have varying degrees of significant positive effects on abundance, size, and density (Sanchirico 2000). Investigations on the views, perceptions and attitudes of commercial fishermen that influence support or opposition to marine protected areas have been accomplished (Stump and Kriwoken 2006). Main concerns are the potential negative impact of additional MPAs in terms of resource sustainability and the long-term economic viability of fisheries. Fishermen support MPAs if they sustained or increased fish populations, supported research, allowed fishing in multiple use areas, and if multiple use areas contained small no-take zones. Fishermen are concerned about the ability of the government to provide adequate MPA monitoring and compliance.

5. In Europe, displacement of fishermen and certain types of fishing such as trawling by offshore energy structures has occurred due to insurance and safety concerns (see Chapter 8, Renewable Energy and Other Offshore Development). Fishermen have supported the creation and management of no-take zones to coincide with the energy facility developments in cases where the benefits for fisheries in adjacent waters have been demonstrated (Mee 2006). It is important to be aware of the fact that fishermen displaced from areas that are closed to fishing may actually exert increased impacts on fish populations and the environments outside closed areas (Dinmore et al. 2003). Another possibility is that designation of no take zones for trawling may shift fishing pressure from one gear type (trawling) to others (i.e. fixed gear, recreational fishing).

6. The Nature Conservancy (TNC) is working with fishermen on California's Central Coast to develop environmentally sensitive fishing practices for harvesting groundfish. TNC's Central Coast Groundfish Project wishes to pioneer cutting-edge science, conservation tools and markets to encourage stewardship. TNC buys trawl-fishing permits and leases them back to fishermen, who are required to follow specific conservation practices. TNC is exploring similar approaches to provide incentives for fisheries conservation on the East Coast with a pilot planned for Maine (Littlefield pers. comm.).

940.2.1 Placement of Artificial Reefs

1. The post-glacial environment of the Ocean SAMP area has terminal moraines, which, when compared to other ocean areas, offer a substantial amount of structure and relief.

Boulder fields in moraines are not suitable for development of windfarms, nor are they good areas for bottom trawling by groundfish fisheries. The moraines have been observed to contain high biodiversity, and although they are not trawled by mobile fishing gears are still fished by an array of fixed or transitory gears (traps, lines, pots, nets, etc.; see Chapter 5, Commercial and Recreational Fisheries). Boulder fields in or outside of moraines are not suitable for development of offshore energy or other offshore structures, with sand/gravel areas considered the best. In such areas, erosion at the base of turbines is a major consideration and is often countered by placement of either rock for armoring and/or concrete mattresses or mats. Rock armor placed at the base of wind turbines effectively forms an artificial reef which is colonized by marine organisms.

2. In sand/gravel depositional areas, artificial reefs have been placed to enhance marine fisheries by creating additional habitat for selected species and/or life stages (Blaxter 2000; Sayer 2001); for habitat restoration (Caddy 1999); for protecting additional habitat from fishing gear impacts with access and/or effort restrictions (Wilson and Cook 1998; Pitcher et al. 2000); or to alter local circulation patterns, and therefore energy flows of marine ecosystems, in order to promote new production and help mitigate impacts of offshore developments (Steimle et al. 2002; Sheehy 2009, Sheehy and Vik 2010). In Japan, artificial reefs are widely used, and range from massive structures designed to force upwelling of deep, nutrient-rich waters to the surface to increase primary production and to increase fisheries, to smaller units designed to provide fish attraction or as substrate for algae and mollusk aquaculture (Morikawa 1996).

3. Baine (2002) reviewed more than 90 published articles on artificial reefs worldwide to enhance fisheries management objectives. He identified more than 300 materials used for reefs, with concrete, rocks, stones and boulders the most common, but tires, trees and wrecks all used, with purposes as varied as support for fisheries management, habitat creation/protection, waste management, sport diving, and seaweed culture. For fisheries enhancement, designed materials and natural rock are recommended, and a wide range of designed reef modules are currently in use worldwide that have undergone extensive testing to document their predicted stability and life expectancy. Sheehy and Vik (1992) developed valuable ideas on how to increase the ecological value via use of ecological engineering of reefs to enhance ecological functions. Turpin and Bortone (2002) conducted an assessment of artificial reefs pre- and post-hurricane to look for evidence for their potential use as fish refugia. Lighter materials were moved for distances of approximately 1000 m, while higher density materials were unaffected by the wave surge. Eklund (1997) studied the ecological processes limiting fish production in association with artificial reefs and concluded that it is possible to design and manage artificial reefs with the aim of promoting the development of benthic communities as possible forage areas for important fisheries species by providing greater availability and heterogeneity of refuge space, which supports more fish. The most important findings were that: (1) artificial reefs increased habitat complexity, fish densities, species richness and diversity over the short-term, and gradually over time; and (2) carrying capacities and catches per unit effort (CPUE) by numbers and weights, densities and biomasses were higher in artificial reefs than control areas (Baine 2002). Wilson et al. (2002) discussed the advantages of linking artificial reefs with the creation of marine reserves. Studies indicate that enhancing MPAs with artificial reefs can increase juvenile recruitment and enhance fisheries production (Bohnsack and Sutherland 1985).

4. A continuous scientific debate has existed for more than 30 years on whether artificial reefs merely aggregate or actually increase fishery biomass (Bortone 1998; Svane and Petersen 2001). Artificial reefs can only increase fisheries where there is habitat limitation for a given species, and where the resources utilized by a fishery on new, artificial reef habitats would not have been used by that, or another fishery, in another location (Linley et al. 2007). Bohnsack et al. (1997) deemed it unlikely that an exploited species, where individuals are constantly removed from their habitat by fishing, will be habitat-limited, at least in terms of the habitat for individuals of a large enough size to enter the fishery. Simard (1996) concluded that in spite of the massive investment Japan has made in artificial reef technology, only octopus productivity actually increased as a direct consequence of the construction of artificial reefs. In studies conducted over a 24-year period, Stephens and Pondella (2002) considered if artificial reefs in Southern California Bight acted as sources or sinks for fish by comparing annual densities of fish larvae from artificial reefs with control areas. They showed higher densities of larvae at the artificial reefs in comparisons to non-reef areas, indicating that mature artificial reefs contributed significantly to the fish larval pool, thereby acting as sources, and not sinks. Positive studies of marine fisheries enhancement by artificial reefs remain inconclusive, as local results cannot be generalized, and ecosystem processes cannot be assessed as systematic (Linley et al. 2007).

5. Surveys at offshore wind farms in Europe suggest an increased association of some commercial fisheries species with turbine towers (Dong Energy n.d.; Fayram and deRisi 2007). However, one important factor to consider is that the density of wind turbines needs to ensure that each is effectively independent and faces a non-turbulent air stream to attain maximum energy density. This results in turbines that are generally 0.5-1.0 km apart on the axis of the prevailing wind. This distance may increase if turbines increase in size. Wilhelmsson et al. (2006) investigated the potential of wind turbines off the southeast coast of Sweden to function as artificial reefs and alter fish assemblages. Fish abundances were greater near the turbines than in surrounding areas, but species richness and diversity were similar. Blue mussels and barnacles covered most of the submerged structures which offered good conditions for growth.

6. Researchers in Rhode Island have been investigating the use of artificial reefs for lobster enhancement, and for the recovery of lobsters from an oil spill, since the 1970's (Sheehy 1982; Castro et al. 2001). More recently, demolition of the Jamestown Bridge created debris which was used to create two inshore artificial reefs, the Gooseberry Island and Sheep Point Reefs in 2006-2007 (Travisono 2010).

7. Several types of designed artificial shelters for lobsters fabricated from concrete were deployed in several shallow sites off Point Judith to determine if the carrying capacity for lobster in sand bottom areas could be increased (Sheehy 1976, 1977, 1982). Results indicated that the addition of lobster shelters significantly increased resident lobster populations, and that abundances were equal to or greater than those observed on good natural habitats. Shelter spacing had a significant effect on occupancy by lobsters, and shelter orientation, with respect to predominant wave and current directions, affected the stability of the shelters on the bottom. Triple chamber shelters had the highest overall use and supported larger populations due to the compartmentalization. During studies, all benthic life stages of the lobster were observed on and within the reefs. Significant

seasonal variations in both lobster and other populations were also observed. Additional studies indicated that the addition of artificial shelters in areas devoid of natural shelter or substrate suitable for burrowing can significantly increase the abundance of lobsters. Sheehy (1982) stated that suitable sites for lobster reefs are limited, and that careful examinations of site factors, particularly maximum wave and current conditions, substrate, and available food resources, should be made prior to future construction.

8. Castro et al. (2001) investigated six experimental artificial reefs for hatchery-reared lobsters in Narragansett Bay in 1997 using a before-after-control-impact design. Juvenile and adult lobster densities at the reefs were significantly higher than the 2 control areas, and settlement of young-of-year lobsters also increased significantly. However, recoveries of hatchery-reared lobsters were poor. Field observations indicated possible behavior differences in the hatchery-reared lobsters that might have made them more susceptible to predation.

9. The Gooseberry Island Reef is located 1.5 miles south of Newport, R.I. in approximately 80 feet of water, while the Sheep Point Reef is located 1.1 miles east of Newport, R.I. in approximately 65 feet of water (Travisono 2010). The objectives for the reefs were to offer sites for recreational angling and diving. Reef construction did not lead to any significant increase in bottom profile (Fugate, pers. comm.). Pinckard (2009) evaluated the sites using bathymetry and side-scan sonar surveys, underwater photos, fish census, and conducted experimental reef habitat comparisons. Reefs had a "moderate degree of colonization" by encrusting organisms (e.g., hydroids, bryozoans, and mussels), lobsters, and various fish species (e.g., cunner and sea bass). Invasive species, including the tunicates *Didemnum* sp., *Botrylloides violaceus*, and *Ciona intestinalis*, were observed on the bridge debris. These findings raise the possibility that any additional structures such as artificial reefs or energy structures that are placed in RI's offshore waters—any additional artificial habitat—would be colonized by invasive tunicates (and other invasives such as macrophytic algae) in offshore areas (see Chapter 2, Ecology). *Didemnum* sp. has been found to colonize extensive areas of Georges Bank gravel habitats (Valentine et al. 2007).

940.2.2 Enhancement of Recreational Fisheries

1. In the U.S., especially off of the small coastline of the state of Alabama in the Gulf of Mexico, artificial reefs ("reef balls") are used extensively to enhance sport, recreational fishing and diving, especially with respect to the use of abandoned oil rigs as artificial reefs (Kaiser 2006). Enhancement of recreational fishing by placement of artificial reefs has been shown to be related to reef technology selection, site conditions, target species, and fishing communities. Site conditions, including water depth, substrate composition, wave, and currents, determine the types of reef designs and materials suitable for deployment. Enhancement of recreational fishing has been most successful for species showing a strong affinity for structures and homing to sites. Workman et al. (2002) studied juvenile red snappers and found that they had homing capabilities to smaller artificial structures, concluding that their habitat requirements were met by the presence of these small structures, including shells and burrows. However, as fish grew larger they preferred larger and more complex structures. Recruitment to larger structures was, however, limited by the presence of larger fish. They concluded that the proximity of

large artificial reefs to smaller structures influenced recruitment patterns. Marine recreational management areas have been designated in California in Morro Bay where recreational or commercial takes are not allowed in southern areas, but certain recreational and commercial takes are allowed in northern areas (California Dept. of Fish and Game 2007).

Section 950. Biofouling Control by Shellfish Harvests

1. Oil industry engineers are well aware of safety concerns due to continual build-up of large quantities of attached sessile marine organisms, especially masses of bivalve shellfish and barnacles which require regular removal to reduce stress on the platform legs and supporting cross members. Regular cleaning also allowed detection of structural cracks or weld failures. Design requirements developed by regulatory agencies and the American Petroleum Institute require regular cleaning and control of biofouling loads as a safety measure to reduce the increasing environmental stresses (hydrodynamic loading from waves and currents) on offshore oil platforms (Richards et al. 2009).

2. In temperate areas, the subtidal biological community of oil platform legs (Richards et al. 2009) and wind towers (Wilhelmsson et al. 2006) is dominated by mussels. Mussels outcompete earlier settlers such as tunicates and encrusting bryozoans (Bram et al. 2005). The biomass (g wet weight) of mussels at a depth of 12 m has been estimated (prior to cleaning) to reach up to 80% of the total wet weight of all attached invertebrates and macroalgae found at that depth on the platform (Page et al. 2010). Mussel mats have been documented on southern California oil platforms to reach 4 ft (1.2 m) in thickness (Page and Hubbard 1987).

3. Removal of this biofouling is a time-consuming and costly process for offshore operators, running into hundreds of thousands of dollars per oil platform, depending on the time between cleanings, platform location, and surface area of the platform “jacket” (submerged structure) (Richards et al. 2009). Removal of biofouling is done by high pressure washers by divers contracted by offshore operators, and sends thousands of kilograms of mussels and other invertebrates to the sea floor, forming massive shell mounds. Accumulations on the seabed of mussels, barnacles and other marine debris (Hiscock et al. 2002) that scavengers such as crabs, lobsters, starfish, whelks, urchins, and numerous species of fish. Accumulations of debris also offer additional habitats (Love and Schroeder 2006) that may make a contribution to local recruitment (Wilhelmsson et al. 2006).

4. The potential for mussel harvests from offshore structures and for mussel aquaculture has been evaluated as two of the best economic opportunities for multiple uses of offshore energy platforms themselves, and their lease areas (Linley et al. 2007; Richards et al. 2009). Mussels grow very rapidly on offshore oil platforms. Growth in California was reported to be among the highest recorded in the world, from at least 0.25 in (6 mm) to 0.5 in (13 mm) per month, reaching a size of 2 inches (50 mm) in six to eight months (Richards and Trevelyan 2001; Page et al. 2007).

5. Three California companies harvested mussels from the California oil platforms as a business and biofouling control strategy (Richards et al. 2009). The most successful was “ECOMAR,” who over 20 years documented the business and environmental strategy and developed all regulatory approvals for human consumption. ECOMAR estimated it harvested $50-75,000 of shellfish per platform every 16-20 months (Meek 1989). Between 1992 and 1997, mussel production rose in California from 84,822 kg to 213,642 kg, with most production coming from southern California platform harvest. Development of shellfish harvesting as a biofouling control strategy and profitable

business was a win-win situation for both the oil and gas industry and shellfish harvesting entrepreneurs, allowing oil platform operators to reduce or eliminate costs for cleaning stress-load biofouling communities off platform legs and crossbeams and entrepreneurs (harvesters) an opportunity to develop the human food market for a valuable shellfish.

Section 960. Use for Aquaculture Developments

1. Aquaculture is defined as the farming of freshwater and saltwater organisms such as finfish, mollusks, crustaceans and aquatic plants under controlled conditions and with full ownership, in contrast to wild harvest or stock supplementation. It is estimated that aquaculture supplies about 47% of the fish and shellfish that is directly consumed by humans today (Food and Agriculture Organization [FAO] 2009). Ecological aquaculture plans, designs, develops, monitors and evaluates aquatic farming systems for food or non-food organisms that preserve and enhance the form and functions of the natural and social environments in which they are situated. Ecological aquaculture farms are "aquaculture ecosystems" (Soto et al. 2008; Costa-Pierce 2008).

960.1. Shellfish aquaculture

1. Buck et al. (2004) have demonstrated that offshore aquaculture of shellfish (mussels, oysters, clams) may benefit from a number of advantages in comparison with inshore sites in terms of increased growth, increase in product quality, and reduced levels of parasitic infections. These benefits need to be considered against the increases in time, labor and logistical resources needed to access sites and the difficulties in maintaining them in harsh offshore conditions. There may be more interest in pursuing offshore shellfish culture in the future as many inshore sites suffer from user conflicts and/or become unavailable due to problems with water quality.

2. Concerns and constraints regarding the expansion of marine aquaculture are much different for fed and non-fed aquaculture. For non-fed shellfish aquaculture, there has been a convergence over the past 10 years or so around the notion that user conflicts in shellfish aquaculture can be solved so that it can expand due not only to new technological advances, but also due to a growing global science/NGO consensus that shellfish aquaculture can "fit in" in an environmentally and socially responsible manner into many coastal and offshore marine environments, many of which are already crowded with existing users (National Research Council 2010). Included in this are: (a) development of submerged technologies for shellfish aquaculture such as longlines (Langan and Horton 2003), modified rack and bag shellfish gear (Rheault and Rice 1995), and upwellers for nursery stages of shellfish, some of which are placed unobtrusively under floating docks at marinas (Flimlin 2002); (b) scientific findings and reviews demonstrating the environmental benefits of shellfish aquaculture providing vital ecosystem and social services (National Research Council 2010) such as nutrient removal (Haamer 1996; Lindahl et al. 2005) and habitat enhancement (DeAlteris et al. 2004; National Research Council 2010); (c) research on natural and social carrying capacities for shellfish aquaculture, and sophisticated, collaborative work group processes (McKinsey et al. 2006; Byron et al. 2008); (d) development and wide use by industry of best and better management practices (National Research Council 2010); (e) diversification of traditional wild harvest fishing/shellfishing families into shellfish aquaculture as part-time enterprises, breaking down barriers between fishing/aquaculture user communities; and (f) publication of global comparisons with fed aquaculture, indicating a strong movement in shellfish aquaculture globally towards an adoption of ecological approaches to aquaculture at all scales of society (Costa-Pierce 2008).

3. Shellfish aquaculture such as longlines (Langan and Horton 2003) can be developed attached to offshore energy structures or within the leased areas. Food availability is vital to siting shellfish aquaculture, with rapid growth occurring at about 20 µg chlorophyll/liter, good growth at around 2 µg chlorophyll/liter, and poor growth in waters where phytoplankton concentrations fall below 0.8 µg chlorophyll/liter (Hawkins et al. 1999). Site specific models are required to determine the economic feasibility of shellfish aquaculture development and carrying capacities which describe hydrodynamics, primary production and seston availabilities and linking with feeding, metabolism, growth and population dynamics of each shellfish species, taking into account interrelations with other organisms that already exist (Dowd 1997; Bacher et al. 1998) prior to the development and investment in an offshore shellfish aquaculture development in the Ocean SAMP region. Maar et al. (2009) modeled biomass and growth of mussels on wind turbine foundations offshore in Denmark and found that mussels located higher up in the water column on turbine pillars had seven to 18 times higher biomass than those located deeper in the water on the scour protection, and attributed this to an enhanced advective food supply. The high mussel biomasses created local hot spots of biological activity and changed ecosystem dynamics. Model results were validated by field measurements.

4. The Woods Hole Oceanographic Institution and the Marine Biological Laboratory have both initiated pilot projects and experimental farms within the Ocean SAMP planning region to test the economic and environmental viability of offshore mussel aquaculture. The results from these projects are forthcoming, and should provide guidance for the regulation and permitting of potential future offshore shellfish aquaculture ventures (Paul 2000).

960.2. Finfish Aquaculture

1. Rhode Island has large seafood markets, both for local sales and for export. The largest distributor of frozen fish on the U.S. East Coast that supplies a national and global market is Seafreeze (Seafreeze, Ltd. 2009). Frozen fish are imported and exported from the Port of Davisville where Seafreeze is located. Seafreeze also supplies bait to both domestic and international longline fishing fleets.

2. Use of offshore energy sites for the development of finfish aquaculture is intuitively attractive and has received recent attention in Rhode Island and elsewhere (Buck et al. 2004; Mee 2006; James and Slaski 2006; Rhode Island Sea Grant 2009). A detailed analysis of offshore aquaculture has been completed (James and Slaski 2006) which concluded that economic, legal, environmental and technical constraints exist which must be overcome before investor confidence increases. The economic viability of offshore finfish aquaculture is highly dependent on external market forces that will likely drive the price of fish up in the long term – i.e. decreased supply from wild stocks, increased demand from consumers – thus potentially increasing the viability over time, but is also strongly dependent on the capital investment required for the new technologies that must be developed.

3. For offshore finfish aquaculture to develop within federal lease areas for offshore energy facilities, substantial legislative progress is required, some of which is already anticipated

in a bill introduced in the House, The National Sustainable Offshore Aquaculture Act of 2009 (H.R. 4363, 111th Cong., 2009). Discussions around this legislation suggest that many issues relating to aquaculture uses of offshore leased areas will need further stakeholder agreement, and will require additional legislative and regulatory changes.

4. Offshore finfish aquaculture is also constrained by available species (salmon and to a much lesser extent, cod are the only species with adequate hatchery and feed infrastructure in the region), and appropriate engineering and technology. Competition with land-based facilities is also an issue, and these facilities also avoid the legal/regulatory problems inherent in the development of commercial, offshore finfish aquaculture. Future opportunities exist with black sea bass (*Centropristis striata*) tautog or blackfish (*Tautoga onitis*) (Berlinsky et al. 2000; Howell et al. 2003; Perry et al. 2008).

5. Technical engineering advances in submersible, offshore cages with volumes 500 times or more greater than traditional surface, gravity cages have occurred. Submerged cages protect finfish from the stresses of wind, waves and currents generated by wind, tides and storms (Page 2011). Submerging cages significantly reduces stresses on structures and such units will likely be necessary in offshore areas where significant wave heights exceed 2 m. However, in such locations depth will be a constraining factor and there will need to be sufficient depth such that a submerged structure will have adequate clearance from both the surface and the sea bed.

960.3. Seaweed Aquaculture

1. Commercial aquaculture of seaweeds has grown rapidly in the last decade and is now estimated to comprise 86% of total seaweed supplies worldwide, with a significant proportion supplied by Japan, where seaweed culture is the most productive and economically profitable form of aquaculture (FAO 2009). Most seaweed aquaculture focuses upon high value export markets in Asia, with much research attention being given to future potential uses for seaweeds for the extraction of biotech/high value compounds.

2. Seaweeds settle where surfaces are available, generally within five hours of the release of spores, thus tides and wave action may restrict the potential colonization of novel surfaces which are beyond dispersal limits of spores. Evidence from offshore oil rigs show there is often good growth of kelps on these structures, and that it appears kelp spores may be robust enough to survive longer periods between release and settlement than some other species (Hiscock et al. 2002). In general, seaweeds do not grow well on vertical surfaces, although slopes which are in excess of 20° from the vertical are suitable for colonization. Buck et al. (2004) have investigated several possible designs for seaweed rafts in association with offshore wind farms, testing different construction methods and mooring systems, developing a new offshore-ring system for the open ocean seaweed aquaculture which can sustain rough weather conditions). Mee (2006) expressed concerns with potential conflicts with wind farm operations and maintenance, how the system could be maintained, and how the seaweed could be harvested. Buck and Buchholz (2005) developed a modeling approach for the culture of *Laminaria saccharina* indicating that culture is feasible in high energy environments. In Japan a new culture

method has been developed that is apparently able to withstand strong winds and large waves called the "modified triangular method". Reports state that it is an efficient and profitable seaweed aquaculture system in comparison with traditional mono-line culture methods (Linley et al. 2007). Bergman et al. (2002) suggest that synergies exist between seaweed aquaculture and fisheries that could be developed and applied within offshore sites. In this research, seaweed aquaculture increased associated fish fauna in terms of abundance, species richness, and fish community composition as a result of the additional habitat structure created, rather than the utilization of seaweeds as a direct food resource.

960.4. Harvesting and Culture of Bioactive Compounds

1. Schmitt et al. (2006) studied fouling organisms on the legs of seven oil platforms in the Santa Barbara Channel, California and found that invertebrates, such as sponges, tunicates, and bryozoans, which may contain potentially useful marine natural products, were abundant on offshore oil platforms. Significant biological activity in the crude extracts of a number of species were found in their studies, some of which showed potential to be harvested and processed into new drugs for cancer treatments. However, significant variation was found in the distribution, recruitment and growth of invertebrates among platforms, which suggested that factors such as location and temperature could affect the potential harvest of these organisms for use in the development of marine natural products.

Section 970. Expansion of Ecotourism and Underwater Cemeteries

1. Ecotourism is "responsible travel to natural areas that conserves the environment and improves the welfare of local people" (International Ecotourism Society 2006). Ecotourism is the fastest growing sector of tourism at approximately 26 to 34% per year (Honey 2010).

2. Offshore renewable energy structures may enhance marine tourism in the future by attracting recreational boaters, charter boat clients, cruise ship passengers, and other visitors (Minerals Management Service 2006). Land-based wind farms across North America have received significant interest from tourists. Palm Springs, California windfarms receive an estimated 12,000 tourist visits each year, and wind farms have seen the number of visitors requesting tours climb. (More information on this topic is presented in Chapter 8, Renewable Energy and Other Offshore Development.) Offshore wind farms have increased tourism in the U.K., Denmark (wind farm at Middelgrunden, near Copenhagen), and Ireland (Arlow Offshore Wind Power Plant; see Arklow Offshore Wind Park 2004). A British Wind Energy Association study (BWEA 2006) indicated that tourism increased at U.K. destinations adjacent to offshore wind farms, to the point that visitor centers had been developed at some of these sites. In Denmark, a study found that tourism in areas near wind farms had increased by 25% after project completion (Golubcow 2006). Flynn and Carey (2007), in a study examining the potential economic impacts of an offshore windfarm to South Carolina, assumed that 5,000 tourists a year would visit a farm after construction, with each paying an average $100 per sightseeing trip, generating $500,000 annually.

3. Burial at sea services and locations are changing rapidly, and underwater cemeteries are growing in popularity. Traditionally in the U.S., ashes have to be scattered at least three miles (4.8 km) from shore, and bodies can be given to the sea if the location is at least 600 feet (200 m) deep. Special regulations may also apply to urns and coffins. Local laws may differ; for example, in the Great South Bay, New York it is legal to drop ashes right from the dock. Underwater cemeteries are being constructed. Ashes of the deceased are mixed with concrete. Concrete blocks are dropped to the seafloor to form artificial reefs. Cremated remains are mixed to form different reef structures and columns. The Neptune Memorial Reef, also known as the Atlantis Memorial Reef, is an underwater cemetery located 3.25 miles off the coast of Key Biscayne, Florida. It is the world's largest man-made artificial reef (covering over 56,000 m^2 of seafloor). Phase I of the underwater cemetery holds an estimated 850 remains, with a goal of accommodating at capacity more than 125,000 remains. The Neptune Memorial Reef is designed as both an artificial reef and as a destination for divers (Nolin 2009).

970.1. Development of a Research and Education Center

1. There are no offshore wind farms in the United States, and no offshore research and education centers that can investigate and conduct field-based experimental projects to monitor the construction, performance and environmental interactions of offshore renewable energy developments. There are substantial opportunities to investigate the interactions between potential multiple uses of ocean observations (for example, Northeastern Regional Association of Coastal Ocean Observing Systems

[NERACOOS]), fisheries, aquaculture, reserves, and the ecological, economic, social and technological interactions. It is ventured that a permitted, marine technology research park in an ocean area could attract considerable federal, industry and state funding. The State of Rhode Island, the University of Rhode Island and a windfarm developer have discussed that one or two of the proposed commercial Block Island wind turbines could be used as research turbines. Extension of turbine use to allow use of a portion of the lease area would make progress toward establishment of a research and development area.

2. Some marine scientists have touted the considerable ancillary benefits of increases in non-consumptive use values for research, education, diving, photography, tourism, and conservation of marine biodiversity (Bohnsack 1993; Sobel 1993). Numerous research and development innovations could occur, including measurements of productivity and economic impacts following deployment of artificial reefs (Bohnsack and Sutherland 1985); experimental development of finfish, shellfish and seaweed aquaculture offshore in lease areas (Buck et al. 2004; Rhode Island Sea Grant 2009); and the use of artificial structures that alter nutrient regeneration mixed with aquaculture. Use of ecological design and engineering principles and practices could allow design optimization of energy generation, seafood production, biodiversity, and marine ecosystem health in a research and education center that could potentially benefit all stakeholders. In addition, scientific research could include the development of additional tools for understanding ecosystem function and the impacts of human activities as few such areas exist in New England ocean waters. As such, it is difficult to form a complete understanding of ocean ecosystems and the impacts of various existing and potential new stressors.

3. One model for Rhode Island is an innovative research and development strategy announced in Ireland at a 2010 meeting entitled, “Harnessing Ireland’s Potential as a European and Global Centre for Ocean Technology” (Marine Institute n.d.). Ireland plans to develop 10 “Ocean Innovation Test Platforms” that will allow companies to form partnerships in order to test new concepts, equipment, technologies, and solutions in real-life situations. Called “SMARTOCEAN Innovation Clusters,” they seek to target newly emerging niche markets (marine renewable energy, environmental monitoring, and water management), as well as established markets (oil and gas, aquaculture, maritime transport, tourism, coastal erosion) to develop innovative and competitive production systems and service models and target both niche and high value markets.

Section 980. Summary

1. The Ocean SAMP planning region faces the following challenges and potential threats in the near-term of approximately 10 years which will require consideration of new or revision of existing policies by the CRMC. Short sea shipping is likely to develop rapidly in the region which will increase marine traffic and add to the potential for increased, dispersed pollution inputs to the area. Development of offshore LNG buoys is unlikely in the near-term as southern Rhode Island has no land-based LNG storage infrastructure (exists only in Providence). Aquaculture operations proposing to use offshore energy structures such as wind turbines is unlikely in the near-term since design standards for turbines in the region do not yet exist. Studies will be required to measure impacts of storms and possible hurricanes which will require longer-term monitoring of stresses and wind/wave forcing using load cells, etc. Options for harvesting biofouling and mussels for food and bioactive products and to remove stresses through the development of private partnerships such as that developed by Ecomar, Inc. for oil/gas structures appear feasible in the near-term, but will require additional policy and legal studies. Placement of artificial reefs for commercial and recreational fishing and biodiversity enhancement is feasible, but studies would be needed to ascertain the site-specific effects and concerns over range extensions of invasive species to the offshore. Development of the Ocean SAMP region for additional ecotourism and even for underwater cemeteries and burials is likely in the near-term, which will lead to increased vessel traffic, recreational use, and the need for new policies for burials.

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