

# **The Application of Ocean Zoning Management for Offshore Energy Development in North Carolina**

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## ***Abstract***

The concept of spatial planning, or zoning, is widely applied for regulating land use activities. This project assesses the potential for using ocean zoning as a management tool in North Carolina. In particular, this project looks at the role of new offshore energy developments, such as wind farms, and how management policies may adapt to handle these projects. Ocean Zoning has been successfully applied in the Great Barrier Reef Marine Park and the Florida Keys National Marine Sanctuary. Zones are designated based on their biological and physical properties. Activities within each zone are classified as compatible, conditionally compatible, or incompatible and are permitted based on their classification and the overall management objectives.

For this project, a survey of current users of the North Carolina coastal community was conducted to gather data on the variety of activities in the North Carolina coastal zone and the user's opinions on compatibility of 13 different activities. These results were compiled into a compatibility matrix to guide classification of activities. Based on this matrix of responses, conservation and planning are clearly perceived as activities benefiting the activities of all respondents. Conversely, minerals mining and coastal development are perceived as harmful to all respondents activities. The apparent compatibility of other activities varies by respondent and activity.

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## Introduction to Ocean Zoning

Ocean Management and Policy in the United States has taken many forms throughout its history; from Grotius' *Mare Liberum* treaty in the early 17<sup>th</sup> century declaring the seas as open to all nations to the internationally regulated territorial seas and exclusive economic zones the first declared in the 1940's and 1950's. Prior to the end of World War Two, U.S. ocean policy had changed very little since the nation's founding. The economic boom following WWII led to increased usage of ocean and coastal resources and the beginning of an "enclosure movement" with nations claiming territorial seas and boundaries for their exclusive resource rights.<sup>1</sup> A series of ocean-related acts, such as the Outer Continental Shelf Lands Act in 1953, laid the groundwork for a management structure to guide human activities in the marine environment. From this management structure, a myriad of governing agencies and authorities have developed to manage specific uses and resources in the ocean and coastal environment. Numerous agencies may be involved in managing several human activities in a spatial region, akin to "a number of specialist physicians, who are not communicating well, treat[ing] a patient with multiple medical problems".<sup>2</sup>

This approach to management has coincided with deteriorating conditions in all aspects of the coastal environment, from fisheries stocks collapsing to runoff pollution and "dead zone" formation. Numerous governmental, non-governmental, and academic sources have suggested a spatially-based approach to ocean management such as ocean zoning.<sup>3,4</sup>

Ocean Zoning is a regulatory tool for implementing a management plan.<sup>5</sup> Spatial zones are identified based on properties of the biophysical ecosystem. A zone should encompass a biological community such as a coral reef or unique spawning ground or habitat. Within each zone, management objectives

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<sup>1</sup> Cicin-Sain and Knecht, 2000

<sup>2</sup> Crowder, et. al., 2006

<sup>3</sup> U.S. Commission on Ocean Policy, 2004

<sup>4</sup> Pew Oceans Commission. 2003

<sup>5</sup> Courtney and Wiggin, 2003

and existing and potential human uses are identified. Human activities within the zone are evaluated and classified as compatible, conditionally compatible, or incompatible with other uses, the resource, and the management plan.<sup>6</sup> These activities can vary widely from resource extraction such as minerals mining and fishing to conservation or recreational uses. By observing the spatial layout of all activities and zones in a region, potential conflicts and overlapping uses can be identified. Add to this a layer of managerial jurisdictions and authorities and the complexity of activities and interactions becomes readily apparent.

A spatial planning approach, such as ocean zoning, in this situation would develop a management plan to make sense of the web of stakeholders, resource competition, and existing jurisdictional duties in a define space. In its place, a plan with clearly identified priorities and a limited number of compatible or conditionally compatible uses all under the jurisdiction of a single supervisory authority would be established. This single supervisory agency would not eliminate the governing agencies, but simply coordinate their efforts or be authorized to act on their behalf in management issues.

The current approach to ocean and coastal management addresses issues individually under a multitude of authorities. The approval process for an aquaculture site in North Carolina, as an example, would require coordination with multiple state and federal agencies such as NC Division of Coastal Management, Fish and Wildlife Service or National Marine Fisheries Service, and county approval for consistency with state and federal coastal zone management acts. Each of these regulatory bodies would have to “sign off” on each activity or issue that arose in their jurisdiction. In addition, the impact of the aquaculture site in regards to the I management objectives of other agencies would not be clearly outlined making it difficult to establish consistency.

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<sup>6</sup> Juda and Hennessey, 2001

There are numerous potential benefits and associated costs of an ocean zoning management approach. The ocean zones are management areas based primarily on the natural environment rather than political boundaries, which helps management design plans to meet the needs of that specific environment. Zoning plans may apply different scale zones to avoid having multiple biophysical environments with conflicting needs/priorities in a single zone. The Florida Keys National Marine Sanctuary Zoning Plan, discussed in the next section, employs different size zones to focus their resources on managing highly sensitive areas. Complex marine environments could be subdivided at a fine scale to reduce the occurrence of zones encompassing multiple environments.

These benefits may require additional cost to achieve. Current management plans are based on county, state, and federal boundaries and redrawing the boundaries around biophysical zones would come at the cost of significant time investments and debating over how the zones should be defined and how the resources to manage those zones should be allocated. Such a redesign could take years to plan and organize and even longer to implement to achieve more effective management.

Other potential benefits of ocean zoning include a stream-lined evaluation process for proposed activities. With activities in each zone being classified as compatible, conditionally compatible, or incompatible, there would be fewer stakeholders to address as well as fewer agencies to coordinate with on the approval process. The potential cost of this improved process would be denying incompatible activities the opportunity to operate in certain zones. This would raise access issues with stakeholders such as fisherman, who already face similar limitations with no-catch zones and limited fishing calendars.

## Review of existing ocean zoning plans

While the concept of ocean zoning and place-based management is relatively new to the U.S. policy arena, it has been in practice for nearly 30 years in Australia's Great Barrier Reef Marine Park (GBRMP). In 1981 the GBRMP adopted its first zoning plan as a means of managing the 345,000 km<sup>2</sup> of reefs, islands, and corals. Since then "zoning has been widely regarded as the cornerstone of GBR management".<sup>7</sup> The zoning plans were developed in accordance to the Great Barrier Reef Marine Park Act of 1975.<sup>8</sup>

The GBRMP developed a multiple-use zoning approach allowing the managers to provide varying levels of protection and accessibility to the different zones. Zones were delineated and classified within the context of the region, rather than simply evaluating zones on a case-by-case basis. Activities and uses within each zone category are classified as compatible, incompatible, or requiring a permit. Each zone has a "specific written objective" identifying the priorities for that zone.

In developing the zoning plan, GBRMP managers incorporated the need for monitoring and evaluation of the plan. Through this review process, the plan has been adapted to changes in the reef environment and its use. Quoting Jon Day, "Because both natural systems and management approaches are never static, a wide variety of changes can, and do, occur which makes the need for monitoring, evaluation, and adaptation of spatial and other plans necessary on a continuing basis".<sup>9</sup> This emphasis on adaptive management allows the plan to respond more quickly to new information, which is constantly being collected and incorporated. In addition, an adaptive plan may be more readily accepted by stakeholders concerned with the limitations of a static management plan. Based on the

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<sup>7</sup> Day, 2002

<sup>8</sup> Day, 2002

<sup>9</sup> Day, 2008

papers by Jon Day, the managers of the GBRMP have a strong appreciation for the stakeholder engagement process associated with developing and adopting a management plan.<sup>10</sup>

In his paper “The need and practice of monitoring, evaluating, and adapting marine planning and management-lessons from the Great Barrier Reef”, Day identifies four key components to the rezoning process: scientific knowledge, effective leadership, high level of public participation, and the consequent socio-political support. He wisely notes “the best scientific arguments in the world alone would not have achieved the final zoning plan”. Public participation and education in the planning process seems to be a key component to the GBRMP’s success. The governing legislation requires at least two phases of public involvement in the planning process.<sup>11</sup> Implementing revisions to the zoning plan involves a public education campaign complete with zone maps and brochures. The clearly stated objectives and adaptive nature of the GBRMP’s zoning plan have made it a model of how effective this approach can be to enacting a management plan.

Ocean zoning in the United States is currently practiced in the Florida Keys National Marine Sanctuary (FKNMS). Established in 1990 through the Florida Keys National Marine Sanctuary and Protection Act, the sanctuary seeks to protect the biological diversity of the marine environment in the Keys. The zoning approach to implementing the management plan allows managers to spread certain uses across a larger geographic region as needed and focus a disproportionate amount of their resources on a smaller, higher priority area.<sup>12</sup>

Like the GBRMP plan, the FKNMS plan employs a multiple zone system. The FKNMS plan has five different zone types: Wildlife Management Areas, Ecological Reserves, Sanctuary Preservation

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<sup>10</sup> Day, 2008

<sup>11</sup> Day, 2002

<sup>12</sup> Florida Keys National Marine Sanctuary, Marine Resource Protection, [http://floridakeys.noaa.gov/resource\\_protection/welcome.html#zoning](http://floridakeys.noaa.gov/resource_protection/welcome.html#zoning) (last visited: 21 February 2009)



Areas, Existing Management Areas, and Special-use Areas. Wildlife Management Areas are designed to protect sensitive species and their habitat. While protecting these wildlife areas, the plan still strives to allow public access to this zone, although use restrictions such as no-wake or no motor zones may still be in place. Ecological reserves serve as undisturbed habitat for all species in the sanctuary. These areas are designed to provide spawning and residence areas for local species, particularly species that are not protected elsewhere in the sanctuary.<sup>13</sup>

Sanctuary preservation areas are designed to decrease the burden on historically heavy-use areas. This classification will lead to limits on the frequency and magnitude of certain uses in that area and distribute some of the activities and users to other parts of the sanctuary. The objective is to reduce the burden on depleted areas allowing them to naturally regenerate their resources.<sup>14</sup>

Existing management areas are already under the jurisdiction of another agency with regulations in place. Any additional zoning-related regulations would be developed in coordination with the existing management entity. Special Use areas may be designated to a specific use for a period of time. These uses include scientific research, education, monitoring, and other developments.

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<sup>13</sup> *ibid*

<sup>14</sup> Florida Keys National Marine Sanctuary, 2009

## Introduction to Offshore Renewable Energy

American awareness of our energy consumption and growing energy demand coupled with a politically uncertain global energy market has motivated the US to pursue securing domestic energy supplies. For centuries, America's domestic energy supply has been in the form of coal, oil, and natural gas extracted from onshore mines and wells. Many believe America's energy future lies offshore in oil and gas fields beneath the ocean floor as well as renewable sources of wind, wave, and tidal energy. Emerging from this situation is the challenge of regulating an increased level of activity for development in our coastal and offshore waters.

Renewable energy projects in the United States have largely been wind farms in the plains states from Texas to Minnesota. Between 2000 and 2007, the installed wind energy capacity in the U.S. increased 6.5 times from 2,578 MW to 16,818 MW with 5,244 MW of capacity added in 2007.<sup>15</sup> Unfortunately, the vast majority of the U.S.' land-based wind resources are not near the major electricity load centers along the coasts, particularly the northeastern states.

This challenge can be addressed by investing in massive transmission infrastructure projects to transmit the electricity from the windy plains and the sunny southwest to the major metropolitan areas along the east and west coasts of the U.S. Alternatively, the renewable energy projects could be developed closer to the coastal cities. This leads to the topic of offshore renewable energy projects.

Tapping into the renewable energy potential of the coastal and offshore environments could provide more electricity than the current installed capacity in the U.S. (Musial, 2004). Figure 1 below illustrates the U.S. wind resource along the coastlines and the populations inhabiting these coastal regions.

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<sup>15</sup> Department of Energy, "Renewable Energy Data Book", September 2008

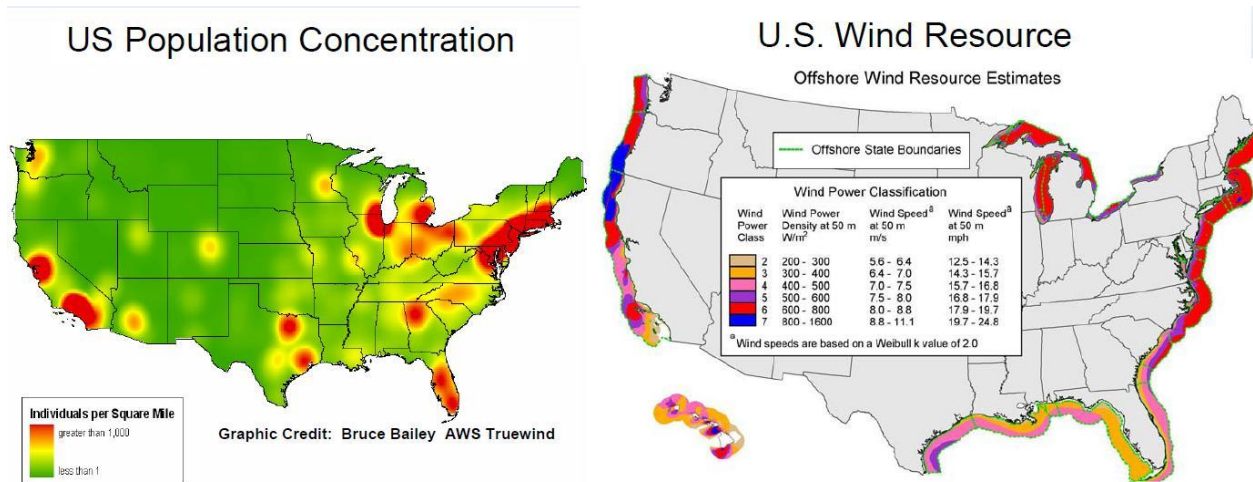


Figure 1: Map of U.S. Population Concentration and Offshore Wind Resource (Source: Musial, 2007)

This pair of maps clearly illustrates the opportunity for developing renewable energy resources close to the demand. While the offshore environment presents the prospect of a clean energy solution, it requires developing new technologies and placing them in the harsh marine environment.

Congress responded to this challenge in part, by passing the Marine and Hydrokinetic Renewable Energy Research and Development Act as part of the Energy Independence and Security Act of 2007.<sup>16</sup> Under this act, Congress allocated \$50 million per year for five years towards studies evaluating the feasibility of wave, tidal, ocean current, and ocean thermal energy projects including their environmental impacts, operational issues, and grid integration procedures. This will be achieved through grants and the establishment of National Marine Renewable Energy Research, Development, and Demonstration Centers. These centers will develop, test, and improve wave and tidal energy conversion devices. These devices, in combination with existing and developing wind turbines, will create a portfolio of technologies to harness the energy potential of the offshore environment.

<sup>16</sup> Section 631-636, H.R. 6 (110<sup>th</sup>)

## Renewable Energy Technologies

### *Wind*

Wind turbines are the most mature and economical offshore energy technology. Commercial wind energy in the U.S. began in the 1980's with 100kw turbines onshore in California's Altamont Pass. Today's onshore commercial turbines are rated up to 2.5MW for onshore and 3.6MW offshore. Plans for offshore turbines up to 5MW are in process.

Wind turbines are comprised of four primary components: foundation, tower, nacelle, and blades. A typical turbine has three blades rotating on a horizontal axis. As the wind hits the blades, the kinetic energy of the wind is transferred to the blades causing rotation of the shaft. The rotating shaft is connected to a generator and associated gears are located inside the nacelle. The nacelle is the housing or "box" fixed atop a tower of hollow steel which is set into the foundation. There are three different types of tower foundations currently in use: monopile, gravity foundations, and tripod foundations.<sup>17</sup> Conceptual plans for floating and anchored turbines have been developed and are often included in articles and presentations..

Locating wind turbines offshore takes advantage of the more consistent, higher speed winds. The relatively smooth surface of the ocean allows for more consistent, higher velocity winds. Offshore turbines can accommodate larger rotors to maximize the power extracted. The power of the wind is calculated from:

$$W = \frac{1}{2}\rho Av^3 \quad \text{where: } \rho = \text{air density, } A = \text{rotor sweep area, and } v = \text{wind speed.}$$

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<sup>17</sup> DWIA, 2003

Much of the increase in wind turbine capacity increases in the past 20 years has been due to increases in rotor sweep area. This calculation also highlights the importance of wind speed in the power potential of a turbine. Wind speed has the greatest impact of power potential, which increases exponentially with increases in wind speed.

### *Wave*

Wave energy is one of the most concentrated forms of renewable energy available. Waves are formed from friction between surface winds and the water's surface. Mesoscale wind circulation generates substantial wave energy on the eastern side of ocean basins in the northern hemisphere and western side in the southern hemisphere. Transforming this wave energy into usable electricity is accomplished with Wave Energy Conversion devices. There are four general categories of these devices: Point Absorbers, Attenuators, Terminators Oscillating Water Column, and Overtopping devices.

Point Absorbers look similar in appearance to a traditional navigation buoy, but vastly different beneath the water's surface. The Point Absorbers occupy a small horizontal footprint, only a few meters in diameter, but have a much larger vertical profile. One such device, Ocean Power Technologies' PowerBuoy, consists of two parts, a relatively stationary component and another component which oscillates with the wave. This relative motion powers a hydraulic or mechanical motor which is used to make electricity. The buoys are anchored to the seabed with a mooring system.

Attenuators are long floating structures made up of multiple segments tens of meters in length. Attenuators align parallel to the direction of the wave and the segments pitch with the rolling waves. This motion drives hydraulic pumps at the hinges between segments and the hydraulic pumps are used to generate electricity. Each attenuator is anchored to the seafloor with a mooring system. Examples of attenuators include Pelamis Wave Power's Pelamis Wave Energy Converter and the McCabe Wave

Pump. Pelamis is currently developing demonstration-scale projects off the coast of Portugal, Scotland, and England.<sup>18</sup>

Terminators are oriented perpendicular to the wave direction to capture or reflect the wave energy. One form of terminator is an oscillating water column (OWC) which can be land-based, nearshore, or offshore. The oscillating motion of the water column pushes air up and out of a chamber with a turbine at the top opening. The turbines rotate, creating rotational force used to drive a generator. The offshore version of this design use parabolic walls to direct wave energy toward the air chamber to increase the oscillating motion.<sup>19</sup> The entire platform is anchored to the seafloor via a mooring system. Oceanlinx (formerly Energetech), a developer of OWC energy conversion devices, currently has seven projects in development in Australia, United Kingdom, Mexico, Namibia, and the United States (Hawaii and Rhode Island).

Overtopping devices combine the fundamental concept of an impoundment hydroelectric dam with an offshore floating wave energy platform. Large parabolic walls extend out perpendicular to the wave direction. These walls reflect wave energy toward a central platform on which the waves crash and “overtop” flooding the top of platform. The platform floats several meters above water, creating a head differential between the reservoir of water on top of the platform and sea level. Openings in the platform allow the water to flow down to turbines and then into the ocean. The rotational force of the turbines drives a generator which generates electricity. One commercialized example of an overtopping device is the Wave Dragon, developed by Wave Dragon Ltd. The company has deployed test sites off the coast of Denmark and is pursuing projects in Portugal.

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<sup>18</sup> Pelamis Wave Power, 2009

<sup>19</sup> MMS, “Wave Energy Potential on the U.S. Outer Continental Shelf”, 2006

## Tidal

Tidal energy has the advantage of being a very predictable form of ocean renewable energy. The ebb and flood of the tides occurs at regular, known intervals and magnitudes allowing ocean energy project developers to accurately estimate their power generation for years into the future. Water is more than 800 times denser than air, which allows large amounts of power to be extracted from small sweep areas (referring to calculation used in wind section above). Tidal energy conversion devices are primarily turbines on either a horizontal or vertical axis.

Horizontal-axis turbines are similar in design to wind turbines. Two and three blade rotor designs, such as those shown in figure 2, are mounted atop, or on extensions from, a monopole. The turbines are designed to rotate or adjust the rotor pitch to allow for capture of tidal energy on both ebbing and flooding tides. In addition to horizontal-axis rotor turbines, there are vertical axis designs such as the Gorlov helical turbine which are designed for use in tidal and in-stream installations.

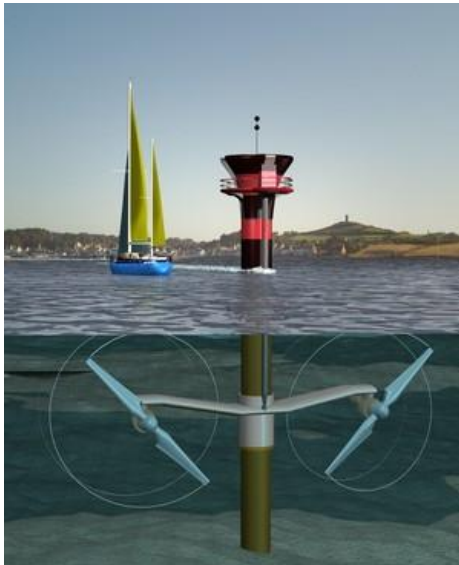


Figure 2: Marine Current Turbines' SeaGen turbine  
Source: Marine Current Turbines, 2009



Figure 3: Ocean Current Project  
Source: MMS, "Technology White Paper on the Ocean Current Energy Potential of the U.S. Outer Continental Shelf", 2006

### *Ocean Current Turbines*

Ocean currents such as the Gulf Stream have the potential to provide tremendous amount of energy using fixed position turbines or moored/dynamic turbines as seen above in figure 3. Challenges associated with extracting power from ocean currents are their dynamic, meandering paths and their distance offshore that can make transmission costs prohibitively expensive.

### **Offshore Foundations and Transmission**

#### *Wind Turbine Foundations*

Monopile foundations are formed by driving the hollow steel tower into the seabed. Depending on substrate, the tower is driven 10 to 20 meters beneath the surface.<sup>20</sup> This foundation can be installed without preparation of the seabed, but does require large piling equipment suitable for working at sea. Monopile foundations are appropriate for water depths up to 30 meters.<sup>21</sup>

Concrete gravity foundations were the first type used in offshore wind turbine installations.<sup>22</sup> The foundations are reinforced concrete which are poured on land and then floated out to the site. The hollow, conical foundations are then filled with sand and gravel as ballast. The concept for this foundation is similar to that used for bridge building. According to the “quadratic rule”, which states that the cost of a concrete foundation is proportional to the square of the water depth<sup>23</sup>, this type of foundation becomes uneconomical in water depths greater than 10m, so alternative foundations are required for deeper sites.<sup>24</sup>

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<sup>20</sup> DWIA, 2003

<sup>21</sup> Musial, 2007

<sup>22</sup> Danish Wind Industry Association, 2009

<sup>23</sup> Ragheb, 2007

<sup>24</sup> ibid



Tripod foundations are a derivation of foundations used in the offshore oil industry. The turbine sets into a steel pile which is supported by three smaller steel piles in a triangular arrangement. These smaller piles are driven into the substrate 10-20 m.<sup>25</sup> Tripod foundations are designed for water depths great than 7m.

*Floating Technology Foundations*

Floating technologies would be moored to anchors on the sea floor. Anchor design would vary with the substrate and in some cases may require leaving anchors in place following project decommissioning. Mooring systems for floating technologies, including wave and tidal technologies, are often proprietary technologies designed for specific situations. All four types of foundations discussed are illustrated in figure 4 below.

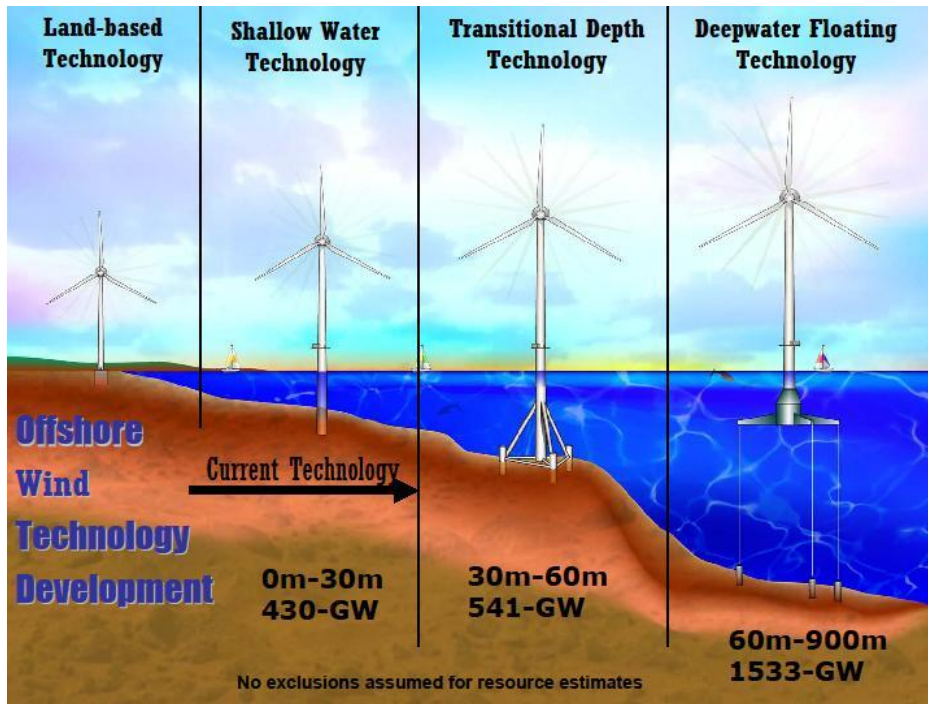


Figure 4: Offshore Wind Foundations (source: Musial, 2007)

<sup>25</sup> Danish Wind Industry Association, 2009

### *Offshore transmission*

Electricity generated at individual devices (turbines, buoys, etc) would be connected to a central sub-station at the site. From the sub-station, a transmission cable would connect the site to the utility power grid onshore. Cables should be buried beneath the sea floor to minimize potential interference from the electromagnetic field associated with electrical transmission and to avoid any impact on bottom fishing and other potential activities on the sea floor.

In sandy substrates, cables can be buried using a “jet plow” which simultaneously lays and buries the cable. Jet plowing is the proposed method for burying cable for the Cape Wind project.<sup>26</sup> As the cable approaches shore, a tunnel is drilled underground to avoid beachfront disruption. The drilling would make way for a conduit to house the transmission cables which would use existing utility rights-of-way to connect to the utility grid.

### *Environmental Impacts*

Burying transmission cables and installing foundations for anchors and wind turbines requires federal action for permitting, which triggers National Environmental Policy Act (NEPA) procedures. Discussed in the greater detail in the Management Structure section, NEPA requires environmental assessments and/or environmental impact statements evaluating the impacts of the proposed action. This section provides an overview of some of the potential impacts associated with developing an offshore renewable energy project. The topics are based on existing projects such as the proposed Cape Wind project and projects in Europe.

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<sup>26</sup> Cape Wind FEIS, 2008

### *Disrupted and displaced sediment*

Sediment and benthic species may be affected by these projects from three activities: installing turbine foundations, jet plowing transmission cables, and anchoring from vessels used in construction. The Cape Wind Final EIS describes some steps which can be taken to minimize sediment disruption such as using mid-point buoys on anchor chains to reduce disruption from chain drag.<sup>27</sup> Plowing and disrupted sediment could negatively impact local sessile shellfish and other benthic organisms and in some cases lead to “high injury or mortality”.<sup>28</sup> Organisms in the immediate plow area could be buried in the jet plow or increased suspended sediment or deposition.

### *Scour around foundations*

Wave-driven sediment transport can occur in sandy coastal environments such as North Carolina. This often takes the form of long, gradual sand waves which migrate across the seabed as a result of wave action. Turbine piles (towers and foundations) can interrupt this flow causing scouring around the pile. Scouring can be mitigated using such techniques as seabed scour control mats or rock armoring.<sup>29</sup> Scour mats installed on the sea floor off Cape Cod enhanced the accumulation of sand around a pile relative to two other piles without scour mats.<sup>30</sup>

Another method of mitigating seabed scouring is with rock armoring around the pile. This method is based off of previous experience and reports on bridges from the Federal Highway Administration. Rocks are positioned around the turbine pile to prevent sediment transport and scour

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<sup>27</sup> MMS, 2009

<sup>28</sup> *Ibid* at 5-127

<sup>29</sup> MMS, 2009, at 5-33

<sup>30</sup> *Ibid*

formation. Appropriate rock size and quantity are determined based on wave current and tidal conditions in the area.<sup>31</sup>

### *Electro-magnetic field*

Transmission lines generate an electromagnetic field (EMF) in the immediate area around the line. There is concern by some that EMFs disrupt certain fish or magneto-sensitive species. The EMF can be significantly reduced by shielding the transmission line in a metal casing. This method can reduce the EMF to less than the Earth's geomagnetic field.<sup>32</sup>

### *Changes in current and wave regime*

Waves on the North Carolina coast bring the benefit of attracting tourists and the cost of eroding beach fronts and threatening homes. As a result, there is considerable attention given to the impact of structures on the wave regime. It has been suggested that offshore wind and wave farms could reduce the wave energy reaching the coast in the wake of the offshore structures. This could lead to long-term shifts in longshore transport of sediment. However, according to research done in preparation of the Cape Wind FEIS, "the presence of the [wind turbine generators] would not affect wave conditions in the area".<sup>33</sup> Other sources indicate "the impact on wave characteristics would generally only be observed 1 to 2 km away from the WEC device in the direction of wave travel".<sup>34</sup> A study would have to be conducted or simulated for any projects off the North Carolina coast to ensure the impact would be negligible.

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<sup>31</sup> ESS Group, 2006

<sup>32</sup> MMS, 2009, at 5-106

<sup>33</sup> MMS 2009, at 5-47

<sup>34</sup> MMS, 2006

### *Avian Impacts*

One of the most common concerns with wind turbines is the potential for bird strikes by the turbine blades. While the blade rotations may not appear to be fast, blade tips rotate at speeds of up to 80 m/s. The Danish, leaders in offshore wind farm development, have conducted several studies on bird migration and movement through wind farms. One such study used a heat activated camera to detect birds and bats flying through the sweep area. Based on 2400 hours of observation, only one small bird or bat collided with the turbine blades.<sup>35</sup> The Massachusetts Audubon Society conducted its own series of studies in Nantucket Shoals, the proposed site of the controversial Cape Wind project. Their preliminary conclusion was that “sensitive species, including the endangered roseate tern and piping plovers, generally avoid the area” and the project would cause no significant harm to birds.<sup>36</sup> These findings seem to have alleviated concerns over massive bird mortality being caused by wind turbines.

### *Marine Mammals*

Protection of charismatic megafauna such as whales and dolphins are common public concerns when considering offshore development projects. The ongoing debate over the impact of mid-frequency active sonar use by the Navy has raised specific concerns about the impact of underwater sound on marine mammals. This concern has been studied in the United Kingdom in based on noise measurements taken during the installation of offshore wind parks.<sup>37</sup> Based on these findings, the physical effects of construction noise, such as driving piles, may occur with a few hundred meters of the site while behavioral effects may extend out to a kilometer or more.<sup>38</sup> Efforts to mitigate this potential

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<sup>35</sup> Fairley, 2007

<sup>36</sup> Associated Press, 2006

<sup>37</sup> MMS, 2009, at 5-134

<sup>38</sup> Nedwell et. al., unpub. Data., according to MMS 2009, at 5-134

impact could include installing turbines during the off-season for whale migration through North Carolina waters.

### *Fisheries*

The impact on fisheries will consist of minimal habitat loss and disruption associated with jet plowing and disturbed sediment. Benthic habitat loss areas will be that area occupied by the pile (about 5 meters in diameter) and the associated rock armoring. There are potential benefits to fisheries associated with turbine piles and rock armoring which are discussed in subsequent sections.

The jet plow will draw water from near ocean and disrupt sediment around the plow area. This could primarily impact fish eggs and larvae. Eggs and larvae could be pumped through the jet plow or covered in sediment, both of which would cause increased injury or mortality. Adult fish would be able to swim away from the disturbed area and return when the sediment has settled.

### **Social Impacts**

The social impacts of coastal development projects could prove to be more significant and contentious than the environmental impacts. Environmental advocacy organizations, such as the NC Conservation Network, occupational groups, such as the Ocracoke Working Waterman's Association, and individual citizens can actively participate in the regulatory and project development process in accordance with procedural acts such as the National Environmental Protection Act. Concerns over social impacts may be raised throughout the coastal community with more visible and direct impacts, both positive and negative, and are likely to find roots in the broader public. Some examples of potential issues are discussed below.

### *Viewshed*

Offshore wind farms are considered by some to be “eyesores” on the seascape. The natural beauty of the Outer Banks and Carolina coast draws tourists from around the world to the beaches of North Carolina. With tourism serving as the basis for much of the North Carolina coastal economy, any potential deterrent to this industry would likely be met with reservation or opposition. Changes in the viewshed and “Not in my backyard” concerns have created considerable opposition from the vacation home and tourist communities towards the Cape Wind project in Massachusetts, so it is reasonable to expect similar concerns from North Carolina’s coastal communities.

### *Changes in accessibility*

The development of an offshore wind farm (or wave or tidal project) would change the accessibility and permissible uses of those waters. This would directly impact other users who previously transited or used those waters, most notably fishermen and commercial traffic.

Determinations on the compatibility of various forms of fishing and an offshore wind farm would be site specific. In some cases, access to the area could be limited causing vessel traffic to be directed around the site area. Accessibility may be temporarily limited during construction.

Concerns over limitations to commercial shipping traffic would probably be addressed during the planning stages of the development based on designated shipping lanes and consultation with the NC Port authority.

## Offshore Wind Energy in Europe

Europe has led the development of wind energy technologies since WWII. Onshore utility-scale wind projects were first developed in 1991 in Germany, who remains the leader in installed capacity of wind power among European nations. European offshore wind farms started with a small development off the coast of Denmark in 1986.<sup>39</sup> It was almost inevitable that offshore wind started in Europe due to their limited space on land and the attractiveness of strong, reliable wind over the water. Current operating offshore wind capacity in Europe is 1,471 MW, with the United Kingdom and Denmark leading the way. Planned capacity to be operational by 2015 is 37,441 MW, so the need for an efficient regulatory process will be essential to handling this increase in activity.

### *United Kingdom*

Coastal waters in the UK, out to 12 miles, are owned by the body of government known as the Crown Estate. Project development activity started in December 2000 when the Crown Estate outlined their process for allocating and leasing a site. In response to this interest, the British Wind Energy Association started a stakeholder dialogue which included fisherman, tourism representatives, and conservation groups. The dialogue was mediated by a third-party which resulted in a set of “best practices” guidelines.<sup>40</sup>

Offshore development has been conducted in a series of rounds for bidding on offshore leases. The third round bidding concluded in March 2009 with 40 bids, demonstrating the strong interest in the potential of offshore wind energy in the UK.

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<sup>39</sup> European Patent Office, 2009

<sup>40</sup> BWEA, 2009



## *Denmark*

In 1996 Denmark's energy plan set a target for 4,000 MW of installed offshore wind power by 2030. The largest site currently in operation is Horns Rev located in western Denmark. Horns Rev operates 80 turbines with a total 160 MW installed capacity. A second installation, Horns Rev 2, will begin operation in late 2009/early 2010 with 91 turbines totaling 209 MW installed capacity, making it the largest offshore wind farm in the world.

The offshore wind farm development process is administered by the Danish Energy Authority under the Ministry of Climate and Energy.<sup>41</sup> When the Danish Energy Authority issues a call for tender on a site, applicants must submit studies of the environmental conditions at the site in addition to the physical conditions of wind speed, water depth, etc. A period of public input and consultation is required for all projects. Upon approval of the environmental impact assessment and addressing any public concerns or interests, the project can be authorized. This authorization is made public and followed by an appeal period in which anyone may appeal the authorization.<sup>42</sup> Upon completing the project, the developer applies for a license from the Danish Energy Authority to begin generating power and tying into the grid.

Like many countries, Denmark is working to develop an integrated coastal zone management structure. Currently, laws governing the sea are primarily sector-based, governed by the Fishery Act, the Harbor Act, and the Marine Environment Protection Act.<sup>43</sup> Under an integrated CZM structure, the governance of land-based development and sea-based development could be more closely aligned.

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<sup>41</sup> Danish Energy Authority website, 2009

<sup>42</sup> Danish Energy Authority website, 2009

<sup>43</sup> Anker, et. al., 2004

## *Germany*

Germany currently has three offshore projects totaling 12 MW of installed capacity. As of January 2009, there were 732 MW of offshore installations under construction with an additional 10,183 MW planned for 2015.<sup>44</sup> Given this level of activity, Germany will need an effective regulatory process to handle this volume of development.

Authorization of offshore wind development in Germany is regulated at the state level for site within the 12-mile territorial limit and at the federal level for sites outside the territorial waters and within the exclusive economic zone.<sup>45</sup> This process is overseen by the Federal Maritime and Hydrographic Agency, which also holds conferences and hearings to facilitate the process. Germany is currently pursuing a gradual development of offshore projects to account for their lack of understanding with regard to the environmental impacts of the projects.<sup>46</sup> Under an amendment to the Federal Nature Conservation Act, the government can establish nature reserves in part of the EEZ to provide protection for migrant birds, marine mammals, and other species of concern.

### *Lessons learned for application in the United States*

From these experiences there are a few simple lessons the U.S. should consider when developing their policy and management structure for offshore development. First, approach the opportunity with gradual development, don't design a system and then begin pushing projects through. Adopting a "learn as you go" strategy will improve the end result of the process. A challenge with this approach is realizing that your initial understanding is imperfect and the decision makers may be wrong at times. This leads to the second recommendation of designing a system that can be altered and

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<sup>44</sup> EWEA, "Offshore Statistics", 2009

<sup>45</sup> German Energy Agency's Offshore-wind website, 2009

<sup>46</sup> German Ministry of the Environment, Nature Conservation and Nuclear Safety, 2009

improved with continued learning. If the system is designed to be continually revised and improved, then making these changes will be less daunting and encourage revisions, rather than having to “scrap” the entire system and start anew.

## **Potential for Offshore Renewable Energy Development in North Carolina**

### *Wind*

North Carolina’s wind resources are primarily located in the mountains and the coast. Coastal wind resource classification ranges from “fair” to “outstanding”(Class 3-6 on the Wind Power Classification Scale), including winds over the sounds. Figure 5 below illustrates the wind energy potential in North Carolina. The North Carolina Solar Center has put together a Coastal Wind Working Group(CWWG) to address the key issues associated with coastal wind development. The group has partnered with State and Federal Policy offices, Utilities, State and National Parks, and various NGOs and NPOs. Town Hall meetings and public awareness sessions have been conducted with members of the group addressing public concerns and educating coastal communities on the opportunities and challenges associated with coastal and offshore wind development. While the CWWG is not focused on offshore developments, coastal wind turbines would be a likely first-step toward developing wind farms offshore. The Department of Energy’s “20% by 2030” report, outlining a plan to generate 20% of the U.S.’ electricity from wind by 2030, indicates 10.44 GW of installed capacity would be expected in the shallow offshore waters of NC to reach their target.<sup>47</sup>

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<sup>47</sup> Lindenberg, S., 2009

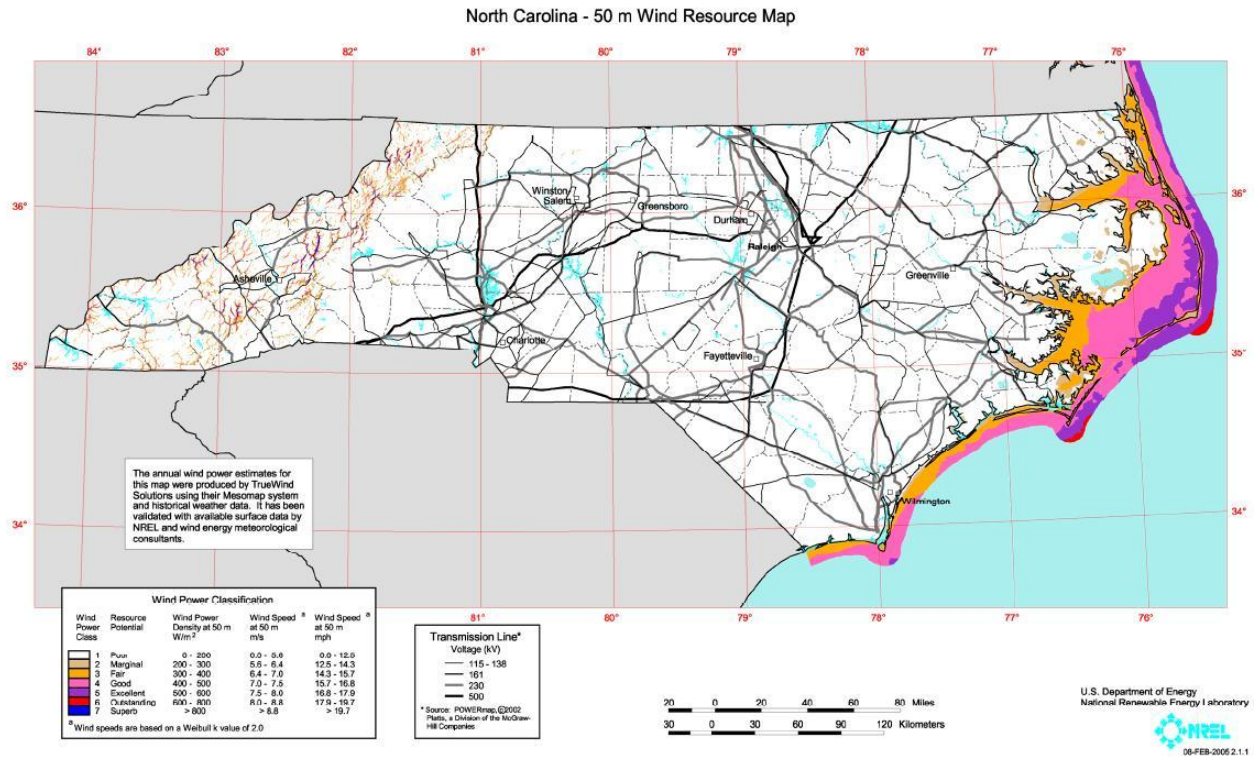


Figure 5: North Carolina 50m Wind Resource Map

Source: NC Wind Energy, Appalachian State University

## Wave

North Carolina wave energy resources are not as competitive as those of states on the Pacific coast of the U.S. The Electric Power Research Institute (EPRI) published several reports evaluating the potential for commercial wave energy projects in six U.S. states: California, Hawaii, Maine, Massachusetts, Oregon, and Washington. Based on the mild wave climate commonly found on western shores of ocean basins in the northern hemisphere, it is unlikely North Carolina will see much wave energy development until projects in higher energy environments such as Hawaii prove the technology. However, an informational website, [www.ncwaveenergy.com](http://www.ncwaveenergy.com), has been established to raise awareness about the technology and its potential in North Carolina.

### *Tidal and Ocean Current*

North Carolina has limited tidal energy potential along its sandy shores and torpid sound waters. The tidal range along the ocean waters are four to five feet, while tides in the sounds are limited to less than a foot. Logically, any naturally occurring strong tides would have shifted the sands, widening the inlet or constriction until the energy intensity was reduced.

Ocean currents present a very different potential for the state. The Gulf Stream flows off the coast of North Carolina moving millions of cubic meters of water per second. Academics and private companies have proposed placing turbines in this ocean current to extract some of the energy and convert it into electricity.<sup>48,49</sup> This technology is still nascent, but efforts at Florida Atlantic University and other institutions may prove the idea commercially viable. This resource offers tremendous potential for North Carolina to achieve its renewable energy targets and create economic activity in the coastal region.

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<sup>48</sup> Zephyr Electric Power, 2009

<sup>49</sup> Outer Banks Ocean Energy, Personal Communication

## **Current Management Structure for Offshore Activities in North Carolina**

### *Legal Mandates associated with Offshore Development*

The process of leasing, permitting, licensing, and developing energy projects in the state and federal waters off the coast of North Carolina is governed by numerous federal, state, and local laws. The most relevant laws are discussed below beginning with federal laws and progressing through state laws. A more thorough discussion of the procedures and agencies related to this issue follows this section.

#### *Rivers and Harbors Act of 1899*

The Constitution grants Congress the power to “regulate commerce with foreign nations and among the several states”.<sup>50</sup> Congress enacted the Rivers and Harbors Act to ensure federal control over the navigable waters of the U.S. Under Section 10 of the Rivers and Harbors Act, the US Army Corp of Engineers (USACOE) has authority over the “creation of any obstruction not affirmatively authorized by Congress, to the navigable capacity of any of the waters of the United States”<sup>51</sup>. This includes oil and gas platforms as well as any foundations or anchors required for renewable energy technologies such as wind, wave, and tidal energy.

#### *Submerged Lands Act*

States were granted ownership of the lands up to three miles from their coastline by the Submerged Lands Act(1953).<sup>52</sup> This ownership includes the natural resources found beneath the sea floor, which in the case of oil and gas, are of significant value to the state. North Carolina’s management

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<sup>50</sup> U.S. Const. art. I, § 8, cl. 3

<sup>51</sup> Section 10 of the Rivers and Harbors Act of 1899, 33 U.S.C. 403

<sup>52</sup> With the exception of Texas and the Gulf coast of Florida which own out to three marine leagues from the coast

of their state waters is discussed later in this paper, but it is important to recognize the Submerged Lands Act as the origin of the state's right to the lands out to three miles.

#### *Outer Continental Shelf Lands Act*

Complementary to the Submerged Lands Act, the Outer Continental Shelf Lands Act (OCSLA), also passed in 1953, affirms the federal government's rights to all lands seaward of three miles out to the edge of the continental shelf. The United States had already laid claim to the "jurisdiction and control" of the seabed and associated natural resources through the Truman Proclamation<sup>53</sup>, but the OCSLA clarified some of the concerns around leasing and management of the federal lands on the OCS. The OCSLA directs the Secretary of the Interior to manage the resources of the OCS and lease tracts for mineral and resource exploration and extraction.<sup>54</sup> The Secretary delegated this authority to the Minerals Management Service (MMS) who operates the current leasing system for resources on the OCS. Historically, this authority has focused on oil and gas development through the Minerals Revenue Program. Through the Energy Policy Act of 2005, MMS was also authorized to regulate the development of renewable energy projects on the OCS through their Offshore Energy and Minerals Management program.

#### *National Environmental Policy Act*

Issuing leases for development on the OCS is a federal action and as such would require compliance with the National Environmental Policy Act (NEPA). NEPA is a procedural act, meaning it outlines a procedure which must be followed to satisfy the act. The process requires an environmental assessment of the proposed action be conducted and, if needed, an environmental impact statement (EIS) prepared. The purpose of these documents is to evaluate and make publicly available the

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<sup>53</sup> Kalo, et. al., 2002, pg. 374

<sup>54</sup> Kalo et. al., 2002, pg. 376

anticipated environmental impact and propose alternative actions including the “no action” alternative. It’s important to note that an EIS is not designed to prevent an action such as drilling an oil well offshore, from happening, only report on the environmental impacts associated with that action. However, if the EIS reveals significant potential impacts, and the lead agency authorizes the action despite the EIS findings, the agency’s decision can be appealed and found to be “arbitrary and capricious”.<sup>55</sup>

### *Endangered Species Act*

North Carolina’s rich and diverse wildlife population includes threatened and endangered species of which at least 14 are found in the marine environment.<sup>56</sup> The species and their habitat are designated “endangered” and “critical” by the Secretary of the Interior as authorized by the Endangered Species Act (ESA).<sup>57</sup> The jurisdiction over habitat would be particularly important and complex in a marine setting where the habitat is fluid and in constant motion. Any development in the coastal and offshore waters could be seen as a threat to the habitat of endangered marine mammals protected by the ESA and the Marine Mammal Protection Act (MMPA).

### *Marine Mammal Protection Act*

Congress enacted the MMPA to protect and preserve all marine mammals at the urging of the scientific and conservation communities. This legislation ensures a permanent ban on all “taking” and importation of marine mammals in the U.S.<sup>58</sup> There are exceptions in which the Secretary of Commerce or Interior (depending on the species) can authorize a “taking”. This has been permitted for culturally significant occasions such as whale hunts. This act differs from other acts in its overriding prohibition of

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<sup>55</sup> 5 U.S.C. § 706(2)(A)

<sup>56</sup> USFWS Endangered Species Program, 2008

<sup>57</sup> 16 U.S.C. § 1533 (A)(1)

<sup>58</sup> 16 U.S.C. § 1371(a)



states from enacting their own marine mammal protection policies. In the context of this paper, the MMPA applies to projects being considered for areas known to the marine mammal habitat or migration paths. The concern being that a project would affect the marine mammal's behavior in violation of the MMPA.

#### *Magnuson-Stevens Fisheries Conservation Act*

The Magnuson-Stevens Fisheries Conservation and Management Act (MSFCA), first enacted in 1976, amended in 1996, and reauthorized in 2006, serves as the primary legislation for regulation of fishing in federal waters. This act created regional fishery management councils responsible for regulating activity in their region between 3 and 200 miles off the coast. North Carolina is governed by the South Atlantic Fisheries Management Council based in North Charleston, SC. Councils prepare management plans which are then submitted to the National Marine Fisheries Service, the agency under NOAA through which the FMCs get their authority.

The MSFCMA and the councils would be involved in evaluating the impact of offshore energy development on the species under their jurisdiction as well as the impact of the development on the fishing community. Depending on management objectives, energy project development could displace fisheries and justify an adaptation of the fisheries management plan.

#### *Clean Water Act*

The Clean Water Act was established in 1972 to protect and promote water quality in the U.S. The legislation is administered and enforced by the Environmental Protection Agency. Section 404 of the Clean Water Act addresses the issue of discharging dredged materials into the navigable waters of the U.S. Dredging and discharging materials requires a permit from the Army Corp of Engineers under

the authority of the Secretary of the Army.<sup>59</sup> During the offshore energy development process, a Section 404 permit would be required for the material removed during the construction of platforms and foundations for either oil and gas wells or wind turbine foundations. This applies to both state and federal waters with projects in state waters also having to satisfy the N.C. Dredge and Fill law discussed in the State legislation section of this paper.

### *Coastal Zone Management Act*

The Coastal Zone Management Act (CZMA) was enacted in 1972 to “preserve, protect, develop, and where possible, to restore and enhance, the resources of the Nation’s coastal zone”.<sup>60</sup> The act is unique in that it encouraged states to develop their own coastal zone management plans and supported their efforts through grants and funding.<sup>61</sup> The act further empowers the role of the state in coastal zone management through the “consistency” clause which requires Federal activities affecting the coastal zone are consistent with the state’s management plan.<sup>62</sup>

## **North Carolina State Laws**

### *Coastal Area Management Act*

The North Carolina General Assembly passed the Coastal Area Management Act (CAMA) in 1974 in response to the CZMA. CAMA established the North Carolina Division of Coastal Management (DCM), which includes the Coastal Resource Commission (CRC), within the Department of Environmental and

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<sup>59</sup> Environmental Protection Agency, 2008

<sup>60</sup> 16 U.S.C. § 1452 (1)

<sup>61</sup> 16 U.S.C. § 1455

<sup>62</sup> 16 U.S.C. § 1456 (1)(A)

Natural Resources (DENR).<sup>63</sup> The CRC implements the rules for CAMA and the NC Dredge & Fill Act, establishes policies for the state's Coastal Management Plan, issues permits for CAMA and other land-use regulations, and supervises areas of environmental concern.<sup>64</sup>

#### *North Carolina Dredge & Fill Law*

This law regulates the addition or removal of material from the estuarine waters, tidelands, marshlands, and lakes of North Carolina.<sup>65</sup> Compliance with this law can be accomplished concurrently through compliance with Section 404 of the Clean Water Act as both regulate the removal and deposition of dredged materials in navigable waters. This matter becomes particularly important for offshore renewable energy projects which require a buried cable landfall for grid integration. Depending on the method used, the cable landfall could require dredging material and the associated permit from the CRC.

### **Policy Process for Developing an Offshore Energy Project**

This section describes in detail the procedure required for getting an offshore energy project approved, permitted, and built. The example project is a wind farm in federal waters off the coast of North Carolina. The role of relevant agencies with authority as well as public and private sector entities and stakeholders will be discussed throughout.

The process begins with the Minerals Management Service developing a leasing program for the OCS. The Energy Policy Act of 2005 amended the OCSLA to grant the Secretary of the Interior

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<sup>63</sup> 15A NCAC 07A .0101

<sup>64</sup> Coastal Resources Commission, 2008

<sup>65</sup> North Carolina General Statutes § 113-229

“discretionary authority to issue leases, easements, or rights-of-way for activities on the Outer Continental Shelf that produce or support production, transportation, or transmission of energy from sources other than oil and gas”.<sup>66</sup> Under this authority, MMS decides which plots to include their leasing program and offers plots for bidding according to a schedule. The OCS Leasing Process is outlined in Appendix I. The leasing program includes a general EIS for the proposed plots. Plots are generally nine square miles in size.<sup>67</sup> When a specific plot is scheduled for auction, a draft EIS is prepared for the area followed by a 60-day comment period. These comment periods, common throughout the leasing process, provide all stakeholders the opportunity to publically comment on the plot as well as the project. Following the 60-day comment period, a final EIS is published, the proposed notice of sale is published in the Federal Register, after which there is a consistency determination with the governors of the affected states pursuant to the CZMA discussed in the previous section. Upon consistency approval by the governors, a final notice of sale is published in the Federal Register 30 days prior to the actual sale.

Project developers, primarily private companies, bid on lease plots. If the bid is accepted, a five-year lease authorizing resource studies, often using meteorological towers to measure wind speeds at various heights, would be issued. The construction of these meteorological towers triggers numerous federal and state actions. The developer would be required to submit an EA, and if necessary an EIS, for the meteorological tower.

The EIS is designed to evaluate the environmental effects of a proposed action and consider alternative actions. While the EIS is prepared by the developer, it represents the combined inputs and

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<sup>66</sup> MMS, 2009b

<sup>67</sup> Federal Registrar, Vol. 73, No. 76, (April 18, 2008), p. 21152-21155

interests of all interested parties. This collective representation is ensured through the public commenting process and the required reply by the developer to all public comments.<sup>68</sup>

For a development off the North Carolina coast, the stakeholders and legislation involved in completing an EIS are diverse and significant. Below is a listing of some of the expected stakeholders in the process and the issues they would be involved in through comments or approval.

### *Fishing Community*

According to the North Carolina Fisheries Association, more than 7,300 fisherman harvest an annual catch valued at close to \$100 million dollars.<sup>69</sup> The fishing industry faces challenges with rising costs and increased restrictions on their harvest of unstable or collapsing fisheries and the threat of losing a productive fishing ground would be met with considerable resistance. Comments to the EIS may include the social impact on the fishing community if a wind farm was located on a common fishing ground or if the project was located between the port and the fishing ground, potentially increasing transit time.

If the wind farm was expected to impact fish habitat, particularly critical habitat, several agencies and organizations would be involved in evaluating the situation. The South Atlantic Fishery Management Council (SAFMC), the National Marine Fisheries Service (NMFS), and the Atlantic States Marine Fisheries Commission (ASMFC) are all responsible for the management and conservation of fisheries in the waters off North Carolina. Impacts to critical habitat, as defined in the ESA, would be protected through the efforts of the US Fish and Wildlife and/or the NOAA fisheries service.<sup>70</sup>

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<sup>68</sup> 43 FR 55997, Nov. 29, 1978

<sup>69</sup> North Carolina Fisheries Association, 2008

<sup>70</sup> Summary of Endangered Species Act, 2008

### *Shipping and Transportation*

The greatest need for energy along the North Carolina coast is in densely populated areas, such as Wilmington and Morehead City. Building wind farms close to these cities would help minimize cost and energy lost in long distance transmission. However, these cities also support a commercial shipping and transportation industry which could be impacted by an offshore wind farm. The concern for safe, unobstructed navigation is addressed by the USACOE as directed in Section 10 of the Rivers and Harbors Act and the construction of a wind farm would require a section 10 permit. If the Army Corps of Engineers deemed the project an unacceptable hazard to navigation, they could with the permit and deny the project.<sup>71</sup>

### *Mineral Mining*

North Carolina's Outer Banks communities have become increasingly reliant on beach nourishment to extend the life of their beaches and the tourism associated with the beaches. Between 1980-1989, 17.4 million cubic yards (cy) of nourishment sand were added to North Carolina's beaches.<sup>72</sup> This number grew to 21 million cy in the 1990's and 22 million in the first seven years of the 21<sup>st</sup> century.<sup>73</sup> Sand for these nourishment projects is sourced offshore and brought into the nearshore environment. A wind farm would likely be sited on a sandy shoal, which would limit the accessibility of the sand as a source for beach nourishment projects. Both the wind farm and the minerals mining are governed by the MMS under the OSCLA as well as the Energy Policy Act of 2005 for the wind farm.

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<sup>71</sup> 33 U.S.C. § 403

<sup>72</sup> WCU Program for the Study of Developed Shorelines, 2009

<sup>73</sup> *ibid*

## *Military*

The United States Navy and Marine Corps have active training sessions in the coastal waters of North Carolina.<sup>74</sup> The footprint area or height of the wind turbines could impact the activities of the military in this region. It is unclear whether the military's interest will be prioritized over opportunities for offshore renewable energy development. Previous situations, such as the Navy's proposed outlying landing field in the Pocosin Lakes National Wildlife Refuge, resulted in the Navy pursuing alternative sites,<sup>75</sup> while other issues, such as mid-range active sonar's impact on whales, cited national security interests over conservation.<sup>76</sup>

## *Conservationists*

Some groups may view a wind farm off the coast as a threat to the natural environment or simply prefer the site in question remain as pristine. In Massachusetts, the Alliance to Protect Nantucket Sound has been very active and outspoken against the Cape Wind project. In North Carolina, conservation organizations such as the North Carolina Coastal Federation may get involved in the public forum of the wind farm development process. Audubon North Carolina publicly supports renewable energy development in North Carolina. They recognize the need for "strenuous siting criteria" and encourage the state to codify requirements for site survey and review of new or existing studies.<sup>77</sup> The experience and expertise of organizations such as the NCCF and Audubon would be valuable in developing alternative action plans for the EIS.

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<sup>74</sup> Presentation, Anna-Marie Laura, Duke University Marine Lab

<sup>75</sup> Audubon North Carolina, 2008

<sup>76</sup> Winters vs. NRDC (2008)

<sup>77</sup> Audubon North Carolina, 2004

### *Recreational Users*

A 2002 survey reported that North Carolina has over 350,000 recreational boaters.<sup>78</sup> This group could organize into the largest constituency to submit comments on the EIS. Recreational boating contributes significantly to the coastal communities economies and any impacts on this group should be carefully considered. Based on a review of the Cape Wind project's Final EIS, numerous recreational boating organizations such as the Massachusetts Boating and Yacht Clubs Association and the Cape Cod Marine Trades Association.<sup>79</sup> Concerns raised regarding the draft EIS included the potential for an oil spill and impacts on recreational access to the project site.<sup>80</sup>

### *Energy Project Developers*

As the party responsible for the preparation and submission of the EIS, the project developers are at the heart of the human ecology. The environmental impact statement is first prepared and publicized as a Draft EIS. Interested parties review the draft and submit comments for clarification or areas for further study. At the close of the comment period for the Draft EIS, the recommendations and comments are considered in preparation of the Final EIS which includes responses to all comments submitted on the DEIS.

In addition to the EIS, filed pursuant to NEPA and SEPA at the state level, the developer must obtain permits for all activities before construction begins. A Section 404 permit and NC Dredge and Fill permit must be obtained, pursuant to the CWA and the NC Dredge and Fill Law, respectively. These water quality laws are administered by the EPA for the CWA and the Coastal Resource Commission under CAMA for the D&F law. Dredging will occur during installation of the monopoles used for the

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<sup>78</sup> 2002 U.S. Recreational Boat Registration Statistics, 2008

<sup>79</sup> Cape Wind FEIS, 2008

<sup>80</sup> *ibid*



wind turbines and potentially during the burying of the transmission cable. Other agencies issuing permits or requiring notification related to wind farm development include the Federal Aviation Administration and the North Carolina Utilities Commission. The FAA requires a Notification of Proposed Construction be submitted for any object more than 200 feet above the ground.<sup>81</sup> The utilities commission is involved in all aspects of electrical utilities, power generation, and renewable portfolio standards in North Carolina.

Prior to developing a full-scale project, individual meteorological towers are erected on the site to gather data and monitor site conditions. Once the developer has obtained the necessary permits and notifications, the actual construction of the project begins. At this point, the developer's lease would require permission from MMS to allow more than monitoring and data collection. Assuming the lease is developed and issued, the final step in the process is connecting the wind farm to the grid. Where the cable makes landfall, an additional CAMA permit would be required in addition to any county permits which vary locally.

As this section outlines, the policies and procedures involved in developing a wind farm in the federal waters off the North Carolina coast involve numerous federal, state, and local parties. It's critical to consider all parties involved and anticipate conflicts before they erupt into entrenched interest groups and derail the process. With so many existing uses and interest groups, it's worth having a series of alternative plans and policies for improving the existing structure of this new and evolving process.

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<sup>81</sup> Airspace issues in Wind Turbine Siting, 2008

## Current and Future Activities in North Carolina Coastal Zones

The use of an ocean zoning management approach requires classifying activities based on compatibility. This section provides an overview of the wide range of current and potential activities in North Carolina's coastal environment.

### *Fishing*

The North Carolina coast has been an abundant fishing ground drawing recreational fisherman from across the country and supporting a historically healthy commercial fishery. The variety of environments in North Carolina, from the calm waters of the sounds to the meandering Gulf Stream, provides habitat for a rich diversity of species. In 2007 the commercial fishing industry landed over 62 million pounds of commercial finfish and shellfish valued at \$82 million dollars.<sup>82</sup> North Carolina issued 23,584 commercial fishing licenses in 2007, although the number of actual commercial fisherman would be considerably less.<sup>83</sup> These catches were landed in 18 counties with Dare, Carteret, and Hyde counties landing the largest shares (on a dollar-value basis).<sup>84</sup> These three counties have shoreline on both the Outer Banks and the sounds, providing substantial fishing opportunities. Fishing fleets from these counties, based in Morehead City/Beaufort, Wanchese, Engelhard, and other coastal communities, all face common challenges of decreasing catch size, increasing fuel costs, and at times, particularly in a down economy, a low market price for their catch. These challenges will be some of the issues evaluated when making recommendations for an ocean zoning plan in North Carolina.

The state issued 469,901 coastal recreational fishing licenses in 2007 to anglers from all 50 United States, several territories, and 61 countries which illustrates the appeal of fishing in North

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82 North Carolina Division of Marine Fisheries, 2008

83 North Carolina Division of Marine Fisheries, 2008

84 North Carolina Division of Marine Fisheries, 2008

Carolina.<sup>85</sup> Recreational fisherman are not limited to catch season or maintaining a fishing fleet in North Carolina's large ports. This group seeks access to fishing from shore, piers, and their boats. The result is a group larger than the commercial fishing population which has a wider variety of interests and needs to preserve. In addition, with recreational fisherman coming from all corners of the world to fish in North Carolina, the economic contributions to tourism and the local economy are significant and provide a substantial arguing point for protecting their interests.

### *Aquaculture*

Commercial aquaculture is considered to be the fastest growing segment of the U.S. agriculture industry.<sup>86</sup> While most of this growth has been with freshwater species such as catfish, there is a growing discussion over the potential for open ocean aquaculture. Establishing large fish pens in the open ocean may reduce some of the pollution concerns associated with aquaculture. These pens would qualify as "hazards to navigation" and require anchors on the sea floor.

Aquaculture has the potential to benefit from other forms of development along the coast. Artificial structures in coastal waters, such as a wind tower, would provide habitat for shellfish. This could be particularly beneficial in the sound waters of North Carolina.

### *Military*

The U.S. military's presence on the North Carolina coast consists of the Naval and Marine Corps air station at Cherry point and Camp LeJeune in Jacksonville. Aircraft from these and other military bases train using bombing target zones at Brant Island and Piney Island located in Pamlico Sound. This activity would likely be viewed as incompatible with any other use and carries the weight of national

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85 North Carolina Division of Marine Fisheries, 2008

86 Goldberg, R.J., M.S. Elliott, R.L. Naylor. 2001.

security interests. However, the military must complete environmental assessments and environmental impact states for all of their activities, so opportunities for compatible and conditionally compatible activities may become evident through examination of these documents.

### *Transportation*

The commercial ports of Wilmington and Morehead City directly and indirectly support 85,000 jobs and contribute nearly \$300 million in annual tax revenues to North Carolina.<sup>87</sup> Commercial shipping traffic moves over 5 million tons of bulk cargo and containers through these two ports each year.<sup>88</sup> A larger, international container port along the Cape Fear River in Brunswick County is currently planned for development. This high volume of commercial traffic requires dedicated traffic lanes in and out of the ports. Permissible activities within these traffic lanes are well known and should not cause much debate.

In addition to commercial shipping traffic in North Carolina there is a public ferry transportation system. Seven ferry routes operate, primarily to and from the Outer Banks. Potential development in the sounds or across river mouths or inlets could interfere with existing ferry routes raising concerns for time, costs, and collision potential along the ferry routes.

### *Recreational boating*

Motorboat and sailboat industry businesses in North Carolina support more than 30,000 jobs and \$500 million in related sales annually.<sup>89</sup> Recreational boaters are similar to the recreational fisherman in that they are widespread across the North Carolina coast and have large numbers to

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<sup>87</sup> North Carolina Ports, Economic Impact, 2009

<sup>88</sup> North Carolina Ports, Port Statistics, 2009

<sup>89</sup> North Carolina Small Business and Technology Development Center, 2008

support their interests. Recreational boat registrations (including inland boats) in North Carolina numbered 350,000 in 2000.<sup>90</sup>

SCUBA diving is another popular activity along the coast. Accessibility to reefs and historic wrecks and dive sites could be an issue for debate in determining the compatibility of various activities along the coast.

### *Conservation*

North Carolina's coast provides a unique and rich habitat for a wide variety of marine life. Conserving this habitat, from the sandy beaches in which sea turtles nest to wetlands supporting fish larvae and migratory birds, is a priority for the state and many of its citizens. Conservation efforts can be driven by concerned citizens and interest groups, or required by state and federal law depending on the species involved. The specifics of laws governing conservation and habitat protection are outlined in the section on management structure.

### *Mining*

North Carolina's coastal communities, particularly along the Outer Banks, rely heavily on beach nourishment as a means of prolonging their oceanfront communities and the tourism industry. Between 2000-2006, NC coastal communities received nourishment projects totaling more than \$116 million.<sup>91</sup> Sand for this beach nourishment is mined from deposits offshore and must meet very specific requirements for grain size and quality. As a result, certain deposits offshore have significant economic value to the local communities and the state. Interests in protecting access to these deposits may become a top priority making most other activities incompatible.

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<sup>90</sup> Bureau of Transportation Statistics, 2008

<sup>91</sup> WCU Program for the Study of Developed Shorelines, 2009

## *Offshore Energy Development*

Interest in energy source in the coastal and outer continental shelf waters of North Carolina, and indeed the entire U.S., has increased in recent years. With former President Bush lifting the presidential moratorium on offshore drilling and the oil price spike during the summer of 2008, the debate for offshore oil drilling and energy security returned to the top of the political agenda.

With President Bush lifting the ban on offshore oil and gas exploration and Congress allowing their moratorium to expire, North Carolina could begin exploring its oil and gas resources. In fact, in January 2009 the N.C. General Assembly commissioned a study to examine the effects of offshore oil and gas exploration.<sup>92</sup> In addition to allowing exploration, in the future North Carolina may consider building an LNG terminal offshore or developing offshore renewable energy resources.

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<sup>92</sup> North Carolina Geological Survey, 2009

## Survey Assessing Perceptions of Compatibility of Coastal Activities

Given the breadth of activities , understanding how current members of the coastal community view other activities appeared to be a key issue. To gain insight into members’ perceptions of how they view other activities, a survey was designed to evaluate how respondents perceive their own activity, the impact or benefit of other activities, and the potential impacts of an offshore wind farm along the North Carolina coast. A copy of the survey is included in this report as Appendix II.

The survey was sent out to over forty members of the North Carolina coastal community with representatives from Aquaculture, Commercial Fishing, Environmental Management, Fisheries Management, Government, Law and Policy, Conservation groups, Minerals Mining, Recreational Fisherman, Offshore Renewable Energy Project Developers, Regional Planners, and Shipping and Transportation. Survey participants were targeted to develop a pool representative of the variety of activities on the coast. Respondents indicated the regions in which they operate, their primary activity, and then ranked their perception of the compatibility of 13 activities with their own activity on a scale from 1-9 with 1 indicating the activities were mutually beneficial and 9 indicating the activities were harmful to their own activity.

The results on compatibility are summarized in table 1 below. The matrix lists the average response from user groups at the top of each column and the activity they rated on the left side of each row. The number of respondents in each group is in parenthesis beneath the group name at the top of each column. The results were then organized from most compatible to least compatible and color-coded to make trends in the data more apparent. Based on the 13 responses received, some initial observations can be made.

Responsets Activities	Government, Law, Policy (3)	Conservation (2)	Recreational Fishing (2)	Aquaculture (2)	Fisheries Management (2)	Offshore Energy (1)	Commercial Fishing (1)	Environmental Management (2)
Conservation	2.00	2	1	1	2	5	2	2.5
Planning	2.33	3	1	3.5	2.5	3	3	4.5
Fisheries Management	1.67	1	1	3	1.5	6	7	2.5
Aquaculture	1.00	6	3.5	1	6.5		5	4
Offshore Energy	1.00	5	4	3	6		5	3.5
Recreational Fishing	2.33	3	1	6	3	6	7	5.5
Commercial Fishing	2.33	2	6.5	4	5.5	6	5	5
Recreational Boating	2.33	4	3	6	4.5	5	7	5.5
Tourism	3.33	5	5.5	4	6.5	2	7	5.5
Shipping	2.67	5	7	4	5	5	5	5.5
Military	2.33	5	5.5	7	5.5	7	5	3.5
Minerals Mining	1.33	6	8.5	9	5.5	5	8	6.5
Coastal Development	4.33	7	8.5	8	7.5	5	7	7

Table 1: Compatibility Matrix based on survey of members of the North Carolina Coastal Community

Scale: Beneficial 1-----2-----3-----4-----5-----6-----7-----8-----9 Harmful



## Survey Results

Survey respondents covered all regions of the North Carolina coast representing eight different user groups. While the volume of responses was not sufficient to draw any definitive conclusions, the initial findings reveal there are areas of common ground among all users regarding both beneficial and harmful activities. The top row of the matrix indicates all but one of the respondents view conservation as an activity which benefits their activity. A similar perception was recorded for planning activities. On the other end of the spectrum, minerals mining and commercial development were viewed as harmful activities by nearly all respondent groups with the exception of the Government, Law, and Policy group. The remaining activities were viewed as beneficial by some and harmful by others.

In addition to the rating system, the survey included several open-ended questions regarding other benefits and hindrances to their stated activity as well as any policy changes they believed would benefit their activity. Recurring concerns and issues in these open-ended responses include: coastal development, water quality, wetlands, and accessibility.

One respondent made some insightful comments which address the matter on a more fundamental level. To paraphrase the respondent's insights, "the concern with some of these activities is not the activities themselves, but the effect the activity has on the environment. Perhaps the goal of the survey should be to ask not 'Are these activities compatible?', but 'How can we make these activities more compatible?'"

If the main issue is compatibility among activities, then knowing which aspects of an activity are 'incompatible' can lead to a deeper understanding. For example, many respondents were critical of coastal development in their ratings (average coastal development rating: 6.79). However, in the written comments it was revealed that opposition to coastal development was based in part on the negative

impact it is having on water quality due to impermeable surfaces and runoff. What is needed in the future is not necessarily less or no development, but better, “smarter” development. Understanding these underlying issues, such as impacts on water quality, will not solve the problem immediately, but it may help community members get at the real issues of concern. they are

## **Recommendations**

Public policy is in many ways an endless process as needs, interests, and resources are inherently dynamic. In concluding this report, the following recommendations are put forth for consideration by the North Carolina legislature and all members of the North Carolina coastal community.

### *1. Adopt an Ocean Zoning Management Approach*

North Carolina enjoys abundant coastal resources which are an integral part of the eastern North Carolina economy and culture. The myriad of interest groups, activities, and agencies involved in the use, regulation, and protection of this environment are susceptible to miscommunication and failed coordination. Defined ocean zones have the potential to reduce this inefficient process into a more orderly, clearly stated set of priorities. It’s important to remember that “ocean zoning is a regulatory tool for implementing a management plan”.<sup>93</sup> Therefore, agencies must first decide and make clear their top management priorities for each zone.

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<sup>93</sup> Courtney and Wiggin, 2003

In designing this system, consider starting with an adaptable plan. Denmark developed their procedure for offshore development gradually, revising it as they learned which presumably led to a better system than if they had designed it with rigidity.<sup>94</sup>

## *2. Identify and Establish Zones based on the Biophysical Environment*

Research carried out for this project found no current maps of the coastal ecosystems of North Carolina. Therefore, the first matter should be for a group or groups to propose zones based on the biophysical ecosystem. The current approach of managing human impact on the coastal environment using political boundaries such as county and state lines removes the focus away from the marine environment and its resources. Managing activities in individual zones defined based on biological and physical processes allows for more focused management priorities. While a politically-based zone could include multiple natural environments with different management “needs”, zones based on natural biophysical boundaries would have a simpler set of “needs”. The proposed zones should be discussed and recommendation put forth.

## *3. Authorize the Division of Coastal Management to lead the Ocean Zoning process*

DCM was tasked to “protect, conserve, and manage North Carolina’s coastal resources”<sup>95</sup> Their integrated approach combines essential components to designing an effective plan, including education which the Great Barrier Reef Marine Park demonstrated was helpful in achieving compliance. In addition, DCM is overseen by NOAA’s Office of Ocean and Coastal Resource Management, a relationship that will be valuable in trying to merge the federal and state efforts.

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<sup>94</sup> Danish Energy Authority, 2009

<sup>95</sup> North Carolina Division of Coastal Management, 2008

#### 4. *Conduct a more thorough survey and dialogue*

The results of this survey reveal some intriguing initial findings regarding the perceptions of community members. However, the number of respondents was limited and a larger participant base and subsequent dialogue would be essential in developing public support and understanding their concerns and perceptions of the issues.

This survey targeted a relatively small pool of potential respondents in the coastal community. The total number of surveys sent out was 44 with 15 responses. Two of the responses were inadmissible; one due to incomplete results and the other due to concerns of impartiality. The size of the pool was limited by the number of surveyors (1) and concerns regarding confidentiality of responses. With greater resources a larger number of respondents could be targeted and concerns of confidentiality could be better managed. A larger, more reputable survey with greater potential for inciting change would likely improve the response rate.

#### 5. *Design a royalty sharing program*

If North Carolina does begin approving offshore energy projects, the state should have in place a royalty program to compensate the state for exploitation and use of the public domain. The state should decide how the royalties will be divided and how much a role the royalties should play in the debate over approved uses for different zones. If an area is closed to fishing, any local fishing ports may experience job loss. The fund could be used to offset those losses or make other improvements to the local economy.

In Texas, revenues and royalties from the sale and lease of public lands are contributed to the School Permanent Fund. The School Permanent Fund was established in 1854 “for the benefit of

public schools of Texas".<sup>96</sup> In Alaska, at least 25% of all mineral lease, sales, and other revenues from public lands are placed in a Permanent Fund. Established in 1976, the fund's principal may only be used for income-producing investments.<sup>97</sup>

6. *Push NOAA to get involved in the development of comprehensive ocean zoning plans.*

Perhaps the greatest challenge to the entire ocean zoning management approach is the existing jurisdictional boundaries. In particular, establishing consistency across the boundary between state and federal waters will be a challenge as these bodies operate on vastly different scales. The National Oceanic and Atmospheric Administration will be at the center of this challenge as they oversee many of the affected offices: National Marine Fisheries, Office of Program Planning and Integration, and the National Ocean Service which includes the Coastal Services Center, the Office of National Marine Sanctuaries, and the Office of Ocean and Coastal Resource Management.. With this breadth of expertise, NOAA could assume the role of lead agency in developing comprehensive plans which integrate state and federal interests. The actual management of the OCS is the jurisdiction of MMS, but NOAA could still be the lead agency in developing a comprehensive national plan.

7. *Look for innovative "win-win" opportunities*

While the proposed management approach is a departure from the current standard, the result does not necessarily have to be negative. New opportunities will be created and it's important for those involved to be "on the lookout" for innovative solutions. One example is the Fisherman Energy Company in New Jersey. This company is owned and operated by a team of commercial fisherman, lawyers, and MBAs. This unique combination of skills and experience positioned the

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<sup>96</sup> Texas Education Agency, 2009

<sup>97</sup> Alaska Permanent Fund Corp., 2009

company to participate in the offshore wind energy development business, not just watch it from the docks. Fisherman’s Energy “views offshore wind energy as an opportunity, rather than a threat.”<sup>98</sup> Solutions such as this one exist and finding and developing the opportunity will improve the outcome for all North Carolinians.

Based on the survey results, one example of a “win-win” opportunity may exist between the aquaculture community and conservation groups. Cultured shellfish, such as oysters, are grown in North Carolina’s waters. These oysters require a minimum level of water quality and substrate, but once established can improve the water quality through their filtration and create habitat for other benthic organisms and fish.<sup>99</sup> Conservation organizations, such as the North Carolina Coastal Land Trust, could work with aquaculture groups to establish oyster hatcheries within their conservation lands. This process would improve the water quality of the area and provide the conservation group with a consistent revenue source to further their efforts. Both organizations have the potential to gain from this relationship.

Ocean and coastal management present unique challenges for the state; managing impact on resources which are mobile, impossible to “see” and therefore difficult to measure, all living in a dynamic, three-dimensional environment. While work on the scientific challenges continues, the human dimension should also be continually studied to understand the how our uses, interactions, and impacts change over time. Projects such as the survey conducted for this report can reveal opportunities to create benefit for North Carolina and its residents by establishing common ground upon which new ideas and objectives can be developed. Whether the benefits are financial resulting from resource-use royalties, environmental benefits associated with a land-use change, or

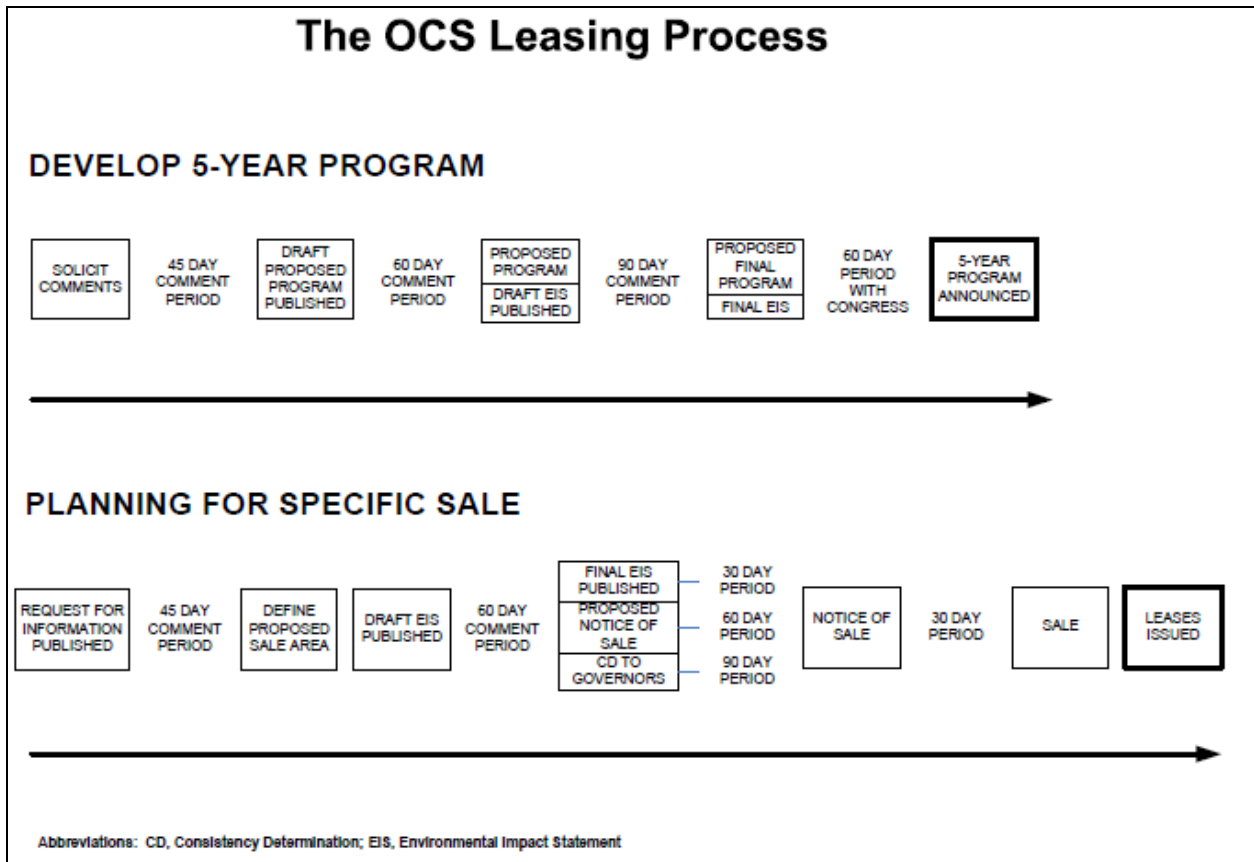
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<sup>98</sup> Fisherman’s Energy, 2009

<sup>99</sup> North Carolina Oyster Hatchery Program, 2009

social benefits in the form of job creation for developing an offshore energy project, effective coastal management has great potential to contribute to North Carolina's future.

# Appendix I



Source: Minerals Management Service, <http://www.mms.gov/ld/PDFs/LeasingProcess.pdf>



## Appendix II

Thank you for your interest in completing this survey on the use of our coastal resources in North Carolina. The goal of this survey is to gain an understanding of the current uses of North Carolina's coastal resources by determining which uses and activities you find compatible and incompatible. This information will be used for a Master's Project proposing policy alternatives for North Carolina. If you have any questions about this survey, please contact me, David Carlson, at [dec19@duke.edu](mailto:dec19@duke.edu) or by phone at (508) 654-2853, or my advisor at Duke University, Dr. Rafe Sagarin, at [rds25@duke.edu](mailto:rds25@duke.edu) or (919) 613-8738.

The survey is designed to take 15 minutes to complete and your involvement in the survey is completely voluntary. You may choose to not to answer certain questions. The questions do not ask for any sensitive personal or professional information, but nonetheless, I will not link names with responses. The information gathered in this survey will be compiled with the responses of other members of the coastal community and used to develop a matrix of compatible and incompatible uses for our coastal resources. The resulting Master's Project will be made publically available.

If you are willing, simply go to the next page to begin the survey. You will see instructions at the end for returning it to me.

**Survey on current uses of North Carolina's coastal waters and resources**

**Question 1**

Please circle (highlight if using electronic copy) from the list below the coastal region(s) in which you operate. If you are in a resource management or policy position, please indicate which areas are under your jurisdiction.

- |           |           |                 |
|-----------|-----------|-----------------|
| Region 1  | Region 3a | Pamlico Sound   |
| Region 2a | Region 3b | Albemarle Sound |
| Region 2b | Region 4a |                 |
| Region 2c | Region 4b |                 |
|           | Region 4c |                 |



Source: Beach and Inlet Management Plan Regions, NC DENR

**Question 2**

What is your primary employment or use of the coastal environment? Please circle (or highlight, if using Word and e-mail)

- Aquaculture
- Coastal Development (housing)
- Commercial Fishing
- Environmental Management
- Fisheries Management
- Government
- Land-based Conservation
- Military
- Minerals Mining
- Recreational Boating
- Recreational Fishing
- Offshore Energy Project
- Development
- Planning
- Shipping and Transportation
- Tourism
- Other\_\_\_\_\_

How does your activity in the coastal environment change throughout the year? (Is your work/activity seasonal?)

**Question 3**

**Compatibility**

In the following section, please indicate the compatibility of each activity with your primary activity. 1 indicates the activity is completely compatible to your activity and 9 indicates that the activity is harmful or incompatible with your activity. A rating of 5 indicates that activity has no perceived impact on your activity.

Coastal Development (housing)

Beneficial    1       2       3       4       5       6       7       8       9       Harmful

Commercial Fishing

Beneficial    1       2       3       4       5       6       7       8       9       Harmful

Fisheries Conservation & Management

Beneficial    1       2       3       4       5       6       7       8       9       Harmful

Land-based Conservation (including wetlands and rivers)

Beneficial    1       2       3       4       5       6       7       8       9       Harmful

Military

Beneficial	1	2	3	4	5	6	7	8	9	Harmful
Mineral Mining										
Beneficial	1	2	3	4	5	6	7	8	9	Harmful
Offshore Energy Project Development (wind, wave, and tidal energy)										
Beneficial	1	2	3	4	5	6	7	8	9	Harmful
Open Ocean Aquaculture										
Beneficial	1	2	3	4	5	6	7	8	9	Harmful
Planning										
Beneficial	1	2	3	4	5	6	7	8	9	Harmful
Recreational Boating										
Beneficial	1	2	3	4	5	6	7	8	9	Harmful
Recreational Fishing										
Beneficial	1	2	3	4	5	6	7	8	9	Harmful
Shipping and Transportation										
Beneficial	1	2	3	4	5	6	7	8	9	Harmful
Tourism										
Beneficial	1	2	3	4	5	6	7	8	9	Harmful
Other (please specify _____)										
Beneficial	1	2	3	4	5	6	7	8	9	Harmful

**Question 4**

What other activities in the coastal environment limit your activity, accessibility or use of the resources?

**Question 5**

What other activities in the coastal environment enhance your activity or interests?

**Question 6**

What changes in management policy would improve your success in your activity?

**Question 7**

Please check-off potential impacts or concerns you have related to the development of a wind farm and associated transmission lines off the North Carolina coast:

- Accessibility to site (for fishing, sand mining, etc)
- Aesthetic/Visual Impact
- Bird Strikes
- Disturbing seafloor
- Impact on Fish Habitat
- Increased Transit time around site
- Marine Mammal Migration
- Navigational Hazard
- Sea Turtle Migration
- Other \_\_\_\_\_

**Question 8**

Do you anticipate any benefits from the development of a wind farm off the North Carolina coast?

If you would like to receive an electronic or printed version of the survey results and final report, please check this box

Please send your completed survey to [dec19@duke.edu](mailto:dec19@duke.edu) or via mail to:

David Carlson  
MEM student  
Nicholas School of the Environment  
LSRC-A  
Duke University  
Durham, NC 27708

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