Chapter 8: Renewable Energy

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Section 800: Introduction

1. One of the objectives of the Ocean SAMP is to encourage marine-based economic development that meets the aspirations of local communities, and is consistent with and complementary to the state's overall economic development, social, and environmental needs and goals.

2. Obtaining a portion of Rhode Island's energy from renewable sources has been a central theme in the recent energy policies of the state.[1] The justification behind renewable energy development in Rhode Island includes: diversifying the energy sources supplying electricity consumed in the state; stabilizing long-term energy prices; enhancing environmental quality, including the reduction of air pollutants and greenhouse gas emissions; reducing the state's reliance on fossil fuels; and creating jobs in Rhode Island in the renewable energy sector. Renewable energy resources offshore have the greatest potential for utility-scale development to meet Rhode Island's renewable energy goals. The SAMP area has the potential to provide sites for those resources, which is addressed in this chapter, along with a discussion of the potential effects renewable energy development may have on the economics of Rhode Island, natural resources, and existing uses of the SAMP area.

[1] R.I. Gen. Law § 39-26-1 et seq.; R.I. Gen. Law § 42-141-3

Section 810: Renewable Energy Overview

810.1 Increasing Energy Demands and Global Climate Change

1. Demand for electricity in the region and the nation as a whole is projected to increase in the coming decades. For example, the most recent forecast by the U.S. Energy Information Administration estimates that annual electricity consumption will increase from 3,873 terawatt-hours (TWh) in 2008 to 5,021 TWh in 2035. This increase represents a 29% increase in demand, requiring an additional 1,148 TWh of production by 2035 (U.S. Energy Information Administration 2010).[2] To help put this increase energy demand in perspective, 1,148 TWh is enough energy to power over 100 million residential homes for a year.[3] Likewise, the Independent System Operator New England (ISO-NE) forecasts that the overall electricity demand of New England will increase by 10,810 GWh over the next decade, from current levels of 131,315 GWh to 142,125 GWh (see Table 1). Rhode Island accounts for a portion of this increase in energy within the region, as ISO-NE predicts that demand increase from 8,460 GWh in 2009 to 9,025 GWh in 2018, requiring an additional 565 GWh of energy production to meet demand (see Table 1). The largest increase in peak loads is projected during the summer months, when an additional 235 MW of production capacity is expected to be required to meet the 2018 summer demand (ISO New England Inc. 2009a). Increases in energy efficiency, or efforts to decrease energy consumption may lower the amount of energy demanded in the future (see Section 810.2 for a discussion of Rhode Island legislation dealing with energy efficiency). However, if these projections are accurate and demand continues to rise into the future, New England will require greater generation capacity to meet the region's demand.

[2] The capacity of an electric generating unit and the load for electricity use is measured in watts; 1,000 watts is equal to a *kilowatt* (kW), a *megawatt* is 1,000 kWs (MW, 1 million watts), a *gigawatt* is 1,000 MW (GW, 1 billion watts), and a *terawatt* is 1,000 GW (TW, 1 trillion watts). These terms are most commonly used to describe the capacity of an electric generator (e.g. a wind turbine or a power plant). Electricity production and consumption are most commonly measured in *kilowatt-hours (kWh)*. A kilowatt-hour refers to one kilowatt (1,000 watts) of electricity produced or consumed for one hour of time; similarly 1,000 kilowatt-hours is a *megawatt-hour (MWh),*1,000 megawatt-hours is a *gigawatt-hour* (GWh), and 1,000 gigawatt-hours is a *terawatt-hour* (TWh).
[3] This estimate is based on the Energy Information Administration statistic that in 2007, the average monthly residential electricity consumption equaled 936 kWh, which equals 11.2 MWh per year.

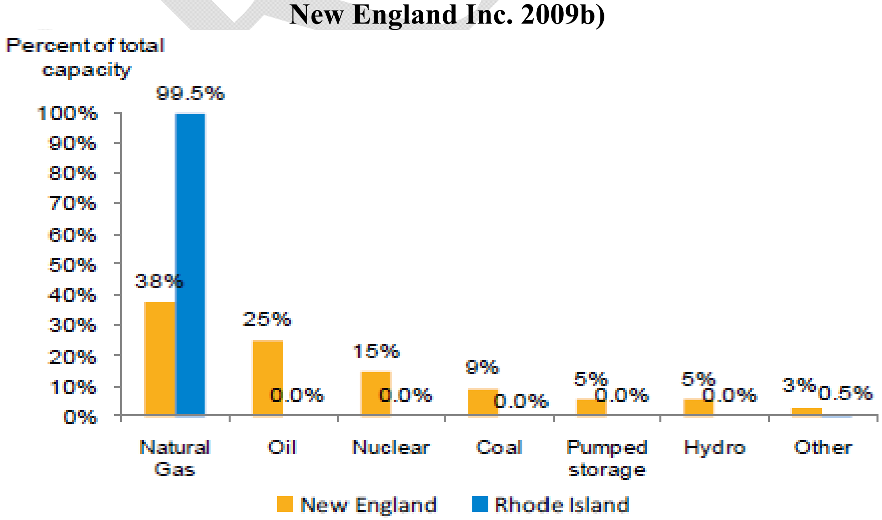
Table 1. Summary of Forecasted Annual and Peak Energy Loads for New England States (ISO New England Inc. 2009a).

	Net Energy for Load (GWh)			Summer Peak Loads (MW)			Winter Peak Loads (MW)		
	2009	**2018**	**Difference**	**2009**	**2018**	**Difference**	**2009**	**2018**	**Difference**
CT	32,710	33,850	1,140	7,500	8,105	605	5,715	5,765	50
ME	11,755	12,610	855	2,075	2,325	250	1,915	1,930	15
MA	60,420	67,095	6,675	12,925	14,455	1,530	10,030	10,505	475
NH	11,660	12,925	1,265	2,450	2,815	365	2,020	2,160	140
RI	**8,460**	**9,025**	**565**	**1,850**	**2,085**	**235**	**1,395**	**1,440**	**45**
VT	6,310	6,625	315	1,075	1,180	105	1,035	1,060	25
Total New England	131,315	142,125	10,810	27,875	30,960	3,085	22,100	22,860	760

* The Net Energy for Load shown in the table is the net generation output within an area, accounting for electric energy imports from other areas and electric energy exports to other areas.
Note: for Summer and Winter Peak Loads, the "reference" or 50/50 forecasted value was used.

2. Currently, fossil fuels supply over 70% of the generating capacity for electricity in New England (see Figure 1). Natural gas and oil are the primary fuels, accounting for more than 60% of the existing capacity. Nearly all (99.5%) generating capacity in Rhode Island is fueled by burning natural gas (ISO New England Inc. 2009b). Gas-fired electrical generating facilities in Rhode Island are located in Burrillville, Providence, Tiverton and Johnston (Rhode Island Office of Energy Resources 2010).

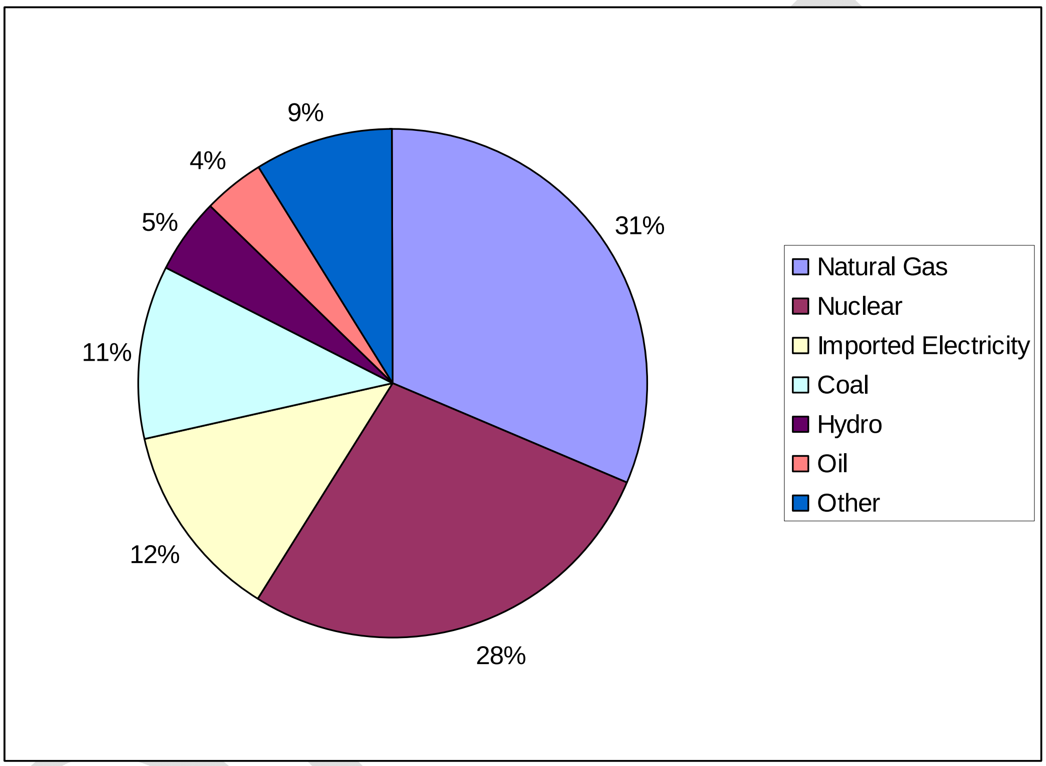
Figure 1. Fuel Sources Used for Electricity Generation in New England and Rhode Island. (ISO New England Inc. 2009b)



3. It is important to note that the energy generated in Rhode Island does not directly supply the energy needs of the state, rather it is fed into the regional electric grid operated by ISO-NE and then distributed to consumers by a distributer. In Rhode Island, National Grid provides electrical transmission and distribution services to approximately 99% of residents, the main

exception being the residents of Block Island who are not currently integrated into the regional utility grid (see below for further discussion). National Grid procures the electricity it supplies to Rhode Island from multiple sources; for the period July 1, 2007 to June 30, 2008 the mix was as follows: natural gas (31.4%), nuclear (27.5%), imported electricity (12.4%), coal (11.2%), hydro power (4.7%), oil (3.8%); a diversity of other sources provided the remaining nine percent (9%), see Figure 2 (Rhode Island Office of Energy Resources 2010).[4]

Figure 2. Energy Sources Supplying Rhode Island Electricity Demand from July 1, 2007, to June 30, 2008 (National Grid Data cited in Office of Energy Resources 2010).



4. Natural gas is not an energy resource indigenous to New England, and therefore must be brought into the region by interstate natural gas pipelines from other states in the Northeast, Texas and Louisiana, the Trans-Canada pipeline from Canada into New York and Vermont, and by the offshore buoy-based offshore LNG receiving facilities Northeast Gateway Deepwater Port located off the coast of Massachusetts (Energy Information Administration 2009; U.S. Department of Energy 2004; Rhode Island Office of Statewide Planning 2002; Excelerate 2010).[5] Petroleum products, home heating oil and transportation fuels, as well as some liquefied petroleum gas are supplied to Rhode Island through the Port of Providence, which is a sub-regional center for the distribution of these fuels (see *Chapter 7 Marine*

[4] Electricity providers do programs for consumers to voluntarily pay a premium to obtain electricity from renewable sources. For example, National Grid in Rhode Island offers the GreenUo program, allowing consumers to request that all or part of their electricity come from renewable sources.

[5] A second offshore LNG facility, Neptune LNG LLC is currently under construction and is expected to be online during 2010. This facility will also provide natural gas to the regional pipeline (GDF Suez Energy North America 2010).

Transportation, Navigation and Infrastructure for further information). See *Chapter 9 Future Uses* for further discussion of the potential future transport of natural gas through the SAMP area.

5. The ISO-NE has stated that over-reliance on natural gas subjects the New England region to substantial price fluctuations that are influenced by a variety of market-based factors (i.e. exercising of natural gas contractual rights, tight gas spot-market trading), and technical factors (i.e. pipeline maintenance requirements and limited pipeline capacity) (ISO New England 2005). The U.S. Department of Energy (2004) also recognized the region's need for increased energy diversity and suggesting renewable energy development as a possible solution.

    > "To alleviate New England's volatile energy market and reduce its over reliance on natural gas, the region needs to pursue an energy policy that is focused on fuel diversity. Increased use of renewable energy will enable New England to diversify the region's energy portfolio, thereby increasing electric reliability and lowering energy costs by utilizing local resources in the generation of electricity." (U.S. Department of Energy 2004, pg. 1)

    Moreover, in the Cape Wind Energy Project Final Environmental Impact Statement, the Minerals Management Service (2009, pg. 1-2) stated that:

    > "Over-reliance on natural gas and other fossil fuel sources (e.g. coal) for the generation of electricity also subjects the region to adverse air quality impacts associated with ground level ozone. There is, therefore, a need for projects in New England that aid in diversifying the region's energy mix in a manner that does not significantly contribute to the region's existing air quality concerns."

    In addition to ozone concerns, increasing energy production through the burning of fossil fuels adds to greenhouse gas emissions. Today, CO_2 emissions in the United States approach 6 billion metric tons annually, 39% of which are produced when electricity is generated from fossil fuels (U.S. Department of Energy 2008; Energy Information Administration 2008). Refer to *Chapter 3 Global Climate Change* for further discussion on CO_2 emissions and the impacts of increased greenhouse gas emissions. See also Section 850.1 for further discussion of renewable energy development and avoided air emissions.

6. Block Island is not currently connected to the mainland utility grid that supplies electricity to the rest of Rhode Island. Instead, the island generates its energy using diesel-powered generators operated by the Block Island Power Company. The fuel is transported by truck aboard the Block Island Ferry (see *Chapter 7 Marine Transportation, Navigation and Infrastructure*), and stored in four 20,000 gallon (75,708 liter) storage tanks located on the island. In 2006, the Block Island Power Company used almost 950,000 gallons (3.6 million liters) of #2 fuel oil to meet the energy demands of Block Island (HDR Engineering Inc. 2007). Currently, there are five generating units, with a total generating capacity of approximately 7.3 MW (HDR Engineering Inc. 2007). As of 2007, Block Island Power Company served a total of 1,742 customers, who use a total of approximately 10.7 GWh of electricity. Based upon the seasonal nature of tourism and island living, the loads on the island vary greatly between winter and summer months. In the summer, peak demand may reach 4MW as a result of all the businesses operating and the large number of visitors. In comparison, the winter peak demand is much lower, measuring approximately 1.5 MW. Rates on Block Island are the highest in Rhode Island and the region as a whole. Rates

generally hover between 30 cents and 40 cents a kilowatt-hour, but in the summer of 2008 it went as high as 62 cents (Rhode Island Public Utilities Commission 2010b), compared to an average electricity rate in Rhode Island of 17.4 cents per kWh (Energy Information Administration 2010). Given the use of diesel and its fluctuating market costs, Block Island Power Company includes a fuel adjustment charge within its rates to cover the carrying costs of fuel (HDR Engineering Inc. 2007). See Section 840.3 for more information.

810.2 Renewable Energy Statutes, Initiatives and Standards in Rhode Island

1. Developing renewable energy in Rhode Island is one option to help meet the increasing demand for energy, to add to the energy mix of the state and to also help mitigate the effects of global climate change by reducing the amount of greenhouse gases emitted into the atmosphere from energy production. Legislation and initiatives adopted in Rhode Island, including the Renewable Energy Standard[6], the Systems Reliability and Least-Cost Procurement Act[7], the Regional Greenhouse Gas Initiative (RGGI), and the Long-Term Contracting Standard for Renewable Energy[8] recognize the need for greater diversification of the state's energy resources and a commitment to renewable energy development in the state.

2. Enacted in 2004, the Renewable Energy Standard (RES) mandates a minimum share of electricity generation within the state come from renewable sources. As stated within the RES:

   > "It is in the interest of the people, in order to protect public health and the environment and to promote the general welfare, to establish a renewable energy standard program to increase levels of electric energy supplied in the state from renewable resources. More specifically, Rhode Island's RES has the goals of (i) diversifying the energy sources supplying electricity consumed in the state, (ii) stabilizing long-term energy prices, (iii) enhancing environmental quality, including the reduction of air pollutants, carbon dioxide emissions, that adversely affect public health and contribute to global warming, and (iv) creating jobs in Rhode Island in the renewable energy sector."

3. Twenty-nine other states, plus the District of Columbia, have enacted similar standards (see Figure 3 and Table 2). Under these standards, electricity retailers must meet a certain percentage of total energy production from renewable sources through the use of Renewable Energy Credits (RECs). Energy retailers can obtain RECs by: (i) generating renewable energy themselves, (ii) purchasing energy from a renewable energy producer, or (iii) buying credits from a renewable energy producer without purchasing the electricity from them directly (Redlinger et al. 2002).

[6] R.I. Gen. Law § 39-26-1 et seq.
[7] R.I. Gen. Law § 39-1-27.7
[8] R.I. Gen. Law § 39-26.1-1.

Figure 3. U.S. States with Renewable Energy Standards (DSIRE 2010).

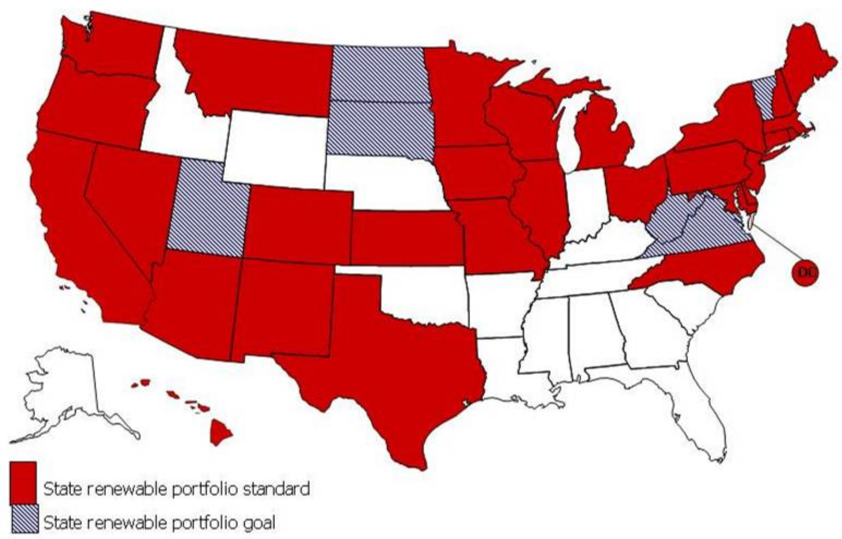


Table 2. Summary of all State Renewable Energy Standards (DSIRE 2010).

State	Amount	Year
Arizona	15%	2025
California	33%	2030
Colorado	20%	2020
Connecticut	23%	2020
District of Columbia	20%	2020
Delaware	20%	2019
Hawaii	20%	2020
Iowa	105 MW	
Illinois	25%	2025
Massachusetts	15%	2020
Maryland	20%	2022
Maine	40%	2017
Michigan	10%	2015
Minnesota	25%	2025
Missouri	15%	2021
Montana	15%	2015
New Hampshire	23.8%	2025
New Jersey	22.5%	2021
New Mexico	20%	2020
Nevada	20%	2015
New York	24%	2013
North Carolina	12.5%	2021
North Dakota*	10%	2015
Oregon	25%	2025
Pennsylvania	8%	2020
Rhode Island	16%	2019
South Dakota*	10%	2015
Texas	5,880 MW	2015
Utah*	20%	2025
Vermont*	10%	2013
Virginia*	12%	2022
Washington	15%	2020
Wisconsin	10%	2015

4. Rhode Island's Renewable Energy Standard, enacted in June 2004, requires electric utility providers within the state to supply 16% of their retail sales from renewable resources by the end of 2019. The target began at 3% by the end of 2007, increasing by an additional 0.5% per year through 2010, an additional 1% per year from 2011 through 2014, and an additional 1.5% per year from 2015 through 2019 (see Figure 4 and Table 3). In 2020, and in each year thereafter, the minimum renewable energy target established in 2019 must be maintained unless the Rhode Island Public Utilities Commission determines that the standard is no longer necessary. Electric distributors may meet these targets by purchasing certificates from approved renewable energy generators, paying Alternative Compliance Credits to the Rhode Island Renewable Energy Development Fund (equal to $60.92/MWh in 2009), or a combination of both (Rhode Island Public Utilities Commission 2009; DSIRE 2010). If renewable energy credits are purchased, the Renewable Energy Standard requires that a certain percentage come from new sources (see Table 3). In addition, the legislation that

created Rhode Island's Renewable Energy Standard also directed the Rhode Island State Energy Office to authorize the Rhode Island Economic Development Corporation to integrate and coordinate all renewable energy policies within the state to maximize their impact.

Figure 4. Renewable Energy Targets under the Rhode Island Renewable Energy Standard 2007-2020.

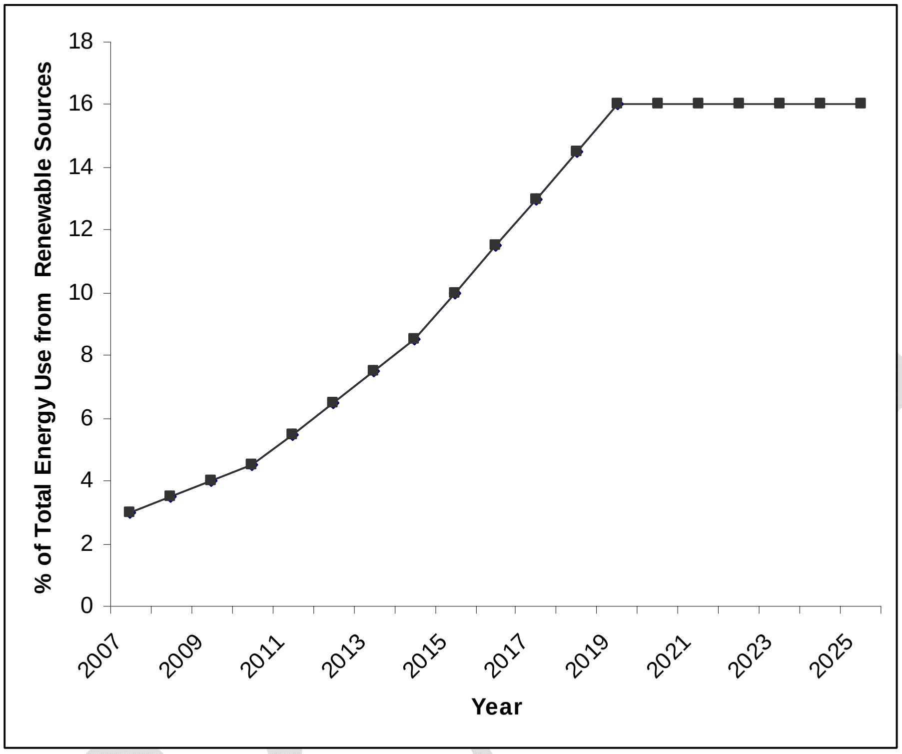
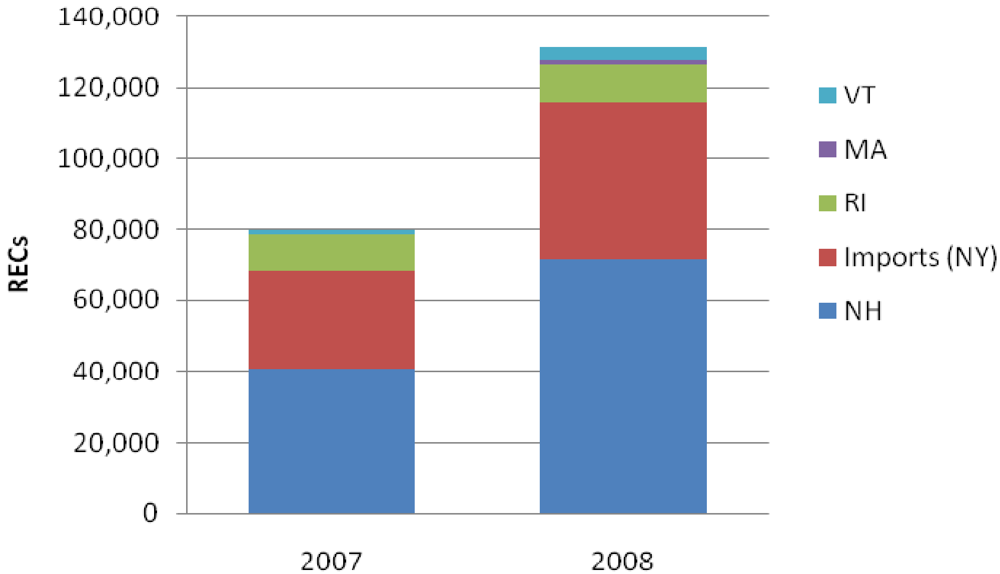


Table 3. Renewable Energy Targets under the Rhode Island Renewable Energy Standard 2007-2020 (Rhode Island Public Utilities Commission 2010a).

Year	Total Target Percentage	Minimum Percentage of Target that must be obtained from **New** Renewable Energy Sources	Actual* or Forecasted Amount of New Renewable Energy Needed to Satisfy RES Requirements (MWh)
2007	3.0	1.0	83,357*
2008	3.5	1.5	124,190*
2009	4.0	2.0	168,389
2010	4.5	2.5	212,064
2011	5.5	3.5	299,097
2012	6.5	4.5	387,174
2013	7.5	5.5	476,416
2014	8.5	6.5	566,822
2015	10.0	8	701,509
2016	11.5	9.5	838,113
2017	13.0	11	976,318
2018	14.5	12.5	1,116,434
2019	16.0	14	1,258,274
2020 and thereafter	16.0	14	1,266,191

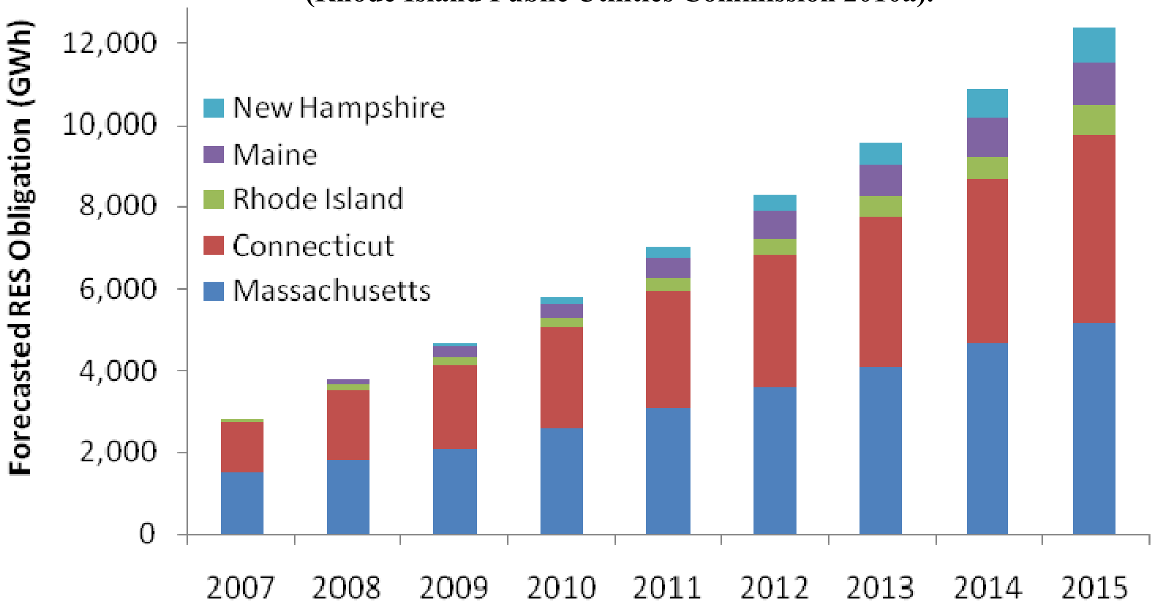
5. In 2008, only 8% of the new renewable energy credits used to meet the Renewable Energy Standard originated from sources within Rhode Island (Rhode Island Public Utilities Commission 2010a). The majority of the new renewable energy generation being used to meet the 2007 and 2008 target is located in New Hampshire and New York (see Figure 5).

Figure 5. Contribution of New Renewable Energy Generation Used to Meet the Rhode Island Renewable Energy Standard in 2007 and 2008 (Rhode Island Public Utilities Commission 2010a).



6. Over the next decade, the requirements for new renewable energy sources to meet Rhode Island's Renewable Energy Standard will increase (see Table 3). Similarly, the demand for renewable energy generation in the region will increase as a result of the targets set by other states in New England (see Figure 6). As a result of this increasing demand for renewable energy credits, development of renewable energy facilities will be necessary. Alternatively, if there is not a sufficient amount of renewable energy generation to fulfill the targets, energy distributors will be required to make payment into the appropriate state renewable energy fund.

Figure 6. Projection of the Demand for New Renewable Energy Needed to Meet the Renewable Energy Targets Set By All New England States (Rhode Island Public Utilities Commission 2010a).



7. In 2006, Rhode Island then adopted the System Reliability and Least-Cost Procurement Act requiring the Rhode Island Public Utilities Commission to establish standards and guidelines related to energy diversification (system reliability procurement) and energy efficiency and conservation (least-cost procurement). System reliability procurement refers to increasing the diversity in Rhode Island's energy portfolio, by diversifying the energy supply to include sources such as renewable energy. Least-cost procurement refers to using energy efficiency and energy conservation measures that are prudent and reliable when such measures are lower cost than the acquisition of additional supply. Moreover, under this legislation, each electrical distribution companies must submit plans for how the company plans to reach the standards and guidelines outlined by the Rhode Island Public Utilities Commission. This plan (which must be updated every three years) must include measurable goals and targets for multiple criteria including efficiency and renewable energy.

8. Following the enactment of the RES and the System Reliability and Least-Cost Procurement Act, in 2007 Rhode Island entered into the Regional Greenhouse Gas Initiative (RGGI). RGGI is an agreement among ten Northeastern and Mid-Atlantic States (Connecticut, Delaware, Maine, Maryland, Massachusetts, New Jersey, New Hampshire, New York, Rhode Island and Vermont) to reduce greenhouse gas emissions from power plants. Participating States have committed to cap and then reduce the amount of carbon dioxide that certain power plants are allowed to emit, limiting the region's total contribution to atmospheric greenhouse gas levels. This initiative is implementing the first mandatory cap-and-trade program in the United States to reduce greenhouse gas emissions (RGGI 2010). Beginning in 2011, RGGI will limit the total amount of CO_2 emissions from conventional fossil-fuel power plants in all ten states to an amount called the "cap," currently set at 188 million tons of CO_2 per year (RGGI 2010). While there is no limit on the amount of CO_2 that any particular power plant can emit, the combined CO_2 emissions from all covered power

plants within the region cannot exceed this cap. Under this system, every regulated power plant is required to own one permit (called an "allowance") for each ton of CO_2 that it emits. Allowances can be traded within a market, at any time before a compliance deadline, though the individual states control the total number of allowances available within their state to guarantee that the cap is not exceeded (RGGI 2010).

9. The most recent piece of legislation enacted within Rhode Island regarding renewable energy is the Long-Term Contracting Standard for Renewable Energy that was signed into law in 2009. Under this act energy distributors in Rhode Island (i.e. National Grid) are required to sign 10- to 15-year contracts to buy a minimum of 90 MW of its electricity load from renewable developers and up to 150 megawatts from utility-scale offshore wind energy facilities developed off the coast of Rhode Island.[9] These long-term contracts, referred to as Power Purchase Agreements, outline how much, and at what price, energy from a renewable energy producer will be purchased by a utility company. Power purchase agreements provide assurances to developers that the power produced by a project will be purchased at a stated price, which may in turn aid a developer in obtaining financing for a project. In addition, power purchase agreements define the purchase price of the renewable energy over many years, allowing utility companies to identify energy costs from the renewable source well in advance.

10. This body of existing laws and initiatives recognizes the importance of renewable energy development and energy diversification in Rhode Island, as well as the importance of reducing greenhouse gas emissions that contribute to global climate change. Given the commitment Rhode Island has exhibited to renewable energy through the passage of these laws and initiatives, the following section examines what sources of renewable energy hold the greatest potential for future development.

810.3 Renewable Energy Sources in Rhode Island

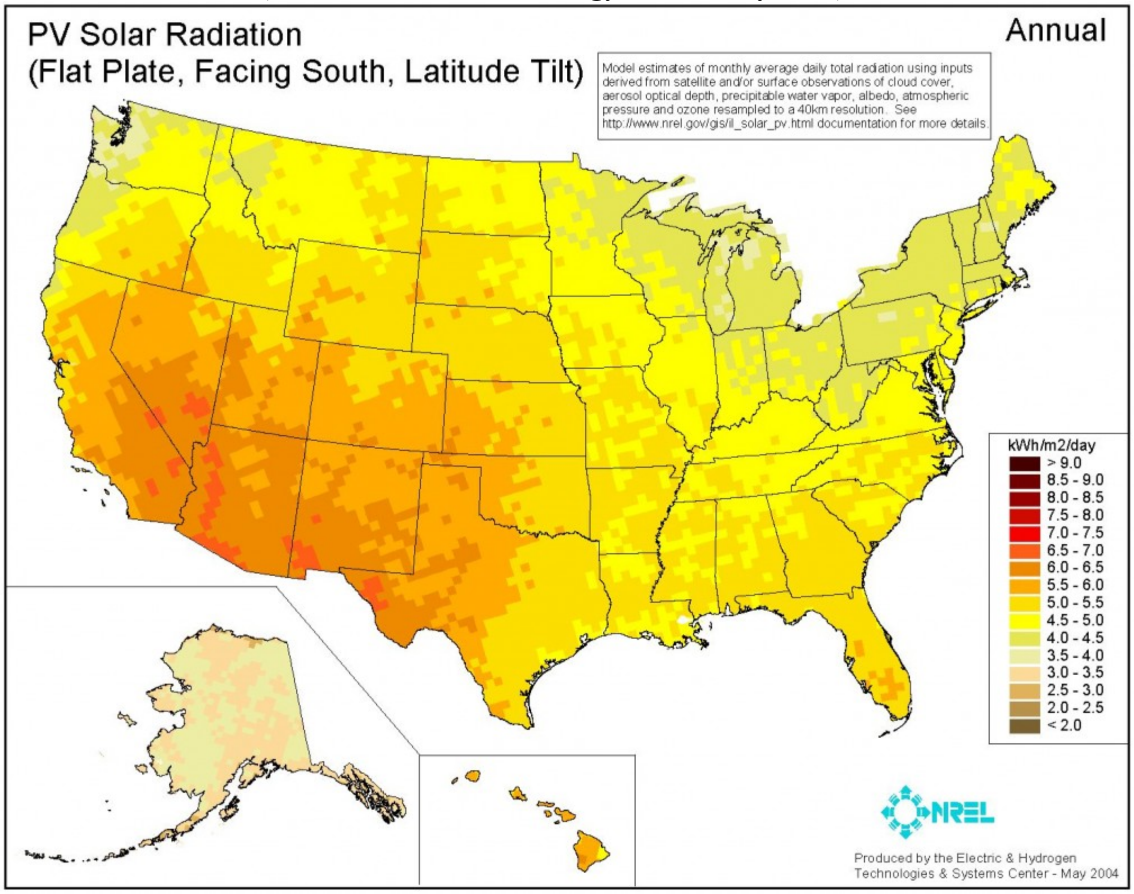
1. The U.S. Department of Energy has defined renewable energy as ‘energy derived from natural sources that replenish themselves over short periods of time’ (U.S. Department of Energy et al. 2004, pg. 4). These resources include the sun, wind, moving water, organic plant and waste material (biomass), and the earth’s heat (geothermal). Landfill gas (LFG) (i.e., the gas that results from decomposition in landfills and is collected, cleaned, and used for generation or is vented or flared) is also often regarded as a renewable resource (U.S. Department of Energy et al. 2004). In Rhode Island not all of these sources of renewable energy are capable of supporting utility-scale energy projects. Therefore, in order to determine which type of renewable energy technology can best meet the renewable energy goals of the state, the resource potential must be examined.

2. Energy from the sun may be converted to other more usable energy forms through a variety of demonstrated solar technologies including thermal and photonic systems. Solar thermal technologies first convert solar energy to heat (such as heating water for residential or commercial use), whereas solar photonic technologies directly absorb solar photons (i.e. particles of light that act as individual units of energy) converting photon energy to electricity

[9] R.I. Gen. Law §39-26.1

through the use of a photovoltaic [PV] cell. Due to Rhode Island's northern latitude, low elevation, and frequency of overcast or cloudy days, the potential for large scale solar energy is limited (Rhode Island Office of Energy Resources 2010). Residential and small scale commercial use of solar thermal and photo-voltaic energy may be feasible, depending on site-specific conditions, as smaller scale projects require less overall resource abundance (Rhode Island Office of Energy Resources 2010). Resource assessments performed by the U.S. National Renewable Energy Laboratory (see Figure 7) suggest that the highest concentrations of solar energy in the U.S., with the potential to power large-scale electric generation facilities, are located in the southwest sections of the country. Average annual photovoltaic solar radiation for Rhode Island and the New England region range between 4 to 5 kWh per square meter per day; 6 kWh per square meter per day has been used as the screening criteria to eliminate marginal and less desirable solar energy sites (U.S. Department of the Interior Bureau of Land Management and U.S. Department of Energy, Energy Efficiency and Renewable Energy 2003). Accordingly, Rhode Island does not experience sufficient solar radiation to make utility-scale solar power a viable option.

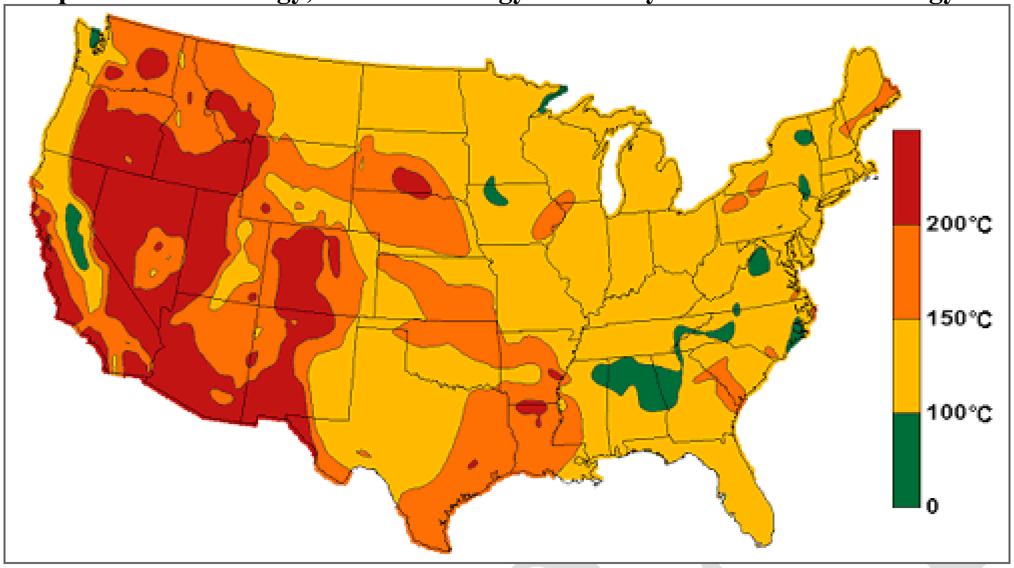
Figure 7. Average Annual Photovoltaic Solar Radiation in the United States (National Renewable Energy Laboratory 2004).[10]



3. Geothermal energy is energy derived from the natural heat within the earth. For commercial use, a high temperature geothermal reservoir (greater than 150°C [302°F]) capable of providing hydrothermal (hot water and steam) resources is necessary. These geothermal reservoirs are located in areas of the country where the earth's naturally occurring heat flow is near enough to the earth's surface to bring steam or hot water to the surface (U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy 2010). A map of the geothermal resources in the United States below shows the estimated subterranean temperatures at a depth of 6 kilometers (3.73 miles) (see Figure 8). Areas that have the greatest resource potential for utility-scale energy production include the Geysers Region in Northern California, the Imperial Valley in Southern California, and the Yellowstone Region in Idaho, Montana, and Wyoming (Idaho National Laboratory 2010). In Rhode Island, temperatures 6 km (3.73 miles) below the surface range between 100°C and 150°C (212°F and 302°F). Therefore, geothermal energy has the potential for small-scale commercial and residential applications, but not as a utility-scale source for electrical generation (Rhode Island Office of Energy Resources 2010).

[10] These maps provide monthly average daily total solar resource information on grid cells of approximately 40 km by 40 km in size. The insolation values represent the resource available to a flat plate collector, such as a photovoltaic panel, oriented due south at an angle from horizontal to equal to the latitude of the collector location.

Figure 8. U.S. Geothermal Resource Map at a Depth of 6 km
(U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy 2010).[11]



4. A related process called Ocean Thermal Energy Conversion (OTEC) uses the heat energy stored in the earth's oceans to generate electricity. OTEC is a viable renewable energy source in areas where the thermal gradient between the surface and a depth of 1,000 meters (0.62 miles) is at least 22°C (71.6° F) (Pelc and Fujita 2002). This technology has the greatest potential for energy production in tropical coastal areas, roughly between the Tropic of Capricorn and the Tropic of Cancer (U.S. Department of Energy 2010b). The difference in temperature between the surface and bottom waters in the SAMP area range between approximately 0-2°C (32-36°F) in the winter months and 10°C (50°F) in the summer months (Codiga and Ullman 2010a; 2010b; 2010c). As a result, OTEC technology is not a viable alternative energy source for Rhode Island. For more information on the water temperature in the SAMP area see *Chapter 2 Ecology of the Ocean SAMP Region*.

5. Wave energy uses energy of moving waves to generate electricity. The greatest potential for wave energy exists where the strongest winds and larger fetch are found, which in general corresponds to temperate latitudes between 40° and 60° north and south (Pelc and Fujita 2002). Furthermore, because global winds tend to move west to east across ocean basins, wave resources on the eastern boundaries of oceans also tend to be greater than those on the western edges since the fetch is longer (Pelc and Fujita 2002; Musial 2008a) (see Figure 9). Therefore, in the U.S. the greatest potential for wave energy development occurs on the west coast as a result of the wind resources that move west to east across the Pacific Ocean (Musial 2008a; Hagerman 2001). Musial (2008a) estimates that the entire New England and Mid-Atlantic coasts have approximately only one-tenth the wave resources estimated for the southern coast of Alaska (see Table 4). Further studies examining the wave energy potential off Southern New England have determined that the greatest resource potential for the area

[11] To determine the Earth's internal temperature at any depth below the capabilities of normal well drilling, multiple data sets are synthesized. The data used for this figure are: thermal conductivity, thickness of sedimentary rock, geothermal gradient, heat flow, and surface temperature.

exists far offshore (beyond the SAMP area boundary) because in nearshore areas there is not adequate fetch for winds out of the west to build up large waves. Exposed waters north of Cape Cod and within the Gulf of Maine were shown to have the greatest annual average significant wave height (approximately 2.0 meters [6.6 feet])(Hagerman 2001). Asher et al. (2008) found that the significant wave height for a site in Rhode Island Sound south of Block Island measured approximately 1.2 m (3.9 feet) over 20 years, and 8.4 m (27.6 feet) in extreme wave events. Closer to shore within Rhode Island Sound, Grilli et al. 2004 determined that the significant wave height at two locations equaled 1.04 m and 1.11 m (3.4 and 3.6 feet) (see *Chapter 2 Ecology of the SAMP Area* for further discussion on waves in the SAMP area). A rough estimate of the average power potential from wave energy off of Block Island has been cited as 5.7 kW/m (Spaulding 2008). Researchers have suggested that because of the current state of technology, it may not be economically viable or cost-effective to try to generate energy from the present resource capacity (e.g. Hagerman 2001; Spaulding 2008; Rhode Island Office of Energy Resources 2010). However, this may change in the future with technological advancements.

Figure 9. Global Average Annual Wave Power Potential (kW/m) (Fugro OCEANOR AS 2008).

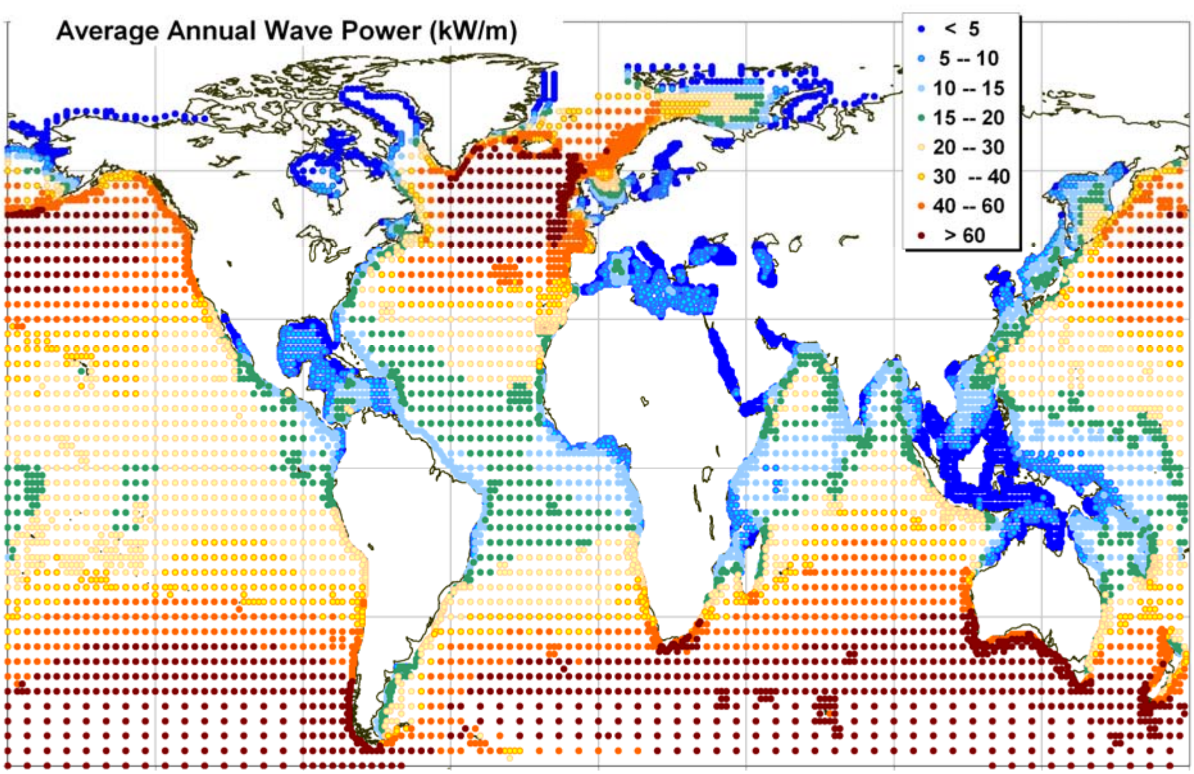
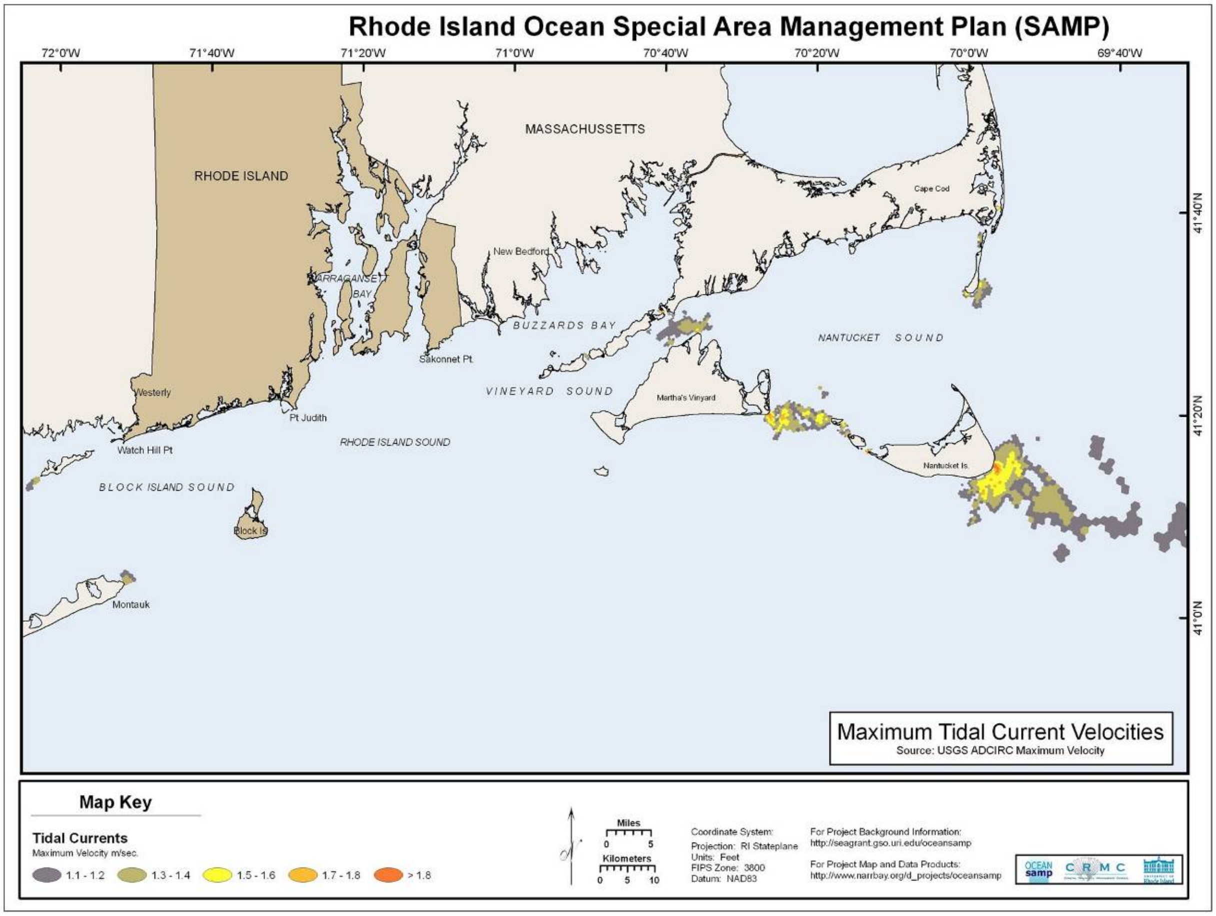


Table 4. Wave Resources in the United States (Musial 2008a)

US Wave Resource Regions (>10kW/m)	TWh/yr
New England and Mid-Atlantic States	100
Northern California, Oregon and Washington	440
Alaska (exclusive of waves from the Bering Sea)	1,250
Hawaii and Midway Islands	330

6. Tidal energy produces kinetic energy from the rise and fall of the tides. The availability of tidal energy is very site specific, as tidal range and current velocity is amplified by factors such as shelving of the sea bottom, funneling in estuaries, reflections by large peninsulas, and resonance effects when tidal wave length is about 4 times the estuary length (Pelc and Fujita 2002). Utility-scale tidal energy requires large tidal ranges and strong tidal currents to produce sufficient energy to be feasible. In stream tidal energy typically requires velocities greater than 1.5- 2 m/sec [3-4 knots] (Spaulding 2008; Pelc and Fujita 2002). In the SAMP area, the mean tidal range equals 1.0 meters [3.28 feet] and tidal currents below 1 m/s (2.2 mph); see Figure 10 below (see also *Chapter 2 Ecology of the SAMP Region* for further discussion). Potential sites for tidal energy may exist within Narragansett Bay, or surrounding the SAMP area boundary (e.g. in and around Nantucket Sound or Long Island Sound); however, utility-scale tidal energy is not currently feasible for development in the SAMP area (Spaulding 2008).

Figure 10. Map of Maximum Tidal Current Velocities of the SAMP Area and Surrounding Waters.

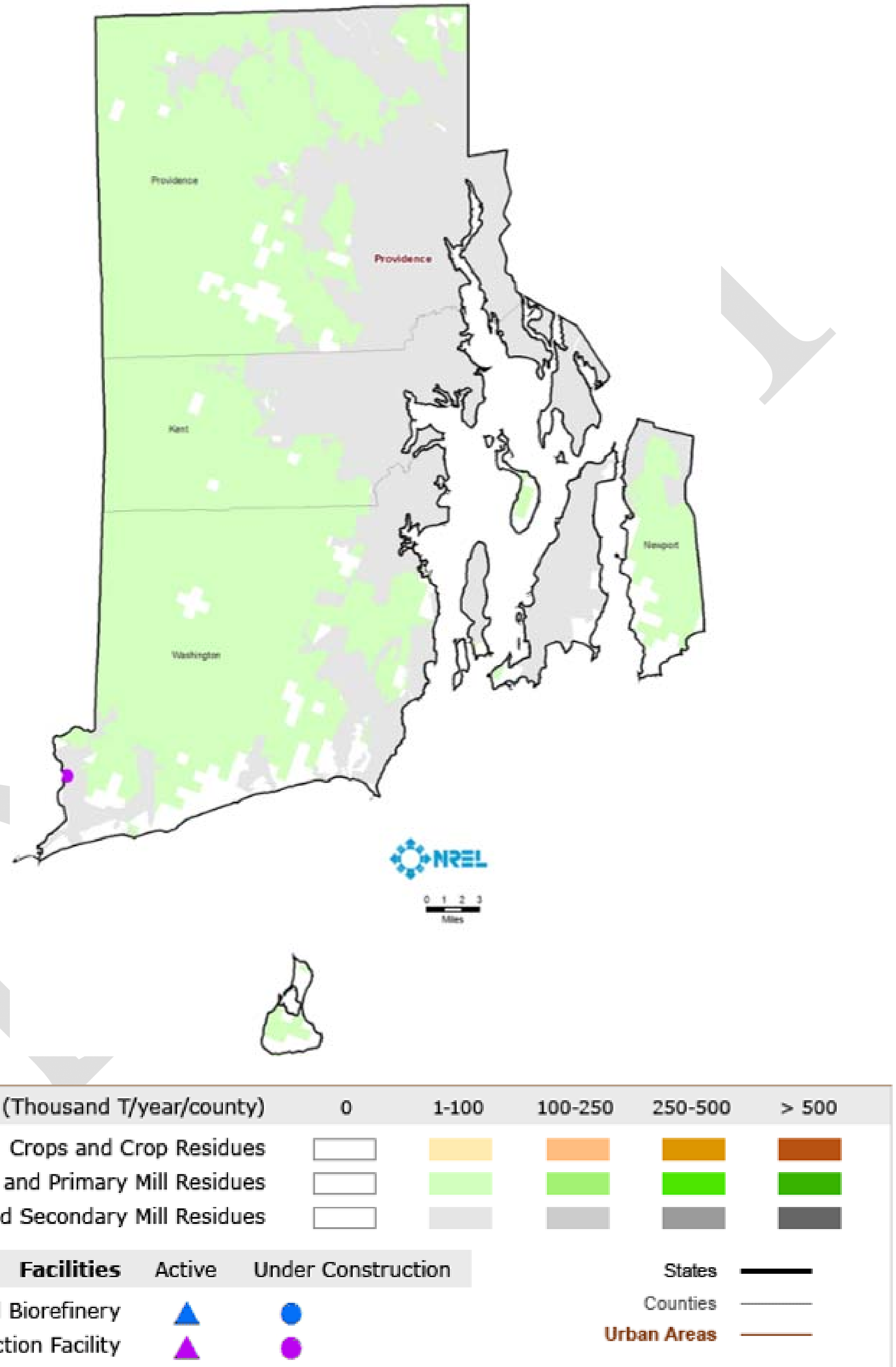


7. Rhode Island also lacks the freshwater resources for large-scale hydropower. A 1995 study by the Idaho National Laboratory estimated that Rhode Island has only 11.5 to 13.5 MW of energy potential and that essentially all that potential occurred at sites already developed for other purposes (Francfort 1995). Only three sites, representing 1.3-1.6 MW of energy potential were undeveloped and therefore had the potential for any future hydropower production (Francfort 1995).

8. Biomass resources from wood, crops, manure, and some garbage may be used to generate renewable energy either through burning directly or by converting the biomass into other useable forms of energy such as methane gas. Currently, Rhode Island does produce some energy from methane captured from the state's landfill. As of 2005, over 90% of the methane gas produced from the Rhode Island Central Landfill has been captured and used to produce over 20 MW of power each year (Rhode Island Resource Recovery Program 2007). Additional sources of biomass in Rhode Island are not sufficient enough to support utility-scale energy production. For example, even though the western part of the state is more sparsely populated, there are neither large tracts of land for timber management, nor industries that use wood for paper production or lumber to generate wood waste as a by-product (Rhode Island Office of Energy Resources 2010) (See Figure 11). However, while wood is not used in energy production, it is used for home heating in Rhode Island (Rhode Island Office of Energy Resources 2010). Furthermore, an assessment of Rhode Island's

biomass resources performed by the National Renewable Energy Laboratory, illustrates that crops and agricultural byproducts are not abundant enough in the state to support utility-scale biomass energy production. See Figure 11.

Figure 11. National Renewable Energy Laboratory Assessment of Rhode Island Biomass Resources (U.S. Department of Energy Office of Energy Efficiency and Renewable Energy 2010).



9. The remaining source of potential renewable energy to be evaluated in Rhode Island is wind power. Wind power converts the energy of the blowing wind into usable electricity and may be developed both onshore and offshore. As a renewable resource, wind is classified according to wind power classes, which are based on typical wind speeds (see Table 5). These classes range from Class 1 to Class 7, with Class 1 having the slowest rated wind speeds and the least power-generating capability. In general, at 50 meters (164 feet) altitude, wind power Class 4 or higher is considered suitable for generating wind power with large turbines (Brower 2007; U.S. Department of Energy Office of Energy Efficiency and Renewable Energy 2010). With current advances in technology, locations in Class 3 areas may also be suitable for utility-scale wind development. Also, depending on location and possible wind shear, particular locations in the Class 3 areas could have higher wind power class values at heights over 50 meters (164 feet) (U.S. Department of Energy Office of Energy Efficiency and Renewable Energy 2010).

Table 5. Defined Wind Power Classes
(U.S. Department of Energy Office of Energy Efficiency and Renewable Energy 2010).

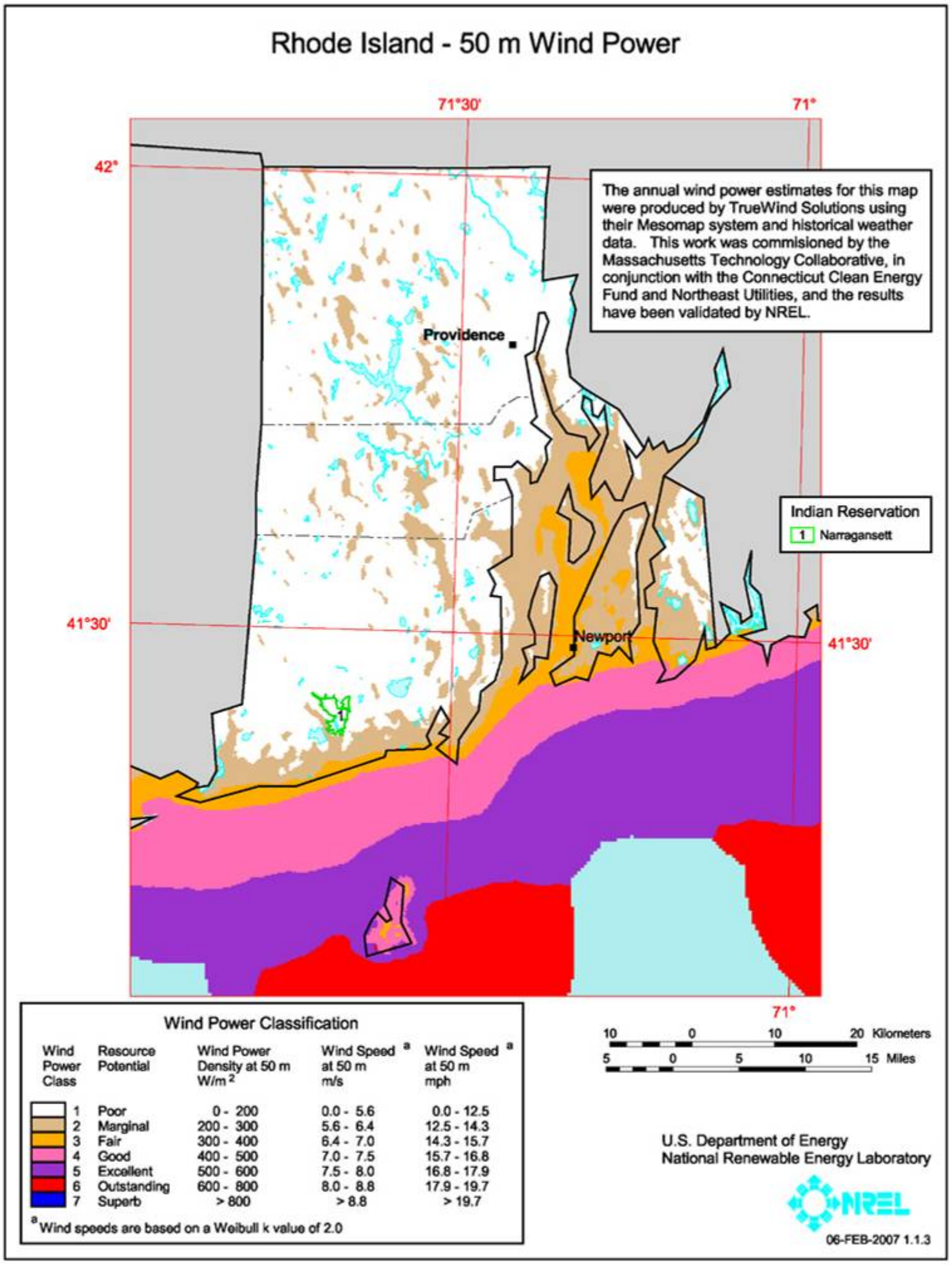
Wind Power Class	Wind Power Density (Watts/m^2) at 50 m*	Wind Speed at 50 m*	
		m/s	mph
1	0-200	0 - 5.6	0 – 12.5
2	200-300	5.6 - 6.4	12.5 – 14.3
3	300-400	6.4 - 7.0	14.3 – 15.7
4	400-500	7.0 - 7.5	15.7 – 16.8
5	500-600	7.5 - 8.0	16.8 – 17.9
6	600-800	8.0 - 8.8	17.9 – 19.7
7	>800	>8.8	>19.7
* Note 50 meter hub height is used here to define classes, however, heights above 50 m will give higher wind speeds and hence higher power output.			

10. The U.S. Department of Energy's National Renewable Energy Laboratory mapped the wind resources of Rhode Island at a height of 50 meters (164 feet), both onshore and offshore, using data provided by AWS TrueWind (see Figure 12). Onshore the wind power classes range from 1 to 3, with inland Rhode Island characterized as having primarily class 1 wind resources. Coastal areas and Block Island have the greatest onshore wind resources, characterized by class 3 to class 5. As a result, some coastal locations may have wind regimes feasible for community or small-scale wind power projects (Rhode Island Office of Energy Resources 2010). Offshore wind resources have been classified as class 3 or 4 in nearshore areas, increasing to class 5 or 6 further offshore. The difference is largely explained by the effect of surface roughness (Brower 2007). Land surfaces, especially forested areas exert friction on the wind, greatly reducing wind speeds near the surface. As the prevailing winds move offshore above the sea surface, the frictional effect of land is removed, causing the speed near the surface to increase (Brower 2007).[12] If Rhode Island had similar topography to the Great Plains, mostly open farmland, mean wind speeds would be at least 1 m/s higher (Brower 2007).[13] As a general rule, the power output of a wind turbine

[12] The roughness of the sea surface is on the order of 10^{-4} versus 1 to 6 over trees.
[13] Brower provides this caveat regarding large scale wind resource mapping: "It should be emphasized that the mean wind speed or power at a site may differ substantially from the predicted values if there are differences in the elevation, exposure, or surface roughness compared to that assumed by the wind mapping system. The map estimates were developed using 1:100,000 scale topographical and land cover data from the US Geological Survey."

increases by the cube of wind speed, therefore even small increases in wind speed over the SAMP area may result in an exponentially greater amount of energy production (Wizelius 2007). This resource assessment suggests that the greatest utility-scale wind power potential exists offshore, where the wind speeds reach speeds of 7.5 to 8.8 m/sec (16.8 to 19.7 mph), capable of generating 500-800 W/m^2. Further analysis of this data was performed to map wind speeds in the SAMP area and is discussed in greater detail in Section 830.1. See also *Chapter 2 Ecology of the Ocean SAMP Region* for more information on wind.

Figure 12. Map of Wind Power Potential in Rhode Island (U.S. Department of Energy Office of Energy Efficiency and Renewable Energy 2010).[14]



11. The resource assessment presented in Figure 12 supports the findings of the *RIWINDS Phase I Wind Energy Siting Study* commissioned by the Rhode Island Office of Energy Resources. The study, completed by Applied Technology and Management Inc., concluded in April 2007 that the goal of meeting 15 percent of Rhode Island's energy needs (equivalent to 400-

[14] This map only illustrates the wind resources of Rhode Island out to the territorial sea border. The lack of data displayed in each of the lower corners of the map is a result of these areas lying outside the territorial sea border, and not because no wind resources exist in those areas.

450 MW) with wind energy was achievable, and that 98 percent of the wind opportunity is offshore (ATM 2007).

12. In conclusion, of all renewable energy sources available in Rhode Island, wind power has the greatest potential to support utility-scale energy production. While other renewable resources may be used in residential or small-scale commercial installations, to meet the targets set forth by the Rhode Island Renewable Energy Standard, the most feasible option is offshore wind energy.

810.4 No Action Alternative

1. Alternatively, if offshore wind energy development did not occur in the SAMP area, the increased demand for electricity in Rhode Island and the New England region as a whole would need to be met with the development of one or more generating facilities, and/or adopting energy conservation measures to lower future demand. Alternative methods of energy generation may include: conventional energy generation facilities (e.g. gas-fired; coal; or oil-fired), renewable energy facilities located outside of Rhode Island, or a combination of both.

2. Generation facilities fueled by fossil fuels such as natural gas, coal or oil produce pollutants including: NO_x which may contribute to ground level ozone and acid rain; volatile organic compounds and carbon monoxide, as a result of incomplete fuel combustion; SO_2 which may contribute to acid rain; particulate matter which has been attributed to a variety of human health effects such as respiratory ailments, and; the emission of CO_2 a green house gas (Minerals Management Service 2009a, U.S. Department of Energy 2008). A single 1 MW turbine operating for one year displaces approximately 1,800 tons of carbon dioxide, the primary global warming pollutant based on the current average U.S. utility fuel mix. Alternatively, to generate the same amount of electricity as a single 1-MW turbine operating for one year, using the average U.S. utility fuel mix, would mean emissions of 9 tons of sulfur dioxide and 4 tons of nitrogen oxide each year (AWEA 2009). While there are potential impacts from offshore wind energy development, in many cases impacts tend to be localized and temporary, whereas climate change is wide spread and on a magnitude not found from any other potential impact. For a further discussion on the emissions that may potentially be avoided with offshore wind energy development see Section 850.1. More information on the impacts of CO_2 emissions and global climate change on Rhode Island and the SAMP area see *Chapter 3 Global Climate Change*.

3. In addition, continued reliance of Rhode Island and the region on fossil fuels, subject consumers to continued price volatility in the energy market. Additional natural gas-fired facilities may potentially result in greater use of the SAMP area by Liquefied Natural Gas tankers. See *Chapter 9 Other Future Uses* for further discussion of future use of the SAMP area by Liquefied Natural Gas tankers.

Section 820: Utility-Scale Offshore Wind Energy

1. Interest in offshore wind energy as an alternative commercial energy source in the United States has increased recently. Reasons include rising energy prices, uncertainties surrounding oil supply, global climate change concerns, opportunities for local economic and employment growth, and the demonstrated viability of offshore wind farms in Europe. The New England region is particularly vulnerable to energy supply and price volatility because the region has virtually no indigenous supply of natural gas and oil, which are responsible for a large fraction of the region's energy generation (see Section 810.1).

2. Generating wind power offshore has a number of distinct advantages. First, offshore wind turbines can generate power close to coastal load centers where demand for energy is high, electrical rates are high, but space for new power facilities is often limited.

3. Second, placing wind turbines offshore avoids the constraints on size that onshore turbines face, allowing projects to take advantage of economies of scale and increase production efficiency (Robinson and Musial 2006). Offshore the largest wind turbines can be used, turbines much larger than those used onshore, with a much greater capacity (see Section 820.2 for more information). Turbines used offshore can be transported and delivered to a project site using large carriers and barges and, therefore, are not limited by the physical constraints of land-based transportation sytsems (Musial 2008b; Wizelius 2007).

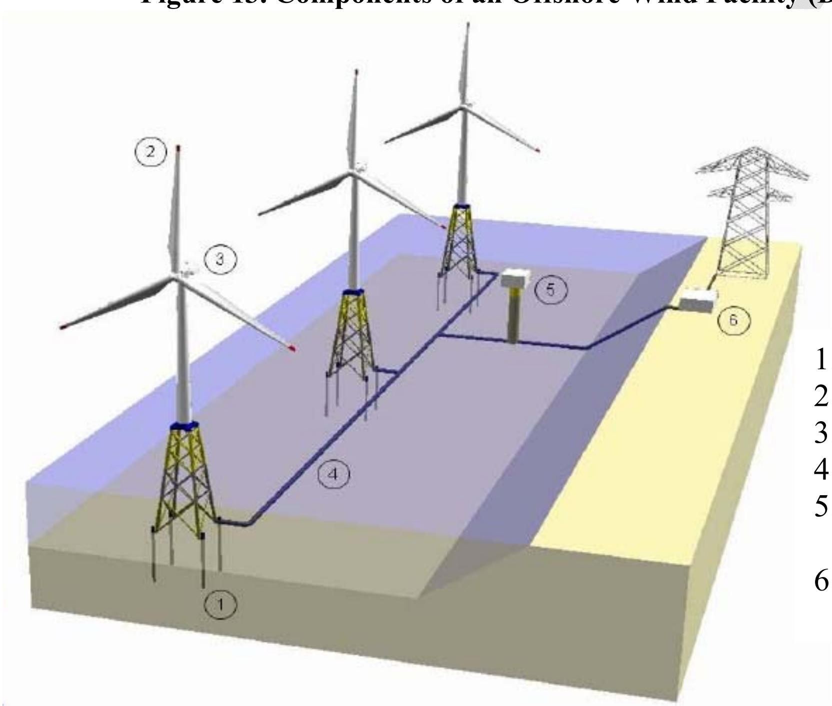
4. Third, offshore wind is stronger and more consistent than onshore wind, further increasing the amount of power that can be produced offshore. Since the power output of wind turbines increases by the cube of wind speed, slight increases in wind speed produce large increases in the amount of potential energy production (Wizelius 2007). On land, winds can be diverted or slowed by interference with the landscape, compared to offshore where the amount of turbulence created by the physical environment is much less due to the less rough sea surface. Overall, this results in steadier wind resources and overall faster average wind speeds. More consistent, stronger winds offshore also means that power generation can better meet peak demand for the energy requirements of load centers compared to onshore wind installations.

5. Currently, there are no installed offshore wind energy facilities in the United States. However, offshore wind energy has been developed over the past two decades in Europe. This section, drawing on information from the European experience, examines the technology used in an offshore wind energy facility, provides a description of the lifecycle stages of a facility from pre-construction through decommissioning, and discusses the project costs and governmental incentives associated with installing an offshore wind energy project.

820.1 Offshore Wind Facilities

1. Offshore wind facilities are comprised of six main parts (see Figure 13), including foundation structures, wind turbines, nacelles, submarine cables, an offshore substation, and an onshore grid connection. Offshore wind turbines are secured to the seafloor with a foundation and convert the energy in the blowing wind to electricity through a drivetrain and electric generator housed in the nacelle. The energy produced is collected at an offshore substation where it is then transported back to shore via a submarine transmission cable and fed into the onshore utility grid. While offshore wind facilities can vary in size and design, the main components remain relatively consistent across projects.

Figure 13. Components of an Offshore Wind Facility (Deepwater Wind 2009).

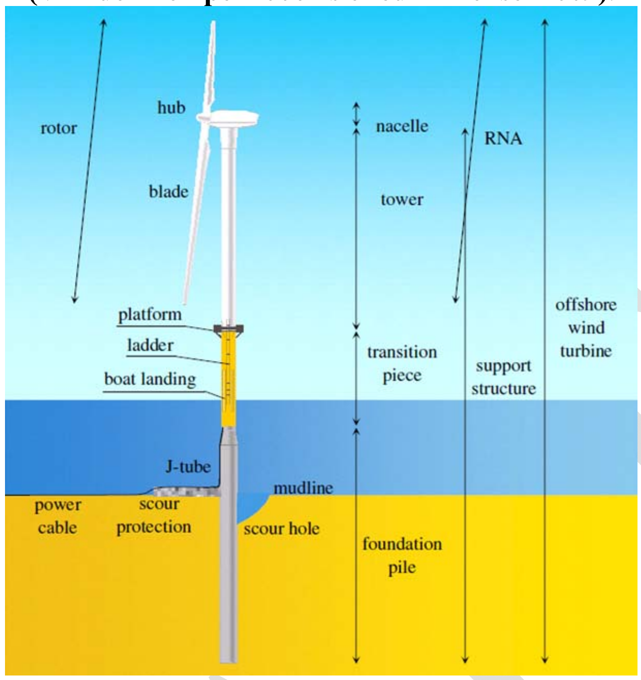


1. Foundation
2. Wind Turbine Blades
3. Generator and Nacelle
4. Inter-Turbine Submarine Cables
5. Offshore Substation & Export Submarine Cable
6. Onshore Grid Connection

820.2 Turbine and Foundation Technology

1. Above the water level most offshore wind turbines are similar in appearance. Current turbine technology has three evenly spaced composite blades mounted to a hub (see Figure 14). The blades and hub together are referred to as the rotor. The rotor spins a shaft that is connected through a drivetrain to an electric generator that converts the energy of the spinning rotor into electricity. The rotating shaft, gearbox, drivetrain and generator are all housed within a protective shell referred to as the nacelle that is fixed atop a steel tower. To use the wind efficiently, the rotor should be perpendicular to the direction from which the wind is blowing. A yaw motor, placed at the base of the nacelle, rotates the nacelle until it is optimally aligned with the wind direction (Wizelus 2007). At the base of the tower is a platform and/or boat landing used by personnel and vessels servicing the turbine. Some turbines (especially those located far offshore) are also equipped with a helicopter landing pad for personnel access. The structure used to connect the tower to the foundation is referred to as the transition piece.

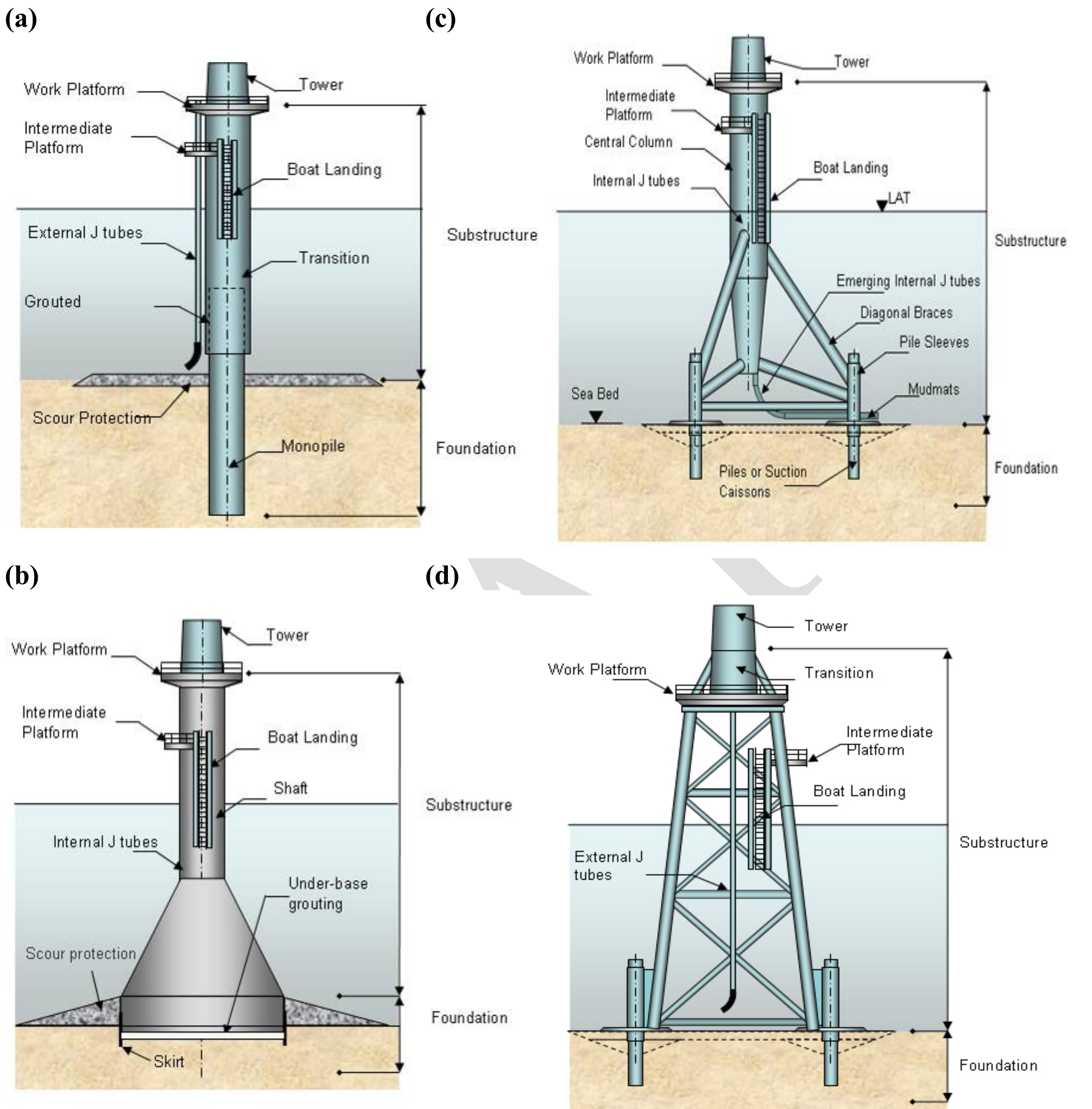
Figure 14. Overview of offshore wind turbine terminology (Van der Tempel 2006 as cited in Hensel 2009).



2. Below the water surface, offshore wind turbines can be affixed to the sea floor through a variety of different foundation structures (see Figure 15 and Figure 16). Foundations are designed to best suit the site-specific geology and water depth of the project site (see Table 6). Factors influencing the type of foundation technology used includes: water depth, seabed and sub-seabed composition, turbine loads, wave loads, manufacturing requirements and installation procedures (European Wind Energy Association 2009). To date the majority of installed offshore wind turbines have used monopile and gravity base foundations (European Wind Energy Association 2009). Both types of foundation structures are used primarily in shallow water depths (less than 30 meters [98.4 feet]).[15]

[15] From Musial et al. (2006): "Monopiles are depth-limited due to their inherent flexibility. This limit occurs when the natural frequency of the turbine/support structure system is lowered into a range where coalescence with excitation sources such as waves and rotor frequencies becomes unavoidable. To maintain adequate monopile stiffness in deeper waters, a volumetric (cubic) increase in mass and therefore cost is required. This means the monopile length, diameter, and thickness are all growing to accommodate greater depths. At the same time, installation equipment such as pile hammers and jack-up vessels become more specialized and expensive, and eventually the required hammer capacities and jack-up depth limits cannot be reached. These limits are thought to be somewhere between 20 and 30m." (pg.4)

Figure 15. Different support structure types for offshore wind turbines (a) monopile, (b) gravity base, (c) tripod, and (d) jacket. (European Wind Energy Association 2004).



***Illustrations by Garrad Hassan and Partners Ltd**

Figure 16. Floating Wind Turbine Designs (Musial 2008b).

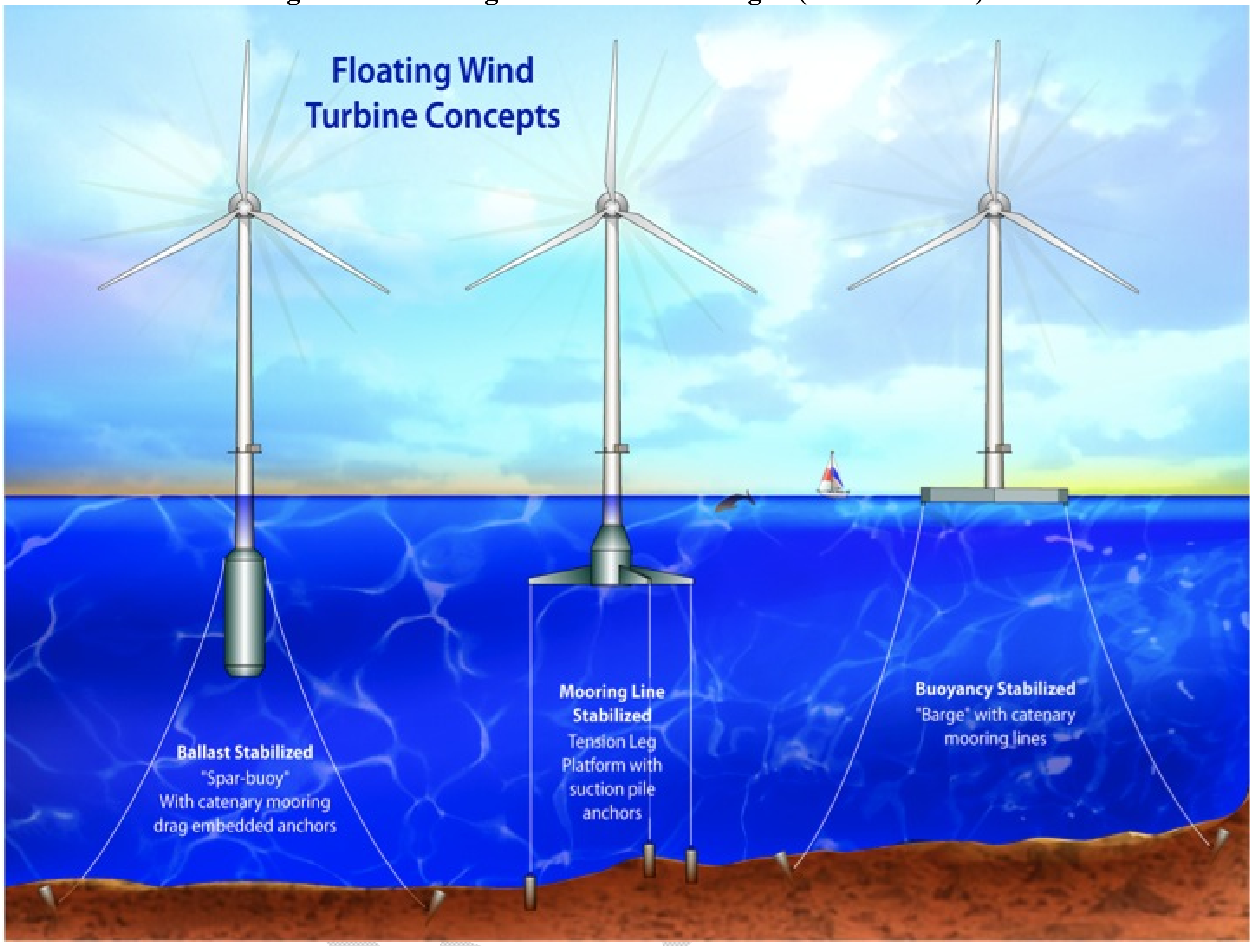


Table 6 Descriptions of Foundation Types Used to Support Offshore Wind Turbines (European Wind Energy Association 2004).

Type of Foundation Structure	Water Depth	Construction	Examples
Monopile	Shallow	Made from steel tubes (typical diameters 3m to 6m); Installation of the pile by drilling or driving; Connection from pile and tower with grouted transition piece	Utgrunden (Sweden); Egmond aan Zee (Netherlands); Horns Rev (Denmark); North Hoyle (UK); Barrow (UK); Blyth (UK); Scroby Sands (UK); Kentish Flats (UK); Arklow (Ireland)
Gravity Base	Shallow	Construction material: concrete or reinforced concrete; Self weight of structure resists overturning; Seabed needs sufficient load bearing capacity; Scour protection needed	Vindeby (Denmark); Tuno Knob (Denmark); Middelgrunden (Denmark); Nysted (Denmark); Lilgrund (Sweden); Thornton Bank (Belgium)
Tripod	Mid to deep water	Made from steel tubes (typical diameter 0.8m to 2.5m); Center pile connected to tower (diameter up to 5.5m); Pile or bucket foundation (piles about 2m in diameter, drilled or driven)	Alpha Ventus (Germany)
Jacket	Mid to deep water	Jacket made from steel tubes (typical diameter 0.5m to 1.5m); Pile or bucket foundation (pile diameter from 0.8m to 2.5m, drilled or driven)	Beatrice (UK)
Floating	Very deep	Still under development; Buoyancy effect used for load bearing; Held in place with anchors	Statoil (North Sea)

3. Monopile foundations are made from steel tubes, typically 3.5 to 5.5 m (12 to 18 ft) in diameter that is hammered, drilled, or vibrated 9 to 18 m (30 to 60 ft) into the seabed (Minerals Management Service 2007a). The turbine is secured to the monopile with a grouted transition piece (European Wind Energy Association 2004). Gravity foundations rely on gravity to secure the wind turbine to the sea bottom and are constructed of a large concrete structure that rests on the seafloor using weight to stabilize against any overturning moments. Although gravity foundations may be used on multiple bottom types, seabed preparation to create a smooth, flat seabed is required prior to installation to ensure uniform loading (Minerals Management Service 2007a). Preparation of the seabed requires precision, assuring the surface is level within 20 mm (0.79 inches). However, installation effort is reduced once this preparation is complete. Extensive site-specific bottom analysis is required for each gravity base, to verify homogeneous soil properties and compaction, in order to minimize uneven settling (Musial et al. 2006). In addition to site specific preparation, gravity-based foundations also require shoreside facilities capable of handling the construction of these massive structures (450 to 910 MT [500 to 1,000 tons], compared with 160 MT [175 tons] for a monopile). Further, their large mass may complicate transport and installation operations (European Wind Energy Association 2004).

4. While monopiles and gravity-based foundations are best suited for shallow water (less than 30 m), tripod and jacketed substructures are considered suitable for transitional water depths of 30 to 60 meters (98.4 to 196.9 feet) and above (Musial et al. 2006). Both tripod and jacketed structures are constructed of welded steel tubes fixed atop piling driven into the seabed. Tripod technology is secured to the bottom with 3 piles, compared to the jacketed

structures which use 4 driven piles. Jacket technology has been used extensively in the oil and gas industry (Musial et al. 2006). Floating turbine technologies are beginning to be designed and prototyped for use in deeper water depths (European Wind Energy Association 2009; Musial et al. 2006). See Figure 16 for an illustration of potential floating turbine designs.

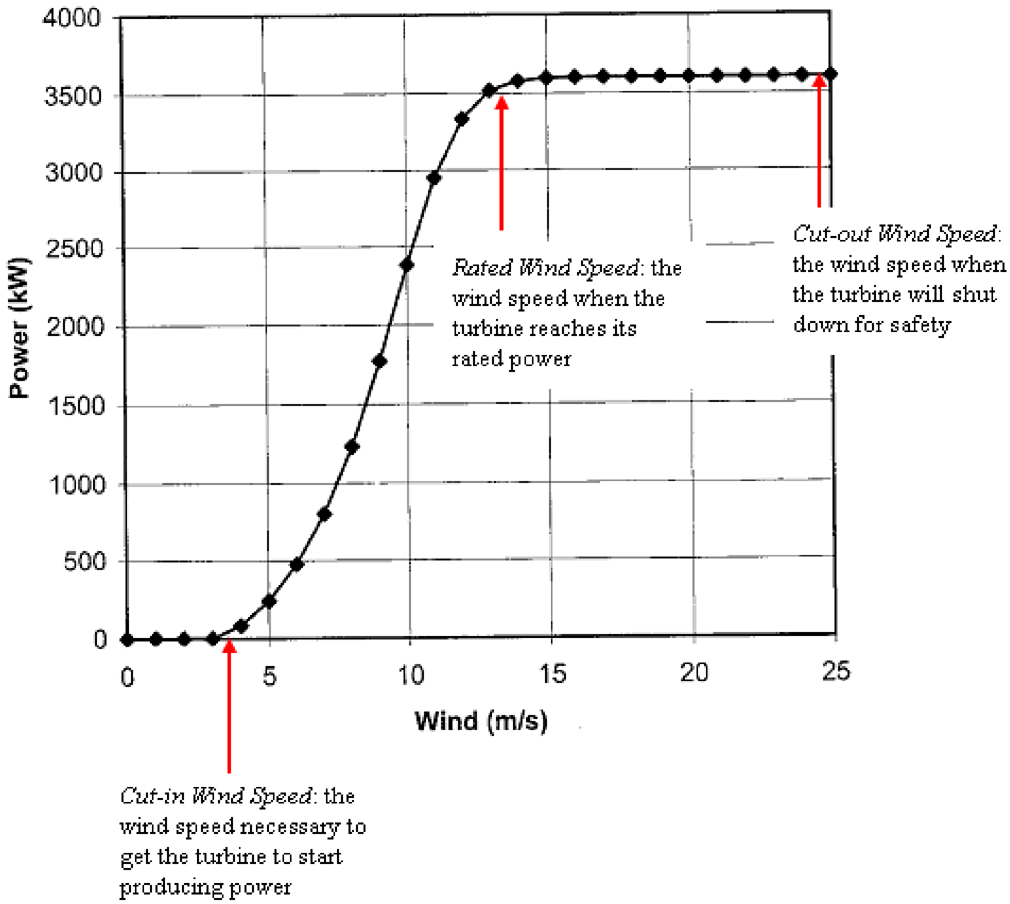
5. The movement and transport of surface sediments along the seafloor by currents, tidal circulation, and storm waves can undermine foundation structures by removing sediments or 'scour' away portions of the seafloor that are supporting the structure. In cases where the erosion of sediments is strong enough to compromise the structural integrity of the offshore structure or influence coastal sediment transport, scour protection devices are installed. Scour protection devices such as boulders, grout bags, and grass mattresses may be used to minimize the effects of scouring on the seafloor topography (Minerals Management Service 2007a). Section 850 contains further discussion of potential scouring action around offshore structures. For more information on storm occurrence and circulation patterns in the SAMP area see *Chapter 2 Ecology of the Ocean SAMP Area*.

6. While offshore wind turbines are similar in appearance to turbines used onshore, offshore turbines usually require several design modifications to withstand the more demanding offshore environment. For example, in offshore wind turbines the tower structure is reinforced to cope with the added stress from wave exposure. In addition, all components including those within the nacelle require additional protection from the corrosive nature of sea air and spray. Offshore turbines are typically equipped with corrosion protection, internal climate control, high-grade exterior paint, and built-in service cranes. Typically offshore wind turbines also have warning devices and fog signals to alert ships in foul weather and navigation and aerial warning lights. Turbines and towers are typically painted light blue or grey to help the structures blend into the horizon. However, the lower section of the support towers may be painted in bright colors to aid in navigation and to highlight the structures for passing vessels. To minimize expensive servicing, offshore turbines may have automatic greasing systems to lubricate bearings and blades, and preheating and cooling systems to maintain gear oil temperature within a narrow temperature range (Minerals Management Service 2007a).

7. Wind turbines are classified based on their rated output, or nominal power rating, which is the amount of energy that the turbine is rated to produce at a set wind speed.[16] To determine how much electrical power will be produced by a particular turbine at a given wind speed a power curve is created (see Figure 17). Power curves also illustrate the turbines cut-in speed, or the minimum wind speed that causes the turbine to spin and produce power, and the cut-out speed, or the wind speed at which the turbine should be shut down due to a risk of breakage. When the cut-out wind speed is reached, the blades of a turbine are turned out (or feathered) to allow the wind to blow through the rotor without any rotation (Wizelus 2007).

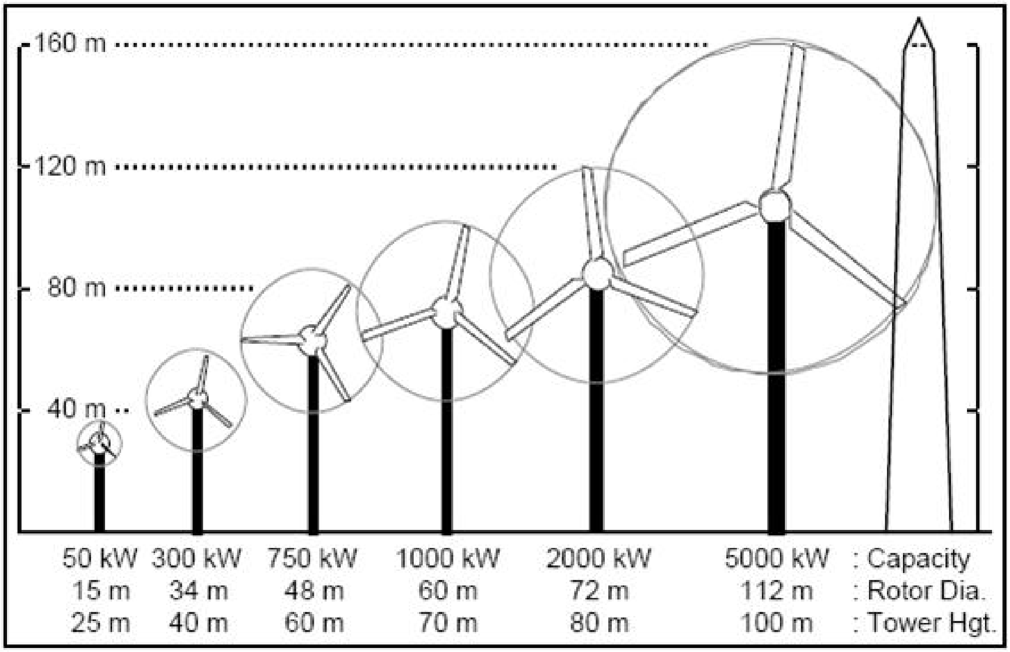
[16] Nominal power ratings are calculated based on wind speeds of 12 or 16 m/s depending on the manufacturer specifications.

Figure 17 Power Curve for a Siemens 3.6 MW Offshore Wind Turbine (Seimens Wind Power A/S 2008).



8. Offshore wind turbine sizes have evolved over time to take advantage of economies of scale by increasing in size and power generating capabilities. Typical onshore turbines installed today have a tower height of about 60 to 80 m [200 to 260 ft], blades of approximately 30 to 40 m [100 to 130 ft] in length, and generating capacities of 1-2 MW. Conversely, offshore turbines may be twice that size, with towers reaching heights of 120 m [394 feet], see Figure 18 (Minerals Management Service 2007a; Wizelus 2007). The majority of offshore turbines installed to date have power-generating capacities of between 2 and 4 MW, with tower heights greater than 61 m [200 ft] and rotor diameters of 76 to 107 m [250 to 350 ft]. A 3.6-MW turbine weighs 290 metric tons (MT) [320 tons] and stands from 126 to 134 m [413−440 ft] tall, approximately the height of a 30-story building (Minerals Management Service 2007a). Turbine size continues to increase, as turbines rated for 5 MW (with rotor diameters of up to 130 m [425 ft]) are being manufactured. Plans for 7 MW structures are being developed (European Wind Energy Association 2009). The use of such large turbines means offshore wind facilities can generate greater amounts of electricity with fewer installed turbines, which decreases the cost per kWh of energy production (Robinson and Musial 2006). For further discussion of the production costs associated with offshore wind energy see Section 820.5.

Figure 18. Schematic of Wind Turbine Sizes (Connors and McGowan 2000).



9. In addition to rated output an offshore wind turbine is capable of producing, it is also important to consider the capacity factor of a turbine. The capacity factor is an indicator of how much power a particular wind turbine generates in a particular place and is one element in measuring the productivity of a wind turbine, or any other type of power production facility. It compares the facilities actual production over a given period of time with the amount of power the plant would have produced if it had run at full capacity (American Wind Energy Association 2010).

$$\textbf{Capacity Factor} = \frac{\textbf{Turbine average power output in a year}}{\textbf{Turbine rated power}}$$

A conventional utility power plant fueled by natural gas or coal runs almost continually unless it is idled by equipment problems or for maintenance. Therefore, a capacity factor of 40% to 80% is typical for these types of plants. Conversely, because an offshore wind facility is "fueled" by the wind, which blows steadily at times and not at all at other times, modern utility-scale wind turbines typically operate 65% to 90% of the time, and therefore run at less than full capacity. Offshore wind energy capacity factors commonly range between 25% and 40%, and may vary over the span of a year depending on the intermittency of the wind resource (American Wind Energy Association 2010).[17] For example, if the capacity factor of

[17] The American Wind Energy Association (2010) goes on to explain that "[w]ith a very large rotor and a very small generator, a wind turbine would run at full capacity whenever the wind blew and would have a 60-80% capacity

an offshore wind energy facility is 33% and Rhode Island sets a goal of 150 MW of renewable energy production, the actual amount of installed wind capacity needs to be greater than that goal. As a result of the capacity factor of the offshore wind turbine technology, requires the installation of approximately 450 MW of wind turbine capacity to meet the 150 MW goal. The capacity factors for the European offshore wind facilities Nysted and Horns Rev were estimated to fall between 40-47% (International Energy Agency 2005).[18]

10. Turbine technologies and foundation designs are ever-changing and advancing, as engineers strive to increase the generating capacity of offshore wind turbines, expand the water depths in which structures may be placed, and aim to lower the cost of energy production. As a result, the technology available presently may differ from the technology used in future installations.

820.3 Transmission Cables and Substations

1. The current method for interconnecting offshore wind facilities with onshore utility transmission systems is through alternating current (AC) submarine cable systems. Underwater cables located between the turbines are used to collect the electricity produced from each turbine and feed it into an offshore substation, also referred to as the electric service platform, where a transformer then converts the electricity to a higher voltage before transmission to shore. The transmission cable connected to each turbine runs from the generator within the nacelle, down the length of the tower into a "J" shaped plastic tube, referred to as the J-tube (see Figure 15), and guides the cable into the cable trench leading to the offshore substation (European Wind Energy Association 2009). The collection voltages within the facility typically range from 24 to 36 kV, compared to transmission voltages (from the substation to the shore), which range between 115 and 150kV (Minerals Management Service 2007a).

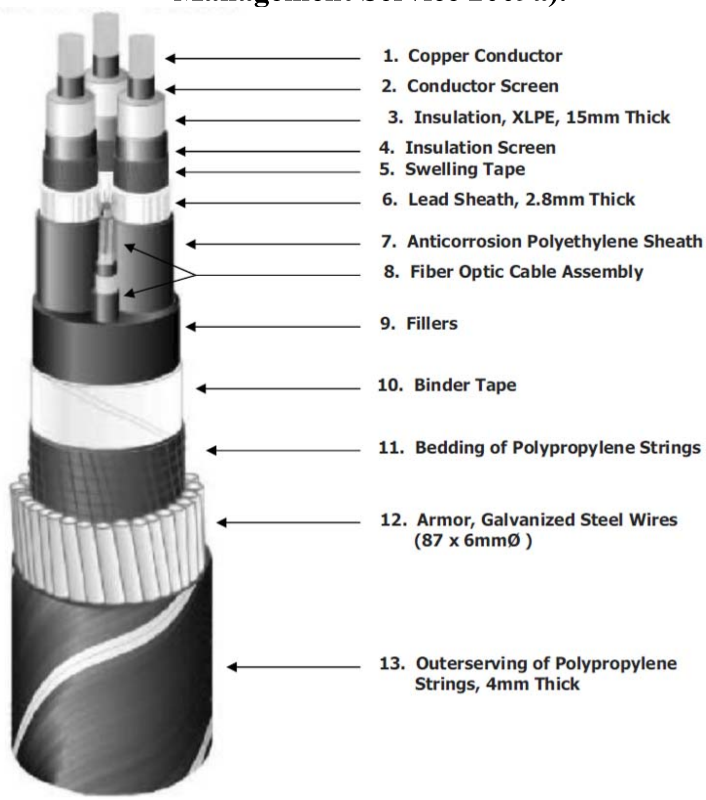
2. Currently, offshore wind facilities are connected to onshore utility transmission systems through AC submarine cable systems, which may comprise one or more underwater cables (see Figure 19) each capable of carrying up to 150 or 200 MW at a high voltage such as 150 kV (Wright et al. 2002). For distances less than 30 kilometers (18.6 miles) and power levels below 200 MW, AC cable connections are considered adequate. However, for greater distances (30 to 250 km [20 to 155 mi] depending on voltage and cable type) and voltages (greater than 175kV), AC cables may be less practical and technically infeasible, as transmission losses limit the length of AC cables. For offshore wind facilities sited farther than 30 km (18.6 miles) from shore, high-voltage direct current (HVDC) cables may be a suitable alternative as this technology is able to operate safely at higher voltages, and with negligible transmission losses over longer distances (Wright et al. 2002). However, such a system requires an AC/DC converter station both offshore and onshore which require large installations (European Wind Energy Association 2009). This technology shows potential as

factor—but it would produce very little electricity. The most electricity per dollar of investment is gained by using a larger generator and accepting the fact that the capacity factor will be lower as a result."

[18] Due to some technical issues at the Horns Rev site in Denmark, where 30-50% of the turbines were non-operational during the year, the capacity factor for this facility during 2004 was 26% (International Energy Agency 2005).

a future alternative to AC, especially as facilities are sited farther offshore; however, it has not yet been proven to be a commercially viable technology for current offshore wind energy development.

Figure 19. Cross-Section of an AC 115kV Underwater Transmission Cable (Minerals Management Service 2009a).



3. As mentioned above, an electric service platform is a central offshore platform that provides a common electrical interconnection of all of the wind turbines in the array and serves as an offshore substation where the electrical output is combined, brought into phase, and stepped up in voltage for transmission to a land-based substation and ultimately the onshore utility grid (Minerals Management Service 2007a). The purpose of these offshore substations is to reduce electrical losses that may occur along the transmission cable by increasing the voltage prior to exporting the power to shore. Generally a substation does not need to be installed if: (i)the project is small (~100 MW or less), (ii)it is close to shore (~15 km [9.3 miles] or less), or (iii) if the voltage at the grid connection is the same as the voltage being collected from the turbines (e.g. 33 kV). Many of the early offshore wind projects met some or all of these criteria, so were built without an offshore substation (European Wind Energy Association 2009). However, most offshore wind farms being built currently are large and/or located far from shore and require one or more offshore substations. Offshore substations typically serve to step up the voltage from the voltage collected at the turbines (e.g. 30–36 kV) to a higher voltage (e.g. 100–220 kV), equivalent usually to the voltage of the utility grid connection. This step-up reduces the number of underwater cables needed to connect to the shore side utility grid (European Wind Energy Association 2009).

4. In addition to housing the offshore substation, the electric service platform may also provide a central service facility for the wind facility and may include a helicopter landing pad, control and instrumentation system, crane, man-overboard boat, communication unit, electrical equipment, fire extinguishing equipment, emergency back-up (diesel) generators, staff and service facilities, and temporary living quarters (for emergency periods or inclement weather when crews cannot be removed) (Minerals Management Service 2007a). The electric service platform may also provide a central area to store insulating oil used in the turbine generators, potentially storing up to 150,000 L (40,000 gal) of insulating oil and 7,600 L (2,000 gal) of additional fluids such as diesel fuel and lubricating oil to support the operations of a large offshore wind facility (Applied Science Associates 2006).

820.4 Stages of Development

1. There are four stages of development associated with the lifecycle of an offshore wind energy facility: pre-construction, construction, operation and decommissioning (see Table 7). The duration of each stage will vary between projects though the activities associated with each stage of development are similar across projects.

Table 7. Stages of Development for an Offshore Wind Energy Facility.

Stage of Development	Approximate Duration	Associated Activities
Pre-Construction	Years	Siting of Proposed Project • Wind Resource Assessment • Seabed topography and substrate composition Facility Design • Size • Turbine Technology • Foundation and Substructure • Transmission Permitting and Review Process • Baseline Monitoring • Environmental Impact Assessments • Lease Agreements
Construction	Months – Years	Installations • Foundations and Substructure • Turbines • Electric Service Platform/ Offshore Substation • Cable Laying • Onshore Substation/Connection to Utility Grid
Operation	Expected Life of Facility: Approximately 20-25 years	Maintenance Activities • Equipment Servicing Monitoring Activities • Environmental Monitoring
Decommissioning	Months	• Removal of Structures to the Mud Line • Repowering the Project with New Turbines

2. The pre-construction stage involves all activities associated with siting the location of an offshore wind energy facility, the assessment of physical and biological characteristics specific to a site, and the permitting/review process of a project proposal by the appropriate federal, state and local agencies. The entire pre-construction period may last many years depending on the project. Meteorological towers are installed to collect continuous data on wind speed and direction, along with other weather related information to be used in estimating the potential energy output. Assessment of the wind resources and overall microclimate of a site provides vital information on potential revenue, and projected installation and operation costs, which are ultimately used to support financing agreements (Brown 2008). Developers must also investigate the seabed topography and substrate composition of a proposed site to engineer the appropriate foundation and installation techniques for the turbines and transmission lines (Hammond 2008).

3. During the pre-construction stage, project permitting on the federal, state and local levels is completed, involving substantial reviews and assessments of environmental impacts and compliance with applicable environmental legislation. Table 8 summarizes applicable state actions relevant to offshore wind energy construction. The review process of an offshore wind energy project located in state waters is led by the U.S. Army Corps of Engineers, as opposed to projects located in federal waters, whose review process is led by the U.S. Department of the Interior Minerals Management Service (see *Chapter 10 Existing Statutes, Regulations, and Policies* for a description of federal versus state waters). The National Environmental Policy Act (NEPA)[19] mandates that an environmental analysis be prepared prior to the issuance of federal action (e.g. permits or approvals) for offshore wind farms. Based on the project, the environmental review may consist of an Environmental Assessment or a more extensive review in the form of an Environmental Impact Statement. The review process includes: an analysis of alternatives, an assessment of all environmental, social, and existing use impacts (i.e. ecological, navigational, economic, community-related, etc.), a review for regulatory consistency with other applicable federal laws and the implementation of mitigation measures. Concurrent with the preparation of the final Environmental Impact Statement or other NEPA documentation, a consistency review (under the Coastal Zone Management Act) and subsequent Consistency Determination (CD) is completed relative to each affected State's federally approved coastal zone management program. Each CD includes a review of each State plan, analyzes the potential impacts of the proposed lease sale in relation to program requirements, and makes an assessment of consistency with the enforceable policies of each State's plan (Minerals Management Service 2009b). Moreover, the installation of a submarine cable through state waters and through and state upland areas at which point all applicable state permits and approvals would be required. See *Chapter 10 Existing Statutes, Regulations, and Policies* for more information on state and federal reviews and regulations relevant to offshore wind energy development.

[19] 42 U.S.C. §4332

Table 8. Potential State Actions Required to Construct an Offshore Wind Energy Facility in the SAMP area.

Permitting Agency	Applicable Permit or Approval	Statutory/Regulatory Authorities Establishing Scope of Jurisdiction	Projects Applicable to this Permit/Approval
Rhode Island Coastal Resources Management Council (CRMC)	State Assent	R.I. Gen. Laws § 46-23 et seq.	Facilities located in state waters Transmission Cables sited in state waters
	Lease/ License of Offshore Land	CRMC Enabling Legislation, R.I. Gen. Laws § 46-23-6(4)(iii) (authorizing CRMC to "[g]rant licenses, permits and easements for the use of coastal resources… and impose fees for the private use of these resources.")	
	Coastal Wetlands Permit and Freshwater Wetlands Permit	CRMC Coastal Resources Management Program, CRIR 04-000-010 (2009); Rules and Regulations Governing the Protection and Management of Freshwater Wetlands in the Vicinity of the Coast CRIC 04-000-017 (2009).	
	Permit for Marine Dredging and Associated Activities	R.I. Gen. Laws § 46-6; 1 Marine Infrastructure Maintenance Act of 1996 and the Marine Waterways and Boating Facilities Act of 2001	
CRMC	Coastal Consistency Determination	Coastal Zone Management Act 16 U.S.C. § 1451 (as amended through Pub. L. No. 109-58, the Energy Policy Act of 2005) CRMC Enabling Legislation, R.I. Gen. Laws §§46-23-1 et seq.; CRMC Coastal Resources Management Program CRIR 04-000-010 (2009)	Facilities located in federal waters
Rhode Island Department of Environmental Management (RIDEM)	Freshwater Wetlands Permit (not in the vicinity of coast)	RI Freshwater Wetlands Act, R.I. Gen. Laws §§2-1-18 through 2-1-24; Administration and Enforcement of the Freshwater Wetlands Act, CRIR 12-190-025 (2009)	Onshore connection of Transmission Cable
	401 Water Quality Certification and/or State Water Quality Certification	Clean Water Act § 401(a)(1), 33 U.S.C. § 1342(a)(1); 40 C.F.R. § 121.1(g); RI Water Pollution Act, R.I. Gen. Laws §§ 46-12-1 et seq.; Water Quality Regulations, CRIR 12-190-001 (2009)	Facilities located in state waters Transmission Cables sited in state waters

	Rhode Island Pollutant Discharge Elimination System Permit	R.I. Gen. Laws §§ 46-12,42-17.1 & 42-35, as amended	Facilities located in state waters
Rhode Island Energy Facilities Siting Board	Energy Facility License	Energy Facility Siting Act, R.I. Gen. Law § 42-98.	Facilities located in state waters
Rhode Island Natural History Survey (SHPO)	Consultation Under the National Historic Preservation Act, Section 106; Consultation and Determination Under the Abandoned Shipwreck Act	National Historic Preservation Act, 16 U.S.C. 470; Abandoned Shipwreck Act, 43 U.S.C. 2101 et seq.	Facilities located in state waters Transmission Cables sited in state waters

4. Prior to construction, a developer must first obtain a lease from the appropriate state or federal agency for the land on which facility will be sited. For projects located in Rhode Island waters, the CRMC has the authority to issue the lease or license of offshore lands (see Table 8). Projects located in federal waters must obtain a lease from the U.S. Department of the Interior Minerals Management Service. The lease process will vary depending on if there is a competitive interest for the same area by multiple developers. The Minerals Management Service may use a general Request for Interest to gauge interest in renewable energy leasing anywhere on the outer continental shelf, or a specific Request for Interest to assess interest in specific areas after receiving an unsolicited leasing proposal from a developer. Any Request for Interest will be published in the Federal Register (Minerals Management Service 2009b). If the Minerals Management Service determines there is a competitive interest, the lease may be awarded based on a competitive lease process. If only one developer expresses interest, a noncompetitive lease process may be followed (see Figure 20).

Figure 20. Minerals Management Process for Awarding Leases for Offshore Renewable Energy Development (Minerals Management Service 2009b).

Request for Interest in Federal Register
(60 day comment period)

Multiple Developers Submit Lease Request

Only One Developer Submits a Lease Request

COMPETITIVE LEASE PROCESS

Call for Information and Nominations

- Request comments on areas which should receive special consideration and analysis;
- Request comments concerning geological conditions (including bottom hazards); archaeological sites on the seabed or nearshore; multiple uses of the proposed leasing area (including navigation, recreation, and fisheries); and other socioeconomic, biological, and environmental information; and
- Suggest areas to be considered by the respondents for leasing.

Lease Area Identification
The MMS will identify areas for environmental analysis and consideration for leasing; in consultation with appropriate Federal agencies, States, local governments, affected Indian tribes, and other interested parties.

Proposed Sale Notice
The MMS will publish the Proposed Sale Notice in the Federal Register and send it to the Governor of any affected State and the executive of any local government that might be affected. The comment period following issuance of a Proposed Sale Notice will be 60 days.

Final Sale Notice
The MMS will publish the Final Sale Notice in the Federal Register at least 30 days before the date of the sale.

Lease Sale
(Most Competitive Bid Wins Auction)

Lease Awarded

NON-COMPETITIVE LEASE PROCESS*

MMS Determination of No Competitive Interest
MMS will file a notice in the Federal Register of this determination

Developer Must Submit Plans
The MMS will coordinate and consult with affected Federal agencies, State, and local governments, and affected Indian tribes in the review of non-competitive lease requests and associated plans.

Approval and Acceptance of Lease Agreement
MMS approves plans and developer agrees to the terms and conditions of the lease agreement

Lease Awarded

Notice of Lease Award
The MMS will publish in the Federal Register a notice announcing the issuance of the lease.

* A Non-Competitive Lease Process may also be initiated by an unsolicited request by a developer for a commercial lease.

5. Once a lease is awarded by MMS, there are a series of plans and reports that must be submitted prior to construction, including the Site Assessment Plan (SAP) and the Construction and Operation Plan (COP). The requirements of each plan are described in detail in 30 C.F.R. 285. Each of these plans will undergo a NEPA review and consistency review under the CZMA, where appropriate, prior to approval by MMS. A SAP describes the site assessment activities (e.g., installation of meteorological towers, meteorological buoys) a developer plans to conduct at a lease site. A COP and GAP describes all the proposed construction activities, operations and conceptual decommissioning plans a developer intends to follow when installing and operating an offshore wind energy facility. These plans include not only the offshore installations, but also the plans for onshore support facilities. In conjunction with the COP, a developer must also submit a facilities design report, and a fabrication and installation report as outlines in 30 C.F.R. 285.701 and 285.702. Following the approval of these plans, a developer of a federal lease area may then commence the construction stage of development. Similar developer requirements will be outlined in Section 860 for projects proposed in state waters in the Ocean SAMP.

6. The construction stage of development is the period in which the turbines, substructures and foundations, cables and offshore substations are installed at the project site. For each of these installations various construction vessels, barges and equipment are required, some of which are specialized for the construction of offshore wind farm. Transport barges are used to carry towers, blades, nacelles, scour protection and foundation structures from the onshore staging areas to the project site. In some cases, certain assemblies may occur onshore to reduce installation time offshore. For example, the developer of the Beatrice Wind Farm Demonstration Project (a jacketed offshore wind project) transported the turbine fully assembled to the project site. The tower and rotor had been assembled onshore, transported via barge and lifted onto the jacketed substructure by crane (Talisman Energy et al. 2007) (see Section 840.1 for further discussion). Foundations, substructures, towers and rotors are installed using a jack-up barge outfitted with a crane which lifts and positions structures into place. To stabilize the position of the jack-up barge, four to six legs may be deployed. These legs allow the barge to be raised up to a suitable working elevation (Minerals Management Service 2009a). Vessels equipped with pile driving rams or vibratory hammers embed the foundation piles to specified depths. Alternatively, in areas where pile driving is not possible, drilling techniques may also be used to create holes within the seabed for the piles to be placed.

7. Cable laying activities are performed by vessels towing a jet-plowing device which uses pressurized sea water to carve a trench in the sediments. The jet-plow creates the trench and lays the cable within the trench allowing the disturbed sediments to settle atop the cable. This technique is used for both the inner-array of cables that connect the turbines to the offshore substation and the longer transmission cables that connect the entire facility to the shore side utility grid. The transmission cables connecting the offshore wind facility to shore may be embedded 6 feet below the seafloor surface. Once the transmission cable reaches the shore, it is run through a buried conduit installed to protect the cable in the coastal zone. In addition, to the vessels directly involved in laying the cables, multiple small auxiliary vessels may be present to provide support and assistance. Cable laying activities may occur continuously, on a 24 hour basis (Minerals Management Service 2009a).

8. 8.Because the transport, placement, and installation of the wind turbine structures requires acceptable weather conditions and sea states, the duration of construction activities will vary dependent on the local weather (U.K. Department of Trade and Industry 2007). In areas prone to inclement weather or rough sea conditions, construction activities may require much more time to be completed. See *Chapter 2 Ecology of the SAMP Area* for more information on storm occurrence in the SAMP area.

9. Offshore wind energy facilities have been designed to operate without the attendance of any operator (Minerals Management Service 2009a). Therefore, once installed the majority of day-to-day operations and monitoring of turbine functions are conducted remotely. Sensors within the turbine's nacelle gather and transmit data on the performance of the generator and other equipment, as well as current weather conditions, wind speed and direction to onshore control centers. Remote control centers would also have the ability to shut down a turbine if necessary. Prior to operation, a project must obtain the appropriate operating licenses and permits from the Federal Energy Regulatory Commission.

10. While monitoring and daily operations may be controlled remotely, periodic maintenance visits to the facility by service vessels and crews are required. Periodic maintenance activities may include: regular inspections of all installed structures, preventative maintenance on all equipment, or repairs to any malfunctioning equipment. According to the Minerals Management Service (2009a), approximately five days per year per turbine may be anticipated for both planned and unplanned maintenance activities. However, the number of maintenance visits will likely be influenced by the dependability of the technology employed.

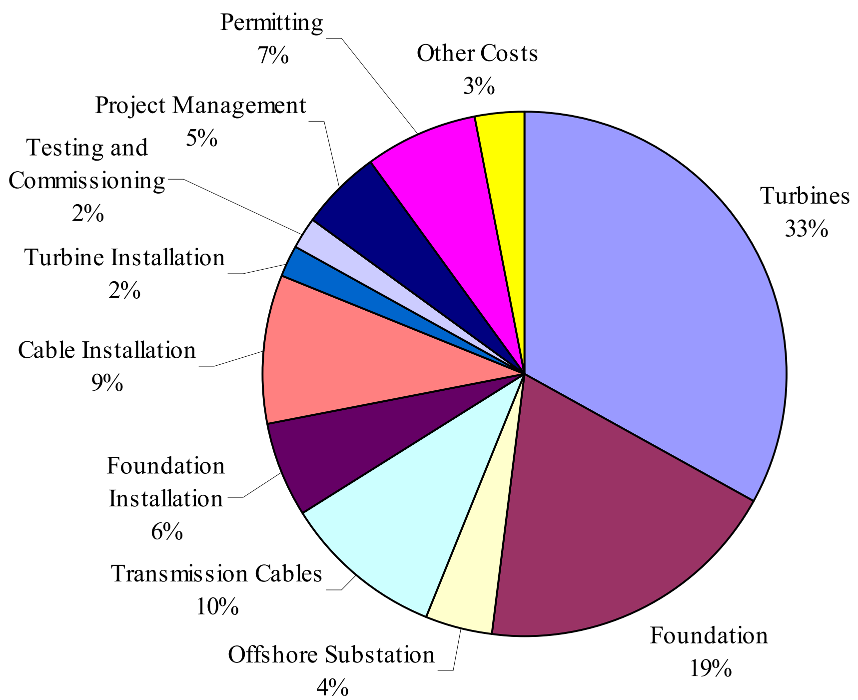
11. The final stage of an offshore wind energy facility is its decommissioning, in which installed structures are removed from the project site. Decommissioning of a wind facility involves the dismantling and removal of infrastructure from each wind turbine platform to 15 meters [49.2 feet] below the mud line, the removal of offshore transformers, and the shipment of these materials to shore for reuse, recycling, or disposal. The decommissioning process is largely the reverse of the installation process and uses similar vessels employed during the facility's construction. Cranes would be used to lift away structures, whereas piles may be removed using one or a combination of acetylene cutting torches, mechanical cutting devices, or high pressure water jets (Minerals Management Service 2009a; Minerals Management Service 2007a). Piles are required to be removed to 15 meters [49.2 feet] below the mud line; therefore, the section of the piles below that depth will remain in the seabed after decommissioning. Explosive techniques may also be used for the removal of some platforms if permitted (Minerals Management Service 2007a). Alternatively, MMS may allow structures to be left in place to serve as an alternate use, such as an artificial reef. However, such a determination will be made on a case-by-case basis. While the typical life-span of an offshore wind energy facility is approximately 20-25 years, there is the potential for a site lease to be extended for longer use if approved by the MMS (Minerals Management Service 2009b).

820.5 Project Costs

1. The cost of constructing an offshore wind energy facility will vary based on site specific conditions and the timing of installation. Figure 21 illustrates the estimated breakdown of

capital costs for an offshore wind farm in the United Kingdom, based on a compilation of primary data on constructed U.K. projects performed by the U.K. Department of Trade and Industry (2007). These percentages differ among projects.

Figure 21. Estimated Capital Costs of an Offshore Wind Energy Facility (U.K. Department of Trade and Industry 2007).



2. Due to the large cost of offshore structures, foundations, installation, and grid connection, the current cost of constructing offshore wind energy facilities tend to be much more expensive than onshore wind energy facilities (Blanco 2009). For example, a study performed by the U.K. Department of Trade and Industry (2007) estimated that per megawatt of installed capacity, offshore wind energy facilities cost 78% more than onshore projects.[20] The high project costs for offshore wind energy facilities may be due in part to the high capital costs associated with the turbines and foundation structures. Foundations for offshore turbines may cost two to three and a half times more than onshore foundations as they are much larger, because they must accommodate the force of the spinning turbine, as well as forces from ocean currents and waves. In addition, foundation structures require additional installation costs compared to onshore projects (U.K. Department of Trade and Industry 2007). Offshore installation costs may also be amplified due to acquiring expensive, specialized vessels or the potential for delays from poor weather and sea conditions. The U.K. Department of Trade and Industry (2007) study concluded that developers typically factor in an addition 20 to 25% of time needed for construction due to anticipated downtime during the construction phase as a result of poor weather. While the actual costs vary widely between projects, industry analysts predict that as technology advances and installation procedures are improved the cost of developing offshore wind energy projects may decrease (U.K. Department of Trade

[20] The U.K. Department of Trade and Industry study (2007) estimated that per megawatt of installed capacity onshore projects cost approximately £0.9 million, compared to offshore which was estimated to cost £1.6 million.

and Industry 2007; Concerted Action on Offshore Wind Energy in Europe and the European Commission 2001).

3. The cost of operation and maintenance (O&M) activities, which may include regular maintenance for the turbines and other structures, repairs, insurance, management, royalty and lease payments, also contributes to the cost of an offshore wind energy facility. The relative percentage of O&M costs will vary between projects and between technologies and because current offshore turbines are not more than 20 years old, long-term O&M data is not available. Manufacturers, however, are continuously aiming to shrink these costs through the development of new turbine designs requiring less regular service visits and, therefore, reduced downtime (Blanco 2008). During the initial years of operation, manufacturers offer warranties to cover malfunctions and part replacements, but after the warranty period those costs become the burden of the developer.

820.6 Federal and State Incentives for Development

1. To encourage the development of renewable energy, Rhode Island and the federal government offer incentives to encourage development. Table 9 summarizes all incentives currently available for renewable energy development. While additional incentives are also offered to individuals or municipalities for the installation of renewable energy technology, only incentives applicable to utility-scale projects are presented here.

2. Federal incentives for renewable energy in the U.S. have focused primarily on subsidizing the industry, through the Renewable Electricity Production Tax Credit (PTC) enacted by the Energy Policy Act of 1992.[21] Under this legislation, a tax credit of 1.5 cents/kWh (presently equals 2.1 cents/kWh but is periodically adjusted for inflation) is granted to all qualified renewable energy producers (including wind, biomass, hydroelectric, methane, and geothermal) for the first 10 years of operation. The PTC plays a central role in renewable energy proposals such that many land-based wind projects have been largely financed based on these tax savings (Astolfi et al. 2008). The American Recovery and Reinvestment Act of 2009[22] extended this incentive for three more years, allowing any new installations in service before December 31, 2012 to receive the credit. It also allowed the option for developers to receive a grant from the U.S. Treasury Department instead of taking tax credit. The cash grant from the U.S. Treasury Department can be used to cover 30% of the cost of qualified property (new equipment, including tangible property, integral to the wind energy facility). However, the grant application must be filed prior to October 1, 2011 (DSIRE 2010).

3. A second federal tax credit provided under the federal Modified Accelerated Cost-Recovery System (MACRS), allows developers to recover a greater proportion of their capital investment during the early years of operation, through greater depreciation deductions on installed turbines.[23] The MACRS establishes a five-year depreciation period for wind technology placed in service after 1986, and allows a depreciation deduction of 50% of the asset cost at the time the asset is placed into service in the first year, with the remainder

[21] 26 U.S.C § 45
[22] Public Law No: 111-5.
[23] 26 USC §168

depreciated over the regular depreciation period. Accelerated depreciation of the fixed assets associated with a wind farm (i.e. turbines, substations, transmission cables) during the first five years of operation acts to lower a developers federal tax liability during that period.

4. Title XVII of the federal Energy Policy Act of 2005 authorized the U.S. Department of Energy (DOE) to issue loan guarantees for projects that:

   > [A]void, reduce or sequester air pollutants or anthropogenic emissions of greenhouse gases; and employ new or significantly improved technologies as compared to commercial technologies in service in the United States at the time the guarantee is issued.[24]

   As a result of the American Recovery and Reinvestment Act of 2009, this loan guarantee program has $6 billion appropriated to issue loan guarantees for energy efficiency, renewable energy, and advanced transmission and distribution projects through September 30, 2011.

5. In addition to the Renewable Energy Standard and the cap and trade system established under the Regional Greenhouse Gas Initiative (described in detail in Section 810.3), Rhode Island also offers a number of financial incentives to encourage the development of renewable energy within the state. Financial incentives within the state are funded through the Rhode Island Renewable Energy Fund (RIREF).[25] This system benefit fund is supported by a surcharge on electric customers' bills, set at $0.0023 per kWh. However, this surcharge is divided into two types of programs, renewable energy promotion and demand-side management programs. The portion of the total surcharge dedicated to renewables is $0.0003 per kWh, compared to demand-side management programs that collect $0.002 per kWh from the surcharge (DSIRE 2010). This charge will remain in effect for a 10-year period (which began on January 1, 2003) resulting in an annual budget for the fund of approximately $2.4 million; however, only the portion of the RIREF funded from the renewable surcharge can be used to support renewable development (DSIRE 2010). From the RIREF, a number of grants, recoverable grants, and loans are offered for renewable projects. Commercial projects within the state can receive up to $250,000 per year in assistance; municipal renewable energy projects can apply for up to $1 million per year in grants from the fund; and technical and feasibility studies can receive up to $200,000 per year in funding. Relative to the cost of constructing an offshore wind energy facility, these awards are small and may not provide much incentive for utility-scale development.

6. Besides the incentives provided under the RIREF, Rhode Island also offers two tax exemptions to renewable projects within the state. One is the Renewable Energy Sales Tax Exemption, which exempts wind turbines sold within the state from state sales tax (a 7% savings).[26] The second is the Jobs Development Act, which provides an incremental reduction in the corporate income tax rate (currently 9%) to companies that create new employment in Rhode Island over a three-year period.[27] A firm that creates a certain proportion of jobs relative to the company's size may permanently reduce its state income tax liability down to 3%, provided the jobs remain within the state and the employees are paid above a set wage standard (Rhode Island Economic Development Corporation 2010a).

[24] 42 USC § 16511 et seq.; 10 CFR 609
[25] R.I. Gen. Laws § 39-2-1.2.
[26] R.I.G.L § 44-18-30. Rhode Island's Sales Tax Rate equals 7% (Federation of Tax Administrators, 2008)
[27] R.I. Gen. Laws §42-64.5-1

7. As described in Section 810.2, the Long-Term Contracting Standard for Renewable Energy[28] is also meant to encourage and facilitate the creation of 'commercially reasonable' long-term contracts between electric distribution companies and developers or sponsors of newly developed renewable energy resources. In addition to stabilizing long-term energy prices, enhancing environmental quality, and creating jobs in Rhode Island in the renewable energy sector, the goals of this standard is to help facilitate the financing of renewable energy generation within the jurisdictional boundaries of the state or adjacent state or federal waters or providing direct economic benefit to the state. Power purchase agreements that result from this legislation provide assurances to developers that the power produced by a project will be purchased at a stated price, which may in turn aid a developer in obtaining financing for a project. For more information on this standard see Section 810.2 and 840.2).

8. The Ocean SAMP process may also be classified as a type of incentive as it may inform and potentially expedite the permitting and review process for proposed projects in areas determined suitable for future offshore renewable energy development. The research conducted as part of the Ocean SAMP provides baseline data on the physical, biological, ecological resources, as well as describes human uses and activities that occur in the SAMP area which may be informative in siting or reviewing proposed projects in state and federal waters. This baseline data will also be important when monitoring the potential effects of any future offshore renewable energy development. Furthermore, the renewable energy policies and standards outlined in the Ocean SAMP will clarify the considerations of the CRMC when evaluating future projects, as well as identify the design and monitoring protocols that will be expected of any future developers. Once approved by the National Oceanic and Atmospheric Administration as part of Rhode Island's coastal zone management program, the Ocean SAMP policies will also inform the consistency review determination of future offshore renewable energy development in federal waters within the Ocean SAMP boundary, as the CZMA requires federally approved projects be consistent with state coastal management program policies. For more information on consistency determination, see Section 820.4, *Chapter 1 Introduction,* as well as *Chapter 10 Existing Statues, Regulations, and Policies*).

[28] R.I. Gen. Laws §39-26.1

Table 9. Summary of Federal and State Incentives Applicable to Offshore Wind Energy Development (Armsby 2009).

	Promotional Policies				Financial Incentives			
	Renewable Energy Quotas	**Cap and Trade Programs**	**Expedited Permitting Scheme**	**Long-Term Contracting Requirements**	**Investment Subsidy/ Rebate**	**Investment Credit**	**Production Credit**	**Grants/ Loans**
U.S. Federal						MACRS- Accelerated Depreciation (No expiration) Investment Credits for Projects Involving Creating Manufacturing Facilities*	Production Tax Credit (Expires: 12/31/2012*)	Department of Energy Loan Guarantee Program (Expires: 9/30/2011*) U.S. Treasury Grants (Application Deadline 10/1/2011)*
RI	16% by 2020 and a Governor Initiative to obtain 15% of state's power from wind	RGGI- CO^2 Allowance System for Conventional Power Plants (Beginning 2011)	Ocean SAMP	Long-Term Contracting Standard for Renewable Energy	Equipment Sales Tax Exemption	Jobs Development Act- reduces Corporate State Income Tax Rate based on job creation		RIREF funded grants & loans
* Represents incentives included in the American Recovery and Reinvestment Act of 2009								

Section 830: Offshore Renewable Energy in the SAMP Area

830.1 Offshore Wind Resources in the SAMP Area

1. Proper siting of offshore wind energy development in the SAMP area first requires an assessment of the offshore wind resources. As described in Section 810.3, offshore wind speeds increase as distance from shore increases. Data provided by AWS True Wind (Brower 2007) at 70 and 100 meters (230 and 328 feet) above sea level were interpolated to estimate the wind speed at a height of 80 meters (262.5 feet) throughout the SAMP area (see Figure 16).[29] The data used to create Figure 22 is the same data used to produce the National Renewable Energy Laboratory map shown in Figure 12, though the resource displayed in Figure 18 represents winds speeds at a height of 80 meters (262.5 feet) instead of 50 meters (164 feet). Wind speed data at the height of 80 m (262.5 feet) is important, as this is the approximate hub height of an offshore wind turbine. Calculated wind speeds closest to shore ranged from 7.0-7.2 m/sec [15.7-16.1 mph], increasing steadily to 9.6 m/sec [21.5 mph] at the southern edge of the SAMP boundary.

2. Actual wind speeds vary day to day and seasonally. Winds in the Ocean SAMP region are diurnal, and seasonal, with winter winds blowing from the northwest and summer winds from the southwest (Loder et al. 1998; Spaulding et al. 2010d). In general, winter wind speeds tend to be greater than summer wind speeds (HDR Engineering Inc. 2007; Spaulding et al. 2010d). For more information on wind in the SAMP area, see *Chapter 2 Ecology of the Ocean SAMP Region*. In addition to daily and seasonal variation, variation in mean wind speeds has been observed over longer time periods. For more information on the observed long-term trend in wind speed in Rhode Island refer to *Chapter 3 Global Climate Change*.

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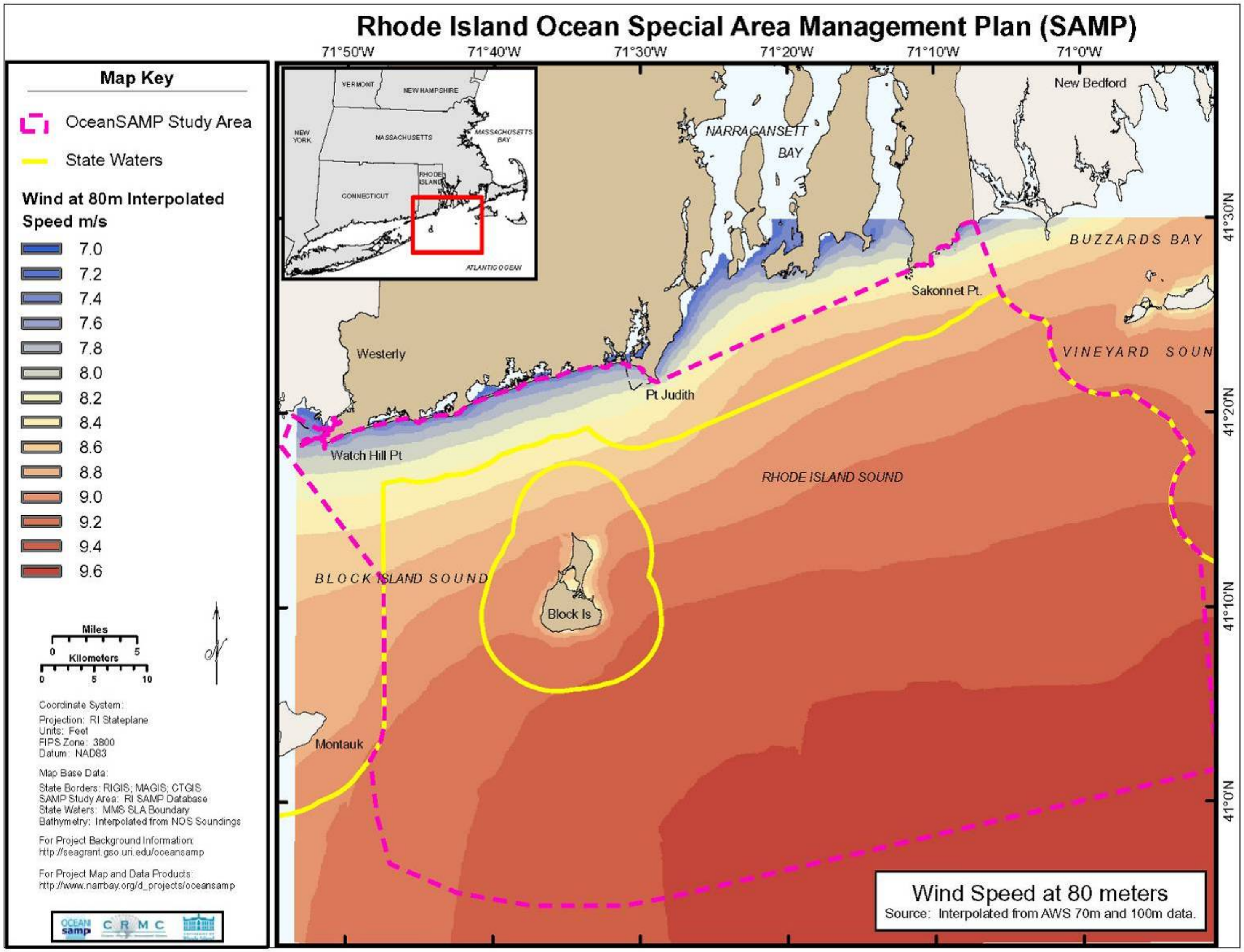
[29] Meteorological model predictions and mass flow analyses developed by AWS TrueWind (MesoMap) were used to predict the wind energy resource along a 200 m grid throughout the waters of Southern New England. The model calculated the mean wind speeds using 366 independent days of simulation, selected from 15 year historical record The accuracy of the model's predictions were then compared to measurements from 33 towers in the region including airports, offshore buoys and platforms, and wind measurement programs from the 1980s and 1990s. For a complete description of the AWS TrueWind methodology see Brower (2007).

Figure 22. Average Annual Wind Speeds at a Height of 80 Meters Above Sea Level.



830.2 Siting Analysis- Technology Development Index

1. Selecting potential sites for the development of any form of offshore renewable energy requires the identification of areas with adequate energy resources, followed by an analysis of any constraints imposed by the physical characteristics specific to a site (e.g. water depth, geology, etc.), or other existing uses in the area. Geospatial analysis using Geographic Information System (GIS) tools is one technique whereby potential sites can be identified based on specified criteria (i.e. the potential for power production, the expense or difficulty of construction, or areas where competing uses do not occur). This systematic analysis allows sites to be selected which have the greatest potential for offshore renewable energy development, while also minimizing impacts on existing uses.

2. One new tool created to aid in the site selection process is the Technology Development Index (TDI), developed by Spaulding et al. (2010a). The TDI is defined as the ratio of the Technical Challenge Index (TCI) to the Power Production Potential (PPP). TCI is a measure of how difficult it is to construct a device (e.g. an offshore wind facility) at a given location plus a measure of the distance to the closest electrical grid connection point. This measurement can be expressed as the cost in dollars of installation, or if cost data is unavailable, as a relative estimate ranked by the level of difficulty based on professional judgment (i.e. 1 to 5, with 5 being the most difficult). The PPP is an estimate of the annual power production possible at the location measured in watts, determined from wind resource measurement. In other words, the TDI is a quantitative measure of how difficult it would be to develop a facility at a given location, taking into account construction challenges and expenses, and how much power production may be possible at a site. Sites with the lowest TDI value represent the optimum sites for development.

$$\text{Technology Development Index (TDI)} = \frac{\text{Technical Challenge Index (TCI)}}{\text{Power Production Potential (PPP)}}$$

$$\text{TDI} = \frac{\text{Measure of the Technology Required (e.g. foundation) + Cable Distance}}{\text{Measure of the Extractable Energy in Watts}}$$

3. To develop a TDI value for all areas within the SAMP boundary, Spaulding et al. (2010) calculated PPP and TCI values using a 100 meter by 100 meter grid. First, the wind speed data, shown in Figure 22, was converted to wind power per unit area.[30] While the mean wind speed increases gradually with distance offshore, from 7 to 9.6 m/sec (15.7 to 21.5 mph) (a 37% increase), wind power increases by a factor of 2.6. This is due to the relationship between wind speed and potential power. The power output of a wind turbine increases by the cube of wind speed, so even a small increase in wind speed can substantially increase the amount of potential power production. The TCI value was calculated using a number of assumptions: the use of jacket foundations at all sites, cost estimates based Roark (2008) and water depth measurements of the site (see Figure 23); and cable distance estimates calculated

[30] Spaulding et al. (2010d) have performed a detailed comparison of model predictions to observations in the study area. The difference between predictions and measurements is normally distributed with an average value of about 0.17 m/sec and a standard deviation of 0.15 m/sec.

based on the closest straight-line distance to shore.[31] Because the effort (and cost) of installing lattice jacket structures (especially pile-driving activities) is known to be sensitive to composition of the seabed sediments within the upper 30 to 50 m (98.4 to 164.0 feet) of the sediment column, Spaulding et al. (2010a) adjusted TCI values for the impacts of seabed geology. The seabed geology in the SAMP area is dominated by glacial end moraine and lake floor sediments which were deposited in several incidents of glacial advancements and retreats (Boothroyd 2009). A map of construction effort (see Figure 24) was developed by glacial geological experts familiar with the Ocean SAMP waters, ranking areas on a scale of 1 to 5 (pers. comm. Boothroyd and King as cited in Spaulding et al. 2010a) (for more information on the geology of the SAMP area see *Chapter 2 Ecology of the Ocean SAMP Region*). A low ranking indicates deposits amenable to pile driving operations, while the highest values reflect areas with shallow depth to bedrock, which would require drilling and grouting techniques to install the piles. Intermediate values (level 3) are indicative of complex end moraine sediment deposits, consisting of a mix of lake floor sediments and sand, gravel, and boulders of varying size. Figure 24 is an initial estimate of construction effort and will be refined as additional sub-bottom mapping and geotechnical studies of the SAMP area are completed.

4. The resulting TDI values for the entire SAMP area are shown in Figure 25.[32] The red shaded areas represent the most difficult locations to develop an offshore wind facility. When geology is included, the range of TDI values equal 1 to 3.5, with the largest TDI values corresponding to the areas of highest construction effort. Near the coast, TDI values are generally high in spite of low TCI values (due to shallow water depths and close proximity to shore) because the available wind energy in these areas is low. TDI values decrease with continuing distance off shore because the wind energy grows substantially, even though water depth continues to increase. Variations from this general pattern are principally a result of the bathymetric variations and the distribution of glacial end moraine and lake floor sediments deposits. For example, variations in TDI values near the Rhode Island coast, south and west of Block Island, and the shallower area in the vicinity of Cox's Ledge and Southwest Shoals in the center of Rhode Island Sound can be attributed to bathymetric variations in those areas. The optimum (lowest TDI) site in state waters is the shallow areas south and southwest of Block Island. For federal waters the optimum site, if distance to shore is considered, is the deep-water tongue located between two end moraine deposit sequences just landward of Cox's Ledge and Southwest Shoals in the center of RI Sound.

[31] Roark (2008) calculated that the cost of a jacket wind turbine support structure increased from $ 3.36 million in water depths 5 to 25 m, to $ 4.48 million in water depths 25 to 45 m, to $ 5.76 million in water depths 45 to 65 m.
[32] TDI values represented were converted to a non-dimensional form by dividing by the lowest possible TDI in the study area. The non-dimensional TDI values are from 1 and higher, where values close to 1 represent optimum sites.

Figure 23. SAMP Area Bathymetry.

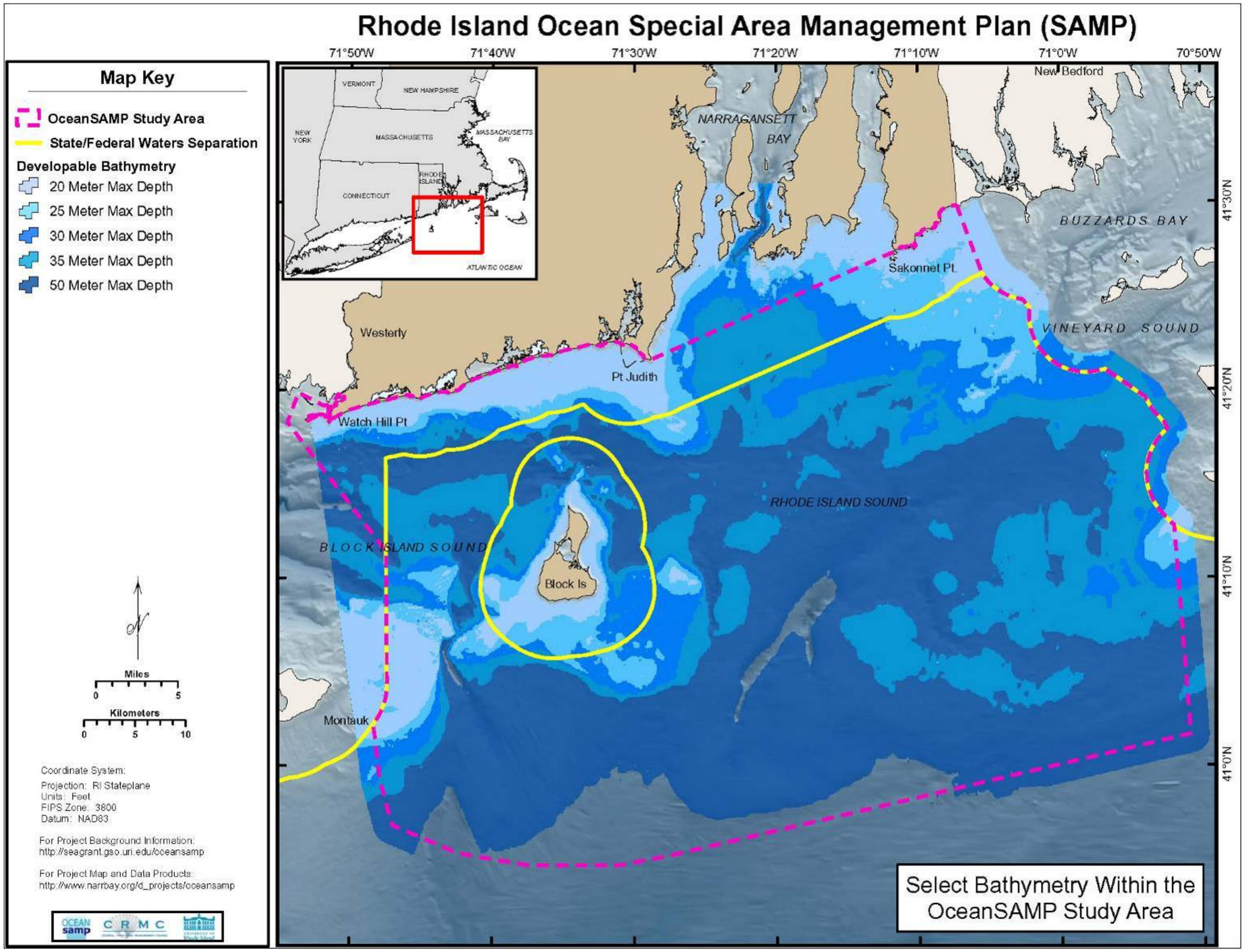


Figure 24. Estimated Construction Effort Based on Seabed Geology and Glacial Deposits (Boothroyd and King as cited in Spaulding et al. 2010a).

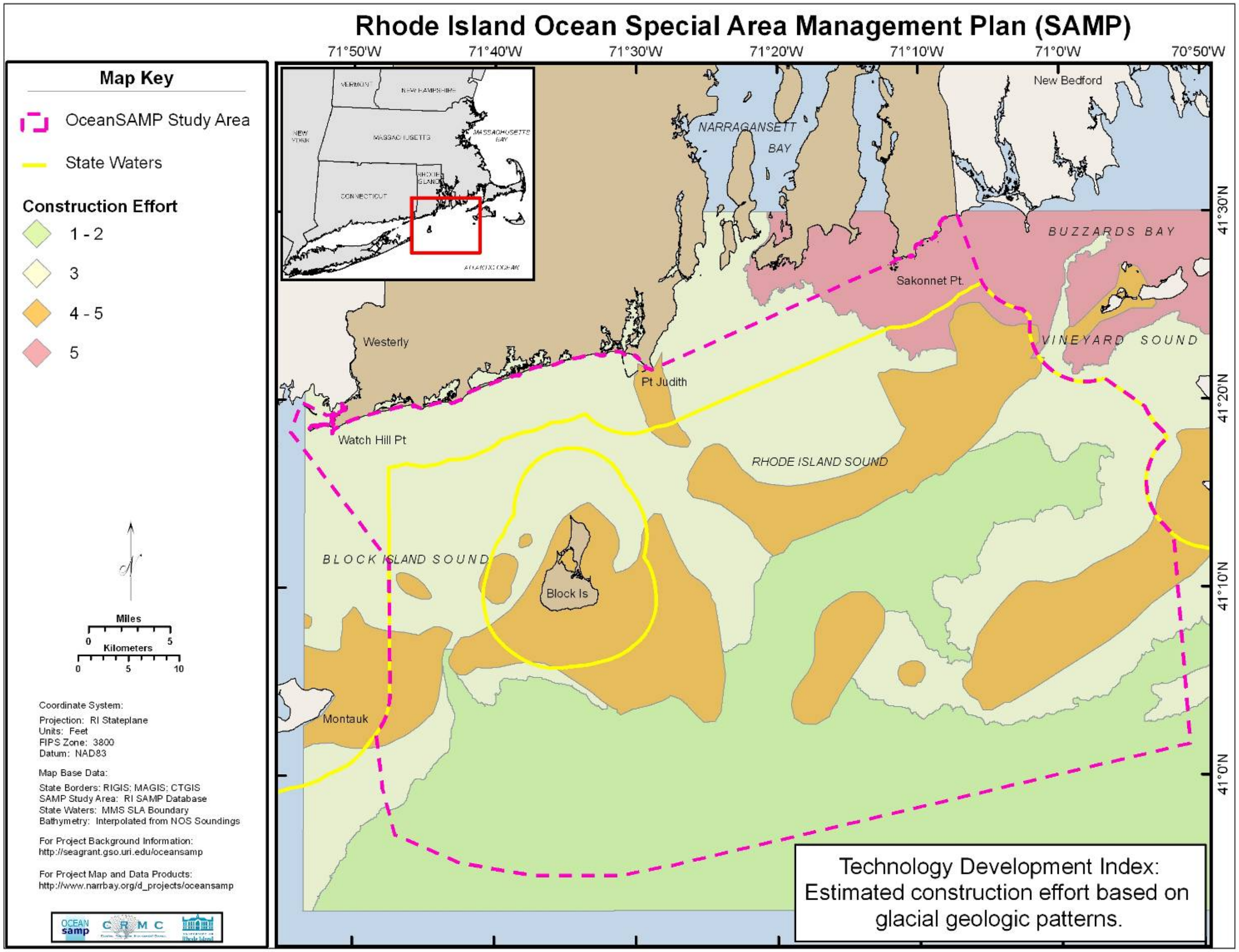
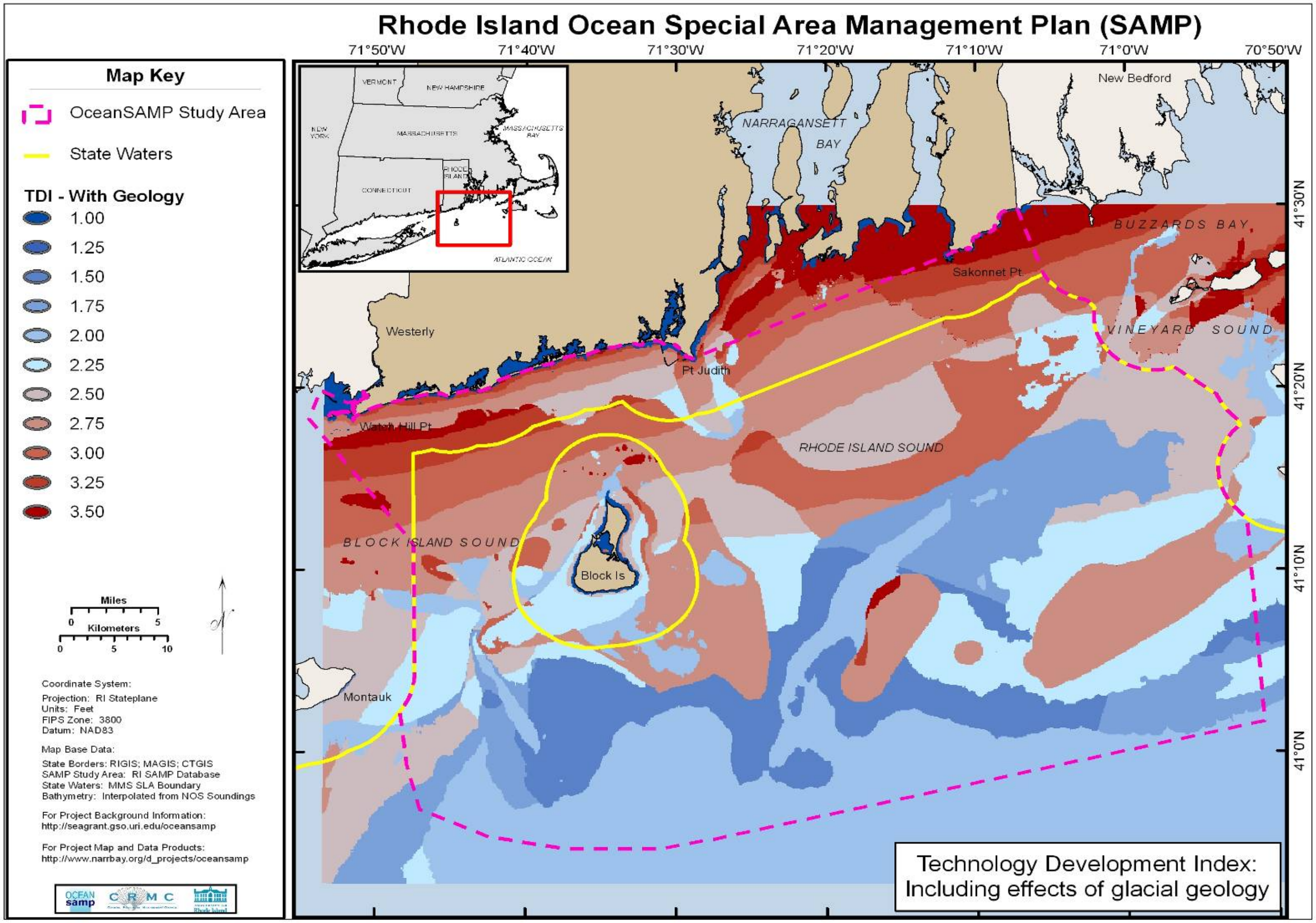


Figure 25. SAMP Area Non-Dimensional Technology Development Index with Geology.



5. Further refinement of the site selection process was conducted by Spaulding et al. (2010a) excluding areas of hard constraints or areas where incompatible uses occur. Existing uses or restrictions considered as hard constraints by Spaulding et al. (2010a) included: regulated marine transportation areas (such as shipping lanes, precautionary areas, preferred routes, ferry routes), regulated uses (disposal sites, unexploded ordnance, marine protected areas and conservations zones, military areas), areas permitted or licensed for existing developments (oil and gas, offshore renewable, aggregate extraction, aquaculture), setbacks from airports, and a coastal buffer zone (see Figure 26). This analysis is performed by overlaying GIS layers for each of the uses, with each layer further reducing the area considered for offshore renewable energy development. Figure 27 is an example of such an analysis (Tier 1 Analysis), where TDI values greater than 3.0 and the following areas were excluded:

   - Designated Shipping Lanes and Precautionary Areas
   - Recommended Vessel Routes
   - Ferry Routes
   - Areas with > 50 Records of Commercial Ship Traffic (AIS Data)[33]
   - Dredge Disposal Sites
   - Military Testing Areas
   - Unexploded Ordnances
   - Airport buffer zones[34]
   - Coastal buffer zone of 1 km (0.6 miles)[35]

   The areas remaining after the excluded areas were removed are illustrated in Figure 28.

[33] Automatic Identification System (AIS) is a transponder-based ship tracking system required aboard certain commercial vessels. See *Chapter 7 Marine Transportation, Navigation and Infrastructure* for more information on AIS and the data set used in this analysis. The value of vessel traffic density (i.e. > 50 Records of Commercial Ship Traffic) is not a hard constraint but instead a matter of subjective judgment. A sensitivity study was performed varying this threshold and showed that at densities higher than 50 captured the major shipping activities in the area.

[34] Airport buffer distances were determined by the Federal Aviation Administration and are based on runway size. The Block Island airport has a 10,000 ft [3,048m] buffer, and the Westerly airport has a 20,000 ft buffer, however these airport buffers overlap the 1 km coastal buffer zone and therefore were already excluded.

[35] This coastal buffer zone was set based on the fact that there is likely to be significant recreational use of the waters close to the coastline (e.g. swimming, boating, diving, fishing) that potential development may interfere with. In addition, this coastal buffer was also set in part to avoid areas where construction and maintenance support of the facilities may be difficult (e.g. sufficient draft and operational area for construction vessels, zone where waves break because of shallow water depths).

Figure 26. Exclusions Used in the Tier 1 Analysis by Spaulding et al. 2010.

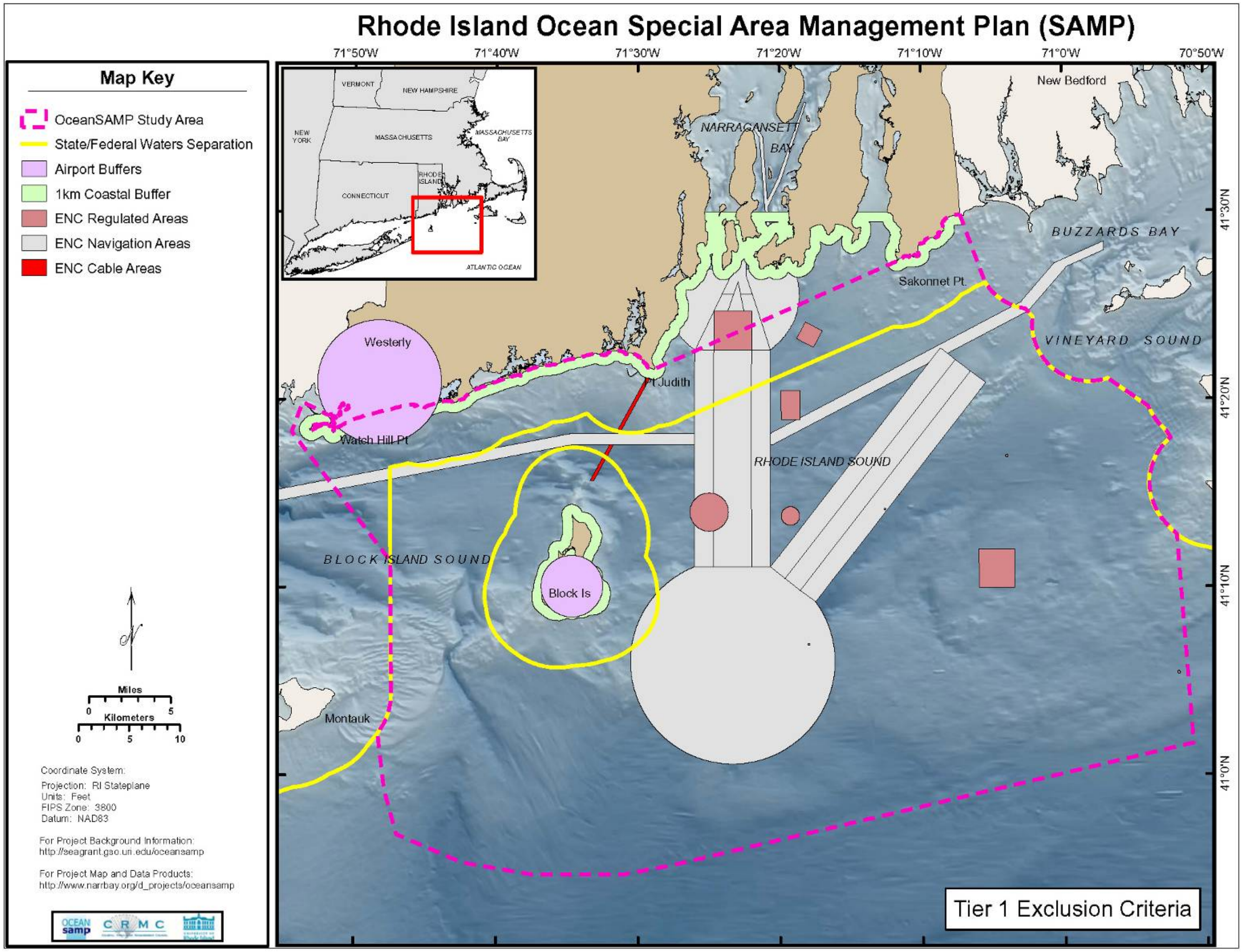
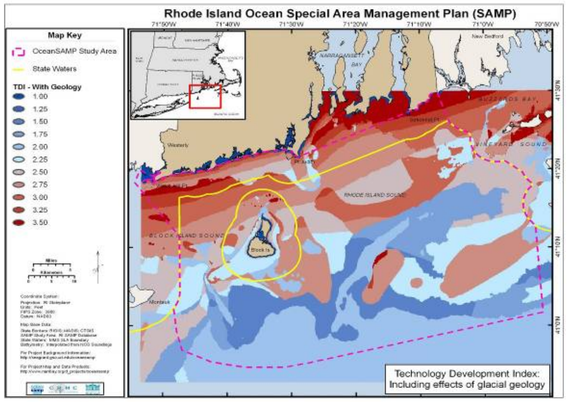
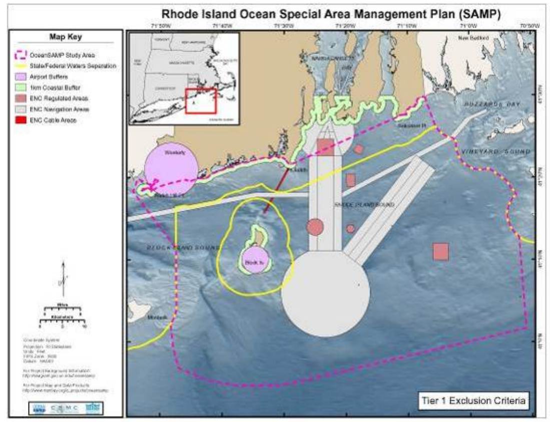
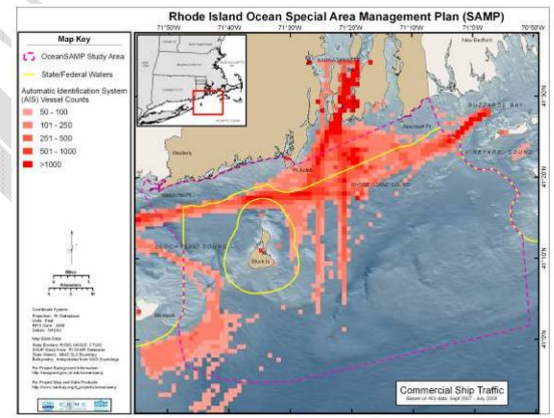


Figure 27. Schematic of the Data Layers Used in the Tier 1 Analysis.

TDI< 3.0 - **Excluded Areas** - **Areas AIS >50 Counts**







Tier 1 Results

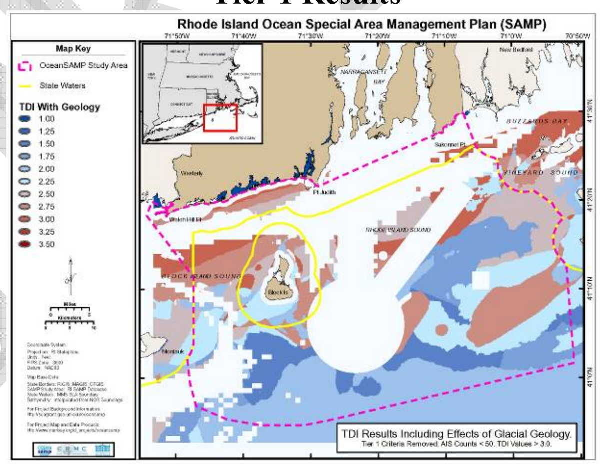
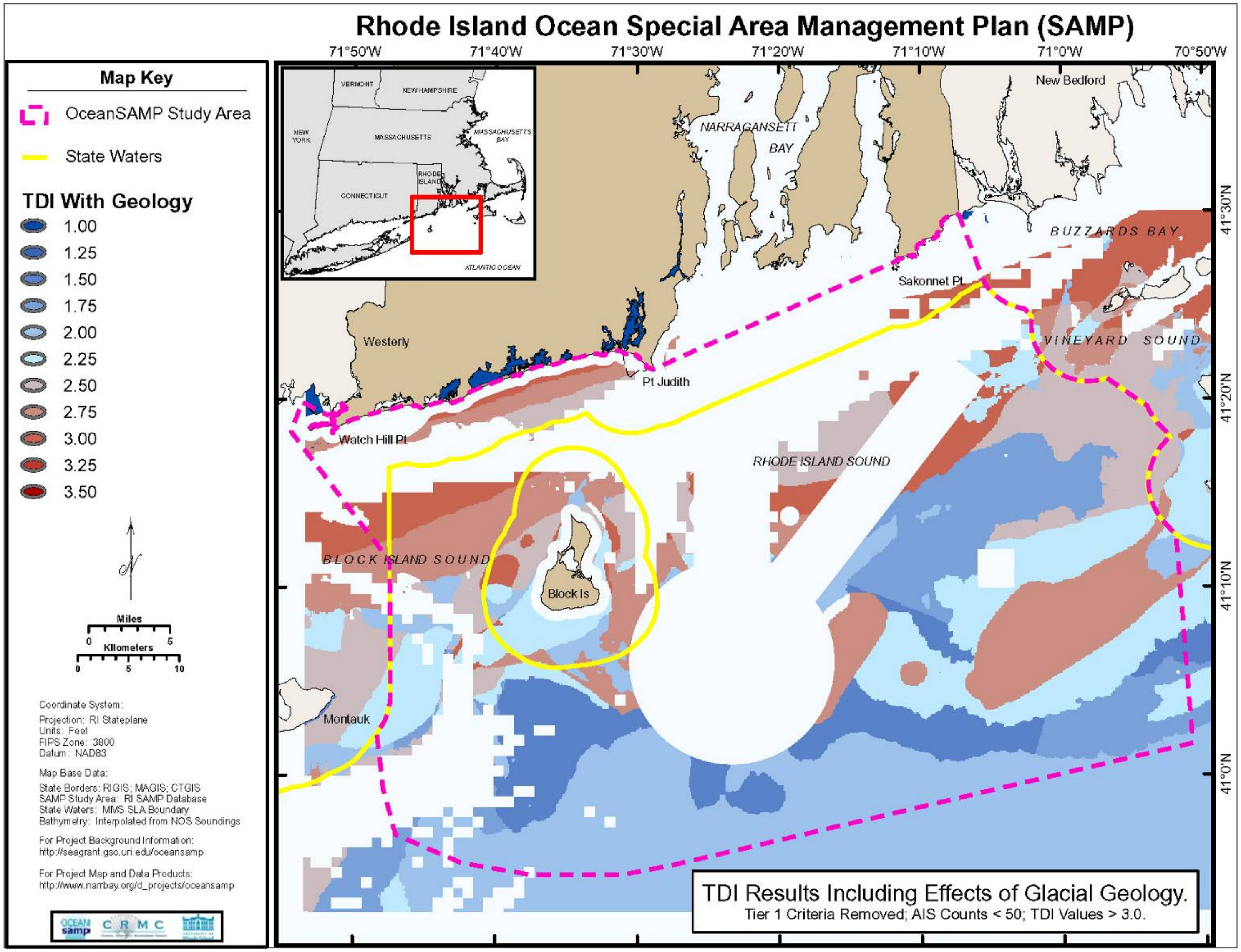


Figure 28. Map of Tier 1 Analysis of the SAMP Area.



6. A review of the results of the TDI Tier I analysis, with a focus on potential sites for offshore wind development in state waters, shows that the best location is south of Block Island. The value of the TDI in this area is about 2.25 to 2.5. This compares to values of 2.75 or higher in state waters adjacent to the southern Rhode Island coastline. In this region, while water depths are generally low, and hence the technology challenge is low, the wind power is low given the proximity to land and its enhanced roughness. South of Block Island the water depths are deeper but the wind power is considerably higher and hence is the most suitable site in state waters, based on the TDI analysis.

7. A higher resolution TDI analysis was performed by Spaulding et al. (2010b) focusing on the waters south of Block Island to provide a more detailed understanding of the potential for offshore wind energy development in this area. The same type of analysis described above for the Tier I analysis was performed concentrating on the waters south of Block Island. First, the bathymetry was examined (see Figure 29). Next, a construction effort map was generated by University of Rhode Island researchers.[36] The map is based on high resolution (250 m [820 feet] track line spacing) side scan and sub-bottom profiling data collected by King, with interpretation of seabed surface geology by Boothroyd and Oakley and sub seabed geology by King and Pockalny. The construction effort ranged from 1 to 5 (see Figure 30), and was consistent with the construction effort calculations of the TDI Tier I analysis (Spaulding et al., 2010). Due to a lack of physical data for several areas south of the state water boundary, construction effort has been estimated for these locations based on the large scale glacial geology. However, data from boring samples collected at eight sites were used to support the construction effort values generated for this area.[37] Lastly, wind speed data at 80 meters (262.5 feet) above the sea surface were mapped (see Figure 31) and combined with the construction effort map to generate TDI values for the area (see Figure 32). A second set of wind speed data was analyzed in this high resolution TDI. The results of the analysis using this alternative set of wind data illustrate very similar results and therefore are not described here, though they are presented in Spaulding et al. (2010b).

[36] URI Researchers John King and Rob Pockalny, Graduate School of Oceanography and Jon Boothroyd and Brian Oakley, Geosciences generated the construction effort maps shown.

[37] Chris Baxter, URI Ocean Engineering, reviewed data from boring logs (typically 65 m in depth) that DeepWater Wind (DWW) collected at eight sites in the study area, SE of Block Island. Based on this data and his review of the construction effort maps he has developed a scaling factor of 1 for CE 1-2, 1.5 for CE-3, 1.8 for CE 4-5, and 2.2 for CE 5.

Figure 29. Bathymetry of the Area South of Block Island

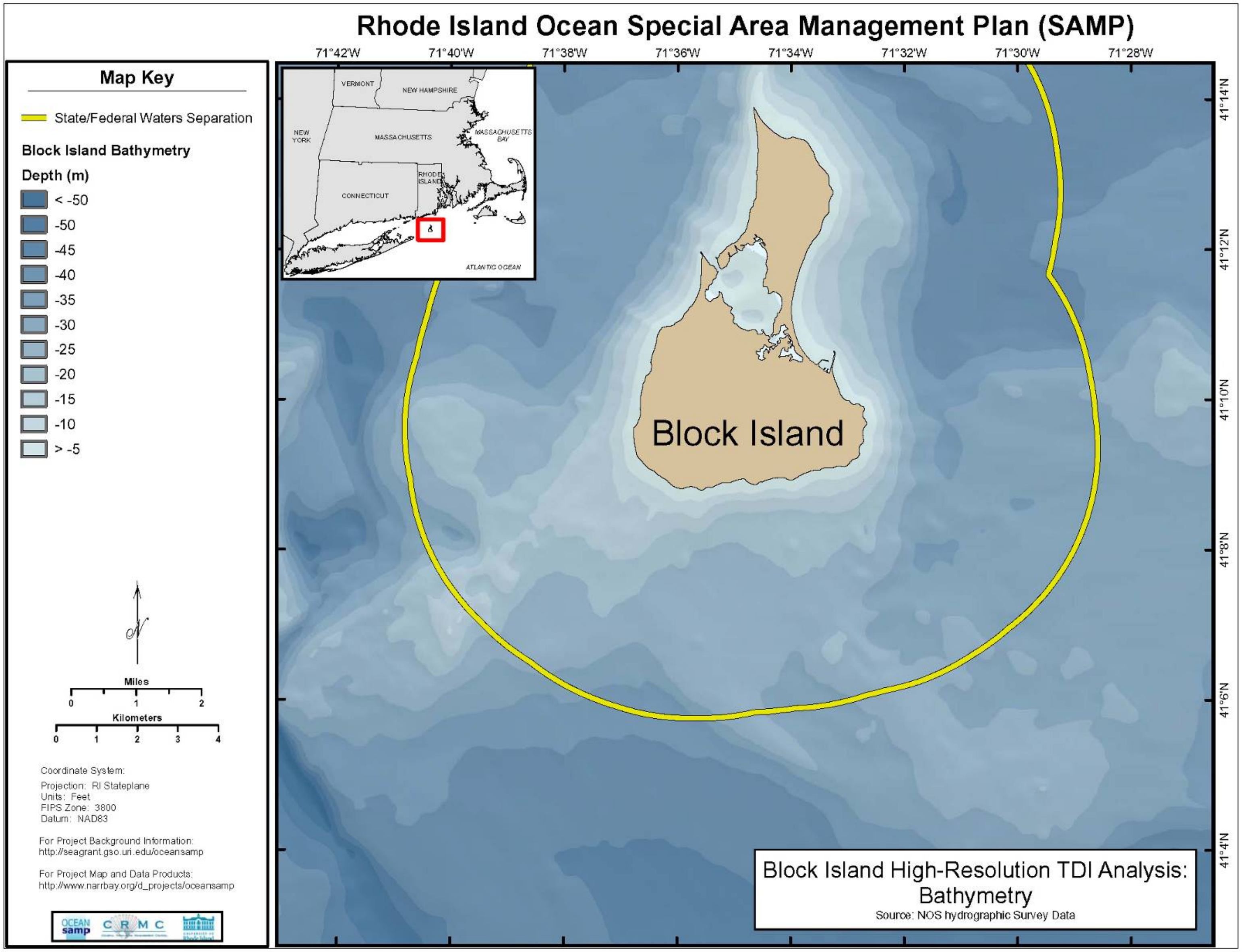


Figure 30. Estimated Construction Effort of the Area South of Block Island Based on Interpreted Glacial Geology.

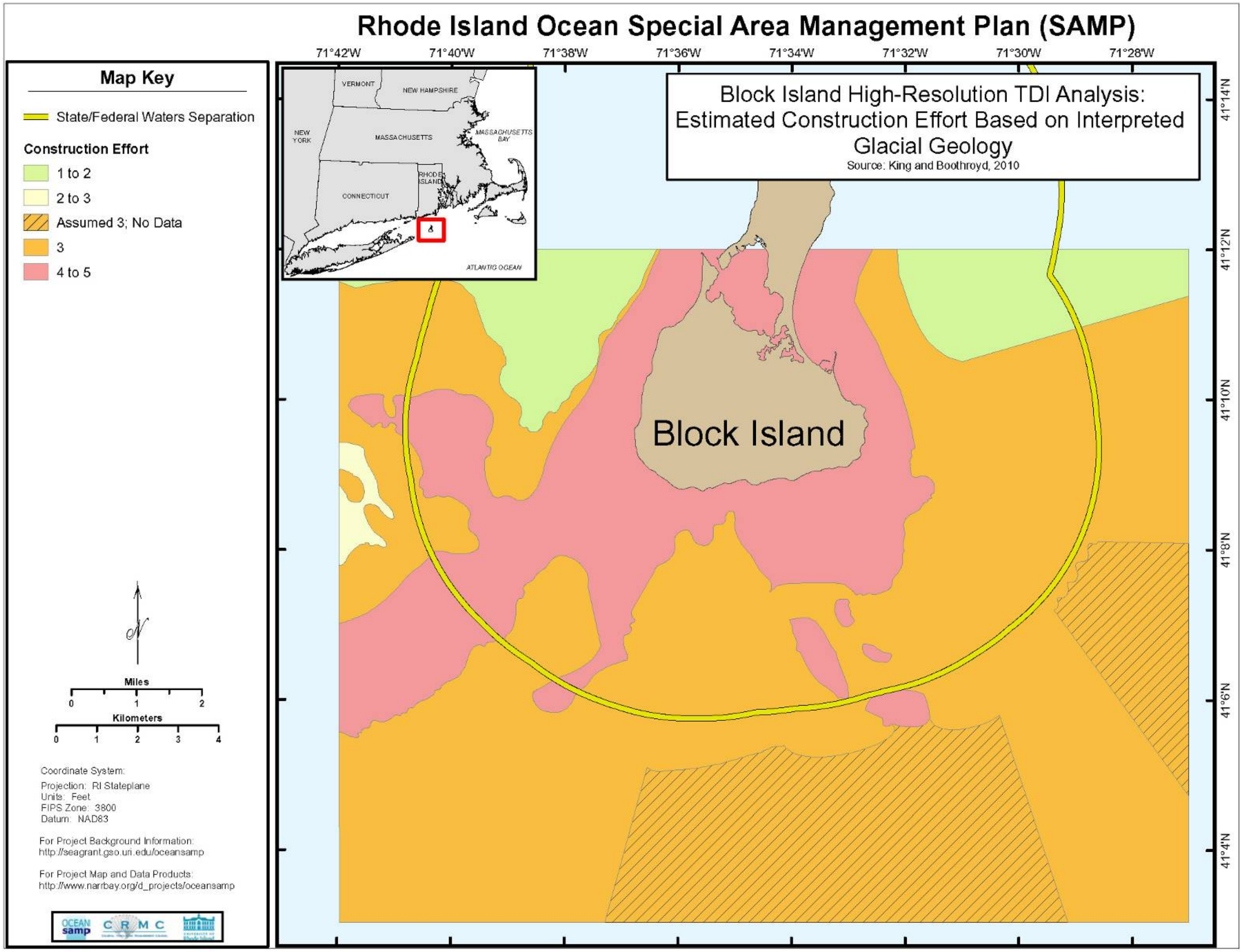


Figure 31. Estimated Wind Speed South of Block Island at 80 Meters Above the Sea Surface.

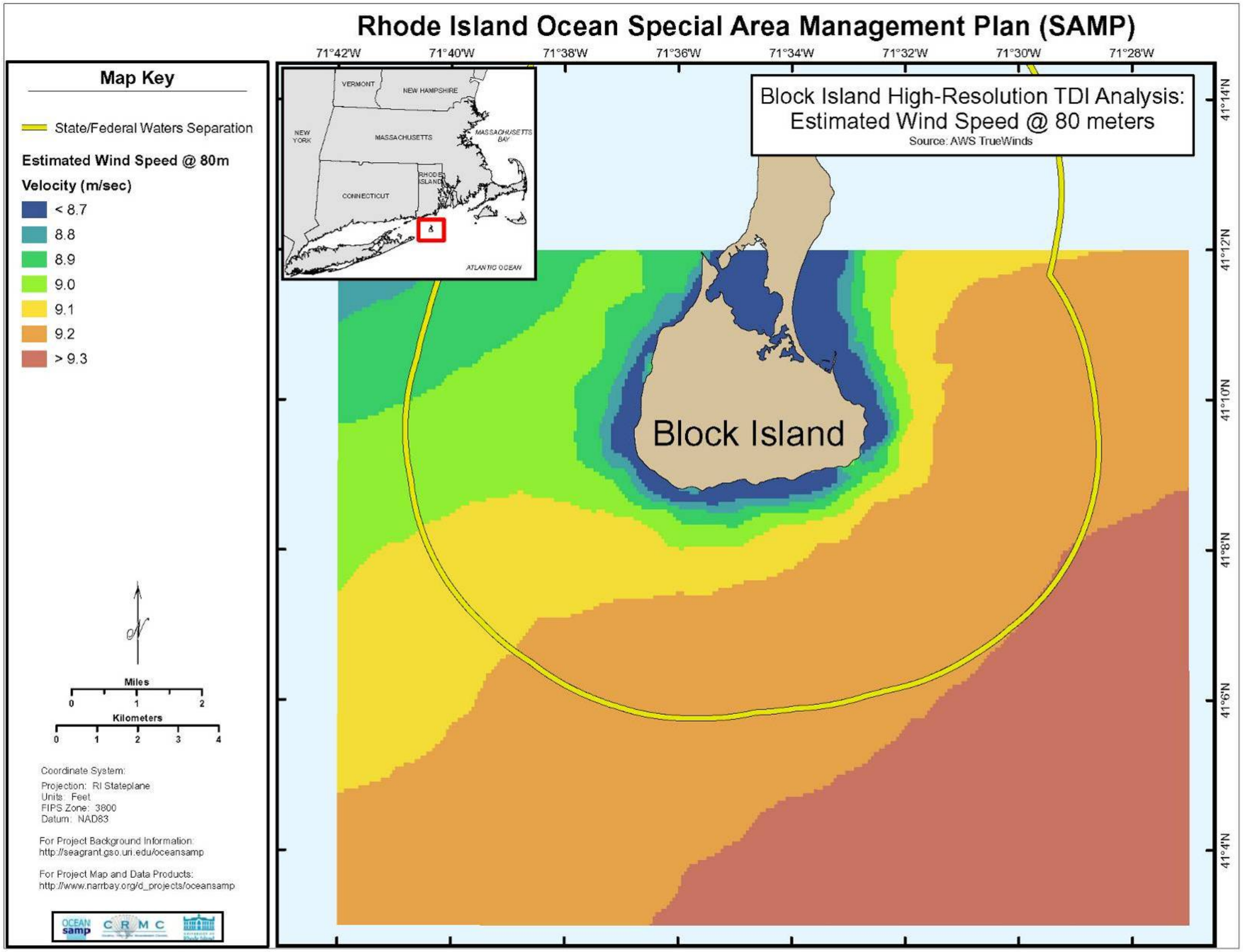
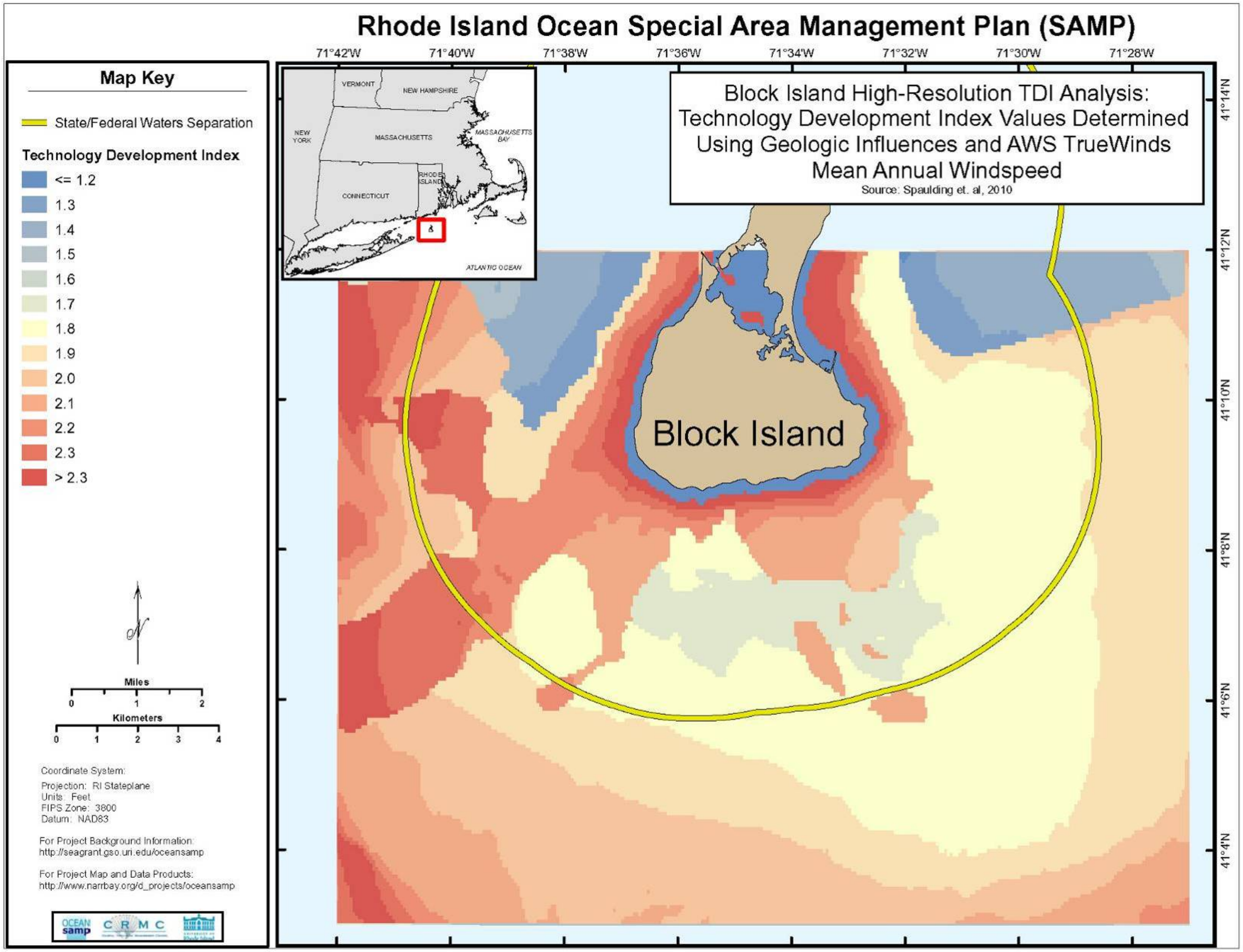


Figure 32. Non-Dimensional TDI Values for the area South of Block Island.



8. Similar to the analysis performed in the Tier I TDI analysis, areas with hard constraints were excluded (see description above). As the only hard constraint relevant to this area was the exclusion of the precautionary area and areas with more than 50 records of commercial ship traffic an analysis of AIS data was conducted. Figure 33 shows the excluded areas where AIS data taken over one year recorded over 50 commercial vessels. After excluding areas of high commercial ship traffic and the designated precautionary area (see Figure 34), the remaining areas south of Block Island with low TDI values provide the basis for establishing a suitable zone for offshore renewable energy development. While some of this area may not be viable due to environmental considerations, the TDI analysis has narrowed down the waters within the SAMP area to be considered for offshore renewable energy development. For further discussion of the selection of a renewable energy zone in the SAMP area see Section 830.4.

9. Tools such as the TDI, can be applied to the site selection process conducted for any type of development project. Spaulding et al. (2010) apply the TDI analysis to offshore wind energy development, though this process may help to inform a multitude of future uses in the SAMP area. In addition, the criteria used in the Tier 1 analysis may be modified or expanded to best reflect areas that should be excluded from future development. A complete description of the formation and application of the TDI can be found in Spaulding et al. 2010.

Figure 33. Areas South of Block Island with AIS Vessel Counts Greater than 50.

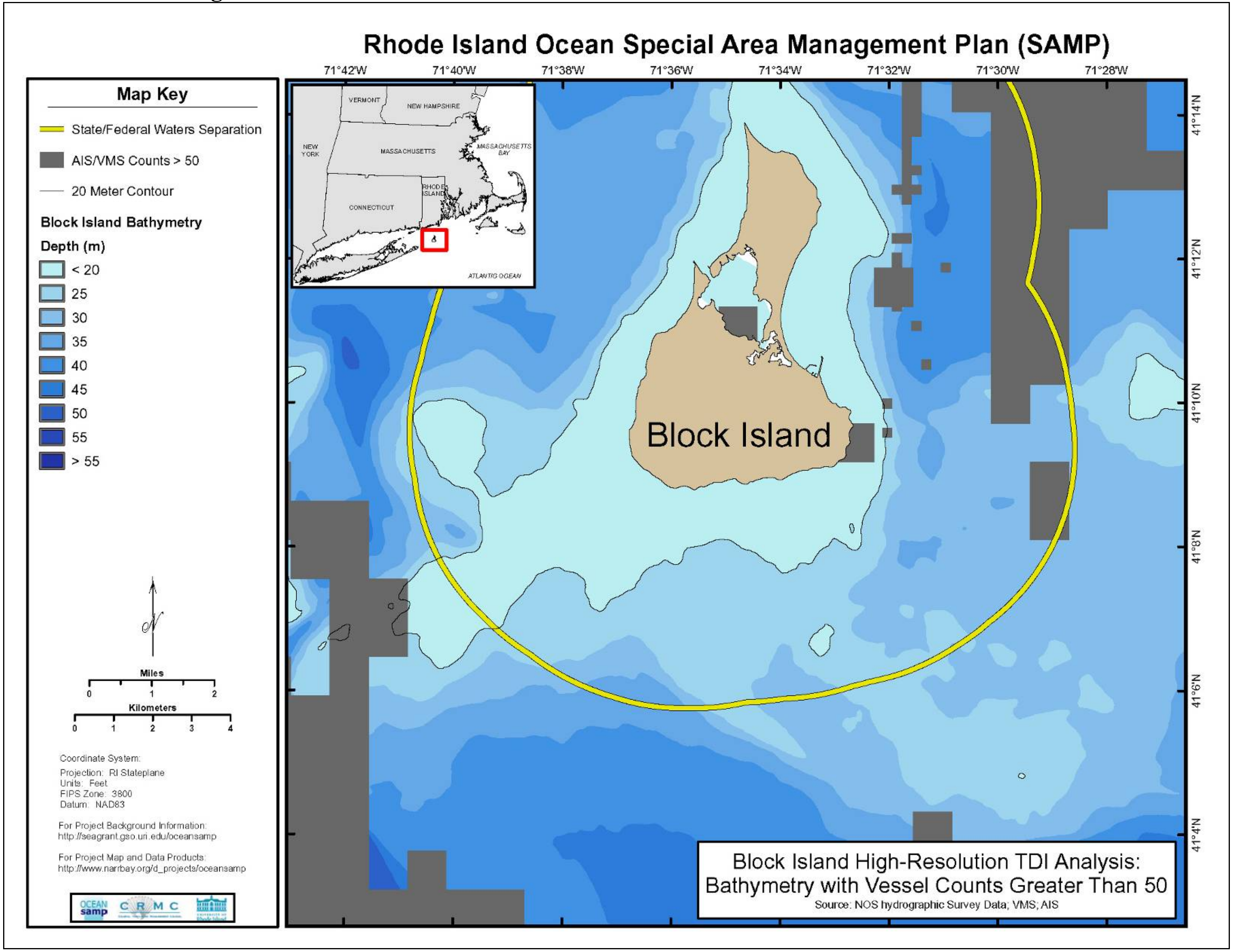
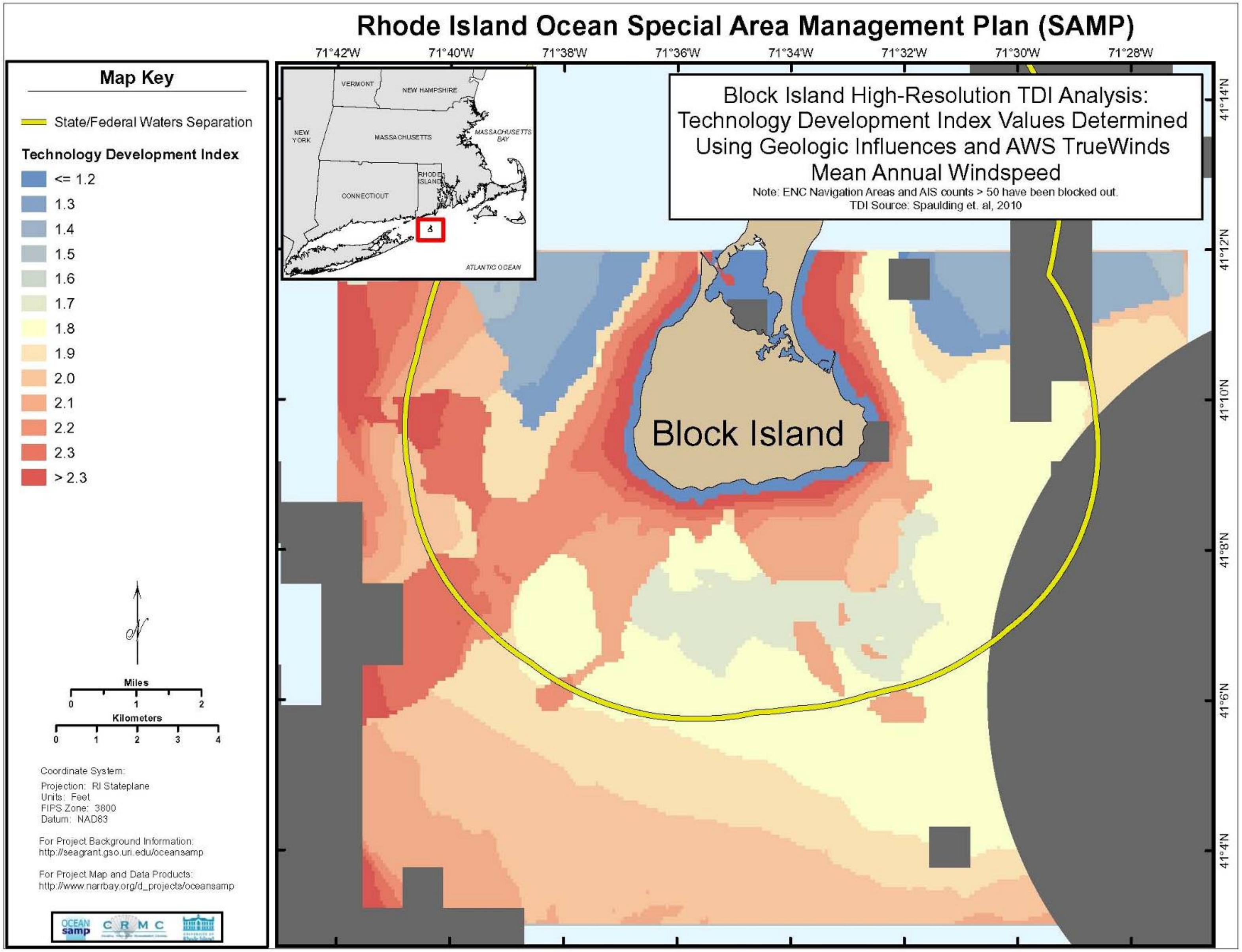


Figure 34. Non-Dimensional TDI Analysis of the Area South of Block Island with Exclusions



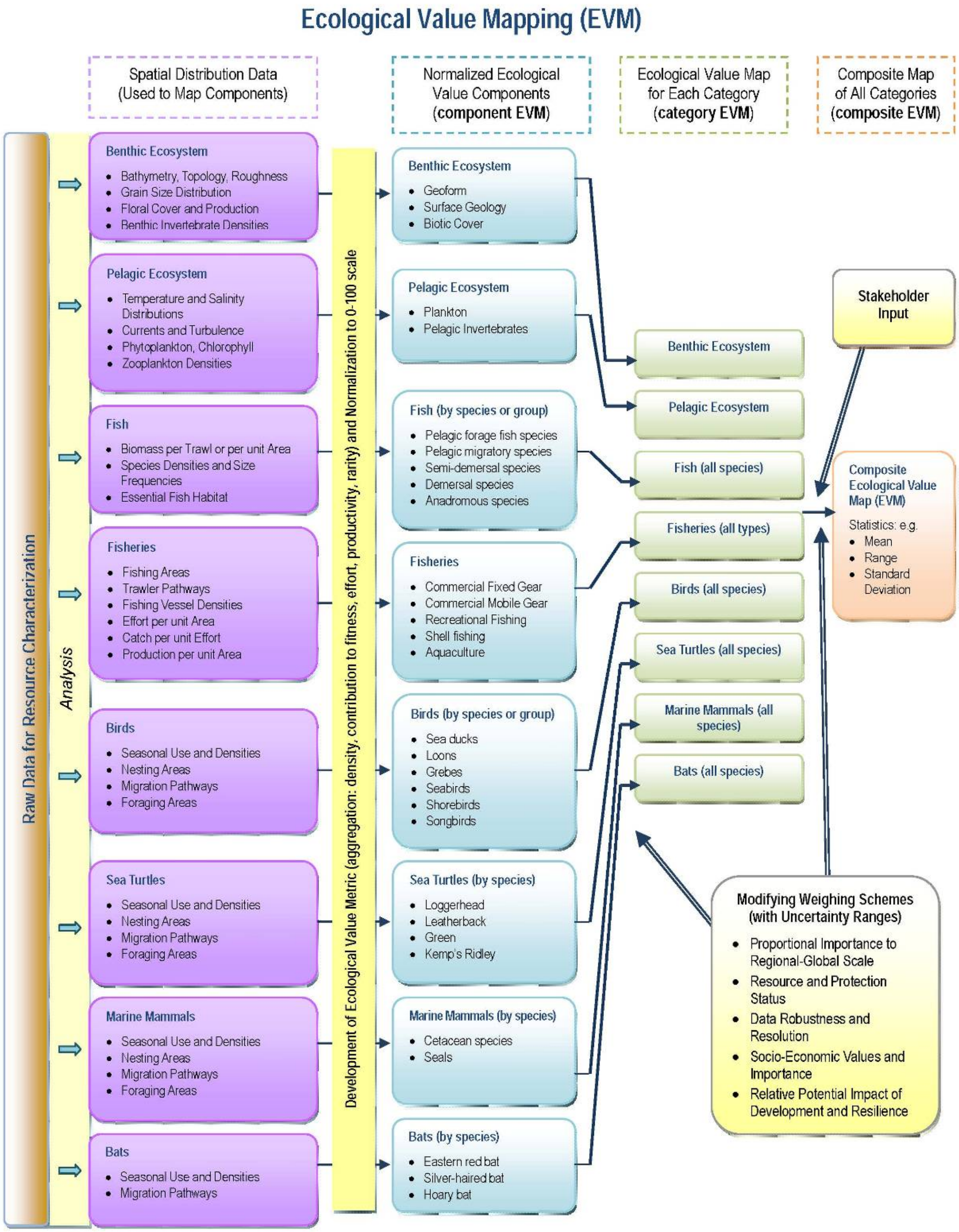
830.3 Siting Analysis- Ecological Value Map

1. A second tool developed to help identify areas most suitable for offshore renewable energy development is the Ecological Value Map (EVM) created by French-McCay and Grilli (2010). As part of the EVM framework, French-McCay and Grilli (2010) modeled the ecological value of the SAMP area by inputting geospatial data describing the geophysical environment, fish and wildlife species distribution, ecosystem and habitat characteristics, as well as human uses, such as fishing activity collected by Ocean SAMP researchers. For this analysis, French-McCay and Grilli (2010) defined 'ecological value' to include both the intrinsic value of biodiversity and the socioeconomic value associated with the goods and services provided by the marine ecosystem (e.g. fishing activity). See French-McCay and Grilli (2010) for more information on the development and application of EVM.

2. The process used by French-McCay and Grilli (2010) is illustrated in Figure 35. First, separate EVMs were generated for individual species based on aggregation data collected and modeled over a 100 meter grid across the SAMP area (the same grid used by the TDI analysis described in Section 830.2).[38] The species specific EVMs were then combined to create group EVMs, resulting in EVMs for the following categories: benthic ecosystems, pelagic ecosystems, fish, birds, sea turtles, marine mammals, bats and fisheries. This grid is the same grid used by the TDI analysis described in Section 830.2. French-McCay and Grilli (2010) used alternative weighing schemes when combining species maps into group maps to reflect relative intrinsic and service values, as well as uncertainties in the underlying data. The researchers then combined all category EVMs, across all resources, to create a composite EVM for the entire SAMP area. In the end, the EVM framework provides a tool to help identify portions of the SAMP area that have greater ecological value. Understanding where these zones of greatest ecological value exist in the SAMP area may help in determining appropriate sites suitable for an offshore renewable energy development.

[38] To quantify distributions and relative densities of specific species, French-McCay and Grilli (2010) applied the wildlife movement (migration and behavior) model (WILDMAP™). This model is based on life history information, nesting/breeding and foraging locations, and available observational data for the species evaluated. The model predictions are then ground-truthed by presence/absence, abundance, frequency and spatial observational data. For more information on the WILDMAP model used to predict usage by marine life see (ASA 2010).

Figure 35. Framework for Ecological Valuation Mapping as applied to the RI Ocean SAMP (French-McCay and Grilli 2010).



4. To complement the EVM framework, French-McCay and Grilli (2010) also performed a principal component and cluster analysis on the maps of species distribution to identify homogeneous areas within the SAMP boundary and generate an Ecological Topology Map of the SAMP area. To accomplish this, French-McCay and Grilli (2010) used principal component analysis to identify what factors best explain species distribution (e.g. bathymetry, water temperature, fishing activity). The researchers then use cluster analysis to identify similar zones within the SAMP area, in terms of biodiversity and ecological structure, and generate an ecological topology map. This type of analysis may also provide a useful tool when siting offshore renewable energy facilities, as it provides information on what factors are influencing biological distributions in the SAMP area. For more information on the principal component and cluster analysis used please see French-McCay and Grilli (2010).

830.4 Selection of Suitable Sites

1. Although the TDI analysis provides a tool to identify potentially suitable sites for offshore renewable energy development, because the research associated with the Ocean SAMP is not yet complete selecting a suitable site is not yet possible.

Section 840: Potential Economic Effects of Offshore Renewable Energy in the SAMP Area

840.1 Port Development and Job Creation

1. The Port of Quonset/Davisville has the potential to become a staging area for offshore wind energy construction activities. The port features include deep-water capacity (a depth of 30 feet [9.1 m]), and two piers that are 1,200 feet [365.9 m] in length. These features may allow it to accommodate the construction and transport vessels used during the facility's installation. In addition to the draft and length of its piers, the load bearing capacity of Pier 2 exceeds 1,000 pounds per square foot [4,890 kg/m^2] which makes it capable of holding the weight of the large offshore structures (Minerals Management Service 2009a). Future use of local port facilities for the construction staging areas may also result in improvements or upgrades to current infrastructure.[39] See *Chapter 7 Marine Transportation, Navigation and Infrastructure* for more information on Quonset/Davisville.

2. If Quonset/Davisville were to become a staging area for offshore wind energy construction activities, the economic impact of these activities may contribute to local economies as well as Rhode Island's economy as a whole. Direct economic impacts would result from the hiring of manufacture, assembly, construction and operations workers, and the purchase of non-labor goods and services. Goods and services that may be purchased in Rhode Island to directly support the construction and operation of an offshore wind energy facility may include: concrete, steel, barge services, purchase or lease of vessels and equipment. Indirect and induced economic effects may result from activities such as local vendors replacing their inventory, or the spending of new hires (Minerals Management Service 2009a).

3. While the impact of offshore wind energy development on Rhode Island's economy will vary depending on the project, Table 10 provides one example of the scale of economic impact the construction and operation of an offshore wind energy facility may have on surrounding communities. While these figures cannot be applied directly to offshore wind energy development in the SAMP area, it does suggest that large, utility-scale offshore wind projects have the potential to generate millions of dollars in economic activity and support a number of new jobs.

[39] Waterside improvements proposed as part of constructing the wind facility may be subject to additional state and federal permitting.

Table 10. Total Economic Impact of the Cape Wind Energy Project on the Local, State and Regional Economies (Global Insight 2003; Minerals Management Service 2009a).

Construction and Installation Phase	• 597 - 1,013 direct, indirect, and induced full-time jobs created
	    o 391 direct full-time jobs
	    o 206-622 indirect and induced jobs
	• Total State economic output will increase $85 - $137 million annually
	    o Value added will increase $44 - $71 million annually
	• Wages of $32 - $52 million annually
	• $9.2- $14.8 million annually in increased property income (rent, dividends and interest, corporate profits)
	• $4.8-$7.8 million in increased personal income tax revenue
	• $1.3-2.6 million in increased corporate income tax revenue

Operational Phase	• Approximately 50 direct jobs, and 104 indirect and induced jobs • Wages of approximately $6.9 million annually • $21.8 million in State output, $10.2 million in value added • $16 million in annual purchases to maintain facility

4. Because Quonset/Davisville have been considered as a potential staging area for proposed offshore wind energy projects outside the SAMP area (e.g. the Cape Wind Energy Project), Rhode Island may also benefit from the economic impact of any regional offshore renewable energy development. The Cape Wind Energy Project, Final Environmental Impact Statement (Minerals Management Service 2009a) estimated that the Rhode Island economic impact from the manufacturing, assembly, construction and installation of this project would include:
   - 237 Rhode Island jobs directly related to manufacturing, assembly, construction and installation activities;
   - $32.4 million in wages over 27 months;
   - $360 – 410 million in purchases of non-labor goods and services;
   - $180.6 – 292 million annual increase in total output for Rhode Island;
   - $93.3- 151 million annual increase in value-added;
   - $19.6 – 31.5 million annual increase in Rhode Island property income (rent, dividends and interest, corporate profits); and
   - $2.8 – 4.5 million in increased revenue from corporate income taxes.

5. In February 2010, Quonset Development Corporation was awarded a $22.3 million Transportation Investment Generating Economic Recovery (TIGER) grant from the US Department of Transportation (Rhode Island Economic Development Corporation 2010b). The grant will be used to support infrastructure improvements to the Port of Davisville piers and terminals in the Quonset Business Park including activities such as pier repairs, deck surfacing and marine hardware, rebuilding of rail tracks in the port area, terminal improvements, construction of crane platforms and the purchase of

a crane suitable to load and off load offshore wind turbine components, substructures and foundations. The projects are designed to further support the potential role of Quonset/Davisville as a hub for the emerging offshore wind energy industry (Rhode Island Economic Development Corporation 2010b).

840.3 Electricity Rates

1. Under Rhode Island's Long-Term Contracting Standard for Renewable Energy, energy distributors (i.e. National Grid) is required to sign 10- to 15-year contracts to buy a minimum of 90 MW of its electricity load from renewable developers and up to 150 megawatts from utility-scale offshore wind energy facilities developed off the coast of Rhode Island (see Section 810.2).[40] These long-term contracts, referred to as Power Purchase Agreements, outline how much, and at what price, energy from a renewable energy producer will be purchased by a utility company. Power purchase agreements provide assurances to developers that the power produced by a project will be purchased at a stated price, which may in turn aid a developer in obtaining financing for a project. In addition, power purchase agreements define the purchase price of the renewable energy over many years, allowing utility companies to identify energy costs well in advance. The cost of conventional fuel sources, such as natural gas, varies with the market and result in greater volatility in energy prices. Depending on the prices agreed upon in the power purchase agreement, the effect of offshore renewable energy development in the SAMP area may result in higher or lower electricity rates for Rhode Island residents.

2. One argument is that offshore wind energy may exert downward pressure on electricity rates in Rhode Island and the entire New England region, resulting in overall lower energy prices. The U.S. Department of Energy (2004) notes that as renewable energy generation increases, the demand for natural gas in the electric generation sector is reduced, resulting in overall lower demands for this finite resource. Lower demand may put downward pressure on natural gas prices overall and result in an economic benefit to consumers in both the electricity and natural gas end-user markets. Likewise, the electric industry has also called for greater fuel diversity to alleviate its reliance on limited fuel sources in an effort to reduce electricity prices (U.S. Department of Energy 2004). While the amount of potential reduction in energy prices will vary depending on the project, a recent analysis of the impact the Cape Wind Energy Project would have on New England electricity prices determined that:
    - Adding Cape Wind would lead to a reduction in the wholesale cost of power averaging $185 million annually over the 2013-2037 time period, resulting in an aggregate savings of $4.6 billion over 25 years.
    - With Cape Wind in service, over the 2013-2037 time period, the price of power in the New England wholesale market would be on average $1.22/MWh lower (Charles Rivers Associates 2010).

[40] R.I. Gen. Law §39-26.1

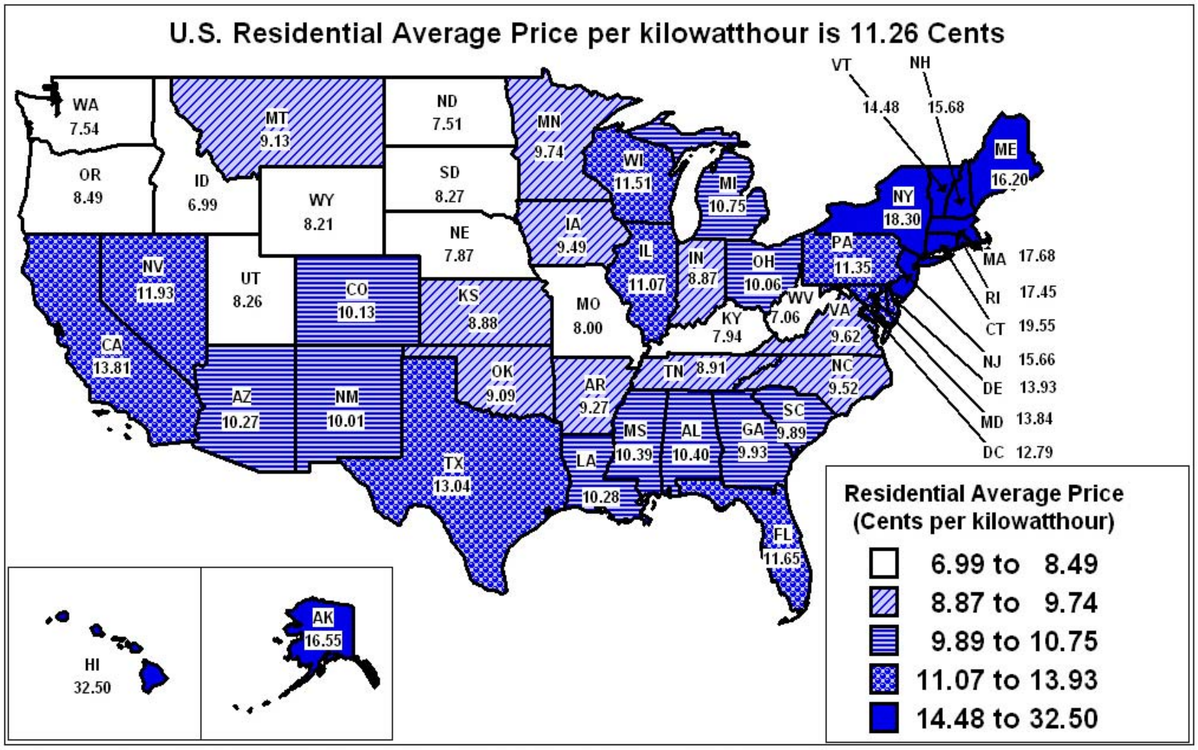
3. Potential benefits of lower electricity rates from offshore renewable energy development in the SAMP area may be most pronounced on Block Island, as residents there currently experience the highest electricity rates in Rhode Island (see also Section 810.1). The electricity rates on Block Island have recently hovered between 30 cents and 40 cents a kilowatt-hour, but in the summer of 2008 it went as high as 62 cents (see Table 11) (Rhode Island Public Utilities Commission 2010b). The average rate for residential customers in Rhode Island during 2008 was calculated to equal 17.45 ¢/kWh (see Figure 36) (U.S. Energy Information Administration 2008). Offshore wind energy development in the SAMP area may provide a cheaper form of energy to Block Island residents, or it may facilitate a connection to the mainland utility grid and access to lower electricity rates through the installation of an underwater transmission cable.

Table 11. Summary of Block Island Residential Electric Rates, January 2008-December 2009 (Rhode Island Public Utilities Commission 2010b).

Month	Total Charge for Electricity (¢/kWh)*
Jan-08	34.23
Feb-08	33.57
Mar-08	34.55
Apr-08	40.59
May-08	40.20
Jun-08	61.07
Jul-08	62.18
Aug-08	56.77
Sep-08	54.18
Oct-08	37.57
Nov-08	32.99
Dec-08	29.99
Jan-09	24.92
Feb-09	21.15
Mar-09	23.90
Apr-09	23.32
May-09	24.10
Jun-09	41.37
Jul-09	41.55
Aug-09	43.68
Sep-09	42.40
Oct-09	27.42
Nov-09	30.24
Dec-09	29.99

* Total Charge for Electricity (¢/kWh) includes all customer, energy and fuel charges.

Figure 36. Average U.S. Residential Electricity Rates in 2008 (U.S. Energy Information Administration 2008)



4. Alternatively, the energy produced from an offshore wind energy facility may result in higher electricity rates, especially as the offshore renewable energy industry in the U.S. is just beginning to develop. The price per kilowatt hour of electricity produced from on offshore renewable energy facility will vary between projects.

840.4 Potential Revenue Sharing

1. In addition to the economic impacts associated with an offshore wind facilities construction and operation activities, Rhode Island may also receive a portion of any federal leasing or operating fees charged for use of public submerged lands.

2. Offshore wind energy facilities installed in U.S. federal waters are subject to annual lease payments and operating fees as determined by the U.S. Department of the Interior, Minerals Management Service. Revenues subject to distribution to eligible States, as described in detail in the Mineral Management Service's Final Rule[41], include all bonuses and acquisition fees associated with the lease, rental fees and operating fees derived from the entire qualified project area and associated project easements (e.g. area used for the transmission cable) (see Table 12). Royalty payments are shared between the state (27%) and federal government (73%) when a coastal State's coastline is located within 15 miles (24.1 km) of the calculated geographic center of the qualified project area. If more than one coastal state is

[41] 30 CFR Parts 250, 285, and 290.

within 15 miles (24.1 km) of a project, revenues will be shared between the states based on proximity to the project.

Table 12. Rental and Operating Fee Equations Used by the Minerals Management Service for Offshore Renewable Energy Project (30 CFR Parts 250, 285, and 290).

Rental Fee = $3.00 * Total Acreage of Project
Operating Fee = Annual Energy Output (MWh) *Avg. Wholesale Electric Power Price ($/MWh) *2%

840.5 Non-Market Value

1. Beyond the economic effects associated with the development of offshore wind energy, future developments may also contribute non-market values to Rhode Island such as a reduction in greenhouse gas emissions from fossil fuels, support for clean energy development, and diversifying the state's energy resources. The reduction in greenhouse gases would have a mitigating impact on global change—reducing harmful environmental impacts at the source. This would also result in cutting back on—but not eliminating—adaptation techniques designed to reduce the inevitable impacts of climate change projections, such as sea level rise. This has a ripple effect on owners of homes and businesses along the coast who are facing problems such as sea level rise and erosion which result in more costly home designs and future required setbacks. For more information on the effects of global climate change to Rhode Island and the SAMP area see *Chapter 3 Global Climate Change*.

Section 850 Potential Effects on Existing Resources and Uses in the SAMP Area

1. Offshore renewable energy may potentially affect the natural resources and existing human uses of the SAMP area. Some effects may be negative, resulting in adverse impacts on these resources and uses. Alternatively, other effects may be neutral, producing no discernible impacts, while others may be positive, resulting in enhancements to the environment or to offshore human uses. The degree to which offshore renewable energy structures may affect the natural environment or human activities in the area varies in large part on the specific siting of a project. Careful consideration when planning the location of an offshore renewable energy facility, as well as the use of appropriate mitigation strategies during the construction, operation and decommissioning stages can minimize any potential negative impacts (Minerals Management Service 2007a).

2. To date, most research on the potential effects of offshore renewable energy installations has been conducted in Europe, though some research has been conducted during the review of the proposed offshore wind farm project in Nantucket Sound by Cape Wind, LLC (U.S. Coast Guard 2009; Technology Service Corporation 2008). In anticipation of future offshore renewable energy development within the U.S., the U.S. Department of Interior Minerals Management Service (MMS) has identified potential impacts and enhancements of such development on marine transportation, navigation and infrastructure in the "Programmatic Environmental Impact Statement for Alternative Energy Development and Production" (PEIS) (Mineral Management Service 2007). These sources, as well as other scientific literature and relevant reports have informed this synthesis of the potential effects on existing resources and uses in the SAMP area. Where possible, research conducted as a part of the Ocean SAMP process has been incorporated to help further assess the potential for effects within the SAMP study area.

3. As presented in Section 810.3, offshore wind energy currently represents the greatest potential for utility-scale offshore renewable energy in the SAMP area. For that reason, the focus of this section is mainly on the potential effects from the development of offshore wind energy facilities. However, many of the potential effects discussed may be similar across all forms of offshore renewable energy development and offshore marine construction in general.

4. While this section is meant to provide a summary of all potential effects of offshore renewable energy development, the potential effects of a particular project will be thoroughly examined as part of the review conducted under the National Environmental Policy Act (NEPA).[42] The review process includes: an analysis of alternatives, an assessment of all environmental, social, and existing use impacts (i.e. ecological, navigational, economic, community-related, etc.), a review for regulatory consistency with other applicable federal laws and the implementation of mitigation measures. See Section 820.4 and *Chapter 10 Existing Statutes, Regulations, and*

[42] 42 U.S.C. §4332

Policies for more information on the NEPA review process, as well as other state and federal reviews and regulations relevant to offshore wind energy development.

5. This section begins with an examination of the potential effects of offshore renewable energy development on the physical environment through a discussion of the potential for avoided air emissions and the potential effects on coastal processes. Next, the potential effects of offshore renewable energy development on the ecological resources, including the benthic ecology, avian species, sea turtles, marine mammals and fish. Potential effects to human uses are then examined through a discussion of cultural and historic resources, commercial and recreational fishing activities, recreation and tourism and lastly marine transportation, navigation and infrastructure. The final section considers the potential cumulative effects of offshore renewable energy development.

Section 850.1 Avoided Air Emissions

1. The development of an offshore wind farm or any other offshore renewable energy project would have implications for air emissions within the state. While the development of a project will produce some air emissions (especially during the construction stage), a renewable energy project, by not burning fossil fuels, will produce far fewer emissions of carbon dioxide and conventional air pollutants. This section summarizes the effects of air emissions produced and avoided by the development of an offshore renewable energy project.

2. Air emissions produced during conventional fossil fuel energy production include carbon dioxide, sulfur dioxide, nitrogen oxides, volatile organic compounds, particulate matter, and carbon monoxide. These pollutants have been demonstrated to have detrimental impacts to human health and the environment. Exposure to poor air quality is a major health risk and health cost in the United States. Smog and particle pollution are the cause of decreased lung function, respiratory illness, cardiovascular disease, increased risk of asthma, and the risk of premature death (U.S. Department of Energy 2008). The largest sources of sulfur dioxide emissions are from fossil fuel combustion at power plants; sulfur dioxide has been linked to respiratory illnesses and is a major contributor to acid rain (EPA Office of Air and Radiation 2009). Nitrogen oxides combine with volatile organic compounds (VOCs) to form ozone, a major component of smog. Ozone can cause a number of respiratory problems in humans, and can also have detrimental effects on plants and ecosystems, including acid rain. Additionally, nitrogen dioxide has also been shown to cause adverse respiratory effects (EPA Office of Air and Radiation 2009). The effects of carbon dioxide emissions, the major contributor to global climate change, are discussed in further detail in Chapter 3: *Global Climate Change*.

3. The process of siting, constructing, and decommissioning an offshore renewable energy project of any kind would entail some adverse impacts to air quality through the emission of carbon dioxide and conventional pollutants. Construction activity in

the offshore environment would require the use of fossil fuel-powered equipment that will result in a certain level of air emissions from activities including pile installation, scour protection installation, cable laying, support structure and turbine installation, and other activities required for the development of a wind farm. During the pre-construction and installation stages, there would be some air emissions in the SAMP area from fossil fuel fired mobile sources such as ships, cranes, pile drivers and other equipment. Decommissioning would also result in some air emissions from the activities involved in the removal of the wind turbines, although emissions from decommissioning would be lower than those involved in construction (Minerals Management Service 2009a).

4. When considering the benefits of wind power displacing electricity generated from fossil fuels, the CO_2 emissions of manufacturing wind turbines and building wind plants need to taken into account as well. White and Kulsinski (1998) found that when these emissions are analyzed on a life-cycle basis, wind energy's CO_2 emissions are extremely low—about 1% of those from coal and 2% of those from natural gas, per unit of electricity generated. The American Wind Energy Association has calculated that a single 1 MW wind turbine (operating at full capacity for one year) has the potential to displace up to 1,800 tons (1633 MT) of CO_2 per year compared with the current U.S. average utility fuel mix (made up of oil, gas, and coal) burned to produce the same amount of energy (AWEA 2009). The generation of renewable wind energy will result in avoided future emissions of CO_2 and will allow Rhode Island to meet targets set by the Regional Greenhouse Gas Initiative (RGGI) (See *Section 810.1*).

5. Developing offshore renewable energy sources in the form of wind turbines would have a positive impact on air emissions by displacing future air emissions caused by generating electricity. The level of avoided air emissions, and the net impact from renewable energy, will be dependent upon the future demands for electricity in Rhode Island, and the proportion of this which can be met by offshore wind farms and other renewable energy sources. At the very least, an offshore wind farm would have the effect of reducing the need for adding capacity for fossil-fuel generating plants in Rhode Island and throughout New England. At present, roughly 99% of the energy generated within Rhode Island comes from combined cycle natural gas, which is considered a marginal generator, in that it provides variable output which can easily be adjusted to meet demand (ISO New England Inc. 2009c). NO_x is the principal pollutant of concern for gas fired energy generation (Minerals Management Service 2009a). Much of the electricity used within Rhode Island comes from the Brayton Point Power Station in Somerset, MA, the largest fossil-fueled generating facility in New England. The Brayton Point Power Station has three units that use coal and one that uses either natural gas or oil, for a combined output of over 1500 MW (Dominion 2010). The additional energy production from wind turbines would be more likely to result in avoided air emissions from natural gas plants, which are marginal and would produce less energy in the event demand was lowered because of the additional output of wind turbines. Wind energy is also a marginal source, because wind speeds and thus energy output varies. The Brayton Point Power Station, which because of its reliance on coal is mostly a baseload generator, or one that does not change short term

output depending on demand (because of the difficulties in doing so), would likely continue to produce energy at the same rate. Thus air emissions from this plant would not be avoided, at least in the short term.

6. A second important benefit of switching to a zero-emission energy generation technology like wind power is impact on air quality through reduced levels of nitrogen oxides, sulfur dioxide, and mercury emitted in electrical energy generation using fossil fuels. The Cape Wind EIS determined that a wind farm would result in the net reduction in emissions of NO_x, a precursor of ozone, although only a slight reduction because of the levels of NO_x still being produced by power sources elsewhere (Minerals Management Service 2009a).The emissions of sulfur dioxide and nitrogen oxides have declined significantly since the early 1990s (ISO New England Inc. 2009c). However, there still may be a benefit in terms of avoided future increases in emissions of NO_x and other pollutants if a project can meet increasing future energy demands. A reduction in these pollutants will have positive health effects for residents of the state of Rhode Island from the perspective of avoiding future respiratory illnesses.

Section 850.2 Coastal Processes and Physical Oceanography

1. The following section summarizes the general potential effects of a renewable energy project on coastal processes and physical oceanography in the SAMP area. The introduction of a number of large structures into the water column may have an effect on coastal processes such as currents, waves, and sediment transport.

2. The potential effect of offshore renewable energy structures in the water column on currents and tides have been examined using modeling techniques. Modeling of the proposed Cape Wind project found that the turbines would be spaced far enough apart to prevent any wake effect between piles; any effects would be localized around each pile (Minerals Management Service 2009a). The analysis of Cape Wind demonstrated that the flow around the monopiles (which range in diameter from 3.6-5.5 m [11.8-18.0 feet] wide) would return to 99% of its original flow rate within a distance of 4 pile diameters (approximately 14.4-22 m [47.2-72.2 feet]) from the support structure (ASA 2005). Both of these studies, however, are representative of monopile wind turbine subsurface structure and may not be directly applicable to jacket-style foundations. The potential localized effects of lattice jacket structures on the hydrodynamics are likely to be even less compared to that found with monopiles as pile diameters for lattice jackets are much smaller (1.5 m [4.9 feet]) than monopiles (4-5 m [13-16.5 feet] diameter). Furthermore, the spacing between the turbines using lattice jacket support structures will be much greater than the 4 pile diameters

3. One predicted potential effect of wind turbines has been changes to the wave field from diffraction caused by the monopiles, and resulting changes to longshore sediment transport (CEFAS 2005). A study of the wave effects at Scroby Bank found no significant effects to the wave regime (CEFAS 2005). Modeling of the effects of wind farms on waves found a reduction in wave height on average of 1.5% in the region, and maximum localized amplification of wave heights at the site of the wind farm of about 0.0158 m (0.6 inches). As the modeled wind farm was moved further from shore, the wave height amplification decreased (ABP Marine Environmental Research Ltd 2002). Modeling for the Cape Wind project found that the largest wave diffraction occurred for small waves with low bottom velocities that did not cause significant sediment transport; larger waves were not affected by the presence of the turbines. Overall, the models found that the presence of turbines would have a negligible impact on wave conditions in the area (Minerals Management Service 2009a). Because there are no significant changes predicted for tides and waves, there are not expected to be significant effects to sediment movement or deposition along the coastline (ABP Marine Environmental Research Ltd 2002).

4. Preliminary scaling estimates for the cumulative generation of water column turbulence due to wakes behind subsurface pilings, using parameters applicable to OSAMP waters and a 100-turbine wind power generation field, suggests their influence on vertical mixing could be comparable to that due to bottom friction (Codiga and Ullman 2010c; Ullman, pers. comm. April 28, 2010). The known persistence of stratification in much of the OSAMP region during summertime suggests that bottom friction is relatively weak, and thus the effects of platform pilings are not expected to produce major, large scale

changes in water column stratification. However, additional research is needed to address the extent to which the spatial patterns and seasonal cycle of stratification in OSAMP waters could potentially be altered by the presence of arrays of various types (pilings, lattice jackets, etc) of subsurface structures as infrastructure for renewable energy generation devices.

5. The turbine foundations may increase turbulence and disrupt flow around the structures, potentially causing local erosion around the structures, or "scour". This process is caused by the orbital motion of water produced by waves and currents, and the vortices that result as the water flows around the pile of a wind turbine or another structure (Minerals Management Service 2009a). Scour often results in the erosion of the sediments supporting the structure as they are transported elsewhere, forming a hole at the base. Scour can also affect sediments in areas between structures where multiple structures are present, also known as "global scour". However, because of the distances required between turbines, it has often been assumed that global scour will be limited (Minerals Management Service 2007b). In addition, the use of scour protection such as boulders, grout bags or grass mattresses may be used to minimize the effects if scouring on the seafloor (Minerals Management Service 2007a).

6. The seabed disturbance during construction and from scour may result in changes to sediment grain size. Smaller grains may be transported if suspended during disturbance, leaving only grains too large to be transported to remain. This could affect the structure of the benthic habitat and its associated community (Minerals Management Service 2007b).

7. The placement of submarine cables will have limited and localized effects on the sea bed and on sediments. Jet plowing, the method most likely to be used in the SAMP area, will likely result in the resuspension of bottom sediments into the water column. Heavier particles will settle in the immediate area of the activity, but finer particles are likely to travel from the disturbed area. These effects will be relatively small and short-term, however. Modeling of sedimentation during the cable laying process for the Cape Wind project found that sediment would settle within a few hundred yards of the cable route (Minerals Management Service 2009a). In some cases, where suspended sediment levels are already high in the vicinity because of storms, areas of mobile surface sediment, or fishing activities such as trawling, the additional increase in sediments from cable-laying will probably not be significant. Once it is buried, the cable will not likely have any significant effect on sediments or the sea bed (ABP Marine Environmental Research Ltd 2002). If the cable becomes exposed, increased flow could occur above the cable, resulting in localized sediment scour (Minerals Management Service 2009a).

8. The cable laying process would form a seabed scar from where the jet plow passed over; the scar would be predicted to recover naturally, but this process may take anywhere from a day to months or years depending on local tidal, current, and sediment conditions at various points along the cable route (Minerals Management Service 2009a).

9. Studies on the effects of radiated heat from buried cables have found a rise in temperature directly above the cables of 0.19ºC [0.342 ºF] and an increase in the temperature of seawater of 0.000006ºC [0.0000108 ºF]. This is not believed to be significant enough to be detectable against natural fluctuations (Minerals Management Service 2009a).

10. Overall, it is unlikely that wind farms will have a significant effect on wave, current, and sediment processes overall, with only small effects within the areas of the wind farms. The further to sea the wind farm is located, and the deeper water it is in, the lesser the effects to coastal processes are likely to be (ABP Marine Environmental Research Ltd 2002).

Section 850.3 Benthic Ecology

1. Offshore renewable energy development in the SAMP area, especially offshore wind energy development, may potentially affect the benthic ecology of a project site by: disturbing benthic habitat during construction activities; introducing hard substrate that may be colonized and produce reef effects, or alter community composition; generate noise or electromagnetic fields that may effect benthic species; or impacting the water quality of an area during the installation or operation of a facility. This section summarizes the general potential effects of a renewable energy project on the SAMP area's benthic ecosystem; potential effects of these phenomena on species groups (e.g. birds, marine mammals, and finfish) are detailed below in separate sections.

2. Undoubtedly, the construction of large, offshore structures will result in effects to coastal processes and to benthic habitats and species, at least in the immediate vicinity of the turbine installation. However, it may be a challenge to accurately assess changes in the benthic ecology of the Ocean SAMP area unless a good baseline is established. Studies of European offshore renewable energy projects, the PEIS and the Cape Wind EIS (Minerals Management Service 2009a) provide some insight into the range of potential ecological effects offshore wind energy development, though the specific effects produced within the SAMP area will vary depending on site specific conditions and the size and design of the proposed project..

850.3.1 Benthic Habitat disturbance

1. The PEIS indicates that habitat disturbance may result through the construction of offshore renewable energy infrastructure (Minerals Management Service 2007a). Here, habitat disturbance is used broadly to refer to sediment disturbance and settling; increased turbidity of the waters in the construction area; and the alteration or loss of habitat from installation of infrastructure including piles, anti-scour devices, and other structures.

2. Sediment disturbance caused by the installation of foundations or underwater transmission cables may result in the smothering of some benthic organisms as suspended sediments resettle onto the seafloor (Minerals Management Service 2007a). Smothering would primarily affect benthic invertebrates as most finfish and mobile shellfish would move to nearby areas to avoid the construction site (Minerals Management Service 2007a). Smaller organisms are more likely to be affected than larger ones, as larger organisms can extend feeding and respiratory organs above the sediment (BERR 2008b). Sediment also has the potential to affect the filtering mechanisms of certain species through clogging of gills or damaging feeding structures; however, most species in the marine environment likely have some degree of tolerance to sediment and this effect is likely to be minimal (BERR 2008b). In the Ocean SAMP area, species that may be impacted by the settling of sediments include eastern oysters (*Crassostrea virginica*) and northern quahogs (*Mercenaria mercenaria*), among others, resulting in mortality or impacts to reproduction and growth (Minerals Management Service 2009a).

3. In addition to the disturbance of sediments, construction of the foundation substructure and the installation of cables may result in increased turbidity in the water column. This may in turn affect primary production of phytoplankton and the food chain; however, these effects are likely to be short-term and localized, as sediments will likely settle out after a few hours or be flushed away by tidal processes (Minerals Management Service 2009a). Increased turbidity in a project area is generally temporary and will subside once construction has been completed (Johnson et al. 2008). Sediment suspension times will vary according to particle size and currents. In Nantucket Sound, sediments were predicted to remain suspended for two to eighteen hours, and the amount of sediment suspended would be minimal compared with normal sediment transport within the region due to typical tidal and current conditions (Minerals Management Service 2009a). This may impact the abundance of planktonic species by decreasing the availability of light in the water column. Sediment suspended during the construction or decommissioning activities and transported by local currents may result in impacts to neighboring habitats, perhaps posing a temporary risk of smothering to nearby benthic species. Sediment transport in the SAMP area will need to be further modeled to predict the potential effects to turbidity from construction of offshore wind turbines.

4. Habitat conversion and loss may result from the physical occupation of the substrate by foundation structures or scour protection devices. Steel foundations and scour protection devices, which may be made up of rock or concrete mattresses, may modify existing habitat, or create of new habitat for colonization (Johnson et al. 2008). The direct effects of these hard structures to the seabed are likely to be limited to within one or two hundred meters of the turbine (OSPAR 2006). Additionally, cables will need to be installed between turbines, and this will require temporarily disturbing the sediment between the turbines. The total area of seabed disturbed by wind turbine foundations is relatively small compared to the total facility footprint. The scour protection suggested for the Cape Wind project around each monopile vary depending on the pile and the location, though the total scour protection area of 47.82 acres (0.19 square kilometers). Compared to the total footprint of the Cape Wind project (64 km^2 or 15,800 acres), the area affected by scour protection equals only 0.3% (Minerals Management Service 2009a).

5. In addition to physically changing benthic habitat, the placement of wind turbines, especially in large arrays, may alter tidal current patterns around the structures (see *850.2 Coastal Processes and Physical Oceanography*), which may effect the distribution of eggs and larvae (Johnson et al. 2008). However, a study of turbines in Danish waters found little to no impact on native benthic communities and sediment structure from a change in hydrodynamic regimes (DONG Energy 2006). Studies conducted at wind farms in the North Sea did not find significant changes in the benthic community structure that could be related to changes in the hydrodynamics as a result of the placement of in-water wind turbine structures (DONG Energy 2006). See *Chapter 2 Ecology of the SAMP Region* for more information on physical oceanography and primary production in the SAMP area.

6. The installation and burial of submarine cables can cause temporary habitat destruction through plowing trenches for cable placement, and may cause permanent habitat alteration if the top layers of sediment are replaced with new material during the cable-laying process, or if the cables are not sufficiently buried within the substrate. Likewise, cable repair or decommissioning can impact benthic habitats. The effect of the cables will depend on the grain size of sediments, hydrodynamics and turbidity of the area, and on the species and habitats present where the cable is being laid. Cables are usually buried in trenches 2 m (6.6 feet) wide and up to 3 m (9.8 feet) in depth (OSPAR 2008a). Disturbance to the seabed during cable-laying may also result from anchor and chain damage from the installation barge, as the barge will have to repeatedly anchor along the length of the cable route (Minerals Management Service 2007b). In addition, sediments disturbed in the cable-laying process may contain contaminants, and these may be dispersed in the process. However, most contaminated sediments are likely to be found close to the coast, unless the cable route passes close to a disposal site (BERR 2008b).

7. In most cases, the seabed is expected to return to its pre-disturbance state after cable installation. On rock or other hard substrates where the seabed may not recover easily, backfilling may be required, or else permanent scarring of the seabed may result. Species found in rock habitats tend to be sessile (permanently attached to a substrate), either encrusting or otherwise attached to the rock, and are therefore more susceptible to disturbance (BERR 2008b). Clay, sand, and gravel habitats are typically less affected. Undersea cables can also cause damage to benthic habitat if allowed to "sweep" along the bottom while being placed in the correct location (Johnson et al. 2008). Initial re-colonization of the site by benthic invertebrates takes place rapidly, sometimes within a couple of months (BERR 2008b). In deeper waters, where disturbance of the seabed occurs with less frequency, recovery to a stable benthic community can take longer than in shallow waters, sometimes years. Generally, the effect on the benthic ecology will not be significant if the cabling is done in areas where the habitat is homogenous. However, if the cabling activity takes place in areas of habitat that are rare or particularly subject to disturbance, the effects could be greater (BERR 2008b). The most serious threats are to submerged aquatic vegetation, which serves as an important habitat for a wide variety of marine species. Shellfish beds and hard-bottom habitats are also especially at risk (Johnson et al. 2008). Shellfish in particular are usually not highly mobile, and cannot relocate during the cable-laying process. Biogenic reefs made up of mussels or other shellfish may become destabilized if plowing for cable-laying damages the reefs (BERR 2008b).

8. The magnitude of the habitat disturbance effects depends on the duration and intensity of the disturbance, and on the resilience of species living within the sediment (Gill 2005). The expected effects are a local loss of sedentary fauna living in the substrate, with mobile bottom-dwellers being displaced from the area (Gill 2005). During the construction and decommissioning phases of a project, the eggs and larvae of many fish species may be vulnerable to being buried or removed. After the activity has ceased, recolonization may take months or years (Gill 2005). Studies

conducted on Danish wind farms found the effects on benthic communities from burial by sediment were minimal when monopiles were used, and the effects were both temporary and had limited spatial distribution. Effects to the benthic community were limited primarily to the area immediately surrounding the pile driving activity (DONG Energy 2006). Studies of the effects of sediment displacement from cable laying found macro algae and benthic infauna were still recovering two years after the activity had ceased (DONG Energy 2006).

9. The recovery period, or the time required for an area disturbed by construction related activities to return to its pre-construction state, will vary between sites. For example, research on the effects of trawling on the seabed have found that benthic communities in habitats already subject to high levels of natural disturbance will be less affected by trawling disturbance than more stable communities (Hiddink et al. 2006). Typically, habitats such as coarse sands are in general more dynamic in nature and therefore recover more rapidly after disturbance than more stable habitat types such as mud and muddy sand, where physical and biological recovery is slow (Dernie et al. 2003). Disturbance from the construction of wind turbine towers and laying cable is likely to produce similar results. A few studies of dredging found that recovery times are roughly six to eight months for estuarine muds, two to three years for sand and gravel bottoms, and up to five to ten years for coarser substrates (e.g. Newell et al. 1998).

10. See below for the potential effects of benthic habitat disturbance on SAMP area species including birds, sea turtles, marine mammals, and fisheries resources.

850.3.2 Reef Effects

1. Offshore renewable energy development, especially offshore wind development, will result in the presence of man-made structures in the water column and on the seafloor. These hard structures, such as the foundation structures and scour protection devices, will introduce new habitat into the area that did not previously exist. In this way, wind turbine structures may serve as artificial reefs, in providing surfaces for non-mobile species to grow on and shelter for small fish (Wilhelmsson et al. 2006). Any man-made structure in the marine environment is usually rapidly colonized by marine organisms (Linley et al. 2007). Fouling communities will colonize the hard structure and will create new pathways for nutrients to be moved from the water column to the benthos (Gill and Kimber 2005). Once a structure such as a wind turbine has been erected, it increases the heterogeneity of the habitat. The physical structure represents more colonization opportunities for invertebrates, as they have more surface area. This in turn increases the number of food patches available, as food resources generally are not uniformly distributed in coastal waters (Gill and Kimber 2005). This will cause a fundamental shift in the overall food web dynamics of the ecosystem, and may result in further shifts in benthic community diversity, biomass and organic matter recycling (Gill and Kimber 2005). Because some European offshore renewable energy facilities have been closed to fishing activity (see *Section 850.8, Commercial and Recreational Fishing*), the ecological effects observed in these facilities may be in part due to decreased fishing disturbances.

Researchers in the North Sea (DONG Energy 2006) found that a reduction in fishing activity complicates their ability to assess ecological change from wind farm development; there is no good information for ecosystem functioning prior to or without fishing activity impacts and therefore difficult to establish any cause-and-effect.

2. In places where the wind turbines are under threat from erosion, large boulders are often used as scour protection; these also serve as an artificial reef of their own (Petersen and Malm 2006). Scour protection also provides hard surfaces for colonization by fouling communities, as well as providing crevices and structural complexity likely to attract fish and invertebrate species seeking shelter (Minerals Management Service 2007b).

3. It has been found that although colonizing communities on offshore structures may vary depending on geographic location and a number of other factors after initial colonization, the differences are likely to decrease over the years as more stable communities develop (Linley et al. 2007). Colonizing communities will develop through the process of succession, where early colonizing species are subsumed by secondary colonizers, leading to what is known as the climax community, or the stable end point in the colonization process. It may take five to six years for the climax community to develop at a given site (Whomersley and Picken 2003, in Linley et al. 2007).

4. The changes likely to be brought about by the reef effect of the turbines are not universally considered to be beneficial. The changes in abundance and species composition could degrade other components of the system, potentially pushing out other species found in the particular habitat where construction is taking place. In particular, this could affect vulnerable or endangered species through factors such as loss of habitat, increased predation, or increased competition for prey as the composition of the benthic community shifts to that of a hard bottom community (Linley et al. 2007).

5. The diversity and biomass of the colonized structures will depend in part on the choice of material, its roughness (rugosity), and overall complexity. Concrete attracts benthic organisms; however, when used in sub-marine construction, it is often coated with silane or silicone, which deters the settling of organisms. Smooth steel monopiles, which are often painted, tend to attract barnacles (*Balanus improvisus*) and filamentous algae (Petersen and Malm 2006). The scaffolding used for oil and gas rigs provides more structural complexity than monopile foundations; the same is likely to be true for a jacketed structure for a wind turbine. These rougher, complex structures offer more protection from predators and from high velocities and scour (Minerals Management Service 2009a).

6. Another factor influencing the colonization of wind turbine structures will be the orientation of the structures to the prevailing currents. Current speed and direction can influence food availability, oxygen levels and the supply of larval recruits to an

area. As a result, structures more exposed to local currents may be more colonized than other installations within the facility. Furthermore, structures with more complex shapes will offer a greater range of localized hydrographic conditions, offering more potential for colonization and greater biodiversity (Linley et al. 2007). Colonization of structures will be dependent on sufficient numbers of larvae present in the area, and on suitable environmental conditions (Linley et al. 2007).

7. Often barnacles are the first colonizers of the intertidal zone, while algae such as red seaweeds and kelp, along with mussels, will dominate colonization starting at 1 to 2 meters below the surface. Colonies based on mussels will also attract scavengers such as starfish and flounder. In addition to mussels, some structures may instead be colonized by a grouping of species including anemones, hydroids, and sea squirts. The larvae present in the water column will vary depending on the time of year, so colonization may be dependent on the time of year in which the structures are erected. Community structure will also be dependent on the presence of predators and on secondary colonizers (Linley et al. 2007). Other species found within the SAMP area that are likely to be early colonizers include algae, sponges, and bryozoans, and other secondary colonizers are likely to include polychaetes, oligochaetes, nematodes, nudibranchs, gastropods, and crabs (Minerals Management Service 2009a). These substantial colonies of invertebrates will attract fish to the structures, resulting in a reef effect around the support structures. For more on reef effects and the attraction of fish, see Section 850.7.7 below.

8. Studies conducted in Denmark (Dong Energy 2006) at two wind farms sites (Nysted, 76 turbines; Horns Rev, 80 turbines) has shown major changes in community structure of the offshore ecosystem from one based on infauna, or invertebrates that live within the substrate, to that of a hard bottom marine community and a commensurate increase in biomass by 50 to 150 times greater.

9. Wind turbines in the Baltic Sea built on monopiles are almost entirely encrusted with a monoculture of blue mussels (*Mytilus edulis*), which may be the result of a lack of predation and competition from other species (Petersen and Malm 2006), as well as from low salinity in the area where the turbines have been constructed. Mussels provide a hard substratum used by macroalgae and epifauna, and therefore have the potential to induce further change in the ecosystem by providing more surface area for colonization. Colonization of wind farms will be determined partly through zonation, the distribution of various communities of organisms at different depths in the water column. A study of the Nysted offshore wind farm found high concentrations of blue mussels on the wind turbine foundations, with mussel biomass increasing closer to the surface, although in the highest zonation, in the upper one meter of depth, the foundation was instead colonized by barnacles. The biomass of barnacles was determined, through modeling techniques, to be seven to eighteen times higher on the foundation close to the surface than on the scour protection. The extent to which these mussels serve as an artificial reef and increase productivity and biomass will depend on the ecosystem feedback between the mussel colonies and the pelagic and benthic environments around them, such as whether other invertebrates

colonize the mussels, and whether fish and other animals utilize these colonies for food and shelter (Maar et al. 2009). On oil and gas platforms in California, the structures are encrusted with mussels, at least at depths above 100 feet (30.5 m); as mussels are knocked off the platforms and accumulate at the bottom, they create shell mounds on the seafloor which provide a secondary habitat for fish and other species (Love et al. 2003).

10. A study of the effects of the Horns Rev wind farm in Denmark found a shift in the benthic community from the indigenous infaunal community to an epifouling community associated with hard bottom habitats as both the monopiles and the scour protection were colonized by algae and invertebrates. Two species of amphipods (*Jassa marmorata* and *Caprella linearis*) were the most abundant species found on the turbines, and a total of seven species of invertebrates, including the two amphipods, the common mussel (*Mytilus edulis*), a barnacle species (*Balanus cretanus*), the common starfish (*Asteria rubens*), the bristle worm (*Pomatoceros triqueter*), and the edible crab (*Cancer pagurus*) made up 94% of the total biomass on the structures. There were also eleven taxa of seaweeds found on the monopiles and the scour protection. The monopiles and scour protection were found to be hatchery or nursery grounds for a number of invertebrates, including crabs. The wind turbine substructure and scour protection were found to house two species of worms new to this area, and considered threatened elsewhere in the region. The result of this new community has been an estimated 60-fold increase in the availability of food for fish and other organisms in the area compared with the original benthic community (Leonhard and Pedersen 2005). For information on the potential future uses associated with the epifouling communities formed on offshore wind energy turbines see *Chapter 9 Other Future Uses*.

11. Conversely, one study conducted at the Nysted offshore wind farm in Denmark, found an overall decline in biomass measured over three years. The encrusting community at this site had evolved to become almost a monoculture of mussels. This particular area is brackish; the lack of sea stars, an important mussel predator, was attributed to the low salinity. Similar changes were observed at a test site; it was concluded that these were the result of natural variations rather than an effect of the wind turbines (Minerals Management Service 2007b).

12. If scour holes form in the sea bed adjacent to the turbines, these holes may be attractive habitat to species such as crab and lobster, and to some fish species, furthering the reef effect of the structures (Rodmell and Johnson 2005). For more on effects on scour and the physical oceanography of the SAMP area from wind turbines, see Section 850.2.5.

13. If periodic cleaning of the encrusting organisms on the structure base occurs, the community will be more or less permanently in the early-colonization phase, and will not develop through succession into a more mature climax community with greater biodiversity. Instead, after each cleaning a new community will redevelop on the structure, with the species composition varying based on the season, depending on

which larval species are present in the water column at the time. Moreover, if shells are periodically removed, the discarded debris may attract scavenging animals, and may serve to create new habitat on the seafloor where they accumulate (Linley et al. 2007).

14. The reef effect is particularly relevant to fisheries resources as well as other species groups; see sections on marine mammals, fish, and sea turtles below for further discussion.

850.3.3 Changes in Community Composition

1. Wind energy and other offshore renewable energy projects could have indirect ecological effects that could affect the benthic community. A change in the type and abundance of benthic species can be expected at the turbine sites, which will change food availability for higher trophic levels. Studies of habitat disturbance resulting from fishing or dredging activity have shown effects on local species diversity and population density; the effects of offshore renewable energy projects are likely to be similar (as suggested by Gill 2005). The magnitude of these effects depends on the duration and intensity of the disturbance, and on the resistance and resilience of species living within the sediment. The expected effects are a local loss of sedentary fauna living in the substrate, with non-sedentary bottom-dwellers being displaced from the area.

2. Because the placement of wind turbines will increase habitat for benthic species, the structures will have the effect of increasing local food availability, which may bring some fish and other mobile species into the area. This may increase use of the area by immigrant fauna. More adaptable species will probably dominate the area under these new ecological conditions. The change in prey size, type, and abundance in the vicinity of the structures may also affect predators. Predators moving into the area may result in prey depletion (Gill 2005).

3. The MMS Programmatic EIS (2007a) indicates that the removal and deposition of benthic sediments associated with construction may result in the smothering of some benthic organisms within the footprint of the towers or along the cable route. Smothering would be a problem primarily for sedentary invertebrates as most finfish and mobile shellfish would be expected to move out of the way of incoming sediment (MMS 2007a). Studies conducted on Danish wind farms found the impacts on benthic communities from burial by sediment were minimal when monopile substructures were installed, and the impacts were both temporary and had limited spatial impact (DONG Energy 2006). The recolonization of an area disturbed during the construction process may take months or years (Gill 2005). Studies of the impacts of sediment displacement from cable laying found macro algae and benthic infauna were still recovering two years after the activity had ceased (DONG Energy 2006).

4. If fishing pressure is reduced in the areas around the turbines as a result of fewer fishing vessels in the vicinity of the turbines, this could have impacts on the

community as a whole, both from a reduction on fishing mortality of some species and a resulting increase in predation by these species on others (Minerals Management Service 2007b). For example, in the Horns Rev wind farm, an increase in bivalves and worms inside of the park was attributed to a decline in predation from scoters (a waterfowl species), who were avoiding the wind turbines (Leonhard and Pedersen 2005). At the Nysted wind farm in Denmark, densities of sand eels were found to increase by 300 percent between 2002 and 2004. The increase was likely attributable to either a decrease in sand eel predation, or a decrease in fishing mortality (Jensen et al. 2004, in Minerals Management Service 2007b).

5. There is also a possibility that invasive species may colonize the structures (Minerals Management Service 2007a). The disturbances caused by the placement of new structures may make the area more susceptible to invasion by non-native species (Petersen and Malm 2006). Monitoring at Denmark's Horns Rev wind farm in 2004 found an invasive species of tube amphipod, *Jassa marmorata*, not previously seen in Denmark, to be the most abundant invertebrate found on hard bottom substrate in the area (DONG Energy 2005).

6. *Didemnum spp*., a particularly aggressive invasive tunicate (sea squirt) of unknown origin, arrived in the New England region in the late 1980s and has become firmly embedded in the aquatic community from Eastport, ME to Shinnecock, NY (Bullard et al. 2007). There are no known, consistent predators of this species, which grows rapidly on hard structure to depths of 80 m (262.5 feet). This sea squirt could be problematic on new subsurface structures placed in the Ocean SAMP area, potentially colonizing the structure and competing with native species for planktonic food resources. Furthermore, this species is known to be able to regenerate entire individuals from fragments (Bullard et al. 2007), such as might be formed during maintenance procedures to control biofouling on wind turbine support structures, for instance. *Didemnum* is known to grow particularly well in areas that are well-mixed (Valentine et al. 2007); it is unknown if the turbulence created downstream of subsurface structure, wind turbine pilings for instance, would further promote conditions that favor this organism. See *Chapter 2 Ecology of the SAMP Region* for more information on invasive species in the SAMP area.

7. One study of the North Hoyle wind farm in the UK found that variability in benthic organisms taken from surveys around the wind farm pre- and post-construction was more likely related to natural variability, such as localized sediment composition, than to any effects caused by the construction or operation of the wind farm (NWP Offshore Ltd. 2007).

8. The decommissioning of wind turbines would also have significant ecological effects, as the new habitat and accompanying species are removed. Habitat heterogeneity would be immediately reduced, removing a large component of the benthic community (Gill 2005).

9. In summary, the significant human activity resulting from the wind turbines would be likely to have significant effects upon the food web, but just what those effects are is unknown.

10. See Section 850.7.5 below for the potential effects of changes in community composition on fisheries and fishery resources.

850.3.4 Noise

1. Underwater noise may be generated during all stages of an offshore renewable energy facility, including during pre-construction, construction, operation and decommissioning. The potential affects of noise from offshore renewable energy are especially a concern for marine mammals and fish species (see Sections 850.5 and 850.7) It is not understood whether the noise generated in the construction, operation, and decommissioning of a wind turbine array would have an effect on invertebrate species in the benthic environment. Few marine invertebrates have the sensory organs to perceive sound pressure, although many can perceive sound waves (Vella et al. 2001 in Minerals Management Service 2007b). Studies on the potential impact of air guns on squid have found few behavioral or psychological effects unless the organisms are within a few meters of the source (Minerals Management Service 2007b). If there is any effect to these species, it is likely to be much less than any potential effects to fish or marine mammals (Linley et al. 2007).

850.3.5 Electromagnetic Fields (EMF)

1. Underwater transmission cables used to carry the electricity from an offshore renewable energy facility back to shore produce magnetic fields around the cables, both perpendicularly and in a lateral direction around the cable. While the design of industry standard AC cables prevents electric field emissions, magnetic field emissions are not prevented. These magnetic emissions induce localized electric fields in the marine environment as sea water moves through them. Furthermore, in AC cables the magnetic fields oscillate, and thereby also create an induced electric field in the environment around the cables, regardless of whether the cable is buried. Thus the term electromagnetic field, or EMF, refers to both of these fields (Petersen and Malm 2006). While EMF is primarily an issue for fish, sharks and rays (see Section 850.7), some invertebrate species, such as a variety of crustacean species, have demonstrated magnetic sensitivity and could be affected by EMF. These animals may become disoriented; it is not known whether this will have a small or a significant impact on these animals, although the likely impact is believed to be small (BERR 2008b). For more information on the effects of electromagnetic fields, see *Section 850.8 Fish and Fisheries Resources*.

2. If electromagnetic fields affect the presence or behavior of species likely to colonize wind turbine structures, this could have an effect on the potential reef effects of the structures However, the interaction between most invertebrates and EMF is not

known, and the existence of healthy communities of colonizing species on turbine structures in Europe indicates EMF will not have a significant impact on at least these species assemblages (Linley et al. 2007).

850.3.6 Water Quality Impacts

1. Offshore renewable energy facilities would result in increased vessel traffic through the site characterization, construction, operation, and decommissioning phases. The MMS Programmatic EIS indicates that such an increase in traffic could increase the likelihood of fuel spills as a result of vessel accidents or mechanical problems, though it indicates that the likelihood of such spills is relatively small (Minerals Management Service 2007a). In addition, wastewater, trash, and other debris may be generated at offshore energy sites by human activities associated with the facility during construction and maintenance activities (Minerals Management Service 2007a, Johnson et al. 2008). The platforms may hold hazardous materials such as fuel, oils, greases, and coolants. The accidental discharge of these contaminants into the water column could affect the water quality around the facility; however these contaminants would likely remain at the surface and not impact benthic ecosystems (Minerals Management Service 2007a). In the PEIS, MMS indicates that the potential risk to water quality from offshore renewable energy development is negligible to minor (Minerals Management Service 2007a).

2. Water quality may also be impacted during the construction process by re-suspending bottom sediments, increasing the turbidity within the water column. For the potential effects of water quality impacts on birds, marine mammals, and fish, see sections below.

Section 850.4 Birds

1. Offshore renewable energy may have a variety of potential effects on avian species in the SAMP area. Some effects may be negative, resulting in adverse impacts, other effects may be neutral, producing no discernible impacts, while others may be positive, resulting in enhancements. The purpose of this section is to provide an overview of all the potential effects of offshore renewable energy development on birds, including the potential for habitat displacement or modification; disturbances associated with construction activities and/or vessel traffic; avoidance behavior or changes in flight patterns; risk of collision with installed structures; the risk of exposure to pollutants accidentally discharged during construction, operation or decommissioning. Potential affects to birds in the SAMP area will vary based on the species, as well as on the particular site, and size of the project.

2. Key to measuring and understanding the effects of offshore renewable energy development on avian species requires first sufficient baseline data on the abundance, distribution, habitat use and flight patterns in the project area. Baseline studies provide an important comparison point for assessing the effects of pre-construction, construction, operation or decommissioning activities. The duration of baseline studies may vary between project areas to account for 'natural variability' observed in avian use of an area. Locations that experience large fluctuations in avian densities over time may require additional baseline monitoring to accurately assess pre-construction conditions (Fox et al. 2006).

3. Research conducted by Paton et al. (2010) for the Ocean SAMP has collected baseline data on species occurrence and distribution in the Ocean SAMP area through land-based, ship-based and aerial surveys, as well as through radar surveys from 2009 to 2010, although the exact time period of surveys varied by survey technique. The goal of this research is to assess current spatial and temporal patterns of avian abundance and movement ecology within the Ocean SAMP boundary. Preliminary analysis of the surveys conducted in nearshore habitats during land-based point counts from January 2009 to January 2010 recorded 121 species and over 440,000 detections in the nearshore portion of the SAMP area (Figure 37; Paton et al. 2010). Observations during these nearshore surveys have demonstrated that a wide range of birds use the SAMP area, including seaducks (e.g. eiders and scoters), other seabirds (e.g. loons, cormorants, alcids and gannets), pelagic seabirds (e.g. storm petrel and shearwaters), terns and gulls, shorebirds, passerines and other land birds (e.g. migrating species and swallows). The most abundant bird species observed in nearshore habitats in the SAMP area during land-based surveys were Common Eider (*Somateria mollissima*), Herring Gull (*Larus argentatus*), Surf Scoter (*Melanitta perspicillata*), Black Scoter (*Melanitta nigra*), Double crested Cormorant (*Phalacrocorax auritus*), Tree Swallow (*Tachycineta bicolor*), Great Black-backed Gull (*Larus marinus*), Laughing Gull (*Leucophaeus atricilla*), and the Northern Gannet (*Morus bassanus*) (see Figure 37) (Paton et al. 2010). Farther offshore, more pelagic species were detected during boat-based surveys conducted from June 2009 to

March 2010. During boat-based surveys, which sampled eight 4 by 5 nm grids, 55 species were detected from 10,422 detections (see Figure 38). In offshore areas, Herring Gulls, Wilson's Storm-Petrels (*Oceanites oceanicus*), Northern Gannets, Great Black-backed Gulls, White-winged Scoters (*Melanitta fusca*) were among the most commonly detected species.

Figure 37. Most Abundant Species Observed in Nearshore Habitats of the Ocean SAMP Study Area Based on Land-based Point Counts from January 2009 to January 2010 (Paton et al. 2010).

(Note: Total detections= 440,000)

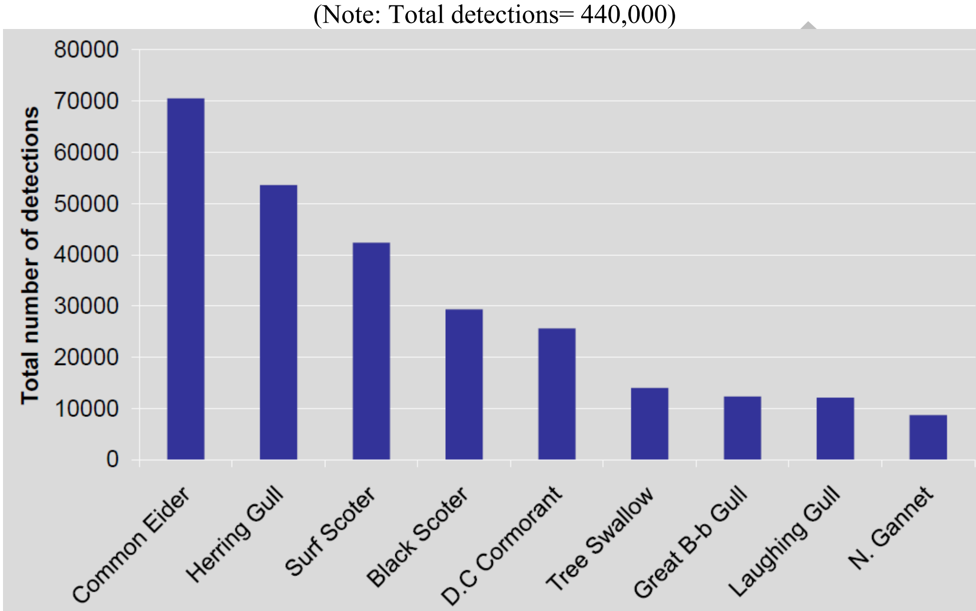
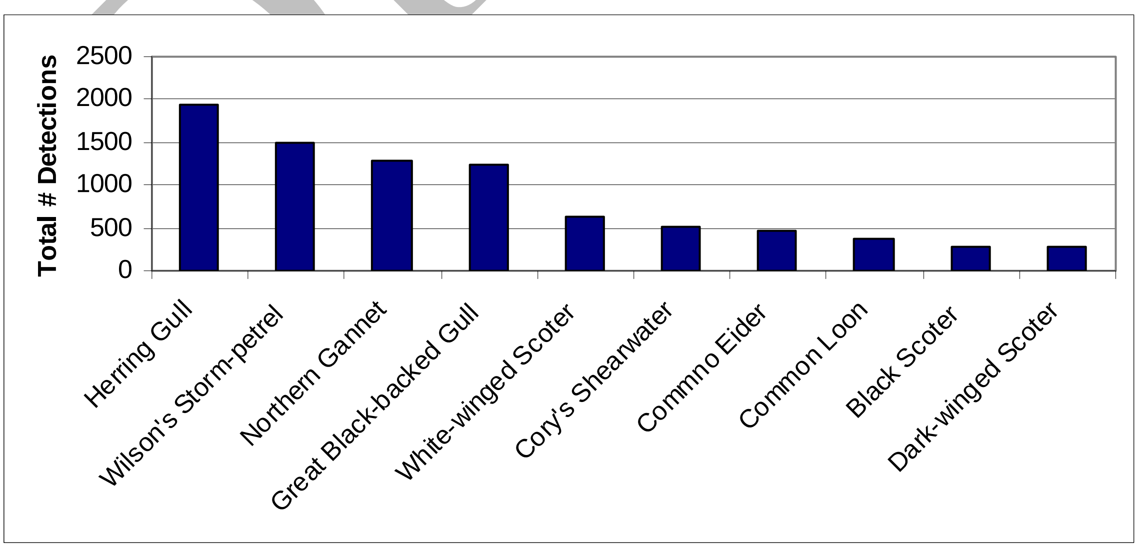


Figure 38. Most Abundant Species Observed in Offshore Habitats Based on Boat-Based Point Counts in the Ocean SAMP Study Area from June 2009 to March 2010 (Paton et al. 2010)



4. Species distribution and abundance varied both spatially and seasonally in the SAMP area. Most birds that use the SAMP area are migratory, so that their occurrence is highly seasonal. Following the completion of their work, Paton et al. (2010) will describe the seasonal and spatial distribution of different species based on their findings. For further discussion of the findings of Paton et al. (2010) see *Chapter 2 Ecology of the SAMP Region*.

5. In addition to recording occurrence and abundance in the SAMP area, Paton et al. (2010) have also identified potential foraging habitat for avian species. Based on a literature review performed by Paton et al. (2010) nearshore habitats, with water depths of less than 20 m [66 ft], are believed to be the primary foraging habitat for seaducks (Table 13). Figure 39 illustrates the areas within the Ocean SAMP boundary with water depths less than 20 m (66 feet) and therefore represents the primary foraging habitat for the thousands of seaducks that winter in the Ocean SAMP waters. Preferred sea duck foraging areas are strongly correlated with environmental variables such as water depth, bottom substrate, bivalve community, and bivalve density (Vaitkus and Bubinas 2001). Currently, bathymetric data (water depth, bottom substrate) of the Ocean SAMP area is well known, but relatively little is known about bivalve community and bivalve density, especially further offshore. Foraging depths of seaducks differ among species and are a function of preferred diet, but average depths tend to be less than 20 meters (66 feet) for most species. Common eiders forage in water less than 10 m (33 feet) during the winter when diving over rocky substrate and kelp beds (Goudie et al. 2000; Guillemette et al. 1993). Preferred diet of common eider changes with season and foraging location, but mainly consists of mollusks and crustaceans (Goudie et al. 2000; Palmer 1949; Cottam 1939). Maximum diving depths of scoters are about 25 m (82 feet), although most birds probably forage in water less than 20 meters (66 feet) deep, particularly during the winter months (Vaitkus and Bubinas 2001; Bordage and Savard 1995). Scoter diet in marine environments predominantly consists of mollusks (Bordage & Savard 1995; Durinck et al. 1993; Madsen 1954; Cottam 1939). Much of the study area is relatively deep (> 25 meters [82 feet]), thus most of the SAMP area is probably not preferred suitable foraging habitat for seaducks, although seaducks can roost in deeper waters.

Table 13. Foraging depths of seaducks based on a literature review (Paton et al. 2010).

Species	Dive depth	Source
Common eider	0-15 m (0-49 feet)	Ydenberg and Guillemetter 1991.
Surf Scoter - day	90% of dives <20 m (66 feet) depth during diurnal period – used deeper waters at night – but rarely dived at night	Lewis et al. 2005.
White-winged Scoter-day	~90% of diver <20 m (66 feet) depth - used deeper waters at night – but rarely dived at night	Lewis et al. 2005.
Black Scoter	>95% of observations were in waters <20m (66 feet) deep	Kaiser et al. 2006.
Common Eider	100% <16 m (52.5 feet) deep	NERI Report 2006.
Black Scoter	100% <20 m (66 feet) deep	NERI Report 2006.

6. Land-based surveys conducted by Paton et al. (2010) support the findings of the literature review, as large concentrations of seaducks (e.g. scoters and eiders) have been recorded in these nearshore areas, particularly off Brenton Point (see Figure 40). Because one potential effect of offshore renewable energy development may include habitat displacement, identifying potentially important foraging habitat prior to siting future projects may help to minimize any adverse impacts.

Figure 39. Potential Foraging Areas for Seaducks Within and Adjacent to the Ocean SAMP Boundary (based on a literature review by Paton et al. 2010).

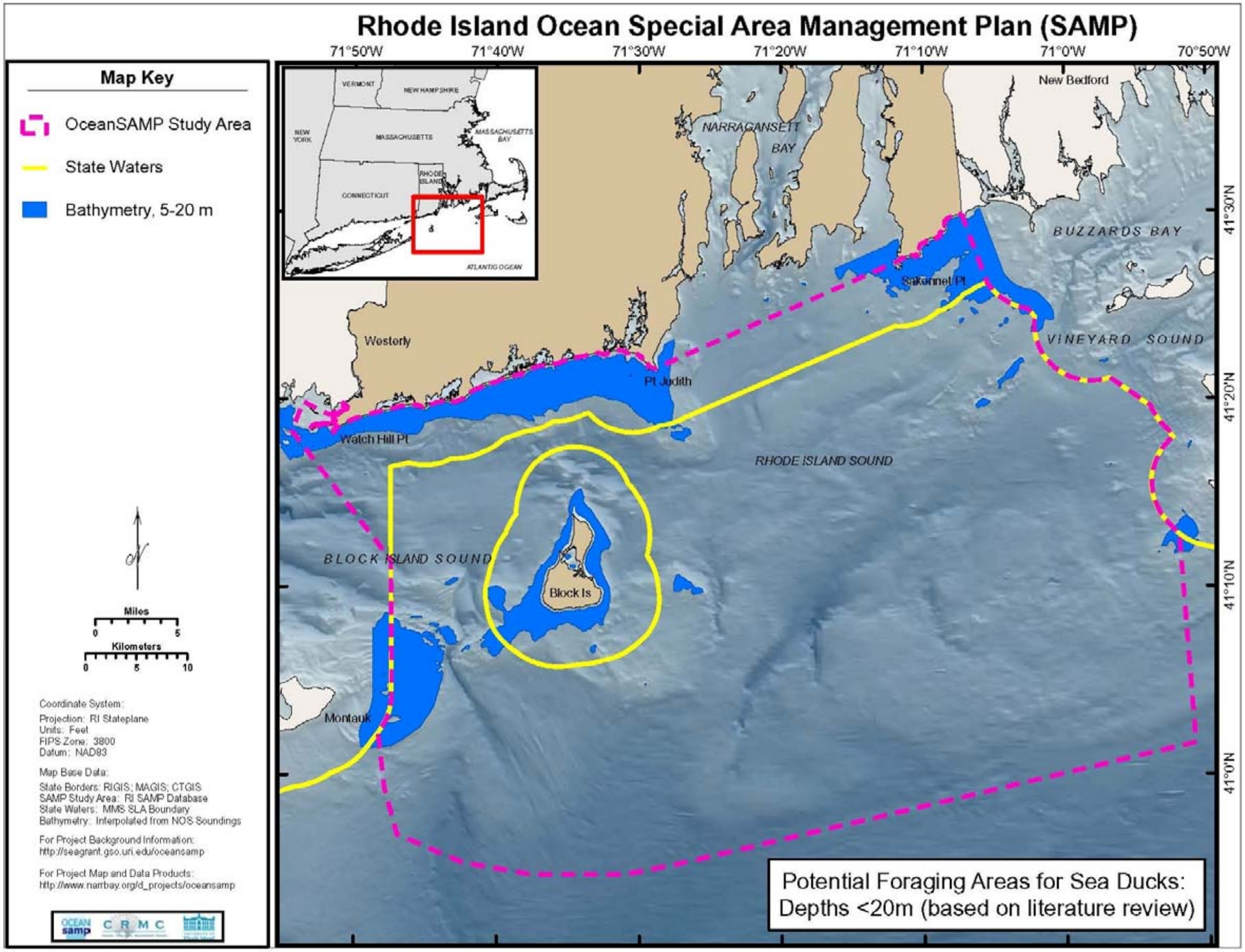
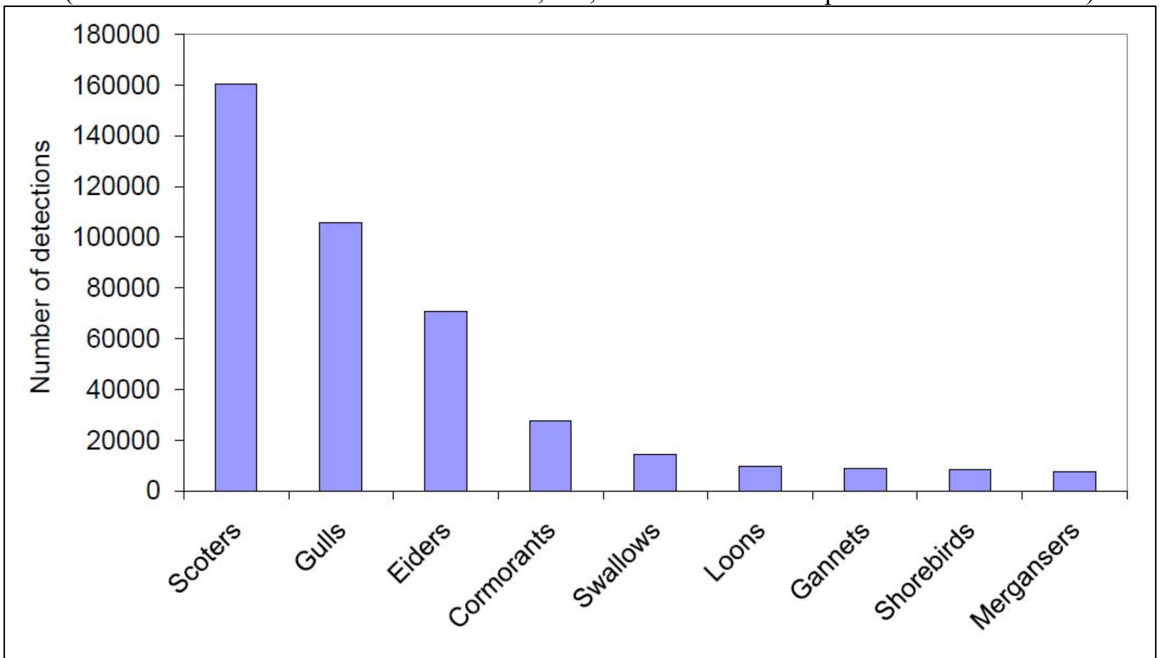


Figure 40. Total Number of Detections for the Most Abundant Guilds Observed in Nearshore Habitats During Land-Based Point Counts, January 2009-January 2010 (Paton et al. 2010).

(Note: Total Number of detections >440,000; Total Number of Species Recorded= 121)

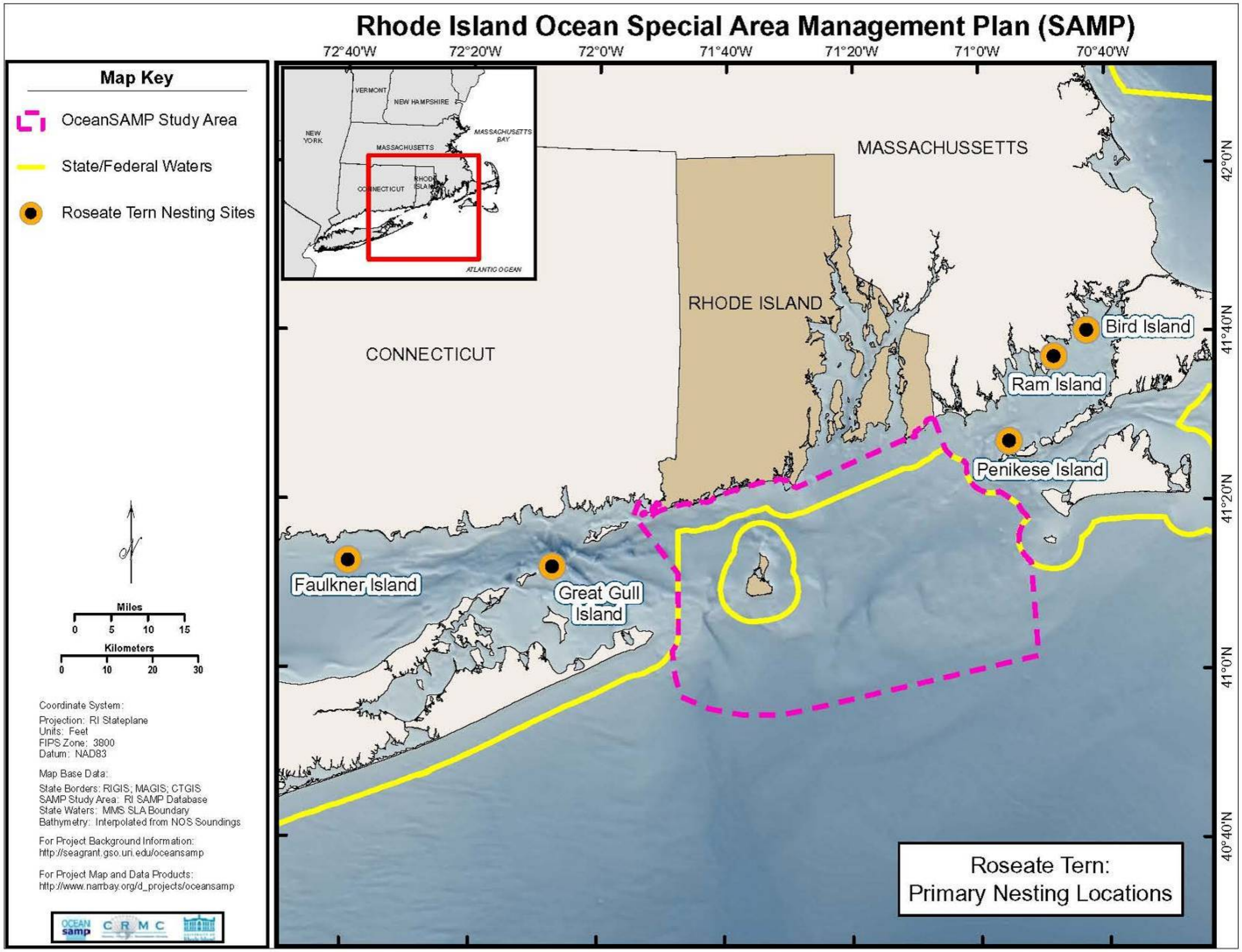


7. When assessing the potential effects of offshore renewable energy development, the impact on endangered or threatened species are of particular concern, mainly because the magnitude of the potential impact may be much more severe to these species due to their low population numbers (Minerals Management Service 2007a). The one federally-listed endangered bird using the Ocean SAMP area is Roseate Tern (*Sterna dougalli dougalli*). This species is a long-distance migrant that spends the summer months in New England, including within the SAMP area (Paton et al. 2010). Although this species does not nest in Rhode Island, there are nesting colonies in Connecticut, New York, and Massachusetts that are close enough that foraging adults from nesting colonies may use Ocean SAMP waters (see Figure 41). Terns may travel substantial distances, 25.8 to 30.6 km [16 to 19 miles] from their breeding locations to access foraging habitat, and therefore Roseate Terns may use portions of the SAMP area (Paton et al. 2010). As of 2007, about 85% of the population was concentrated at Great Gull Island, NY (1,227 pairs); Bird Island, Marion, MA (1,111 pairs); and Ram Island, Mattapoisett, MA (463 pairs).There was a small colony (48 pairs) on Penikese Island and 26 pairs nesting on Monomoy National Wildlife Refuge (Mostello 2007). Areas located in the northeast and northwest of the SAMP area lie within the foraging range of the Roseate Tern, and may potentially be used by for foraging adults.

8. In addition to foraging activity, migrating Roseate Terns may also pass through the Ocean SAMP area on their way to and from their nesting colonies. (Harris 2009). Recent studies of post-breeding staging by Roseate Terns documented 20 sites on Cape Cod where Roseate Terns congregate in the fall before migrating south. Many

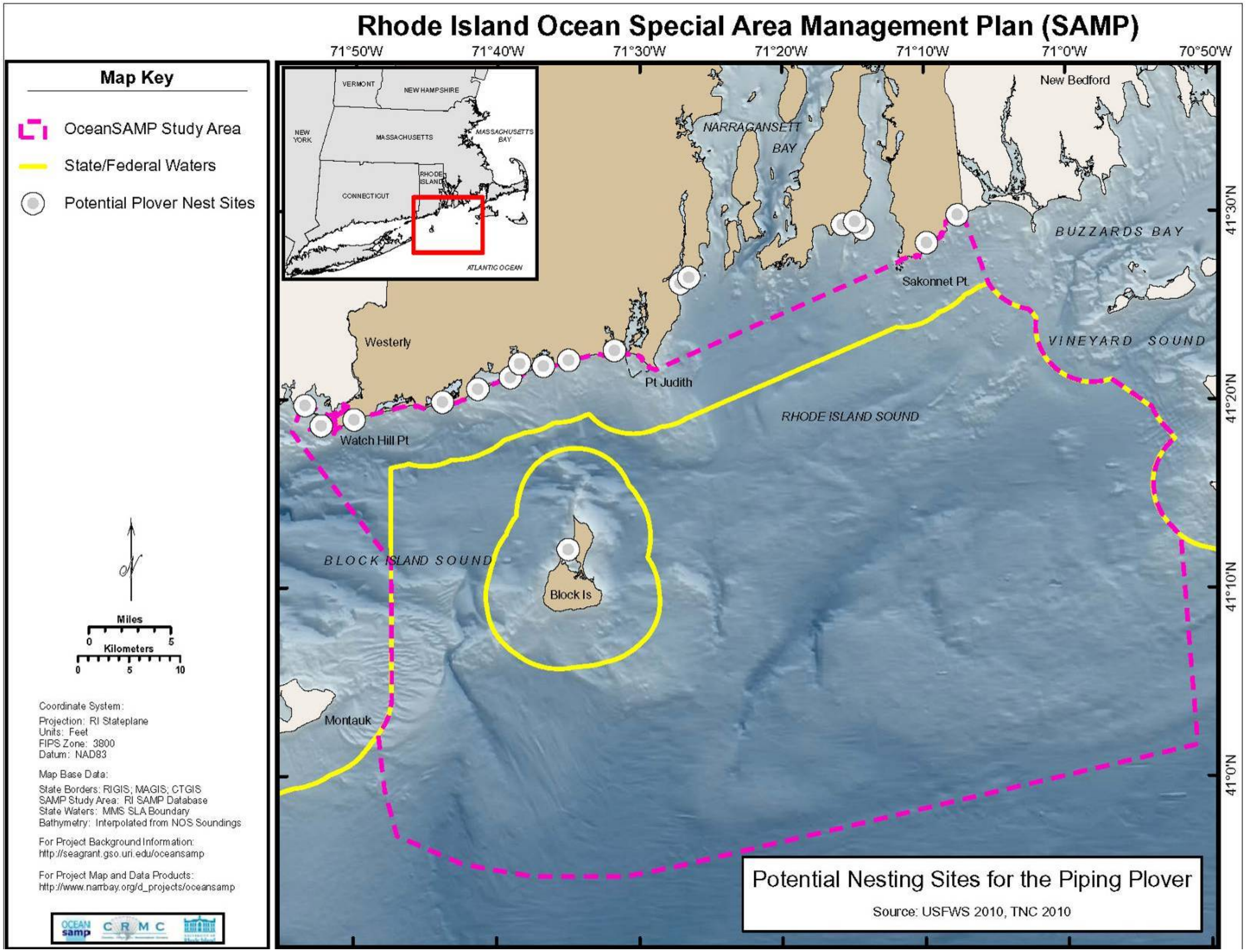
uniquely color-banded birds from Great Gull Island in NY at the western edge of the SAMP area were located on Cape Cod (Harris 2009), thus it is probable that many terns are migrating through the SAMP area in July and August, but their migratory routes, the diurnal variation of this migration, and flight elevations are uncertain. Paton et al. (2010) conducted surveys specifically to record Roseate Tern use of the SAMP area during summer (July, August), and detected relatively few birds. While the current evidence suggests that few Roseate Terns use Ocean SAMP waters for foraging habitat, of the sightings recorded the majority were located in nearshore sites, presumably where water depths are shallow enough to allow access to prey (Paton et al. 2010).

Figure 41. Roseate Tern Nesting Locations in Southern New England (Paton et al. 2010).



9. The Piping Plovers (*Charadrius melodus*) is another federally-listed species threatened species that nests on coastal beaches in Rhode Island and on Block Island, adjacent to the SAMP area (Figure 42). While there is uncertainty surrounding the migratory routes taken by Piping Plovers, the U.S. Fish and Wildlife Service (1996) presumes that the majority of the migratory movements of Atlantic Coast Piping Plovers occur along a narrow flight corridor above the outer beaches of the coastline. Moreover, inland and offshore migratory observations are rare (U.S. Fish and Wildlife Service 1996). However, further investigation into Piping Plover movements in a project area prior to construction would help minimize the impact of avoidance behavior.

Figure 42. Potential Piping Plover Nesting Sites Adjacent to the Ocean SAMP Boundary (Data from U.S. Fish and Wildlife Service 2010).



10. Under Section 7 of the Endangered Species Act[43] all federal agencies are directed to consult with the U.S. Fish and Wildlife Service (USFWS) to ensure that their actions do not jeopardize listed avian species or, destroy or adversely modify critical habitat of such species. If the USFWS determines that a federal action is likely to adversely affect a species, formal consultation is required, and the issues are examined thoroughly through the preparation of a Biological Assessment by the lead federal agency and a Biological Opinion by the USFWS. Each addresses whether any part of the proposed action is likely to jeopardize the existence of the listed species, and may outline any necessary binding, and/or discretionary recommendations to reduce impacts (Minerals Management Service 2009a). Compliance with the ESA regulations and coordination with the USFWS ensures that project activities are conducted in a manner that greatly minimizes or eliminates impacting listed species or their habitats (Minerals Management Service 2007). See *Chapter 10 Existing Statutes, Regulations and Policies* for more information on the ESA.

11. Existing federal legislation also provides protection to migratory bird species under the Migratory Bird Treaty Act[44] and the Migratory Bird Executive Order 13186. Consequently, when a proposed offshore renewable energy project undergoes NEPA review, the USFWS will be consulted to determine impacts to migratory species. As a result of the Migratory Bird Executive Order 13186, MMS and USFWS have produced a Memorandum of Understanding that identifies specific areas for cooperative action between the agencies and will inform the review process of offshore wind energy facilities in federal waters, and contribute to the conservation and management of migratory birds and their habitats (Minerals Management Service and U.S. Fish and Wildlife Service 2009). For more information on the Migratory Bird Treaty Act and the Migratory Bird Executive Order 13186, see *Chapter 10 Existing Statutes, Regulations and Policies.*

12. Past studies have shown that passerine species use Block Island as a migratory stopover and also as a breeding area (Reinert et al. 2002). Radar surveys on Block Island as part of the research conducted by Mizrahi et al. (2010) has supported these findings. Preliminary analysis of radar data suggests that large numbers of passerines are flying over the SAMP area, especially during the fall. Further analysis of the radar data by Mizrahi et al. (2010) will provide some evidence of the directional movements, abundance and flight elevations. Little is known regarding offshore passerine migration, though the work of Mizrahi et al. (2010) will provide greater insight into the use of the Ocean SAMP area.

13. The current understanding of the potential effects of offshore renewable energy development on birds is based primarily on monitoring performed at European offshore wind energy facilities, particularly Horns Rev and Nysted Offshore Wind Energy Facilities in Denmark (see Table 14). It should also be noted that at three of the operational sites where bird surveys have taken place (Horns Rev, Nysted and

[43] 16 U.S.C. 1531 et seq.
[44] 16 U.S.C. 703-712.

North Hoyle) bird numbers were relatively low prior to construction. Therefore, while the overall conclusions of these reports are useful in identifying potential effects, the authors caution that the results may be applicable to other sites only on a very general level (Petersen et al. 2006; Michel et al. 2007). In addition to European reports, the Final Environmental Impact Statement for the Cape Wind Energy Project, LLC (Minerals Management Service 2009a) and the Programmatic Environmental Impact Statement for Alternative Energy Development and Production (Minerals Management Service 2007a) have also identified potential effects of offshore wind energy development to avian species. Ultimately, the nature and magnitude of effects of offshore wind energy development on marine and coastal birds depends on the specific location of the facility and its transmission cable (e.g proximity to nesting sites or foraging habitat), the scale and design of the facility, and the timing of construction-related activities (OSPAR 2006; Minerals Management Service 2007a).

Table 14. Summary of European Monitoring of Avian Species.

Offshore Wind Energy Facility	Survey Years	Summary of Findings	Citation
Tuno Knob, Denmark: 10 turbines; online since 1995	1994-1997 1998-1999	Displacement/Changes in Distribution: • Common Eiders declined by 75% and Black Scoters* by more than 90% during post-construction Flight Activity/Avoidance: • Nocturnal flight activity of eiders and scoters occurred within and near the project site • Nocturnal flight activity was 3-6 times greater on moonlit nights compared to dark nights • Flight activity inside and in the vicinity the facility was lower than outside the facility	Guillemette et al. 1998, 1999 Tulp et al. 1999
Nysted, Denmark: 72 turbines; online since 2004	1999-2005	Displacement/Changes in Distribution: • Significant reduction in long-tailed duck staging in the project area post-construction • Gulls and cormorants demonstrated attraction behavior to the structures within the facility Flight Activity/Avoidance: • 91-92% of all birds recorded avoided the offshore wind energy facility • Lateral deflection averaged .5 km (0.3 miles) at night and 1.5 km (0.9 miles) or greater during the day • Moderate reactions in flight routes were observed 10-15 km (6.2-9.3 miles) outside the facility • For eiders, minor flight adjustments were made at 3 km (1.9 miles)and marked changes to orientation within 1 km of the facility Collision Risk • One collision was recorded using a Thermal Animal Detection System	Dong Energy and Vattenfall 2006

Horns Rev, Denmark: 80 turbines; online since 2002	1999-2005	Displacement/Changes in Distribution: • Loons and alcids avoided foraging and staging in the facility during construction • Gulls demonstrated attraction behavior to the structures within the facility Flight Activity/Avoidance: • Several species of loons, scoters, and seabirds showed avoidance of the facility and adjacent areas (2-4 km [1.2-2.5 miles]) post-construction, though this was not significantly different** Collision Risk: • No collisions were observed	Dong Energy and Vattenfall 2006
Utgrunden and Yttre Stengrund, Kalmar Sound, Sweden: 12 turbines total; online since 2001	1999-2003	Displacement/Changes in Distribution: • Staging waterfowl declined throughout the study period Flight Activity/Avoidance: • Eider spring migration paths were altered through the project area post-construction • Lateral deflection occurred 1-2 km (0.6-1.2 miles) away from the facility (in good visibility) • 15% of the autumn flocks and 30% of the spring flocks altered flight paths around facility Collision Risk: • Out of the 1.5 million waterfowl observed migrating through Kalmar Sound, no collisions were observed	Pettersson 2005
North Hoyle, U.K.: 30 turbines; online since 2003	2001-2004	Displacement/Changes in Distribution: • Red-throated loon and cormorant shifted their distribution toward the wind park during construction • Cormorant avoided the wind park during and after construction • No significant change in distribution was observed in the common scoter, terns, guillemots, auks***	National Wind Power 2003
Blyth, U.K.: 2 turbines offshore, 9 turbines on the breakwater; offshore online since 2000; onshore online since 1993	1991-2001	Displacement/Changes in Distribution: • No evidence of significant long-term displacement of birds from their habitats (either feeding areas or flight routes). • Temporary displacement of cormorants was observed. Flight Activity/Avoidance: • Approximately 80% of observed flight activity was below rotor height • Gulls were the primary species flying at rotor height and feeding between turbines	U.K. Department of Trade and Industry 2005

		Collision Risk: • Overall collision rate from 1991-2001 was 3% • Eider collision rates declined over the monitoring period, suggesting adaptive behavior	
Kentish Flats, U.K. 30 turbines; online since 2005	2001-2005	Displacement/Changes in Distribution: • No significant changes in abundance of bird population were observed between pre- and post-construction periods • Though not statistically significant, observational data suggested that red-throated loons and great and lesser black-backed gulls decreased in abundance, and herring gulls increased in abundance at the study site Flight Activity/Avoidance: • Observational data showed fewer common terns were observed flying through the facility (though not statistically significant)	Gill, Sales, and Beasley, 2006
* Guillemette et al. 1998 and 1999 also found decreased scoter abundance in the control site. ** Authors stated that low overall bird numbers at the Horns Rev site, high variability between surveys and limited observations during poor visibility conditions prevented sufficient observance to assess avoidance. *** Authors stated that low overall bird numbers at North Hoyle made detecting changes in abundance difficult.			

850.4.1 Habitat Displacement or Modification

1. Offshore renewable energy development may result in temporary or permanent habitat displacement or modification during the construction, operation or decommissioning of a facility. Depending on the location of the facility, birds may potentially be displaced from offshore feeding, nesting, migratory staging, or resting areas. Displacement may be caused by the visual stimulus of rotating turbines, or the boat/ helicopter traffic associated with construction or maintenance activities (Fox et al. 2006). Habitat loss or modification on avian species may result in increased energy expenditures as birds may need to fly farther to access alternate habitat (Minerals Management Service 2009a). Increased energy expenditures if severe may result in decreased fitness, nesting success, or survival (Minerals Management Service 2009a). The severity of the effects of displacement from foraging habitat depends on the amount of habitat lost, the distance to, and the food resources available at the nearest alternate site (Minerals Management Service 2009a). Siting offshore renewable energy facilities in areas to avoid important bird foraging areas may minimize any potential adverse impacts on birds (OSPAR 2006; Minerals Management Service 2007a).

2. Changes in species distribution have been observed at a number of offshore wind energy facilities in Europe. One reported example of habitat displacement was found to occur at the Nysted Offshore Wind Energy Facility in Denmark. Long-tailed ducks (*Clangula hyemalis*) at this site showed statistically significant reductions in density within and 2 km (1.2 miles) around the wind farm post-construction. Prior to construction the same area had shown higher than average densities, suggesting that the facility had resulted in the displacement of this species from formerly favored feeding areas. However, the observed number of long-tailed ducks was relatively low and therefore, the sample size was small (Dong and Vattenfall 2006).

3. At the Horns Rev Demonstration Project, Red-throated and Arctic Loons (*Gavia stellata* and *Gavia arctica*), Northern Gannets (*Sula bassana*), Common Scoters (*Melanitta nigra)*, Common Murre and Razorbills (*Uria aalge* and *Alca torda)* decreased their use of the wind farm area after the installation of the wind turbines, including also zones of 2 and 4 km (1.2 and 2.5 miles) around the wind farm (Dong and Vattenfall 2006). The reason for this avoidance was unknown, though the researchers suggest that perhaps disturbance effects from the turbines or from increased human activity associated with maintenance of the facility may be possible reasons. However, changes in the distribution of food resources in the study area may have also played a role. In contrast, Herring Gulls (*Larus argentatus)* showed a decreased avoidance of the wind farm area, while Great Black-backed Gulls (*Larus marinus)*, Little Gulls (*Larus minutus)* and Arctic and Common Terns (*Sterna paradisaea/hirundo*) showed a general shift from preconstruction avoidance to post construction preference of the wind farm area. Gulls and terns recorded within the facility were mainly observed at the edges of the wind farm and far less in the central parts of the facility. The presence of the turbines and the associated vessel activity in the area were suggested as possible reasons for increased use of the project areas by the gulls (Dong and Vattenfall 2006).

4. Additional evidence of displacement or changes in distribution patterns of birds post-construction were reported in the monitoring reports from Tuno Knob (eiders and scoters), Yttre Stengrund and Utgrunden wind parks in Kalmar Sound (waterfowl), North Hoyle

(shag, a species of cormorant), Blyth (cormorant), and Kentish Flats (loons and gulls) (Guillemette et al.1998; Dong Energy and Vattenfall 2006; Pettersson 2005; National Wind Power 2003; U.K. Department of Trade and Industry 2006; Gill, Sales, and Beasley 2006) though the statistical significance of displacement varied widely among studies (Michel et al. 2007) (see Table 14). Changes in distribution or displacement of avian species from an area as a result of an offshore renewable energy facility may be difficult to detect in some situations, especially when there is a large annual or seasonal fluctuations in densities, or when prey availability also varies spatially or temporally (Fox et al. 2006; Petersen et al. 2006).

5. Alternatively, changes in species distribution in an area may result from the attraction to an offshore wind energy facility. For species who do not avoid the project area, the reef effects caused by the underwater structures of an offshore renewable energy facility may increase prey availability. At the Nysted Offshore Wind Energy Facility observations suggested that both Great Cormorants (*Phalacrocorax carbo)* and Red-breasted Mergansers (*Mergus serrator*) were attracted to the project site. Cormorants were observed roosting on the meteorological masts and the foundation of the turbines, suggesting that this species was not avoiding the area but instead using the installed structures (Dong and Vattenfall 2006). Observations of the Red-breasted Mergansers showed indications of an increased preference of the wind farm site and peripheral areas (within 4 km [2.5 miles]) after the installation of the wind farm. Increased fish availability in the area in the post-construction phase was suggested as a possible explanation for this increase (Petersen et al. 2006). For a more detailed discussion of the potential for reef effects around offshore renewable energy facilities see Section 850.3.2.

6. Temporary or permanent habitat modification may result from construction activities such as foundation or turbine installation, cable laying, or onshore installations. For example, during construction periods, installation activities associated with substructures and cable laying may increase temporarily the turbidity in the project area. Increased total suspended solids may limit a birds' ability to see under water and thereby search for food by sight, especially seaducks that depend on benthic invertebrates as food. The Cape Wind FEIS predicts that sediment suspended by the cable installation will be localized (within 457 m [1,500 ft] of the trench) and may result in levels of 20 mg/liter. However, the turbidity effects caused by cable laying and other construction related activities will be highly site specific. Any impacts to turbidity are likely to be localized and temporary (Minerals Management Service 2009a).

7. Onshore construction associated with offshore renewable energy development may result in the loss or alteration of coastal habitat used by birds for foraging, roosting, nesting, migratory staging or resting. While the impacts of habitat modification on most birds would be expected to be temporary (lasting only until construction was completed), modifications to some coastal habitats (e.g. near onshore substations) may be long-term (Minerals Management Service 2007a).

850.4.2 Human Disturbance

1. Construction, operation and decommissioning activities may cause a temporary or long-term disturbance to birds in the vicinity of an offshore renewable energy facility, or in coastal

areas where underwater transmission cables are connected to the grid. Vessel traffic, noise associated with pile driving or other construction of above-water portions of the towers and the substation may result in the disturbance of birds offshore. Affected birds would be expected to leave the area during the construction period, and some may permanently abandon the area due to the subsequent presence and operation of the completed offshore renewable energy facility (Minerals Management Service 2009; Petersen et al. 2006). One observed example of disturbance at the Horns Rev site involved a passing service helicopter through an area outside of the wind farm where a congregation of Black Scoters was present. The helicopter activity resulted in a massive flush of birds which took to the air in avoidance. However, this reaction was only temporary as most of the disturbed birds were recorded landing in the same area after the helicopter had left (Petersen et al. 2006). Onshore, coastal construction involved in connecting the transmission cable to the grid, may disturb shorebirds in the area (Minerals Management Service 2009a). Particularly sensitive species, such as the Piping Plover, may be disturbed from their nests or from foraging activities which may have consequences on individual health or breeding success (Minerals Management Service 2009a). Siting onshore transmission cable connections away from known nesting habitats when possible, and scheduling onshore construction activities during non-breeding seasons may minimize any potential adverse impacts to shorebirds.

850.4.3 Avoidance/Flight Barrier

1. Avoidance behavior or the alteration of flight patterns may also result from the presence of an offshore renewable energy facility, as studies have shown that some birds chose to fly outside an offshore wind energy facility rather than fly between the turbines (Minerals Management Service 2007; Fox et al. 2006; Petersen et al. 2006; Desholm and Kahlert 2005). Such avoidance behavior may reduce the risk of collision, however the offshore wind energy facility may also present a barrier to movement, increase distances to foraging habitats, or increase migratory flight distances (Tulp et al. 1999, Kahlert et al. 2004, Desholm and Kahlert 2005; Fox et al. 2006). The level of impact may depend on the size of the facility, the spacing of the turbines, the extent of extra energetic cost incurred by avoiding the area (relative to the normal flight costs pre-construction) and the ability of the bird to compensate for this degree of added energetic expenditure. In extreme conditions, increased energy exerted by a bird to avoid a project site may potentially result in a reduced physical condition (Fox et al. 2006).

2. Avoidance behavior and changes in flight orientation were reported for Tuno Knob (1 to 1.5 km [0.6 to 0.9 miles] from turbines), Nysted (0.5 to 3 km [0.3 to 1.9 miles] from turbines, and sometimes moderate adjustments were observed 10 to 15 km [6.2 to 9.3 miles] away), Horns Rev (0.2 to 1.5 km [0.1 to 0.9 miles]), and Kalmar Sound (1 to 2 km [0.6 to 1.2 miles]) (Tulp et al. 1999; Dong Energy and Vattenfall 2006; Pettersson 2005). Extra energetic costs as a result of alterations to flight paths were calculated and considered to be negligible at Nysted (0.5 to 0.7 percent) and Kalmar Sound (0.4 percent). In addition, decreased numbers of migrant flocks were observed crossing Nysted, Horns Rev, and the Kalmar Sound offshore wind energy facilities when compared to baseline periods (Dong and Vattenfall 2006; Pettersson 2005). To date, all studies that have monitored lateral deflection of migrating flocks reported active avoidance of turbines (Michel et al. 2007).

3. Researchers at Tuno Knob, Nysted, Horns Rev, and Kalmar Sound also examined how the effect of reduced visibility (at night or in poor weather conditions) affected flight patterns around an offshore wind energy facility (Tulp et al. 1999; Dong Energy and Vattenfall 2006; Pettersson 2005). The researchers concluded that flight adjustments often were made closer to the edge of the wind park at night or in low visibility conditions than during the day or in clear weather. Observations using the Thermal Animal Detection Systems (TADS) at Nysted provided infra-red monitoring over extended periods of nighttime and detected no movements of birds below 120 m (393.7 feet) during the hours of darkness, even during periods of heavy migration. This suggests birds flying in the vicinity of the wind farm are doing so at higher altitudes at night (up to 1500 m (0.9 miles) altitude), and that even at heights above the rotor swept zone a lateral response can be detected amongst night migrating birds (Dong and Vattenfall 2006; Blew et al. 2006).

850.4.4 Collision with Structures

1. The risk of collision with offshore renewable energy structures, such as offshore wind turbine blades and towers, by birds is based on: the frequency of species occurrence in the project area, visibility conditions during encounters with structures, and the flight behavior or height of birds when in the vicinity of a facility (Minerals Management Service 2009, Petersen et al. 2006). Monitoring at European offshore wind energy facilities has reported relatively few collisions, perhaps in part due to the avoidance reaction many species exhibit prior to reaching the facility (Michel et al. 2007).

2. Out of a total 1.5 million migrating waterfowl observed during the monitoring of the Swedish offshore wind energy facilities in Kalmar Sound, no collisions were observed (Pettersson 2005). Similarly, no collisions were observed at the Horns Rev facility throughout the monitoring period (2002-2005). While no collisions were observed, the risk was modeled and predicted to equal approximately 14 birds per year or 1.2 birds per turbine per year at Kalmar Sound (Pettersson 2005).

3. At Nysted thermal imaging equipment was mounted to a turbine during operation to capture bird movement and collisions. One bird collision was recorded during the 2005 monitoring period which covered all four seasons of that year. However, the equipment was only stationed at one site, limiting the probability of capturing a collision (Dong and Vattenfall 2006). Because not all turbines could be outfitted with thermal imaging equipment, a collision model was used to estimate the numbers of Common Eiders, the most common species in the project area, likely to collide with the sweeping turbine blades each autumn at the Nysted offshore wind farm. Using parameters derived from radar investigations and TADS, and 1,000 iterations of the model, it was predicted with 95% certainty that out of 235,000 passing birds, 0.018 to 0.020% would collide with all turbines in a single autumn (41 to 48 individuals), equivalent to less than 0.05% of the annual hunt in Denmark (currently approximately 70,000 birds) (Dong and Vatenfall 2006).

4. The collision rate at Blyth Offshore Wind Energy Facility was more accurately measured since nine of the turbines are located on a breakwater and the entire facility is relatively close to shore and therefore more easily accessible. From 1991 to 1996, the collision rate was calculated to equal less than 0.01 percent. During 10 years of monitoring (1991 to 2001), 3,074 bird carcasses were collected; however, only 3 percent were directly attributed to

collisions with turbines (Still et al. 1996 as cited in Michele et al. 2007; U.K. Department of Trade and Industry 2006). Researchers suggested that mortality events may have correlated with reduced visibility or poor weather conditions. Eider collision rates declined during the monitoring period, possibly because of adaptive behavior. Approximately 80 percent of observed flight activity was below rotor height; gulls were the primary species flying at rotor height and feeding between turbines.

5. Research conducted by Paton et al. (2010) and Mizrahi and Fogg (2010) will provide baseline information on the frequency of occurrence of different avian species in the SAMP area, as well as information on the flight elevation of individuals traveling through the SAMP area. This information will help to assess the risk of bird collisions in the SAMP area if an offshore wind energy facility were to be developed.

850.4.6 Water Quality

1. Water quality around an offshore renewable energy facility may potentially be impacted if illegal dumping or accidental spills occurs from vessels or equipment. Because many marine and coastal birds follow behind vessels to forage in their wake, individuals may be exposed to accidental discharges of liquid wastes (such as bilge water, operational discharges). Dumping and oil spills are already subject to standard operating procedures and discharge regulations (30 CFR 250.300 and MARPOL, Annex V, Public Law 100-220 [101 Statute 1458]), and the discharge of any legally allowed waste is not expected to pose any threat to avian species (Minerals Management Service 2007a). Substances that are legally discharged from vessels offshore are rapidly diluted and dispersed posing negligible risk to birds in the area (Minerals Management Service 2007a). Accidental spills from offshore renewable energy facilities may pose a potential hazard to birds if they result in the release of large volumes of hazardous materials (Minerals Management Service 2007a). For example, transformers, used to transmit energy generated from the offshore renewable energy facilities to shore, may contain reservoirs of electrical insulating oil or other fluids. The accidental release of these materials may impact the health and survival of waterbirds exposed to the spill, or may indirectly impact avian species by adversely affecting prey species in the area (Minerals Management Service 2009a). The severity of these impacts depend on the location of the facility, the volume and timing of the spill, the toxicity of the material and the species exposed to the spill (Minerals Management Service 2007a; Minerals Management Service 2009). An assessment performed on the Cape Wind Project found that the potential risk associated with accidental spills is insignificant to minor, and that precautionary measures such as developing an oil spill response plan may minimize any adverse impacts on avian species (Minerals Management Service 2009a).

2. If solid waste is released, marine and coastal birds may become entangled in or ingest floating, submerged, and beached debris, potentially resulting in strangulation, the injury or loss of limbs, entrapment, or the prevention or hindrance of the ability to fly, swim or ingestion food, or release toxic chemicals (Dickerman and Goelet 1987; Ryan 1988; Derraik 2002). These adverse impacts may potentially reduce the growth of an individual or may be lethal in severe cases (Minerals Management Service 2007a). Bird species utilizing the SAMP area are already exposed to the potential risks associated with marine debris resulting from existing uses of the SAMP area.

Section 850.5 Marine Mammals

1. Offshore renewable energy may have a variety of effects on marine mammals in the SAMP area. The purpose of this section is to provide an overview of all of the potential effects of offshore renewable energy facilities on the marine mammal species that are known to occur within the SAMP area. It should be noted that these potential effects may vary widely depending on the species as well as the particular site or project. In addition, it should be noted that scientific inquiry into the interactions between offshore wind farms and marine mammals is relatively new, and in most cases still under development. This section provides an overview of the best information available to date. It is expected that this section and the entire Ocean SAMP document will be updated in the future, as new information is made available.

2. Understanding the responses of marine mammals to offshore renewable energy facilities requires sufficient data on the abundance, distribution, and behavior of marine mammals, which are difficult to observe because they spend most of their time below the sea surface (Perrin et al. 2002). In order to understand the context in which a specific development site is being used by target species (e.g., for feeding, breeding or migration) baseline data should be collected before any human activity has started (OSPAR 2008a). A desk-based study conducted by Kenney and Vigness-Raposa (2009) for the Ocean SAMP, has synthesized all available information on marine mammal occurrence, distribution and usage of this area, providing valuable background of the importance of this area to marine mammal species. This report also ranks marine mammal species found within the SAMP area according to conservation priority, taking into account such factors as overall abundance of the population, the likelihood of occurrence in the SAMP area, endangered or threatened status, sensitivity to specific anthropogenic activities, and the existence of other known threats to the population (Kenney and Vigness-Raposa 2009).

3. Marine mammal species in the SAMP area are either whales (cetaceans), a scientific order which includes dolphins and porpoises, or seals (pinnipeds). Marine mammals are highly mobile animals, and for most of the species, especially the migratory baleen whales, the SAMP area is used temporarily as a stopover point during their seasonal movements north or south between important feeding and breeding grounds. The SAMP area overlaps with the Seasonal Management Area for right whales, although the typical migratory routes for right whales and other baleen whales lie further offshore and outside of the SAMP area (Kenney and Vigness-Raposa 2009). Right whales and other baleen whales have the potential to occur in the SAMP area in any season, but would be most likely during the spring, when they are migrating northward, and secondarily in the fall during the southbound migration. In most years, the whales would be expected to transit through the SAMP area or pass by just offshore of the area. Therefore, any future offshore renewable energy projects within the SAMP area are unlikely to impede the movement of animals between important feeding and breeding grounds.

4. While the impact on any species of marine mammal within the vicinity of an offshore renewable energy facility is important, endangered or threatened species are of particular

concern, mainly because the magnitude of the potential impact may be much more severe to these species due to their low population numbers (Minerals Management Service 2007a). The following marine mammals are of highest concern because they are listed as endangered under the federal Endangered Species Act (ESA) and may also occur within the SAMP area: the North Atlantic Right whale (*Eubalaena glacialis*), the humpback whale (*Megaptera novaeangliae*), and the fin whale (*Balaenoptera physalus*). Other marine mammal species that occur commonly or regularly within the SAMP area are listed in Table 15. Three very abundant species that are likely to occur frequently in the SAMP area include the Harbor Porpoise (*Phocoena phocoena*), the Atlantic White-Sided Dolphin (*Lagenorhynchus acutus*) and the Short-Beaked Common Dolphin (*Delphinus delphis*) (Kenney and Vigness-Raposa 2009).[45]

[45] For further explanation of the terminology used to describe marine mammal abundance within the SAMP area, see Kenney and Vigness-Raposa 2009.

Table 15. Marine Mammal Species Most Commonly Occurring in the Ocean SAMP Area (Kenney and Vigness-Raposa 2009)

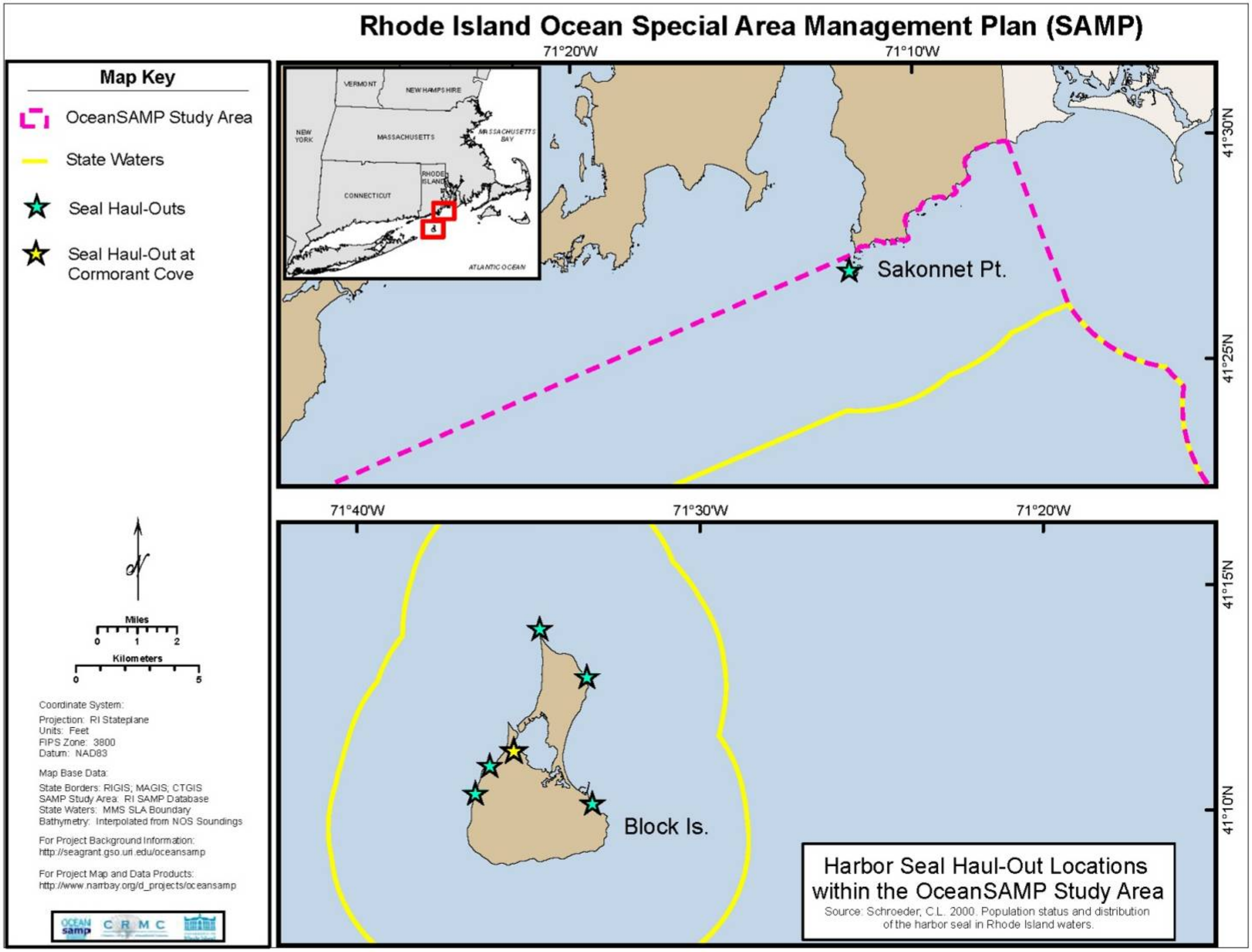
	Season Most Abundant in Ocean SAMP Area†	Comments on Distribution or Activity in the SAMP Area
North Atlantic Right Whale (*E*)	Spring & Fall	Mostly transits through outer regions of the SAMP area as individuals migrate south in the fall and north in the spring; occasionally individuals will linger for days or weeks to feed in SAMP area
Humpback Whale (*E*)	Spring & Summer	Abundance varies year to year in response to prey distribution
Fin Whale (*E*)	Summer	More abundant outside the SAMP boundary
Sperm Whale (*E*)	Summer	More abundant outside the SAMP boundary, primarily in deeper water.
Harbor Porpoise	Spring	Can occur in the SAMP area during all seasons, but are most abundant in the spring when they are moving inshore and northeastward toward feeding grounds. They are among the most abundant marine mammal species within the SAMP area.
Atlantic White-Sided Dolphin	All seasons	Most abundant outside SAMP boundary
Short-beaked Common Dolphin	All seasons	Likely to occur frequently in the SAMP area.
Harbor Seal	Fall, Winter and Spring	Regular haul-out sites along the periphery of Block Island (October through early May). These haul-out sites are thought to be used primarily by younger animals that are foraging in the area prior to migrating further north.
Sei Whale (*E*)	Spring	Irregular abundance in SAMP area
Common Minke Whale	Spring and Summer	More abundant outside the SAMP boundary
Long-Finned Pilot Whale	Spring	More abundant outside the SAMP boundary
Risso's Dolphin	Spring and Summer	More abundant outside the SAMP boundary
Bottlenose Dolphin	Summer	Likely only to be seen in outer part of SAMP area

† In many cases marine mammal species may be present in all seasons. Seasons listed are those with the greatest probability of occurrence.

(*E*) Marine Mammal is listed as Endangered under the Endangered Species Act

4. The only species that can be classified as a seasonal resident marine mammal in the SAMP area is the Harbor Seal (*Phoca vitulina*). Harbor seals are known to regularly occupy haul-out sites on the periphery of Block Island (along with other sites outside of the SAMP area within Narragansett Bay) during the winter and early spring (Kenney and Vigness-Raposa 2009). The haul-out site used most frequently on Block Island is a wooden raft located in Cormorant Cove within the Great Salt Pond, located near the center of the island (See Figure 43) (Kenney and Vigness-Raposa 2009; Schroeder 2000). Because the site is at the center of the island, it is unlikely to be disturbed by activities associated with the development of offshore renewable energy.

Figure 43. Seal Haul-Out Sites in the SAMP Area
(Schroeder 2000; Kenney and Vigness-Raposa 2009)



5. The degree to which offshore renewable energy facilities may affect marine mammals depends in large part on the specific siting of a project, as well as the use of appropriate mitigation strategies to minimize any adverse effects (Minerals Management Service 2007). All potential adverse impacts and enhancements posed by any future project within the SAMP area to marine mammals will undergo rigorous review under the National Environmental Policy Act (NEPA)[46] to comply with the standards under the Marine Mammal Protection Act (MMPA)[47] and the Endangered Species Act (ESA).[48] Under the MMPA all marine mammals are protected, and acts that result in the taking (a take is defined as "harass, hunt, capture, collect, or kill, or attempt to harass, hunt, capture, collect, or kill any marine mammal") of marine mammals in U.S. waters is prohibited without authorization from the National Marine Fisheries Service (NMFS). Further protection is granted under the ESA by the NMFS for marine mammals that are threatened or endangered. As a result, any proposed project's effects on the welfare of marine mammals are scrutinized prior to development in order to ensure that potential adverse impacts are minimized. For more information on the MMPA and the ESA see *Chapter 10 Existing Statutes, Regulations, and Policies.*

6. The principle impacts identified in the PEIS include potential effects of increased underwater noise, impacts to water quality, vessel strikes and displacement (Mineral Management Service 2007a). Of these potential impacts, increased underwater noise poses the greatest risk to marine mammals, especially to baleen whales (e.g. humpback whales and the North Atlantic right whale), who are in theory most sensitive to the low frequency sounds produced during construction activities (see below for further discussion).

850.5.1 Noise

1. Marine mammals have highly-developed acoustic sensory systems, which enable individuals to communicate, navigate, orient, avoid predators, and forage in an environment where sound propagates far more efficiently than light (Perrin et al. 2002) Evaluating noise effects on marine mammals can be challenging, as information on hearing sensitivity for most marine mammal species is currently not available (Richardson et al. 1995; Southall et al. 2007). As a result, when analyzing potential noise effects from offshore renewable energy installations, the hearing sensitivities of most marine mammal species need to be inferred.

2. In principle, marine mammals can be expected to be most sensitive to sounds within the frequency range of their vocalizations (Richardson et al. 1995). For example, baleen whales produce low frequency sounds (~10Hz to 10 kHz), that travel long distances under water, and therefore, it is expected that these whales would also be most acoustically sensitive at lower frequencies (Richardson et al. 1995). However, there is no data on hearing sensitivities in any baleen whale species to date, making assessments on noise effects quite difficult. It is known that smaller toothed whales can hear frequencies over a range of 12 octaves, with a hearing range that overlaps the frequency content of their echolocation clicks and their vocalizations used for communication (Hansen et al. 2008; Au 1993; Richardson et al. 1995; Southall et al.

[46] Pub. L. 91-190, 42 U.S.C. 4321-4347, January 1, 1970, as amended by Pub. L. 94-52, July 3, 1975, Pub. L. 94-83, August 9, 1975, and Pub. L. 97-258, § 4(b), Sept. 13, 1982.
[47] 50 CFR 216.
[48] 7 U.S.C. § 136, 16 U.S.C. § 1531 et seq.

2007). In addition, as with any mammal, hearing sensitivity varies between individuals within a species (Houser and Finneran, 2006). Consequently, as a result of the incomplete data on marine mammal hearing, it can be difficult to predict the potential impact of noise from offshore renewable energy facilities on marine mammal species.

3. Underwater noise may be generated during all stages of an offshore renewable energy facility, including during pre-construction, construction, operation and decommissioning. The strength and duration of the noise varies depending on the activity (see Table 16). For example, some construction activities, such as pile driving, result in short periods of intense noise generation, compared with long-term, low level noise associated with operational activities. While the intensity and duration of the noise produced by pile driving activities and operational wind turbines vary, both produce low frequency noise, and therefore potentially pose a risk in particular to large whales, such as the North Atlantic right whale, humpback whales, and fin whales, as these species are thought to be most sensitive in this frequency range (Southall et al. 2007; see
4.
5. Figure **44**). In order to minimize the risk of causing hearing impairment or injury to any marine mammal during activities of high noise, monitoring the project area for the presence of marine mammals has been required (Minerals Management Service 2009; JNCC 2009). Furthermore, scheduling construction activities to avoid periods when marine mammals may be more common in the project area is one precautionary measure to minimize any potential adverse impacts (OSPAR 2006). Information on the potential long-term impacts of displaced individuals, or on the potential effects under water noise may cause to resident marine mammal populations, is not currently available (Minerals Management Service 2007a, OSPAR 2008a).

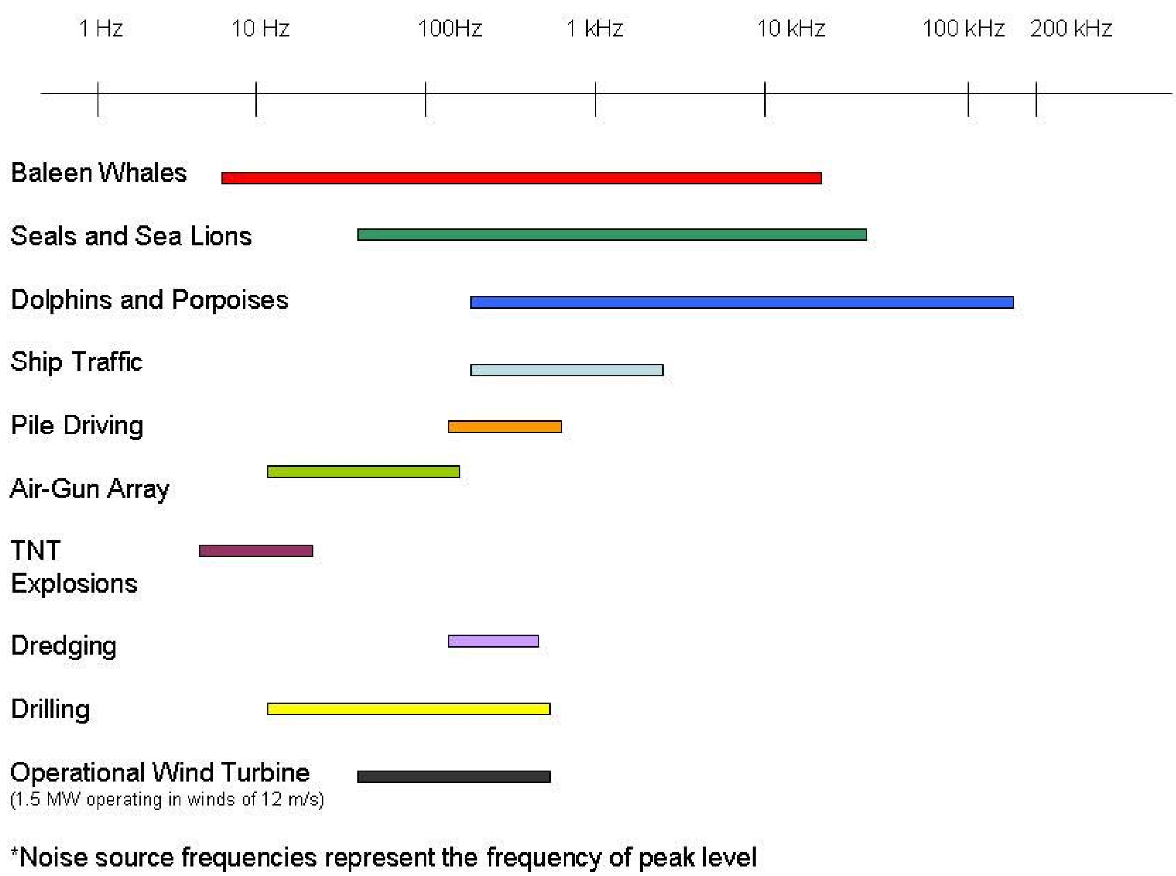
Table 16. Above and Below Water Noise Sources Associated with Offshore Renewable Energy Development (Minerals Management Service 2007a; OSPAR 2009a)

Above Water Noise					
Noise Source	**Duration**	**Frequency Range**	**Frequency of Peak Level (Hz)**	**Peak Sound Intensity Level (dB re-20 µPa)**	**Reference Distance (m)**
Ship/barge/ boat[a,b,d]	Intermittent to continuous, up to several hours or days	Broadband, 20−50,000 Hz	250−2,000	68−98	Near source
Helicopter	Intermittent, short duration	Broadband with tones	10−1,000	88	Near source
Pile driving [a,d]	50-100 millisecond pulses/beat, 30−60 beats/min, 1−2 hours/pile	Broadband	200	110	15 m (49.2 feet)
Construction [d]	Intermittent to continuous	Broadband	Broadband	68–99	15 m (49.2 feet)
Underwater Noise Sources					
Noise Source	**Duration**	**Frequency Range**	**Frequency of Peak Level (Hz)**	**Peak Sound Intensity Level (dB re-1 µPa)**	**Reference Distance (m)**
Ship/barge/ boat[a,b,c,,f]	Intermittent to continuous, up to several hours or days	Broadband, 20−50,000 Hz	250−2,000	150-180 rms	1m (3.3 feet)
Pile driving[a,d,f]	50-100 millisecond pulses/beat, 30−60 beats/min, 1−2 h/pile	Broadband 20- above 20,000 Hz	100-500	228 peak, 243-257 peak to peak	1m (3.3 feet)
Seismic air-gun array [b,f]	30-60 millisecond pulses, repeated at 10 to 15 sec intervals	Mainly low frequency, but some 10-100,000 Hz	10-125	Up to 252 downward, up to 210 horizontally	1m (3.3 feet)
Seismic explosions TNT (1-100lbs)[e,f]	~1-10 milliseconds	2-1,000 Hz	6-21	272-287	1m (3.3 feet)
Dredging [c,f]	Continuous	Broadband 20-20,000 Hz	100-500	150-186	1m (3.3 feet)
Drilling [b,c,f]	Continuous	Broadband 10-10,000 Hz	20-500	154	1m (3.3 feet)
Operating Turbine (1.5 MW operating in winds	Continuous		50 Hz/ 150 Hz	120-142	1m (3.3 feet)

of 12 m/s)[a]					

[a] Thomsen et al. (2006).
[b] LGL (1991).
[c] Richardson et al. (1995).
[d] Washington DOT (2005).
[e] Ross (1976).
[f] OSPAR (2009a).

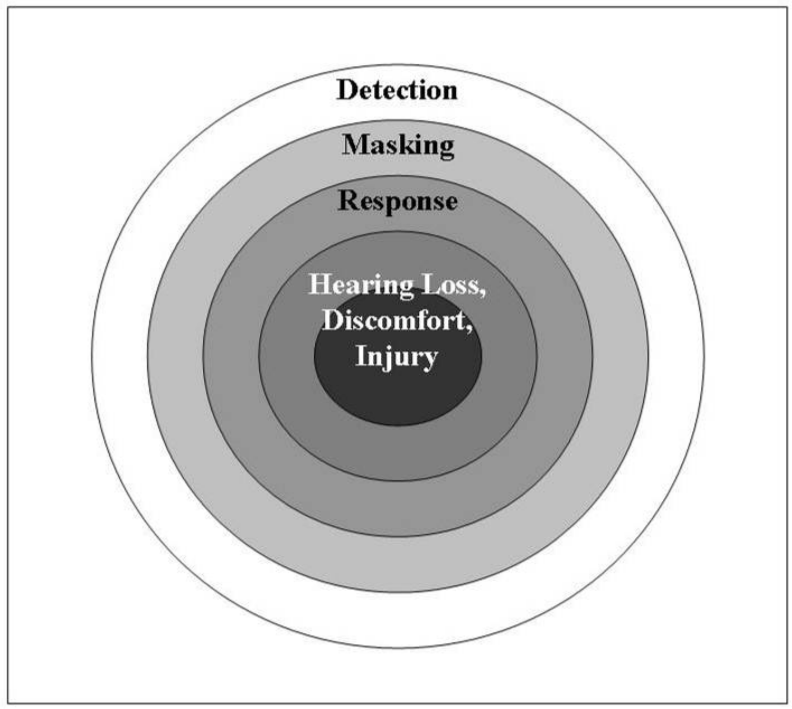
Figure 44. Typical frequency bands of sounds produced by marine mammals compared with the main frequencies associated with offshore renewable energy development (OSPAR 2009a)



6. When examining acoustic impacts on marine mammals, four overlapping impact zones are commonly used (see Figure 45; Richardson et al. 1995), corresponding to the different effect levels:
   · the zone of hearing loss, discomfort, or injury,
   · the zone of responsiveness,
   · the zone of masking and,
   · the zone of detection/ audibility.

   The zone closest to the sound source usually has the highest sound levels, which may result in physical damage or injury to a marine mammal if sound levels are sufficiently high (OSPAR 2009a). In the zone of responsiveness, noise exposure may result in behavioral reactions such as avoidance, disruption of feeding behavior, interruption of vocal activity or modifications of vocal patterns. In the zone of masking, the overlap in the frequencies of sounds produced by a sound source and those used by marine mammals has the potential to mask vocalizations, interfering with their reception and inhibiting the efficient use of sound. The detection zone is the area in which the noise generated from the sound source is audible to a marine mammal, and above ambient noise levels (Richardson et al. 1995).

Figure 45. Theoretical Zones of noise influence (Richardson et al. 1995).



7. Regarding the impacts of offshore renewable energy construction on marine mammals, the MMPA considers the zone of physical impairment, responsiveness and masking when determining a proposed project's compliance. Under the MMPA: "*Level A Harassment* means any act of pursuit, torment, or annoyance which has the potential to injure a marine mammal or marine mammal stock in the wild. *Level B Harassment* means any act of pursuit, torment, or annoyance which has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering but which does not have the potential to injure a marine mammal or marine mammal stock in the wild." See Table 17 for the criteria used to define Level A and Level B affects under the MMPA.

Table 17: Criteria for Estimating the Effects of Noise on Marine Mammals under the Marine Mammal Protection Act (U.S. Department of Commerce 2008).

Criteria	NMFS Criteria
Level A Injury (Pinnipeds)	190 dB re 1 µPa rms (impulse)
Level A Injury (Cetaceans)	180 dB re 1 µPa rms (impulse)

Level B Harassment/Behavior	160 dB re 1 μPa rms (impulse)

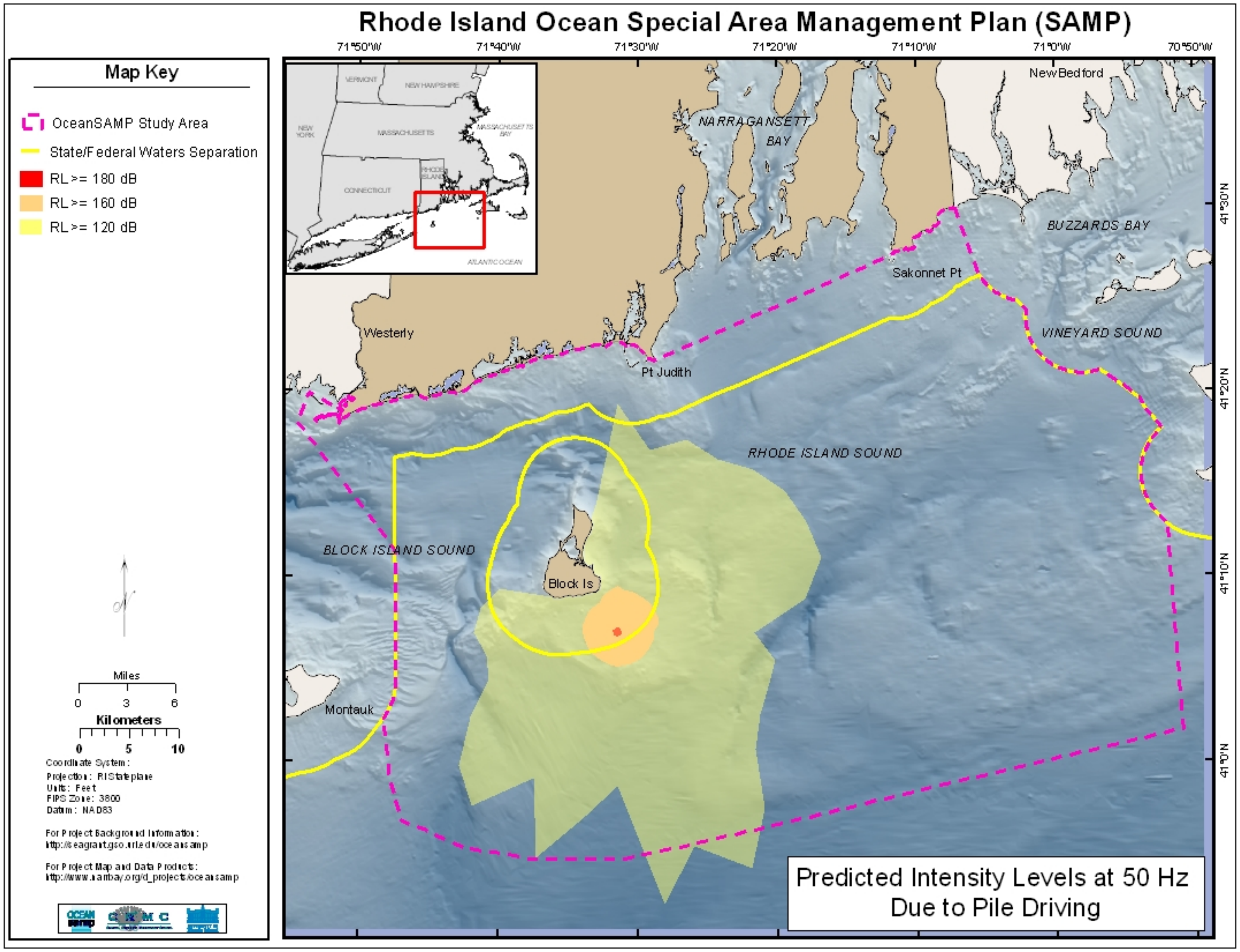
8. Prior to construction, geophysical surveys performed to characterize ocean-bottom topography or geology may include the use of air gun arrays or side-scan sonar. Survey techniques using high-energy air gun arrays pose a greater risk to marine mammals in the vicinity of the sound source, as opposed to side-scan sonar, and may result in temporary hearing impairment or in extreme cases physical injury very close to the source. Side-scan sonar, which uses a more focused beam of sound, is the most common survey technique used in the siting of offshore wind facilities. Side-scan sonar was found to result in only temporary behavior changes, even during the more extreme cases, and is unlikely to result in any hearing impairment or physical injury (Minerals Management Service 2007a; NMFS 2002a). It is possible that individual animals will leave the area or change behavior temporarily as a result of the noise disturbance (Minerals Management Service 2007a). In particular, behavioral reactions of whales (cetaceans) may include: avoidance or flight from the sound source, disruption of feeding behavior, interruption of vocal activity, or modifications of vocal patterns. However, the response of an individual cetacean may be unpredictable, as it depends on the animal's current activity, its ability to move away quickly (especially a concern with regard to North Atlantic Right whales), and the animal's previous experience around vessels (Minerals Management Service 2009a). It is unknown what long-term effects these changes in behavior may have on the individual animal or entire cetacean populations.

9. Seals (pinnipeds) have shown avoidance in response to noise generated by geophysical surveys (NMFS 2002b; Thomson et al. 2001; Minerals Management Service 2003, OSPAR 2009a). Since harbor seals regularly haul-out on sites around Block Island (Kenney and Vigness-Raposa 2009), survey activities in these areas may cause a temporary disturbance. The PEIS states that any displacement from the study area as a result of these surveys is likely to be temporary, resulting in negligible impacts to marine mammals (Minerals Management Service 2007a; Minerals Management Service 2009). Siting facilities away from important marine mammal congregation, mating or feeding areas and taking into account marine mammal activity in the area when scheduling surveys will further minimize any potential negative impacts (Minerals Management Service 2007a).

10. Underwater noise from the construction of an offshore renewable energy facility is generated during the installation of the foundation piles used to support the turbines and transformer platforms. Most offshore turbines are placed on steel foundations, which are affixed to piles driven into the seabed. Piles can range in diameter from 1 to 5 m [3.3-16.4 ft], with the larger piles being used for monopile turbines and smaller piles used for jacketed structures. The piles are driven into the bottom by powerful hydraulic hammers, causing very loud noise emissions, which may be audible for marine mammals over distances of several tens of kilometers (Thomsen et al. 2006, Nedwell et al. 2007). The zone of audibility may extend beyond 80 km [49.7 mi] to perhaps hundreds of kilometers for some marine mammal species (e.g. harbor porpoises and harbor seals) (Thomsen et al. 2006). Yet pile driving for one single turbine is of relatively short duration. The level of noise emitted by pile driving operations is dependent on a variety of factors such as pile dimensions, seabed characteristics, water depth, and the strength and duration of the hammer's impact on the pile (Nedwell et al. 2007; OSPAR 2009a).

11. Research conducted by Miller et al. (2010) modeled the extent of pile-driving noise within the SAMP area and mapped the areas subject to sound intensities of concern under the MMPA (see Table 17 and Figure 46). The red shaded area represents the zone of injury, the orange area represents the zone of harassment or potential behavior response, and the yellow area represents the zone of audibility or detection by marine mammals.

Figure 46: Estimate of the affected area in the vicinity of pile driving (Miller et al. 2010).



12. Pile driving may create noise that may adversely affect marine mammal feeding or social interactions, or alter or interrupt vocal activity (Minerals Management Service 2007; Thomsen et al. 2006). However, these impacts will vary within, as well as between, species. Any marine mammal that remains within the project area at the start of pile driving activities are subject to the increased risk of hearing impairment that may occur within close range (Madsen et al 2006; Thomsen et al. 2006). Placing marine mammal observers onboard construction vessels and halting construction activity once a marine mammal has been spotted within a project area are precautionary measures that can be taken to reduce this potential risk (Minerals Management Service 2007a). In addition, acoustic isolation of the ramming pile may reduce the noise level of pile driving activities. Acoustic deterrent devices and ramp-up pile-driving procedures may also help to protect individuals from impairment or injury by encouraging them to leave the construction site (Thomsen et al. 2006; Tougaard et al. 2003; Tougaard et al. 2005).

13. In Denmark, the construction of two offshore wind farms, Nysted and Horns Rev 1, have provided opportunities for monitoring the behavioral reactions of two marine mammal species, harbor porpoises and harbor seals, to pile driving activities. Evidence of temporary avoidance behavior during pile-driving at Horns Rev was found in harbor porpoises up to approximately 20 km [12.4 mi] away, both visually, through fewer observed individuals, and acoustically, through temporarily decreased acoustic activity (Tougaard et al. 2003). This reduction in echolocation clicks suggests that either pile-driving affected the porpoises' behavior causing individuals to go silent, or the porpoises left the area during this activity.[49] Tougaard et al. (2003) observed a return to previous acoustic activity after 3-4 hours. At the Nysted site, where piling only occurred for a brief period of time, harbor porpoises left the area during construction and stayed away for several days (Tougaard et al. 2005).[50] Overall lower abundance of harbor porpoises was observed at the Nysted site after construction when compared to baseline data, lasting at least until the second year of operation (Tougaard et al. 2005). However, it should be noted that researchers are uncertain if the observed long-term avoidance of the Nysted site by harbor porpoises was caused by the noise effects of construction. Porpoise abundance was relatively low in the area before the start of construction, so the decrease in abundance may have been unrelated to installation activities (Thomsen et al. 2006). Edren et al. (2004) found a 10 – 60% decrease in the number of hauled out harbor seals on a sandbank 10 km [6.2 mi] away from the Nysted construction site during days of ramming activity. This effect was of short duration but does suggest that both harbor porpoises and seals demonstrate behavioral changes or avoidance during pile-driving activity, and that these effects can span large distances.

14. In addition to surveying and pile-driving activities, noise associated with ships engaged in construction, operations and maintenance activities may potentially impact marine mammals in the project area (Köller et al. 2006; OSPAR 2009a) (see Table 16). Overall, the ambient

[49] Thomsen et al. (2006) found pile driving noise would unlikely mask the echolocation of harbor porpoises, as the sonar signals used by harbor porpoises, are much higher in frequency (130 kHz) than pile-driving noise (below 1 kHz).

[50] Very little (approximately 25 days) piling activity occurred at the Nysted Offshore Wind Energy Facility due to the use of gravity base foundations. Piling was only involved in the usage of sheet piles to stabilize the sediment at one of the turbines.

noise created by marine transportation, including ships associated with the wind farms as well as other ship traffic in the area, will be of a higher intensity than what would likely be created by wind turbines (OSPAR 2009a). Shipping noise should be taken into account when considering the overall levels of ambient noise underwater where wind turbines are in place. The use of ships in servicing the turbines and other activities should be accounted for when predicting the overall noise levels from the wind farms (Wahlberg and Westerberg 2005). Shipping noise is likely to be significantly higher during the construction phase (BMT Cordah Limited 2003). It is estimated that each turbine will require one to two days of maintenance each year; depending on the size of a wind farm, ship noise could be present in the vicinity of the turbines often (Thomsen et al. 2006). However, given the existing levels of shipping in the SAMP area and resulting background noise (see *Chapter 7, Marine Transportation, Navigation and Infrastructure*), the added noise from maintenance vessels is likely to be negligible. Observed reactions of marine mammals to vessel noise have included apparent indifference, attraction (e.g. dolphins attraction to moving vessels), cessation of vocalizations or feeding activity, and vessel avoidance (Richardson et al 1995; Nowacek and Wells 2001). Noise may also be caused by transit of helicopters used to support offshore renewable energy facilities far offshore (Minerals Management Service 2007a). Marine mammal behavior would likely return to normal following the passage of the vessel (Minerals Management Service 2007a). Edren et al. (2004) conducted video monitoring during the construction of the Nysted offshore wind farm and found no discernible changes in harbor seal behavior as a result of the increased ship traffic, although ship movements were controlled to avoid the seal sanctuary. In the SAMP area, the most heavily used seal haul out site on Block Island is located within a protected cove (see Figure 43) and therefore would not be affected by the noise from construction traffic. However, the other haul out sites surrounding Block Island may be affected if vessel routes pass in their vicinity or during winter seasons when these sites are most frequently used (Kenney and Vigness-Raposa 2009). Prior to construction, all potential impacts (including noise impacts) to marine mammals by a proposed offshore renewable energy facility in the SAMP area will be reviewed under the MMPA to determine if incidental take or harassment authorization, or specific mitigation measures are required.

15. Underwater noise may also result from cable laying activities, including cable laying vessels or jet plowing techniques (OSPAR 2009b). Noise measurements are not available for cable laying activities in Europe associated with offshore wind energy facilities (OSPAR 2009b). However, research conducted to assess the potential noise impacts associated with the laying of submarine cables for the Cape Wind Energy Project found that the jet plowing embedment process would not add appreciable sound into the water column (Minerals Management Service 2009a). However, the nature of the seabed will dictate the type of cable installation procedures used, and thus the noise profiles that will result will depend on the physical characteristics of the seafloor (Minerals Management Service 2007a). In areas with unconsolidated sediments, only the sound associated with the cable laying vessels will likely be produced, as the sediments insulate the cable laying noise (Minerals Management Service 2009a).

16. Operational noise generated from offshore renewable energy structures, such as by the spinning offshore wind turbines, may be transmitted into the water column via the turbine support structures (OSPAR 2006). The level of noise emitted into the water column by an

operational turbine varies based on wind speed, the speed of the spinning blades, and the type of foundation structure (Wahlberg and Westerberg 2005; Ingemansson AB 2003). The operational noise produced by wind turbines is significantly less than the levels of noise produced during the construction phase. Underwater noise generated by the turbines is mostly the result of the movement of mechanical components within the generator and gearbox, which result in vibrations in the tower, rather than sounds from the turbine blades themselves. Both the frequency and intensity of sound generated by the turbines increases with wind speed. To date, the available data on the effects of noise from operating wind turbines are sparse, but suggest that behavioral effects, if any, are likely to be minor and to occur close to the turbines (review by Madsen et al. 2006; Nedwell et al. 2007). For example, Koschinski et al. (2003) reported behavioral responses in harbor porpoises and harbor seals to playbacks of simulated offshore turbine sounds at ranges of 60-200 m [196.8-656.2 ft], suggesting that the impact zone for these species is relatively small.[51] In addition, because noise emissions from operating wind turbines are of low frequencies and low intensity (Nedwell et al. 2007), operational noise is not thought to be audible to many marine mammal species over distances greater than a few tens of meters, as the hearing abilities of most marine mammals are better at higher frequencies (Richardson et al. 1995; Southall et al. 2007). One exception may be baleen whales, such as the North Atlantic Right whale, whose hearing abilities are thought to include very low frequency sounds (Madsen et. al. 2006). Scientists predict that individuals of this species may respond to noise from operating turbines at ranges up to a few kilometers in quiet habitat (Madsen et al. 2006). However, no studies have been performed to date on the effect of noise from operational offshore wind turbines on right whales, or baleen whales in general, and these predictions have been based primarily on the results of related acoustic studies (Nowacek et al. 2004; Richardson et al. 1995; Madsen et al. 2006).

17. Recent measurements by Nedwell et al. (2007) at five operational wind farms off the U.K. indicate that wind farm sound could not be detected at a hydrophone at distances of a few kilometers outside the wind farm. Measurements taken at a range of 110 meters from a 1.5 MW monopile GE turbine in Utgruden, Sweden in water depths of approximately 10 meters found operational noise measured 118 dB re 1 mPa^2 in any 1/3 octave band at a range of 100 meters at full power production (Betke et al. 2004). Based on these measurements and measurements of the ambient noise in the waters just southwest of Block Island, Miller et al. (2010) determined that the additional noise from an operational offshore wind turbine is significantly less than noise from shipping, wind and rain in the region. Miller et al. (2010) calculated that the noise would be greater than the ambient noise present within 1 km of the wind turbines and at ranges of 10 km operational noise would be below the ambient noise in the region.[52]

18. The decommissioning of offshore renewable installations will also temporarily generate underwater noise. However, because an offshore renewable energy facility has not yet been decommissioned, the activities and duration of the removal is not yet known (Nedwell and

[51] This study used amplified recordings of operational turbines that may have also contained some unintended high-frequency artifacts that the porpoises and seals may have been responding to rather than the low-frequency wind turbine noise.

[52] It should be noted that this research was conducted using data from a 1.5 MW monopile offshore wind turbine and the technology currently being considered for the SAMP area is 3.6 MW or larger and a lattice-jacket design.

Howell 2004). Abrasive jet cutting (using the force of highly pressurized water) is likely to be used to cut piles from the seafloor, while the destruction of the concrete foundations and scour protection may require some blasting or the use of pneumatic hammers, if the protective structures cannot be lifted from the seafloor after dismounting the turbine support structure. Currently, no sound measurements are available on the use of abrasive jet cutting when decommissioning offshore structures. While explosives may be a loud point source of underwater sound, and consequently pose a serious risk of physical damage to any marine mammals in the detonation area (Minerals Management Service 2007a), non-explosive removal techniques are expected to cause short-term, negligible to minor impacts (Minerals Management Service 2007a). Therefore, the PEIS suggests the use of these alternative methods to minimize any adverse effects (Minerals Management Service 2007a). If explosives are used, following MMS guidelines (NTL No. 2004-G06) may reduce the potential for negative impacts (Minerals Management Service 2007a).

19. In summary, noise impacts associated with offshore renewable energy facilities are currently thought to affect marine mammals. The nature and scale of effects will depend on:
    - the hearing ability of the species and the individual animal,
    - the distance the individual is from the sound source,
    - the frequency and intensity of the noise source,
    - the activities of the marine mammals at the time of noise exposure,
    - the duration of the noise-producing activity (i.e. hours, days, months), and
    - transmission through the area (dependent upon physical conditions of the area such as topography, geology, sea state, etc.)

    To date, only a limited number of studies have been published documenting effects of construction and operation of offshore wind energy facilities on two species of marine mammals, harbor porpoises and harbor seals (Carstensen et al. 2006; Tougaard et al. 2006; Koschinski et al. 2003). Additional studies have inferred potential effects based on theoretical models or findings from similar activities in other industries (the most comprehensive review of observed effects can be found in OSPAR 2009a). It should be noted, however, that the range of effects may vary between installations.

850.5.2 Vessel Strikes

1. Increased vessel traffic associated with the construction, operation, or decommissioning of an offshore renewable energy facility may increase the risk of ship strikes. Impacts are expected to be minor for most species, especially seals and smaller cetaceans that are agile enough to avoid collisions (Minerals Management Service 2007a). Of all the whale species present within the Ocean SAMP area, the species considered at the greatest risk of vessel strikes are fin whales, humpback whales, North Atlantic right whales and sperm whales, based on the findings of the Large Whale Ship Strike Database (Jensen and Silber 2004; Minerals Management Service 2007a).[53] However, the response of an individual animal to an approaching vessel may be unpredictable, as it depends on the animal's behavior at the time, as well as its previous experience around vessels (Minerals Management Service 2009a).

[53] Sei and blue whales, which are also found in the SAMP area, have far fewer reported vessel strikes in U.S. waters (Jensen and Silber 2004).

2. Of all whale species within the SAMP area, the population-level impacts of a vessel strike would be most severe to the North Atlantic right whale (Minerals Management Service 2007a). Ship strikes more commonly result in whale fatalities when a ship is travelling at speeds of 14 knots [16 mph] or more. In fact, the number of ship strikes recorded decreases significantly for vessels travelling less than 10 knots [11.5mph] (Jensen and Silber 2004), which suggests that reducing ship speeds to this level may reduce the risk of vessel strikes even further (Minerals Management Service 2009a). As a result of this finding, the PEIS suggests vessels reduce ship speed and maintain a safe operating distance when a marine mammal is observed (Minerals Management Service 2007a, Minerals Management Service 2009a). In addition, by locating offshore renewable energy installations away from migratory routes, the risk of vessel strikes is further minimized (Minerals Management Service 2007a). It should also be noted that there is already a vessel speed restriction in place during parts of the SAMP area during certain times of the year to minimize the risk of right whale ship strikes; this speed restriction is part of the Right Whale Seasonal Management Area and is enforced by NMFS (NOAA National Marine Fisheries Service n.d.). See *Chapter 7: Marine Transportation, Navigation, and Infrastructure* for further discussion.

850.5.3 Turbidity & Sediment Resuspension

1. Water quality within a project area may be affected by the construction and decommissioning activities, including cable laying, associated with an offshore renewable energy facility. Specifically, construction or decommissioning activities may re-suspend bottom sediments, which may in turn increase concentrations of total suspended solids (TSS) in the water column (Minerals Management Service 2009; OSPAR 2008a). The level of impact caused by increased TSS is primarily dependent upon the sediment composition of the project site, grain size distributions, and the hydrodynamic regime (OSPAR 2006). Areas composed of fine grained, loose sediment, accustomed to frequent increases in turbidity (associated with storms, tidal or wave action) will likely not be substantially impacted by the temporary disturbances caused by these activities (Minerals Management Service 2009a). Increased TSS concentrations may impact prey abundance in an area (i.e. zooplankton or fish species), and therefore indirectly impact marine mammals which depend on those species as a food source (Minerals Management Service 2009; Köeller et al. 2006). However, because individuals can move to adjoining areas not affected by the temporary increases in TSS, these impacts are not expected to pose a threat to marine mammals (Minerals Management Service 2009a). In the case of the Cape Wind Project, while TSS concentrations were anticipated around construction and decommissioning time periods, the increases were predicted to be temporary and localized (Minerals Management Service 2009a). Pre-construction modeling may be useful in predicting the importance of sediment resuspension at a particular site, and monitoring programs during the construction can be used to validate model predictions of the potential TSS effects (OSPAR 2006). Monitoring programs may help to ensure that TSS levels remain within an acceptable range (OSPAR 2006).

2. The PEIS also identifies the potential risk posed by re-suspending contaminated sediments into the water column. The suspension of contaminated sediments from construction activities may in some instances result in bioaccumulation of toxins in marine mammal

tissue, due to the consumption of contaminated prey (Minerals Management Service 2009, see also Hooker et al. (2008)

3. Water quality around an offshore renewable energy facility may potentially be impacted if illegal dumping or accidental spills occurs from vessels or equipment. Vessel discharges and oil spills are already subject to standard operating procedures and discharge regulations (30 CFR 250.300 and MARPOL, Annex V, Public Law 100-220 [101 Statute 1458]), and the discharge of any legally discharged waste is not expected to pose any threat to marine mammals (Minerals Management Service 2007a). Substances that are legally discharged from vessels offshore are rapidly diluted and dispersed posing negligible risk to marine mammals (Minerals Management Service 2007a). Accidental spills from offshore renewable energy facilities may pose a potential hazard to marine mammals if they result in the release of large volumes of hazardous materials (Minerals Management Service 2007a). For example, transformers, used to transmit energy generated from the offshore renewable energy facilities to shore, may contain reservoirs of electrical insulating oil or other fluids. The accidental release of these materials may impact the health and survival of marine mammals exposed to the spill, or may indirectly impact marine mammals by adversely affecting prey species in the area (Minerals Management Service 2009a). The severity of these impacts depend on the location of the facility, the volume and timing of the spill, the toxicity of the material and the species exposed to the spill (Minerals Management Service 2007a; Minerals Management Service 2009a). An assessment performed on the Cape Wind Project found that the potential risk associated with accidental spills is insignificant to minor (Minerals Management Service 2009a), and that precautionary measures such as producing an oil spill response plan may minimize any adverse impacts on marine mammals (NOAA 2009).

850.5.4 Electromagnetic Fields (EMF)

1. Cetaceans have received attention with respect to induced magnetic fields around underwater transmission cables as it is hypothesized that they use the Earth's magnetic field to navigate during migration (Gill et al. 2005). However, there is very little data supporting the theory of magnetic orientation in cetaceans. If an effect does exist, transient mammals would likely only be temporarily affected by an induced magnetic field (Gill 2005). Moreover, since migration generally occurs in open water and away from the seabed (Kenney and Vigness-Raposa 2009), electromagnetic fields are unlikely to have a detrimental effect on whale migration (Gill et al. 2005). Research conducted by Miller et al. (2010) examined the potential electromagnetic fields that may be created from submarine cables used to support offshore renewable energy development in the SAMP area and found that the effects of EMF will be confined to within 20 meters [65.6 feet] of the cable. No adverse impacts to marine mammal behavior or navigation is expected from the undersea transmission cables (Minerals Management Service 2009a; Gill 2005). EMF associated with offshore wind energy projects may have potential effects on some fisheries resources; see Section 850.7 below.

850.5.5 Habitat Alteration & Reef Effects

1. Offshore renewable energy installations sited in soft sediment might locally change the sea bed characteristics from soft, mobile sediments to a harder substrate by introducing hard

structures for scour protection (rock, concrete mattresses, grout bags etc. Underwater structures are soon overgrown by sessile, benthic animals and algae which may increase the biomass locally, and attract fish and marine mammals as their predators (Wilhelmsson et al. 2006; OSPAR 2006; NOAA 2009). Similarly, the steel piles introduce a hard substrate into the water column, and provide a surface that can be colonized by species that might not ordinarily be present in soft sediment environments (OSPAR 2006). The offshore wind farm foundations at Horns Rev and Nysted have been readily colonized with epifouling communities, causing a local increase in biodiversity compared to amounts recorded prior to construction (DONG Energy et al. 2006; Bioconsult A/S, 2003a; Energi E2 A/S, 2004). However, no evidence has been found to date to suggest that these reef effects enhance or alter the prey availability of marine mammal species in the area. For a more detailed discussion of this potential effect see Section 850.3.

Section 850.6 Sea Turtles

1. The observed effects of offshore renewable energy development on sea turtles are unknown, as sea turtles are not present in any of the areas where wind turbines are currently in place (Minerals Management Service 2007a).

2. According to the NOAA Biological Opinion for the Cape Wind EIS (Minerals Management Service 2009a) and to Kenney and Vigness-Raposa (2009), the sea turtles that may be found in the SAMP area include the following:

Table 18. Abundance and Conservation Status of SAMP Area Sea Turtles
Kenney and Vigness-Raposa 2009

Turtle	*Status*	*Abundance*
Leatherback Sea Turtle (*Dermochelys coriacea*)	Endangered	The sea turtle most likely to be found in SAMP area, found in SAMP area in summer and early fall when water is warmest. Dispersed; higher abundance outside SAMP area
Loggerhead Sea Turtle (*Caretta caretta*)	Threatened	More abundant in the Northeast than Leatherbacks, but less likely to be found in the SAMP area – not often seen in cool or nearshore waters. May be seen occasionally in summer or fall
Kemp's Ridley Sea Turtle (*Lepidochelys kempii*)	Endangered	Sighted off southern New England only a few times; small juveniles known to use habitats around Long Island and Cape Cod, and may pass through SAMP area but are not detected in surveys
Green Sea Turtle (*Chelonia mydas*)	Threatened	Only one recent sighting in southern New England; small juveniles known to use habitats around Long Island and Cape Cod, and may pass through SAMP area but are not detected in surveys

3. Sea turtles may use the SAMP area for foraging. They are capable of diving to great depths, although most tracking studies of turtles in the Northeast have found them primarily foraging

in waters between 16 and 49 feet (4.9 and 14.9 meters) in depth. Leatherback turtles, likely the most abundant sea turtles in the SAMP area, have been shown to dive to great depths and may spend considerable time on the bottom , sometimes holding their breath for as long as several hours. Some sea turtles, particularly green sea turtles, feed on submerged aquatic vegetation (Minerals Management Service 2009a). While the placement of wind turbines will be at depths greater than where this foraging takes place, if cables are placed through areas of submerged aquatic vegetation, this could have an effect on sea turtles. Similarly, many sea turtles may feed on benthic invertebrates such as sponges, bivalves, or crustaceans, all of which are likely be found in the SAMP area (Minerals Management Service 2009a). Sea turtles may be affected by any loss of these food species during the cable-laying process; again, turtles are unlikely to forage at the depths where the turbine bases are likely to be located. Leatherback turtles are known to consume Lion's mane jellyfish (*Cyanea capillata*) as a mainstay of their diet; these jellyfish are plentiful in the SAMP area during the summer and fall (Lazell 1980).

4. Additionally, any of these turtle species may migrate through the SAMP area as part of their northward or southward migration in spring and fall, respectively (Minerals Management Service 2009a).

850.6.1 Noise

1. Little is known about the hearing capabilities of sea turtles. It is believed that pile driving and vessel noises are within the range of hearing of turtles, although they may have a limited capacity to detect sound underwater. Observed reactions from sea turtles exposed to high intensity sounds include startle responses such as head retraction and swimming towards the surface, as well as avoidance behavior (Minerals Management Service 2007a). For more detailed information on the effects of noise within the SAMP area, see the Effects of Noise on Marine Mammals, Section 850.51.

2. The Cape Wind EIS (2009) predicts that no injury during the pile driving process is likely to occur to sea turtles, even if the turtle were as close as 30 m (98.4 feet) from the source. The noise generated by pile driving is likely to cause avoidance behavior in sea turtles, which may move to other areas. However, only leatherback turtles are likely to be foraging in the area of the construction activity, as the other species seek out prey available at shallower depths, and their preferred prey items are located throughout the SAMP area. Sea turtles migrating through the area may also be affected, as they may avoid the construction area. These effects are expected to be short-term and minor (Minerals Management Service 2009a).

3. Any seismic surveys used in the siting process have the potential to affect individual sea turtles by exposing them to levels of sound high enough to cause disturbance if a turtle is within a certain distance of the sound source (1.5 km [0.9 miles]), although not high enough to cause injury. These effects will be minimal and short-term (Minerals Management Service 2009a).

4. The levels of noise generated by construction and maintenance vessels are expected to be below the levels that would cause any behavioral reaction in sea turtles except at very short

distances. Likewise, the sound generated by wind turbines during operation is not expected to affect the behavior or abundance of sea turtles in the area (Minerals Management Service 2009a).

5. The levels of sound generated by the turbines during operation could have the ability to interfere with communication, the location of prey or the orientation of sea turtles if the sounds are in the same frequency ranges heard by sea turtles. As it is not well understood what the hearing capacity of sea turtles is, more studies would be needed to understand whether the sound generated by wind turbines would have any effect (Minerals Management Service 2007a).

850.6.2 Habitat disturbance

1. Cable-laying activities may cause sea turtles to temporarily change swimming direction, but are not likely to have a significant effect. The increased turbidity as a result of cable-laying and construction, however, may interfere with the ability of sea turtles to forage by obscuring or dispersing prey (Minerals Management Service 2009a).

2. Sea turtles could be harmed by marine debris generated from the personnel working on the construction, operation, or decommissioning stages, particularly plastics that may be accidentally or purposely discarded, which may be mistaken for prey items by turtles, or which may cause them to become entangled (Minerals Management Service 2009a). The dumping of marine debris and other waste is already strictly regulated under existing statutes (30 CFR 250.300 and MARPOL, Annex V, Public Law 100-220 [101 Statute 1458]), and if followed marine debris will likely not pose a great threat to sea turtles.

3. Sea turtles may be at increased risk of ship strike from increased vessel traffic in the SAMP area, particularly during construction activities. However, ship strikes are relatively rare, and increased vessel traffic will not necessarily lead to an increase in ship strikes. Vessels engaged in construction activities are probably moving too slowly to present a risk, as turtles can easily move to avoid them. Collision risks will be greater with vessels moving to and from the construction site (Minerals Management Service 2009a). Sea turtles may avoid areas of high vessel activity, or may dive when approached by a vessel (Minerals Management Service 2007). Turtles engaged in feeding are at less of a risk for collision, as they spend most of their time submerged. Loggerhead and Kemp's ridley turtles are bottom feeders, so spend most of their time well below the surface, but leatherback turtles feed at or near the surface, and so are at greater risk of collision (Minerals Management Service 2009a).

4. Lights from construction activities during non-daylight hours could affect sea turtle hatchlings, which are known to be attracted to light (Minerals Management Service 2007a).

However, sea turtle hatchlings are not expected to be found within the SAMP area, as sea turtles do not nest in this area.

850.6.3 Electromagnetic Fields

1. Sea turtles have been found to use the earth's geomagnetic field for orientation and migration (Minerals Management Service 2007a). However, the Cape Wind EIS anticipated no adverse impacts from electromagnetic fields on sea turtles (Minerals Management Service 2009a). Electromagnetic fields may have potential effects on some fisheries resources; see Section 850.7.2 below for further information.

850.6.4 Reef Effects

1. The potential reef effects of the turbines, attracting finfish and benthic organisms to the structures, could affect sea turtles by changing prey distribution or abundance in the SAMP area. Sea turtles that eat benthic invertebrates, particularly loggerhead and Kemp's ridley turtles, which consume crustaceans and mollusks, may be attracted to the structures as an additional food source. Sea turtles may also be attracted to wind turbine structures for shelter; loggerheads in particular have been observed using oil rig platforms for this purpose (Minerals Management Service 2009a). Loggerheads are the species most likely to be attracted to the wind turbines for both food and shelter, and they are frequently observed around wrecks and underwater structures (Minerals Management Service 2009a). For more on reef effects, see Section 850.3.2, Reef Effects and Benthic Ecology.

Section 850.7 Fisheries Resources and Habitat

1. Offshore renewable energy development may have several potential effects on fisheries resources and habitat. Generally, the effects of offshore renewable energy projects on fisheries resources are difficult to interpret given the lack of scientific knowledge and consensus in several relevant subject areas. Given the information available, potential effects to fisheries resources and habitat are discussed below in general terms, but it is important to note that site-specific impacts of an offshore renewable energy project in the SAMP area will require separate, in-depth evaluation as part of the permitting process. It also must be noted that if threatened or endangered species are found in the project area, additional consultation with relevant federal agencies in accordance with the Endangered Species Act would be necessary to evaluate any potential impacts to these species (Minerals Management Service 2007a). See *Chapter 5 Fisheries Resources and Uses* for more information on endangered or threatened fish species. See also *Chapter 10 Existing Statutes, Regulations and Policies* for more information on the ESA.

2. With regard to fisheries resources, potential effects may take place at any phase of the project, including pre-construction testing and site characterization, construction, operation, and decommissioning. Some of these effects may include, but are not limited to: underwater sound associated with increased vessel traffic, scientific surveys, construction, operation, and decommissioning; electromagnetic fields created by the cables connecting the turbines and carrying the electricity to land; construction-related habitat disturbance; water quality impacts; changes in benthic community composition; other effects of structures, including the reef effect; and the effects of decommissioning offshore renewable energy developments.

850.7.1 Underwater sound

1. As noted above in Section 850.5.1, an offshore renewable energy project would generate underwater sound in all phases of development. Noise generated by pile driving activities during construction may be most significant and potentially harmful to fish individuals and then onto populations. For more detailed information on sound produced in the construction and operation of an offshore wind facility, please see Section 850.5.1, The Effects of Noise on Marine Mammals.

2. Fish vary greatly in their hearing structures and auditory capabilities, so it is difficult to generalize about the effects of noise generated by wind farm construction and operation on fish. There is lack of knowledge about the hearing capacities of most fish species. Certain fish species are thought to be hearing specialists, and may have enhanced hearing sensitivity and bandwidth, while others may be hearing generalists, and may be less sensitive to sound (Popper and Hastings 2009). Similar to marine mammals, the effect of noise will depend on the overlap between the frequency of the noise and the level of hearing of the species, and whether the sound exceeds the level of ambient noise (Thomsen et al. 2006). The impact of the sound produced will also vary greatly depending upon the environmental setting and conditions at the time and place where the sound is being produced (Popper et al. 2006).

3. The potential effects of sound from wind farm surveying, construction, decommissioning, and operation, on fish can be divided into three general categories:
   i. temporary or permanent hearing damage or other physical injury or mortality;
   ii. behavioral responses; for example, the triggering of alarm reactions, causing fish to flee or interrupting activities necessary for survival (e.g. feeding) and reproduction, and potentially inducing stress in the fish;
   iii. masking acoustic signals, which may be communication among individuals, or may be information about predators or prey (Thomsen et al. 2006).

4. As noted in Section 850.5.1, activities in the pre-construction phase generating underwater noise may include side-scan sonar and air guns for surveying. Studies on fish exposed to air gun blasts have found damage to sensory cells in the ear. While air guns are not likely to be used in the construction or operation of wind farms, they may be used in pre-construction seismic surveys for determining geological hazards and soil conditions in siting a wind farm (Minerals Management Service 2007a). Side-scan sonar is likely to have little impact on fish, as it is unlikely to cause hearing impairment or physical injury (Minerals Management Service 2007a).

5. The construction phase is most likely to produce levels of sound that could generate temporary and permanent hearing loss for fish near the source. Injuries of tissues or auditory organs can also occur at close range. Pile driving creates an impulsive sound when the driving hammer strikes the pile, resulting in a rapid release of energy (Hastings and Popper 2005). Only a handful of studies have been conducted on fish in the vicinity of pile driving, and while some have found evidence of injury or mortality in the fish near the source of the sound, others have found no mortality or injury. One study of pile driving found fish of several different species were killed within at least 50 m [164 feet] of the pile driving activity; it also found an increase in the number of gulls in the area, indicating additional fish mortality (Caltrans 2001). Another study found that the noise levels produced by pile driving during wind tower construction and cable-laying could damage the hearing of species within 100m [328 feet] of the source (Nedwell et al. 2003).

6. Injury to fish from sound can be in the form of damage to organs such as the swim bladder, or damage to the auditory sensor in the ears. Sound can also cause permanent or temporary threshold shift in hearing (PTS or TTS respectively), meaning fish lose all or part of their hearing, on either a permanent or temporary basis. There is some evidence that fish, unlike mammals, can repair their sensory cells used for hearing, and may recover from hearing loss caused by underwater noise. Popper et al. (2005) found the effects from even substantial TTS to have worn off for fish within eighteen hours of exposure. However, hearing loss, even if temporary, could render the fish unable to respond to environmental sounds that indicate the presence of predators or that allow the location of prey or potential mates (Popper and Hastings 2009).

7. A review and modeling study conducted by Thomsen et al. (2006) based on measurements of wind turbines in the German Bight and Sweden found that sound levels created during pile driving for construction of wind turbines was loud enough to be heard at long distances by

some fish species - perhaps as far as 80 km [49.7 mi] from the source for cod and herring, which are considered to be sensitive to sound. Salmon and dab, which have a poor sensitivity for sound pressure, could in theory detect pile driving sound over large distances as well. Flatfish might detect sound that is partly transported through the sediment. Pile driving noise may have the effect of masking other biological noises out to this distance. The nature and scale of behavioral response cannot be determined; however, behavioral responses to the construction noise might happen anywhere within the zone of audibility and could affect fish reproduction and population levels if biologically important activities such as migration, feeding, and spawning are interrupted. The authors determined that injury and mortality may occur in the vicinity of the activity (Thomsen et al. 2006). One playback study of pile driving sounds at relatively low pressure levels found sole to increase their swimming speeds during the playback, while cod were found to freeze their movements at the start of the playback (Mueller-Blenkle et al. 2010). While studies have generally found that impacts on fish will decrease the further from the source of the sound, this effect is not clearly understood because the relationship between distance and sound level is not straightforward. In some cases sound levels may be higher at some distances from the source due to propagation through the seabed and sound reflections from objects (Hastings and Popper 2005).

8. The relationship between sound exposure and physiological damage with regard to fish is not well understood, and more research is required to determine the potential effects of pile driving on fish (Thomsen et al. 2006). Little is known about potential long-term effects, including later death from injury, predation, or behavioral changes that may affect the individual fish or their populations, nor have studies examined the potential cumulative impacts from pile driving. The effects that noise may have on eggs and larvae have been little studied. Research is also lacking on the impacts on fish at larger distances from the source, where they are unlikely to be killed but may suffer from other physiological effects such as damage to the swim bladder or internal bleeding (Hastings and Popper 2005).

9. The noise created during the construction and decommissioning processes may cause some fish species to leave the area. This could cause a disruption in feeding, breeding, or other essential activities, and may have significant impacts if fish are removed from a spawning area. Less mobile species are likely to be more susceptible (Gill and Kimber 2005). The effect on fish populations would be greater if they are dispersed during the times of year when they would be naturally congregating for spawning or other purposes (Gill and Kimber 2005). Thus, effects will be determined in part by the timing of the project, such as the time of year when the noise disturbance occurs and for how long it occurs. Some studies have found that fish displaced from an area by noise during construction processes are likely to return following construction activity (Minerals Management Service 2007a). This may be dependent upon duration of the construction project; if construction occurs over a prolonged period, some fish species may not return. The length of time will in turn be dictated by a number of factors including the number of turbines, the availability of vessels, and access to the site as a result of weather conditions. The cumulative effects are likely to be more significant for a larger wind farm where more turbines would be constructed and the period of construction is longer. Miller et al. (2010) predicted that pile driving activity within the Ocean SAMP area could have observable behavioral effects on fish within 4000 m (2.5 miles) of the pile driving activity. If explosives were used in the decommissioning process,

the noise produced could have a serious impact on any marine life within 500 m (0.3 miles) of the activity (Miller et al. 2010).

10. Fish of different species produce a variety of sounds, many of which may be used for mating or other communication purposes. The sounds produced by wind turbines, particularly in the construction phase, may mask some of these sounds produced by fish, as the frequencies of pile driving and fish signals overlap. For example, cod, which are found in the Ocean SAMP area, produce a number of grunting sounds that are used in defensive and aggressive behaviors, and in courting mates. Masking these sounds with construction noise could have implications for mating and other behaviors. Because the transmission of the sounds could be audible by some species over great distances, the masking effects may also occur over great distances (Thomsen et al. 2006). The effect may depend on the signals produced by the fish; in species where only a single sound makes up a communication signal the effect may be negligible, because the duration of the pile driving sound is very short. However, some fish produce sequences of sounds that might be disrupted by pile driving pulses. Where a large number of turbines are being installed and the length of construction is longer, the masking effect may be appreciable (Thomsen et al. 2006). The noise produced in construction and operation could also mask the sounds of approaching predators or prey. Detecting those sounds may be crucial for survival (Wahlberg and Westerberg 2005). However, because neither the hearing capabilities of most fish nor the function of sounds produced by the fish is well understood, the effects of masking cannot yet be determined (Thomsen et al. 2006).

11. One potential effect on fish from noise could be stress; while this is difficult to quantify, some studies have shown that exposure to stressors can result in opportunistic infections, or may make fish more susceptible to predation or other environmental effects. Some studies on fish exposed to noise found no significant change in stress levels, but these results cannot necessarily be extrapolated to predicting the overall effects of exposure to noise on fish stress levels (Popper and Hastings 2009).

12. If the effects of noise on fish are poorly understood, the effects on invertebrates are even less well understood. One study found that shrimp demonstrated decreases in growth and reproductive rates when exposed to noise for an extended period (Popper and Hastings 2009).

13. Research on existing offshore wind farms in the Baltic Sea has found that the operation of the turbines adds to the existing array of underwater sound, and that the acoustic disturbance caused by the turbines is most likely a function of the number of turbines and their operation procedure (studies reviewed by Gill 2005). As noted above, operational noise produced by wind turbines is significantly less than the levels of noise produced during the construction phase. Even within ten meters of the turbine, the noise created is not likely to be sufficient to cause temporary or permanent hearing loss in any species of fish (Wahlberg and Westerberg 2005). One study found that the noise created by a 1.5 MW turbine was merged with ambient noise within one kilometer from the source (Thomsen et al. 2006). Miller et al. (2010) predicted that within the Ocean SAMP area where eight wind turbines are proposed south of Block Island, the operational noise of the turbines would be greater than ambient noise within one kilometer (0.6 miles) of the source, and would be below ambient noise levels at a distance of ten kilometers (6 miles) from the source.

14. Thomsen et al. (2006) predicted the noise generated by wind turbine operation might be heard up to four or five kilometers from the source by fish with exceptional hearing such as cod and herring, and maybe less than one kilometer by fish with less specialized hearing capabilities such as dab and salmon. Any behavioral or physiological effects on fish for levels of noise created by turbine operation would likely be restricted to very short ranges (Thomsen et al. 2006). However, it is important to note that most of these studies have been for 1.5 MW turbines, while those proposed for the Ocean SAMP area would likely be 3.6 or 5.0 MW. Additional studies are needed on the noise levels generated by these larger turbines.

15. As noted above, another source of sound from wind turbine projects is ship traffic, from ships carrying parts and maintenance equipment during the construction, operation, and decommissioning processes. The noise levels of sound created by vessels will not cause physical harm to fish, but may cause avoidance of the area (Minerals Management Service 2007a). The duration of avoidance may be determined by the duration of construction activity and the accompanying period of increased vessel traffic.

850.7.2 Electromagnetic Fields

1. Producing electricity with a wind turbine requires it to be moved over long distances by means of a submarine cable. The transmission is either via high voltage Direct Current (DC) or Alternating Current (AC) cables, with AC being the favored for short distances and DC for longer distances between the project and shore. These cables will necessarily produce magnetic fields around the cables. The intensity of the magnetic field increases with the electric current, and decreases with distance from the cable. The design of industry standard AC cables prevent electric field emissions, but do not prevent magnetic field emissions. These magnetic emissions induce localized electric fields in the marine environment as sea water moves through them. Furthermore, in AC cables the magnetic fields oscillate, and thereby also create an induced electric field in the environment around the cables, regardless of whether the cable is buried. Thus the term electromagnetic field, or EMF, refers to both of these created fields (Petersen and Malm 2006).

2. Exposure to magnetic fields is not unique to undersea cables; the earth has its own geomagnetic field, which many organisms utilize for orientation. Little is understood about the orientation of animals in response to the geomagnetic field, but evidence of geomagnetic orientation has been observed in a number of marine species, including fish, mollusks, and other crustaceans. In laboratory experiments conducted on a number of different marine animals in response to static magnetic fields generated by electrical current, most demonstrated no short-term change in behavior when the magnetic field was introduced. In one experiment by Bochert and Zettler (2004) where several organisms were exposed to EMF generated by a DC power source, of four crustacean species, blue mussels, and flounder studied, only one crustacean species, an isopod, demonstrated any avoidance of the magnetic field. In other experiments by the same authors on the long-term effects of magnetic fields on crustaceans and flounder, no significant effects were demonstrated. The authors conclude that the static magnetic fields of submarine cables produced by DC currents have no clear influence on the orientation, physiology, or movement of the benthic animals they tested (Bochert and Zettler 2004).

3. However, some evidence exists supporting the argument that EMF may have detrimental effects. Other studies have shown that some species of sharks, rays, and bony fishes detect electromagnetic fields and have demonstrated sensitivity to these EMFs (Gill et al. 2005). The induced electrical fields created by the magnetic fields from the cables are within the range of electrical transmissions detectable by sharks and rays (Gill and Kimber 2005). Exposure to certain magnetic fields was found to delay the development of embryos in fish and sea urchins (Cameron et al. 1985; Cameron et al. 1993; Zimmerman et al. 1990). Barnacle larvae exposed to high frequency AC EMF were found to retract their antennae, which would interfere with settlement (Leya et al. 1999). In another study, brown shrimp (*Crangon crangon*) were found to be attracted to magnetic fields of the magnitude that would be expected to be present around wind farms (ICES 2003). Little is known about the effects of EMF on lobsters. However, because effects have been demonstrated on brown shrimp and other crustaceans, an effect on lobsters can be anticipated.

4. Species using the Earth's magnetic field for navigation or orientation may be affected by the EMF, possibly becoming confused, but this effect will likely be short-lived as the animal moves through the area. Species that are magnetosensitive may either be attracted to or avoid the area (Gill 2005). If elasmobranchs (sharks, rays or skates) and other fish are sensitive to the electromagnetic fields and avoid passing over the cables, this could prevent movement from one location to another, trapping fish either within our outside of the cables (BMT Cordah Limited 2003). It is generally thought that the magnetic fields created by the cables will be much lower than the earth's geomagnetic field and will therefore cause no significant response (Gill and Kimber 2005). One study on the European eel (*Anguilla anguilla*) found that eels significantly decrease their swimming speed when passing over an AC cable (Westerberg and Lagenfelt 2008). A study of cables at Danish wind farms found some effects on fish behavior from the presence of the cables, but the effects included both avoidance and attraction, and could not be correlated with the strength of the EMFs (DONG Energy 2006). Catch studies on some species of fish (Baltic herring, common eel, Atlantic cod and flounder) at the Nysted wind farm in Denmark found the catches of these species were reduced in the vicinity of the cables, indicating the migration of fish across the cables may be reduced, but not blocked. In a separate study, they also found cod accumulating close to the cables however this was not when the cables were energized so there may be some other stimuli that the fish were responding to such as the physical presence of the cable trench (DONG Energy 2005).

5. If the electric fields being emitted by the cables approximate the bioelectric fields of some species, there is a possibility that certain electro-sensitive species, particularly elasmobranchs (sharks, skates, and rays) and sturgeon species, will be attracted to the cables, thinking them to be prey. The same species may be repelled by stronger electric fields closer to the cables, depending on the power sent through the cable and the characteristics of the cable itself. Because the cables will be buried in sediment or laid along the bottom, benthic species are most likely to encounter them (Gill and Kimber 2005). There is one report of sharks biting an unburied cable on the seafloor that was emitting induced AC electric fields (Marra 1989); however, there is little other data on interactions between sharks or other species and cables.

6. Miller et al. (2010) predict the electromagnetic fields that would be produced by the 26 kVA power cables likely to be used for the wind turbines proposed south of Block Island could have behavioral effects on marine life within 20 m (66 feet) of the cables.

7. There is no conclusive evidence at present on whether EMFs may have an impact on marine species (Johnson et al. 2008). However, because the effects of electromagnetic fields on fish and other species are poorly understood, more research is needed in this field. The effects of EMFs on species present within the SAMP area should not be assumed until further research is completed. It is not known whether resident species will be able to habituate to EMF, but this could be important for helping to determine appropriate mitigation measures.

850.7.3 Habitat disturbance

1. Disturbance to existing habitat is likely to result through the construction of offshore renewable energy infrastructure. Here, habitat disturbance is used broadly to refer to sediment disturbance and settling; increased turbidity of the waters in the construction area; and the installation of infrastructure including piles, anti-scour devices, and other structures (Minerals Management Service 2007a). The period of time and the extent of the disturbance, and thus its severity, will depend on the size of the wind farm and the amount of time necessary to construct it. For the proposed large-scale project in the SAMP area, this is likely to be a year or two. The total area of the seafloor affected within the SAMP area will be small; however, the overall effect will depend in part upon the relative prevalence or scarcity of the habitat type(s) affected, and the availability of similar habitat in the adjacent area. For more on the effects of offshore renewable energy on habitat and the benthic ecology of the SAMP area, see Section 850.3.1.

2. The construction of wind turbines is likely to have both short- and long-term effects on habitat. Habitat conversion and loss can result because of physical occupation of the substrate, and includes both changes to existing habitat and the creation of new habitat. Scour protection around the structures, which is made up of rock or concrete mattresses, increases the loss or conversion of habitat (Johnson et al. 2008). Direct effects to the seabed are likely to be limited to within one or two hundred meters of the structure, and there are likely to be areas between turbines which remain undisturbed (OSPAR 2006). For more on the creation of new habitat, see Section *850.7.7 Reef Effects and Fisheries*, and *850.3.2 Reef Effects and Benthic Ecology.*

3. Construction of the wind turbine foundations and the installation of cables can result in increased turbidity in the water column as well. This may in turn affect primary production of phytoplankton and the food chain, which could lead to an increased likelihood of eutrophic conditions. However, these effects are likely to be short-term and localized, and the overall impact on fish resources would be negligible (Minerals Management Service 2007a). Removal of sediments may result in habitat loss (Gill 2005). These are generally short-term impacts which will subside once construction has been completed (Johnson et al. 2008). Any sediments resuspended in the construction or decommissioning processes are likely to be transported by water movement, and may smother the neighboring habitats of sedimentary species. These sediments may also carry contaminants with them if the area has a history of industrial processes emitting into the adjacent waters (Gill 2005).

4. The interference in water flow caused by the wind turbine substructures may accelerate local tidal currents and wave action around the structures, forming scour holes in the sea bed adjacent to the pilings. These holes may be attractive habitat to species such as crab and lobster, and to some fish species (Rodmell and Johnson 2005).

5. Additional impacts from wind turbines would come from the eventual decommissioning and removal of the undersea structures, immediately reducing habitat heterogeneity and removing a large component of the benthic community that has established since the wind farm has been in operation (Gill 2005).

6. The installation and burial of submarine cables causes temporary habitat destruction through plowing and from barge anchor damage, and can cause permanent habitat alteration if the top layers of sediment are replaced with new material during the cable-laying process, or if the cables are not sufficiently buried within the substrate. Likewise, cable repair or decommissioning can impact benthic habitats. The effect of the cables will depend on the grain size of sediments, hydrodynamics and turbidity of the area, and on the species and habitats present where the cable is being laid (OSPAR 2008a). Undersea cables can also cause damage if allowed to "sweep" along the bottom while being placed in the correct location. The most serious threats are to submerged aquatic vegetation, which serves as an important habitat for a wide variety of marine species. Shellfish beds and hard-bottom habitats are also especially at risk (Johnson et al. 2008).

7. The placement of wind turbines, especially in large arrays, may affect flow regimes by altering tidal current patterns around the structures, which may affect the distribution of eggs and larvae (Johnson et al. 2008). Because the structures are likely to affect currents, the settlement of new recruits may be locally affected. These effects on habitat will be most harmful if they affect the spawning or nursery areas of species whose populations are depleted, especially if the spawning or nursery areas used by these species are limited and the species have long maturation periods, such as sharks and skates (Gill 2005). A study of turbines in Danish waters found little to no impact on native benthic communities and sediment structure from a change in hydrodynamic regimes (DONG Energy 2006). For more on the effects of wind turbines on coastal processes, see Section 850.2.

850.7.4 Water Quality Impacts

1. Offshore renewable energy facilities would result in increased vessel traffic through the pre-construction site characterization, construction, operation, and decommissioning phases. The MMS Programmatic EIS indicates that such an increase in traffic could increase the likelihood of fuel spills as a result of vessel accidents or mechanical problems, though it indicates that the likelihood of such spills is relatively small because of the small amount of vessel traffic that would be associated with the project (Minerals Management Service 2007a). The risk of fuel spills could also increase because of the increased likelihood of vessel collisions with the wind turbine structures.

2. Wastewater, trash, and other debris can be generated at offshore energy sites by human activities associated with the facility (in construction and maintenance processes). The

platforms may hold hazardous materials such as fuel, oils, greases, and coolants. The discharge of these contaminants into the water column could affect the water quality around the facility. Large-scale offshore renewable energy projects are likely to have one or more transformers, which will contain dielectric fluid, such as mineral oil, which could pose a threat to water quality through leakage or in the event of a collision (Minerals Management Service 2009a). Vessels traveling to and from the platforms may dump gray water or sewage, or may release plastics and other debris (Johnson et al. 2008).

3. Water quality may also be impacted during the construction process by re-suspending bottom sediments, increasing the sedimentation within the water column. This may impact the abundance of planktonic species, and could lead to eutrophication.

850.7.5 Changes in Community Composition

1. Wind energy and other offshore renewable energy projects could have indirect ecological effects that could affect the composition of fish species within the area. During the construction and decommissioning phases of a project, highly mobile fauna, including fish and large crustaceans, are likely to be displaced from the area, and there may be changes to some habitats, either through habitat loss or through enhancement. These factors may affect the composition of species found in the area. For more on the effects of changes in community composition, see *Section 850.3.3*, changes in community composition for benthic ecology.

2. During the construction and decommissioning phases of a project, the eggs and larvae of many species of fish may be vulnerable to being buried or removed. Some species, such as herring and sand eels, lay their eggs in the substrate; if wind farm construction took place within the spawning grounds of these species, it would likely impact the species (BMT Cordah Limited 2003). Other benthic organisms may also be buried in the process, which could affect finfish and shellfish that rely on these organisms for food. Individual fish are likely to move out of the area during construction because of the disturbance and because of the loss of food (Minerals Management Service 2007a). After the activity has ceased, recolonization may take months or years (Gill 2005).

3. No detailed, long-term analyses have yet been conducted on entire fish assemblages around either decommissioned oil platforms (a suitable comparable development of the coastal environment) or wind energy projects (Ehrich et al. 2006). Ehrich et al. (2006) hypothesize that any effects on fish densities and diversity resulting from newly installed wind turbines will be restricted to the immediate vicinity of the structures, and will not have wide-reaching effects, unless rare species are directly affected, which could have effects at the population level. The authors also note that in cases where wind turbines are constructed in areas with a sandy bottom, there may be localized removal of species dependent on soft-bottom habitat, favoring species which prefer hard bottoms, as the hard structures serve as habitat for these species. As most wind farms thus far have been constructed in areas of sandy bottom, there is little data on changes to other types of benthic habitats. They suggest that the wind farms will

also favor large predators, particularly if fishing pressure among the turbines is reduced (Ehrich et al. 2006).

4. There may also be changes in predator-prey relationships, in which some predators move out of the area temporarily or have their numbers temporarily reduced during the construction phase. This can result in the process of competitive release, in which species preyed upon by these predators become available to other predators. Often it is smaller species with faster rates of reproduction that will replace existing species. This could have secondary effects elsewhere, if the numbers of predators increase outside of the area of development (Gill and Kimber 2005).

5. The decommissioning of wind turbines would also have significant ecological effects, as the new habitat and accompanying species are removed. Habitat heterogeneity and the abundance of species would be reduced.

850.7.6 Structures

1. Organisms may either collide with or avoid the wind turbine structures underwater. While little information is available regarding this topic, the greatest impacts are likely to be within enclosed waters or where the devices form a barrier to movement (Gill 2005); thus collision and avoidance are not likely to be major impacts of the proposed wind turbines in the Ocean SAMP area.

850.7.7 Reef Effect

1. As noted above in Section 850.3.2, wind turbine structures may serve as both artificial reefs, in providing surfaces for non-mobile species to grow on and shelter for small fish, and as fish aggregating devices, which are used to enhance catches by attracting fish (Wilhelmsson et al. 2006).

2. After the wind turbines are in place, a change in the type and abundance of benthic species can be expected, which will change food availability for higher trophic levels. Because the placement of wind turbines may increase habitat for benthic species, the structures may have the effect of increasing local food availability, which may bring some species into the area. This may increase use of the area by immigrant fauna. More adaptable species will probably dominate the area under these new ecological conditions. The change in prey size, type, and abundance in the vicinity of the structures may also affect predators. Predators moving into the area may result in prey depletion (Gill 2005).

3. Oil and gas platforms have been found to harbor large numbers of larval and juvenile fish, and wind turbine support structure can be expected to have a similar effect. Because the structures extend throughout the water column, juvenile or larval fish are more likely to encounter them than other habitat types found only on the bottom, and may be more likely to settle there. There may also be less predation on small fish in midwater habitats, so they can safely hide in the structure at a variety of depths (Love et al. 2003). Fish can take advantage of the shelter provided by the structures while being exposed to stronger currents created by

the structures, which generate more plankton for plankton-eating fish (Wilhelmsson et al. 2006). While colonization of the new structures will begin shortly after construction, it will usually take several years for the colonization to be completed, because not all species will colonize the area at once (DONG Energy 2006) and there will be a succession of species and a likely increase in species using the newly formed community hence increasing diversity.

4. Wind turbines may also provide refuge from predation for juveniles of a number of mobile species, which is critical in promoting growth and survival until they reach maturity. Similarly, the structures may also provide refuge for both large and small fish and other species from fishing pressure. In the UK, where fishing is currently not permitted around the structures, they are being promoted as protected areas, and may eventually contribute to stock replenishment for some species. These structures have not yet been in the water long enough to see these effects; however, many of the juvenile fish found around the turbines are small *Gadoid* species such as cod. Additionally, if there is an absence of trawling and dredging between the wind farms, it may result in increases in benthic fauna (DONG Energy 2006; Kaiser et al. 2000). Even if fishing is permitted, most fishermen are unlikely to fish immediately next to the turbines because of the possibility of having gear tangled in the structures (see Section 850.8). In oil and gas platforms, fish that remain within the jacketed structures may be less vulnerable to fishing pressure than others (Love et al. 2003). In addition to fish, these structures may also provide important habitat for lobsters and crabs. Young, newly-settled individuals of these species typically seek out refuge to avoid predation, including hiding among stones and cobbles, or burying in sediments. Wind turbines and scour protection may provide suitable hiding places for these individuals, and may enhance the lobster fishery in cases where habitat is a limiting factor (Linley et al. 2007).

5. A number of studies of decommissioned oil platforms have indicated fish are attracted by the structures (Ehrich et al. 2006). A study conducted on oil and gas platforms off the Californian coast found that the platforms tended to have higher abundances of large, commercially targeted fish than did natural reefs. This result may have been because of low fishing activity around the platforms, creating de facto marine protected areas. Generally, the platforms also had higher numbers of young-of-the-year rockfish than other areas, including natural reefs (Love and Schroeder 2006). One study noted the tendency of large, recreationally targeted species such as tunas and mackerel to associate with fish aggregating devices, and predicted wind turbines might have the same effect (Fayram and de Risi 2007). A study of decommissioned oil rigs in the North Sea off Norway found aggregations of cod, mackerel, and other species around the structures (Soldal et al. 2002).

6. The observed effect of other wind turbines has found some species are attracted to wind farms. A study of wind farms in Danish waters found the increased habitat heterogeneity from turbine foundations resulted in an increase of species from adjacent hard surfaces, leading to a local increase in biomass of 50 to 150 times, most of which served as available food for fish and seabirds (DONG Energy 2006). Monitoring of the Horns Rev wind farm in Denmark found a 300% increase in the number of sand eels around the wind turbines between 2002 and 2004, and an eight-fold increase in the availability of food for fish in the area, but not a statistically significant difference in the number of fish (DONG Energy 2005). Another study found an increased number of cod in the area surrounding wind turbines at the

Vindeby Offshore Wind Farm in Denmark (Bio/consult 2002). Some studies have not found an increase in fish around structures; this may be because the studies were conducted during the early stages of colonization (Dong Energy 2006).

7. One question to be determined about wind turbines is whether they actually increase fish populations by providing habitat, or simply attract fish from elsewhere, concentrating them in the area of the structure. If individual fish are being attracted to the site, but populations are not increasing, this may have impacts on adjacent habitats where the fish would ordinarily be found (Gill 2005). If the structures serve only to aggregate fish and not to produce additional biomass, there is a risk of harvesting pressure around the structures leading to overexploitation of certain stocks by concentrating the fish and leaving them more vulnerable to harvesting (Whitmarsh et al. 2008).

8. Love and Schroeder (2006) found that in some instances, the fish found at the platforms were producing significant amounts of larvae that may have been increasing populations around the platforms and elsewhere. They also found that while some of the fish present around oil and gas platforms were adults of species that had likely migrated from elsewhere, the majority of individuals for many species were small juveniles that had likely been brought to the platforms as plankton and settled there (Love et al. 2003). Love and Schroeder (2006) also found that juvenile fish living around oil and gas platforms had lower predation rates than fish living on natural reefs, because of a low density of predators in the mid- and upper waters around the platforms, and that there appeared to be no difference in growth rates between fish living on platforms or on natural reefs.

850.7.8 Decommissioning Effects

1. As discussed above, wind turbine structures may serve as artificial reefs, providing habitat for a number of invertebrate and fish species, especially juvenile fish. As such, the eventual decommissioning of the turbines could have negative environmental impacts by reducing or removing this habitat. While this issue has not yet been dealt with for offshore wind energy projects, the debate over how to best decommission oil and gas platforms has been ongoing in California and the Gulf of Mexico. For oil and gas platforms, it is estimated that the life of a decommissioned platform left in place will be from 100 to more than 300 years (Love et al. 2003). A large-scale wind farm will occupy more seabed space than individual oil and gas rigs, and thus the area of the ocean floor affected by both construction and decommissioning will be larger than for oil and gas rigs. The decommissioning of the wind turbines and the resulting effects on fish and fisheries should be considered.

Section 850.8 Commercial and Recreational Fishing

1. Offshore renewable energy may affect commercial and recreational fisheries activity in many different ways. Some of the potential effects on fishermen from the placement of a wind farm in the SAMP area may include changing the distribution and/or abundance of fish populations, increasing stocks of certain fish through reef effects; limiting fishermen's access to traditional fishing grounds; gear or vessel damage; and other changes to fishing activities. These general types of effects are discussed below, though specific effects are dependent on site-specific conditions such as location, type and scale of project, and other factors. The potential site-specific effects of an offshore renewable energy project in the SAMP area will undergo in-depth evaluation as part of the permitting process (see Section 820.4 and *Chapter 10 Existing Statutes, Regulations and Policies*).

850.8.1 Effects on Fish Populations

1. Some fish species, especially rare or overfished species, could be negatively affected by the presence of wind farms if the wind farms result in a localized concentration of fishing effort and an increased harvest if the species are attracted to the structures. Alternatively, the increased habitat for some species created by the structures may result in increased populations of commercially important species (see Section 850.7.7), leading to economic gains for fishermen targeting these species (BMT Cordah Limited 2003).

2. There is also the potential for secondary effects on fish populations if fishermen are displaced from the wind farm area, and as a result concentrate their efforts elsewhere on vulnerable populations or habitats (BMT Cordah Limited 2003).

3. Fish populations could be affected by some or a combination of the factors listed in Section 850.7, such as noise or electromagnetic fields, which could potentially have effects at the population levels if activities such as spawning or feeding are affected. Some fish populations could also be affected by a change in benthic habitat as some areas of the seafloor are converted to hard structures. The cumulative effects of the factors mentioned above may also need to be considered. For more on the ways in which wind farms may affect fish, see Section 850.7.

850.8.2 Effects on Fish Catch

1. Impacts to fish catches may be greatest during the construction phase, when the noise generated by construction activities may drive some mobile species out of the immediate area.

2. Engås et al. (1996) found the average catch rates for cod to decrease by about 50% both in the immediate vicinity of and at a distance from air gun activity. Haddock catches also decreased by similar percentages. Five days after the air gun was used, fish catches had not increased. However, as noted above, air guns are unlikely to be used in the pre-construction siting process.

3. Westerberg (1994, 2000, as reported in Thomsen et al. 2006) found that catches of cod decreased within 100m [328 ft] of a wind turbine while it was operating, likely because of the noise generated by the turbine itself. The study also found higher catches within 100m [328 ft] of the turbines than in the surrounding areas when the turbines were stopped, likely because of the reef effect (for more on the reef effect and fisheries, see Section 850.7.7). However, in a separate study, Wahlberg and Westerberg (2005) estimated that the levels of noise produced by operating turbines (1.5 MW) were only likely to cause avoidance responses by fish closer than 4 m [13 ft] to the turbines and only at high wind speeds (13 m/s [29.1 mph]). They also noted that fish may habituate to the noise created by the wind turbines and disregard the sound. The potential effect of operational noise on fish may vary between projects, as operational noise will varies depending on the turbine size, model, foundation type and speed of rotation (see Section 850.5.1).

4. In a study by Vella et al. (2001), the catch per unit effort (CPUE) of cod (*Gadus morhua*) and shorthorn sculpin (*Myoxocephalus scorpius*) was greater within 200 m [656 ft] of a wind turbine than between 200 – 400 m [656-1,312 ft] of a turbine, regardless of whether the turbine was operational or not. The study did find that CPUE was lower in the vicinity of the turbine while the turbine was operational, but still higher than in the area 200 – 400 m from the turbine. This indicates that the turbine may be increasing catch because it is acting as a fish aggregating device (Rodmell and Johnson 2005).

850.8.3 Access to Fishing Grounds

1. Offshore renewable energy facilities may have an adverse impact on commercial and recreational fishermen's access to traditional fishing grounds. The degree of impact varies significantly by facility design, stage of the development process, location in the offshore environment, and type of fishing activity, and may be either temporary or long-term. Fishermen may be displaced from traditional fishing grounds by the structures themselves, regulatory decisions that limit access around the structures or through the facility, or other factors.

2. Fishing access around existing offshore renewable energy facilities in Belgium, Germany, the Netherlands, and the United Kingdom is subject to restrictions imposed by those countries' respective governments. In Belgium, Germany, and the Netherlands, a 500-meter Safety Zone is established around the entire wind farm, and fishing is prohibited within this area. In the United Kingdom, a 500-meter [0.3 mi] Safety Zone is established around each individual turbine only during the construction period. During operation, a 50-meter [164 ft] Safety Zone is established around each individual turbine. These restrictions are primarily instituted for safety reasons and are similar to those applied to offshore oil and gas rigs in these same countries (except for Belgium, where there are no rigs).[54]

3. In the Ocean SAMP area and other U.S. waters, access around individual turbines or through wind farms is the jurisdiction of the U.S. Coast Guard, in partnership with the U.S. Army Corps of Engineers (in state waters) and the U.S. Minerals Management Service (in federal

[54] Findings confirmed through responses to informal questionnaires completed by the Center for Environment, Fisheries, and Aquaculture Science in the UK; the German Maritime and Hydrographic Agency; and the Belgian and Dutch delegations to the OSPAR and London Convention Scientific Group, March 12, 2010.

waters). At the time of this writing, there is no formal policy in place that would universally limit fishing or navigational access around and through offshore wind farms in U.S. waters. In addition, as a point of reference, it should be noted that safety zones are not universally established at Gulf of Mexico offshore oil and gas platforms. Those few platform specific safety zones that are in place are designed to address site- and activity-specific safety issues and typically allow recreational activities, including recreational fishing (LeBlanc, pers. comm., April 19, 2010).

4. Fishing activity will be affected differently through different stages of the development process. Fishing vessels may be required or may choose to avoid the area during the construction process to avoid conflict with construction activities and vessels. During the operation phase, fishermen may be required or may choose to avoid the turbines because of the potential risk to their vessels or fishing gear from collision with a turbine, snagging gear, or other safety concerns.

5. The potential impacts of offshore renewable energy on fisheries activity varies by gear type. The MMS Programmatic EIS (2007a) indicates that bottom trawling has the greatest potential for conflict with offshore facilities because of the potential for snagging bottom gear on cables and debris. It further indicates that surface longlining may encounter water-sheet use conflicts with renewable energy facility construction and service vessels.

6. If certain gear or vessel types are restricted from the wind farms, either for safety and navigational reasons, or because those fishermen choose to fish elsewhere because of the difficulty of navigating amongst the turbines, this may actually benefit competing gear types fishing for the same species within the wind farms. The presence of a wind farm may significantly alter the patterns of fishing within the area (North Western and North Wales Sea Fisheries Committee n.d.).

7. A loss of fishing grounds from the placement of a wind farm could cause vessels to have to travel further to fishing grounds (BMT Cordah Limited 2003), increasing fuel costs and potentially risks to safety. This could have a disproportionate impact on smaller fishing vessels, to which the risks of venturing further to sea will be greater.

8. Some fishermen have expressed the concern that marine insurance companies might increase their insurance premiums or prohibit insured fishing vessels from operating within the vicinity of offshore wind farms (e.g. Ichthys Marine 2009). However, it should be noted that at the time of this writing, Sunderland Marine does not currently impose restrictions or higher premiums on their members, nor have they heard of other insurance companies issuing such demands (McBurnie, pers. comm., March 15, 2010). Sunderland Marine is the world’s largest insurer of fishing vessels, and insures The Point Club, a fishing vessel insurance and safety club that insures many of the fishing vessels operating out of Point Judith and Newport (Nixon, pers. comm., April 8, 2010).

850.8.4 Gear/Vessel Damage

1. Wind farms may present a navigational hazard for fishing and other vessels, and there is some risk of collision with turbines, or with service vessels. Power cables and bottom fishing

gear present mutual possibilities for damage, and may endanger the safety of fishing vessels. Burying cables between the turbines, as well as from the wind farm to shore, will mitigate some of this problem. However, even if cables are buried, there is a potential for them to become uncovered through sea bed movement, putting a trawled net and perhaps the fishing vessel in danger of hang ups (Rodmell and Johnson 2005). Rodmell and Johnson (2005) note that single vessel trawling within and around the wind turbines may be possible if cables are sufficiently buried or protected, but that pair trawling may not be practical, and scallop dredging may not be compatible with wind farms.

2. Long lining and gill nets may be feasible in the vicinity of wind turbines, although their lengths may need to be limited depending on the spacing of the turbines. Purse seining within the wind farms is likely to be difficult, although may be possible on a small scale. The use of lobster and fish pots in the vicinity of the wind turbines should be mostly undisturbed. Even if fishing activity is permitted within the wind farms, fishing vessels may prefer to avoid navigating within and through wind farms (Rodmell and Johnson 2005).

850.8.5 Changes to Fishing Activity

1. The presence of wind farms may impede access to fishing grounds for some fishermen; even if fishing within the turbines is not restricted, some fishermen may choose to avoid the wind farms for safety or insurance reasons, and may have to travel further to fish, making it harder or more costly to retain the same level of catch. The greatest impacts may be to smaller vessels, which may be more limited in their ability to fish elsewhere. This may also result in increased competition for space in other areas (Rodmell and Johnson 2005). Those vessels most likely to have to avoid the wind farm areas will be those with towed or static nets (Mackinson et al. 2006), which in the Ocean SAMP waters includes primarily trawlers and scallop dredges. As many trawlers are targeting groundfish, already a vulnerable fishery due to declining catches and increasing regulations, groundfishing vessels may be the most vulnerable to possible increased costs or reduced earnings from displacement.

2. Fishermen interviewed in the UK were concerned that if they were displaced from their usual fishing grounds, they would have to spend time searching for new fishing grounds, and that if there were insufficient resources in the new fishing grounds to support them, they would inevitably suffer from a reduction in catch. If the fishermen are displaced, they may also suffer a reduction in catch because of the time required to search for and develop the specialized local knowledge of their new fishing grounds they have held at their previous grounds. Fishermen relocated to another area may suffer reduced earnings because they are competing with vessels already fishing in the area, or, in the case that a larger vessel is displaced and seeks out new fishing grounds, it may in turn displace smaller vessels fishing already fishing in the new area (Mackinson et al. 2006).

3. Fishermen in the UK were concerned about impacts on the availability and cost of insurance for fishing vessels navigating around wind farms, even if fishing within wind farms is legal (Mackinson et al. 2006).

4. If the wind turbine support structures serve as artificial reefs or fish aggregating devices, they could have positive economic benefits for some fishermen. A study of artificial reefs off

Portugal found that fishing around the artificial reefs resulted in substantially higher revenues, and that the value per unit of effort was also greater, because the fish were more concentrated (Whitmarsh et al. 2008). These benefits would likely only accrue to fishermen able to fish in the vicinity of the structures, although if the reef effects of the turbine support structures serve to increase fish biomass overall, this could benefit all fishermen in terms of spillover to adjacent habitats and thereby increased catches. There is also a danger that the economic benefits from fish aggregation and the resulting increase in catch efficiency around the turbines could lead to overexploitation of stocks and decrease catches elsewhere, negating any positive benefits to be had (Whitmarsh et al. 2008).

5. Fishing incomes may be supplemented or enhanced by offshore aquaculture activities that may be based around the wind turbines. For more on this potential future use, see *Chapter 9 Other Future Uses*.

Section 850.9 Cultural and Historic Resources

1. The potential effects of offshore renewable energy on cultural and historic resources may include physical impacts on existing offshore submerged archaeological resources such as shipwrecks or pre-contact settlements on the ocean floor, as well as visual impacts when the development is proposed within the viewshed of onshore land-based sites designated as historically significant.

2. Research and documentation of the effects of offshore renewable energy on cultural and historic resources have been compiled for projects in Europe, and during review for the Cape Wind project proposal in the United States (Minerals Management Service 2010). In anticipation of future offshore renewable energy development within the U.S., the Department of Interior Minerals Management Service (MMS) has identified potential impacts and enhancements of such development on cultural and visual resources in the "Programmatic Environmental Impact Statement for Alternative Energy Development and Production" (PEIS) (Minerals Management Service 2007). From Europe, the Collaborative Offshore Wind Research Into the Environment (COWRIE) released, "*Guidance for Assessment of Cumulative Impacts on the Historic Environment from Offshore Renewable Energy*", that identifies both synergistic and cumulative impacts on cultural and historic resources. (COWRIE 2007).

3. For offshore development proposals, an Area of Potential Effect (APE) is defined to include both offshore submerged areas and onshore land-based sites where physical disturbance would be required for construction, operation, maintenance, and decommissioning. The APE for submerged areas includes footprints of proposed structures to be secured on the ocean floor and related work area or cable routes where ocean sediments and sub-bottom may be disturbed. (Minerals Management Service 2010). For onshore sites, the APE would include any soil disturbance required for cables or connections to onshore electric transmission cable systems, or visual impacts specifically related to National Historic Landmarks, properties listed or eligible for listing on the National Register of Historic Places, or Traditional Cultural Properties (Minerals Management Service 2010).

4. The construction of offshore renewable energy facilities may result in direct disturbance of offshore submerged archaeological resources, including shipwreck sites and potential settlements that may have existed on what is now the ocean floor. The maps presented in Section 420.3 illustrate a paleo-geographic landscape reconstruction that suggests much of the area that is now Block Island and Rhode Island Sound was dry land over 12,500 years Before Present (yBP), and that human settlement in these areas was possible. Any disturbance of the bottom could potentially affect any cultural resources present, including early settlement sites; the level of impact may depend on the number and importance of cultural resources in that location, and any seabed disturbance that has occurred previously in the location (Minerals Management Service 2007). MMS requires if any unanticipated cultural resources are encountered during a project, all activities within the area must be stopped and MMS consulted (Minerals Management Service 2007).

5. Visual impacts to onshore land-based sites may result from the final project as well as the various phases of construction in an offshore renewable energy project. If turbines were

visible from shore, this would represent a change in the viewshed and an alteration of the aesthetics from areas where they were visible. For onshore land-based sites, the overall perception of visual impacts of offshore developments is subjective and opinions vary about whether visual impacts for a given project are positive, negative, or neutral (Minerals Management Service 2007). In advance of the construction phase, a meteorological tower will likely be installed in the project area to collect data to assess the wind resources. The visual impact of the tower will depend on its distance and thus visibility from shore. During the construction, operation and decommissioning phases, there will be increased vessel traffic in the project area, which will alter the visual characteristics of this area in that many of the construction and maintenance vessels, including a variety of ships and crane/jack-up barges, may be larger in size than other vessels traditionally in use within the project area (Minerals Management Service 2009a). The FAA will likely require aircraft warning lights on the turbines for air safety purposes; these will be single red lights that flash at night on the nacelles of the peripheral turbines. Whether these lights are visible from land, and thus have an effect on land-based viewing, will depend on whether the turbines themselves are visible from land (Minerals Management Service 2009a).

6. Section 106 of the National Historic Preservation Act, however, requires that a given project's visual effect on historic resources be evaluated from National Historic Landmarks, properties listed or eligible for listing on the National Register of Historic Places, or Traditional Cultural Properties (Minerals Management Service 2010). The Criteria of Adverse Effect defined in Section 106 of the National Historic Preservation Act [36 CFR 800.5(a)(1)] states, *"An adverse effect is found when an undertaking may alter, directly or indirectly, any of the characteristics of a historic property for inclusion in the National Register in a manner that would diminish the integrity of the property's location, design, setting, materials, workmanship, feeling, or association."* Examples of adverse effects relevant to the development of offshore renewable energy are listed as including, but not limited to, the following [36 CFR 800.5(a)(2)]: *"Alteration of a property…; Change of the character of the property's use or of physical features within the property's setting that contribute to its historic significance…; Introduction of visual, atmospheric or audible elements that diminish the integrity of the property's significant historic features."*

7. The magnitude of the visual impacts will depend on site- and project-specific factors, including: distance of the proposed wind facility from shore; size of the facility (i.e., number of wind turbines); size (particularly height) of the wind turbines; surface treatment (primarily color) of wind turbines and electrical service platforms (ESPs); number and type of viewers (e.g., residents, tourists, workers); viewer location (onshore vs. offshore); viewer attitudes toward alternative energy and wind power; visual quality and sensitivity of the landscape/seascape; existing level of development and activities in the wind facility area and nearby onshore areas (i.e., scenic integrity and visual absorption capability); presence of sensitive visual and cultural resources; weather conditions; lighting conditions; and presence and arrangements of aviation and navigation lights on the wind turbines (Minerals Management Service 2007).

8. Factors that influence the perception an evaluation of visual impacts include: viewer distance; view duration; visibility factors; seasonal and lighting conditions;

landscape/seascape setting; number of viewers; and viewer activity, sensitivity, and cultural factors (Minerals Management Service 2007).

Section 850.10 Recreation and Tourism

1. The potential effects of offshore renewable energy on recreational and tourism activities are not well understood given the relatively recent occurrence of offshore renewable energy. The PEIS indicated that offshore renewable energy installations might have visual impacts on marine recreational users and coastal tourists, though this depends on the location and visibility of the structures, as well as the preferences of the individual (Minerals Management Service 2007a). Visual impacts may be caused by the offshore structures themselves, as well as the sights of support vessels, construction equipment, and helicopters traveling to and from offshore facilities, which may impact cruise ship tourists, coastal tourists, beach users, and recreational boaters. Such impacts could result in the reduction of tourism or recreational activity within sight of the project area (Lilley et al. 2009). MMS cites no evidence of such impacts in other locations with offshore renewable facilities and indicates that such impacts, if any, are expected to be minor (Minerals Management Service 2007a).

2. Alternatively, the PEIS also indicates that offshore renewable energy structures may enhance marine recreational and tourism activities by becoming an attraction that recreational boaters, charter boat clients, cruise ship passengers, and other visitors may want to visit (Minerals Management Service 2007a). A 2007 University of Delaware study found that 65.8% of surveyed out-of-state tourists were likely to visit a beach in order to see a wind farm offshore, and 44.5% were likely to pay to take a boat tour of an offshore wind facility (Lilley et al. 2009). Anecdotal data provided by a 2006 British Wind Energy Association study indicates several instances in which tourism increased at UK destinations adjacent to offshore wind farms, or where surveyed tourists indicated that the wind farm had no effect on their likelihood to visit the site (British Wind Energy Association 2006). Visitor centers have been developed at some of these sites to facilitate tourists' experience (British Wind Energy Association 2006).

3. Noise associated with on-site marine construction, or traffic noise from support vessels and helicopters traveling to and from the offshore facility, may have a potential impact on coastal tourists and marine recreational users. Such impacts could result in the reduction of tourism or recreational activity within the affected area. In the PEIS, MMS cites no evidence of such impacts in other locations with offshore renewable facilities and indicates that such impacts, if any, are expected to be minor (Minerals Management Service 2007a).

4. The construction and operation of offshore renewable energy facilities may result in short- or long-term displacement of marine recreational users, particularly recreational boaters. The construction phase may result in temporary closures of the offshore project area and/or adjacent shoreline areas during activities such as driving piles or installing transmission cables. Though less likely, the operation phase may also result in the long-term displacement of recreational users from all or part of the project area. Such temporary or long-term closures could alter recreational activities and use patterns within the SAMP area by lengthening transit times between destinations, displacing fishing activities conducted by income-generating charter boat operations, or displacing large-scale sailboat races that rely on the use of the project area. Such a displacement could also cause individual users or entire events to relocate, resulting in increased recreational activity in other in-state or out-of-state

locations (Minerals Management Service 2007a; Royal Yachting Association and the Cruising Association 2004). In the PEIS, MMS indicates that such impacts, if any, are expected to be minor (Minerals Management Service 2007a). It should also be noted that enforcing access restrictions around an offshore renewable energy facility may be very difficult given the offshore location.

5. The construction and operation of offshore renewable energy facilities may impact navigation and marine safety for recreational boaters in and around the project area. Alternatively, offshore facilities may provide enhancements to navigation and marine safety by providing mariners access to offshore weather data. Such impacts, enhancements, and mitigation measures are discussed at length in the Section 850.11 which deals with potential affects to marine transportation, navigation, and infrastructure.

6. Some of the recreational uses discussed in this chapter rely on the presence and visibility of marine and avian species including fish, whales, sharks, and birds. Offshore renewable energy facilities may have some impacts on these species and/or the habitats on which they rely. Alternatively, offshore renewable energy support structures may add to habitat complexity and increase biodiversity within the immediate area, attracting more fish, birds, whales and sharks, thereby improving recreational activities that rely on these species. See Sections 850.3, 850.4, 850.5 and 850.7 for more information on the potential affects offshore renewable energy development may pose to these resources.

7. If offshore renewable energy development results in a reduction in marine recreation and tourism in the SAMP area, Rhode Island-based businesses that serve these industries may lose some business. Alternatively, marine trades and coastal tourism businesses may benefit from offshore renewable energy in response to the potential growth of marine and coastal tourism activities such as wind farm boat trips (OSPAR 2004) (see above). In addition the construction and operation of an offshore facility may require additional shore-based infrastructure or services that may boost the marine trades sector.

Section 850.11 Marine Transportation, Navigation and Infrastructure

1. Offshore renewable energy may have some effects on marine transportation, navigation activities and other infrastructure in the SAMP area. The degree to which offshore renewable energy structures may affect marine transportation, navigation and infrastructure varies in large part on the specific siting of a project. Careful consideration when planning the location of an offshore renewable energy facility, as well as the use of appropriate mitigation strategies, can minimize any potential negative impacts (Minerals Management Service 2007a).

2. In addition to the potential effects identified in European research, the PEIS and the Cape Wind FEIS, the U.S. Coast Guard has issued a Navigation and Vessel Inspection Circular (U.S. Coast Guard NAVIC 02-07) to provide guidance on the information and factors the Coast Guard will consider, which include navigational safety and security, when reviewing a permit application for an offshore renewable energy installation in the navigable waters of the United States (U.S. Coast Guard 2007).

3. Offshore renewable energy facilities may affect navigational safety in a project area by increasing the risk of collision, limiting visibility, or limiting a vessel's ability to maneuver (Minerals Management Service 2007a; U.S. Coast Guard 2007; BWEA 2007; U.K. Maritime and Coast Guard Agency 2008). However, collision risk was found to be low, especially when facilities are sited appropriately (e.g. Minerals Management Service 2007a). Risks that have been identified include vessels colliding with offshore renewable structures themselves; with other vessels; or with ice that has formed on or around the structures during winter months. Moreover, visibility may be impaired surrounding an offshore renewable energy facility, as structures may block or hinder a mariner's view of other vessels, nearby land masses, or other navigational features (U.S. Coast Guard 2007; United Kingdom Maritime and Coast Guard Agency 2008). Obstructed visibility could potentially put a vessel at risk of collision or running aground. However, mitigation measures have been identified that can lower this potential risk to acceptable levels. For instance, mariners have been advised to follow required standard operating procedures, where applicable, as outlined in the International Regulations for Preventing Collisions at Sea (COLREGS) for limited visibility conditions. Adherence with these standard regulations can mitigate hazards to navigation caused by impaired visibility within an offshore renewable energy facility (U.S. Coast Guard 2009; U.K. Maritime and Coast Guard Agency 2008). Offshore renewable energy structures may also limit the ability of some larger vessels to maneuver to avoid collision, as these vessels usually require greater stopping distances and have wider turning radii (U.S. Coast Guard 2007; U.S. Coast Guard 2009). The MMS PEIS (2007a) notes that such impacts can be mitigated to acceptable levels by siting offshore renewable energy facilities so that they do not interfere with designated fairways or shipping lanes, and using appropriate signage and/or lighting to warn passing vessels (Minerals Management Service 2007a, U.S. Coast Guard 2009). In addition, the U.S. Coast Guard considers all of these navigational safety issues when evaluating a permit application for an offshore renewable energy structure (U.S. Coast Guard 2007).

4. Whereas offshore renewable energy facilities may potentially displace marine transportation, military, or navigation uses, appropriate siting away from shipping lanes, military usage

areas, or other intensively-used areas can minimize or eliminate any potential displacement of these uses (Minerals Management Service 2007a). Vessels that cannot safely operate or navigate within an offshore renewable energy facility may be excluded from areas that were previously used, and therefore would need to alter travel routes in the vicinity of such projects (United Kingdom Maritime and Coastguard Agency 2008; U.S. Coast Guard 2007). Route alterations may potentially extend vessel travel times. The MMS PEIS (2007a) notes that such impacts can be mitigated to acceptable levels by siting offshore renewable energy facilities away from designated fairways or shipping lanes. In addition, MMS (2007a) expects that the military impacts of offshore wind farms will be negligible provided that development is coordinated with the U.S. Department of Defense and all appropriate military agencies.

5. Offshore renewable energy structures may affect the physical characteristics of a waterway, which include localized currents and sediment deposition and erosion (United Kingdom Maritime and Coastguard Agency 2008) though can be minimized to acceptable levels through proper siting and mitigation methods (U.S. Coast Guard 2007; Minerals Management Service 2007a). Currents that are altered in direction and/or speed within or around an offshore renewable energy facility, may affect how vessels navigate through an area. In addition, structures that attach to the seafloor or extend through the water column may affect the surrounding water depth by altering sediment movement or deposition (Minerals Management Service 2007a; U.S. Coast Guard 2007; United Kingdom Maritime and Coastguard Agency 2008). Consequently, if shoaling occurs, vessel navigation may be impacted within or around an offshore renewable energy facility. These effects may be most pronounced in predominantly shallow areas, or areas composed of highly mobile substrate (i.e. sands) with strong waves or currents. Mitigation measures may include installing scour-protection devices and monitoring sediment transport processes (United Kingdom Maritime and Coastguard Agency 2008; U.S. Coast Guard 2007; Minerals Management Service 2007a). For more information on scour and the potential affects to coastal processes and physical oceanography see Section 850.2.

6. Due to the large size of some offshore renewable structures, offshore renewable energy installations may interfere with the use of radar by ships or shore-based facilities within the area. However, interference may be negligible to minor when properly mitigated (Minerals Management Service 2007a; U.S. Coast Guard 2007; Technology Service Corporation 2008; Howard and Brown 2004; U.S. Department of Defense 2006). Studies have shown that ship and land-based radar systems may have some difficulty in detecting marine targets within an offshore renewable energy facility as the result of the distortion or degradation of radar signals by the installed structures (U.S. Coast Guard 2009; Technology Service Corporation 2008; Minerals Management Service 2007a; U.S. Department of Defense 2006, BWEA 2007). Research conducted to assess the potential radar impacts of the proposed Cape Wind project in Nantucket Sound found that the facility would only pose adverse impacts in accurately detecting targets within and immediately behind the wind farm, as the installed structures may produce false targets or mask real targets (U.S. Coast Guard 2009; Technology Service Corporation 2008; United Kingdom Maritime and Coastguard Agency 2008). In other words, vessels navigating near but outside a wind farm may not be able to clearly identify, by radar, another vessel operating within the wind farm due to radar clutter. However, radar impacts observed within the wind farm can be mitigated to acceptable levels

through greater attention by radar operators in distinguishing between real and false targets (U.S. Coast Guard 2009). No adverse impacts were found to occur between vessels operating completely outside, but within the vicinity of, the wind farm (U.S. Coast Guard 2009; Technology Service Corporation 2008). Because the severity of impacts to radar varies widely depending on site-specific characterizations, the U.S. Coast Guard considers impacts on navigation radar when reviewing a permit application (U.S. Coast Guard 2007).

7. Weather radar located near offshore renewable energy installations may also be adversely impacted by offshore renewable energy structures; impacts may include misidentification of thunderstorm features, false radar estimates of precipitation accumulation, and incorrect storm cell identification and tracking (Minerals Management Service 2007a).

8. The installation of offshore renewable energy facilities may cause either minimal impacts or possible enhancements to navigation and communication tools and systems, including global positioning systems, magnetic compasses, cellular phone communications, very-high frequency (VHF) communications, ultra-high frequency (UHF) and other microwave systems, and automatic identification systems (AIS) (Minerals Management Service 2007a, United Kingdom Maritime and Coastguard Agency 2008). The MMS PEIS (2007) indicates that any impacts are likely to be negligible to minor, and cites a number of studies in which no negative impacts were found. For example, Brown and Howard (2004) found no impact of wind farms on GPS accuracy and also noted that magnetic compasses, AIS, and VHF communications (ship-to-ship and ship-to-shore) were not affected within the wind farm installation. The U.S. Coast Guard requires permit applicants to conduct research on the potential impacts of an offshore renewable energy installation on navigation and communication systems prior to construction (U.S. Coast Guard 2007).

9. Search and rescue operations by agencies such as the U.S. Coast Guard, may be positively and/or negatively affected by offshore renewable energy installations (U.S. Coast Guard 2007; LeBlanc 2009). For example, installations may prolong the response time of search and rescue missions in cases where longer routes around the facility are required. Alternatively, offshore renewable energy structures may provide refuge to distressed mariners stranded or disabled within the vicinity of the facility (U.S. Coast Guard 2007). When evaluating an offshore renewable energy permit, the U.S. Coast Guard will examine if an offshore renewable energy facility will prolong an agency's response time during a rescue mission (LeBlanc 2009). Previous research conducted to analyze the effects of offshore wind farms on search and rescue operations, involving helicopters, showed that radio communications and VHF homing systems worked satisfactorily, as did thermal imaging of vessels, turbines, and personnel within the wind facility (Brown 2005).

10. Operational offshore renewable energy facilities may provide enhancements to navigation and marine safety by providing mariners with access to in-situ offshore weather, wave and current data. This information may increase navigational safety by informing mariners of current offshore conditions, or providing a recent history of offshore conditions to aid in search and rescue operations within the area.

11. During the construction of an offshore renewable energy facility, vessel traffic may temporarily increase in a project area (Minerals Management Service 2007a). Transits and

operations of vessels involved in the transport of equipment and materials, facility construction, or the laying of submarine cables may temporarily increase (Minerals Management Service 2007a). As a result, port facilities may also experience increased activity (Minerals Management Service 2007a). Increased vessel activity may continue, albeit to a lesser extent, through the operation of the offshore renewable energy facility, as maintenance vessels will be required to service the installed structures. The presence of these vessels may increase the demand for port services, and enhance the economic activity associated with port facilities and marine industries.

12. Siting of offshore renewable energy facilities near pre-existing submarine cables may impact the security and accessibility of these cables. Such impacts can be mitigated to acceptable levels by considering pre-existing cables when siting offshore renewable energy facilities. Cable ships require a minimum distance from an offshore structure in order to safely access a submarine cable for repair or replacement (International Cable Protection Committee 2007). Offshore renewable energy installations whose location does not allow for safe access to existing submarine cables by the appropriate vessels may negatively impact the operation, performance, and longevity of this infrastructure (International Cable Protection Committee 2007). In addition, laying new submarine cables associated with an offshore renewable energy facility may require crossing existing cables in the area.

Section 850.12 Cumulative Impacts

1. Table 18 summarizes of all the potential effects of offshore renewable energy development on existing resources and uses identified in this section. The range and severity of effects will vary depending on the project. Project specific effects will be thoroughly examined as part of a project's NEPA review. In order to assess what the net effect might be from any of these effects related to offshore renewable energy, numerous factors will need to be taken into account, including the duration, frequency, and/or intensity of the effect. Furthermore, most effects are still not fully understood and will require further monitoring (see Section 860 for monitoring requirements for offshore renewable energy in the SAMP area).

2. In addition to the effects caused by any one renewable energy project within the SAMP area, the cumulative impact of past, present, and future uses on the SAMP area must be considered. The SAMP area is not pristine – activities in the offshore waters have been taking place for hundreds of years – but neither is it heavily industrialized. The ecosystem and its resources, as well as those who use the SAMP area, are currently being directly or indirectly affected by activities taking place inside of and beyond the SAMP area. When considering the effects of a wind energy project on the marine environment, the cumulative effects of existing activities such as fishing, marine transportation, and recreation will need to be considered alongside the proposed project, as should the effects of multiple renewable energy or other development projects on this area. Particularly important will be the cumulative effects of global climate change along with other current and future activities. The total cumulative effects cannot be fully understood and cannot be predicted with certainty, but nonetheless the potential for cumulative effects should be taken into account. A cumulative impact analysis of a proposed project would be required under 40 CFR Section 1508.7 of NEPA regulations.

3. While not all offshore renewable energy projects will have the same affects on the natural resources or existing uses of the Ocean SAMP area, identifying all potential effects aids in determining the most appropriate siting for any future projects. Through the Ocean SAMP process existing uses and resources have been identified and described, adding to the current understanding of the area. Moreover, the policies and standards outlined in the Ocean SAMP document provide protection and consideration to important areas, resources and uses of the area. In the end, the findings and policies of the Ocean SAMP will help to manage and address cumulative impacts of potential offshore renewable energy development, or any future development within the waters of the SAMP boundary.

Table 19 Summary of Potential Effects of Offshore Renewable Energy Development During Each Stage of Development.

Area	Pre-construction Siting	Construction	Operation	Decommissioning
Alteration of waves and currents	N/A	N/A	Changes in current velocity and direction; changes in wave heights; Changes in larval distribution; Scour (local and global)	N/A
Water Column Density Stratification	N/A	N/A	Reduced spatial extent of stratification; Shorter seasonal duration of stratification	N/A
Alteration of Benthic Habitat	N/A	Redistribution of sediments; Smothering of benthic organisms; smothering of eggs and larvae; damage to benthic habitat from cable sweep; Loss of habitat; disturbance to shellfish beds or hard bottom habitats from cable laying	Introduction of hard substrate; Loss of seabed area	Loss of habitat; Redistribution of sediments; Smothering of benthic organisms; smothering of eggs and larvae;
Water quality	Accidental spillage of contaminants or debris	Accidental spillage of contaminants or debris	Accidental release of contaminants	Accidental spillage of contaminants or debris
Noise effects – marine mammals	Avoidance; sound masking; stress	Masking of sounds; displacement; temporary/permanent hearing threshold shifts; stress; injury; mortality	Avoidance; sound masking; stress	Avoidance; sound masking; stress

Noise effects - fish	Avoidance; sound masking; stress	Masking of sounds; displacement; temporary/permanent hearing threshold shifts; stress; injury; mortality; decreased catch rates	Avoidance; sound masking; stress	Avoidance; sound masking; stress
Noise effects – sea turtles	Avoidance	Avoidance	Probably none	Avoidance
EMF	N/A	N/A	Avoidance or attraction by sensitive species, resulting in changes to feeding or migratory behavior	N/A
Reef effects	N/A	N/A	Increased colonization for invertebrates; increased fish habitat; shelter for juvenile species; increased predators; possibility of invasive species; increased fish catch; attraction for sea turtles	Loss of reef effects
Vessel traffic	Increased risk of collision with marine mammals; Increased noise causing avoidance by fish and marine mammals	Increased risk of collision with marine mammals; Increased noise causing avoidance by fish and marine mammals; Increased risk of collision with sea turtles	Increased risk of collision with marine mammals; Increased noise causing avoidance by fish and marine mammals	Increased risk of collision with marine mammals; Increased noise causing avoidance by fish and marine mammals
Turbidity	N/A	Affect primary production; secondary effects on prey species	N/A	Affect primary production; secondary effects on prey species
Effects to birds	N/A	Displacement; disturbance	Displacement; disturbance;	Displacement; disturbance

			avoidance; collision with turbines	
Visual effects	Increased vessel traffic	Increased vessel traffic, including heavy construction equipment	Presence of wind turbines	Increased vessel traffic, including heavy construction equipment

860 Renewable Energy and Large Scale Projects Policies and Standards

860.1 Policies

1. For the purposes of the Ocean SAMP, Renewable Energy and Large-scale Offshore Developments are defined as:
    a. offshore wind facilities (5 or more turbines within up to 2 km of each other, or 18 MW power generation);
    b. wave generation devices (2 or more devices, or 18 MW power generation);
    c. instream tidal or ocean current devices (2 or more devices, or 18 MW power generation); and
    d. offshore LNG platforms (1 or more); and
    e. artificial reefs (1/2 acre footprint and at least 4 feet high), except for those projects whose primary purpose is habitat enhancement.

   The items listed in section 860.2 shall be required for large-scale offshore developments in state waters. Small-scale projects (lower than the above thresholds) will need to meet the data requirements specified by the joint agency working group, as described in 860.1.6.

2. Renewable Energy and Large-scale Offshore Developments proposed to be sited in State waters pursuant to the Ocean SAMP shall not have a significant adverse impact on the natural resources or human uses of the SAMP area. Where the Council determines that impacts on the natural resources or human uses of the SAMP area through the pre-construction, construction, operation, or decommissioning phases of a project constitute significant detrimental impacts, the Council shall require that the applicant modify the proposal or the Council shall deny the proposal.

3. In assessing the natural resources and existing human uses present in state waters of the Ocean SAMP area, the Council finds that the most suitable area for offshore renewable energy development in the state waters of the Ocean SAMP area is the Renewable Energy Zone depicted in Figure X. The Council designates this area as Type 4E waters. In the Rhode Island Coastal Resources Management Program these waters were previously designated as Type 4 (or multipurpose) but are hereby modified to show that this is the preferred site for large scale renewable energy projects in state waters.

4. The Council may require the applicant to fund a program to mitigate the potential impacts of a proposed Renewable Energy or Large-scale Offshore Development to natural resources and human uses. The mitigation program may be used to support restoration projects, additional monitoring, preservation, or research activities on the impacted resource or site.

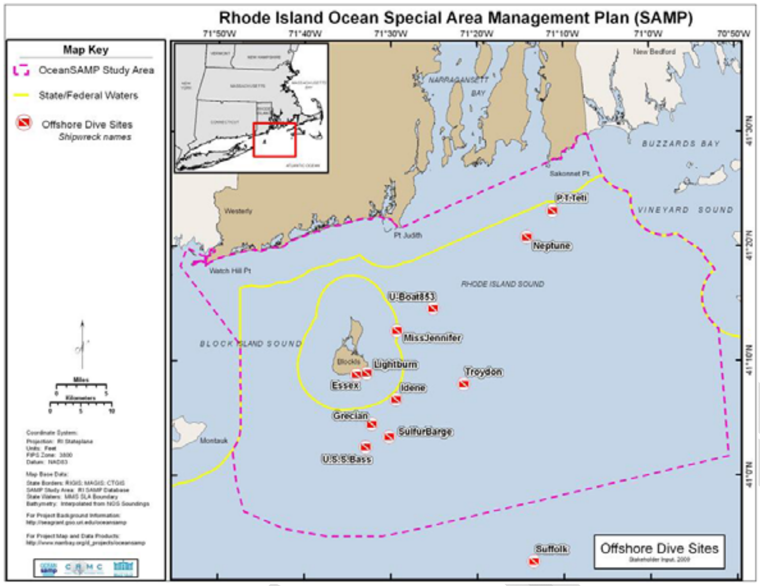
5. The Council shall work in coordination with the U.S. Department of the Interior Minerals Management Service to develop a seamless process for review and design approval of offshore wind energy facilities that is consistent across state and federal waters.

6. The Council shall work together with the project applicant, U.S. Coast Guard, the U.S. Navy, the U.S. Army Corps of Engineers, NOAA, recreational boating organizations, marine pilots, and other marine safety organizations to promote safe navigation around and through Renewable Energy and Large-scale Offshore Developments and cable routes during the construction, operation, and decommissioning phases of such projects. The Council will promote and support the education of all mariners regarding safe navigation around offshore renewable energy facilities, including the potential effects such facilities may have on radar.

7. The Council shall work in coordination with a joint agency working group when establishing pre-construction survey and data requirements, monitoring requirements, and protocols and mitigation measures for a proposed Renewable Energy and Large-scale Offshore Development. The joint agency working group will comprise those state and federal agencies that have a regulatory responsibility related to the proposed project. The agency composition of this working group may differ depending on the proposed project. The joint agency working group will be co-led by the CRMC and the lead federal agency with primary jurisdiction over the proposed project.

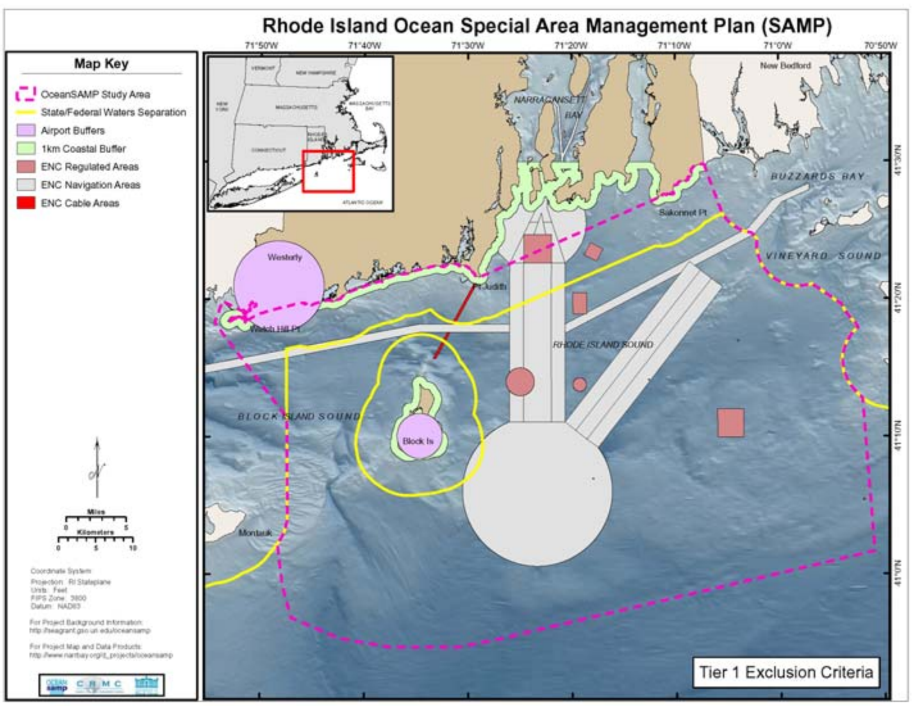
8. The Council has designated the areas listed in 860.1.8(i)-860.1.8(vii) as Areas of Particular Concern, and the areas listed in 860.1.8(viii)-860.1.8(ix) as Areas Designated for Preservation. The Council shall require applicants of Renewable Energy and Large-scale Offshore Developments in areas of particular concern within the Ocean SAMP area to avoid these sites. Where these sites can not be avoided, proponents shall minimize to the greatest extent possible any impact, and, if necessary, mitigate any significant impact to these resources. The Council shall prohibit any large scale projects in area designated for preservation or their buffer zones. Areas of particular concern that have been identified in the Ocean SAMP area are:

i. Dive sites, as shown below and in Chapter 6, Figure 6, "Offshore Dive Sites."



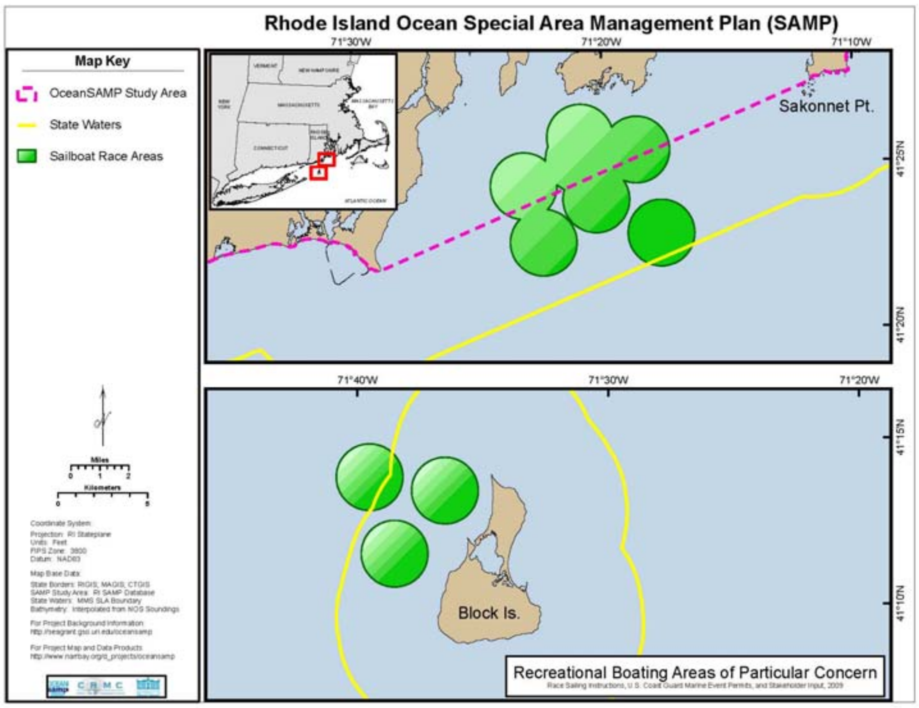
ii. Moraines and fish habitat as identified in Maps xx and yy (in development).

iii. Exclusion Areas contained in the Technology Development Index (as listed in Section 830.2) as applicable.



iv. Areas of high fishing activity as identified during the pre-application process by the Fishery Advisory Board (as described in Section 560.1.3).

v. Areas identified as high intensity recreational use areas, as identified in Chapter 6 Figure 4.

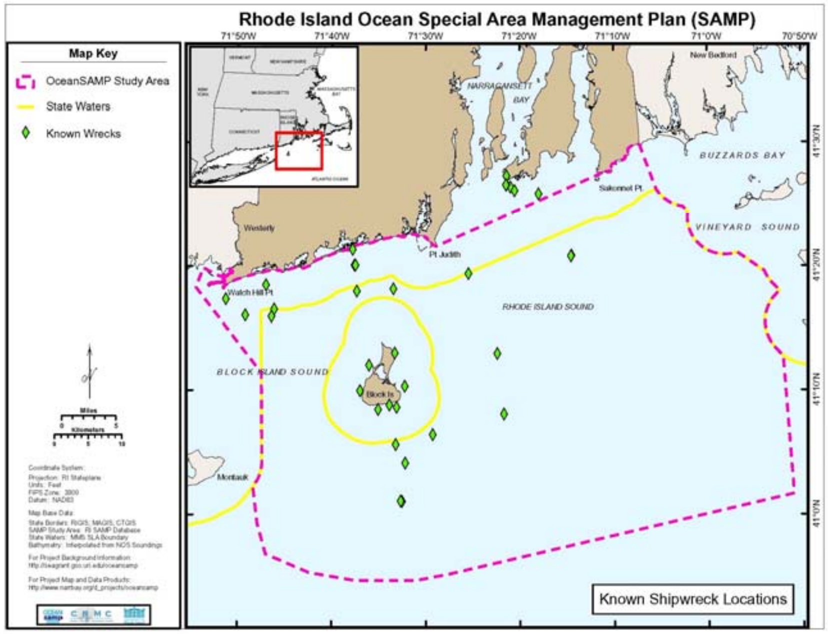


vi. Naval Fleet Submarine Transit Lane, as identified in Chapter 7, Figure 2.

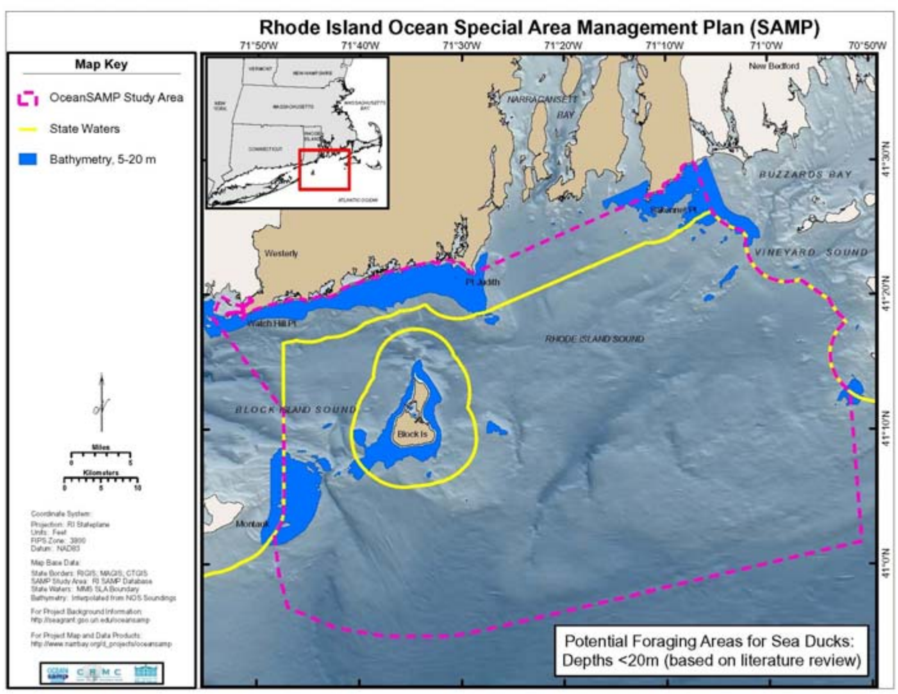
vii. Other areas identified during the pre-application review by state and federal agencies as areas of importance.

Areas designated for preservation include:

viii. Known historic shipwreck sites, as listed in Chapter 4, Table 3, “Known Shipwrecks in the Ocean SAMP Study Area” and shown below (draft version):



ix. Sea recognized duck foraging habitat, as shown in Chapter 8, Figure 39, “Foraging Areas for Seaducks” or subsequent iterations of this map.



9. The Council may issue a permit for period of up to 50 years to construct and operate a Renewable Energy and Large-scale Offshore Development. A lease will be issued at the start of the construction phase and payment will commence at the end of the construction phase. Lease payments will be due when the project becomes operational. Lease renewal must be submitted 2 years before the end of the lease term. Council approval will be required for any reassignment of the permit or lease.

10. To the greatest extent possible, Renewable Energy and Large-scale Offshore Development structures shall be made available to researchers for the investigation into the effects of large-scale installations on the marine environment.

860.2 Standards

860.2.1 Overall Standards

1. To minimize permitting inefficiencies and streamline the review process for Renewable Energy and Large-scale Offshore Developments, the Council will adopt a format of regulatory review similar to the regulations of the U.S. Department of the Interior's Minerals Management Service for offshore renewable energy. All documentation required at the time of application will be similar with the requirements followed by the U.S. Department of the Interior Minerals Management Service when issuing renewable energy leases on the Outer Continental Shelf. For further details on these regulations see 30 CFR §285.

2. The Council will coordinate with the appropriate federal and state agencies to establish project specific standards that must be followed by the applicant during the construction, operation and decommissioning of a Renewable Energy or Large-scale Offshore Development.

3. Any assent holder of an approved Renewable Energy or Large-scale Offshore Development must:
    i. Design the project and conduct all activities in a manner that ensures safety and will not cause undue harm or damage to natural resources, including their physical, chemical, and biological components to the extent practicable; and take measures to prevent unauthorized discharge of pollutants including marine trash and debris into the offshore environment.
    ii. Submit requests, applications, plans, notices, modifications, and supplemental information to the Council as required;
    iii. Follow up, in writing, any oral request or notification made by the Council or notification made, within 3 business days;
    iv. Comply with the terms, conditions, and provisions of all reports and notices submitted to the Council, and of all plans, revisions, and other Council approvals, as provided in §860.2;
    v. Make all applicable payments on time;

vi. Conduct all activities authorized by the permit in a manner consistent with the provisions of this document, the Rhode Island Coastal Resources Management Program, and all relevant federal and state statutes, regulations and policies;
vii. Compile, retain, and make available to the Council within the time specified by the Council, any data and information related to the site assessment, design, and operations of a project; and
viii. Respond to requests from the Council in a timely manner.

4. Any assent holder of an approved Renewable Energy or Large-scale Offshore Development shall work with the Council when designing the proposed facility to incorporate where possible mooring mechanisms to allow safe public use of the areas surrounding the installed turbine or other structure.

860.2.2 Site Assessment Plan Required for an Application for a Renewable Energy or Large-scale Offshore Development

1. Prior to construction, the following necessary data and information will be required by the Council:

   i. **Site Assessment Plan -** A SAP describes the activities (e.g. installation of meteorological towers, meteorological buoys) the applicant plans to perform for the characterization of the project site**. Within the renewable energy zone if an applicant applies within 2 years of adoption of the Ocean Special Area Management Plan they may elect to combine the SAP and Construction and Operation Plan (COP) phase, but only within the renewable energy zone and only for 2 years after the adoption date. If an applicant elects to combine these two phases all data requirements must still be met.** The SAP must describe how the applicant will conduct the resource assessment (e.g., meteorological and oceanographic data collection) or technology testing activities. The applicant must receive the approval of the SAP by the joint agency working group and the approval of the COP by the Council before beginning any of the approved activities on the applicant's lease. For projects within Type 4E waters (depicted in Figure X) the applicant may use data generated by the Ocean SAMP provided the data meets the timeliness requirements of the joint agency working group.

      a. The applicant's SAP must include data from:
         1. Physical characterization surveys (e.g., geological and geophysical surveys or hazards surveys); and
         2. Baseline environmental surveys (e.g., biological or archaeological surveys).
      b. The SAP must demonstrate that the applicant has planned and is prepared to conduct the proposed site assessment activities in a manner that conforms to the applicant's responsibilities listed above in §860.2.1.3 and:
         1. Conforms to all applicable laws, regulations;

2. Is safe;
3. Does not unreasonably interfere with other existing uses of the state waters,
4. Does not cause undue harm or damage to natural resources; life (including human and wildlife);the marine, coastal, or human environment; or sites, structures, or direct harm to objects of historical or archaeological significance;
5. Uses best available and safest technology;
6. Uses best management practices; and
7. Uses properly trained personnel.

c. The applicant must also demonstrate that the site assessment activities will collect the necessary information and data required for the applicant's COP, as described below in §860.2.2.1(ii).

d. The applicant's SAP must include the necessary data and information described in Table 20, as applicable.

Table 20. Contents of a Site Assessment Plan.

Project information:	**Including:**
(1) Contact information	The name, address, e-mail address, and phone number of an authorized representative.
(2) The site assessment or technology testing concept.	A discussion of the objectives; description of the proposed activities, including the technology to be used; and proposed schedule from start to completion.
(3) Designation of operator, if applicable.	
(4) Stipulations and compliance.	A description of the measures the applicant took, or will take, to satisfy the conditions of any permit stipulations related to the applicant's proposed activities.
(5) A location.	The surface location and water depth for all proposed and existing structures, facilities, and appurtenances located both offshore and onshore.
(6) General structural and project design, fabrication, and installation.	Information for each type of facility associated with the applicant's project.
(7) Deployment activities.	A description of the safety, prevention, and environmental protection features or measures that the applicant will use.
(8) The applicant's proposed measures for avoiding, minimizing, reducing, eliminating, and monitoring environmental impacts.	A description of the measures the applicant will take to avoid or minimize adverse effects and any potential incidental take, before the applicant conducts activities on the project site, and how the applicant will mitigate environmental impacts from proposed activities, including a description of the measures to be used.
(9) Reference information.	Any document or published source that the applicant cites as part of the plan. The applicant may reference information and data discussed in other plans previously submitted by the applicant or that are

	otherwise readily available to the Council.
(10) Decommissioning and site clearance procedures.	A discussion of methodologies.
(11) Air quality information.	Information required for the Clean Air Act (42 U.S.C. 7409) and implementing regulations
(12) A listing of all Federal, State, and local authorizations or approvals required to conduct site assessment activities on the project site.	A statement indicating whether such authorization or approval has been applied for or obtained.
(13) A list of agencies or persons with whom the applicant has communicated, or with whom the applicant will communicate, regarding potential impacts associated with the proposed activities.	Contact information and issues discussed.
(14) Financial assurance information.	Statements attesting that the activities and facilities proposed in the applicant's SAP are or will be covered by an appropriate performance bond or other Council approved security.
(15) Other information.	Additional information as requested by the joint agency working group.

e. The applicant's SAP must provide the results of geophysical and geological surveys, hazards surveys, archaeological surveys (as required by the joint agency working group), and biological surveys outlined in Table 21 (with the supporting data) in the applicant's SAP:

Table 21. Necessary Data and Information to be provided in the Site Assessment Plan.

Information.	**Report contents.**	**Including.**
(1) Geotechnical.	Reports from the geotechnical survey with supporting data.	A description of all relevant seabed and engineering data and information to allow for the design of the foundation of that facility. The applicant must provide data and information to depths below which the underlying conditions will not influence the integrity or performance of the structure. This could include a series of sampling locations (borings and *in situ* tests) as well as laboratory testing of soil samples.
(2) Shallow hazards.	The results from the shallow hazards survey with supporting data, if required.	A description of information sufficient to determine the presence of the following features and their likely effects on the proposed facility, including: (i) Shallow faults; (ii) Gas seeps or shallow gas; (iii) Slump blocks or slump sediments; (iv) Hydrates; and

		(v) Ice scour of seabed sediments.
(3) Archaeological resources.	The results from the archaeological survey with supporting data, if required.	(i) A description of the results and data from the archaeological survey; (ii) A description of the historic and prehistoric archaeological resources, as required by the National Historic Preservation Act (NHPA) of 1966, as amended.
(4) Geological survey.	The results from the geological survey with supporting data.	A report that describes the results of a geological survey that includes descriptions of: (i) Seismic activity at the proposed site; (ii) Fault zones; (iii) The possibility and effects of seabed subsidence; and (iv) The extent and geometry of faulting attenuation effects of geologic conditions near the site.
(5) Biological survey.	The results from the biological survey with supporting data.	A description of the results of a biological survey, including descriptions of the presence of live bottoms; hard bottoms; topographic features; and surveys of other marine resources such as fish populations (including migratory populations), marine mammals, sea turtles, and sea birds.

f. The applicant must submit a SAP that describes those resources, conditions, and activities listed in Table 22 that could be affected by the applicant's proposed activities, or that could affect the activities proposed in the applicant's SAP, including but not limited to:

Table 22. Resource Data and Uses that must be described in the Site Assessment Plan.

Type of information	**Including:**
(1) Hazard information.	Meteorology, oceanography, sediment transport, geology, and shallow geological or manmade hazards.
(2) Water quality.	Turbidity and total suspended solids from construction.
(3) Biological resources.	Benthic communities, marine mammals, sea turtles, coastal and marine birds, fish and shellfish, plankton, seagrasses, and plant life.
(4) Threatened or endangered species.	As required by the Endangered Species Act (ESA) of 1973 (16. U.S.C. 1531 et. seq.).
(5) Sensitive biological resources or habitats.	Essential fish habitat, refuges, preserves, areas of particular concern, sanctuaries, rookeries, hard bottom habitat, and calving grounds; barrier islands, beaches, dunes, and wetlands.
(6) Archaeological resources.	As required by the NHPA (16 U.S.C. 470 et.

	seq.), as amended.
(7) Social and economic resources.	Employment, existing offshore and coastal infrastructure (including major sources of supplies, services, energy, and water), land use, subsistence resources and harvest practices, recreation, recreational and commercial fishing (including typical fishing seasons, location, and type), minority and lower income groups, and viewshed.
(8) Coastal and marine uses.	Military activities, vessel traffic, and energy and non-energy mineral exploration or development.

g. The Council will review the applicant's SAP in conjunction with the joint agency working group to determine if it contains the information necessary to conduct technical and environmental reviews and will notify the applicant if the SAP lacks any necessary information.
h. As appropriate, the Council will coordinate and consult with relevant Federal and State agencies, and affected Indian tribes.
i. During the review process, the Council may request additional information if it is determined that the information provided is not sufficient to complete the review and approval process
j. Once approved by the joint agency working group the applicant may begin conducting the activities approved in the SAP.
k. Reporting requirements of the applicant under an approved SAP:
    1. Following the approval of a SAP, the applicant must notify the Council in writing within 30 days of completing installation activities of any temporary measuring devices approved by the council.
    2. The applicant must prepare and submit to the Council a report semi-annually. The first report will be due 6 months after work on the SAP begins and every 6 month thereafter until the SAP is completed. The report will summarize the applicant's site assessment activities and the results of those activities.
    3. The applicant must submit a certification of compliance annually (or other frequency as determined by the Council) with certain terms and conditions of the applicant's SAP that the Council identifies under § 860.2.2.1(ix). Together with the applicant's certification, the applicant must submit:
        a. Summary reports that show compliance with the terms and conditions which require certification; and
        b. A statement identifying and describing any mitigation measures and monitoring methods and their effectiveness. If the applicant identified measures that were not effective, the applicant must include the applicant's recommendations for new mitigation measures or monitoring methods.
l. The applicant must seek the Council's Executive Director's approval before conducting any activities not described in the approved SAP,

describing in detail the type of activities the applicant proposes to conduct and the rationale for these activities. The Executive Director will determine whether the activities proposed are authorized by the applicant's existing SAP or require a revision to the applicant's SAP. The Executive Director may request additional information from the applicant, if necessary, to make this determination.

m. The Council will periodically review the activities conducted under an approved SAP. The frequency and extent of the review will be based on the significance of any changes in available information and on onshore or offshore conditions affecting, or affected by, the activities conducted under the applicant's SAP. If the review indicates that the SAP should be revised to meet the requirements of this part, The Council will require the applicant to submit the needed revisions.
n. The applicant may keep approved facilities (such as meteorological towers) installed during the SAP period in place during the time that the Council reviews the applicant's COP for approval. Note: Structures in waters of the state will require separate authorizations outside the SAP process.
o. The applicant is not required to initiate the decommissioning process for facilities that are authorized to remain in place under the applicant's approved COP. If, following the technical and environmental review of the applicant's submitted COP, the Council determines that such facilities may not remain in place, the applicant must initiate the decommissioning process.

Section 860.2.3 Construction and Operations Plan for an Application for a Renewable Energy or Large-scale Offshore Developments

1. Prior to construction, the following necessary data and information will be required by the Council:

   i. **Construction and Operations Plan (COP) -** The COP describes the applicant's construction, operations, and conceptual decommissioning plans for the proposed facility, including the applicant's project easement area.
      a. The applicant's COP must describe all planned facilities that the applicant will construct and use for the applicant's project, including onshore and support facilities and all anticipated project easements.
      b. The applicant's COP must describe all proposed activities including the applicant's proposed construction activities, commercial operations, and conceptual decommissioning plans for all planned facilities, including onshore and support facilities.
      c. The applicant must receive the Council's approval of the COP before the applicant can begin any of the approved activities on the applicant's project site, lease or easement.
      d. The COP must demonstrate that the applicant has planned and is prepared to conduct the proposed activities in a manner that:

1. Conforms to all applicable laws, implementing regulations.
2. Is safe;
3. Does not unreasonably interfere with other uses of state waters;
4. Does not cause undue harm or damage to natural resources; life (including human and wildlife); the marine, coastal, or human environment; or sites, structures, or direct impact to objects of historical or archaeological significance;
5. Uses best available and safest technology;
6. Uses best management practices; and
7. Uses properly trained personnel.

e. The applicant's COP must include the following project-specific information, as applicable.

Table 23. Contents of the Construction and Operations Plan.

Project information:	**Including:**
(1) Contact information	The name, address, e-mail address, and phone number of an authorized representative.
(2) Designation of operator, if applicable.	
(3) The construction and operation concept	A discussion of the objectives, description of the proposed activities, tentative schedule from start to completion, and plans for phased development, as provided in § 285.629.
(5) A location.	The surface location and water depth for all proposed and existing structures, facilities, and appurtenances located both offshore and onshore, including all anchor/mooring data.
(6) General structural and project design, fabrication, and installation.	Information for each type of structure associated with the project and, unless the Council provides otherwise, how the applicant will use a CVA to review and verify each stage of the project.
(7) All cables and pipelines, including cables on project easements.	Location, design and installation methods, testing, maintenance, repair, safety devices, exterior corrosion protection, inspections, and decommissioning. Must prior to construction also include location of all cable crossings and appropriate clearance from the owners of existing cables.
(8) A description of the deployment activities.	Safety, prevention, and environmental protection features or measures that the applicant will use.
(9) A list of solid and liquid wastes generated.	Disposal methods and locations.
(10) A listing of chemical products used (if stored volume exceeds Environmental Protection Agency (EPA) Reportable Quantities).	A list of chemical products used; the volume stored on location; their treatment, discharge, or disposal methods used; and the name and location of the onshore waste receiving, treatment, and/or disposal facility. A description of how these products would be brought onsite, the number of transfers that may take place, and the quantity that will be transferred each time.
(12) Decommissioning and site clearance procedures.	A discussion of general concepts and methodologies.
(13) A listing of all Federal, State, and local authorizations,	A discussion of general concepts and methodologies.

approvals, or permits that are required to conduct the proposed activities, including commercial operations.	
(14) The applicant's proposed measures for avoiding, minimizing, reducing, eliminating, and monitoring environmental impacts.	A description of the measures the applicant will take to avoid or minimize adverse effects and any potential incidental take before conducting activities on the project site, and how the applicant will minimize environmental impacts from proposed activities, including a description of the measures.
(15) Information the applicant incorporates by reference.	A listing of the documents referenced and the actual document if requested.
(16) A list of agencies and persons with whom the applicant has communicated, or with whom the applicant will communicate, regarding potential impacts associated with the proposed activities.	Contact information and issues discussed. and the actual document if requested
(17) Reference.	Contact information and data discussed.
(18) Financial assurance.	Statements attesting that the activities and facilities proposed in the applicant's COP are or will be covered by an appropriate bond or security, as required by §§ 860.2.2.1.
(19) CVA nominations	CVA nominations for reports required.
(20) Construction schedule.	CVA nominations for reports required.
(21) Air quality information.	Information required for the Clean Air Act (42 U.S.C. 7409) and implementing regulations.
(22) Other information.	Additional information as required by the Council.

f. The applicant's COP must include the following information and surveys for the proposed site(s) of the applicant's facility(ies):

Table 24. Necessary Data and Information to be provided in the Construction and Operations Plan.

Information:	Report contents:	Including:
(1) Shallow hazards.	The results of the shallow hazards survey with supporting data, if required.	Information sufficient to determine the presence of the following features and their likely effects on the proposed facility, including: (i) Shallow faults; (ii) Gas seeps or shallow gas; (iii) Slump blocks or slump sediments; (iv) Hydrates; or (v) Ice scour of seabed sediments.
(2) Geological survey relevant to the siting and design of the facility.	The results of the geological survey with supporting data.	Assessment of: (i) Seismic activity at the proposed site; (ii) Fault zones; (iii) The possibility and effects of seabed subsidence; and (iv) The extent and geometry of faulting attenuation effects of geologic

		conditions near the site.
(3) Biological	The results of the biological survey with supporting data.	A description of the results of biological surveys used to determine the presence of live bottoms, hard bottoms, and topographic features, and surveys of other marine resources such as fish populations (including migratory populations), marine mammals, sea turtles, and sea birds.
(4) Geotechnical survey.	The results of any sediment testing program with supporting data, the various field and laboratory tests employed, and the applicability of these methods as they pertain to the quality of the samples, the type of sediment, and the anticipated design application. The applicant must explain how the engineering properties of each sediment stratum affect the design of the facility. In the explanation, the applicant must describe the uncertainties inherent in the overall testing program, and the reliability and applicability of each method.	(i) The results of a testing program used to investigate the stratigraphic and engineering properties of the sediment that may affect the foundations or anchoring systems of the proposed facility. (ii) The results of adequate *in situ* testing, boring, and sampling at each foundation location, to examine all important sediment and rock strata to determine its strength classification, deformation properties, and dynamic characteristics. (iii) The results of a minimum of one deep boring (with soil sampling and testing) at each edge of the project area and within the project area as needed to determine the vertical and lateral variation in seabed conditions and to provide the relevant geotechnical data required for design.
(5) Archaeological resources, if required.	The results of the archaeological resource survey with supporting data.	A description of the historic and prehistoric archaeological resources, as required by the National Historic Preservation Act (NHPA) of 1966, as amended.
(6) Overall site investigation.	An overall site investigation report for the proposed facility that integrates the findings of the shallow hazards surveys and geologic surveys, and, if required, the subsurface surveys with supporting data.	An analysis of the potential for: (i) Scouring of the seabed; (ii) Hydraulic instability; (iii) The occurrence of sand waves; (iv) Instability of slopes at the facility location; (v) Liquefaction, or possible reduction of sediment strength due to increased pore pressures; (vi) Degradation of subsea permafrost layers; (vii) Cyclic loading; (viii) Lateral loading; (ix) Dynamic loading; (x) Settlements and displacements; (xi) Plastic deformation and formation collapse mechanisms; and

		(xii) Sediment reactions on the facility foundations or anchoring systems.

g. The applicant's COP must describe those resources, conditions, and activities listed in Table 6 that could be affected by the applicant's proposed activities, or that could affect the activities proposed in the applicant's COP, including:

Table 25. Resources, Conditions and Activities that must be described in the Construction and Operations Plan.

Type of Information:	**Including:**
(1) Hazard information.	Meteorology, oceanography, sediment transport, geology, and shallow geological or manmade hazards.
(2) Water quality.	Turbidity and total suspended solids from construction.
(3) Biological resources.	Benthic communities, marine mammals, sea turtles, coastal and marine birds, fish and shellfish, plankton, seagrasses, and plant life.
(4) Threatened or endangered species.	As defined by the ESA (16 U.S.C. 1531 et. seq.)
(5) Sensitive biological resources or habitats.	Essential fish habitat, refuges, preserves, areas of particular concern, sanctuaries, rookeries, hard bottom habitat, barrier islands, beaches, dunes, and wetlands.
(6) Archaeological resources.	As required by the NHPA (16 U.S.C. 470 et. seq.), as amended.
(7) Social and economic resources.	As determined by the joint agency working group.
(8) Coastal and marine uses.	Military activities, vessel traffic, and energy and non-energy mineral exploration or development.

h. The applicant must submit an oil spill response plan per the Oil Pollution Act of 1990, 33 USC 2701 *et seq*. This plan should also comply with MMS regulations, 30 CFR 254, "oil spill response requirements for facilities located seaward of the coastline".

i. The applicant must submit the applicant's Safety Management System which describes:
    i. How the applicant plans to ensure the safety of personnel or anyone on or near the facility;
    ii. Remote monitoring, control and shut down capabilities;
    iii. Emergency response procedures;
    iv. Fire suppression equipment (if needed);
    v. How and when the safety management system will be tested; and
    vi. How the applicant will ensure personnel who operate the facility are properly trained.

j. The Council will review the applicant's submitted COP and the information provided to determine if it contains all the required information necessary to conduct the project's technical and environmental reviews. The Council will notify the applicant if the applicant's submitted COP lacks any necessary information.

k. As appropriate, the Council will coordinate and consult with relevant Federal, State, and local agencies and affected Indian tribes.

l. During the review process, the Council may request additional information if it is determined that the information provided is not sufficient to complete the review and approval process. If the applicant fails to provide the requested information, the Council may disapprove the applicant's COP.

m. Upon completion of the technical and environmental reviews and other reviews required, the Council may approve, disapprove, or approve with modifications the applicant's COP.

n. In the applicant's COP, the applicant may request development of the project area in phases. In support of the applicant's request, the applicant must provide details as to what portions of the site will be initially developed for commercial operations and what portions of the site will be reserved for subsequent phased development.

o. If the application and COP is approved, prior to construction the applicant must submit to the Council the documents listed :

   1. Facility Design Report- The applicant's Facility Design Report provides specific details of the design of any facilities, including cables and pipelines, that are outlined in the applicant's approved SAP or COP. The applicant's Facility Design Report must demonstrate that the applicant's design conforms to the applicant's responsibilities listed in § 860.2.1.3. The applicant must include the following items in the applicant's Facility Design Report:

Table 26. Contents of the Facility Design Report.

Required documents:	Required contents:	Other requirements:
(1) Cover letter.	(i) Proposed facility designations; (ii)The type of facility	The applicant must submit 4 paper copies and 1 electronic copy.
(2) Location.	(i) Latitude and longitude coordinates, Universal Mercator grid-system coordinates, state plane coordinates in the Lambert or Transverse Mercator Projection System; (ii) These coordinates must be based on the NAD (North American Datum) 83 datum plane coordinate system; and (iii) The location of any proposed project easement.	The applicant's plat must be drawn to a scale of 1 inch equals 100 feet and include the coordinates of the project site, and boundary lines. The applicant must submit 4 paper copy and 1 electronic copy.
(3) Front, Side, and Plan View drawings.	(i) Facility dimensions and orientation; (ii) Elevations relative to Mean Lower Low Water; and	The applicant's drawing sizes must not exceed 11" x 17". The applicant must submit 4 paper copies and 1 electronic copy.

	(iii) Pile sizes and penetration.	
(4) Complete set of structural drawings.	The approved for construction fabrication drawings should be submitted, including, e.g., (i) Cathodic protection systems; (ii) Jacket design; (iii) Pile foundations; (iv) Mooring and tethering systems; (v) Foundations and anchoring systems; and (vi) Associated cable and pipeline designs.	The applicant's drawing sizes must not exceed 11" x 17". The applicant must submit 4 paper copies and 1 electronic copy.
(5) Summary of environmental data used for design.	A summary of the environmental data used in the design or analysis of the facility. Examples of relevant data include information on: (i) Extreme weather; (ii) Seafloor conditions; and (iii) Waves, wind, currents, tides, temperature, snow and ice effects, marine growth, and water depth.	The applicant must submit 4 paper copies and 1 electronic copy. If the applicant submitted these data as part of the SAP or COP, the applicant may reference the plan.
(6) Summary of the engineering design data.	(i) Loading information (e.g., live, dead, environmental); (ii) Structural information (e.g., design-life; material types; cathode protection systems; design criteria; fatigue life; jacket design; deck design; production component design; foundation pilings and templates, and mooring or tethering systems; fabrication or installation guidelines); (iii) Location of foundation boreholes and foundation piles; and (iv) Foundation information (e.g., soil stability, design criteria).	The applicant must submit 4 paper copies and 1 electronic copy.
(7) A complete set of design calculations.	Self-explanatory.	The applicant must submit 4 paper copies and 1 electronic copy.
(8) Project-specific studies used in the facility design or installation.	All studies pertinent to facility design or installation, (e.g., oceanographic and soil reports)	The applicant must submit 4 paper copies and 1 electronic copy.
(9) Description of the loads imposed on the facility.	(i) Loads imposed by jacket; (ii) Turbines; (iii) Transition pieces; (iv) Foundations, foundation pilings and templates, and anchoring systems; and (v) Mooring or tethering systems.	The applicant must submit 4 paper copies and 1 electronic copy.
(10) Geotechnical report.	A list of all data from borings and recommended design parameters.	The applicant must submit 4 paper copies and 1 electronic

		copy.

a. For any floating facility, the applicant's design must meet the requirements of the U.S. Coast Guard for structural integrity and stability (e.g., verification of center of gravity). The design must also consider:
   i. Foundations, foundation pilings and templates, and anchoring systems; and
   ii. Mooring or tethering systems.

b. The applicant is required to use a Certified Verified Agent (CVA). The Facility Design Report must include two paper copies of the following certification statement: ''The design of this structure has been certified by a Council approved CVA to be in accordance with accepted engineering practices and the approved SAP, or COP as appropriate. The certified design and as-built plans and specifications will be on file at (given location).''

2. Fabrication and Installation Report- The applicant's Fabrication and Installation Report must describe how the applicant's facilities will be fabricated and installed in accordance with the design criteria identified in the Facility Design Report; the applicant's approved SAP or COP; and generally accepted industry standards and practices. The applicant's Fabrication and Installation Report must demonstrate how the applicant's facilities will be fabricated and installed in a manner that conforms to the applicant's responsibilities listed in § 860.2.1.3. The applicant must include the following items in the applicant's Fabrication and Installation Report:

Table 27. Contents of the Fabrication and Installation Report.

Required documents:	**Required contents:**	**Other requirements:**
(1) Cover letter.	(i) Proposed facility designation,; (ii) Area, name, and block number; and (iii) The type of facility	The applicant must submit 4 paper copies and 1 electronic copy.
(2) Schedule.	Fabrication and installation.	The applicant must submit 4 paper copies and 1 electronic copy.
(3) Fabrication information.	The industry standards the applicant will use to ensure the facilities are fabricated to the design criteria identified in the Facility Design Report.	The applicant must submit 4 paper copies and 1 electronic copy.
(4) Installation process information.	Details associated with the deployment activities, equipment, and materials, including offshore and onshore equipment and support, and anchoring and	The applicant must submit 4 paper copies and 1 electronic copy.

	mooring permits.	
(5) Federal, State, and local permits (e.g., EPA, Army Corps of Engineers).	Either 1 copy of the permit or information on the status of the application.	The applicant must submit 4 paper copies and 1 electronic copy.
(6) Environmental information.	(i) Water discharge; (ii) Waste disposal; (iii) Vessel information; and (iv) Onshore waste receiving treatment or disposal facilities.	The applicant must submit 4 paper copies and 1 electronic copy. If the applicant submitted these data as part of the SAP or COP, the applicant may reference the plan.
(7) Project easement.	Design of any cables, pipelines, or facilities. Information on burial methods and vessels.	The applicant must submit 4 paper copies and 1 electronic copy.

p. A CVA report must include the following: a Fabrication and Installation Report which must include four paper copies of the following certification statement: ‘‘The fabrication and installation of this structure has been certified by a the Council approved CVA to be in accordance with accepted engineering practices and the approved SAP or COP as appropriate. Based on the Council's environmental and technical reviews, if approved, the Council may specify terms and conditions to be incorporated into any approval the Council may issue. The applicant must submit a certification of compliance annually (or another frequency as determined by the Council) with certain terms and conditions which may include:
   1. Summary reports that show compliance with the terms and conditions which require certification; and
   2. A statement identifying and describing any mitigation measures and monitoring methods, and their effectiveness. If the applicant identified measures that were not effective, then the applicant must make recommendations for new mitigation measures or monitoring methods.

q. After the applicant's COP is approved, construction must begin by the date given in the construction schedule included as a part of the approved COP, unless the Council approves a deviation from the applicant's schedule.

r. The applicant must seek approval from the Council in writing before conducting any activities not described in the applicant's approved COP. The application must describe in detail the type of activities the applicant proposes to conduct. The Council will determine whether the activities the applicant proposes are authorized by the applicant's existing COP or require a revision to the applicant's COP. The Council may request additional information from the applicant, if necessary, to make this determination.

s. The Council will periodically review the activities conducted under an approved COP. The frequency and extent of the review will be based on the significance of any changes in available information, and on onshore or offshore conditions affecting, or affected by, the activities conducted under the applicant's COP. If the review indicates that the COP should be revised, the Council may require the applicant to submit the needed revisions.

t. The applicant must notify the Council, within 5 business days, any time the applicant ceases commercial operations, without an approved suspension, under the applicant's approved COP. If the applicant ceases commercial operations for an indefinite period which extends longer than 6 months, the Council may cancel the applicant's lease, and the applicant must initiate the decommissioning process.
u. The applicant must notify the Council in writing of the following events, within the time periods provided:
    1. No later than 10 days after commencing activities associated with the placement of facilities on the lease area under a Fabrication and Installation Report.
    2. No later than 10 days after completion of construction and installation activities under a Fabrication and Installation Report.
    3. At least 7 days before commencing commercial operations.
v. The applicant may commence commercial operations 30 days after the CVA or project engineer has submitted to the Council the final Fabrication and Installation Report for the fabrication and installation review.

860.2.4 Certified Verification Agent for Renewable Energy and Large-scale Offshore Developments

i. **Certified Verification Agent-** The applicant must use a CVA to review and certify the Facility Design Report, the Fabrication and Installation Report, and the Project Modifications and Repairs Report. The applicant must use a CVA to:
    a. Ensure that the applicant's facilities are designed, fabricated, and installed in conformance with accepted engineering practices and the Facility Design Report and Fabrication and Installation Report;
    b. Ensure that repairs and major modifications are completed in conformance with accepted engineering practices; and
    c. Provide the Council immediate reports of all incidents that affect the design, fabrication, and installation of the project and its components.
    d. **Nominating a CVA for Council approval**- The applicant must nominate a CVA for the Council approval. The applicant must specify whether the nomination is for the Facility Design Report, Fabrication and Installation Report, Modification and Repair Report, or for any combination of these.
        1. For each CVA that the applicant nominates, the applicant must submit to the Council a list of documents they will forward to the CVA and a qualification statement that includes the following:
            a. Previous experience in third-party verification or experience in the design, fabrication, installation, or major modification of offshore energy facilities;

   b. Technical capabilities of the individual or the primary staff for the specific project;
   c. Size and type of organization or corporation;
   d. In-house availability of, or access to, appropriate technology (including computer programs, hardware, and testing materials and equipment);
   e. Ability to perform the CVA functions for the specific project considering current commitments;
   f. Previous experience with the Council requirements and procedures, if any; and
   g. The level of work to be performed by the CVA.

e. Individuals or organizations acting as CVAs must not function in any capacity that will create a conflict of interest, or the appearance of a conflict of interest.
f. The verification must be conducted by or under the direct supervision of registered professional engineers.
g. The Council will approve or disapprove the applicant's CVA prior to construction.
h. The applicant must nominate a new CVA for the Council approval if the previously approved CVA:
   1. Is no longer able to serve in a CVA capacity for the project; or
   2. No longer meets the requirements for a CVA set forth in this subpart.
i. The CVA must use good engineering judgment and practices in conducting an independent assessment of the design of the facility. The CVA must certify in the Facility Design Report to the Council that the facility is designed to withstand the environmental and functional load conditions appropriate for the intended service life at the proposed location.
j. The CVA must conduct an independent assessment of all proposed:
   1. Planning criteria;
   2. Operational requirements;
   3. Environmental loading data;
   4. Load determinations;
   5. Stress analyses;
   6. Material designations;
   7. Soil and foundation conditions;
   8. Safety factors; and
   9. Other pertinent parameters of the proposed design.
k. For any floating facility, the CVA must ensure that any requirements of the U.S. Coast Guard for structural integrity and stability (e.g., verification of center of gravity), have been met. The CVA must also consider:
   1. Foundations, foundation pilings and templates, and anchoring systems; and
   2. Mooring or tethering systems.

l. The CVA or project engineer must do all of the following:
    1. Use good engineering judgment and practice in conducting an independent assessment of the fabrication and installation activities;
    2. Monitor the fabrication and installation of the facility;
    3. Make periodic onsite inspections while fabrication is in progress and verify the items required by § 860.2.2.2(iii)(p);
    4. Make periodic onsite inspections while installation is in progress and satisfy the requirements of § 860.2.2.2(iii)(q); and
    5. Certify in a report that project components are fabricated and installed in accordance with accepted engineering practices; the applicant's approved COP or SAP; and the Fabrication and Installation Report.
        h. The report must also identify the location of all records pertaining to fabrication and installation.
        i. The applicant may commence commercial operations or other approved activities 30 days after the Council receives that certification report, unless the Council notifies the applicant within that time period of its objections to the certification report.

m. The CVA or project engineer must monitor the fabrication and installation of the facility to ensure that it has been built and installed according to the Facility Design Report and Fabrication and Installation Report.
    1. If the CVA or project engineer finds that fabrication and installation procedures have been changed or design specifications have been modified, the CVA or project engineer must inform the applicant; and
    2. If the applicant accepts the modifications, then the applicant must also inform the Council.

n. The CVA or project engineer must make periodic onsite inspections while fabrication is in progress and must verify the following fabrication items, as appropriate:
    1. Quality control by lessee (or grant holder) and builder;
    2. Fabrication site facilities;
    3. Material quality and identification methods;
    4. Fabrication procedures specified in the Fabrication and Installation Report, and adherence to such procedures;
    5. Welder and welding procedure qualification and identification;
    6. Structural tolerances specified, and adherence to those tolerances;
    7. Nondestructive examination requirements and evaluation results of the specified examinations;
    8. Destructive testing requirements and results;
    9. Repair procedures;
    10. Installation of corrosion protection systems and splash-zone protection;

11. Erection procedures to ensure that overstressing of structural members does not occur;
12. Alignment procedures;
13. Dimensional check of the overall structure, including any turrets, turret and- hull interfaces, any mooring line and chain and riser tensioning line segments; and
14. Status of quality-control records at various stages of fabrication.

o. The CVA or project engineer must make periodic onsite inspections while installation is in progress and must, as appropriate, verify, witness, survey, or check, the installation items required by this section. The CVA or project engineer must verify, as appropriate, all of the following:
   1. Load out and initial flotation procedures;
   2. Towing operation procedures to the specified location, and review the towing records;
   3. Launching and uprighting activities;
   4. Submergence activities;
   5. Pile or anchor installations;
   6. Installation of mooring and tethering systems;
   7. Transition pieces, support structures, and component installations; and
   8. Installation at the approved location according to the Facility Design Report and the Fabrication and Installation Report.

p. For a fixed or floating facility, the CVA or project engineer must verify that proper procedures were used during the following:
   1. The loadout of the jacket, transition pieces and support structures, piles, or structures from each fabrication site; and
   2. The actual installation of the facility or major modification and the related installation activities.

q. For a floating facility, the CVA or project engineer must verify that proper procedures were used during the following:
   1. The loadout of the facility;
   2. The installation of foundation pilings and templates, and anchoring systems; and
   3. The installation of the mooring and tethering systems.

r. The CVA or project engineer must conduct an onsite survey of the facility after transportation to the approved location.
s. The CVA or project engineer must spot-check the equipment, procedures, and recordkeeping as necessary to determine compliance with the applicable documents incorporated by reference and the regulations under this part.
t. The CVA or project engineer must prepare and submit to the applicant and the Council all reports required by this subpart. The CVA or project

engineer must also submit interim reports to the applicant and the Council, as requested by the Council. The CVA or project engineer must submit one electronic copy and one paper copy of each final report to the Council. In each report, the CVA or project engineer must:

1. Give details of how, by whom, and when the CVA or project engineer activities were conducted;
2. Describe the CVA's or project engineer's activities during the verification process;
3. Summarize the CVA's or project engineer's findings; and
4. Provide any additional comments that the CVA or project engineer deems necessary.

u. The Council may hire its own CVA agent to review the work of the applicants CVA. The applicant will be responsible for the cost of the council's CVA.

v. Until the Council releases the applicant's financial assurance under § 860.2.2.1, the applicant must compile, retain, and make available to the Council representatives, all of the following:

1. The as-built drawings;
2. The design assumptions and analyses;
3. A summary of the fabrication and installation examination records;
4. The inspection results from the inspections and assessments required.
5. Records of repairs not covered in the inspection report submitted

w. The applicant must record and retain the original material test results of all primary structural materials during all stages of construction until the Council releases the applicant's financial assurance under § 860.2.2.1. Primary material is material that, should it fail, would lead to a significant reduction in facility safety, structural reliability, or operating capabilities. Items such as steel brackets, deck stiffeners and secondary braces or beams would not generally be considered primary structural members (or materials).

x. The applicant must provide the Council with the location of these records in the certification statement.

860.2.3 Pre-Construction Standards

1. Prior to construction, the assent holder must post a Performance Bond sufficient to ensure removal of all structures at the end of the lease. The Council shall review the bond amount every 5 years to ensure the amount is sufficient.

2. Prior to construction, the assent holder must show compliance with all federal and state agency requirements, which may include but are not limited to: the Rhode Island Coastal Resources Management Council, the Rhode Island Department of Environmental Management, the Rhode Island Energy Facilities Siting Board, the Rhode Island Historical Preservation and Heritage Commission, U.S. Department of the Interior Minerals Management Service, Army Corps of Engineers, National Oceanic and Atmospheric Administration, U.S. Fish and Wildlife Service, and the U.S. Environmental Protection Agency.

3. Where possible, offshore renewable energy facilities and other large-scale offshore developments should be designed in a configuration to minimize adverse impacts on other user groups, which include but are not limited to: recreational boaters and fishermen, commercial fishermen, commercial ship operators, or other vessel operators in the project area. Configurations which may minimize adverse impacts on vessel traffic include, but are not limited to, the incorporation of a traffic lane through a development to facilitate safe and direct navigation through, rather than around, a large-scale offshore development.

4. Applicants or proponents of an approved project shall work with the Council and the Fisheries Advisory Board (as described in Section 560.1.3) in the micro-siting of installed structures to avoid sensitive habitat or other areas of concern.

5. The facility shall be designed in a manner that minimizes adverse impacts to navigation. As part of its application package, the project applicant must submit a navigation risk assessment that meets the standards and requirements contained in the U.S. Coast Guard's Navigation and Vessel Inspection Circular 02-07, "Guidance on the Coast Guard's Roles and Responsibilities for Offshore Renewable Energy Installations." The navigation risk assessment must address, at a minimum:
   i. Visual navigation and collision avoidance;
   ii. Communications, radar, and position systems;
   iii. Marine navigational marking;
   iv. Standards and procedures for individual unit shutdown, or shutdown of the entire facility, in the event of an emergency such search and rescue, pollution response, or security operation.

6. The Applicant shall, prior to construction, provide a letter from the U.S. Coast Guard showing it meets all applicable U.S. Coast Guard standards. In addition the Council may require some or all of the following measures to reduce adverse impacts to navigation safety (list is not all-inclusive):

   i. The applicant may be required to mark each installed structure with U.S. Coast Guard-approved lighting, sound signals, and alphanumeric designations. All such aids to navigation shall be clearly visible to mariners in accordance with guidelines set by the International Association of Marine Aids to Navigation and Lighthouse Authorities.

ii. The applicant may be required to provide the Council, U.S. Coast Guard, other local, state and federal agencies, mariners, and fishermen with a detailed plan showing the location and designation of each installed structure.

iii. The Council shall work with the U.S. Coast Guard and NOAA to ensure that each installed structure and related aids to navigation are denoted on NOAA nautical charts and printed in Local Notice to Mariner publications as appropriate.

iv. The applicant may be required to equip each installed structure as necessary with safety lines, mooring attachments, access ladders, and other safety equipment.

v. The applicant may be required to adopt traffic management measures to accommodate the safe flow of vessel traffic around and through the facility. These may include but are not limited to: specifically marked traffic lanes around or through the facility; recommended vessel routes; or other specific navigation rules for operation within the facility that are consistent with the International Collision Regulations (COLREGS).

vi. The applicant may be required to establish a shoreside Control Center, manned 24 hours a day, 7 days a week. The Control Center would be in regular direct communication with the U.S. Coast Guard Sector Southeastern New England. The Control Center would be equipped to facilitate immediate remote shutdown of the facility, upon notification by the U.S. Coast Guard, in the event of an emergency.

7. Large-scale offshore developments will be required to comply with all other site- and project-specific transportation and navigational safety provisions as required by the U.S. Coast Guard.

8. Proponents of large-scale offshore developments in Rhode Island waters should contact U.S. Coast Guard Sector Southeastern New England Waterways Management Division at 401-435-2351 to receive the latest Coast Guard guidance and begin the process of drafting a navigational risk assessment.

860.2.4 Standards for Construction Activities

1. The Assent Holder must use the best available technology and techniques to minimize impacts to the natural resources and existing human uses in the project area.

2. The Council shall require the use of an environmental inspector to monitor construction activities. The environmental inspector must be a private, third-party entity that is hired by the Assent Holder, but is approved and reports to the Council. The environmental

inspector shall possess all appropriate qualifications as determined by the Council. This inspector service may be part of the CVA requirements.

3. Installation techniques for all construction activities should be chosen to minimize sediment disturbance. Jet plowing and horizontal directional drilling in nearshore areas will be required in the installation of underwater transmission cables. Other technologies may be used provided the applicant can demonstrate they are as effective, or more effective, than these techniques in minimizing sediment disturbance.

4. All construction activities occurring within state waters must comply with the policies and standards outlined in the Rhode Island Coastal Resources Management Program (aka the 'Red Book'), as well as the regulations of other relevant state and federal agencies.

5. The applicant must conduct all activities on the applicant's permit under this part in a manner that conforms with the applicant's responsibilities in § 860.2.1.3, and using:
    i. Trained personnel; and
    ii. Technologies, precautions, and techniques that will not cause undue harm or damage to natural resources, including their physical, atmospheric, and biological components.

6. The Assent Holder shall be required to use the best available technology and techniques to mitigate any associated adverse impacts of offshore renewable energy development.
    i. As required, the applicant must submit to the Council:
        1. Measures designed to avoid or minimize adverse effects and any potential incidental take of endangered or threatened species as well as all marine mammals;
        2. Measures designed to avoid likely adverse modification or destruction of designated critical habitat of such endangered or threatened species; and
        3. The applicant's agreement to monitor for the incidental take of the species and adverse effects on the critical habitat, and provide the results of the monitoring to the Council as required; and
        4. The applicant's agreement to perform any relevant terms and conditions of the Incidental Take Statement that may result from the ESA consultation.
        5. The applicant's agreement to perform any relevant mitigation measures under an MMPA incidental take authorization.

7. If the Assent Holder, the Assent Holder's subcontractors, or any agent acting on the Assent Holder's behalf discovers a potential archaeological resource while conducting construction activities, or any other activity related to the Assent Holder's project, the applicant must:
    i. Immediately halt all seafloor disturbing activities within the area of the discovery;
    ii. Notify the Council of the discovery within 24 hours; and

iii. Keep the location of the discovery confidential and not take any action that may adversely affect the archaeological resource until the Council has made an evaluation and instructed the applicant on how to proceed.
    1. The Council may require the Assent Holder to conduct additional investigations to determine if the resource is eligible for listing in the National Register of Historic Places under 36 CFR 60.4. The Council will do this if:
        a. The site has been impacted by the Assent Holder's project activities; or
        b. Impacts to the site or to the area of potential effect cannot be avoided.
    2. If the Council incurs costs in protecting the resource, under section 110(g) of the NHPA, the Council may charge the applicant reasonable costs for carrying out preservation responsibilities.

8. Post construction, the Assent Holder must provide a side scan sonar survey of the entire construction site to verify that there is no post construction debris left at the project site. These side-scan sonar survey results must be filed with the Council within 90 days of the end of the construction period. The results of this side-scan survey will be verified by a third-party reviewer, who will be hired by the Assent Holder but who is pre-approved and reports to the Council.

9. All pile-driving activities must comply with the best management practices established by the joint agency working group.

10. The council may require the assent holder to hire a CVA to perform periodic inspections of the structure(s) during the life of those structure(s). The CVA will work for and be responsible to the council.

860.3 Monitoring Requirements

1. The Council shall facilitate a Joint Agency Working Group, comprised of relevant federal and state agency representatives (as described in Section 860.1.6), to determine requirements for monitoring prior to construction, during construction and post-construction. Specific monitoring requirements will be determined on a project by project basis and may include but are not limited to the monitoring of:
    i. Coastal Processes and Physical Oceanography
    ii. Underwater noise
    iii. Benthic Ecology
    iv. Avian species
    v. Marine Mammals
    vi. Sea Turtles
    vii. Fish and fish habitat
    viii. Commercial and Recreational Fishing
    ix. Recreation and Tourism
    x. Marine Transportation, Navigation and Infrastructure

xi. Cultural and Historic Resources

2. The Joint Agency Working Group and the Council may also require facility and infrastructure monitoring requirements, that may include but are not limited to:
   i. Post construction monitoring including regular visual inspection of inner array cables to ensure proper burial, foundation and substructure inspection.

860.4 Recommended Targets

1. The following are industry goals that projects should strive for. These are not required standards at this time but are targets project proponents should try to meet where possible to alleviate potential adverse impacts.

2. Underwater noise from offshore wind turbines has been measured in Europe at 118 dB re 1 mPa^2 in any 1/3 octave band at a range of 100 meters at full power production. The noise is due to gear noise and transmitted in to the ocean through the monopile support structure. This noise would be greater than the ambient noise present within 1 km of the wind turbines. It is likely that the operational wind turbine noise at ranges of 10 km would be below the ambient noise in the region.

   Mitigation Recommended: Reducing the levels of noise from the wind turbines to below the ambient noise level in the area nearest to the wind farm may able to be achieved using the lattice jacket structure (which should reduce the noise level as compared to a monopile structure), appropriate isolation technology in the design of the structure, and lower noise drive systems. A monitoring system deployed to measure the operational noise time series on appropriate hydrophones and geophones. In addition, accelerometers should be installed on at least one of the turbines to monitor structural vibration. A goal for the wind farm applicant and operator is to have operational noise from wind turbines average less than or equal to 100 dB re 1 mPa^2 in any 1/3 octave band at a range of 100 meters at full power production.

3. Airborne noise from the offshore wind turbines for the Block Island site (~3 nm south of the island) will not be detectable by humans or animals on Block Island. Airborne noise from the turbines will be detectable by humans and animals within 200 meters of the turbines.

   Mitigation Recommended: The applicant and manufacturer should endeavor to minimize the radiated airborne noise from the wind turbines.

4. Electromagnetic fields from transmission lines may have behavioral effects on marine life within 20 meters of the 26 kVA power lines likely to be used in the Block Island wind farm. The effects could include both attraction and repulsion.

   Mitigation Recommended: A monitoring system including acoustical, optical and other sensors should be established near these facilities to quantify the effects.

Section 870: Works Cited

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