Appendix N

Framework for the Avian and Bat Monitoring Plan

Framework for the Avian and Bat Monitoring Plan for the Cape Wind Proposed Offshore Wind Facility

PREPARED BY: U.S. DEPARTMENT OF THE INTERIOR
MINERALS MANAGEMENT SERVICE
381 ELDEN STREET
HERNDON, VA 20170

AND

CAPE WIND ASSOCIATES
75 ARLINGTON STREET
SUITE 704
BOSTON, MA 02116

SEPTEMBER 19, 2008

TABLE OF CONTENTS

1.0 INTRODUCTION

The Minerals Management Service (MMS) and Cape Wind Associates (CWA) present this framework for an Avian and Bat Monitoring Plan (ABMP) for the Cape Wind Project, an offshore wind facility consisting of 130 wind turbine generators located on Horseshoe Shoal in Nantucket Sound, Massachusetts (see attached Figure 1). This ABMP and the attached matrix outline methods and requirements for gathering data which will be used to evaluate potential impacts from the proposed project to avian and bat populations in Nantucket Sound, with particular emphasis on the Endangered Species Act (ESA) listed piping plover and roseate tern. This ABMP also serves as part of the ESA Section 7 consultation with the US Fish and Wildlife Service (FWS) and to meet requirements for assessing impacts from MMS's potential authorization of this project under various other statutes, including but not limited to the Outer Continental Shelf Lands Act, National Environmental Policy Act, Executive Order 13186, Responsibilities of Federal Agencies to Protect Migratory Birds (10 Jan 2001).

The specific objectives of this ABMP include:

- Address and/or add to the information base for the following key monitoring questions:
    - What bird/bat species are found in Nantucket Sound and the proposed project area (Horseshoe Shoal) and what seasonal/annual variation exists in their use of these areas?
    - How often and when do birds/bats use the airspace (travel corridors and flight trajectories) in, around and over the proposed project area?
    - What is the effect of the wind energy facility on the distribution and movements of birds/bats in Nantucket Sound and the proposed project area?
    - How effective are anti-perching devices in discouraging birds from perching on turbines or the Electrical Service Platform (ESP)?
    - How can we effectively measure the numbers of bird/bat strikes or collisions with wind turbines and/or monopiles?
    - How can we answer these questions at costs that retain the project's economically viability?
- Gather and summarize existing information on monitoring techniques and their effectiveness in use at offshore wind facilities worldwide
- Evaluate the applicability of these methods for use under the Cape Wind proposed action
- Specify requirements for *pre-construction (post lease)*:
    - tracking of movements, travel corridors, and flight trajectories of terns and plovers in and around Nantucket Sound and the proposed project area
    - testing the effectiveness of anti-perching devices, radio telemetry, and acoustic monitoring to detect roseate terns, piping plovers, other avian species (including red knot) and bats in the proposed project area
- Specify requirements for *post-construction*:
    - tracking of movements, travel corridors, and flight trajectories of roseate terns and piping plovers in and around Nantucket Sound and the proposed project area

    - acoustic monitoring to detect presence of roseate terns, piping plovers, other avian species (including red knot) and bats in the proposed project area
    - visual monitoring of the effectiveness of anti-perching devices and altering these devices periodically if needed and based on monitoring results
    - aerial surveys of overall bird abundances and distribution in the proposed project area
    - collision detection through the use of TADS or similar system
- Establish a reporting system which will effectively and timely use the results from the required monitoring to identify future adjustments to monitoring and also drive mitigation requirements.

Given there are only a few existing offshore facilities worldwide, it is important to note there is limited information regarding the effectiveness of monitoring impacts to avian and bat species from these facilities. Where information does exist, it is not always directly transferable to the Cape Wind proposal or the species of focus. The development of this ABMP thus required a careful consideration of all the available and emerging monitoring technologies, their applicability, cost and engineering feasibility for the Cape Wind proposal, the potential impacts of their use on the species of focus, and any information known on the effectiveness of these techniques in various locations and conditions. Recognizing the challenges in developing a monitoring plan in light of limited information, MMS and CWA solicited the avian expertise of the FWS in developing this plan. Coordination and input from the FWS experts will continue through the implementation of this plan (if the proposal is authorized). In addition, as technology advances and more information is available, MMS and CWA will work in coordination with the FWS to make adjustments to improve the plan.

Within this ABMP, there are a few methods which can be considered as emerging technologies or have not yet been fully field-tested for applicability to an offshore wind facility similar to the Cape Wind proposal. Where this situation exists, this ABMP includes pilot testing of these technologies during the pre-construction phase and further refinement of these technologies prior to operation of the proposed facility. Statistical analyses will be taken into account during final protocol designs for pre- and post-construction methods. These protocols will then be approved by MMS, in coordination with the FWS, and the resulting data will be made available to MMS and FWS for a final determination on the implementation of these monitoring methods post-construction.

This ABMP therefore represents a commitment by CWA to further refine monitoring techniques for offshore wind facilities which will significantly add to the information base on the effects of offshore wind facilities on these species of focus and avian species in general, allow for better assessments of the feasibility and effectiveness of monitoring methods and ultimately lead to improved decision-making for future offshore wind projects. Results of the monitoring and effectiveness of these methods in assessing impacts will also be made publicly available.

2.0 SUMMARY OF AVAILABLE INFORMATON ON MONITORING TECHNIQUES AND THEIR EFFECTIVENESS

The following provides an overview of available information on the feasibility and effectiveness of various monitoring methods used at offshore wind facilities to date. It is meant to provide a brief yet informative overview of the current state of available knowledge as it relates to this subject and also describe the various monitoring techniques that MMS considered in developing this ABMP. The conclusions presented at the end of this section provide a summary of the reasoning for selecting the specific monitoring methods outlined in this ABMP.

Anti-perching devices

The Cape Wind proposal uses tubular towers instead of lattice towers which will help discourage perching under the rotors. Vibrations created by operating turbines may also deter birds from perching. Dooling 2002 suggested that birds may be able to acoustically detect operating turbines, allowing them to avoid encounters with turbines. The implementation of anti-perching devices may also reduce the likelihood of perching or roosting. A study conducted in California to investigate the effectiveness of wire and wire screen perch guards estimated a 54% reduction in avian perching on turbines (Nelson and Curry 1995).

Roseate terns are known to cross the proposed project area and are also prone to perching on a variety of natural and human-made structures. MMS will require CWA to implement anti-perching mitigation requirements as part of any approved lease. This ABMP then contains monitoring measures to test the effectiveness of these perch deterrents (pre-construction) and then continue monitoring these deterrents post-construction to ensure their continued effectiveness and, where needed, make necessary adjustments as approved by MMS in coordination with the FWS.

Lighting

There is a concern that the lighting on tall, man-made structures increases the risk of collision during periods of fog or rain when birds may become disoriented by artificial light sources. There have been substantial avian collisions with communication towers reported in the U.S. (Shire *et al*. 2000). A large scale mortality event at a wind facility was believed to be associated with sodium vapor lighting of nearby substation (Kerns and Kerlinger 2004). After these lights were no longer used, no other large scale mortality events were reported. Emerging data from existing onshore wind farms in the U.S. suggest that FAA required lighting on wind turbines (red or white flashing lights) does not increase avian risk of collision. Available studies indicate no significant trends between mortality at lit turbines verses unlit turbines (Erickson *et al.* 2004, Jain *et al*. 2007, Arnett *et al*. 2005). The substantially higher numbers of fatalities observed at lit communication towers (at heights greater than 305 m (1,000 feet) in the U.S. may be influenced by the greater heights of the towers, the guy wires, or the steady-burning lights mounted on many towers (Jain *et al.* 2007), verses the pulsing lights on wind turbines.

The ABMP does not propose any monitoring of the effects of lighting on avian species. Mitigation will be required in any approved MMS lease as noted below. This mitigation is based on information from FWS guidelines on lighting for communication towers and other land-based tall structures, and MMS feels it adequately addresses the lighting issue.

> "As allowed by the Federal Aviation Agency (FAA) and United States Coast Guard (USCG), lighting of the wind power turbines and associated structures should:

- Include the minimum amount of pilot warning and obstruction avoidance lighting
- Use only white (preferable) or red strobe lights at night, and these should be the minimum number, minimum intensity, and minimum number of flashes per minute
- Flashes should be synchronous among structures
- Never use solid red or pulsating red lights at night.
- Never use large-scale, continuous illumination.
- Leave lights on only when necessary and downshield when possible, including onshore security and equipment lighting.
- As allowed by the FAA and USCG, lighting of any support vessels should minimize use of high-density work lights."

Painting of turbine blades

Although no existing offshore wind facility has painted blades to deter or reduce collisions, some limited experimental work has been conducted to test various types of visual deterrents (Hodos *et al.* 2003), with a particular focus on raptors. This work included testing various painting patterns, including an anti-motion-smear pattern, single-colored blades, and devices attached to blade tips. The results of testing showed that anti-motion-smear patterns did not have an effect for large turbines at distances less than 50 meters and the results were limited to less than 20 meters for small, fast turbines. Testing with single-colored blades showed that, although color contrast could be a critical variable in a fixed laboratory setting, the applicability of the results to typical wind facilities was very limited because the contrast between background and foreground is constantly changing and because avian color vision is different from human color vision. Testing with devices attached to blade tips had inconclusive results and the relevance to typical facilities is unknown.

At this time, the ABMP does not include any mitigation or monitoring requirements for painting turbine blades given aesthetic concerns and the largely unproven effectiveness of this method for deterring birds.

Visual surveys

Daytime visual surveys conducted from boats, the ESP, and from planes during breeding and migration periods have been used to assess changes in bird behavior, abundance, or distribution in response to turbines. However, visual surveys are limited to periods of fair weather and nighttime and inclement weather periods could not be sampled. Visibility of high flying targets during boat and ESP surveys, as well as low flying targets during aerial surveys, is also a limiting factor. The size of the ESA species of focus, roseate tern and piping plovers, also makes visual detection difficult even under the best visibility conditions. Post-construction visual surveys could yield more accurate data than pre-construction surveys because observers will have structures of known height/size with which to compare the flight heights of birds.

Visual surveys alone would not provide would not provide the information necessary to address the questions posed in this ABMP. In addition, the piping plover and, to a lesser extent, the roseate tern may be too small to detect. Visual surveys are included in this ABMP in two specific situations: (1) where they supplement or groundtruth another selected monitoring technique (i.e., radio telemetry); or (2) where they can provide general before/after information on more large-scale avian use of Nantucket Sound and the proposed project site (i.e., aerial surveys methodology used to date will be implemented post-construction to monitor for changes to avian use of the area).

Radar surveys

Radar studies have provided information regarding bird behavior in the presence of existing offshore wind turbines in Europe. Radar observations at the Horns Rev wind farm reported by Petersen *et al.* 2006, suggest that birds approached turbines at closer distances at night than during the day, and that more birds entered the wind farm at night than during the day. Observations indicated avoidance behavior of the turbines by nighttime migrants. The typical distance at which an avoidance reaction occurred was 500 m from turbines at night and 3 km during the day (Petersen *et al.* 2006). Another study conducted with vertically oriented radar suggests that migrating birds may also react to turbines by 'vertical deflection' at night instead of the linear avoidance primarily observed during the day (Blew *et al.* 2006).

Radar tracking to determine bird use of airspace over the proposed project area was given careful consideration, but ultimately rejected as an impractical technique which would provide data needed to address the objectives of this ABMP. This is due to a number of reasons, including: (1) periods of heavy rain or inclement weather limit radar data collection; (2) radar will not provide species specific information unless correlated with visual surveys and these surveys cannot be done at nighttime or during reduced visibility; and (3) desired information on use of the airspace in and around the proposed project area by the species of focus, during good and reduced visibility, can better be determined from other methodologies (i.e., radio telemetry, acoustic monitoring).

Telemetry surveys

Telemetry surveys can provide species-specific information. Telemetry data could also provide movement and use patterns within the proposed project area by the two ESA-listed species of focus. Perrow *et al.* 2006 outlines a case study where radio telemetry was used to assess little tern (*Sterna albifrons*) movements, habitat use of a 30-turbine wind farm located 1-2 miles (2-3 km) offshore in the UK. It was found that the majority of tern foraging activity occurred in vicinity of the shore, however, in a low food availability year, there was small use (3%) by terns of habitat at the distance of the wind farm (Perrow *et al.* 2006).

There are a number of telemetry tags which can be used to track bird movements, including satellite, transponders/diodes and radio. Satellite telemetry can yield the most useful information but cannot be used safely on piping plovers and roseate terns due to the large tag size. Crossband transponders weighing ≤ 1.0 gm and/or harmonic diodes would be considered safer for use with these species and also have long battery life of 18-24 months. These tags work by only emitting a signal when they detect a specific microwave pulse trigger initiated by an observer (Earthspan, http://earthspan.org/crossbandtransponder.htm). Henke and Hughes (2005) found that harmonic diodes were detectable at ranges only up to about 500 meters, except in heavily forested sites where range was reduced to only about 30 meters. Vegetation attenuates the signal from the diode, so harmonic diodes are best in very open, sparsely vegetated terrain, or ideally over bare ground and open water. Crossband transponders, with larger batteries than harmonic diodes, can boost the signal received from radar such that their return signals can be detected from up to 7 kilometers (Seegar, pers. comm.). However, these tags are recent technologies and have only been used experimentally (see Henke and Hughes 2005). Radio tags are larger than transponders/diodes but significantly smaller than satellite tags. They fall within 3% of the body weight of piping plovers and roseate terns with the smaller radio tags weighing from 1.2 to 3.8 g with a battery lifespan range of 43-180 days, depending on the tag and the frequency its battery is used (see Holohil Systems Ltd, http://www.holohil.com/xmtrs.htm#bat).

This ABMP ultimately selected radio tags as the safest and best technology for use with these ESA-listed birds, recognizing that we are trading signal life for proven technology. In addition, radio telemetry is a well-established technique for monitoring avian species. We concluded that, despite the shorter battery life expectancy for small radio transmitter packages, this was the best option for obtaining data on if and how roseate terns and piping plovers use Nantucket Sound and the proposed project area as well as flight paths and flight heights (when coupled with visual surveys). The final selection of a specific tag type and application will be fully vetted and approved during the ESA scientific research permitting process and other required Federal and state permitting processes.

Acoustical monitoring

Bat acoustical monitoring would allow for detection of bats in vicinity of the proposed turbines. A study in Europe is investigating the practicality of mounting detectors within the nacelle in order to assess the level of bat activity at rotor height (Ed Arnett, pers. comm.). However, there is some speculation that bats do not use echolocation during migration movements and that infrared (IR) or thermal IR imaging recordings could be combined with acoustic monitoring to better assess the presence of bats in vicinity of turbines.

Acoustic monitoring of birds using microphones is a method ornithologists have used to identify nocturnal migrants for many years onshore and to a lesser extent offshore. Acoustic monitoring can be used to determine species that are present in the project area and acoustical monitoring arrays can be designed in future years to estimate bird altitude (Farnsworth, 2008, pers. comm.). Using sensitive microphones, avian calls can be recorded and analyzed to develop a list of species that have flown through the area (Farnsworth and Russell 2007). However, when acoustic monitoring is not conducted in conjunction with other observations, it will be biased towards species that produce more frequent and louder calls. In addition, it will be biased towards species migrating at lower altitudes which are more easily picked up by the microphones. Methods for converting call counts to passage rates that take into account these species differences in flight heights, call frequency, and call loudness are being developed (Farnsworth, pers. comm.). There has also been some testing of this approach in the offshore environment (Farnsworth and Russell, 2007; Russell 2005.)

This ABMP concluded that acoustic monitoring is a valuable monitoring tool which needs further field testing for use in the offshore environment. This type of monitoring will also help address key questions of presence of calling birds moving through the proposed project area during periods of good and reduced visibility. It is also a relatively cost-effective monitoring technique.

Post-Construction Collision Monitoring

Post-construction collision monitoring at existing onshore and offshore facilities in the U.S. and in Europe have involved carcass searches at onshore and nearshore sites (Vliestra 2007, Arnett *et al*. 2005, Erickson *et al.* 2004, Jain *et al.* 2007, Everaert and Stienen 2006), nighttime thermal imaging investigations of bird and bat turbine-interaction behavior at onshore and offshore facilities (Arnett *et al.* 2005, Desholm 2006, Hoppop *et al*. 2006), day and nighttime radar surveys of bird migration to investigate avoidance behaviors (Huppop *et al*. 2006, Tulp 1999, Kahlert *et al*. 2004, Christensen and Hounisen 2005, Pettersson 2005), and daytime visual surveys at onshore, offshore, and nearshore facilities (Vliestra 2007, Osborn *et al.* 1998, Pettersson 2005, Everaert and Stienen 2006). Ahlen *et. al.* (2007) have also used various techniques, including spotlights, ultrasound detectors and visual observations, to detect and observe bats at offshore wind turbines in two Scandinavian locations. Other current studies are investigating the use of bat acoustical detectors, radio telemetry, infra-red cameras, and blade collision sensor systems at existing wind turbines

Collision sensoring may involve acoustic, vibration, visual monitoring, or a combination of methods for blade impact detection (Pandey *et al*. 2007). It is an evolving technology that is not yet at the point of field testing. Blade collision sensoring cannot provide species specific information.

Some research has focused on using cameras to visually record collisions. Newer camera models may be able to measure flap frequency to aid in species identification (Wiggelinkhuisen *et al., undated*) although this technology is not yet available. To date, many of these cameras use infrared lighting for recording purposes which negates the need for flood lighting at turbines that may disorient avian migrants during periods of rain or fog (Huppop *et al*. 2006). Infrared cameras are expensive and their ability to identify birds at the species level is questionable.

Thermal cameras detect heat that is emitted from and reflects off objects (Arnett *et al*. 2005). No additional lighting is required and thermal imaging, to an extent, can detect objects through fog. This technology may be used to observe bird and bat behavior in the vicinity of turbines at night and, to an extent, during nighttime periods of inclement weather. Multiple cameras can be set up at a single turbine and the images can be used to create 3D spatial models showing avian and bat interactions with specific turbines (Arnett *et al.* 2005). A combination of thermal and high definition cameras may also be able to be used to gather more information at the species specific level. Limitations to these surveys include a high cost of equipment, a small sampling area for one thermal imaging system, and the need for multiple systems set up through the proposed project area in order to depict larger scale movement patterns and flight behavior.

After review of the information available on collision detection technologies, this ABMP concluded that thermal detectors, which trigger video cameras to begin recording for a fixed interval, in combination with high definition cameras (or a comparable system) were the best available technology with the greatest probability of measuring "take" and avoidance events at wind turbines. Blade collision sensors are still much more in the development phase and have not yet been proven to be sensitive to turbine blade vibrations from multiple sources.

Beach carcass searches

Beach carcass searches have been used to detect mortality at an existing facility located on the harbor breakwater in Blythe Harbour, England. Weekly carcass searches were conducted along an adjacent beach. Tests were performed to determine the efficiency of searches. Avian carcasses were placed along the shore to determine the effects of wave action on the presence of carcasses, fresh avian carcasses were deployed in an estuary to determine their maximum buoyancy period, and wooden dummies were deposited in the water near turbines to determine where carcasses may make landfall (Lowther, *undated*). Similar search efficiency and practicality tests could be performed at the proposed project area to determine whether beach carcass searches could be useful. However, as the nearest beach to the proposed turbines is 8 km (5.2 miles) away, the likelihood of finding carcasses during beach searches is very low. Comparing the results of pre-construction and post-construction surveys may indicate a change in the number of carcasses; however, it would be difficult to attribute actual sources of mortality to the proposed facility.

At this time, this ABMP does not include any monitoring requirements for beach carcass searches given the low likelihood of carcasses from struck birds making it to shore and, if carcasses are found, being able to correlate cause of death to potential turbine strikes. However, this ABMP will require that the potential for integrating with the SEANET beached-bird monitoring program be further investigated to determine if there would be any value to using this program to supplement information gathered from this plan. The SEANET beached-bird survey volunteer monitoring program collects limited data on the southern coast of Cape Cod.

Conclusions

After careful consideration of all the available information on monitoring techniques and consultation between experts at MMS, FWS and CWA, this ABMP ultimately determined that a combination of radio telemetry, acoustic monitoring, aerial surveys, anti-perching devices and monitoring, and TADS (or similar system) would be the most effective and feasible means in determining the impacts and measuring "take" from the proposed action on the species of focus in addition to the general avian population. These techniques demonstrated the most applicability for the Cape Wind proposal and species of focus as well as were economically feasible. Again, it is important to stress that some of these more recently available techniques will require further refinement and field testing (as noted throughout this ABMP), and this effort will be subject to MMS approval in coordination with the FWS.

3.0 SUMMARY OF DATA COLLECTED BY CAPE WIND ON AVIAN PRESENCE AT PROJECT SITE

CWA conducted and reviewed a number of studies starting in 2002 that characterized bird use of Nantucket Sound. CWA's initial avian studies and reports were used to support the assessment of potential impacts to avian species and are summarized in the US Army Corps of Engineers (USACE) DEIS/DEIR (DEIR) of November 2004 (USACE 2004). Since the release of the DEIR in 2004, CWA has collected and reviewed additional data on bird use of Nantucket Sound, which were presented in the Final Environmental Impact Report (FEIR) of February 2007 (ESS 2007).
The results of the DEIR and FEIR studies provide a data set on the use of Nantucket Sound by terns, plovers, winter sea ducks, and migrants and can be used to assess potential impacts these avian species and the general avian population in Nantucket Sound. Additional studies included in the FEIR focused on roseate terns, the only ESA-listed avian species documented to regularly use the proposed project site on Horseshoe Shoal. This information is also outlined in the MMS DEIS and associated ESA biological assessment.

Beginning in 2002, the Massachusetts Audubon Society (Mass Audubon) also conducted avian surveys and compiled data on bird use of Nantucket Sound from summer 2002 through winter 2006. This data was also considered in MMS's DEIS and in the development of this ABMP.

CWA has reviewed over four years of Mass Audubon data in support of its avian impact assessment. A review of the CWA and Mass Audubon studies provides information on the distribution of various avian groups within Nantucket Sound. For example, average tern density (number per square kilometer [#/km^2]) during breeding and staging periods was greatest in areas east of Horseshoe Shoal, closer to Monomoy Island. Sea ducks were found in larger concentrations with the highest average densities in the area south of Horseshoe Shoal between Martha's Vineyard and Nantucket, followed by Horseshoe Shoal and Monomoy Island. Winter waterbirds were evenly distributed throughout the study area with the exception of several scattered areas of higher average densities outside of Horseshoe Shoal (ESS 2007). CWA has recognized that the lack of observation of shorebirds passing over Horseshoe Shoal may constitute a significant information gap. Information on shorebirds use of the area may, in part, be limited because shorebirds may not cross Horseshoe Shoal or may be difficult to detect visually.

A primary area of research focused on tern use of the shoal. Multiple years of monitoring have demonstrated that local tern distribution appears to vary annually and most observed birds on the shoal were traveling and not actively feeding or resting (Perkins et al. 2004a; Perkins et al. 2004b; Sadoti et al. 2005a; Sadoti et al. 2005b). Results of Mass Audubon led researchers to hypothesize that the Shoal is more important as a migratory stopover point or "refueling" area for terns than as a feeding area for locally nesting resident terns (Sadoti et al. 2005a).

Avian surveys on Horseshoe Shoal also provided information on the interannual variability of the local distribution of terns, and seasonal variability of tern distribution in the Sound (Sadoti et al. 2005b). These data provide the baseline characterization of tern use of Horseshoe Shoal, which will be compared with results from operational monitoring.

In addition, an analysis of the potential collision risk to birds was conducted by Hatch and Brault (2007). This analysis resulted in an estimate of 0 to 2 fatal bird collisions per turbine per year or a maximum of 260 total bird fatalities annually resulting from the operation of the Cape Wind Project. (This figure includes all bird species.) The potential distribution of species within this range of collision risk indicates that roseate terns are expected to have a mortality of 0.8 individuals/year and piping plovers are likely to sustain losses of less than one bird per year from the wind project (ESS 2007).

In its ESA biological opinion, the FWS estimated that four to five roseate terns per year (80-100 terns over the 20-year life of the project) are likely to be taken (injured or killed) as a result of collisions with the WTGs on Horseshoe Shoal. If any of the four or five individuals are successful adult breeders with dependent young of the year, the survival rate of their young will be reduced, adding to the level of take. The FWS also anticipated that a maximum of 10 piping plovers will be taken over the life of the Cape Wind Energy Project, based on their upper bound estimate of one piping plover collision every two years with the WTGs in the Horseshoe Shoal project area.

This ABMP incorporates protocols that will be used for the purpose of recording actual collisions of birds with turbines and/or monopiles and provide data that may be used to evaluate these collision risk estimates and other predictive models that may be developed.

Information gathered from pre-construction and post-construction survey data from aircraft surveys, radio-telemetry, and acoustic monitoring, together with collision monitoring from a thermal detection or similar system, will allow the testing of model assumptions about the number of birds flying through the proposed project area, the heights at which they fly, and the degree to which they avoid the project site by diverting around or over it. This should lead to more robust model assumptions and more confidence in the outputs of the model for predicting avian mortality from collisions with turbines.

4.0 PRE-CONSTRUCTION (POST-LEASE) SURVEYS

MMS will require that CWA implement the following monitoring methods pre-construction for the purpose of documenting movements and locations of avian and bat species, especially roseate terns and piping plovers, around and over Nantucket Sound and the proposed project area. In doing so,
MMS will require that a minimum of one full year of data be collected, analyzed and reported prior to commencing construction activities, unless a change is agreed to in advance by MMS in coordination with the FWS. All reported information will be provided to and reviewed by MMS and the FWS prior to the start of construction. Based on the results of the pre-construction monitoring and where applicable and feasible, MMS will coordinate with CWA and the FWS to make any justified changes to monitoring requirements or methodologies.

4.1 Radio Tracking

Radio tracking is a remote sensing technique that has been used for many years to track wildlife of varying sizes, from bats and birds to larger mammals. Traditional radio telemetry involves the use of a transmitter, which emits a radio signal, and a receiver, which picks up the signal through the use of an antenna. Telemetry offers a method to intensively track a species use of small areas and determine a species home range. The disadvantages of telemetry for tracking avian (and other) species are that data relies on a small sample size, high level of effort needed to track tagged birds, challenges in tracking fast birds on water, and the technical difficulties that may arise associated with battery life, attachment methods and loss of transmitters. In addition, there are challenges in getting adequate battery power life so that tags are not too heavy to use on smaller birds like the piping plover and roseate tern. Traditional radio transmitters include a battery to power the release of a pulsed signal every few seconds. Batteries must be large enough to yield data over the needed timeframe but still not exceed the recommended limit of 3% of body weight for birds.

The goal of the pre-construction telemetry study would be to test and refine the use of radio telemetry on surrogate species which have the closest behavior and life history to the roseate tern and piping plover. Common tern will be used as surrogates for roseate terns and semipalmated plovers for piping plovers. If this technique proves satisfactory and safe for these birds, this methodology will be employed on roseate terns and piping plovers in subsequent years subject to the approval of FWS and other needed permits (i.e., approval from the Massachusetts Natural Heritage and Endangered Species Program (MNHESP), auxillary marking authorization from the USGS Bird Banding Laboratory).

The use of surrogates rather than actual roseate terns or piping plovers in the first year of monitoring will preclude the collection of roseate tern or piping plover specific radio tracking data pre-construction. However, the risk of take (e.g., harassment, injury, mortality) from using radio tracking devices, as these are relatively untested on roseate terns and piping plovers, outweighs the desire to gather pre-construction tracking data on these species and necessitates the use of surrogates instead.

Twelve common terns will be captured, tagged with radio transmitters, and attempts will be made to locate tagged birds at least 12 times between July 1 and September 15 to determine their movements within Nantucket Sound and proximity to the proposed action area. Particular emphasis will be placed on their activity during the staging period at Monomoy Island prior to fall migration, and to determine if they pass over the proposed action area when leaving Monomoy Island in large numbers at the initiation of fall migration. Similarly, 12 semipalmated plovers will be tagged to determine their locations at least twice weekly in August. All specifics regarding capture location and technique, demographics of tagged birds, time of capture, etc. will be proposed during any required permitting process and implemented as approved in the permit.

Capture efforts for terns will be coordinated with the tern project leader for the MA NHPESP. Captures for plovers will be coordinated with a FWS-identified representative. During handling, basic measurements such as weight and wing length and band status would be recorded. Birds would be banded with USGS metal bands around the leg for future identification. Given the currently accepted limits of 3% of body weight for birds, plovers (weighing 40-60 g) would likely be tagged with transmitters weighing 1.2 to 1.8 g, with nominal battery life of 56-98 days and a battery lifespan range of 43-140 days. Terns (90-140g weight) would be tagged using slightly larger transmitters of 2.5-3.8 g, with nominal battery life of 90-180 days and lifespan range of 90-270 days (http://www.holohil.com/xmtrs.htm#bat). Tags would be glued to the back with an epoxy especially created for use on seabirds using methods as outlined in Warnock and Warnock (1993).

Tracking of tagged birds would occur from the ground, boats, and aircraft, as suggested by Henke and Hughes 2005, and may also include a receiver on the MET tower or possibly even buoys. There would also be experimentation with using up to 3 yagi antennas with operators on the ground, in boats, and with an antenna attached to an aircraft. Data collected during the surveys could be analyzed using GIS and Ranges (www.anatrack.com), a software program specifically created to identify habitat use, home ranges, dispersal and other metrics related to species distribution. The Ranges software is designed to process telemetry data provided in a number of different formats. The analysis could also potentially include a study of tern prey availability during the time of the telemetry survey as this is an important factor in evaluating tern distribution.

4.2 Avian Acoustic Monitoring

Acoustic monitoring of birds using microphones is a method ornithologists have used to identify nocturnal migrants for many years. Acoustic monitoring can be used to determine species that are present in the project area and acoustical monitoring arrays can be designed to estimate bird altitude (Farnsworth, 2008, pers. comm., see http://www.birds.cornell.edu/brp/), although the latter is not yet adequately field tested. Using sensitive microphones, avian calls can be recorded and analyzed to develop a list of species that have flown through the area (Farnsworth and Russell 2007). However, when acoustic monitoring is not conducted in conjunction with other observations, it will be biased towards species that produce more frequent and louder calls. In addition, it will be biased towards species migrating at lower altitudes which are more easily picked up by the microphones. Methods for converting call counts to passage rates that take into account these species differences in flight heights, call frequency, and call loudness are being developed (Farnsworth, pers. comm.). There has also been some testing of this approach in the offshore environment (Farnsworth and Russell, 2007; Russell 2005.)

An acoustic microphone will be attached to the MET tower and data recorded automatically for later analysis from May through October and, weather permitting, at least three 24-hour intervals per month from November through April. Another microphone will be placed in/near the breeding area for roseate terns and piping plovers to verify the effectiveness of acoustic microphones for detection of these species and discrimination among tern and shorebird species. Results of this pre-construction acoustic field testing will then be used by MMS, FWS and CWA to further design and supplement the acoustic monitoring proposed for post-construction.

4.3 Anti-Perching Monitoring

Section 5.1 of the ESA Biological Assessment prepared for the Cape Wind proposed action outlines the specific proposal by CWA for installation of anti-perching structures on the MET tower, ESP and wind turbines (post construction) and monitoring the effectiveness of these perch deterrents. Pre-construction, remotely operated video cameras or still photo camera with motion detectors would be used to collect observations on bird perching rates and the effectiveness of the proposed perching deterrents on the MET tower. The cameras would have motion-detecting capabilities so that observations are only recorded when they are triggered by a target passing within the field of view (**SeeMore Wildlife Systems** 2008). The cameras will also be fitted with anti-perching deterrents if necessary. If cameras fail to work, observers would monitor the effectiveness of anti-perching devices. Based on the results of this monitoring, MMS and CWA, in coordination with the FWS, would determine whether any changes in anti-perching structures would be required prior to construction.

The level of monitoring will be determined by the selection of the best available and economically feasible camera technology. If the camera cannot be downloaded remotely the camera will need to be actively managed to retrieve the data. The cameras will function for a length of time that provides sufficient data on anti-perching devices. Selection of the camera and level of monitoring effort will be determined by CWA and MMS in coordination with the FWS.

4.4 Bat Surveys

As discussed in the FEIR (ESS 2007) and the MMS DEIS (MMS 2008), little is known about bat species usage of the project area. The lack of any sheltered roosting sites and insect-rich forage locations in the project area make it unlikely that bats use the proposed action area on a daily basis. Possible bat use of the project area is expected to be limited to migratory species passing through during spring and fall migrations and possible periodic travel between the mainland and island habitats (MMS 2008).

To develop a more thorough characterization of existing bat use of the project area, CWA will deploy bat detection equipment on the MET tower from April to October. The proposed detection equipment includes an Anabat SD1 Bat Detector with built-in data storage and associated software. Further investigation will be needed to determine whether Anabat detectors will function as effectively with ambient ocean background noise. The detection equipment is used to identify bat species by detecting, recording and displaying bat ultrasonic echolocation calls (Titley Electronics 2006). The detection equipment converts ultrasonic bat calls into a signal that is audible to humans. In addition, this audible signal is converted to a visual form through a sound analysis. Following the completion of a survey, these data are reviewed and analyzed to determine bat species.

The range at which a bat call is detected varies depending on a number of factors including air temperature, pressure, humidity and the bat call frequency. On land, calls of bats which pass within roughly 100 to 200 feet (30 to 60 meters) of the detector unit are recorded and stored for future analysis (Titley Electronics 2008). The effective detection range in the ocean environment will be determined based on further refinement of the equipment during pre-construction.

If determined to be feasible, a long-term, passive monitoring station will be established on the MET tower for data collection. The station will include the Anabat SD1 Bat Detector unit, long-term power source such as a solar panel, and weather protection equipment. Unlike active monitoring, there will be no observer present on the tower to record visual observations, which for logistical reasons, is not feasible. The station would operate all night for an extended period of time which allows for a greater sampling effort than active monitoring. The use of bat detectors will permit the collection of a continuous set of data which can be used to gain insights into the temporal aspects of bat occurrence within the project area monopole platforms.

5.0 POST-CONSTRUCTION SURVEYS

CWA will use the following monitoring techniques, which employ traditional as well as more recently developed technologies, for the purpose of documenting movements and locations of avian and bat species around and over Nantucket Sound and the proposed project area. Emphasis is particularly placed on the roseate tern and piping plover. This will be the first known attempt in the United States to apply a suite of monitoring methods in a marine/coastal environment on an operating offshore wind facility and, if successful, should contribute significant new information on bird movements, flight corridors, and trajectories and more effective methods for monitoring impacts of offshore wind facilities on avian and bat species.

MMS will require a minimum of three full years of data be collected, analyzed and reported after the completion of construction activities. The ABMP also anticipates continued monitoring during the construction phase. MMS will regularly evaluate the results of the monitoring and make adjustments to the monitoring plan where appropriate and feasible, in coordination with CWA and the FWS.

5.1 Anti-Perching Monitoring

Section 5.1 of the ESA Biological Assessment prepared for the Cape Wind proposed action outlines the specific proposed anti-perching structures on the MET tower, ESP and wind turbines. Narrative of this system is outlined below. However, the exact anti-perching mechanism used post-construction is largely dependent on the results obtained from monitoring the effectiveness of this mechanism pre-construction (see Section 4.3). Should the results of the pre-construction monitoring indicate the anti-perching mechanism proposed below is adequate then this is the deterrent that will be installed and used (at least initially) post-construction. However, if the pre-construction monitoring shows the anti-perching mechanism proposed below to be ineffective then MMS will work with the CWA and the FWS to determine an alternate anti-perching mechanism.

MMS will require three years of post construction monitoring (as proposed below) to continue to evaluate the effectiveness of any deterrents. Again, the results of this monitoring will determine if the mechanism is remaining effective or whether additional changes are needed.

Description of Structures

Each turbine has a transition piece on top of the pile that has an access ladder and boat fender system connected to a deck. The deck is round through 180 degrees and has an extended section on one side. The diameter of the transition piece is 5.39 meters with a deck that is 8 meters in diameter. The deck will have a railing on the outer perimeter covered with an aluminum chain link fence. The deck overhangs the ladder.

The ESP has an overall size of 60 meters by 30 meters consisting of a building like superstructure sitting on a 6 pile structural support. The superstructure overhangs the support. The bottom of the superstructure is 11.5 meters from mean low water and the top of the heliport deck is 30 meters.

Perching Concerns

There are several potential bird uses of the turbines and ESP. Birds may use various perches around the edges of the platform as vantage points from which to watch for prey. Numerous species of birds are likely to use any suitable flat surfaces of the upper decks as places to rest by day and perhaps also by night (roosting). Terns could initiate high courtship flights from turbines or the ESP and drift downwind to a nearby turbine (distance 1,640 feet [500 meters] or more) where they would be at risk of collision. Another concern is that peregrine falcons may also be attracted to potential perching sites which could result in additional predation on roseate terns and other avian species.

Perching Deterrents

Each turbine and the ESP will be equipped with an avian deterrent system to discourage terns and other avian species from perching on the railings and deck areas. The deterrent system consists of a fence to prevent access from the side, a stainless wire on top of the railing and a 0.65-meter tall panel to restrict visibility of any avian species from the deck.

The wire will be 3-millimeter stainless steel marine wire with swage lock terminals and turnbuckles to connect it to posts at appropriate locations to maintain it taut. The spacing between the rail and the wire will be 3 centimeters. The size selected will allow visibility of the wire to various species while being too small to perch upon. Birds, including terns, attempting to perch on the rails would not be at risk of colliding with or being entangled in the wire because it is very close to the rail. Birds attempting to land on the rail would undoubtedly decelerate to a point where their airspeed would be nearly zero, thereby negating the potential for collision injuries.

In addition, a 0.65-meter tall panel will be installed along the outside of the turbine railings. Panels will also be set up at the edges of the helipad, which is situated above the ESP. The panel will restrict visibility making the potential perching area unsuitable for web-footed birds that prefer to perch on near-flat surfaces with views of their surroundings. It is likely that birds may initially be attracted to the turbines for perching, but effective deterrents will likely limit the number of times birds do this. Once they learn that they cannot perch, they will be less likely to attempt to perch on turbines further. In addition to the passive deterrent, the turbines and ESP will be operating most of the time resulting in vibrations and low level noise that may also discourage use by avian species.

Monitoring Perching Deterrents

Based on the effectiveness and refinement of using cameras on the met tower during pre-construction, cameras will be on six turbine monopiles (one at each corner, and two internal turbines) to monitor the effectiveness of the existing perching deterrents. Cameras will also be outfitted with a perch deterrent if necessary.

On the ESP, a camera would be installed so that the structure could be remotely viewed from the Cape Wind Control Station. The structure would be observed first thing every morning and for five minutes at the top of each hour when the Control Station is manned during daylight hours (up to one year). Results of monitoring the ESP and turbine deterrent systems will be reported initially to MMS in bimonthly reports during the first year of project operation. Frequency of reporting will then change to annual cycle unless MMS determines data indicate a need for more frequent reporting.

If perching remains an issue based on the monitoring results, CWA will propose additional anti-perching mechanisms which will need to ultimately be approved by MMS in coordination with the FWS. For each device or mechanism that advances through the screening process, CWA will provide a visual detailing of the proposal and a narrative describing its expected action. To enable efficient testing, these devices may be tested in an appropriate environment where terns are more consistently present.

In addition to monitoring for tern presence in the project area, field biologists will also monitor for avoidance or attraction behaviors at the ESP and select turbines. Avoidance or attraction behaviors of terns will be made from a vantage point on the ESP. CWA will deploy field biologists during the breeding season from mid-May to late July and the staging season from mid-August to late September to observe tern behavior around the ESP and adjacent turbines. Observers will collect 32 hours of observations (staggered during day light hours) in field journals and photo document birds where possible.

5.2 Abundance and Spatial Distribution Surveys

CWA and Mass Audubon have conducted various avian surveys over a five year period, starting in 2002. These surveys were conducted during all seasons, included boat, and aerial work to characterize existing bird use of Nantucket Sound and the proposed project site. One hundred twenty-five aerial surveys and 54 boat surveys were conducted by CWA and Mass Audubon. Of the aerial surveys, 62 were conducted during the winter season when sea ducks are present. In addition, 10 of these boat surveys were conducted during the winter months. CWA and Mass Audubon have developed a good estimate of relative abundance and distribution of birds in Nantucket Sound and the proposed project area.

CWA will conduct aerial surveys using the same methodology employed during the studies conducted during the development of the MMS EIS and State FEIR to document avian species abundance, and spatial distribution within the proposed project area and Nantucket Sound. This will allow for statistical analysis to compare post-construction and pre-construction data to see if/how bird use of the area has changed due to the presence of the wind energy facility. The flight plan for winter sea ducks and waterbirds is shown on attached Figure 2. Flight paths during the tern breeding and staging period will shift to include a transect near Monomoy Island (see attached Figure 3). CWA will fly five aerial surveys from May to late July (tern breeding period), four aerial surveys during the tern fall staging period from mid-August to late September, and ten surveys during the winter (mid October to mid-April) to monitor sea ducks and waterbirds.

CWA will fly surveys at an altitude of 76 meters (250 feet), which was chosen as the lowest possible altitude in order to observe individuals clearly down to sea level with minimal disturbance to bird behavior. This flight height will be confirmed to be safe by a professional research flight pilot prior to the start of surveys. The surveys will be flown in a floatplane (or equivalent) which will maintain an air speed of approximately 90 knots, or the slowest speed the aircraft can safely fly. The 76-meter altitude corresponds approximately to the rotor hub height (78.5 meters) of the proposed wind turbines. The flight lines will be slightly adjusted from pre-construction flight paths so that they are between turbine strings. Any proposed changes to the flights height or air speed resulting from safety concerns of a professional research pilot will be resolved between CWA, MMS and FWS prior to the start of flight surveys.

Birds will be counted and identified along 16 transects spaced approximately 2,286 meters (7,500 feet) apart. Surveys will be flown at different times of the day, at different tides, and in somewhat varying weather conditions, but only when visibility is either good or excellent to ensure that birds can be seen. No observations will be made when sea states are greater than three to ensure birds on the water can be seen. Flights will not take place during inclement weather when the safety of the pilot and survey crew would be compromised.

The survey team will consist of the pilot, a data recorder, and two observers. The pilot will maintain the plane on transect, at the correct altitude and speed, and at the proper wing level attitude. Two observers will be seated on either side of the plane. An aluminum rod will be attached perpendicular to the wing strut on each side of the plane to delineate the transect boundaries. A clinometer will be used to measure the calculated angle for the placement of these aluminum rods. The distances between the plane's float and the aluminum rods will be initially verified by flying over the airport at 76 meters (250 feet) using pre-measured 200-meter (656 feet) markers on the ground. The area visible between the float on the plane and the aluminum rod will provide each observer with a 200-meter (656 feet) transect width within which all birds shall be counted. The observers will not be able to see the area directly below the airplane.

The data recorder and observers will maintain direct communication using aviation headsets. The observers will identify species, number of species, activity of bird (i.e., foraging or flying), and time of sighting. The data recorder will be responsible for entering the data identified by the observers and record a Global Positioning System (GPS) point of the location at the beginning and end of each transect in addition to a GPS point every minute during each transect. Each observer's sightings shall be independently recorded on an audiotape linked directly to each headset.

Results of the surveys will be transferred to a geographic information systems map to show abundance and spatial distribution of key bird species during specific times of year (tern breeding season, tern fall staging, winter sea ducks, and winter waterbirds). Sea duck species include common eider, long-tailed duck, surf scoter, black scoter, and white-winged scoter. Winter waterbird species include loon, grebe, Northern gannet, American black duck, American goldeneye, mergansers, alcids, dovekie, and razorbill. The results of the post construction monitoring will be compared with pre-construction aerial surveys.

5.3 Avian Acoustic Monitoring

Acoustic microphones will be placed on 10 monopiles or the ESP, one on each of the 4 corners of the project, one in the approximate middle of the western and northern sides, and 4 placed at random in the interior of the project array. These will record flight calls of birds over/near the project 24/7 from May through October and during three 24-hour intervals per month from November through April, weather permitting, to determine bird presence/absence in the airspace in/around the proposed project site.

5.4 Telemetry

If the first year radio tracking of common terns and semipalmated plovers proves to be effective and safe for the birds, then radio transmitters will be attached each year to 25 adult roseate terns and 25 adult piping plovers exactly as described for pre-construction radio tracking of common terns and semipalmated plovers and as approved in any permits from the FWS and other regulatory agencies. CWA will also test the effectiveness of using the turbines and/or ESP as receiving stations. Attempts will be made to locate tagged birds at least 12 times between July 1 and August 31. One consideration in the selection of test subjects is the geographic source of the population. For example, plovers captured around Nantucket Sound may not be as vulnerable to collision with turbines as plovers which nested farther north and are migrating down the Atlantic Coast. Such plovers conceivably could be less familiar with the area and with wind turbines and could during migration be further offshore.

5.5 Thermal Animal Detection Systems

To evaluate collision following construction, Desholm (2005) developed a Thermal Animal Detection Systems (TADS) to collect data on bird presence within the rotor swept zone of wind turbines in an offshore wind power facility. As outlined by Desholm (2005), TADS consists of the following features:

1) A thermal video camera
2) Thermal trigger software which begins to download video sequences from the camera when a target passes within the camera's field of view

3) An environmentally sealed metal box to house the camera unit and protect it from weather and salt from sea spray. The metal box contains a windscreen wiper and sprinkler system to keep the lens clear and includes a small water valve to remove condensation inside the box.
4) A data logging device at the turbine to store video sequences from the camera
5) If shown to be practical and useful, a pan/tilt head enabling the operator to change heading and vertical angle of the field of view

The key component of the TADS (or similar system) is the thermal imaging camera which is capable of detecting birds in total darkness as well as cloudy conditions and fog. The camera uses thermography to capture images of objects within its field of view. All objects with a temperature above absolute zero radiate heat. Thermography is the method in which images of objects are obtained by measuring this radiated heat within the infrared spectrum (Desholm 2003). Heat radiation from an object such as a bird is transmitted through the atmosphere to the camera lens, which focuses the radiation onto the infrared detectors. These detectors transform the received radiation into an electrical signal, which is then processed into a visible image, the thermogram (Desholm 2003).

Thermal imaging can be used to identify species. However, it should be noted that when there is a greater distance between the bird and the camera identification becomes difficult. In terrestrial systems it has been used in conjunction with near infrared high resolution video cameras to improve species identification capabilities (Erik Redeker, Landitude Incorporated, 2008, pers. comm.).

Thermal imaging systems like TADS has many features which give it advantages over other monitoring methods. It is currently the only remote method for detection of bird-turbine collisions that is developed for offshore use (Desholm *et al*. 2005). Unlike radar, thermal imagery can be used to help identify bird species and size. It involves a less intensive field effort than radio telemetry and the camera can be monitored from an onshore location. It can detect birds during poor weather conditions when visual observation by boat or aircraft is not feasible. Evaluating collision risk during poor weather conditions is an area in which the thermal imaging can help to address an existing data gap.

The primary disadvantage of systems like TADS is the expense which was reported as 40,000 British Pounds (approximately $80,000 US) for a single TADS unit deployed at Nysted. The per unit costs of a TADS-type system should be less with multiple units, since a component is developing software to trigger either the camera's operation or, alternatively, to sort out images of interest in hours of collected data if the camera runs continuously. A likely range of estimates per unit (camera plus other components) would be $30,000-$60,000.

CWA proposes to have a system similar to TADS installed on separate wind turbines as a component of the post-construction monitoring plan. This would likely include a stratified sampling approach, with possible strata being the perimeter nearest to Monomoy, the perimeter closed to the mainland, the remainder of the perimeter, and the interior turbines. The basic thermal imaging system study design is outlined below, with refinements to the design anticipated based on field testing and evaluation of camera performance.

Thermal imaging cameras will be positioned near the base of the wind turbine monopole. The camera model, lens type and set-up will be refined after further consultation with experts. The cameras and weather-proof housing will be mounted on pan/tilt heads which will enable a change in field of view. To reduce impacts of vibration from the turbine operation on the camera, rubber vibration absorbers will be placed between the housing and the base plate of the mount and between the mounting and the turbine. The number of cameras and the orientation necessary to monitor the turbine will be designed depending on the system used. In addition, the nacelles proposed for the Cape Wind project, to which the rotor and blades are attached, can rotate 360 degrees. Movement of the nacelles will then need to be considered in the design of the monitoring for optimized viewing of the rotor swept zone.

It is anticipated that each thermal imaging camera would be connected to a data logging device at the turbine. To limit data collection to just those times when a target passes within the camera's field of view, the computers would be loaded with thermal trigger software with operator defined settings. Typically, video sequences from the thermal camera would be downloaded and stored on the data logger when at least one pixel in the field of view exceeds the operator-defined threshold temperature. The threshold would be tested and adjusted to help to eliminate non-avian targets.

With a proper set-up and appropriate study design, a thermal imaging system is capable of recording birds within the rotor swept zone even under conditions of poor visibility. Any collisions between birds and rotor blades would also be recorded. The data collected from the system can be used to further assess collision risk and improve inputs to collision models. It could also potentially guide turbine operation management decisions to reduce impacts to birds.

6.0 REPORTING

Cape Wind will submit a monitoring report at the end of construction and then annually by December 15 that contains the following information.

- A summary of results from the previous year's studies, including information that specifically addresses the research objectives outlined in this ABMP and an evaluation of the effectiveness of these monitoring techniques in achieving these objectives
- Details of research plans and objectives for the coming year and how these will logically advance the research objectives outlined in this ABMP as well as address any refinements needed to increase effectiveness of techniques for the coming year

For the first year of operation of the project, MMS will require bimonthly reports on the results of the anti-perching monitoring when listed avian species are potentially present in the action area (April-October). Frequency of monitoring for the second year will depend on the level of perching that was detected in the first year and will be determined by MMS in coordination with the FWS.

In addition, all collisions (with vessels, aircraft, turbines or structures) involving bird and bat species listed under federal or state endangered species laws, will be documented and reported within 24 hours to MMS [Jill Lewandowski, (703) 787-1703] and FWS [Michael Amaral, (603) 223-2541]. With respect to state-only listed species, the applicant will be required to notify an appropriate contact (to be determined) at the Massachusetts Division of Fisheries and Wildlife. For these species, and to the extent necessary, the responsible agencies will coordinate with their respective law enforcement offices to arrange for the proper chain of custody, handling and disposition of any injured or dead specimens. Fatalities of non-listed species would be reported at least annually to MMS and the FWS, or as otherwise stipulated or conditioned by any subsequently issued salvage, collection or scientific permits. In addition to any information that may be required under other permits, minimum data collection includes standard data collected during bird and bat fatality studies at wind plants including: name of person who found carcass or witnessed incident, species, date/time, location, weather, identification of the vessel, aircraft, turbine (turbine number), or structure involved and its operational status when the strike occurred, and known or suspected cause of death (if possible) and status of carcass (complete, incomplete, scavenged, time since death [approximate], etc.). Bird/carcass photographs should also be provided when necessary to document species identification or other relevant attributes. Carcasses of non-listed species shall be retained (for examination and documentation) in a freezer in zip-lock or similar bags with the above listed information included on non-degradable paper. For any banded or marked birds, record the presence and nature of the band (number on band should be recorded) or marking and include in reports. In addition for Federal or research bands and marking, information (band or other identification number) must be reported to the USGS Bird Banding Laboratory (see http://www.pwrc.usgs.gov/BBL/homepage/call800.htm).

Finally, all raw data will be stored according to accepted archiving practices, and will be made available at the request of MMS or FWS. In addition, all reports submitted to MMS and the FWS will be made publicly available. Similarly, MMS or FWS will be granted access to any carcasses.

7.0 REFERENCES

Arnett, E. B., editor. 2005. Relationships between Bats and Wind Turbines in Pennsylvania and West Virginia: An Assessment of Fatality Search Protocols, Patterns of Fatality, and Behavioral Interactions with Wind Turbines. Final Report for the Bats and Wind Energy Cooperative: 1-187.

Ahlén, I., L. Bach, H. Baagøe and J. Pettersson. 2007. Bats and offshore wind turbines studied in southern Scandinavia. Swedish Environmental Protection Agency Report No. 5571. Bromma, Sweden.

Blew, Jan, Ansgar Diederichs, Thomas Grünkorn, Malte Hoffmann, and Georg Nehls. 2006. Investigations of the bird collision risk and the responses of harbour porpoises in the offshore wind farms Horns Rev, North Sea, and Nysted, Baltic Sea, in Denmark. Report to the German Federal Ministry of Environment, Nature Conservation and Nuclear Safety.

Christensen, T. K. and J. P. Hounisen. 2005. Investigations of migratory birds during operation of Horns Rev offshore wind farm. Annual Status Report 2004. National Environmental Research Institute (Denmark)

Collaborative Offshore Wind Research into the Environment (COWRIE), 2008. http://www.offshorewindfarms.co.uk/Default.aspx Accessed February 26, 2008.

Desholm, M. 2003. Thermal Animal Detection Systems (TADS), Development of a method for estimating collision frequency of migrating birds at offshore wind turbines. National Environmental Research Institute (NERI) Technical Report, no. 440. Ministry of Environment, Denmark.

Desholm, M. 2005. Preliminary investigations of bird-turbine collisions at Nysted offshore wind farm and final quality control of Thermal Animal Detection System (TADS). National Environmental Research Institute (NERI), Ministry of Environment, Denmark.

Desholm, M. T. Fox and P. Beasley. 2005. Best practice guidance for the use of remote techniques for observing bird behavior in relation to offshore windfarms. First Draft for Comments. Collaborative Offshore Wind Research into the Environment (COWRIE).

Dooling, R. 2002. Avian hearing and the avoidance of wind turbines. Technical Report for the National Renewable Energy Laboratory: NREL/TP-500-30844.

Erickson, W.P., J. Jeffery, K. Kronner, and K. Bay. 2004. Stateline Wind Project Wildlife Monitoring Final Report, July 2001 – December 2003. Technical report peer-reviewed by and submitted to FPL Energy, the Oregon Energy Facility Siting Council, and the Stateline Technical Advisory Committee.

ESS Group, Inc. 2007. Cape Wind Energy Project-Final Environmental Impact Report (FEIR) EOEA #12643, Development of Regional Impact CCC#JR#20084. Volumes 1-3. Prepared for Cape Wind Associates, L.L.C., Boston, Mass. Wellesley, Mass.

Everaert J. & Stienen E., 2006. Impact of wind turbines on birds in Zeebrugge (Belgium). Biodiversity and Conservation, DOI 10.1007/s10531-006-9082-1 (www.springerlink.com). http://www.inbo.be/content/page.asp?pid=FAU_VO_windturbines

Farnsworth, Andrew and Robert W. Russell. 2007. Monitoring flight calls of migrating birds from an oil platform in the northern Gulf of Mexico. J. Field Ornithology 78(3): 279-289

Farnsworth, Andrew and Christopher W. Clark. Undated. Monitoring using acoustical methods: The power of bioacoustic monitoring for studying nocturnal migration.

Hatch, Jeremy and Brault, Solange. 2007. Collision mortalities at Horseshoe Shoal of Bird Species of Special Concern. Cape Wind Energy Project-Final Environmental Impact Report (FEIR) EOEA #12643, Development of Regional Impact CCC#JR#20084. Volumes 1-3, Appendix 3.6-I. Prepared for Cape Wind Associates, L.L.C., Boston, Mass. Wellesley, Mass.

Henke, Blake and Andrew G. Hughes 2005. Crossband Transponder System and Harmonic Radar System to Track and Monitor Small Animals Over Long Time Scales. Final report to National Science Foundation for NSF Award Number DBI- 0232521.

Hodos, W. 2003. Minimization of Motion Smear: Reducing Avian Collisions with Wind Turbines. Period of Performance: July 12, 1999 – August 31, 2002. National Renewable Energy Laboratory Technical Report.

Huppop, O., J. Dierschke, K-M, Exo, E. Fredrich, and R. Hill. 2006. "Bird migration studies and potential collision risk with offshore wind turbines." Ibis 148: 90-109.

Jain, A., P. Kerlinger, R. Curry, and L. Slobodnik. 2007. Annual Report for the Maple Ridge Wind Power Project Postconstruction Bird and Bat Fatality Study – 2006 FINAL REPORT June 25, 2007. Prepared for PPM Energy and Horizon Energy and Technical Advisory Committee (TAC for the Maple Ridge Project Study).

Kahlert, J., I.K. Petersen, A.D. Fox, M. Desholm, and I. Clausager. 2004. Investigations of birds during construction and operation of Nysted offshore wind farm at Rødsand - Annual Status Report 2003. Commissioned report to Energi E2 A/S. National Environmental Research Institute (Denmark). 82 pp.

Kerns, J. and P. Kerlinger. 2004. A Study of Bird and Bat Collision Fatalities at the Mountaineer Wind Energy Center, Tucker County, WV, USA: Annual Report for 2003.

Kunz, T.H., E.B. Arnett, B.M. Cooper, W.P. Erickson, R.P. Larkin, T. Mabee, M.L. Morrison, M.D. Strickland and J.M. Szewczak. 2007. Assessing Impacts of Wind-Energy Development on Nocturnally Active Birds and Bats: A Guidance Document. Journal of Wildlife Management 71(8), pp 2449-2486.

Lowther, S. The European perspective: Some lessons from case studies. Casella Science & Environment Ltd., Liverpool, UK.

Minerals Management Service (MMS) 2008. Cape Wind Energy Project Draft Environmental Impact Statement. January 2008.

Morrison, M. L. 2006. Bird Movements and Behaviors in the Gulf Coast Region: Relation to Potential Wind Energy Developments. Period of Performance: 22 November 2000 - 31 October 2005. Texas A&M University, Prepared for the National Renewable Energy Laboratory.

National Wind Coordinating Collaborative (NWCC). 2007. http://www.nationalwind.org/default.htm Washington D.C. Last Accessed February 27, 2008.

Nelson, H. K., and R. C. Curry. 1995. Assessing avian interactions with wind plant development and operations. Transactions of the 61st North American Wildlife and Natural Resources Conference. 60:266-277.

Osborn, R.G., C.D. Dieter, K.F. Higgins, and R.E. Usgaard. 1998. Bird flight characteristics near wind turbines in Minnesota. The American Midland Naturalist. 139: 29-38.

Pandey, A., J. Hermence, R. Harness. 2007. Development of a cost-effective system to monitor wind turbines for bird and bat collisions, Phase I: Sensor system feasibility study. Prepared for California Energy Commission Public Interest Energy Research Program.

Perkins, S., T. Allison, A. Jones, and G. Sadoti. 2004a. A survey of tern activity within Nantucket Sound, Massachusetts, during the 2003 breeding season. Final Report for Massachusetts Technology Collaborative.

Perkins, S., T. Allison, A. Jones, and G. Sadoti. 2004b. A survey of tern activity within Nantucket Sound, Massachusetts, during the 2003 fall staging period. Final Report for Massachusetts Technology Collaborative.

Perrow, M.R., E.R. Skeate, P. Lines, D. Brown and M.L. Tomlinson. 2006. Radio Telemetry as a tool for impact assessment of wind farms: the case of Little Terns *Sterna albifrons* at Scroby Sands, Norfolk, UK. ECON Ecological Consultancy, Norwich Research Park, Norwich, NR4 7UH, UK. Ibis 148, pp 57-75.

Petersen, I.K., I. Clausager, and T.K.Christensen. 2004. Bird numbers and distribution in the Horns Rev offshore wind farm area. Annual Status Report 2003. Commissioned report to Elsam Engineering A/S. National Environmental Research Institute. 36 pp.

Petersen, I.K., Christensen, T.K., Kahlert, J., Desholm, M. and Fox, A.D., 2006. *Final results of bird studies at the offshorewind farms at Nysted and Horns Rev, Denmark.* Commissioned Report to DONG Energy and Vattenfall A/S by the National Environmental Research Institute. 166 pp. Available at: http://www.ens.dk/graphics/Energiforsyning/Vedvarende_energ i/Vind/havvindmoeller/vvm%20Horns%20Rev%202/Nysted/Birds%20final%202005.pdf

Perkins, S., T. Allison, A. Jones, and G. Sadoti. 2004. A survey of tern activity within Nantucket Sound, Massachusetts, during the 2003 fall staging period. Final Report for Massachusetts Technology Collaborative.

Perrow, M.R., E.R. Skeate, P. Lines, D. Brown and M.L. Tomlinson. 2006. Radio Telemetry as a tool for impact assessment of wind farms: the case of Little Terns *Sterna albifrons* at Scroby Sands, Norfolk, UK. ECON Ecological Consultancy, Norwich Research Park, Norwich, NR4 7UH, UK. Ibis 148, pp 57-75

Petterson, J. 2005. The Impact of Offshore Wind Farms on Bird Life in Southern Kalmar Sound, Sweden: A Final Report Based on Studies 1999-2003. ISBN 91-631-6878-2. 128 pp.

Redeker, Erik. 2008, Personal communication. Landitude Incorporated.

Russell, R. W. 2005. Interactions between migrating birds and offshore oil and gas platforms in the northern Gulf of Mexico: Final report. U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study MMS 2005-009 327 p.

Sadoti, G., T. Allison, S. Perkins, A. Jones. 2005a. A Survey of Tern Activity within Nantucket Sound, Massachusetts, During the 2004 Breeding Period. Final Report for the Massachusetts Technology Collaborative.

Sadoti, G., T. Allison, S. Perkins, E. Jedrey, A. Jones. 2005b. A Survey of Tern Activity within Nantucket Sound, Massachusetts, During the 2004 Fall Staging Period. Final Report to the Massachusetts Technology Collaborative.

SeeMore Wildlife Systems. 2008. http://www.seemorewildlife.com/index.php Homer, Alaska. Last accessed August 13, 2008.

Shire, G., K. Brown, and G. Winegard. 2000. Communication Towers: A Deadly Hazard to Birds. American Bird Conservancy, Washington, D.C.

Titley Electronics. 2006. http://www.titley.com.au/index.htm Anabat System. Ballina, NSW 2478, Australia. Last accessed August 4, 2008.

Tulp, I., H. Schekkerman, J. K Larsen, J.van der Winden, R. J. W. van de Haterd, , P.van Horrsen, S. Dirksen, and A. L. Spaans. 1999. Noctural flight Activity of Sea Ducks near the

Windfarm Tuno Knob in the Kattegat. Novem, Utrecht, The Netherlands: ECN Wind Energy.

United States Army Corps of Engineers (USACE). 2004. Cape Wind Energy Project - Draft Environmental Impact Statement. USACE #NAE-2004-338-1, EOEA File #12993, Development of Regional Impact CCC #JR#20084. Prepared for Cape, Associates L.L.C., Boston, Mass. Concord, Mass. November 2004.

Vliestra, L.S. 2007. Potential impact of the Massachusetts Maritime Academy wind turbine on common and roseate terns. Massachusetts Maritime Academy report, Buzzards Bay, MA 60 pp.

Warnock, N. and S. Warnock. 1993. Attachment of radio transmitters to sandpipers: review and methods. Wader Study Group Bulletin. 70: 28-30.

Wiggelinkhuizen, E.J., L.W.M.M. Rademakers, S.A.M. Barhorst. WT-Bird: Bird collision recording for offshore wind farms. Technical Report for Energy Research Centre of the Netherlands, Petten, The Netherlands.

The Department of the Interior Mission

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering sound use of our land and water resources; protecting our fish, wildlife, and biological diversity; preserving the environmental and cultural values of our national parks and historical places; and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people by encouraging stewardship and citizen participation in their care. The Department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

The Minerals Management Service Mission

As a bureau of the Department of the Interior, the Minerals Management Service's (MMS) primary responsibilities are to manage the mineral resources located on the Nation's Outer Continental Shelf (OCS), collect revenue from the Federal OCS and onshore Federal and Indian lands, and distribute those revenues.

Moreover, in working to meet its responsibilities, the **Offshore Minerals Management Program** administers the OCS competitive leasing program and oversees the safe and environmentally sound exploration and production of our Nation's offshore natural gas, oil and other mineral resources. The MMS **Minerals Revenue Management** meets its responsibilities by ensuring the efficient, timely and accurate collection and disbursement of revenue from mineral leasing and production due to Indian tribes and allottees, States and the U.S. Treasury.

The MMS strives to fulfill its responsibilities through the general guiding principles of: (1) being responsive to the public's concerns and interests by maintaining a dialogue with all potentially affected parties and (2) carrying out its programs with an emphasis on working to enhance the quality of life for all Americans by lending MMS assistance and expertise to economic development and environmental protection.