Technical Manual for Evaluating Wildlife Impacts of Wind Turbines Requiring Coastal Permits

NJ Department of Environmental Protection

September 7, 2010

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Wind turbines have the potential to impact birds and bats, and when located in tidal waters may also impact marine organisms such as marine mammals and sea turtles. Wind turbines may have different impacts depending on whether they are sited on land or in the water. To assess these impacts the New Jersey Department of Environmental Protection (Department) has developed habitat evaluation, impact assessment, and pre- and post- construction monitoring requirements specific to the location of the wind turbine, on land or in tidal waters. The results will be used by the Department to evaluate the impacts of wind turbines, determine the extent to which operations are causing direct mortality to birds and bats, and the effects of construction and operation on marine organisms. This data will help inform future policies for the siting and operation of wind turbines in the coastal region.

The Department will consider alternative methods than those described in this technical manual provided such alternative methods will provide data that is comparable to that afforded by the technical manual. This is necessary to enable the Department to evaluate the impacts of wind turbines constructed along the coast and in tidal waters and compare data from difference wind turbine developments.

I. Protocol for Evaluating Wildlife Impacts of Wind Turbines Located on Land

A. Purpose:

Wind turbines on land have the potential to impact breeding, wintering and migratory birds and bats through physical strikes with the turbine blades or the loss of habitat through avoidance of areas where wind turbines are located. To assess impacts of wind turbines on birds and bats, the Department has developed pre- and post-construction monitoring guidelines that consist of survey protocols to evaluate the impacts of large wind turbines on birds and bats in the coastal region.

B. Before-After/Control-Impact (BACI) study design

For the largest wind installations on land (Tier 4B turbines), data will be collected using a Before-After/Control (a.k.a. Reference)- Impact (BACI) study design. This will provide the Department with the greatest statistical certainty as to the actual effects of wind turbines on the bird and bat species utilizing an area. This design will require permittees to conduct a series of visual and acoustical surveys before and after the turbines are constructed on the impact (project) site as well as at a nearby reference site. Radar surveys may also be required based on a case-by-case review of the project as described in detail on page 5. The reference site shall be located approximately 3-10 km from the project site and the Department will work with the applicant to find a suitable location. In order to ensure the best results, surveys shall occur concurrently at both the project and reference sites. For example, if a migratory raptor survey is scheduled for a given day during the survey period, data shall be collected at both the project and reference sites simultaneously in order to reduce variability in the data. For more details on a BACI study design and its importance in evaluating the impacts of wind turbines,

please see the National Wind Coordinating Committee's "Studying Wind Energy Bird Interactions: A Guidance Document" (Anderson et al. 1999).

C. Report Format

Reports shall follow a format similar to that of an article in a peer-reviewed journal and include an abstract, introduction, methodology (including site map and survey point locations), results (including all datasheets), discussion, and conclusion. Reports shall be submitted in accordance with the timeframes specified for each tier as set forth in Section D below.

D. Project Classification and Monitoring Requirements:

The Department has taken a tiered approach to regulating wind turbines on land, based on number, height and rotor-swept area of the proposed turbines. This tiered approach is carried through to the pre- and post- monitoring requirements, with the extent and duration of the required monitoring determined by the height and rotor swept area of the proposed turbines. A summary of the definitions for each tier and the pre-and post-construction monitoring requirements for each are found below.

Tier 1 Structures:

Definition:

- 1-3 wind turbines; and
- Wind turbine(s) less than 200 feet in height as measured from ground level to the tip of the blade at its highest position; and
- Cumulative rotor swept area is less than 2,000 square feet.

Pre- and Post-Construction Monitoring Requirements:

- None

Tier 2 Structures*: Survey requirements apply only to the first 15 Tier 2 wind turbine developments constructed.* ***Definition:***

- 1-3 wind turbines; and
- Wind turbine(s) less than 200 feet in height as measured from ground level to the tip of the blade at its highest position; and
- Cumulative rotor swept area is greater than 2,000 square feet and less than 4,000 square feet.

Pre- and Post-Construction Monitoring Requirements:

- No pre-construction monitoring required.
- One full year post-construction carcass search and removal/efficiency trials. All survey results shall be provided to the Department in finalized report form no later than six months after the end of the last post-construction survey period. Reports shall follow the format set forth in Section C above. For details on survey protocols on land, see Sections IF-1 and IF-2.

Tier 3 Structures:

Definition:

- Wind turbine(s) less than 250 feet in height as measured from ground level to the tip of the blade at its highest position; and
- Cumulative rotor swept area of wind turbine(s) is 20,000 square feet or less; and
- Wind turbine(s) does not meet above definition of Tier 1 or Tier 2 structures.

Pre- and Post-Construction Monitoring Requirements:

- No pre-construction monitoring required.
- One full year of post-construction carcass searches and carcass removal/searcher efficiency trials. All survey results shall be provided to the Department in finalized report form no later than six months after the end of the last post-construction survey period. Reports shall follow the format set forth in Section C above. For details on survey protocols on land, see Sections IF-1 and IF-2.

<u>Tier 4 Structures</u>:

Definition:

- Wind turbine(s) greater than 250 feet in height as measured from ground level to the tip of the blade at its highest position; or
- Cumulative rotor swept area of wind turbine(s) is greater than 20,000 square feet.

Pre- and Post-Construction Monitoring Requirements:

- ***Tier 4A: 1-4 turbines***
  - One full year pre-construction visual bird surveys and migratory bat surveys at the project site. All survey results shall be provided to the Department as an interim report no later than six months after the end of the last pre-construction survey period. Reports shall follow the format set forth in Section C above.
  - Two full years of post-construction carcass searches, carcass removal/searcher efficiency trials, visual bird surveys and migratory bat surveys at the project site. All survey results shall be provided to the Department in finalized report form no later than six months after the end of the last post-construction survey period. Reports shall follow the format set forth in Section C above.

- ***Tier 4B: 5 + turbines***
  - One full year pre-construction surveys, including visual bird surveys and migratory bat surveys at the project site and a reference site. All survey results shall be provided to the Department as an interim report no later than six months after the end of the last pre-construction survey period. Reports shall follow the format set forth in Section C above.
  - Two full years of post-construction carcass searches, carcass removal/searcher efficiency trials, visual bird surveys, migratory bat

surveys at the project site and visual bird surveys and migratory bat surveys at a reference site. All survey results shall be provided to the Department in finalized report form no later than six months after the end of the last post-construction survey period. Reports shall follow the format set forth in Section C above.

- Radar may be required based on a case-by-case review of the project, taking into account the number of turbines, the size of turbines, the proposed location for the turbines, particularly their proximity to water, wetlands, and nesting and foraging areas, and on-going review of scientific research and literature in terms of use of radar for site assessment.

For specifics on survey methodology on land, see Section IF.

E. Determining Rotor Swept Area:

The rotor swept area is calculated differently for a horizontal axis turbine than for a vertical axis turbine. The tips of the blades on a horizontal axis turbine form a circle as they rotate. The rotor swept area for this type of turbine is the area of the circle delineated by the tips of the blades. The designs of vertical axis turbines vary greatly in the arrangement of the blades. The rotor swept area for this type of turbine is calculated using the following formula:

Rotor Swept Area = Rotor Radius x Rotor Height x 3.14

F. Pre-construction Survey Requirements for Wind Turbines Located on Land:

Pre-construction surveys are required pursuant to N.J.A.C. 7:7E-7.4(r)1vii(4) to establish the flight patterns and distribution of birds and bats at the project site. The objective of pre-construction monitoring is to document species diversity and abundance of birds and bats utilizing the habitat and airspace where the turbine(s) will be constructed. Tier 4B surveys shall take place on both the impact (project) site location and a nearby (no less than 3 km and no more than 10 km from the project site) reference site. The reference site shall contain similar habitat features as the project site and surveys shall be coordinated to occur, as much as possible, simultaneously at both sites. Approval of survey methodologies by the Department is required prior to initiation of pre-construction monitoring.

1. Visual Bird Surveys

a. Breeding bird surveys*:*

Breeding bird activity is a component of pre- and post-construction surveys because resident breeding birds are a group that may be negatively impacted by the development of large wind turbines. There is potential for both collisions of breeding birds with turbines (Everaert and Stienen 2007) and habitat avoidance (Leddy et al. 1999) that effectively reduces the amount of habitat available for these species. This could be of particular concern if it impacts endangered or threatened species. The findings from these surveys will increase the

Department's understanding of how breeding birds are impacted by wind turbines in New Jersey's coastal region.

Protocol: A point-count survey shall be conducted at the project site and, where required, at a reference site. Survey protocols shall be based on those set forth in Huff et al. 2000 and Somershoe et al. 2006. The following are New Jersey-specific aspects of the survey that shall be adhered to:

- The survey period is from May 15 to June 30. A minimum of three surveys is required during this period, with at least 7-10 days separating each survey.
- The survey point locations shall be approved by the Department prior to commencement of the survey. In general, the points shall be located at least 150 m from one another and shall be arranged to maximize sampling of the entire site. Where possible, survey points shall be located at, or close to, the base of the tower and/or include the area that will be affected by construction and maintenance of the turbines. The size of the project area will determine the number of survey points necessary for a particular site. Geographical coordinates (latitude, longitude) for each point shall be recorded.
- Each point shall be surveyed for 5 minutes and each bird seen or heard must be recorded on the datasheet provided in Appendix A. The 5-minute survey period shall be split into 3-minute and 2-minute segments, respectively, to allow for future comparison with national datasets such as the North American Breeding Bird Survey (BBS).
- Each observation should be accompanied by a distance estimate of how far the individual was seen or heard from survey point. Observations will fall into three "bins" – 0-50m, 50m-100m and > 100m from survey point. Observers should be trained and experienced in distance sampling to ensure accurate estimates. A rangefinder may be employed to assist in distance measurements.
- Surveys shall begin just before or at sunrise and conclude by 9:30 a.m. Surveys shall be conducted during the most favorable weather conditions for seeing and hearing birds such as dry, calm and warm (enough for birds to be expected to be active). Heavy rain, strong winds or other weather conditions where detectability would be diminished shall be avoided.

b. Migratory Songbird Surveys:

Published studies report that, among all bird groups, passerines (including songbirds) are among the bird species most vulnerable to collision with wind turbines (Howe et al. 2002, Johnson et al. 2002, Schmidt et al. 2002, Kerns and Kerlinger 2004, Mizrahi et al. 2008). Although the majority of migrating songbirds travel nocturnally, they do use stopover habitat to rest and forage diurnally (Wiedner et al. 1992). This portion of the survey protocol is intended to capture site-use by migrating songbirds. Therefore, all songbirds, whether observed flying over or on the site, shall be recorded during this survey. Currently, only data from Cape May (NJ Audubon Society, 1988-1989, 2003-present) are available for these species. Additional data from the rest of the coastal region will augment existing data and help assess the patterns of migratory songbirds as they utilize stopover

habitats. Pre- and post-construction data will be used to understand how migration densities translate into number of collisions and also elucidate whether habitat avoidance is an issue for this group of birds.

Protocol: A migratory songbird survey shall be conducted at the project site and, where required, at a reference site. Depending on the habitat at the site, a line transect (if site conditions are open and easily traversable) or point survey (if site is heavily vegetated and difficult to traverse) will be utilized. Applicants should consult with the Department to determine which survey method should be employed. The line transect surveys shall closely follow those set forth in Wakeley 1987. The point surveys shall closely follow those set forth by Mabey et al. 1993. Both surveys will incorporate distance sampling, as discussed in Somershoe et al 2006. The following are New Jersey-specific aspects of the survey that must be adhered to:

- The survey periods are April 1 to May 15 and August 15 to November 15. A survey shall take place once every 5-7 days for a total of 7 surveys in the spring and once at least every 7-10 days for 10 surveys in the fall.
- The line transects or survey point locations shall be approved by the Department prior to commencement of the survey. For the point survey, the points shall be located approximately 150 m from one another and shall be arranged so as to maximize sampling of the entire site. Where possible, survey lines or points shall be located at, or close to, the base of the tower and/or include the area that will be affected by construction and maintenance of the turbines. The size of the affected area will determine the number of survey lines/points necessary for a particular site. Geographical coordinates (latitude, longitude) for each line/point shall be recorded.
- Each point shall be surveyed for 10 minutes using a playback of chickadee alarm calls (surveyors should note whether it appears the callback attracted the same individual to multiple survey points). If the survey is done along a line transect, the playback should be played along the route, as needed. An mp3 file of the alarm call is available from the Department should the applicant be in need of one. Each bird seen or heard must be recorded on the datasheets provided in Appendix B. Distance to each target bird must be noted. Only an observer experienced in estimating distances should be employed for this task, although a rangefinder may be used to assist in distance measurements.
- Surveys shall begin at or just before sunrise and conclude by 9:30a.m. Surveys shall be conducted during the most favorable weather conditions for seeing and hearing birds such as dry, calm and warm (enough for birds to be expected to be active). Heavy rain, strong winds or other weather conditions where detectability would be diminished shall be avoided.

c. Migratory Raptor surveys

Migratory raptors are one of the most susceptible bird groups to direct impacts (collisions) of wind turbines (, Johnson et al. 2002, Schmidt et al. 2002, Mizrahi et al. 2009). The coast of New Jersey is a known migratory pathway for these

species (Allen and Peterson 1936). Extensive count data exists for the fall migration in Cape May, NJ and there are five years of data available from the spring migration at Gateway National Park-Sandy Hook Unit, NJ (http://www.hmana.org/). However, there are no standardized data available to the Department at this time for the rest of the coastal region. Pre- and post-construction data will be used to understand how migration densities relate to number of collisions and also elucidate whether habitat avoidance is an issue for this group of birds.

Protocol: A migratory raptor survey shall be conducted at the project site and, where required, at a reference site. Survey protocols shall closely follow those set forth by the Hawk Migration Association of North America at:
http://rpi-project.org/docs/HMANA_Data_Collection_Protocol_20060611.pdf
The following are New Jersey-specific aspects of the survey that shall be adhered to:

- The survey periods are March 15 to May 15 and September 1 to November 30. A survey shall take place once every 5-7 days for a total of 10 surveys in the spring and once every 7-10 days for 15 surveys in the fall at each site.
- The survey location(s) shall be approved by the Department prior to commencement of the survey but in general shall be located as close as possible to the proposed location of the turbine(s).
- A survey consists of continuous observations between the hours of sunrise and 4:00 p.m. Observation shall be recorded on the datasheets provided in Appendix C.

d. Migratory Shorebird Surveys:

The potential impact of wind turbines on migrating shorebirds is not well understood. Since the large turbines that trigger these surveys are in the coastal region, and given that many thousands of shorebirds pass through this area during each migration season, a better understanding of individual site use is necessary to assess the impacts of turbines on this species group. A migratory shorebird survey may be required if suitable habitats exist (including oceanfront beach, tidal bays, mudflats or other areas where shorebirds are likely to congregate). The Department will not require such a survey it if is determined that the project site, or areas near the project site, contains no suitable habitat for this species group.

Protocol: If the Department determines that a shorebird survey is required, surveys shall be conducted at the project site and, where required, at a reference site. Survey methodology shall follow the protocols by the Department's Division of Fish and Wildlife, Endangered and Nongame Species Program which appear in Appendix D. The following are key aspects of the survey that shall be adhered to:

- The survey periods are April 15 to June 30 and July 15 to October 31. Three surveys are required during each month and must be separated by at least 5-7 days for a total of 7 surveys in the spring and separated by at least 7-10 days for a total of 10 surveys in the fall.

- All suitable habitats on the project and reference sites (e.g. all intertidal areas or mudflats) shall be surveyed for all shorebirds in that habitat. Geographical coordinates (latitude, longitude) of the perimeter of the area surveyed shall be recorded so that results may be converted to a density of birds in each habitat type. Where survey area is limited by distance at which species identification is possible, additional surveyors may be necessary to accurately survey the entire project and/or reference sites.
- All individuals shall be identified, counted and recorded on the datasheets provided in Appendices E1 and E2. Distance to each target bird must be noted. Only an observer experienced in estimating distances should be employed for this task, although a rangefinder may be used to assist in distance measurements.
- Surveys shall be stratified with regard to tidal cycles and time of day. Surveys shall be conducted during the most favorable weather for observing birds such as dry, calm conditions. Heavy rain, strong winds (e.g., over 20 mph) or other weather conditions that limit shorebirds' normal behaviors shall be avoided.

e. Wintering bird surveys:

Wintering bird surveys may be required for projects in the coastal zone because this region is known to harbor significant numbers of wintering birds, particularly waterfowl and shorebirds (NJDEP DFW unpubl. data). There has been research conducted on waterfowl migrating through areas where turbines exist and those results suggest that habitat avoidance may be an issue for this species group (Goodale and Divoll 2009). Migration, however, is different than overwintering and therefore the Department requires data collection on the behavior of wintering birds at some sites. The Department will not require such a survey it if is determined that the project site, or areas near the project site, contain no suitable habitat for this species group.

Protocol: If the Department determines that a wintering bird survey is required, surveys shall be conducted at the project site and, where required, at a reference site. Survey methodology shall follow the protocols by the Department's Division of Fish and Wildlife, Endangered and Nongame Species Program which appear in Appendix D. The following are key aspects of the survey that must be adhered to:

- The survey period is November 1 to March 31. A survey shall take place three times each month, separated by at least 5 days, for a total of 15 surveys.
- All suitable habitats on the project and reference sites (e.g., intertidal area, Spartina marsh, mudflats, and/or open water areas) shall be surveyed for all wintering birds in that habitat. Geographical coordinates (latitude, longitude) of the perimeter of the area surveyed shall be recorded so that results may be converted to a density of birds in each habitat type. Where survey area is limited by distance at which species identification is possible, additional surveyors may be necessary to accurately survey the entire project and/or reference sites.

- All individuals shall be identified, counted and recorded on the datasheets provided in Appendices E1 and E2. This will include wintering shorebirds (such as Dunlin and American Oystercatchers) as well as waterfowl (such as scoters and American Black Ducks).
- Surveys shall be stratified over tidal cycle and time. Surveys shall be conducted during the most favorable weather for observing birds such as dry, calm conditions. Heavy rain, strong winds (e.g. over 20 mph) or other weather conditions that limit birds' normal behaviors shall be avoided.

2. Migratory Bat Surveys:

At sites around the world, bats are consistently a directly impacted species group through collisions with turbines and through barotrauma (Arnett et al. 2008, Baerwald et al. 2008). In fact, the number of mortalities of bats exceeds the number of bird mortalities at many sites where data has been collected, including at the Atlantic County Utilities Authority site, currently the only large wind turbine site in New Jersey's coastal region (Arnett et al. 2008, Mizrahi et al. 2008). Therefore, understanding the utilization of the coastal zone by bats is paramount to taking steps to reduce mortality through siting decisions and possible temporary curtailment in operations. Since bats are nocturnal and nearly impossible to visually survey, the best method currently available to census densities of bats travelling through potential wind turbine sites is through acoustical detectors.

Protocol: A migratory bat survey shall be conducted at the project site and, where required, at a reference site. To assess the use of sites by migratory bats, a network of acoustical sampling stations must be established on the project and reference sites so that bat use of the air space above the site can be determined. See Kunz et al. 2007 for additional information regarding acoustical monitoring. The following are New Jersey-specific aspects of the survey that must be adhered to:

- The survey periods are from April 1 to May 15 and August 15 to October 15, every day from 30 minutes before sunset to 30 minutes after sunrise.
- Sampling area must include the space from ground to the height of the turbine (at a minimum) and encompass the entire rotor swept area. Detectors shall be placed on meteorological towers, or otherwise elevated to an appropriate height, to capture activity in the focal area. Two detectors sampling the horizontal plane and one for the vertical plane will be required for each turbine (exceptions may be made for turbines sited very close together or "wind farm" type projects where a detection array for each turbine would over-sample). Detectors shall face the direction appropriate for the migration season: south-facing in the spring to detect northbound migrants, and north-facing in the fall to detect southbound migrants. Geographical coordinates (latitude, longitude) for each detector shall be recorded.
- The final report shall include an estimate of the number and species of bats recorded flying through the rotor swept area of the turbine(s).

3. Radar Surveys:

Radar surveys may be required on a case-by-case review of Tier 4B projects, taking into account the number of turbines, the size of turbines, the proposed location for the turbines, particularly their proximity to water, wetlands, and nesting and foraging areas, and ongoing review of scientific research and literature in terms of use of radar for site assessment. Remote sensing marine radar will be used to determine activity and patterns of nocturnally migrating birds and bats. Where required, radar surveys will be performed at the project site and a reference site both pre- and post-construction. The Department recognizes that there are other options for recording nocturnally migrating birds and bats (such as acoustic monitoring of birds and thermal imaging for both). These methods may be used in conjunction with radar, but may not replace it unless the Department has given written permission. Additionally, as current remote sensing techniques are improved and new techniques are developed, the Department will consider alternative monitoring methods, that have shown to be effective, as they become available. Until that time, the following protocols shall be followed.

Protocol:

Radar surveys shall be conducted at the project site and reference site, where required, at a reference site. Monitoring nocturnal migrants by remote sensing marine radar is now an established method of measuring of avifaunal and bat volume moving through a given area. For details on marine radar, please see Kunz et al. 2007 and Schmaljohann et al. 2008. The following are New Jersey-specific aspects of the survey that shall be adhered to:

- The survey periods are April 1 to May 31 and August 1 to November 30 from 30 minutes before sunset to 30 minutes after sunrise.
- The radar shall sample in both horizontal and vertical modes to collect information on target density, altitude, direction, and speed. To be cost effective, one radar unit can be used with 50% of the time set in vertical mode and 50% of the time in horizontal mode. The unit should be set to switch modes 6- 30 times per hour. Geographical coordinates (latitude, longitude) for the location of each radar unit shall be recorded.
- Detailed weather conditions shall be reported, including wind speed, wind direction, barometric pressure, ceiling height, temperature, and visibility.
- Data shall be recorded in digital format. Applicants shall make every effort to incorporate filtering methods into their analysis to reduce noise in the data and ensure that it represent migration events as accurately as possible.
- Validation of radar data shall include nocturnal visual observations (by surveying before sunset, through moon watching or with night vision goggles) or thermal imaging periodically during radar operation to ground-truth the data and estimate the proportion of birds and bats being recorded.
- Data shall be submitted to the Department in both its raw interpreted (i.e., data files in Access or Excel) and report formats.

G. Post-Construction Monitoring for Wind Turbines Located on Land

Post-construction monitoring is required pursuant to N.J.A.C. 7:7E-7.4(r)1vii(4) and N.J.A.C. 7:7-7.30(a)8 and 7.31(a)9 to assess the effects of the operation of wind turbines on birds and bats. The objectives of post-construction monitoring are to quantify the direct (bird/bat collisions and barotrauma) and indirect (habitat avoidance) impacts of wind turbines on New Jersey's bird and bat wildlife resources. These surveys are required for one full year after wind turbine construction for applicants issued permits for Tier 2 and Tier 3 wind turbines and two full years after turbine construction for applicants issued permits for Tier 4A and Tier 4B wind turbines. Approval of survey methodologies by the Department is required prior to initiating post-construction monitoring.

1. Carcass Searches:

Carcass searches represent perhaps the best method we have to directly measure collisions and barotrauma caused by wind turbines to birds and bats. Carcass searches will be conducted only on the project site (no reference site) and will focus on migratory seasons when the highest numbers of collisions would be expected to occur.

Protocol: The area surrounding each turbine shall be thoroughly searched for carcasses. If the array is less than or equal to ten turbines, the area around each turbine must be searched. If the array is greater than ten turbines, ten turbines or 20% of the total number of turbines (whichever is greater) must be searched. For more detailed information on how to design these searches and analyze the data, see Section 3.0 of:
http://www.blm.gov/pgdata/etc/medialib/blm/id/plans/cotterel/rod.Par.89587.File.dat/06- avian.pdf

The following are New Jersey-specific aspects of the survey that shall be adhered to:

- The survey periods are March 15 to May 31 and August 1 to November 30 and must commence as close to sunrise as possible. A survey shall take place every 48 hours, for a total of 38 surveys in the spring and 60 surveys in the fall. In addition, if weather conditions suggest a large migration flight was likely to occur the night before, a survey shall be conducted the following morning. To determine if a migration event took place the previous night, consult NEXRAD data at: http://www.rap.ucar.edu/weather/radar/. Interpreting NEXRAD data is a complex task and should be undertaken by a person experienced in this subject. Information on interpretation may be found at: the Clemson Radar Ornithology website at: http://virtual.clemson.edu/groups/birdrad/COMMENT.HTM.
- The search area is defined as the area beneath and around each wind turbine within a distance of the base of the tower equal to 50% of the rotor-tip height of the turbine. For example, a wind turbine with a rotor-tip height of 400 feet would have a survey radius 200 feet extending from the base of the tower.
- A randomized or stratified random sampling approach shall be applied to the order in which individual turbines are surveyed on each visit.
- Digital photographs of each carcass shall be taken and submitted to the Department with the final report. Pictures shall capture the key characteristics needed for accurate identification (wing, bill, plumage coloration, etc.) and must include a ruler in at least one photo of each carcass to provide a context of scale. Any species that is listed as federally or state

endangered or threatened shall be reported to the Department within 24 hours of its discovery (for a list of these species, see: http://njfishandwildlife.com/tandespp.htm). Information on each carcass found shall be recorded on the datasheet provided in Appendix F.

- If observers are not experienced in identifying bat species (particularly those in the *Myotis* genus) the carcasses shall be collected and frozen for identification at a later date by a trained professional.

2. Carcass Removal Trials/Searcher Efficiency Trials

The results of carcass searches can be biased due to the removal of carcasses by scavengers before they can be counted as well as observer bias/error (Johnson et al. 2003). In order to better estimate the actual numbers of fatalities, the Department will require carcass removal trials to assess the impacts of scavengers, and searcher efficiency trials to correct for observer bias. Carcass removal trials are conducted by placing fresh carcasses in the search area and noting how long it takes for the carcass to be removed by a scavenger. Searcher efficiency trials involve a third party placing carcasses in the search area without the searcher knowing where they were placed. The number of carcasses detected and missed will provide information about each searcher's efficiency. These trials must be carried out throughout (and concurrent with) the carcass surveys. These surveys need to take place on the project site; a reference site is not necessary. For more detailed information on how to design these searches and analyze the data, see Section 3.0 of:
http://www.blm.gov/pgdata/etc/medialib/blm/id/plans/cotterel/rod.Par.89587.File.dat/06-avian.pdf
The following are New Jersey-specific aspects of the survey that shall be adhered to:

a. Carcass Removal Trials

- The survey periods are March 15 to May 31 and August 1 to November 30.. A removal trial shall take place once per month for a total of three surveys in the spring and four surveys in the fall.
- The number of carcasses placed out for each survey shall be determined by the Department and dependent the size of the project area. The carcasses shall represent different size classes of birds and shall include some bats as well. Carcasses that are placed in the search area shall be as fresh as possible and not frozen as this makes them less appealing to scavengers. The carcass shall be marked so that observers recognize it as a trial carcass. If carcasses are difficult to obtain, fresh carcasses found during the course of the carcass searches may be marked and used for the removal trials.
- Location of placed carcasses shall be noted and observers shall check the location every day for the first week and every two to three days thereafter until the carcasses disappear (through scavenging or decomposition) or 30 days have passed, whichever comes first.
- Data shall be recorded on the datasheet found in Appendix G1.

b. Searcher Efficiency Trials

- The survey periods are March 15 to May 31and August 1 to November 30. A total of 30 carcasses shall be placed in the turbine area for each searcher to locate (15

in spring, 15 in fall). A searcher efficiency trial shall take place once per month for a total of three trials in the spring and four trials in the fall.

- Carcasses shall not be frozen and shall be discreetly marked to denote their inclusion on this trial. The carcasses shall represent different size classes of birds and shall include some bats as well.
- Carcasses shall be placed in the search area on the morning of a regular search without the observer's knowledge and the person placing the carcass shall make every effort to conceal any indicators of his/her presence (e.g., footprints, crushed vegetation). If different habitats exist on the site (high grass, open area, gravel, etc.) then carcasses shall be placed in each habitat type. To mimic actual circumstances, carcasses shall be placed in a variety of positions (hidden, partially hidden, and exposed).
- When the observer finds the marked carcass, the observer shall note that it was discovered. If the carcass is also being used as part of the carcass removal trial, the observer shall not remove it from its location. If it is not part of a removal trial, the carcass shall be removed and disposed of.
- Data shall be recorded on the datasheet found in Appendix G2.

3. **Visual Bird Surveys –** shall be conducted as described in Section E-1.
4. **Migratory Bat Surveys -** shall be conducted as described in Section E-2.
5. **Radar Study -** shall be conducted as described in Section E-3.

II. Protocol for Evaluating Wildlife Impacts of Wind Turbines Located in Tidal Waters

A. Purpose:

Wind turbines in tidal waters have the potential to impact birds, bats and marine organisms. The potential impacts of wind turbines in tidal waters on birds and bats are similar to those located on land. Other marine organisms, including marine mammals and sea turtles, may also be affected by the wind turbine construction and operation. While the impacts of wind turbines on marine organisms are not well understood, it is known that marine mammals are sensitive to noise and vibrations. Marine mammals, particularly whales, and sea turtles are vulnerable to vessel strikes. Because there is limited information on the abundance, distribution and behavior of these species offshore of New Jersey, the Department has developed habitat evaluation, impact assessment and monitoring guidelines for wind facilities in tidal waters.

Habitat evaluations, including species surveys, impact assessments and post-construction monitoring are required in order to establish the movement corridors and distribution of birds, bats, and marine organisms and impacts of the construction and/or operation of these facilities on these species. Information shall be gathered on species composition, abundance, distribution, behavior, collisions, behavioral changes and, for birds and bats, flight pattern heights, associated with wind turbine construction and/or operation. The habitat evaluation, impact assessment and post construction monitoring are dependent upon the scope of the facility including the number, height and rotor swept area of the turbines. Habitat evaluations, impact assessments and post-construction

monitoring and reporting requirements will be coordinated with the Department, US Fish and Wildlife Service, and National Marine Fisheries Service.

B. Tidal Waters:

Tidal waters of the State of New Jersey extend from the mean high water line out to the three geographical mile limit of the New Jersey territorial sea, and elsewhere to the interstate boundaries of the States of New York, Delaware and the Commonwealth of Pennsylvania. For the purposes of this document, tidal waters are divided into two categories:

1. Atlantic Ocean waters more than 2.5 nautical miles offshore; and
2. Non-ocean tidal waters (those tidal waters located in the Urban area, Northern waterfront and Delaware River regions).

C. Habitat Evaluations for Wind Turbines Located in Tidal Waters

1. Atlantic Ocean Waters

A habitat evaluation, including species surveys, is required pursuant to N.J.A.C. 7:7E-7.4(r)1viii(3) in order to establish the movement corridors and distribution of birds, bats and marine organisms at the project site. Information shall be gathered on species composition, abundance, distribution, behavior and for birds and bats, flight patterns and heights. The survey shall be designed to document species diversity, abundance, and behaviors of birds, bats and marine organisms, such as marine mammals, sea turtles, and fish using the habitat, including airspace, where the turbine(s) will be constructed.

a. Small-scale wind demonstration project

The Coastal Zone Management rules, N.J.A.C. 7:7E provide for the construction of a small-scale wind demonstration project in the State's Atlantic Ocean water's between Seaside Park and Stone Harbor and at least 2.5 nautical miles offshore. A habitat evaluation for this demonstration project shall:

- Reference the Department's Ocean/Wind Power Ecological Baseline Studies at http://www.nj.gov/dep/dsr/ocean-wind; and
- Use existing data and scientific literature, along with targeted survey work such as bathymetry, identification of shoals and bottom type to evaluate habitat and assess impacts of construction and operation and demonstrate compliance with the Coastal Zone Management rules.

Prior to construction, the permittee shall:

- Conduct a one year pre-construction survey consisting of surveys for birds, bats, marine mammals and sea turtles. Scientific methodology appropriate for each species or group of species shall be used. The survey methodologies shall be approved by the Department prior to the initiation of any wildlife surveys.

b. All other offshore wind energy facilities

A habitat evaluation for all other offshore wind energy facilities shall:

- Use scientific methodology appropriate for each species or species group. Surveys for birds, bats, marine mammals and sea turtles, shall be conducted for a minimum of one year.
- Examine specific attributes and characteristics of the site that limit or eliminate its suitability as habitat, including, but not limited to, water depth, proximity to known foraging areas, geographic location relative to bird and marine mammal migratory pathways, and any other factors that could reasonably be used to determine habitat suitability for a species or species group;
- Include survey methodologies used during the Department's Ocean/Wind Power Ecological Baseline Studies at (http://www.nj.gov/dep/dsr/ocean-wind) to determine the presence of species in and around the project site.
- Be approved by the Department prior to the initiation of any wildlife surveys. Habitat evaluations, including species surveys, shall be completed prior to submission of an application and results included in the application.

Applicants are advised to reference the Department's Ocean/Wind Power Ecological Baseline Studies at http://www.nj.gov/dep/dsr/ocean-wind to help guide site selection.

In order for the Department to assist the applicant in siting prior to conducting surveys, the applicant is encouraged to provide the habitat evaluation and impact assessment in two steps, as follows. First, the applicant may provide the Department with a preliminary habitat evaluation and preliminary impact assessment based on existing data and scientific literature prior to applying for a permit or initiating survey work. Existing data to be consulted includes the Ocean/Wind Power Ecological Baseline Studies, Sport Ocean Fishing Grounds map, bathymetry, and shellfish maps. The Department would use the preliminary habitat evaluation and impact assessment along with published and unpublished studies and data to provide a preliminary review of the project's strengths and weaknesses under the Coastal Zone Management rules and guidance on surveys required if the applicant chooses to pursue a permit application. The review would provide guidance and would not constitute a commitment to approve or deny a permit application for the development. Second, if the applicant chooses to pursue an application, the applicant would conduct the required surveys and any forthcoming application would include a final habitat evaluation and final impact assessment, incorporating the results of the surveys.

2. Non-Ocean Tidal Waters

For projects proposed within non-ocean tidal waters, applicants shall examine the Department's Landscape Maps of Habitat for Endangered, or Threatened and Other Priority Wildlife (Landscape Maps) for the presence of endangered or threatened species habitat within 1.5 miles of the project site. Where habitat is present for endangered or threatened animal species that use tidal waters for foraging within 1.5 miles of the project site or when a project is proposed within an area that an endangered or threatened species would reasonably be expected to move through during any time of the year, applicants must demonstrate compliance with N.J.A.C. 7:7E-3.38 by following the habitat evaluation and impact assessment standards described in N.J.A.C. 7:7E-3C. In addition, applicants must conduct a one-year bird and bat survey that includes visual/audio bird

surveys for breeding birds, migrating songbirds, raptors, and shorebirds, and wintering birds; migratory bat surveys and possibly radar surveys. These one-year surveys may be completed either prior to obtaining a permit (and reported in support and as part of the required habitat evaluation) or after the issuance of the permit as a prior to construction permit condition. Wildlife surveys shall be approved by the Department prior to initiation.

The habitat evaluation shall also provide information regarding habitat for species that are not endangered or threatened, including shellfish habitat (N.J.A.C. 7:7E-3.2), prime fishing areas (N.J.A.C. 7:7E-3.4), finfish migratory pathways (N.J.A.C. 7:7E-3.5), submerged aquatic vegetation (N.J.A.C. 7:7E-3.6) and critical wildlife habitat (N.J.A.C. 7:7E-3.39).

D. Impact Assessments for Wind Turbines Located in Tidal Waters

An impact assessment is required pursuant to N.J.A.C. 7:7E-7.4(r)1viii(3) in order to identify the potential impacts of the construction and operation of a wind facility on birds, bats and marine organisms identified in the habitat evaluation. Impact assessments shall consider the likely affects of the proposed wind energy facility on the particular species on or adjacent to the project site and on species that would likely move or migrate through the project site at any time during the year. The impacts shall be assessed using accepted ecological principles and scientific literature on each species and both direct and indirect impacts of the proposed development shall be considered. This assessment shall be based on the habitat requirements and life history of each species, and the manner in which the proposed development may alter habitat, including, but not limited to, aerial space used by birds and bats, finfish migratory pathway, and migratory pathways used by marine mammals and turtles.

The information provided must demonstrate compliance with applicable rules, including Endangered or threatened wildlife species habitat (N.J.A.C. 7:7E-3.38), Critical wildlife habitat (N.J.A.C. 7:7E-3.39), Shellfish habitat (N.J.A.C. 7:7E-3.2), Surf clam areas (N.J.A.C. 7:7E-3.3), Prime fishing areas (N.J.A.C. 7:7E-3.4), Finfish migratory pathways (N.J.A.C. 7:7E-3.5), and Marine fish and fisheries (N.J.A.C. 7:7E-8.2)

E. Reporting Requirements

All habitat evaluations and impact assessments submitted to the Department shall include:

1. An introduction describing the goals of the habitat evaluation and/or impact assessment;
2. A copy of the NOAA Nautical Chart(s) showing the location of the site, with the Universal Transverse Mercator (UTM) coordinates of the site. The accuracy of these coordinates shall be within 50 feet of the actual center point of the site. For linear sites, 2,000 feet in length and longer, additional coordinates shall be provided at each 1,000 foot interval.

3. A map showing all shoals, shipwreck and artificial reef structures, prime fishing areas, shipping lanes, shellfish habitat, surf clam areas, and inlets within 10 nautical miles of the project site.
4. A map identifying the site, and any areas mapped as endangered or threatened wildlife species habitat and critical wildlife habitat on or within 1.5 miles of the site, along with a list of the species that resulted in the mapping of endangered species habitat, threatened species habitat, or critical wildlife habitat.
5. A description of the habitat requirements for each of the species or species groups identified through the habitat evaluation, including appropriate literature citations; and
6. The names and qualifications of all investigators who performed habitat evaluations, surveys, and/or impact assessments.

For wildlife habitat evaluations only, a narrative, including supporting documentation, such as maps, photographs and field logs, which contain the following:

1. A description, for each species or species group, of the findings of the habitat evaluation performed;
2. For wildlife surveys, literature citations for the methodology used and a description of how the methodology was applied to the survey, giving the following information: surveyor's name(s), dates and times surveys were performed, number of samples, and number of replications. This information shall be provided for each species or species group surveyed; and
3. A comparison of the findings of the habitat evaluation with the known habitat requirements for each species or species group, and a description of the specific attributes and characteristics of the site that limit or eliminate the site's suitability as habitat for these species.
4. Reports shall include an abstract, introduction, methodology (including site map and survey point locations), results (including all raw data collected for each survey), discussion, and conclusion.

For impact assessments only, a narrative, including supporting documentation, such as maps and photographs, which contains the following:

1. For each species or species group a description of how the proposed development will alter habitat, including, but not limited to, aerial space used by birds and bats, finfish migratory pathways, and migratory pathways used by marine organisms, including mammals and turtles. The impact assessment shall describe the likely affects of the proposed development on each species or species group on site and for endangered or threatened species, why the development would not directly or through secondary impacts adversely affect each endangered or threatened species habitat; and
2. Literature citations used to reach the conclusions.

F. Pre- and Post-Construction Monitoring for Wind Turbines Located in Tidal Waters

Pre- and post-construction monitoring is required to assess the impacts of the operation of wind turbine facilities on birds, bats and marine organisms. Monitoring

technologies are changing rapidly and some accepted monitoring techniques, such as carcass searches, would not be practical in water. The Department will continue to evaluate emerging technologies, working with the United States Fish and Wildlife Service, Bureau of Ocean Energy Management Regulation and Enforcement, National Marine Fisheries Service and other federal agencies, to determine appropriate post-construction monitoring protocols. In addition, the Department will use information gained through the Ocean/Wind Power Ecological Baseline Studies to refine protocols. Therefore, the post-construction monitoring requirements for wind turbines located in tidal waters will be determined on a case-by-case basis. However, applicants can expect a similar protocol to the baseline study and this may include visual and acoustic surveys (for birds, bats, marine mammals and sea turtles) surveys for marine organisms (such as fish and benthic species) and avian radar. These surveys would be required both pre-construction (for one year) and post-construction (for two years). Although techniques for assessing offshore post-construction mortality are in their nascent stages, some form of post-construction mortality survey is also likely to be required. As with onshore surveys, a BACI design will be incorporated and a reference area will be required. To help reduce costs and increase efficiency of surveys, an expanded project survey area may include the reference area. Exact distance between the area directly impacted by the turbines and the reference area, as well as detailed monitoring requirements, will be determined through consultation with Department.

III. References

Allen, R. P., R. T. Peterson. 1936. The hawk migration at Cape May Point. Auk 53:393-404.

Anderson, R., M. Morrison, K. Sinclair, D. Strickland. 1999. Studying wind energy/bird interactions: a guidance document. Metrics and methods for determining or monitoring potential impacts on birds at existing and proposed wind energy sites. Prepared for the Avian Subcommittee of the National Wind Coordinating Committee. http://www.nationalwind.org/publications/wildlife/avian99/Avian_booklet.pdf

Arnett, E.B., W.K. Brown, W.P. Erickson, J. K. Fiedler, B.L. Hamilton, T. H. Henry, A. Jain, G. D. Johnson, J. Kerns, R. R. Koford, C. P. Nicholson, T. J. O'Connell, M.D. Piorkowski, and R. D. Tankersley JR. 2008. Patterns of Bat Fatalities at Wind Energy Facilities in North America. Journal of Wildlife Management 72(1):61-78.

Baerwald, E.F., G.H. D'Amours, B.J. Klug, R.M.R. Barclay. 2008. Barotrauma is a significant cause of bat fatalities at wind turbines. Current biology 18(16):695-696.

Everaert, J., E. W. M. Stienen. 2007. Impact of wind turbines on birds in Zeebrugge (Belgium). Biodiversity and Conservation 16:3345-3359.

Goodale W. ,T. Divoll. 2009. Birds, Bats and Coastal Wind Farm Development in Maine: A Literature Review. Report BRI 2009-18. BioDiversity Research Institute, Gorham, Maine.

Guidelines for Conducting Bird and Bats Studies at Commercial Wind Energy Projects. Prepared by New York State Department of Environmental Conservation Division of Environmental Permits and Division of Fish, Wildlife and Marine Resources. December 2007. http://www.dec.ny.gov/docs/fish_marine_pdf/drwindguide1207.pdf

Huff, M. H., K.A. Bettinger,. H.L. Ferguson,. M.J. Brown, B. Altman. 2000. A habitat-based point-count protocol for terrestrial birds, emphasizing Washington and Oregon. Gen. Tech. Rep. PNW- G T R - 5 0 1. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 39 p. http://www.dodpif.org/downloads/point-count-protocol-WA-OR.pdf

Howe, R.W., W. Evans, A.T. Wolf. 2002. Effects of wind turbines on birds and bats in northeastern Wisconsin: a report submitted to Wisconsin Public Service Corporation and Madison Gas and Electric Company.

Johnson, G.D., W.P. Erickson, M.D. Strickland, M.F. Shepherd, D.A. Shepherd, S.A. Sarappo. 2002. Collision mortality of local and migrant birds at a large-scale wind-power development on Buffalo Ridge, Minnesota. Wildlife Society Bulletin 30 (3):879-887.

Johnson, G.D., W.P. Erickson, M.D. Strickland, M.F. Shepherd, D.A. Shepherd. 2003. Mortality of bats at a large-scale wind power development at Buffalo Ridge, Minnesota. The American Midland Naturalist 150(2):332-342.

Kerns, J., P. Kerlinger. 2004. A study of bird and bat collision fatalities at the Mountaineer Wind Energy Center, Tucker County, West Virginia: Annual report for 2003. Prepared by Curry & Kerlinger LLC for FPL Energy and Mountaineer Wind Energy Center Technical Review Committee.

Kunz, T.H., E.R. Arnett, B.M. Cooper, W.P.Erickson, R.P. Larkin, T. Mabee, M.L. Morrison, M.D. Strickland, 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):2449–2486.http://www.batsandwind.org/pdf/jwm_m&m.pdf

Leddy, K.L., K.F. Higgins, D.E. Naugle. 1999. Effects of wind turbines on upland nesting birds in Conservation Reserve Program grasslands. Wilson Bull. 111:100-104.

Mabey, S. E., J. M. McCann, L. J. Niles, C. Bartlett, P. Kerlinger. 1993. The Neotropical, migratory songbirds coastal corridor study: Final report. Virginia Department of Environmental Quality to the National Oceanic and Atmospheric Administration's Office of Ocean and Coastal Resource Management (NOAA grant # NA90AA-H-CZ839). 72 pages.
http://www.state.nj.us/dep/fgw/ensp/pdf/literature/regional-study_coastal_mig_stopover_hab.pdf

Mizrahi, D.S., K.A. Peters, V. Elia. 2008. Post-construction wildlife monitoring at the Atlantic City Utilities Authority-Jersey Atlantic Wind Power Facility. Draft report by New Jersey Audubon Society, Cape May Court House, NJ.

NJ DFW, Unpublished data. Mid-winter waterfowl survey, 1955-2009. New Jersey Division of Fish and Wildlife, Trenton, NJ.
Ocean/Wind Power Ecological Baseline Studies, January 2008 - December 2009, Final Report. July 2010. Prepared by Geo-Marine, Inc. Plano, Texas for the NJDEP Office of Science. http://www.nj.gov/dep/dsr/ocean-wind/report.htm

On-Shore Bird and Bat Pre- and Post-Construction Monitoring Protocol for Commercial Wind Energy Facilities in Ohio: An Addendum to the Ohio Department of Natural Resource's Voluntary Cooperative Agreement.
http://www.dnr.state.oh.us/LinkClick.aspx?fileticket=S24B8hy2Iu4%3d&tabid=21467

Schmaljohann, H., F. Liechti, E. Bachler, T. Steuri, B. Bruderer. 2008. Quantification of bird migration by radar –a detection probability problem. Ibis 150: 342–355.
http://infonet.vogelwarte.ch/upload/60228466.pdf

Schmidt, E., A.J Piaggio, C.E. Bock, D.M. Armstrong. 2002. National Wind Technology Center environmental assessment: bird and bat use and fatalities- final report. University of Colorado, Boulder.

Somershoe, S.G.,D.J. Twedt, B. Reid. 2006. Combining breeding bird survey and distance sampling to estimate density of migrant and breeding birds. The Condor 108: 691-699. http://www.pwrc.usgs.gov/prodabs/ab04060906/6599_Somershoe.pdf

Wakeley, J.S. 1987. Avian-line transect methods: Section 6.3.2, US Army Corps of Engineers Wildlife Resources Management Manual, Technical Report EL-87-5, US Army Engineer Waterways Experiment Station, Vicksburg, Miss.
http://el.erdc.usace.army.mil/elpubs/pdf/EL87_5.pdf

Wiedner, D.S., P. Kerlinger, D.A. Sibley, P. Holt, J. Hough, R. Crossley. 1992. Visible morning flights of neotropical landbird migrants at Cape May, New Jersey. Auk 109:500-510.

APPENDICES

Appendix A. Datasheet and Instructions for Breeding Bird Surveys

Observer _____ **Date** _____ **Start Time** _____
Location _____ **End Time** _____
Weather _____

			# Different Individuals							
			0-3 MIN			4-5 MIN				
POINT #	TIME	SPECIES	< 50 m	50-100 m	> 100 m	< 50 m	50-100 m	> 100 m	FLYOVER	ALTITUDE (if possible)

Survey Methods

1. 5-minute point counts (separated into the first 3 min and second 2 min)
2. Record individuals according to their distance from your location (< 50 meters, 50-100 meters, and > 100 meters)
3. Record all species seen and heard; use species code or common name and tick marks to record # individuals
4. Counts shall begin upon arrival at survey point; no waiting period
5. Note species heard before or after a count as "heard before" or "heard after"
6. Counts shall begin at sunrise and shall finish no later than 9:30am
7. No surveys shall be performed when it is raining (light rain is ok) or when wind exceeds 25 mph
8. Record GPS coordinates for each point

Recording Data

1. Please do not copy your data sheets over, write legibly and submit all original data sheets
2. Please be sure to fill out the top of all data sheets; **make sure all point numbers are correct**
3. Note any females or juveniles seen
4. Flyovers shall be recorded separately in column provided
5. Feel free to note evidence of breeding or other behaviors, or other species encountered

Appendix B. Datasheet and instructions for Migratory Bird Surveys

Observer _____ **Date** _____ **Start Time** _____
Location _____ **End Time** _____
Weather _____

			# Different Individuals										
			0-3 MIN			4-5 MIN			5-10 MIN				
TRANSECT/ POINT #	**TIME**	**SPECIES**	0-50m	50-100m	>100m	0-50m	50-100m	>100m	0-50m	50-100m	>100m	**FLYOVER**	**ALTITUDE (if possible)**

Survey Method

1	10-minute point counts (separated into the first 3 min, second 2 min, and last 5 min)
2	Use playback of chickadee alarm calls and record individuals seen and heard. Sequence should be:
	mins 0-3, passive listening; mins 3-6, playback; mins. 6-7, passive; mins 7-9, playback; mins 9-10, playback
3	Record all species seen and heard; use species code or common name and tick marks to record # individuals
4	Counts shall begin upon arrival at survey point; no waiting period
5	Note species heard before or after a count as "heard before" or "heard after"
6	Counts shall begin 2 hours after sunrise and end no later than 1 hour before sunset
7	No surveys shall be performed when it is raining (light rain is ok) or when wind exceeds 25 mph
8	Record GPS coordinates for each point

Recording Data

1	Please do not copy your data sheets over, write legibly and submit all original data sheets
2	Please be sure to fill out the top of all data sheets; **make sure all point numbers are correct**
3	Note any females or juveniles seen
4	Flyovers shall be recorded separately in column provided
5	Feel free to note evidence of breeding or other behaviors, or other species encountered

Appendix C. Datasheet and Instructions for Migratory Raptor surveys.

HAWK
MIGRATION
ASSOCIATION OF
NORTH
AMERICA

LOCATION _____ | |

OBSERVER(S) _____ MO____DAY____YR_____

ADDRESS

_____

TIME **(STD)**	5-6	6-7	7-8	8-9	9-10	10-11	11-12	12-1	1-2	2-3	3-4	4-5	5-6	6-7		
Wind Speed																
Wind Dir. (From)																
Temp. (Deg. C)																
Humidity																
Bar. Pressure																
Cloud Cover																
Visibility																
Precipitation																
Flight Direction																
Height of Flight																
No. of Observers															Total	
Dur. of Obs. (min)																

Black Vulture															BV	
Turkey Vulture															TV	
Osprey															OS	
Swallow-tailed Kite															SK	
White-tailed Kite															WK	
Mississippi Kite															MK	
Hook-billed Kite															HK	
Bald Eagle															BE	
Northern Harrier															NH	
Sharp-shinned															SS	
Cooper's Hawk															CH	
Northern Goshawk															NG	
Red-shouldered															RS	
Broad-winged															BW	
Short-tailed Hawk															ST	
Swainson's Hawk															SW	
Red-tailed Hawk															RT	
Ferruginous Hawk															FH	
White-tailed Hawk															WT	
Zone-tailed Hawk															ZT	
Harris' Hawk															HH	
Rough-legged															RL	
Golden Eagle															GE	
American Kestrel															AK	
Merlin															ML	
Peregrine Falcon															PG	
Gyrfalcon															GY	
Prairie Falcon															PR	
Crested Caracara															CC	
Unid. Vulture															UV	
Unid. Accipiter															UA	
Unid. Buteo															UB	
Unid. Eagle															UE	
Unid. Falcon															UF	
Unid. Raptor															UU	
Other (From Back)															OO	
TOTAL															TH	

Comments

General Directions

For weather, enter for the first hour of observation, for following hours only if data changes, if there are no changes, draw a line from the recorded data through the hours in which no change occurred; do not use ditto marks or dashes.
For hawks, enter only the number seen (no zeros). Write notes, comments, etc. below.
Send completed form to appropriate **Regional Editor** - or to - **HMANA, P.O. Box 822, Boonton,NJ 07005-0822.**

Weather and Observation Codes

Wind Speed: Enter code: 0-less than 1 km/h, (calm, smoke rises vertically); 1 - 1-5 km/h, (smoke drift shows wind direction); 2 - 6-11 km/h, (leaves rustle, wind felt on face); 3 - 12-19 km/h, (leaves, small twigs in constant motion; light flag extended); 4 - 20-28 km/h (raises dust, leaves, loose paper; small branches in motion); 5 - 29-38 km/h (small trees in leaf sway); 6 - 39-49 km/h (larger branches in motion; whistling heard in wires); 7 - 50-61 km/h (whole trees in motion; resistance felt walking against the wind); 8 - 62-74 km/h (twigs small branches broken off trees; walking generally impeded); 9 - Greater than
75
km/h.
Wind Direction: Enter compass direction from which the wind is coming, i.e., N, NNE, SE, etc. If variable, enter VAR.
Temperature: Record temperature in degrees Celsius.
Humidity: Record the percent relative humidity.
Barometric Pressure: Record barometric pressure in inches.
Cloud Cover: Record percent of sky with background cloud cover.
Visibility: Judge from your longest view and enter distance in kilometers. To convert miles to kilometers multiply by 1.61.
Precipitation: Enter code: 0 for none, 1 for Haze or Fog, 2 for Drizzle, 3 for Rain, 4 for Thunderstorm, 5 for Snow, 6 for wind driven dust, sand or snow.
Flight Direction: Enter compass direction migrants are heading, i.e., S, SSW, etc.
Height of Flight: Height of Flight. Enter code: 0 - Below eye level; 1 - Eye level to about 30 meters; 2 - Birds seen easily with unaided eye (eyeglasses not counted as aids); 3 - At limit of unaided vision; 4 - Beyond limit of unaided eye but visible with binoculars - to 10X; 5 - At limit of binoculars; 6 - Beyond limit of binoculars 10X or less, but can detect with binoculars or telescope of greater power (Mark "1" in COMMENT box and note magnification); 7 - No predominant height.
Observers: Number of observers **CONTRIBUTING** to the count for the hour noted.
Duration of Observation: Specify time in minutes.

COMMENTS

Appendix D. Migratory Shorebird and Wintering Bird Survey Protocol

General Timing and Frequency of Surveys, Survey Stratification and Chronology:

1. General Timing and Frequency of Surveys
The survey seasons are 1 May to 30 June (spring) and 15 July to 31 October (fall). A survey shall take place three times each month, separated by minimum of 5 and maximum of 10 days, for a total of 5 surveys in the spring and 11 surveys in the fall. The distribution of survey days shall be sufficient to capture tide variations associated with lunar phase which can affect abundance and habitat use (see Table 1).

Table 1. Survey Strata

Regions	Season	Paired Survey Locations within Region	Moon Phase	Tide State	Habitat Type
Atlantic Coast	Spring (May 1 - Jun 30)	Impact	Full/New (spring tides)	High	Beach
Delaware Bay Coast	Fall (Jul 15-Oct 31)	Reference	Quarter (neap tides)	Falling	Intertidal Flat (sand, mud)
	Winter (Nov 1-Mar 31)			Low	Marsh (vegetated)
				Rising	Marsh mud flat (spring-tide inundated)

2. Surveys stratification:
Within a region, project and reference locations shall be identified. Paired survey locations (project) and reference) shall both be surveyed within each season. All habitats within paired project and reference locations shall be surveyed on the same days and on the same tide state to ensure that data collected on the paired sites are comparable.

3. Survey Chronology:
A. Total Count (absolute abundance) – A total count of all shorebirds present on project and reference sites shall be performed preceding each plot survey (See #2).
B. Plot Surveys (200x 200m) – Plot surveys shall be conducted within a 200 x 200 m plot in a given habitat type on project and reference sites. Plot surveys are 20-minutes in duration; six to nine, 20-minute plot surveys can be done within one, 2-3 hour survey period. Two, 2-3 hour periods can be completed on a given survey date, each at a different tide stage (high/falling, low/rising), to capture shorebird abundance, behavior and habitat use as tides change.
C. Flight direction, flight altitude and flock size surveys -- at least one 20-minute period per survey date (± 2 hrs of high tide).

Flight Direction and Altitude
Habitat use by shorebirds is tide-dependent, and shorebirds will move between habitats as tide state changes. Moreover, spring and neap tides will also influence the use of foraging and roost sites during the lunar period.

Shorebird flocks departing from, or arriving on, project and reference sites shall be recorded as they occur – usually on rising and falling tides (± 2 hrs.). At least one, 30-minute period of flight direction and altitude shall be recorded on each survey date

Survey Protocols

1. Total Counts (two complete counts per survey date; one preceding each plot survey):
All suitable habitats (i.e., all intertidal areas or mudflats on the project and reference sites) shall be surveyed to count all shorebirds in all habitats on the site (i.e., a continuous effort, not area-limited sampling such as a point count or transect). Geographical coordinates (latitude, longitude) of the perimeter of the area surveyed shall be recorded so that results may be converted to a density of birds in each habitat type. Where survey area is limited by distance at which species identification is possible, additional surveyors may be necessary to accurately survey the entire project and/or reference sites.

Direct count and flock estimation methods can be found at:
http://www.ilmb.gov.bc.ca/risc/pubs/tebiodiv/shorebirds Resources Information Standards Committee, Integrated Land Management Bureau, Government of British Columbia Canada. Terrestrial Ecosystems/Biodiversity, Document 14, Shorebirds V. 1.1. March 1997.

2. 200 x 200 m Plot Surveys (two, 2-3 hour plot surveys per survey date)
Burger et al. 1997 (see lit. cite) conducted surveys in marsh, beach and mudflat habitats to assess abundance, behavior and use of habitats during the spring migratory stopover in Delaware Bay. This survey method will be expanded to spring, fall and wintering areas used by shorebirds to provide the basis for statistical comparison of shorebird abundance and use and behavior for pre- and post-construction on project and reference sites.

If possible, survey plots in the various habitats shall be placed at distances ranging from 100m, 300m, 500m, 1km as available to assess if post-construction avoidance of habitats occurs with proximity to turbines.

The protocol for Plot surveys can be found in:
Burger, J., L. Niles, and K. E. Clark. 1997. Importance of beach, mudflat, and marsh habitats to migrant shorebirds on Delaware Bay. Biological Conservation 79:283-292.

3. Flock flight direction, altitude, flock size estimate (one, 30-minute period per survey date):

The object of this survey is to estimate flight altitude, direction, flock size and composition, relative to the locations of proposed turbines, to assess patterns and changes, if any, in flight path, number and composition of species post-construction
Shorebirds in migration, as with those that overwinter, may remain for a period of days, weeks or months in a given area. Shorebirds move among suitable habitats to forage and roost on changing

tides, and movements (flights) are made in both the day and night. Movement patterns are likely to be predictable within and between suitable habitats and between distant habitat complexes. Establishment of daytime, pre-construction movement patterns (flight direction, altitude) between suitable habitats will aid in assessment of post-construction impacts, if any. Coupled with abundance and habitat use data, flight direction and altitude will help assess post construction flight avoidance of turbines or avoidance of suitable habitats resulting in habitat loss (Drewitt and Langston 2006). Flight surveys will also help assess potential for direct impacts, particularly if the flight paths of shorebirds are in line with proposed wind turbines and large numbers of shorebirds are moving to and from the area.

Departing or arriving flocks are most likely to begin to occur with changing tide (± 2 hrs of high tide). Flight direction of flocks, estimated altitude, # of individuals, and species, shall be recorded for a minimum of one, 30-minute period per survey day.

A compass shall be used to determine flight direction to the eight cardinal and half-cardinal directions (N, S, E, W, NE, SE, SW, NW).

Flock size can be estimated in a similar to flock size estimation methods for ground counts (see above).

References

Burger, J., L. Niles, and K. E. Clark. 1997. Importance of beach, mudflat, and marsh habitats to migrant shorebirds on Delaware Bay. Biological Conservation 79:283-292.

Drewitt, A.L., R. H. W. Langston. 2006. Assessing the impacts of wind farms on birds. Ibis 148:29-42.

[RISC] Resources Information Standards Committee, Integrated Land Management Bureau, Government of British Columbia Canada. Terrestrial Ecosystems/Biodiversity, Document 14, Shorebirds V. 1.1. March 1997. http://www.ilmb.gov.bc.ca/risc/pubs/tebiodiv/shorebirds

Burger, J., L. Niles, and K. E. Clark. 1997. Importance of beach, mudflat, and marsh habitats to migrant shorebirds on Delaware Bay. Biological Conservation 79:283-292.

PNAWPPM-III. 2000. Proceedings of National Avian – Wind Power Planning Meeting III, San Diego, California, May 1998. Prepared for the Avian Subcommittee of the National Wind Coordinating Committee by LGL Ltd., King City, Ont. 202 p.*http://www.nationalwind.org/publications/wildlife/avian98/avian98.pdf#page=142*

Appendix E1. Datasheet for Migratory Shorebird and Wintering Bird surveys- Total Counts and Plot Surveys.

Migratory Shorebird or Wintering Bird (circle one) Site type: Project Reference (circle one)
Observer _____ Date _____ Start Time _____
Weather _____ Lat/Long _____ _____ End Time _____

Time High Tide _____ Calculate # hr & min. before/after high tide for survey:
Start: _____hr _____min.
Map # (attach) _____ Stop: _____hr _____min.

	Total Count (1 before each plot survey; 2 per survey date)		**Plot Surveys (200 x 200 m)** (20 min obsn. period, 3 obsn. periods/hr over 2-3 hours; Complete two, 2-3 hour plot surveys per survey date)						
Species	**Total Count**	**Est. or Count (E or C)**	**Plot Survey start and stop time**	**Habitat Type**	**# Feed**	**# Roost**	**# Fly**	**Other**	**Total Count**

Comments:

Appendix E2. Datasheet for Migratory Shorebird and Wintering Bird surveys- Flight altitude, Direction, Flock Size and Composition.

Migratory Shorebird or Wintering Bird (circle one)
Observer _____ Date _____
Weather _____ Lat/Long _____
Time High Tide _____
Start: _____hr
Map # (attach) _____ Stop: _____hr

Flock Estimate	Direction (N, S, E, W NW, SW, SE, NE)	Distance Bin (0-50m 50-100m, or 100+m)	Altitude (m) Estimate	Species Name	Flock composition (% of ea. Spp. in Flock)

Comments:

Migratory Shorebird and Wintering Bird Surveys

General Directions for Data Sheet completion:

Weather
Fair, overcast, cloudy, light rain (note winds exceeding 25 kt. and heavy rain are not appropriate conditions for surveys)

Calculate # of hours before and after high tide for survey start and stop –
This facilitates analyses because some software cannot make this calculation.

Map #
Maps shall be used to delineate locations of Plot Surveys, Flock locations for total counts (foraging and roosting flock locations), and locations of observer for various surveys (total counts, plot surveys, flight direction/altitude surveys). Maps shall be dated, location noted, and numbered; the Map number must indicated on the data sheet to cross reference the map.

Total Count & Plot Surveys
Use one data sheet for one total count and the following plot survey; if more room is needed use an additional data sheet, and fill in appropriate information at top. Use a new data sheet for second total count and second plot survey; complete as above.

Flight Altitude, Direction, Flock Size and Composition
You may only have a brief period to assess the number of birds and composition of a flock in flight. Estimate flock size, and assess proportion of the flock comprised of each species present (see RISC 1997 document for guidance). This count is understood to be an estimate unless otherwise noted.

Appendix F. Datasheet and Instructions for Carcass Searches

Carcass Search Datasheet

Location _____ **Fatality #** _____
Searcher _____ **Species** _____
Date _____ **Age and Sex** _____

Nearest Operational Turbine # _____ **Degree** _____ **Distance** _____
Nearest Structure (if closer than op. turb.) _____ **Degree** _____ **Distance** _____
Photo #'s _____
GPS coordinates _____
Body Parts _____

Cause of Death: *circle one*

Blade Strike/Turb Collision	Electrocution	Line Strike	Predation
Barotrauma	Other	Unknown	

Evidence: _____

Estimated Time Since Death:
circle one 0-3 days (fresh) / 4-7 days / < month / >month / unknown

How ID'ed _____

Type of Scavenger/Predator:
circle one n/a / vertebrate / invertebrate / unclear

Effects of Scavenging/ Predation: _____

Insects Present: Y / N **Types:** beetles / ants / flies / larvae / pupa / other

Decay: fresh / feather and flesh / flesh and bone / bone and feathers / bone / feather spot

Flesh: fresh / gooey / dried / n/a

Eyes: round, fluid filled / sunken / dried / empty,skull / no head

Enamel: present / not present / n/a / culmen / claws

Color: leg scales: n/a / original / partially bleached / bleached
cere: n/a / original / partially bleached / bleached

Notes: _____

Adapted by New Jersey Division of Fish and Wildlife from Altamont Pass Survey Protocols

General Directions for Carcass Search Datasheet

Location- Site name of project site.

Fatality # - Shall be listed in chronological order in which carcass was located and by species group. For example, shall be listed as "Bird 1, Bird 2,...Bird *n*" and "Bat 1, Bat 2,...Bat *n*".

Searchers- Last name all present in case of future questions. The searcher recording the data lists his/her name first.

Species- Species is identified as accurately as possible (red-tailed hawk, unknown Buteo, unknown hawk). If unknown, it is listed as "unknown small bird" (smaller than a mourning dove), "unknown medium bird" (between a mourning dove and raven), "unknown large bird" (red-tail hawk-sized or larger) or "unknown bat". If an endangered or threatened species is located, this information must be reported to the Department within 24 hours of discovery.

Date – Day, Month Year

Age & Sex- if known

Nearest Operational Turbine #- This information is included even if the fatality is far from any turbines or appears to be an electrocution. Be sure to submit a map that shows the numbering system applied to the turbines if there is more than one turbine on the site.

Nearest Structure (if closer to fatality than an op turbine) – the nearest structure to the fatality (met tower, power pole, derelict turbine, other)

Degree- the compass bearing from the nearest intact turbine to the fatality.

Distance- the distance from the nearest intact turbine to the fatality in meters.

Photo Numbers- At least 5 photographs are taken with a digital camera: 4 of the fatality before it is disturbed and 1 of the surrounding area (such as overhead lines, turbines, fences, electrical poles, roads). The photo ID number shall correspond to the Fatality # , so that the photos for the first bird found shall be "Bird1a, Bird1b, ...Bird1e" or the sixth bat found would be "Bat6a, Bat6b...Bat6e".

GPS location- in latitude, longitude

Body Parts- all body parts found (for example, "whole bird" or "right wing" or "flight feathers only" or "skull, vertebrae, and sternum"). Bone measurements are included here.

Cause of Death – probable cause of death as determined by carcass location and condition (turbine blade collision, electrocution, predation, overhead lines, hit by car, etc.).

Evidence--reason for determination of cause of death when cause other than unknown is circled (e.g., fatality has broken right humerus, <10 m from turbine).

Estimated Time Since Death – age of fatality (fresh, <1 week, <1 month, >1 month)

How ID'ed --how species identification was determined (e.g., plumage, bone measurements, etc.). If rare species, give details of determination in "Notes".

Scavenger/Predator- the type of scavenger or predator (vertebrate or invertebrate), if possible to determine, and the effects of scavenging/predation.

Insects Present – if the bird has insects on it or not at the moment.

Types –type of insects observed. If other, state size and briefly describe.

Decay- stage of decay of the carcass (e.g., fresh, flesh and feathers, feathers and bone, feathers only).

Flesh- condition of the flesh of the carcass (fresh, gooey, dried).

Eyes –condition of the eyes

Enamel- if the waxy covering on the culmen and claws is present or not.

Color- if the color of the leg scales or cere have begun to fade.

Notes- additional information such as carcass condition and location, details for identification of rare species, band number if banded, obvious injuries, and potential cause of death if other than those listed above.

Adapted by New Jersey Division of Fish and Wildlife from Altamont Pass Survey Protocols

Appendix G1. Datasheet for Carcass Removal Trials Form

General Information

Site: _____ **Month:** _____

Season: _____ **Other:** _____

Information Regarding Carcasses When Placed							Condition[1] of Carcass on Days Checked										
No.	**Species/Age**	**Location**	**Expos.[2]**	**Placed By**	**Date**	**Time**	**Day**	**Day**	**Day**	**Day**	**Day**	**Day**	**Day**	**Day**	**Day**	**Day**	**Day**
1																	
2																	
3																	
4																	
5																	
6																	
7																	
8																	
9																	
10																	
Checked by:																	

[1] Condition: **I** = Intact, no evidence of scavenging, **S** = evidence of scavenging, **FS** = feather spot. **O** = carcass not present or <10 feathers

[2] Exposure: **1** = exposed position, **2** = hidden, **3** = partially hidden

General Comments:

Notes about locations of each carcass and other carcass specifics comments (including possible scavengers) and photo numbers. Continue on back if necessary.

1 _____
2 _____
3 _____
4 _____
5 _____
6 _____
7 _____
8 _____
9 _____
10 _____

Adapted by New Jersey Division of Fish and Wildlife from Altamont Pass Survey Protocols

Appendix G2. Datasheet for Searcher Efficiency Trials

Searcher Efficiency Trials: Carcass Placement Log

General Information

Site: _____ **Month:** _____

Season: _____ **Other:** _____

No.	Species/Age	Placed By	Date	Time	Location	Found? (Y/N)	Retrieved? (Y/N)	Notes
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								

Weather notes for days that carcasses are placed:

Date	*Time*	*Temp*	*Wind Direction*	*Wind Speed*	*Precipitation*

Adapted by New Jersey Division of Fish and Wildlife from Altamont Pass Survey Protocols