PENNSYLVANIA GAME COMMISSION
WIND ENERGY VOLUNTARY COOPERATION AGREEMENT
SECOND SUMMARY REPORT








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Cooperator	Date Signed
AES	04/18/2007
E. ON Climate & Renewables North America, Inc.	04/18/2007
Competitive Power Ventures, Inc.	04/18/2007
Energy Unlimited, Inc.	04/18/2007
Freedom Wind Energy, LLC	04/18/2007
Gamesa Energy USA	04/18/2007
Iberdrola Renewable Energies USA	04/18/2007
PPM Atlantic Renewable	04/18/2007
ReEnergy, LLC	04/18/2007
First Wind	04/18/2007
US Wind Force	04/18/2007
Acconia Wind Energy USA, LLC	08/20/2007
Global Winds Harvest, Inc.	08/20/2007
Penn Wind	09/28/2007
Laurel Hill Wind Energy, LLC	01/08/2008
Everpower Renewables	02/01/2008
AMP-Ohio/MESA	02/15/2008
Lookout Windpower, LLC	03/21/2008
Forward Windpower, LLC	03/21/2008
BP Alternative Energy	06/24/2008
Wind Park Bear Creek, LLC	04/03/2009
Invenergy Wind Development, LLC	06/01/2009
Tuthill Corporation Dba Blue Mountain Ski Area	12/18/2009
PPL Renewable Energy LLC	12/29/2009
New Tech Wind Inc.	12/30/2009
Duke Energy	02/16/2010
Apex Wind Energy Holdings LLC	03/10/2010
Allegheny Ridge Wind Farm LLC	06/03/2010
Volkswind USA	07/20/2010

EXECUTIVE SUMMARY

The Pennsylvania Alternative Energy Portfolio Standards Act, signed in 2004, requires that 18% of electricity sold to retail customers come from renewable energy sources within 15 years. To further understand, avoid, and minimize potential impacts to wildlife and its habitat from wind energy development, the Pennsylvania Game Commission (PGC) worked collaboratively with the wind industry to develop a Voluntary Wind Energy Cooperative Agreement (Cooperative Agreement) in 2007. The Cooperative Agreement requires at least one year of standardized pre-construction surveys and two years of standardized post-construction mortality monitoring at proposed or active wind energy facilities. Effort level for surveys is determined by assigned risk levels designated by the PGC using criteria outlined in the Cooperative Agreement. The results of pre-construction surveys are used by the PGC to prescribe avoidance and minimization measures whereas post-construction monitoring enables the PGC to assess the impacts of wind energy development to wildlife in Pennsylvania and apply adaptive management techniques to further avoid, minimize, and mitigate wildlife impacts. This report summarizes pre- and post-construction survey data gathered by Cooperators through June 30, 2010.

- During that time, 28 Cooperators were signatories of the Cooperative Agreement, representing 73% of wind projects in Pennsylvania, and 88% of the total number of developers who have active operations in Pennsylvania. See the *Cooperators* section for further information.

- Over 150 wildlife surveys have been conducted by Cooperators since 2007, resulting in better turbine placement to minimize potential impacts, protection of bat roosting locations, abandonment of sites for development, and start of the assessment process to further understand the scale of mortality at Pennsylvania wind sites. See the *Survey Results Summary* section for further information.

    - Most sites observed at least one bald eagle (*Haliaeetus leucocephalus*) or golden eagle (*Aquila chrysaetos*) during pre-construction raptor surveys but, unlike the fall surveys, it appears that eagle observations in the spring are related to raptor risk level. High risk sites tended to have higher counts of bald and golden eagles compared to lower raptor risk sites, suggesting that the current PGC pre-construction risk assessment designations may be appropriate. However, to date no post-construction eagle mortality has been documented at any Pennsylvania wind site.

    - A short-eared owl (*Asio flammeus*) presence/absence survey was conducted in 2009 at one site and no short-eared owls were documented during the survey. While the Cooperator is responsible for conducting all surveys required within the project area, PGC staff was able to help reduce monitoring costs for this Cooperator by conducting the winter portion of this survey. The Cooperator conducted the nesting survey.

- Due to issues regarding the collection, recording, and submission of bat acoustic surveys, the PGC will draft additional guidance prior to the 2011 bat acoustic survey season to address these inconsistencies.

- Telemetry surveys conducted in 2008 on eastern small-footed (*Myotis leibii*) and Indiana bats (*Myotis sodalis*) yielded new capture locations, roost locations, and foraging areas for both species. This new information has since been submitted for inclusion into the Pennsylvania Natural Diversity Inventory (PNDI). See the *Bats: Telemetry* section for further information.

- A new hibernaculum containing the federally and state-listed endangered Indiana bat was located in 2009. Also, telemetry of eastern small-footed bats documented roost locations and foraging areas that were submitted for inclusion into PNDI. See the *Bats: Telemetry* section for further information.

- A Cooperator at a site where fresh and old Allegheny woodrat (*Neotoma magister*) sign was documented has committed to conducting additional studies, including pre-and post-construction trapping of woodrats to determine the impacts of the wind facility on the active population in the area. At a second site where only old woodrat sign was documented, the site plan was adjusted to exclude the area where old woodrat sign was documented.

- The average estimated bats/turbine/year for the five surveys that followed PGC protocol was 24.6 (range 6.8 – 42.7). Hoary bats (*Lasiurus cinereus*) comprised 30% of bat mortality documented at cooperating wind facilities. Adult male bats were documented more often than juvenile or female bats. No threatened or endangered bat mortalities have been documented. However in 2009, two Seminole bat (*Lasiurus seminolus*) fatalities were documented at one site during post-construction mortality monitoring surveys. Seminole bats are known to occur in Pennsylvania, but are uncommon. The two carcasses were in excellent condition and one was submitted to the Carnegie Museum of Natural History, Pittsburgh and the second to The State Museum of Pennsylvania, Harrisburg to be preserved as voucher specimens.

- The average estimated birds/turbine/year for seven of the eleven surveys that followed PGC protocol was 3.9 (range 1.7 – 9.8). Passerines accounted for the largest portion of bird mortality at wind sites, including three migrants that are listed as endangered breeding birds in Pennsylvania. All three fatalities occurred in September 2009 with one being documented at each of three different wind sites. The three endangered birds documented were two blackpoll warblers (*Dendroica striata*) and one yellow-bellied flycatcher (*Empidonax flaviventris*). All three were determined to be migrants (i.e. not from the local breeding population) by the PGC due to the lack of breeding habitat in the vicinity and the time of year mortalities occurred.

- Cooperators did not document any large kills (greater than 50 animals in a single day event).

- Contributions to other wind related studies were made using specimens collected at the various Pennsylvania wind sites. A total of 1,109 samples (hair and/or tissue) were submitted to Eric Britzke of United States Army Corps of Engineers, Engineer Research and Development Center, Vicksburg, MS for use in various ongoing bat genetic studies. Twenty-four bat heads were submitted to the Center for Disease Control Rabies Laboratory, Atlanta, GA for a study investigating the prevalence of rabies infection in bats that are struck by wind turbines. Wing scores from 830 bats were submitted for use in the study entitled *White Nose Syndrome: Multi-state Coordination, Investigation and Response to an Emerging Wildlife Health Threat*. See the *Contributions to other wind related studies* section for further information.

- The PGC, in cooperation with the Pennsylvania Wind and Wildlife Collaborative and Cooperators, drafted best management practices. See *Appendix G* for further information.

- Indiana Bat Conservation Fund (IBCF) has been established to provide a dedicated source of funding that will 1) ensure that the direct, indirect, and cumulative adverse effects on the federally and state-listed endangered Indiana bats are adequately offset within the Pennsylvania and 2) result in tangible conservation and recovery benefits to the Indiana bat within the Commonwealth of Pennsylvania. It is agreed and understood that the IBCF will not be used for reviews of wind power projects, unless the wind developer has signed onto the PGC Cooperative Agreement and is in compliance with that Agreement. See the *Mitigation efforts* section for further information.

- Research at Cooperator wind sites in PA, on bat deterrents and curtailment has shown promise to reduce bat mortality at operational wind sites. See the *Overall Success/Challenges* section for further information.

- The Commonwealth established a new Right-to-Know Law 65 P.S. §§ 67-101-67.3103, effective January 1, 2009. That law changed the definition of public record and expanded the categories of documents that are exempt from disclosure. In order to clarify for the PGC and the public how the new Right-to-Know law will be implemented by the PGC, the PGC Commissioners unanimously voted on April 20, 2010 to amend 58 Pa. Code to include §131.9 (Disclosure of certain records). With regard to wind power records, the amendment stated: *In accordance with the Right-to-Know law (65 P.S. §§ 67-101-67.3103), public access to the following records, wherever located, will and shall only be made as set forth in paragraphs (1) – (4) below: (1) Wind power records. Commission annual reports and Pennsylvania Natural Heritage Program clearance correspondence respecting existing or proposed wind power facilities will be provided upon request, but redacted as necessary. All other records are pre-deliberative, proprietary or tending to identify the location of threatened or endangered species and will not be disclosed.* This change was, in part, needed to better protect the species of concern data collected by the wind energy cooperators' voluntary monitoring efforts. See the *Overall Success/Challenges* section for further information.

The Cooperative Agreement has allowed Pennsylvania to become one of the national leaders in determining and addressing wildlife impacts from wind energy development. The collaborative efforts between the wind industry and the PGC will continue to provide all involved parties with valuable information needed to best manage wildlife at wind energy sites. Cooperators have proven to be partners in developing conscientious renewable energy with the highest regard to the Commonwealth's wildlife resources and have set an example that others should aspire to follow.

INTRODUCTION/BACKGROUND

Act 213 of 2004, the Alternative Energy Portfolio Standards Act, signed into law by Governor Edward G. Rendell on November 30, 2004, requires that 18% of the electricity sold to retail customers in Pennsylvania come from renewable and advanced energy sources within 15 years. One of the technologies that will compete for a substantial share of Pennsylvania's alternative energy market is wind power. Under the direction of William A. Capouillez, Bureau Director of Wildlife Habitat Management, the Pennsylvania Game Commission (PGC) worked collaboratively with numerous wind energy developers (Cooperators) to immediately address potential impacts to the Commonwealth's bird and mammal resources.

As a result of this partnership, PGC biologists from the Bureaus of Wildlife Habitat Management and Wildlife Management, who have expertise in Pennsylvania bats, birds, and threatened and endangered bird and bat species and their habitats, drafted the PGC Wind Energy Voluntary Cooperative Agreement (Cooperative Agreement) in 2007. The Cooperative Agreement draft was then presented to all available wind energy developers as well as the Pennsylvania Wind and Wildlife Collaborative to further facilitate both natural resource agencies and non-governmental organizations input. The Cooperative Agreement was finalized and the first Cooperators signed the agreement on April 18, 2007 after a public news release and formal ceremony was held.

To effectively implement the Cooperative Agreement, the PGC created four limited-term wildlife biologist positions dedicated to wind energy in 2007; a statewide wind energy project coordinator based in Harrisburg in the Bureau of Wildlife Habitat Management and three field support positions that are responsible for two of the six PGC operational regions. The support positions are based in the Southwest region (NW/SW), Northcentral region (NC/SC), and Northeast region (NE/SE). The field support positions were strategically placed in regions of the state to meet the anticipated workload of project reviews and monitoring where the greatest project development was occurring. Wildlife management supervisors in each of these regions oversee the support positions and work with the statewide coordinator to manage PGC program implementation. The wind energy project coordinator position had been vacant since August 2009 and, as of June 30, 2010, two of the three support positions remained vacant. The Commonwealth's hiring freeze severely impacted the Commission's ability to fill these vacancies. However, some progress has been made (wind energy project coordinator position was filled in August 2010) and the Commission is hopeful that full staffing will exist in 2011.

This report summarizes pre- and post-construction survey data gathered by Cooperators through June 30, 2010. For an in-depth review of the Cooperative Agreement and its accompanying protocols, and/or for more background information on the Cooperative Agreement, which can be found in the first annual report, go to the PGC's public website at ***www.pgc.state.pa.us***, click on "Wildlife", "Habitat Management", and then click on "Wind Energy."

COOPERATORS

On April 18, 2007, 12 Cooperators entered into the Cooperative Agreement: AES Headwaters Wind; AES Keystone Wind; E.ON Climate & Renewables North America (formerly Airtricity, Inc.); Competitive Power Venture, Inc.; Energy Unlimited; Freedom Wind Energy; Gamesa Energy USA; Iberdrola Renewable Energies USA; PPM Atlantic Renewable; ReEnergy;

First Wind (formerly UPC Wind Management); and US Wind Force. ***Between April 18, 2007 and June 30, 2010, an additional 16 Cooperators entered into the Agreement for a total of 28.*** The additional Cooperators were Acconia Wind Energy USA; Allegheny Ridge Wind Farm; AMP-Ohio/MESA; BP Alternative Energy; Everpower Renewable; Forward and Lookout Windpower; Global Winds Harvest, Inc.; Laurel Hill Wind Energy; Penn Wind, Wind Park Bear Creek; Invenergy Wind Development; Tuthill Corporation Dba Blue Mountain Ski Area; PPL Renewable Energy; New Tech Wind Inc.; Duke Energy; and Apex Wind Energy Holdings. As of June 30, 2010, no Agreements had been terminated by either party (Cooperator or PGC).

The Cooperators' wind projects represent 73% (63 of the 86) of the wind projects that the PGC was aware of through June 30, 2010. Of the 63 Cooperator-owned projects, 19 were grandfathered into the Agreement, meaning the projects were either planned for construction within one year of entering the Cooperative Agreement or were already built and thus were only required to perform post-construction surveys. Table 1 summarizes the status of wind energy projects in Pennsylvania as of June 30, 2010.

Table 1. Status of wind energy projects in Pennsylvania as of June 30, 2010.

	Cooperator	Non-Cooperator	Total
Active	11	5	16
• Mega-Watts	619	129	748
• Total turbines	333	87	420
Proposed	52	18	70
• New	44	18	62
• Grandfathered	8	N/A	8
Total projects	63	23	86

NON- COOPERATORS

There are five additional wind energy developers in Pennsylvania with active or proposed wind sites who have not signed the Cooperative Agreement. These companies include a subsidiary of Florida Power & Light Energy, NextEra Energy Resources (five active wind sites), Reading Anthracite (one proposed wind site), STK Renewables (three proposed wind sites), OwnEnergy (two proposed wind sites), and Laurel Highlands Energy (three proposed wind sites). There are an additional eight sites in early stages of project proposal for which the potential developer has not been identified.

The PGC is currently investigating the monitoring efforts and site mortality of bats and birds of those non-Cooperators, prioritized by project site location and risk assessment from the PGC's internal reviews. These investigative efforts by the PGC will be directed towards assuring that all projects, including non-Cooperators, are employing feasible measures of protection and minimization of adverse impacts, which are anticipated to occur to the Commonwealth's bat and bird resources.

Currently, very few wind developers with active wind sites in Pennsylvania have not signed the PGC Cooperative Agreement and are not conducting post-construction monitoring. The most significant developer not signed into the Cooperative Agreement, that currently has the largest

projects, greatest number, and highest risk projects in Pennsylvania, is Florida Power & Light Energy's subsidiary, NextEra Energy Resources. Developers that have bat mortality continue to be investigated so the PGC can determine the proper course of action to safeguard and conserve bat and bird species with regard to mortality from wind energy facility operation. In fact, NextEra Energy Resources has received written warnings and several letters from the PGC regarding their post-construction monitoring efforts at their five active wind facilities in Pennsylvania. Each time the PGC has investigated sites not enrolled in the Cooperative Agreement, three times over the last two years, the PGC has found evidence of mortality. Some of the bat carcasses found during these investigations were tested and found to have evidence of barotrauma, indicating the cause of mortality was the operation of the wind facility. The PGC will continue to investigate all wind sites, paying careful attention to those not signed into the Cooperative Agreement, in an effort to further ascertain what avenues, including potential legal action, may be deemed appropriate to safeguard and conserve bat and bird species within the project area.

OBJECTIVES & GOALS

For an in depth review of the Cooperative Agreement pre-and post-construction objectives and goals, please reference the Cooperative Agreement and the 1st Annual Report which can be found on the PGC's public website at ***www.pgc.state.pa.us***, click on "Wildlife", "Habitat Management", and then click on "Wind Energy."

RISK ASSESSMENTS & PGC REVIEW OF PROJECTS

The risk assessments assigned for bats and raptors dictates what surveys and level of effort are required. Risks associated with specific bird and mammal species of special concern are addressed separately through targeted surveys. The PGC, using the criteria listed in the Cooperative Agreement, determines the risk level for monitoring and survey efforts. The Cooperative Agreement protocols use the term 'priority level' rather than 'risk level'. These terms are related and can be used interchangeably. For example, a high risk raptor site is also a high priority site for raptor surveys. The risk level may be adjusted based on new, relevant information. From 2007-2008, bat risk level increased from low to high at three sites based on pre-construction survey results and no sites had their bat or raptor risk level decreased or raptor risk increased due to pre-construction survey results (Capouillez and Librandi Mumma 2008). In 2009, risk levels were adjusted at four sites: one site had both its bat risk and raptor risks increased due to pre-construction survey results; one site had its raptor risk increased due to pre-construction survey results; one site had its bat and raptor risks decreased due to revisions to the project area; and one site had its raptor risk decreased due to revisions to the project area. Table 3 shows the raptor and bat risk assessments of the 86 wind projects as of June 30, 2010.

Table 3. Raptor and bat risk levels of the 86 Pennsylvania wind projects as of June 30, 2010.

Risk Level	Raptor	Bat
Low	45	47
Moderate	26	8
High	15	31
Not assessed yet	0	0

Risk assessments provided by the PGC are used to determine monitoring effort and to help developers site their wind energy projects. Cooperators are encouraged to submit proposed project information more than 14 months prior to construction so that the PGC can help in the early planning stages to avoid and minimize impacts to birds and mammals. Those Cooperators who submitted information on proposed projects more than 14 months in advance noted the benefit to their planning and investor processes. For example, they were better equipped to decide whether or not to proceed with conceptual projects based on the information provided by the PGC. See the *Avoidance, Minimization, and Mitigation* section of this report for more information.

PENNSYLVANIA WIND PROJECT SITE LOCATION

All of the 86 proposed and active wind sites in Pennsylvania are located in one or a combination of the following physiographic provinces: Appalachian Plateau, Ridge and Valley, Piedmont, and Central Lowlands (Figure 1). Wind developers initially targeted ridge tops but they have started to branch out into the north central part of Pennsylvania and onto some of the less prominent ridges and summits statewide. The northwest and southeast portions of Pennsylvania are also starting to be targeted for wind development. This may change in the near future as prime locations are developed and offshore wind development efforts increase in the Great Lakes.

The PGC classifies turbine configuration as one of the following: linear, linear groupings, clusters, and undetermined. "Linear" configuration is a single straight line of turbines. "Linear groupings" are more than one linear string of turbines. "Clusters" are turbines that are configured in non-linear groups. "Undetermined" configurations were those projects in which turbine configuration has not yet been established. The 86 sites include 20 linear, 15 linear groupings, 13 clusters, and 38 undetermined projects. Of these known configurations, there are 8 linear, 12 linear groupings, 13 clusters, and 21 undetermined within the Appalachian Plateau province and 11 linear, 3 linear groupings, no clusters, and 14 undetermined within the Ridge and Valley province. There is one site in the Piedmont province (configuration undetermined), two that contain both the Appalachian Plateau and Ridge and Valley provinces (one undetermined and one linear configuration), and one site located within both Ridge and Valley and Central Lowlands provinces (undetermined configuration).

Site locations are described as being ridgetop, escarpment, butte, or unknown. This determination is made by examining topographical maps. "Ridgetop" is defined as a long, narrow chain of hills or mountains. "Escarpment" is defined as a transition zone involving a sharp, steep elevation differential, characterized by a cliff or steep slope. "Butte" is defined as

an isolated hill (or hills) with steep, often vertical, sides and a small flat top. Site locations were designated by categories with the following frequencies: 30 ridgetop, 8 escarpments, 37 butte, and 11 unknown.

Elevation of wind projects in Pennsylvania ranged from 600 to 3200 feet above sea level (Figure 2); Pennsylvania's elevation ranges from sea level to 3, 213 feet above sea level.

The majority of Pennsylvania's land cover is deciduous forest (57%; Williams et al. 2005) and 90% of wind energy facilities occur in this land cover type. The remaining 10% of Pennsylvania wind energy facilities, are built on agricultural (hay, pastures, or row crops) or mining (mines or quarries) lands. On average, land cover types within Pennsylvania wind project areas include: 71% deciduous forest, 11% pasture/grass, 5% row crops, 5% evergreen forest, 5% mixed deciduous forest, 2% water/wetland, and 1% residential, industrial, and/or commercial lands. Further analysis of land cover types in relation to pre- and post-construction survey results is planned for the future.

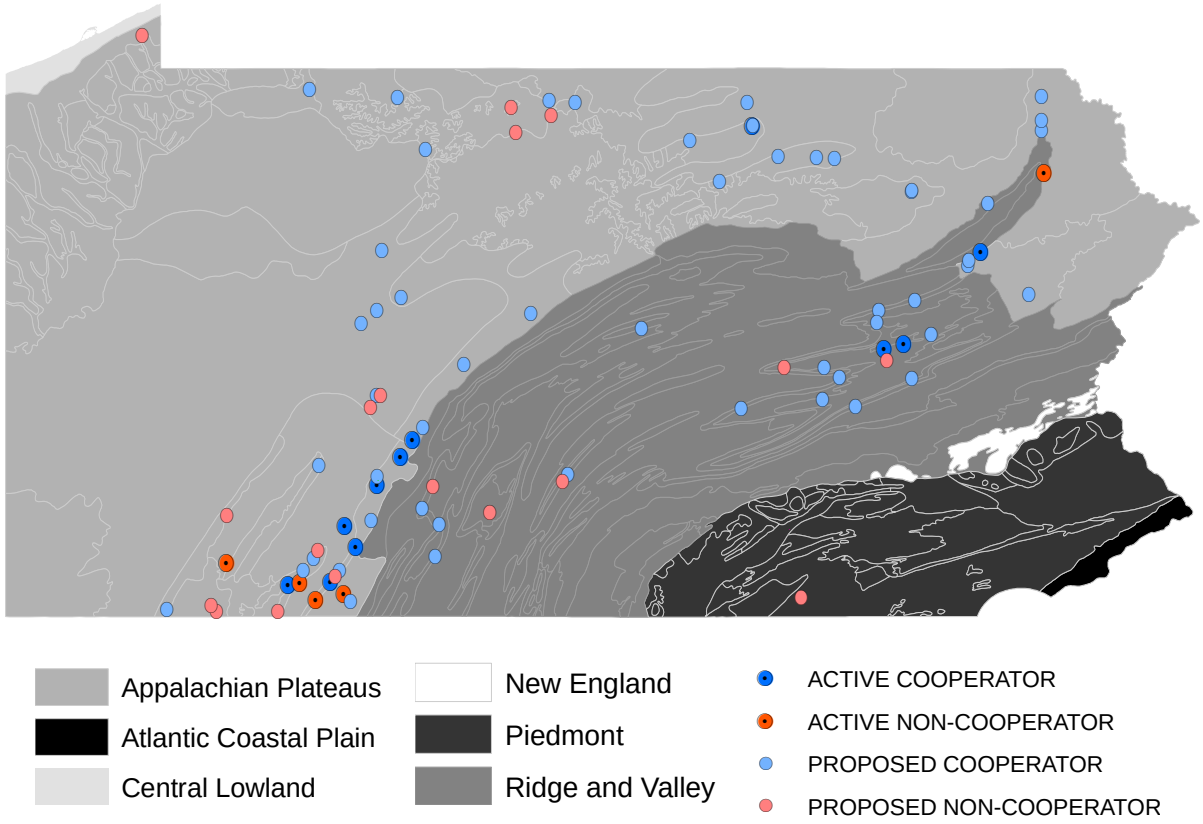

Figure 1. Pennsylvania wind projects (includes both active and proposed) by physiographic province and cooperator status, as of June 30, 2010.

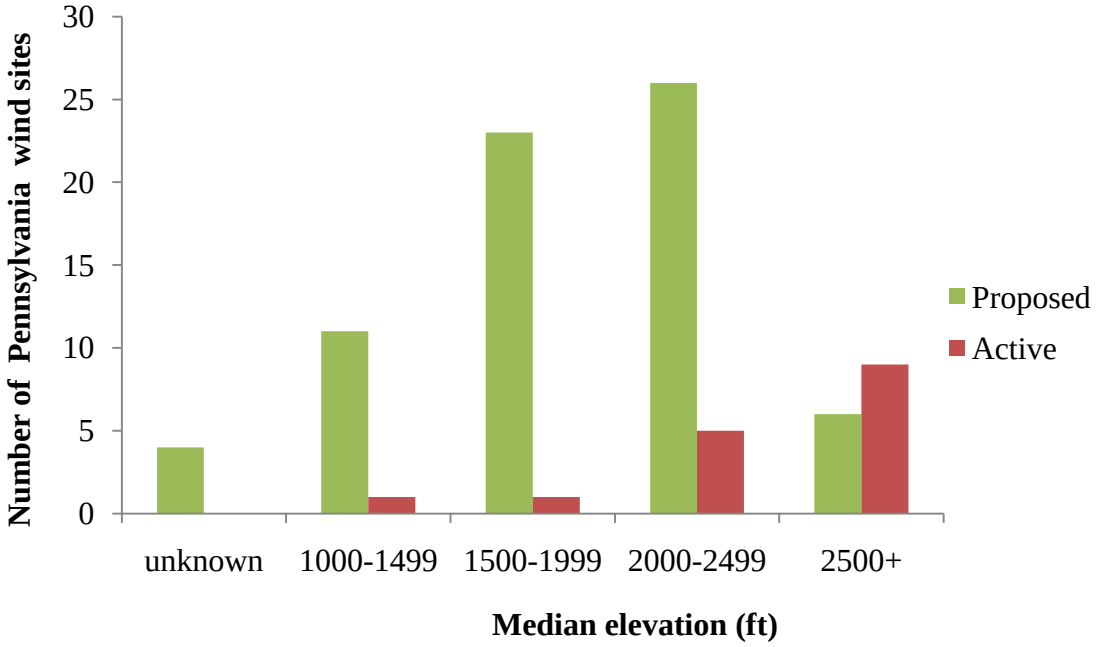

Figure 2. Median elevation (ft) of Pennsylvania's 86 active and proposed wind sites.

SURVEY RESULTS SUMMARY

Two hundred pre- and post-construction bird and mammal surveys have been completed at Pennsylvania wind energy sites since 2004 (Table 4). Inconsistencies in data collection pre- and post- Cooperative Agreement (2007) have resulted in difficulties interpreting results and comparing the results between sites. Site names and locations have been replaced with site identification codes in data summary tables to preserve the confidentiality of this information as provided in the Cooperative Agreement. Since the Cooperative Agreement has been in place, Cooperators have funded one or more pre-construction wildlife surveys at 33 wind sites and post-construction surveys have been initiated at 11 sites, resulting in more than 56,000 hours of data collection.

For pre-construction surveys, the PGC encourages wind energy developers to have PGC staff involved in the selection of observation sites, acoustic detector locations, and other details of the studies. The PGC attempts to visit each site at least once during every survey to answer questions, make sure the agreed upon monitoring protocols are being followed, and the correct data sheets are used and properly completed. Open lines of communication between consultant, wind energy developer, and the PGC are essential for recognizing and correcting problems as they arise instead of collecting a full season of data that are not standardized and unusable because they were not collected in accordance with the approved protocols. PGC wind biologists observed 48 pre-construction surveys between October 1, 2007 and June 30, 2010 (Table 5). From 2007-2009, PGC staff also visited all 11 sites where post-construction monitoring was conducted. The PGC has had vacancies in two of the three field positions within the last year, resulting in a decrease in the number of pre-construction surveys observed.

Table 4. Summary of bird and mammal surveys completed at wind facilities in Pennsylvania, 2004 – 2009.

	2004	2005	2006	2007	2008	2009	Total
Pre-construction							
Potential hibernacula investigations [a]	0	2	5	4	3	4	18
Bat acoustics	0	2	2	9	8	6	27
Bat mist netting	1	2	5	7	11	8	34
Bat telemetry	0	0	0	3	4	1	8
Breeding bird surveys	0	0	2	9	4	7	22
Fall raptor migration	1	1	6	9	5	2	24
Spring raptor migration	0	0	5	6	6	0	17
Mammal species of concern surveys [b]	0	1	3	2	6	2	14
Bird species of concern surveys [c]	0	1	6	1	1	2	11
Post-construction							
Mortality (bird and bat)	1[d]	0	1[d]	1	4	6	13
Bat acoustics	0	0	0	0	3	2	5
Fall raptor migration	0	0	0	0	2	1	3
Spring raptor migration	0	0	0	0	0	0	0
Breeding Bird Surveys	0	0	0	0	0	0	0
Radar	0	0	0	0	2	0	2
Other [e]	0	0	0	0	0	2	2
Total number of surveys conducted	3	9	35	51	59	43	200

[a] Potential bat hibernacula surveys refer only to those conducted on the project area by the Cooperator.

[b] Mammal species of special concern surveys include the following: state threatened Allegheny woodrat (*Neotoma magister*) and state endangered northern flying squirrel (*Glaucomys sabrinus*).

[c] Bird species of special concern surveys include the following: state threatened upland sandpiper (*Bartramia longicauda*) and bald eagle (*Haliaeetus leucocephalus*), and state endangered short-eared owl (*Asio flammeus*).

[d] Mortality surveys conducted prior to the Cooperative Agreement did not follow PGC protocols.

[e] Other surveys include those such as bat deterrent, curtailment, etc.

Table 5. Number of bat, bird, and other (woodrat, radar, etc.) pre-construction surveys observed by PGC between October 1, 2007 and June 30, 2010.

Pre-Construction Surveys Observed	10/1/07 – 9/30/08	10/1/08 – 9/30/09	10/1/09 – 6/30/10	Total (10/1/07 – 6/30/10)
Bat Surveys	5	12	0	17
Bird Surveys	12	8	3	23
Other Surveys	5	3	0	8
Total Surveys Observed	22	22	3	48

PRE-CONSTRUCTION
Birds

Fall raptor migration survey results

Raptor migration varied across the state as expected. A summary of results from pre-construction fall raptor surveys completed 2004 - present, for which the PGC has received data, is shown in Appendix A. The total number of each species observed was divided by the total number of raptors observed at each site to determine percent of flight for each species. Raptors per hour varied for all sites regardless of the raptor risk level. Two low risk raptor sites (wind sites 2-1 and 35-1) recorded more raptors per hour than sites which had a higher risk level. Surveys, such as these, which were conducted for a short period of time during the peak migration for individual species, may explain these higher than expected daily passage rates. For example, both of these fall raptor migration surveys were conducted in September - October when broad-winged hawks *(Buteo platypterus*) migrate. The effect of the survey date on the results is demonstrated by the daily passage rate of this species. This effect is also illustrated by the higher daily passage rate of American kestrels (*Falco sparverius)*, bald eagles (*Haliaeetus leucocephalus*), and broad-winged hawks for wind site 35-1 where the raptor survey was conducted on two days during these species' peak migration periods. One benefit to conducting voluntary raptor migration surveys at raptor sites designated as low risk is that data are being collected on ridges and summits for which there were little or no raptor migration data previously.

Nineteen of 24 raptor survey sites (79%) observed at least one bald eagle. Of the five that did not observe a bald eagle, four were categorized as low raptor risk sites and one was ranked as a moderate risk site. The highest total number of bald eagles counted during any of the fall raptor migration surveys occurred in 2009 when 248 were observed at site 6-11 (high raptor risk site). More than ten bald eagles (range 18 - 248) were observed at seven of the 24 raptor survey sites (29%); the risk levels of the seven sites were: two low risk, one moderate risk, and four high risk. Bald eagles made up 3.8% of the total raptors observed during all fall raptor migration surveys since 2004. Generally, few bald eagles are seen at any site on any given day. However, the number of bald eagles in the Northeastern states has increased as bald eagle populations have recovered (Farmer et al. 2008).

Five of 24 sites (21%) did not observe golden eagles (*Aquila chrysaetos*). Of these five sites, three also did not observe bald eagles (two low risk sites and one high risk site). The highest total number of golden eagles counted during fall raptor migration surveys occurred in 2007 with 73 observed at site 3-4 (high raptor risk site). More than ten golden eagles were observed at 6 sites (25%) during fall surveys (range 22 - 73); the risk levels of the six were all high. Golden eagles comprised 0.7% of the total raptors observed during the fall raptor migration surveys conducted since 2004. High risk raptor sites had higher percentages of golden eagles observed than moderate or low risk sites.

Turkey vultures (*Cathartes aura*) (22.5% of total raptors observed), broad-winged hawks (20.7%), and red-tailed hawks (*Buteo jamaicensis*) (18.7%) were the three most common raptors observed during fall migration surveys. Rough-legged hawks (*Buteo lagopus*) were the least observed raptors (<0.1% of total raptors observed), followed by northern goshawks (*Accipiter gentilis)* (0.2%) and Merlin (*Falco columbarius)* (0.3%). Only four raptor species were observed

at all 24 fall raptor migration surveys: Cooper's hawks (*Accipiter cooperii*), northern harriers (*Circus cyaneus*), red-tailed hawks, and turkey vultures.

Spring raptor migration survey results

A summary of results from pre-construction spring raptor surveys completed 2006 – 2009, for which the PGC has received data, is shown in Appendix B. Spring raptor migration surveys were not conducted prior to 2006. The total number of each species observed was divided by the total number of raptors observed at each site to determine percent of flight for each species. Raptors per hour varied for all sites regardless of the raptor risk level.

Bald eagles were observed at 13 of 17 spring raptor survey sites (76%). The four sites where bald eagles were not observed were categorized as low risk to raptors. The highest total number of bald eagles counted during any of the spring raptor migration surveys occurred in 2009 when 37 were observed at site 6-11 (high raptor risk site). Two of the 16 sites (13%) observed more than ten bald eagles during their spring surveys (23 and 37 respectively); both of these sites are high risk. Bald eagles comprised 1.7% of the total raptors observed during all spring raptor migration surveys.

Eight sites (53%) did not observe golden eagles; of these, three also did not observe bald eagles (two low raptor risk sites and one moderate raptor risk site). Of the eight sites, five were low risk sites that were not required to conduct a spring raptor survey (but still did), two were moderate risk sites, and one was a high risk site. The highest total number of golden eagles counted during any of the spring raptor migration surveys occurred in 2006 when 47 were observed at site 3-2 (high raptor risk site). Four sites observed more than ten golden eagles (range 19 - 42) during spring raptor surveys; all four sites had been ranked as high risk to raptors. Golden eagles comprised 2.3% of the total raptors observed during all spring raptor migration surveys.

More golden eagles were observed during spring raptor migration surveys at high risk sites than at moderate or low risk sites. One exception, however, was one low risk site that only conducted surveys during six days in March, which may have skewed its percentages versus other sites that conducted surveys throughout March. Turkey vultures (55.2% of total raptors observed), red-tailed hawks (14.6%), and broad-winged hawks (7.2%) were the three most common raptors observed during spring migration surveys. Peregrine falcons (*Falco peregrinus*) were the least observed raptors (0.1% of total raptors observed), followed by northern goshawks (0.2%), then merlin and rough-legged hawks, each of which accounted for 0.3% of the total raptors observed. Only three raptor species were observed during all spring raptor migration surveys: sharp-shinned hawks (*Accipiter striatus)*, red-tailed hawks, and turkey vultures.

Most sites did observe at least one bald or golden eagle but, unlike the fall raptor surveys, it appears that eagle observations in the spring are related to raptor risk level. High risk sites tended to have higher counts of bald and golden eagles compared to lower raptor risk sites, suggesting that the current PGC pre-construction risk assessment designations may be appropriate. However, to date no post-construction eagle mortality has been documented at any Pennsylvania wind site.

Spring raptor migration surveys conducted in 2006-2007 were completed when the Cooperative Agreement and protocols were being finalized, so most surveys completed during this time period did not follow the current protocol. For example, many of these surveys were conducted in April instead of March and were not conducted during the times of day outlined in Exhibit A of the Cooperative Agreement. Surveys conducted in March during these years detected golden eagles, whereas sites that conducted April – May spring migration surveys did not detect golden eagles. These data support the premise that spring raptor migration surveys should be conducted in March, in accordance with the PGC's recommended protocols, to capture eagle migration (Brodeur et al. 1996, Brandes 1998, McWilliams and Brauning 2000, Brandes 2006). The 2008 spring raptor migration surveys were not all conducted in accordance with the PGC recommended protocols outlined in the Cooperative Agreement. Issues with the 2008 spring raptor migration surveys included: Cooperators not consulting with the PGC before conducting the surveys resulting in surveys not meeting the effort requirements for their risk level or Cooperators not consulting with the PGC prior to the start of the survey season resulting in delayed starts to their monitoring efforts. In the coming years, flight pathways and height for both fall and spring raptor migration surveys will be analyzed to determine if there are any patterns or trends.

Wind sites where the highest percentages of bald and golden eagles were observed were not always the same between seasons or eagle species. For spring surveys, three (sites 3-2, 2-18, and 24-2) of the top five sites were the same for both bald and golden eagle observations. During fall surveys, however, only one site (site 3-4) was in the top five for both bald and golden eagles.

Sites with the top five highest percentages of observations for bald eagles were not identical between spring and fall surveys either. Only one site (6-11) was in the top five for both spring and fall surveys; this site had the second highest of all spring surveys and highest of all fall surveys. The sites with the top five highest percentages of bald eagles observed in the spring were all high raptor risk sites. The sites with the top five highest percentages of bald eagles observed in the fall were comprised of two high risk, two moderate risk, and one low risk site. Note that spring raptor surveys are required at high risk sites and moderate risk sites that noted eagle migration during their fall raptor migration survey effort. Low risk sites are not required to do raptor migration surveys, but some Cooperators have chosen to conduct at least a few days of fall and/or spring raptor migration monitoring.

For golden eagles, sites with the top five highest percentages of observations were almost identical between spring and fall surveys. Four sites, all high risk, placed in the top five for both raptor migration surveys. The top two sites (3-2 and 3-4, respectively) for spring and fall golden eagle survey observations were identical. The additional spring site (4-3) was of moderate risk and the additional fall site (3-6) was of low risk. Site 3-6 conducted only 14 days of fall raptor migration surveys, which may have resulted in the percent of each species being inflated compared to those sites that conducted over 50 days of fall raptor surveys. These data suggest that bald eagle observations may not be as good of an indicator of risk level as golden eagle observations since the bald eagle population has soared in recent years and thus, observing bald eagles has become more common. We do not currently have post-construction data to validate whether sites with the highest percentages of bald and/or golden eagle observations could lead to eagle mortalities; post-construction surveys are planned at some of the sites in question next year.

Raptor migration surveys showed that bald and golden eagles migrate northward through northcentral and northeast Pennsylvania but not in the high concentration that have been observed at the Allegheny Front and Hawk Mountain hawk watch sites. The raptor migration surveys from these regions concur with research conducted by Todd Katzner (2008) on bald and golden eagles which shows these eagles using northcentral and northeast Pennsylvania as migratory routes. These studies are adding to the information already known about golden eagle migration (see Brodeur et al. 1996, Brandes 1998, Goodrich and Smith 2008) by giving specifics about golden eagle relative numbers at certain ridge, summits, and bodies of water that had not been previously documented.

The PGC will map and analyze the results of all raptor migration surveys in the coming year. This effort is to confirm potential raptor risk levels assigned to those ridges for which we have data. These maps, documenting migratory pathways of raptors and eagles, will be included in the next summary report.

Breeding Bird Survey Results

Results of the breeding bird surveys received by the PGC are included in Appendices C-E. No breeding bird surveys were conducted at proposed wind sites prior to 2006. Nine sites conducted breeding bird surveys in 2007, four sites conducted breeding bird surveys in 2008, and seven sites conducted breeding bird surveys in 2009.

Appendices D and E list Wildlife Action Plan (WAP) bird species identified during point counts and area searches respectively. During the 22 breeding bird surveys conducted at 19 sites through 2009, 20 point counts and 14 area searches detected at least one WAP priority bird species; ten surveys observed one or more Pennsylvania endangered bird species and three surveys documented at least one Pennsylvania threatened bird species and one or more Pennsylvania endangered bird species (Appendices D & E). Total number of species varied considerably from 25 to 107 and number of non-listed WAP bird species detected ranged from 4 to 25.

The state-listed endangered birds observed include yellow-bellied flycatchers (*Empidonax flaviventris*) and blackpoll warbler (*Dendroica striata*). All of these observations were deemed to be migrants based on the date they were observed and lack of appropriate breeding habitat in the area. The state-listed threatened species included osprey (*Pandion haliaetus*) and upland sandpiper (*Baratramia longicauda*). Both osprey observations were of individuals flying over and not confirmed breeders. For the site that documented upland sandpiper, the PGC has since requested an upland sandpiper survey. However, this site has not yet completed the survey due to the project being on hold for the time being. For confirmed breeding species, the PGC will work with the Cooperator to best avoid and minimize impacts to such habitat. The PGC does not have an example of this yet since the state-listed endangered and threatened species that have been documented via breeding bird surveys have all (with the exception of the upland sandpiper) been deemed migrants. The PGC will be tracking all of the sites that have documented state-listed species during pre-construction breeding bird surveys to see if mortality of these species occurs at these sites post-construction.

Although inconsistencies in methodology and reporting preclude rigorous analysis of the breeding bird data, the species lists generated from point counts and area searches are indicative

of species that are likely to be adversely impacted by changes in land cover. This is best exemplified by those sites that found species known to be indicators of high quality forests with structural diversity that are also sensitive to edge effects, created by forest fragmentation, such as blue-headed vireo (*Vireo solitaries*), black-throated blue warbler (*Dendroica caerulescens)*, black-throated green warbler (*Dendroica virens*), worm-eating warbler (*Helmitheros vermivorum*), and scarlet tanager (*Piranga olivacea*). The PGC will continue to investigate how changes in habitat type may affect bird communities at wind sites.

According to the protocols found in Exhibit A of the Cooperative Agreement, point counts are to occur once in May and twice in June, with June visits separated by at least one week. Area searches are to be conducted once within each of three time periods, mid-March – April 30, May 1 - 31, and June 1 – July 10, at each area search location. Derivations from PGC protocols can be found in the 'comments' column in Appendix C. The PGC protocols were designed to target breeding seasons of threatened, endangered, and species of special concern birds. Failure to survey during these time periods may lead to false conclusions about the status (absence or presence, migrant or breeding) of bird species listed in the WAP (Williams et al. 2005) and the relative abundance of their populations at the site.

Area searches are conducted to supplement (or, in unique situations, replace) point counts, yet many of the area search data have not been submitted in a way (i.e. separate from the point count data) that the PGC can determine whether area searches are, in fact, supplementing point counts by increasing the number of species detected. We do know that several species listed in Pennsylvania as either endangered, threatened, or species of special concern are more easily detected with area searches or specialized surveys than with point counts. Therefore, area searches will continue to be used in breeding bird surveys. Lastly, some survey reports were submitted to the PGC without the accompanying data and completed data sheets that verify survey results.

The PGC continues to emphasize the importance of consulting with the PGC early in the planning process to determine where point counts and area searches should be done prior to commencing breeding bird surveys. The Cooperator must coordinate prior to the breeding bird surveys to determine which surveys will best suit the project area, whether they are only point counts, only area searches, or point counts and area searches. The protocol also states that 'the PGC will be flexible with regard to breeding bird survey sampling intervals.' The coordination between the Cooperator and PGC prior to surveys being conducted is when these issues should be resolved, not after a survey has been conducted. Each site is different and thus the PGC attempts to modify survey protocol when possible, to conform to the needs of each individual project, however, this cannot be done if no coordination with the PGC is initiated prior to surveys being conducted. Coordination with the PGC prior to breeding bird surveys will help to ensure the entire area and all habitats are being surveyed adequately and will reduce the chance that the PGC will have to ask the Cooperator to redo or conduct additional surveys.

The Cooperative Agreement does not require post-construction breeding bird surveys unless the PGC deems it necessary due to the presence of a threatened or endangered species or species of special concern. The PGC has started to recommend post-construction breeding bird surveys to record whether the species observed prior to construction activities remain on-site after construction has been completed. To date, the sites for which the PGC has requested post-

construction breeding bird surveys have not yet gone to construction and thus no post-construction breeding bird surveys have been conducted.

Bird Species of Special Concern Survey Results

Bird species of concern surveys conducted at proposed wind sites have included bald eagle nest surveys, short-eared owl (*Asio flammeus*) presence/absence surveys, and upland sandpiper (*Bartramia longicauda*) surveys. Species specific bird surveys such as these are requested by the PGC at sites that have known or historical occurrences of the species on or in the vicinity of the proposed project area. Nine bald eagle nest surveys, one short-eared owl survey, and one upland sandpiper presence/absence survey have been conducted at Pennsylvania wind sites. Only one of the nine has been conducted since the bald eagle was removed from the federal Endangered Species list on August 9, 2007. None of the bald eagles nest surveys documented bald eagle nests within the proposed project area. Only one bald eagle nest survey documented a bald eagle nest outside the project area, over a mile from the proposed project area. Bald eagle nest surveys may be requested by either PGC, because they are a state threatened species, or the U.S. Fish and Wildlife Service, because they are protected under the Migratory Bird Treaty Act and Golden and Bald Eagle Protection Act.

A short-eared owl presence/absence survey was conducted in 2009 at one site and no short-eared owls were documented during the survey. ***While the Cooperator is responsible for conducting all surveys required within the project area, PGC staff was able to help reduce monitoring costs for this Cooperator by conducting the winter portion of this survey.*** The Cooperator conducted the nesting survey. In 2009, at a different site, an upland sandpiper presence/absence survey was conducted following PGC protocols. No upland sandpipers were observed during the survey.

<u>Bats</u>

Potential Hibernacula Investigations

The investigation of potential hibernacula within the project area is the Cooperators' responsibility. Since the Cooperative Agreement has been in effect, the PGC has received reports from 18 sites that have conducted bat hibernacula investigations. Six of the 18 sites (33%) identified potential bat hibernacula on the project area that needed to be trapped. At these six proposed wind sites, 32 potential bat hibernacula features have been trapped. One of these 32 features was identified as a hibernaculum of concern as defined in the Cooperative Agreement (Exhibit C) due to the fact that one of the four bat species captured was an Indiana bat (*Myotis sodalis*), a federally endangered and state threatened species. Eleven of the 32 features trapped (34%) documented northern long-eared bat (*Myotis septentrionalis*), a species of special concern. The other features were not labeled as hibernacula of concern due to the total number of bats captured or number of different species present.

The PGC investigates potential bat hibernacula within five miles of the proposed project area (Table 6). Two of the mine features investigated in the NE/SE region were known bat hibernacula records that were 14 years old with no GPS coordinates available. Once located, these two features were trapped and both were found to contain bats. One hibernaculum contained the state threatened eastern small-footed bat (*Myotis leibii*), reconfirming the bat species presence from the 14 year old record and confirming that the hibernaculum was one of concern according to the Cooperative Agreement. Another mine feature in the NW/SW region

was further investigated by trapping and two species of special concern northern long-eared bat were caught.

Table 6. Number of mine features investigated by PGC regional wind biologists within five miles of wind projects and the number of hours spent conducting those investigations through June 30, 2010.

Investigated by PGC staff	NW/SW	NC/SC	NE/SE	Total
No. mines within 5 mi of project area	241	182	6	429
Total hours spent investigating mines	508	195	29	732

Acoustic Monitoring

Acoustic monitoring has proven to be the most problematic. Many issues have occurred during the data collection and reporting process, making data analysis extremely challenging. One of the most common problems is failure to adjust nightly start and stop times to include the full survey period of ½ hour before sunset until ½ hour after sunrise throughout the monitoring period, as required by PGC protocol. This problem was further complicated by varying detector success rates (percent of the time detectors are properly functioning and collecting data). Another issue is that bat acoustic surveys are not always conducted by Cooperators during the specified seasons. For example, a low risk site is to conduct bat acoustics from July 15 - October 15 but several sites have not started on time and then extended the survey beyond October 15, figuring they can make up for the lost time in July by going into November. Lengthening the season does not provide data for the targeted peak bat activity period of July 15 – October 15. Finally, the Cooperative Agreement states that "all MET towers installed on-site should be equipped with acoustic monitoring devices as close to the rotor zone as possible." This is not always occurring because either the MET towers are not all installed or they are relocated or removed. Because of this, some sites are placing detectors on only a few of the MET towers and/or using portable towers. Detectors are installed as high as possible on these structures, but they still do not reach the height of the rotor sweep zone. Overall, the data being collected are not standardized since Cooperators are not following the protocol guidelines provided in Exhibit B of the Cooperative Agreement.

We have received data and/or reports from 27 pre-construction bat acoustic surveys conducted at 21 individual sites between 2005 and 2009. Cooperator used the following bat acoustic detectors to conduct pre-construction bat acoustic surveys (No. surveys): (2) Pettersson D500x, (6) Anabat 6.2, (10) Anabat II, (3) Anabat SD1, (3) AR 125, and (3) used both Anabat II and Anabat SD1. There is no relationship between type of detector used and whether PGC protocol was followed because the deviations from PGC protocol were mostly operator issues, not equipment malfunctioning issues. Calls per hour varied between 0.1 and 5.6 per site with an average of 1.1 calls/hour and a standard deviation of 1.5. Since all sites did not adhere to PGC protocol these summary statistics should be interpreted with caution. Eight of the 27 surveys (all conducted during 2008 or 2009) did follow PGC protocol. The average calls/hour for these eight sites ranged from 0.1 - 4.7, with an average of 1.2 and a standard deviation of 1.6.

Detector number and height vary between wind sites with most sites having two detectors at different heights; one at ground or low level and the second at moderate or high level. Height

levels fall into one of the following categories: ground level <5 m, low level 5 - 10 m, moderate level >10 - 40 m, and high level 40+ m. The percent of surveys conducted that had at least one detector at each of the following detector levels was as follows: ground = 56%, low = 26%, moderate = 52% and high = 62%. If the high level requirement is expanded to include those detectors at 40 m, 78% of surveys had at least one detector at 40 m or higher. Unfortunately, of the 21 sites that fall into this category, only 43% (9 of the 21) followed PGC protocol.

Some general trends can be derived from the bat acoustic data obtained to date by the PGC. The big brown/hoary/silver-haired guild appear to have greater activity at high detectors; red bats (*Lasiurus borealis*) and tri-colored bats (*Perimyotis subflavus*) are found to have approximately the same activity level at all detector heights; and *Myotis* species are found to have greater activity at the low level detectors. From a seasonal perspective, bat activity peaks in late summer/early fall. At one proposed wind site, bat activity at one detector set up near an open water pond documented ten times more calls then detectors set up in forested areas. The high level of bat activity concentrated at the open water pond can most likely be attributed to bat feeding activity. Regional trends in bat activity and patterns of species detection will be examined in the future since it appears that comparison of call rates between sites may be influenced by the varying attributes of each site.

To make site specific recommendations based on acoustic data, the PGC determined that the overall detector success rate should be at least 80% (i.e. 80% of the nights with detectors operational and able to collect data). This 80% minimum criteria threshold has prompted Cooperators to target 80% success since spring 2008, which is when the PGC initially received and reviewed the acoustic reports from 2007 and realized there was a problem. By having a target success percentage, the Cooperator is encouraged to monitor the detectors more frequently. This ensures that problems are discovered and remedied as soon as possible, minimizing the risk of data loss and potential need to redo the survey. Success rates have improved since 2007, but some sites have success rates of less than 80% because of problems such as memory card overload, vandalism, and malfunctioning detectors. Nine of the 27 (33%) pre-construction bat acoustic surveys had less than an 80% success rate. The success rates at these nine sites ranged from 28 – 78%, with an average success of 61%.

In addition to requiring that acoustic detectors on all MET tower be installed as close to the rotor zone as possible, PGC protocol (Exhibit B of the Cooperative Agreement) states that "detectors should record from 30 minutes prior to sunset to 30 minutes following sunrise every day." For the 18 sites that did not follow protocol, 61% did not survey from 30 minutes prior to sunset to 30 minutes following sunrise every day, 83% did not survey within the correct dates, and 39% did not have at least one detector on a MET tower at the highest level (40 m or higher). The correct date of a survey is dictated by bat risk level, for low risk sites it is July 15 – October 15, for moderate risk it is April 1 - 30 and July 15 – November 15, and for high risk sites it is April 1 – November 15.

The reporting of bat acoustic data has not been consistent. The PGC staff has been unable to extract summary information from the acoustic surveys since the survey data were submitted in various forms, with much of it not following PGC protocol for data collection and presentation. The Cooperative Agreement includes a data sheet for bat acoustics in Exhibit B, but the PGC has converted it to an Excel spreadsheet to facilitate data submission. The spreadsheets are not being

filled out completely, the hourly data are not starting at 30 minutes before sunset, the breakdown of calls into various groups/guilds involves species being represented in more than one category, and/or weather data reporting issues. The PGC has and will continue to volunteer to review a few nights of data early on in the process to make sure the consultant is filling out the spreadsheet correctly. The PGC protocol does not specify which groups the bat calls should be broken into (e.g. low and high frequency, by species, or by groups of species) and therefore frequency limits for each group are not consistent between surveys and/or consultants. ***The PGC will draft additional guidance regarding collection, recording, and submission of bat acoustic surveys prior to the 2011 bat acoustic survey season to address these inconsistencies.***

Mist Net Surveys

Mist net surveys are being conducted based on the Cooperative Agreement criteria on high potential bat risk projects and also in response to U.S. Fish and Wildlife Service (USFWS) requests. Cooperators generally complete these surveys early in the planning stage. Mist net surveys provide valuable data to the PGC because they identify species presence in the project area and indicate breeding populations if juveniles or reproductive females are captured. In addition, mist net surveys may provide critical information about threatened and endangered species because these species will be telemetered and followed if captured. As with the other surveys, consulting with the PGC, and if applicable, the USFWS prior to conducting mist net surveys is critical to avoid having to redo or conduct additional surveys due to inappropriately placed or too few mist net sites. Additionally, early coordination ensures protocols are followed regarding survey hours, duration, and utilization of qualified surveyors. Some Cooperators have learned that the mist net surveys they had completed were unacceptable for one of the above reasons and have had to conduct additional surveys in order to meet the Cooperative Agreement's criteria and obtain clearance from USFWS and/or PGC for their project.

A summary of mist net survey results can be found in Appendix F. One of the highlights of the mist net surveys conducted at proposed wind sites was the discovery of a silver-haired bat (*Lasionycteris noctivagans*) maternity colony in 2007, the first breeding record for the species in Pennsylvania. No mist netting surveys were completed on proposed wind sites prior to 2004. Bats per mist net site varied from 4.6 to 59.2 and do not appear to be correlated with bat risk level. Number of species of bats captured at proposed wind sites also does not appear to be correlated with risk level because seven species of bats (maximum number of species captured to date at proposed wind sites) have been documented at low, moderate, and high risk sites. Captures of threatened, endangered, and species of special concern bats during mist net surveys has provided us with valuable information about foraging areas, roost locations, and maternity colonies for these species (see *Bat: Telemetry* section below).

Telemetry

Eight telemetry surveys have been conducted since the Cooperative Agreement was established. Telemetry surveys identify foraging areas, roost locations, maternity colonies, and behaviors that enable the PGC to determine where to best site wind turbines to avoid and minimize potential adverse impacts to bat species. Three surveys were completed on Indiana bats (two in 2007 and one in 2008), four on eastern small-footed bats (three in 2008 and one in 2009), and one on a silver-haired bat (2007). The 2007 surveys were summarized in the 1st annual report (Capouillez and Librandi Mumma 2008), thus will not be included below with the 2008 and 2009 telemetry surveys results. Because the telemetered species are endangered,

threatened, or species of special concern and due to the confidentiality clause in the Cooperative Agreement, survey locations will remain confidential. However, this information has been submitted for inclusion in the Pennsylvania Natural Diversity Inventory (PNDI) so that it can be used to better site other development projects.

The 2008 surveys include three small-footed bat telemetry surveys and one Indiana bat telemetry survey. The surveys were completed at three different proposed wind sites with one of the three sites conducting both small-footed and Indiana bat telemetry. For all of the 2008 and 2009 bat telemetry surveys, each of the bats was originally captured during pre-construction mist net surveys.

- The first small-footed telemetry survey in 2008 occurred on one female who was tracked for 4 nights/days. This bat used ridgelines, streams, and forested roads as travel corridors. The bat traveled between 4.0 and 8.2 miles each night, travelling from roost location to foraging area and back to roost; this distance excludes flight distances accumulated while foraging. The bat was documented foraging in streams, clearings, and ridge tops. One roost location was documented in talus but no emergence counts were conducted. *This wind site was originally deemed of low potential bat risk, but after the small-foot bat was captured on site, the potential risk level was increased to high.*

- The second small-footed telemetry survey in 2008 occurred on one male who was tracked for 5 nights/days. This bat utilized habitats located at 1400-2400 feet in elevation and foraged in the same area each night - the east slope of the mountain in a 0.75 mi^2 area. Two roost locations were documented in exposed talus located near the crest of the mountain. Emergence counts were conducted at one of the roosts and documented one bat exiting. *This wind site was originally deemed of low potential bat risk, but after the small-foot bat was captured on site, the potential risk level was increased to high.*

- The third small-footed telemetry survey in 2008 occurred on two females; one was tracked for 3 days and the second for 2 days. The bats were documented foraging in a small hilltop area. Two roost locations were documented, both located in exposed talus. Emergence counts were conducted at both roost locations and one of the roost emergent counts provided evidence of a maternity colony (emergence count = 5). *This wind site was originally deemed of high potential bat risk, so the capture of small-foot bats did not change the site's potential risk level to bats.*

- One Indiana bat telemetry survey was conducted on two males in 2008; one was tracked for 3 days and the second for 2 days. Four roost locations were documented and emergence counts were conducted at all with 1-7 bats observed at each. The bats foraged approximately 3 miles from their roost locations in woodlots and near a small pond. The 3 mile trip included an elevation change of 1400 feet. *This wind site was originally deemed of high potential bat risk, so the capture of Indiana bats did not change the site's potential risk level to bats.*

- In 2009, one bat telemetry survey was conducted on five small-footed bats (three males and two females). The bats were each tracked for 6 days. Seven roost locations were documented in sandstone boulders, shale rock piles, and limestone spoil piles. All

emergence counts resulted in no more than one bat exiting therefore no roost locations showed evidence of being maternity colonies. Home range (minimum convex polygons) for each bat ranged from 133 to 1405 hectares and the core habitat (50% fixed kernel utilization distribution) ranged from 4 to 75 hectares. *This wind site was originally deemed of high potential bat risk, so the capture of Indiana bats did not change the site's potential risk level to bats.*

The telemetry survey results have been used by Cooperators to adjust placement and number of turbines to avoid potential impacts to the species and their habitats. Examples include protection of small-footed bat roost locations, relocation of one of three proposed turbine strings to avoid a hibernaculum of concern, and abandonment of a portion of a project area to avoid impacts to listed bat species. Due to the discovery of the first reproductive female silver-haired bat, the PGC now recommends telemetry on other reproductive female silver-haired bats if captured during bat surveys. Part of the minimization effort of the Cooperator will be to avoid these identified areas within their project areas and to set up a post-construction survey targeting the bats in question to determine if any further minimization or mitigation efforts are needed.

<u>Other</u>

Mammals of Special Concern Surveys

Other mammal species of concern surveys have included state threatened Allegheny woodrat (*Neotoma magister*) habitat assessments and trapping and state endangered northern flying squirrel (*Glaucomys sabrinus*) habitat assessments. Allegheny woodrats inhabit steep rocky/talus slopes, boulder fields, or caves in a forest interior matrix in the Appalachian mountain areas where many wind sites are proposed. Northern flying squirrels are found in habitats characterized by mature mixed deciduous-hemlock stands or around stands of pure conifer (Mahan et al. 1999) that contain large (mean = 44.9cm dbh) conifers and many snags (~10 snags/acre) (Mahan et al. 2007).

Woodrat habitat assessment surveys are required if there are known historic, old, or active sites on the project area, or if there is potential habitat on the project area (determined by the PGC woodrat GIS model and field reviews). Allegheny woodrat habitat assessment surveys follow protocols found in the *Allegheny Woodrat: the Environmental Review Process for Pennsylvania* (Mixon 2008). The PGC evaluates all wind sites for potential impacts to Allegheny woodrats and northern flying squirrels because of their state listed status. The operation of wind turbines is not known to directly, negatively impact woodrats or northern flying squirrels; it is the footprint of the project, including infrastructure and turbines that may fragment and/or destroy their habitat and travel corridors. A consultant or PGC staff conducts a field visit if there is a question about the presence of potential habitat. If potential habitat for either northern flying squirrel or Allegheny woodrat is evident, the Cooperator must conduct a full habitat assessment survey to document the habitat and, for woodrat, confirm or deny the actual presence of the species by documenting woodrat sign (e.g. food caches, toilet areas). At this time the PGC does not have a presence/absence survey protocol established for northern flying squirrels, but a habitat assessment survey protocol is commonly used.

Thirteen woodrat habitat assessment surveys have been completed on proposed wind sites between 2007 and 2009 and one northern flying squirrel habitat assessment was conducted in 2009. Only two proposed wind sites have documented woodrat sign; one site documented both

fresh and old signs and a second site documented only old sign. ***The Cooperator for the site where fresh and old woodrat sign was documented has committed to conducting additional studies, including pre-and post-construction trapping of woodrats, to determine the impacts of the wind facility on the active population in the area. The Cooperator for site that documented old woodrat sign has adjusted its project area to exclude the area where old woodrat sign was documented.*** For sites at which woodrats and/or woodrat signs are found, the PGC will work with the Cooperator to avoid and minimize impacts to the species, and, where necessary, require post-construction monitoring to assess the impacts of wind development on woodrats and their habitats. One area with potential northern flying squirrel habitat was identified at the site where a habitat assessment was conducted. The Cooperator for the site has adjusted their project area to minimize the impact to this area. As with woodrats, the PGC will work with the Cooperator to avoid and minimize impacts to northern flying squirrel habitat.

Post-construction

Post-construction mortality surveys were conducted at one site in 2007, four sites in 2008, and six sites in 2009, for a total of eight different sites between 2007 and 2009. As required by the PGC, all post-construction monitoring requires a PGC Special Use Permit to handle and collect carcasses. The PGC requires Special Use Permits in order to conduct surveys for birds or mammals and/or to collect or handle bird or mammal specimens. The PGC Bureau of Wildlife Protection issues Special Use Permits. The mortality studies for wind energy projects require a Special Use Permit that costs $300.00. The Permit is required because birds and bat specimens will be handled during the mortality studies, potentially including state listed species. The Bureau of Wildlife Protection issues the permit after the project monitoring plan has been reviewed and approved by the Bureau of Wildlife Habitat Management, Division of Environmental Planning and Habitat Protection. The permit lists the effective date, expiration date, study methods, renewal, reporting requirements, etc. All eight sites were issued Special Use Permits to conduct post-construction monitoring surveys and no Special Use Permits have been revoked to date.

Mortality

Mortality searches were conducted daily from April 1 – November 15, with the exception of one site that conducted surveys in 2007 (mortality searches were conducted daily May 1 – November 17) and one site in 2009 that conducted surveys from March 1 – December 15 due to its high raptor risk. Two of the four sites in 2008 had operational issues (repairing cracked turbine blades, issues with commissioning turbines, and access issues) that prevented them from adhering to the PGC approved monitoring plan. Two of the six sites in 2009 used a consultant who failed to adhere to the PGC protocols, resulting in inaccurate mortality estimates. PGC staff visited both of these sites several times, reviewed the data being collected, and gave oral and written guidance to the Cooperator and consultant throughout the entire survey season, but the consultant continued to fail to adhere to the PGC protocols. Failure to start surveys at sunrise, failure to conduct blind searcher efficiency trials, and failure to test all searchers were a few examples of the issues at these two sites that persisted throughout the survey. Due to negligence of the consultant to follow PGC protocols (even after guidance was provided), the data did not accurately depict what was occurring on the site. As a result, the PGC advised the Cooperator, who owned both sites, that the PGC would not approve any 2010 Special Use Permits if this particular consultant was listed as the sub-permittee. The Cooperator obtained a different

consultant for both sites for the 2010 monitoring season. The consultant in question was not a sub-permittee at any other Pennsylvania wind sites in 2009 and they did not apply for any Special Use Permits related to wind energy in 2010, as of June 30, 2010.

PGC staff validated the identification of all carcasses from all sites. Estimated mortality was calculated from daily searches conducted at ten turbines, or 20% of turbines, whichever was greater at each site, and the estimator proposed by Erickson et al. (2004) was used, corrected for searcher efficiency and scavenger removal (SESR) biases, to obtain mortality estimates for birds and bats. Other estimators have been used in addition to Erickson's method at several of the Pennsylvania wind sites, all of which have resulted in mortality estimates greater than what is estimated using the Erickson equation. For example, the Manuela Huso estimator (Arnett et al. 2009) results in 4.69 birds/turbine/year, double the 2.27 birds/turbine/year estimated using the Erickson estimator; likewise the Huso estimator resulted in 32.3 bats/turbine/year, almost double the 18.9 bats/turbine/year estimated using the Erickson estimator. There are a few different estimators used currently, but for comparison purposes, the PGC asks that all sites use the Erickson estimator to allow for comparisons between sites. However, because the PGC realizes that using the Erickson estimator likely results in an underestimation of mortality, the mortality estimates provided in Table 7 should be considered minimum estimates, rather than total mortality occurring on wind sites.

Bat Mortality

A summary of bat mortality estimates for eight sites that conducted mortality searches from 2007-09 can be found in Table 7. Gray boxes indicate information that was not included in the annual report for that site. The PGC was unable to determine what percentage of mortality was due to direct collision or other indirect causes, such as barotrauma, because carcasses are not tested for barotrauma and evidence of direct collision (lacerations, broken wing, etc.) is not required to be noted on data sheets.

The average estimated bats/turbine/year for the five surveys that followed PGC protocol was 24.6 (range 6.8 – 42.7).

A total of 1,179 bat carcasses were found during scheduled searches at the Pennsylvania sites conducting mortality monitoring during 2007-09. The majority of bat carcasses found during scheduled searches during 2007-2009 were adult males (Figure 3). Bat mortality by species was as follows: hoary bat (*Lasiurus cinereus*) 30%, silver-haired bat 19%, red bat 18%, tri-colored bat (formerly named eastern pipistrelle) 15%, little brown bat (*Myotis lucifugus*) 12%, big brown bat (*Eptesicus fuscus*) 4%, Seminole bats (*Lasiurus seminolus*) 1%, northern long-eared bat <1%, unknown 1%. Percent composition by year and overall can be found in Table 8. The increase in residential bats in 2009 is likely because one of the six sites had approximately 57% of its bat mortality composed of residential bats versus migratory tree bats, when the average percentage of residential bats for all other sites in Pennsylvania was 26% (Table 7).

Distributions of bat mortality by month and by Julian date are shown in Figures 4 and 5, respectively. Julian date was chosen to standardize the data because 2008 was a leap year. Eighty-six percent of bat mortality occurred between June and September, whereas 98% of mortality occurred between May and October (Table 9). Low bat mortality occurred in the months of April and November. April bat mortality occurred at three of four sites in 2008 and

six of eight sites in 2009. The site that conducted mortality monitoring in 2007 did not conduct April surveys. The following species were found during the April bat mortality surveys: hoary, silver-haired, red, tri-colored, big brown, and little brown. Because bats are exiting bat hibernacula in April and entering during late October/early November, it could be inferred that increases in bat mortality during April and/or late October/early November may indicates the presence of a nearby hibernaculum. Bat mortality documented during these periods was minimal in 2007-09, so the data collected at these sites do not indicated the presence of nearby hibernacula. It is unknown at this time as to what level of mortality during April and/or late October/early November may be an indicator of the presence of a nearby hibernaculum.

Table 7. Summary of bat mortality estimates for the eight sites that conducted mortality searches in 2007-2009. MTB = migratory tree bats (silver, red, and hoary bats); RESB = residential bats. Bat risk, H = high, M = moderate, L = low; CI = confidence interval; SE = searcher efficiency; SR = scavenger removal.

Site code	Bat Risk	Year	PGC protocol followed?	**Estimated bats/turbine /year**	95% CI low	95% CI high	**Estimated bats/MW/ year**	% MTB	% RESB	SE % average (1-day)	SR average (days)
6-3	H	2007	Yes	**42.7**			**21.4**	88	12	25	10.4
6-3	H	2008	Yes	**34.3**			**17.1**	77	23	31	13.4
2-2	H	2008	Yes	**18.9**	15.3	22.9	**21.5**	76	24		31.9
2-2	H	2009	Yes	**12.9**	9.6	16.1	**21.5**	67	33		23.3
2-14	L	2008	No[a]	**7.1**	2.3[e]	13.1[e]	**3.4**	60	40	17	5.4
2-14	L	2009	Yes	**6.8**	3.7	10.5	**3.2**	71	29	24	9.0
2-10	L	2008	No[b]	**16.1**	6.6[e]	29.0[e]	**8.3**	71	29	17	4.4
2-4	L	2009	Yes	**28.5**	19.5	37.5	**11.8**	74	26	47	11.2
5-5	M	2009	No[c]	**13.3**	7.0	21.3	**6.7**	74	26	30	9.1
24-3	L	2009	No[d]	**12.3**	1.0	4.7	**6.2**	80	20	15	4.3
6-1	H	2009	Yes	**28.2**	25.2	31.5	**15.2**	43	57	46	10.1

[a] operational issues at site; less than 10 turbines searched
[b] operational issues at site; less than 10 turbines searched
[c] PGC protocols were not followed
[d] PGC protocols were not followed
[e] 90% confidence interval

Table 8. Percent composition of bat carcasses found during daily searches at Pennsylvania wind sites during mortality survey conducted in 2007-2009, by year (No. sites conducting mortality monitoring), and overall.

	Percent (%) of Total Bat Mortality			
Bat Species	2007 (1)	2008 (4)	2009 (6)	2007-09 (8)
Hoary	31	34	27	30
Silver-haired	12	22	19	19
Eastern Red	33	18	15	18
Tri-colored*	16	14	15	15
Little Brown	5	8	17	12
Big Brown	3	2	6	4
Unknown	1	1	1	1
Northern long-eared	0	0	<1	<1
Seminole	0	0	<1	<1

*formerly eastern pipistrelle

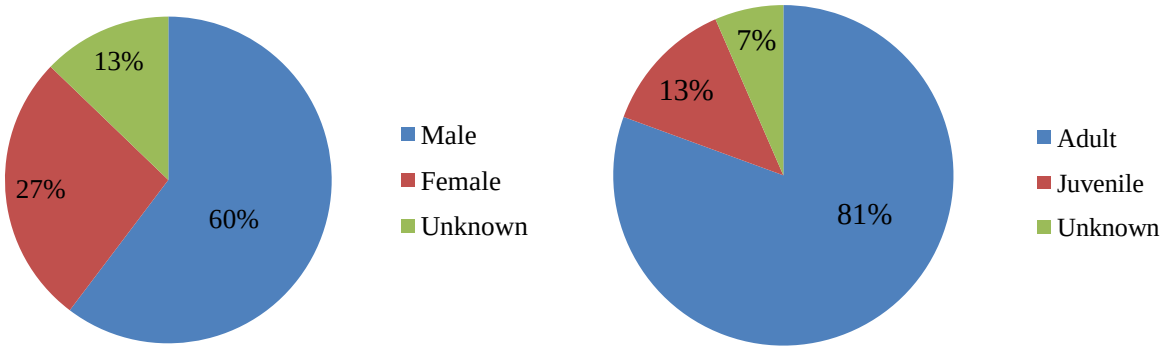

Figure 3. Sex and age composition of all bat mortality documented during standard searches at eight wind sites, 2007-2009.

November bat mortality consisted entirely of migratory tree bats, with bat mortality documented in 2007 (at one site conducting mortality monitoring) and in 2009 (at two of the eight sites), but there was no November mortality in 2008. PGC recommends that the survey period remain April 1 – November 15 for high risk sites because there is insufficient evidence to show that bats entering and exiting hibernacula are not at risk to mortality. For low risk bat sites, the PGC may consider reducing mortality monitoring in the future (e.g. May 1- October 31), since 98% of mortality occurs during this time period. Note that reduced monitoring would only be considered if there are no bird concerns.

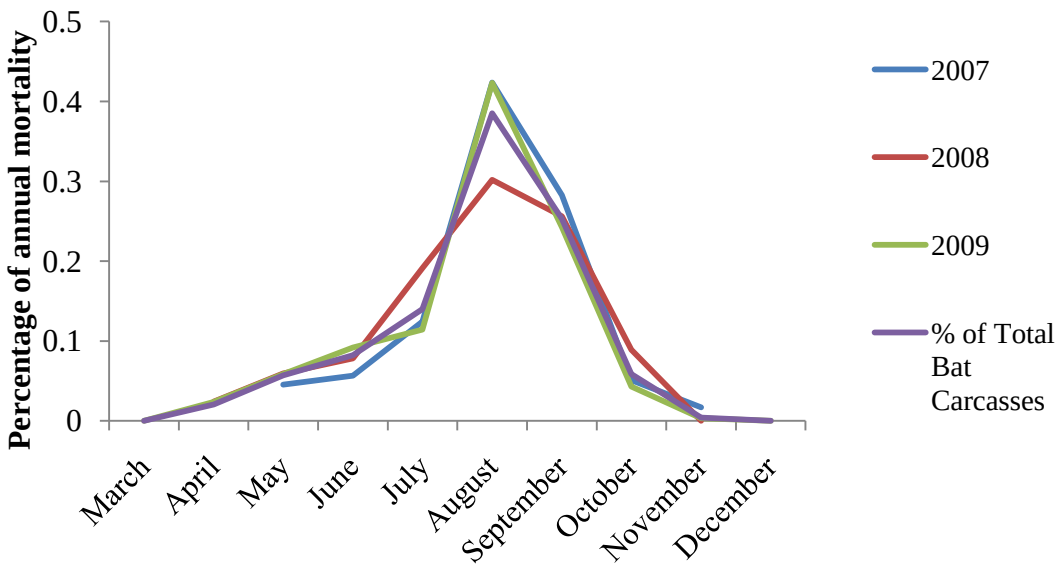

Figure 4. Distribution of bat mortality by month, year, and overall, 2007-2009.

Table 9. Percent bat and bird mortality by month for mortality data collected during standard searches at eight Pennsylvania wind sites, 2007-2009.

Month	Percent Bat Mortality	Percent Bird Mortality
March	0	1
April	2	8
May	6	14
June	8	8
July	14	6
August	39	7
September	25	37
October	6	15
November	0	4
December	0	0

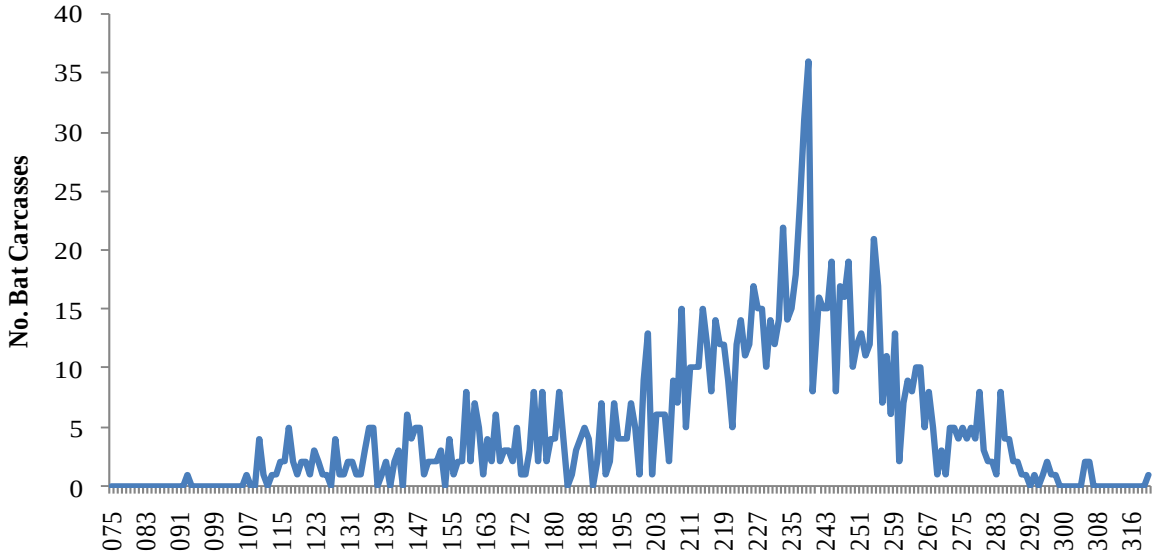

Figure 5. Patterns of bat mortality, by Julian date, for the bat carcasses found at the eight wind sites that conducted post-construction mortality searches in Pennsylvania, 2007-2009.

Bird Mortality

A summary of bird mortality estimates for the eight sites that conducted mortality searches in 2007-2009 can be found in Table 10. Gray boxes indicate information that was not included in the annual report for that site.

The average estimated birds/turbine/year for seven of the 11 surveys that followed PGC protocol was 3.9 (range 1.7 – 9.8).

Bird carcasses found during scheduled searches totaled 195 at the Pennsylvania sites conducting mortality monitoring from 2007-09. Overall bird mortality was composed mostly (69%) of the order Passeriformes, the remaining 31% included the following: 3% Cuculiformes (black-billed and yellow-billed cuckoos), 3% Galliformes (all ruffed grouse), 2% Anseriformes (blue-winged teal and wood duck), 2% Apodiformes (all ruby-throated hummingbirds), 2% Columbiformes (all mourning doves), 2% Accipitriformes (Chesser 2010) (red-tailed hawk, turkey vulture, broad-winged hawk), 1% Piciformes (sapsuckers), <1% Charadriiformes (killdeer), <1% Gruiformes (sora), and 15% unknown birds (Table 11).

Passerine mortality was composed of 35% red-eyed vireo, 8% golden-crowned kinglet, 4% magnolia warbler and veery, 3% blue-headed vireo and red-crowned kinglet, 2% American crow, American redstart, red-breasted grosbeak, Swainson's thrush, and wood thrush, 1.5% American robin, black-throated blue warbler, black-throated green warbler, common yellowthroat, eastern towhee, mourning warbler, northern parula, pine warbler, Tennessee warbler, unknown passerine (vireo and flycatcher), warbling vireo, white-throated sparrow, and <1% black-and-white warbler, brown-headed cowbird, blackburnian warbler, brown creeper, brown thrasher, blue-winged warbler, cedar waxwing, chestnut-sided warbler, eastern bluebird, great crested flycatcher, gray catbird, indigo bunting, northern waterthrush, palm warbler, red-breasted nuthatch, Swainson's warbler, tree swallow, white-eyed vireo, and yellow-throated warbler.

Table 10. A summary of bird mortality estimates for the eight sites that conducted mortality searches in 2007-2009. Raptor risk, H = high, M= moderate, L=low; CI = confidence interval; SE = searcher efficiency; SR = scavenger removal.

Site Code	Raptor Risk	Year	PGC protocol followed?	**Estimated birds/turbine/ year**	95% CI low	95% CI high	**Estimated birds/MW/ year**	SE % average (1-day)	SR mean (days)
6-3	L	2007	Yes	**1.8**			**0.9**	23	10.4
6-3	L	2008	Yes	**2.4**			**1.2**	64	13.4
2-2	L	2008	Yes	**2.3**	0.9	4.0	**1.5**	52	12.7
2-2	L	2009	Yes	**4.3**	2.7	6.4	**3.0**	46	4.7
2-14	M	2008	No[a]	**6.5**	3.8[e]	10.1[e]	**3.1**	23	5.4
2-14	M	2009	Yes	**5.0**	3.3[e]	6.9[e]	**2.4**	30	17.4
2-10	M	2008	No[b]	**1.3**	0.0[e]	3.2[e]	**0.7**	23	4.1
2-4	M	2009	Yes	**9.8**	2.7	12.4	**5.0**	53	11.1
5-5	M	2009	No[c]	**1.0**	0.3	1.7	**1.0**	48	13.2
24-3	H	2009	No[d]	**2.7**	1.0	4.7	**1.4**	15	4.3
6-1	L	2009	Yes	**1.7**	0.8	2.9	**0.9**	45	14.1

[a] operational issues at site; less than 10 turbines searched
[b] operational issues at site; less than 10 turbines searched
[c] PGC protocols were not followed
[d] PGC protocols were not followed
[e] 90% confidence interval

Table 11. Percent composition of bird carcasses found during daily searches at Pennsylvania wind sites during mortality survey conducted in 2007-2009, by year (No. sites conducting mortality monitoring), and overall.

	Percent (%) of Total Bird Mortality			
Bird Order	2007 (1)	2008 (4)	2009 (6)	2007-09 (8)
Anseriformes	0	0	2	2
Galliformes	0	2	4	3
Accipitriformes*	0	2	2	2
Gruiformes	0	0	1	1
Charadriiformes	0	0	1	1
Columbiformes	0	2	2	2
Cuculiformes	0	4	3	3
Apodiformes	10	0	2	2
Piciformes	0	2	1	1
Passeriformes	80	70	68	69
Unknown	10	17	15	15

*sensu Chesser et al. 2010

Raptor mortality at the various sites conducting post-construction monitoring in 2007-2009 was similar, regardless of potential raptor risk level, with 0 – 2 raptors documented during standard searches at any one site. One low potential raptor risk site (6-1), that had zero raptors documented during standard searches in 2009, documented 3 incidental raptor fatalities (1 broad-winged hawk and 2 red-tailed hawks). This site did, however, observe a higher than expected number of raptors during pre-construction raptor migration surveys (see Appendix A and B). The PGC will further examine the raptor mortality documented during post-construction surveys from all sites to see if there is a correlation with pre-construction raptor migration survey results.

Fifty-eight percent of bird mortality occurred between June and September and 88% of mortality occurred between May and October (Table 9). Bird mortality is spread throughout the survey season. Little bird mortality occurred in the months of March and December, but unlike bat mortality, bird mortality has been documented in April (8% of total bird mortality) and November (4% of total bird mortality). Surveys have been requested in March and December at high risk raptor sites in an attempt to document all bird mortality that may be occurring during raptor migration, particularly eagles. Because weather conditions at wind sites during these months are harsh, often resulting in several missed search days, and because only one bird has been documented in March and/or December, the PGC may recommend that high risk sites reduce bird mortality monitoring to one time per week in March and December or eliminate searches in March and December months entirely; however, golden eagle is most likely to occur in these months and is among the most vulnerable to impaction (Brandes 2006).

Distributions of bird mortality by month and by Julian date are shown in figures 6 and 7, respectively. Julian date was chosen to standardize the data because 2008 was a leap year.

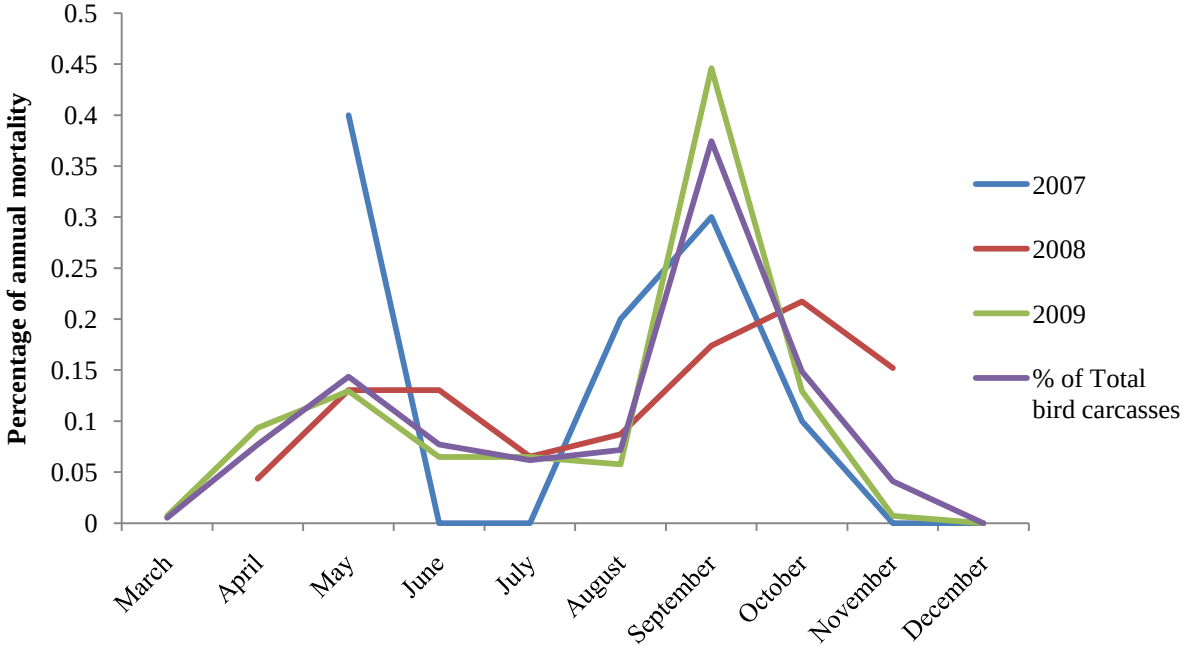

Figure 6. Distribution of bird mortality by month, by year, and overall, 2007-2009.

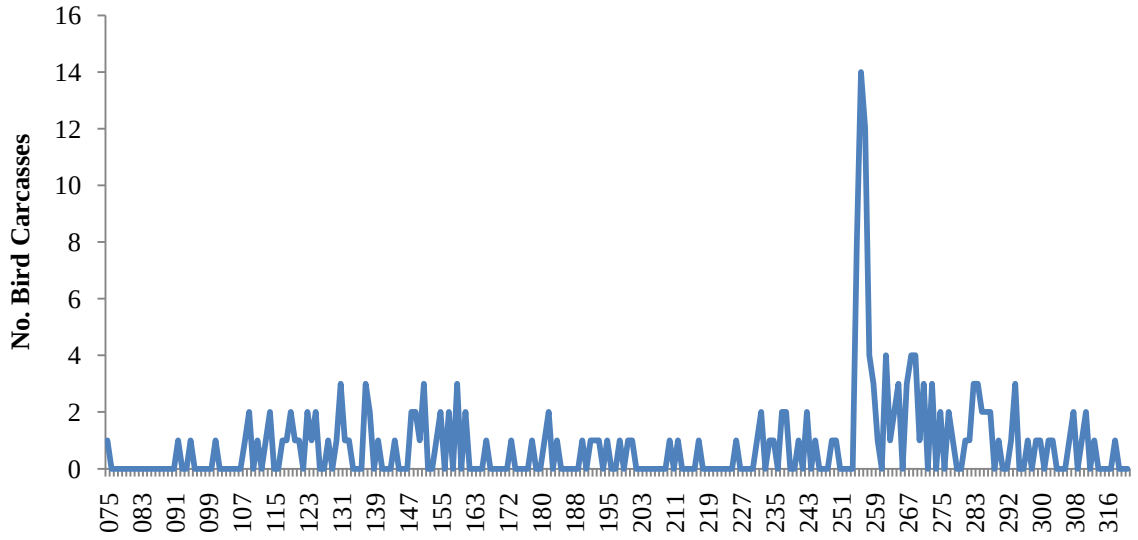

Figure 7. Patterns of bird mortality, by Julian date, for the bird carcasses found at eight wind sites that conducted post-construction mortality searches in Pennsylvania, 2007-2009.

Mortality in Relation to Turbine

Ninety-five percent of detected bat carcasses found during standardized searches occurred within 50 m of the closest turbine and 85% of bat fatalities fell within 40 m, whereas 86% percent of the bird carcasses occurred within 50 m of the closest turbine, and 73% of bird fatalities were found within 40 m (Figures 8 & 9). Bat and bird carcasses appear to be equally distributed in all directions surrounding the turbines (Figure 9). The PGC will investigate if there is any relation between prevailing wind direction and where carcasses are found for the next summary report. At this time, the PGC does not have all the data necessary to investigate this potential relationship.

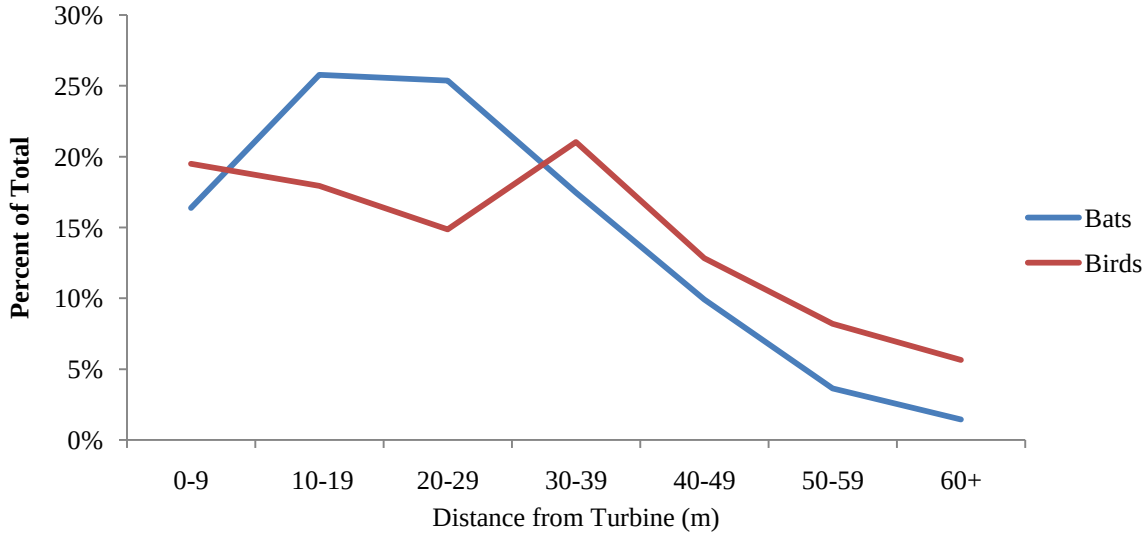

Figure 8. Distribution of the percent of total bird and total bat carcasses documented during standardized searches at the eight Pennsylvania wind sites that conducted mortality monitoring from 2007-2009.

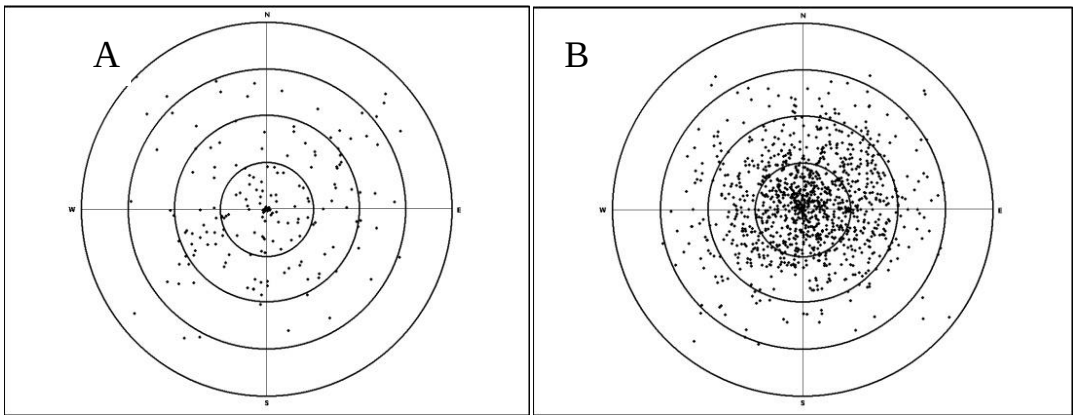

Figure 9. Spatial distribution of all bird (A) and bat (B) carcasses documented during standard searches in 2007-2009 at the eight Pennsylvania wind sites. Concentric circles are at 20 meter intervals from turbine center.

Searcher Efficiency

Search efficiency trials were conducted at all eight sites. Carcasses of birds and bats were placed in random locations throughout the search area in all vegetation classes and were blind to the searchers. Trials occurred in all visibility classes, at all searched turbines, and for all searchers with few exceptions. Searcher efficiency for bats at all eight sites averaged 28% (range 15 - 47%). The average searcher efficiency for bats at sites that followed protocol was 35% (range 24 – 47%). Searcher efficiency for birds at all eight sites averaged 38% (range 15 – 64%). The average searcher efficiency for birds at sites that followed protocol was 45% (range 23 - 64).

The PGC will be analyzing these and future datasets to determine if there are any trends with regard to bat versus bird trials such as carcass coloration, fresh versus frozen carcasses, and quality of carcass (fresh, decomposed, intact, broken/wounded) that may be influencing searcher efficiency trials.

Scavenger Removal

Scavenger removal trials were conducted at all eight sites. Carcasses were placed in random locations throughout the search area in all vegetation classes, but were not blind to the searchers. Scavenger removal for bats at all eight sites averaged 12 days (range 4 - 32). Average time for scavenger removal at those sites that followed protocol was 17 days (range 9 – 32). Scavenger removal for birds at all eight sites averaged 10 days (range 4 – 17). Average time for scavenger removal at those sites that followed protocol was 12 days (range 5 – 17).

Through direct observation, scat and tracks found near carcasses, and motion-sensitive trail cameras, the following potential scavengers have been identified at the various sites conducting mortality monitoring: black rat snake (*Elaphe obsolete*), red-tailed hawk, turkey vulture, long-tailed weasel (*Mustela frenata*), opossum (*Didelphis marsupialis*), raccoon (*Procyon lotor*), American crow (*Corvus brachyrhynchos)*, common raven (*Corvus corax)*, blue jay (*Cyanocitta cristata)*, fisher (*Martes pennanti*), mouse (*Mus* sp.), fox (*Vulpus* sp.), coyote (*Canis latrans*), bear (*Ursus americanus*), and chipmunk (*Tamias striatus*).

The PGC will be analyzing future datasets to determine if there are any trends with regard to bat versus bird trials such as carcass coloration, fresh versus frozen carcasses, and quality of carcass (fresh, decomposed, intact, broken/wounded) that may be influencing scavenger removal.

Incidental Mortality

Incidentals are defined as carcasses found outside scheduled search times and/or found outside the designated search plots during scheduled search times. The species and percentages of the birds and bats found during scheduled searches versus incidental finds are similar for both birds and bats (Tables 12 and 13). For bats, there were slightly more tri-colored (formerly pipistrelle) and little brown bats found as incidentals than during standard searches. This may be due in part to one site that searched additional turbines to obtain additional carcasses for searcher efficiency and carcass removal trials in 2009. This happens to be the same site that had the highest percentage of residential bat mortality. Slightly more birds from the orders Accipitriformes (i.e. hawks) and Galliformes (i.e. ruffed grouse) were found as incidentals than during standard searches. Ruffed grouse incidentals were found during the months of March, April, October, and November. Incidental diurnal raptors (*Accipitriformes*) were spread throughout the survey period (in the months of March, April, May, July, September, and November). Why different species are found during standard mortality searches versus incidental finds is not well understood. These differences could be attributed to the breeding ecology of these birds (e.g. ruffed grouse are nesting in May rather than dispersing) or simply that detection of incidentals is more likely because of their larger size. Ruffed grouse mortality in particular, has been documented at the base of turbines and appears to be result of grouse flushing into the base of the turbine and not from turbine operation.

Table 12. Composition (percent of total bats documented) of bat mortality identified through standard searches versus those found outside standard search times (incidentals).

Bat Species	Standard Searches	Incidental Finds
Hoary	30%	24%
Silver-haired	19%	15%
Eastern Red	18%	17%
Tri-colored*	15%	20%
Little Brown	12%	20%
Big Brown	4%	2%
Unknown	1%	1%
Northern long-eared	<1%	0%
Seminole	<1%	0%

*formerly eastern pipistrelle

Table 13. Composition (percent of total birds documented) of bird mortality identified through standard searches versus those found outside standard search times (incidental finds).

Bird Order	Standard Searches	Incidental Finds
Passeriformes	69%	63%
Unknown	15%	8%
Cuculiformes	3%	0%
Galliformes	3%	13%
Apodiformes	2%	2%
Columbiformes	2%	0%
Accipitriformes*	2%	12%
Anseriformes	2%	2%
Piciformes	1%	0%
Gruiformes	1%	0%
Charadriiformes	1%	0%

*sensu Chesser et al. 2010

Large Mortality Events.---***Cooperators did not document any large kills (greater than 50 animals in a single day event) between 2007 and 2009.***

Eagle Mortality.---***Cooperators did not document bald or golden eagle mortality between 2007 and 2009.***

Threatened and/or Endangered Species Mortality. ---***Cooperators documented three endangered bird mortalities in 2009 (two blackpoll warblers and one yellow-bellied flycatcher). One endangered bird was killed at each of three different wind sites.*** One of the three endangered bird mortalities was documented during scheduled searches and the other two were documented outside scheduled searches and are considered to be incidental finds. ***The three birds were determined to be migrants (i.e. not from the local breeding population) by the PGC due to the lack of breeding habitat in the vicinity and the time of year mortalities occurred. All three fatalities occurred in September 2009, with the yellow-bellied flycatcher fatality found on September 14 and two blackpoll warblers found on September 17 and 24 respectively.*** Due to the Cooperative Agreement and particular Cooperator's effort to avoid and minimize potential impacts, the PGC did not file a formal action of liability for these endangered bird mortalities.

PGC met with Cooperators on August 5, 2010 at PGC headquarters to discuss the draft second wind energy summary report, endangered bird mortality documented in 2009, and acceptable levels of bat and bird mortality. Twenty of the 29 Cooperators sent representatives and ten PGC staff were present for a total of 46 attendees. The group discussed different methods for determining threshold values for bird and bat mortality. Because of the complexity and implications of this question, the PGC will continue to investigate the most appropriate mechanism for determining these thresholds. The PGC presented draft guidance regarding the steps to be taken following the mortality of a state threatened or endangered species. A second meeting with the Cooperators was held on September 9, 2010 to further discuss the draft guidance for threatened or endangered species mortality and to edit the draft Best Management Practices (BMPs). Twenty of the 29 Cooperators sent representatives and nine PGC staff were

present for a total of 42 attendees. The draft threatened and endangered species guidance is currently under internal review by the PGC to ensure it conforms to the regulatory constraints of the agency. Once finalized, the threatened and endangered species guidance will be made a part of the Cooperative Agreement and thus a part of each Cooperators' overall commitments in order to remain in compliance with the Cooperative Agreement. The PGC anticipates this guidance will be finalized in 2011. Cooperators comments have been incorporated into the draft BMPs found in Appendix D. The PGC plans to officially incorporate these BMPs into the Cooperative Agreement in 2011.

Mortality - Weather Correlation. ---From September 13-14, 2009, 20% of the bird mortality occurred, yet only 2% of bat mortality occurred during that same period. This two- day period included a front moving through the state which resulted in foggy conditions both days and the preceding nights. Bird mortality increased on both September 13 (14 birds) and 14 (11 birds) but bat mortality did not increase on either of these days. The PGC will continue to analyze bird mortality in the future to determine if there is any correlation with migration timing and/or weather events.

There appears to be a correlation between bat mortality and wind speed (Arnett et al. 2010). Bat mortality is greater at low wind speeds, when bats are more active, compared to high wind speeds, when bats are less active.

Can Mortality be Predicted? ---To date, the PGC does not yet have enough pre- and post-construction data to develop a mortality prediction model. The eight sites that have conducted post-construction mortality monitoring thus far were grandfathered into the Cooperative Agreement, meaning they were only obligated to conduct post-construction monitoring. All of these sites conducted some pre-construction monitoring surveys, but not all of these the surveys were conducted following standardized PGC protocols, so comparison of data is nearly impossible. It will be several years before there are data from sites that conducted both pre- and post-construction surveys following PGC protocols that can be evaluated to determine whether the conditions under which mortality is likely to occur can be predicted.

Post-construction Raptor Migration Survey

Can raptor migration survey observations be correlated with mortality? No post-construction raptor migration surveys were completed in 2007. Post-construction fall raptor surveys were conducted at two moderate risk sites (2-10 and 2-14) in 2008. No raptor mortality was documented at either facility in 2008. Twelve percent of total raptors observed at site 2-10 and seven percent of total raptors observed raptors at site 2-14, respectively, appeared to alter their flight path to avoid turbines, circle around them, or pass above or below the turbine rotors. No raptors were observed flying between blades of rotating turbines; however raptors were observed flying between the blades of inactive turbines.

The fall 2008 raptor migration surveys at site 2-10 documented 12 species of raptors composed of 48% turkey vultures, 23% red-tailed hawk, 9% broad-winged hawk, 3% Cooper's hawks, 2% northern harrier, 1% sharp-shinned hawks, and <1% of each of the following American kestrel, bald eagle, golden eagle, osprey (*Pandion haliaetus*), peregrine falcon, and red-shouldered hawk (*Buteo lineatus*). For special concern species, the following approximate percentages of those individuals observed were documented flying below 125 meters within the project area: 100%

of peregrine falcons, 86% of northern harriers, 60% of osprey, 50% of bald eagles, and 0% of golden eagles. The PGC determined that spring raptor migration surveys were not warranted at this site because few raptors species of special concern were documented and no raptor mortality was documented.

The fall 2008 raptor migration surveys at site 2-14 documented 13 species of raptors composed of 47% turkey vultures, 20% broad-winged hawk, 10% red-tailed hawk, 8% sharp-shinned hawks, 2% Cooper's hawks, 1.4% black vulture, 1% osprey (*Pandion haliaetus*), and <1% of each of the following American kestrel, bald eagle, golden eagle, Merlin, northern harrier, and red-shouldered hawk. For special concern species, the following approximate percentages of those individuals observed were documented flying below 125 meters within the project area: 70% of osprey, 50% of northern harriers, 50% of bald eagles, and 0% of golden eagles. The PGC determined that spring raptor migration surveys were not warranted at this site because few raptors species of special concern were documented and no raptor mortality was documented.

Two post-construction raptor migration surveys were conducted in 2009, at one site (24-3) during the spring 2009 and at a second site (5-5) during fall 2009. Both migration surveys were concurrent with mortality surveys.

The spring 2009 survey was conducted at site 24-3, deemed to be of high potential risk to raptors. Since this site is a high potential risk site, both spring and fall post-construction raptor surveys are required. The fall raptor surveys were conducted in 2010. Only one spring raptor fatality (turkey vulture) was documented during the spring 2009 raptor migration survey, but due to the limited mortality data, an analysis could not be conducted to determine if any correlation exists between spring raptor mortality and spring raptor migration observations at this site. The spring 2009 raptor migration survey documented 10 species of raptors composed of 46% turkey vultures, 33% red-tailed hawks, 7% sharp-shinned hawks, 4.6% Cooper's hawks, 4% golden eagles, 2% American kestrel, 1.4% bald eagles, and <1% of each of the following northern harrier, northern goshawk, and red-shouldered hawk. For special concern species, approximately 66% of northern harriers, 60% of bald eagles, 57% of golden eagles, and 0% of northern goshawks observed were documented within the rotor sweep zone.

The fall 2009 survey was conducted at site 5-5, deemed to be of moderate potential risk to raptors. Since this site is of moderate risk to raptors, a fall post-construction raptor survey is required, and if eagle migration is noted in the fall, spring monitoring may be warranted. The fall raptor surveys were conducted in 2010. No fall raptor fatality was documented during the fall 2009 raptor migration survey therefore an analysis could not be conducted to determine if any correlation exists between fall raptor mortality and fall raptor migration observations at this site. The fall 2009 raptor migration survey documented 16 species of raptors composed of 30% broad-winged hawk, 22% red-tailed hawk, 13% sharp-shinned hawks, 11% turkey vultures, 5% bald eagle, 5% osprey, 3% Cooper's hawks, 2% American kestrel, 2% northern harrier, and <2% of each of the following red-shouldered hawk, golden eagle, peregrine falcon, Merlin, northern goshawk, black vulture, and rough-legged hawk. For special concern species, approximately 54% of northern harriers, 29% of peregrine falcons, 3% of osprey, and 0% of bald eagles, golden eagles, and northern goshawks observed were documented within the rotor sweep zone. The PGC has determined that spring raptor migration surveys are not warranted at this site because

few bald and golden eagles were documented and, of those that were documented, none were documented within the rotor sweep zone.

Post-construction Bat Acoustic Surveys

Can bat acoustic data be correlated with mortality? No post-construction bat acoustic surveys were completed in 2007, but three sites in 2008 and two sites in 2009 conducted post-construction bat acoustics.

In 2008, two of the four sites (both being low potential bat risk sites, 2-14 and 2-10) that conducted post-construction bat acoustics were the same two sites that had operational issues that prevented them from adhering to the PGC protocols. These two sites had several periods of time during which the turbines were non-operational and thus mortality at both sites was reduced. Acoustic detectors (both Anabat SD1 and Anabat II at each site) were deployed in the guy wires of MET towers and documented a peak in activity levels of migratory bats between mid-August and mid-September at both sites. Although nightly peaks in acoustic activity did not correspond to mortality events, the documentation of higher levels of acoustic activity of migratory bat species at both sites during this time period may suggests movement of these species through the area.

The third site (high potential bat risk site, 2-2) that conducted post-construction bat acoustics (Anabat II detector) concurrent with mortality monitoring in 2008 documented a slight correlation between hoary bat mortality and activity. There was little evidence that the number of bat fatalities occurring on the site on each night was related to total number of calls recorded each night. There was only a slight relationship between hoary bat fatality and hoary bat activity, but no relationship was found for all bat species combined. These results indicate that the potential for predicting future impacts to bats from pre-construction activity data appears limited based on this one year study. However, the researchers did suggest that measurements of activity further into the rotor swept zone may be more closely related to observed fatality, and that detectors placed on turbine nacelles may prove useful for predicting fatality. Overall, the post-construction acoustic findings were highly variable among turbines and among nights.

In 2009, the same high potential bat risk site (2-2) that found a slight relationship between hoary bat activity and hoary bat mortality, conducted a second year of bat acoustics (voluntary – second year was not required by the Cooperative Agreement). The second year of post-construction bat acoustics (Anabat II detector) did not document a relationship between hoary bat activity and mortality. The post-construction acoustic findings were highly variable among turbines and among nights in both years (2008 and 2009) of the study. Direct models relating fatality to activity at each turbine on each night detected only a weak relationship for all bats in 2008 and no relationship in 2009. Models on the scale of the individual turbine detected no relationship at any height. Only the site scale model indicated a fairly strong relationship between hoary bat fatality and hoary bat activity in 2008, but not in 2009, and no relationship was found for all bat species combined with this model in either year.

The second post-construction bat acoustic survey in 2009 was conducted a moderate potential bat risk site (5-5) and did not adhere to PGC protocols. Bat acoustic detectors (Anabat SD1) were supposed to be conducted from the nacelle of a turbine but the PGC later learned that the acoustics were conducted at a detector that was placed at 10 m near a turbine. Success was less

than 80% for this study. Data were not collected during peak bat activity periods because of data overload, there was a failure to swap cards, there were card reading failures, and/or equipment malfunctions. Due to the various consultant and survey issues at this site, the survey data from 2009 were deemed unacceptable and the Cooperator is conducting an additional year of monitoring using a different consultant.

Of the four sites that conducted post-construction bat acoustics, only one of the sites also conducted pre-construction bat acoustics. This site also conducted two years of post-construction bat acoustic surveys in 2008 and 2009. This site was grandfathered into the Cooperative Agreement and thus was not obligated to conduct pre-construction bat acoustic surveys, but at the time the developer signed the Cooperative Agreement, they had already done the pre-construction bat acoustic surveys. The researcher who conducted these bat acoustic surveys is currently looking at both pre- and post-construction bat acoustic data to determine if there are any correlations.

Post-construction Radar Surveys

Marine surveillance radar surveys were conducted at two sites (2-10 and 2-14) for twelve days between September 8 and October 10, 2008. Targets ranged from 128-681 targets/km/hr. Only two carcasses (one bat on September 16 and one bird on October 10) were found during standard searches on days that followed nocturnal radar surveys. Both carcasses were fresh, indicating they had collided with a turbine the previous night. The second bird was found the morning after the second highest passage rate was recorded for the survey (October 9). However, this survey did not yield sufficient data for determining if there exists a correlation between radar data and mortality rates.

Correlation between Pre-construction Breeding Bird Surveys and Post-construction Mortality

Only one of the three sites with state endangered bird mortality in 2009 had conducted pre-construction breeding bird surveys (all three sites were grandfathered into the agreement, therefore pre-construction breeding bird surveys were not required). The species of endangered bird that was documented as a fatality in 2009 had not been documented during the pre-construction breeding bird surveys at the site where they were conducted. Breeding bird surveys are used to determine risk to residential breeding birds however the endangered bird fatality in question was deemed to be a migrant by the PGC based on the time of year the mortality occurred and because there is no breeding habitat for that species in the vicinity of the project.

Post-construction Woodrat Surveys

A woodrat study is being conducted at one Pennsylvania site by a Cooperator to document whether woodrats are being impacted by that particular wind energy project. This site conducted pre-construction surveys to obtain baseline data and will be conducting several years of post-construction surveys once the site is built. The study will include trapping, telemetry, food availability, and predator presence.

Contributions to Other Wind Related Studies

A total of 1,109 samples (493 tissues and 616 hair) were collected from 630 Pennsylvania wind site bat carcasses in 2008 and 2009 and submitted to Eric Britzke of United States Army Corps of Engineers, Engineer Research and Development Center, Vicksburg, MS (who is working with Susan Loeb, Southern Research Station, United States Forest Service, Clemson

University, Clemson, SC and Maarten Vonhof, Department of Biological Sciences, Western Michigan University, Kalamazoo, MI) for use in various ongoing bat genetic studies.

In 2009, 24 bat heads were submitted to the Center for Disease Control Rabies Laboratory, Atlanta, GA for a study investigating the prevalence of rabies infection in bats that are struck by wind turbines. All of the carcasses from which the heads were submitted, were collected no more than one-two days post-collision and all had visible signs of collision (laceration, broken wings, etc.). All 24 Pennsylvania bats tested negative for rabies.

In 2009, wing scores from 830 bats collected at Pennsylvania wind sites were submitted for use in the study entitled *White Nose Syndrome: Multi-state Coordination, Investigation and Response to an Emerging Wildlife Health Threat*. Scoring was conducted following the *Wing-Damage Index Used for Characterizing Wing Condition of Bats Affected by White-nose Syndrome* (Reichard, n.d.).

SIGNIFICANT FINDINGS FROM COOPERATORS' SURVEYS

2007.--During the first year of the Cooperative Agreement, several new wildlife findings occurred. The first was the discovery of the second largest Indiana bat maternity colony in Pennsylvania during an Indiana bat telemetry project that was funded by two Cooperators in 2007.

The second discovery was of the first lactating silver-haired bat recorded in Pennsylvania and subsequent discovery of a silver-haired bat maternity colony in 2007. The bat was captured during pre-construction mist net surveys, conducted by a Cooperator, and was tracked to a roost tree that contained 24 individuals, including juveniles.

2008.--Telemetry surveys were conducted on small-footed and Indiana bats that were captured on proposed wind sites. Capture locations, roost locations, and foraging areas were documented and submitted for inclusion into the Pennsylvania Natural Diversity Inventory (PNDI). See the *Bats: Telemetry* section for further information.

2009.--A new Indiana bat hibernacula was discovered in 2009. Small-footed bat telemetry documented roost locations and foraging areas that were submitted for inclusion into PNDI. See the *Bats: Telemetry* section for further information.

The second significant finding was of two Seminole bat (*Lasiurus seminolus*) fatalities documented at one site during post-construction mortality monitoring surveys. Seminole bats are known to occur in Pennsylvania, but are uncommon. The two carcasses were in excellent condition and one was submitted to the Carnegie Museum of Natural History, Pittsburgh and the second to The State Museum of Pennsylvania, Harrisburg to be preserved as voucher specimens.

BEST MANAGEMENT PRACTICES

As part of the Cooperative Agreement, Cooperators agree to utilize, to the greatest extent possible, all reasonable and feasible generally accepted wind industry and PGC approved best management practices (BMP) relevant to the conservation of wildlife resources during construction and subsequent operation of their wind energy facility. ***The PGC, in cooperation with the Pennsylvania Wind and Wildlife Collaborative and Cooperators, has drafted best***

management practices. These BMPs have been endorsed by the PGC and can be found in Appendix G. We anticipate that the BMP's will be incorporated into the Cooperative Agreement in 2011.

AVOIDANCE, MINIMIZE, AND MITIGATION BY COOPERATORS

Avoidance

In the first 18 months of the PGC Wind Energy Voluntary Cooperative Agreement, three proposed wind sites were abandoned by four developers due to potential wildlife resource impacts. Since then the PGC has not been made aware of any additional wind sites that have been abandoned due to potential wildlife resource impacts.

Minimization efforts from Cooperators have included the following:

1. Reduction of overall project size to minimize wildlife impacts.
2. Additional evaluation and/or elimination of project areas within five miles of known hibernacula containing the federally protected Indiana bat. At the request of the U.S. Fish and Wildlife Service, the Indiana bat hibernacula buffer was extended from five miles to ten miles in the PNDI during the spring of 2010.
3. Avoidance of existing forested landscape and use of disturbed lands to the maximum extent possible.
4. Placement of turbines on reclaimed strip mine lands to avoid land clearing.
5. Elimination of planned turbines on ridge tops near raptor flyways.
6. Turbines set back 50 – 400 m off escarpments to minimize potential raptor collisions.
7. Movement of turbines 30 – 100 feet away from potential woodrat habitat.

Mitigation efforts:

1. Plans to place bat gates on up to three hibernacula of concern. The gates are designed to control third party access to critical bat habitat. None of the hibernacula have been gated to date.
2. Funds were contributed in 2009 to acquire land containing habitat for the state-listed threatened upland sandpiper (*Bartramia longicauda*). The land (a portion of State Game Lands #93) has since been purchased.
3. Plans to create small-footed bat roost habitat at two proposed wind sites where small-footed bat roost habitat is being lost. Both sites are currently in the permitting stage and thus the alternative roost structures have yet to be built.
4. The PGC has requested curtailment at two proposed wind sites due to high bat risk. Both sites are currently in the permitting stage and thus have not yet been built.
5. Voluntary replacement of consultants that were identified by the PGC as failing to provide the necessary monitoring data. This issue arose due to negligence of the consultant to follow PGC protocols even after guidance was provided by the PGC.
6. ***Indiana Bat Conservation Fund (IBCF) has been established to provide a dedicated source of funding that will 1) ensure that the direct, indirect, and cumulative adverse effects on the federally and state-listed endangered Indiana bats are adequately offset within the Pennsylvania and 2) result in tangible conservation and recovery benefits to the Indiana bat within the Commonwealth of Pennsylvania. The IBCF will be used to fund projects important to the conservation and recovery of the Indiana bat within Pennsylvania. The USFWS, during project review will determine if and when use of the IBCF is appropriate,***

consistent with the most recent Indiana Bat Mitigation Guidance for Pennsylvania. It is agreed and understood that the IBCF will not be used for reviews of wind power projects, unless the wind developer has signed onto the PGC Cooperative Agreement and is in compliance with that Agreement.

RESEARCH

Research done or in progress:

Assessing Conservation Needs of Eastern Golden Eagles in Pennsylvania.-- The goal of this research project is to collect information on where and how the unique eastern population of golden eagles migrates through Pennsylvania and to use these data to provide statewide maps showing the relative risk to eagles from development of wind power. These maps will provide a crucial tool for managers, policy makers and legislators to guide development of wind power throughout the state. This project is being funded by the State Wildlife Grant program and is currently active (Todd Katzner, West Virginia University).

Testing Solutions to Bat Fatalities by Wind Turbines: Proactive Response to Threats.—Two Pennsylvania wind energy facilities have participated in a program designed to test deterrence and curtailment options to reduce the threat of wind turbines to bats (http://www.batsandwind.org). The curtailment study was conducted in 2008-09 and showed 44-93% reduction in bat mortality with cut-in speeds of five m/s (Arnett et al. 2010). A bat deterrent study is currently (2009-2010) underway at another Pennsylvania wind site. Preliminary results suggest turbines with deterrents have 20-53% fewer bat fatalities compared to those without deterrents. While these findings are encouraging, more experimentation is needed and we do not yet have an operational deterrent device for broad-scale mitigation (BWEC e-Newsletter v. 8 July 2010). Portions of the bat deterrent study have been funded by the State Wildlife Grant program.

Suggested research needs:

There is still much research needed to help us better understand what impacts wind development has on wildlife and what can be done to help avoid and minimize impacts. Research topics include:

1. Mitigation experiments (such as curtailment) at multiple sites – testing various treatments (cut-in speeds, time of year) and determining which are most effective for reducing mortality and at what economic cost to the industry.
2. Impacts to bat populations – determine population size of bat species (genetic studies) and how mortality from wind sites is affecting them; cumulative effects of mortality on bat populations; effects of habitat and landscape alteration on bat populations.
3. Migratory pathways of bats – little is known about migratory tree bats, which are being killed in the greatest numbers; more information is needed on these species in regards to where and when they migrate.
4. Improving mortality estimating protocols – find better ways to estimate mortality while minimizing cost to industry.
5. Improving mortality estimators – develop better estimators and techniques to determine impacts to bat populations.
6. Determine if there are any correlations between pre-construction surveys and post-construction mortality.

7. Determining why bats appear to be attracted to wind turbines – testing current hypotheses; identify attraction in order to reduce the appeal, if feasible.
8. Bat deterrents – evaluate current bat deterrents under different operating conditions and turbine characteristics at multiple sites in regards to reducing bat mortality and cost effectiveness.
9. Conduct monitoring on high risk, priority non-Cooperator wind facilities currently operating in Pennsylvania in an effort to correlate existing statewide data derived from Cooperators' who have sites located in the general proximity.
10. Techniques to minimize forest fragmentation and manage vegetation at wind development facilities to best protect Pennsylvania's birds of greatest conservation need and their habitats.

OVERALL SUCCESSES/CHALLENGES

Successes

1. Avoidance/abandonment of three sites in areas to avoid high mortality risk to wildlife.
2. Many Cooperators are pro-active in terms of getting PGC input early in the planning stages – sharing of data between PGC and developers is helping developers make better decisions in regards to siting wind facilities.
3. Pre-construction survey data continues to be received by the PGC resulting in improved site locations for wind turbines, thus reducing potential adverse impacts to wildlife resources.
4. ***Research on bat deterrents and curtailment has shown promise to reduce bat mortality at operational wind sites.***
5. The Cooperative Agreement has been recognized on a national level with at least one neighboring state following a similar model. Ohio DNR has used the Cooperative Agreement as a model for its wind energy cooperative agreement which will allow for ease of data comparison across state boundaries.
6. ***The Commonwealth established a new Right-to-Know Law 65 P.S. §§ 67-101-67.3103, effective January 1, 2009. That law changed the definition of public record and expanded the categories of documents that are exempt from disclosure. In order to clarify for the PGC and the public how the new Right-to-Know law will be implemented by the PGC, the PGC Commissioners unanimously voted on April 20, 2010 to amend 58 Pa. Code to include §131.9 (Disclosure of certain records). With regard to wind power records, the amendment stated: <u>In accordance with the Right-to-Know law (65 P.S. §§ 67-101-67.3103), public access to the following records, wherever located, will and shall only be made as set forth in paragraphs (1) – (4) below: (1) Wind power records. Commission annual reports and Pennsylvania Natural Heritage Program clearance correspondence respecting existing or proposed wind power facilities will be provided upon request, but redacted as necessary. All other records are pre-deliberative, proprietary or tending to identify the location of threatened or endangered species and will not be disclosed.</u> This change was, in part, needed to better protect the species of concern data collected by the wind energy cooperators' voluntary monitoring efforts.***

Challenges

1. Some wind developers with proposed and/or active sites in Pennsylvania have not yet signed the Cooperative Agreement and are not following suggested PGC monitoring and avoidance/minimization processes. The PGC will continue to investigate all wind sites, paying careful attention to those not signed into the Cooperative Agreement, in an effort to

further ascertain what avenues, including potential legal action, may be deemed appropriate to safeguard and conserve bat and bird species within the project area.

2. Cooperators are not always updating the PGC on the status of projects nor are they providing up-to-date maps; this inhibits the PGC's ability to provide a complete review of project areas. As a proposed solution, the PGC encourages Cooperators to delineate larger potential project areas rather than smaller ones to ensure that all potential wildlife impacts are identified early on in the planning stages.
3. Protocols are still not being followed completely. The surveys with the most issues are bat acoustics followed by breeding bird surveys, as discussed above under pre-construction surveys. PGC strongly recommends that all Cooperators and their consultants communicate with the PGC prior to commencing surveys to review survey site locations and protocol details to ensure that the surveys are being done efficiently and in accordance with the Cooperative Agreement. The PGC not only attempts to provide guidance prior to the surveys starting, but also attempts to be on site for at least one day of every survey being conducted at each site to answer questions, provide guidance, and help to remedy any problems as soon as possible.
4. Keeping sites that were abandoned by responsible developers due to very high risk of wildlife impacts from being developed by another developer.
5. Keeping the wind biologist positions filled during to the current state budget crisis. Due to the hiring freeze and promotions within the agency several of the positions have been vacant during the past two years.
6. Survey reports and data are not submitted in a timely manner. Pre-construction survey reports are not always being submitted by the end of the calendar year. The PGC continues to stress the importance of submitting survey reports and data as soon as possible so that potential issues can be resolved sooner than later. Likewise, the PGC continues to ask that Cooperators not submit pre-construction survey reports all at once, at the conclusion of all surveys. Submitting all the reports and data in this fashion, usually right before the developer is planning on submitting applications for permits, does not give the PGC or developer adequate time to resolve potential issues. If there are potential issues, additional surveys may be warranted, which may result in delays to the project's development timeline. These delays can be best avoided by submitting survey reports and data to the PGC in a timely fashion, as soon as possible after the conclusion of the survey. Post-construction surveys must be submitted by December 31 of the survey year as per the Special Use Permit.

FUTURE

Wind energy development in Pennsylvania continues to occur and, with the creation of the Cooperative Agreement, the PGC has and continues to gain much information regarding the impacts to birds and mammals. Information collected from these data continues to provide needed insight into which species are at risk from wind energy development and helps all involved parties determine the best ways to avoid and minimize impacts to birds and mammals from wind energy development. As analysis of the information produced from the Cooperative Agreement continues, both the wind energy industry and the PGC will be more equipped with the knowledge to make better decisions regarding the protection and conservation of the Commonwealth's wildlife resources.

We now have three years of post-construction mortality monitoring data from eight different sites. At the conclusion of the 2010 season, we will have four years of mortality monitoring data

from a combination of ten different sites (note that each site conducts mortality monitoring for two years). As our dataset increases, we have been better able to detect trends and determine which species are at risk from wind energy development. We will continue to further analyze our increasing dataset for other trends and use the data to better site wind energy projects.

The relationships between the PGC and Cooperators continue to grow and communication is improving. The PGC will keep working with Cooperators in all stages of wind energy development to safeguard and conserve birds and mammal wildlife resources.

The PGC is committed to making sure all wind energy projects, including non-Cooperators, are employing feasible measures to protect and minimize adverse impacts, which are anticipated to occur to the Commonwealth's bat and bird resources. The Best Management Practices that have been created will aid both the PGC and Cooperators in avoiding and minimizing impacts from wind energy. The PGC will continue to investigate the monitoring efforts and mortality of birds and bats at non-Cooperator wind energy sites using the PGC's limited resources, prioritized by project site location and risk assessment from the PGC's internal reviews.

With the unprecedented decline in bats due to white nose syndrome in Pennsylvania and other states, it is anticipated that additional bat species will be added to the state and federal listings of threatened and endangered species. Cooperators continue to work with the PGC to avoid and minimize impacts to bats and will therefore be in a better position to deal with new regulations as new bat species are listed compared to non-Cooperators who have not been working with the PGC to minimize impacts to bats.

The PGC recognizes that each project is unique and therefore remains committed to all Cooperators to keep the Cooperative Agreement both flexible and adaptive. As information and subsequent analysis of data generated through the Cooperative Agreement continues, the PGC will work collaboratively with all the Cooperators to incorporate proposed revisions. At this time, the PGC does not have enough evidence to support deletion of any of the current surveys. However, feedback from the Cooperators has indicated that further clarification to specific protocol guidelines is needed (e.g. bat acoustics, breeding bird survey). The PGC will work with Cooperators to provide further written guidance for bat acoustic surveys in early 2011. Further, there remains a critical need to compare pre- and post-construction results from several sites before making any major changes to the Cooperative Agreement that would result in eliminating surveys or changing protocols. Encouragingly though, there has been a wealth of information on wildlife impacts from wind energy development already collected through the Cooperative Agreement.

In summary, the PGC's Wind Energy Voluntary Cooperative Agreement continues to be successful and achieve its intended purpose. The Cooperative Agreement has allowed Pennsylvania to become one of the national leaders in determining and addressing wildlife impacts from wind energy development. Due to all the collaborative efforts between the wind industry and PGC, the Cooperative Agreement has and will continue to provide all involved parties with valuable information needed to best manage wildlife at wind energy sites. Cooperating wind companies have set an example that others should aspire to follow. These Cooperators have proven to be partners in developing conscientious renewable energy with the

highest regard to the Commonwealth's wildlife resources to the mutual benefit of all the citizens of the Commonwealth of Pennsylvania.

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APPENDIX A: Summary of pre-construction fall raptor migration surveys done at Pennsylvania wind sites, 2004 – present. Raptor species are designated by AMKE=American kestrel, BAEA=Bald eagle, BLVU=Black vulture, BWHA=Broad-winged hawk, COHA=Cooper's hawk, GOEA=Golden eagle, MERL=Merlin, NOGO=Northern Goshawk, NOHA=Northern harrier, OSPR=Osprey, PEFA=Peregrine falcon, RSHA=Red-shouldered hawk, RTHA=Red-tailed hawk, RLHA=Rough-legged hawk, SSHA=Sharp-shinned hawk, TUVU=Turkey vulture, and Unidentified raptor.

										Percent in Flight								
Wind Site	Raptor Risk	Year	Dates	# days	hrs/ day	total observation hours	raptors/ hr	total # raptor spp	total # raptors observed	AMKE	BAEA[a]	BLVU	BWHA[b]	COHA	GOEA[c]	MERL	NOGO[d]	NOHA[e]
2-2	L	2004	10/7-11/15	37	6.8	251	4.0	13	997	1.6	0.4	2.3	0.0	4.3	0.5	0.0	0.3	8.4
3-2	H	2005	10/09-12/14	54	6.4	348	2.3	12	792	0.0	1.1	0.0	0.0	1.3	6.6	0.0	0.1	0.8
2-7	L	2006	9/1-11/15	33	7.4	245	2.3	13	552	0.4	0.4	3.4	9.8	2.4	0.4	0.4	0.0	0.7
2-15	L	2006	10/25-12/1	34	7.4	253	1.3	8	322	0.9	0.0	0.0	0.0	5.3	0.3	0.6	0.3	8.1
2-1	L	2006	9/14-10/13	10	6.0	60	10.4	10	622	1.4	0.5	0.0	56.3	0.5	0.0	0.0	0.0	2.3
6-1	L	2006	9/1-11/15	62	7.2	445	4.6	16	2058	1.4	0.9	5.9	20.4	1.5	0.0	1.4	0.1	2.7
6-3	L	2006	9/1-11/15	62	7.2	445	4.6	16	2058	1.4	0.9	5.9	20.4	1.5	0.0	1.4	0.1	2.7
5-6	M	2006	9/15-11/14	28	7.3	206	3.0	14	616	2.3	3.1	0.0	6.8	3.9	0.3	3.9	0.0	0.6
5-15	L	2007	9/16-12/17	5	8.0	40	3.6	10	144	0.7	0.0	0.0	41.7	4.2	0.0	1.4	2.8	1.4
3-6	L	2007	9/17-12/16	14	7.8	109	1.4	10	147	0.0	0.7	0.0	53.1	2.0	2.0	0.0	0.7	1.4
35-1	L	2007	9/13-9/19	2	8.0	16	6.3	12	101	5.0	4.0	0.0	29.7	5.9	1.0	3.0	0.0	2.0
2-4	M	2007	9/10-12/18	51	6.1	310	1.4	15	419	7.2	1.0	0.0	11.5	1.0	1.0	1.4	1.0	10.0
2-5	M	2007	9/10-12/18	51	6.1	310	1.4	15	419	7.2	1.0	0.0	11.5	1.0	1.0	1.4	1.0	10.0
4-3	M	2007	8/24-12/14	74	7.9	584	0.9	13	514	1.2	0.8	11.7	19.1	1.4	1.0	0.0	0.0	0.6
3-4	H	2007	8/25-12/14	67	7.6	507	1.5	15	2014	0.6	2.1	0.8	23.2	2.3	3.6	0.2	0.0	1.9
24-2	H	2007	8/24-12/14	67	7.1	478	2.8	14	1332	0.4	1.4	0.0	17.9	2.2	3.0	0.2	0.1	1.1
2-18	H	2007	8/26-12/14	76	7.7	586	2.1	16	1207	0.7	0.7	0.2	18.4	4.0	3.5	0.2	0.2	1.2
5-14	L	2008	9/23-12/14	5	8.2	41	3.3	11	137	1.5	0.0	0.0	4.4	16.8	1.5	0.0	1.5	2.2
2-25	L	2008	9/16-12/15	10	8.0	80	2.6	9	209	0.5	0.0	6.2	6.7	5.3	0.0	0.0	0.0	1.0
6-10	M	2008	9/3-11/24	28	5.6	158	1.7	12	276	6.5	1.8	5.1	36.6	7.6	0.0	0.4	0.0	5.8
6-12	H	2008	8/15-12/15	76	7.7	1170	2.8	16	3268	1.4	1.4	6.2	27.0	2.0	0.7	0.3	0.1	0.9
6-11	H	2008	8/15-12/15	76	7.9	598	6.6	16	3940	1.1	6.3	7.3	16.6	1.8	0.9	0.3	0.3	1.5
2-24	L	2009	8/31-10/22	10	8.0	80	2.8	11	220	15.9	1.4	3.2	6.8	2.3	0.5	0.9	0.0	3.6
2-9	M	2009	8/15-12/15	77	8.1	623	0.3	7	167	0	0	0.0	4.8	1.8	0.0	0.0	0.0	2.4
							3.1		8080	1.8	3.8	6.5	20.7	2.2	0.7	0.3	0.2	1.4

[a] Pennsylvania threatened; Pennsylvania Wildlife Action Plan high level concern; [b] Pennsylvania Wildlife Action Plan maintenance concern; [c] Pennsylvania Wildlife Action Plan PA vulnerable; [d] Pennsylvania Wildlife Action Plan PA vulnerable; [e] Pennsylvania Wildlife Action Plan high level concern; [f] Pennsylvania listed threatened; Pennsylvania Wildlife Action Plan Pennsylvania vulnerable; [g] Pennsylvania endangered; Pennsylvania Wildlife Action Plan high level concern; [h] Pennsylvania Wildlife Action Plan maintenance concern; [i] Pennsylvania Wildlife Action Plan maintenance concern.

APPENDIX A (continued): Summary of pre-construction fall raptor migration surveys done at Pennsylvania wind sites, 2004 – present. Raptor species are designated by AMKE=American kestrel, BAEA=Bald eagle, BLVU=Black vulture, BWHA=Broad-winged hawk, COHA=Cooper's hawk, GOEA=Golden eagle, MERL=Merlin, NOGO=Northern Goshawk, NOHA=Northern harrier, OSPR=Osprey, PEFA=Peregrine falcon, RSHA=Red-shouldered hawk, RTHA=Red-tailed hawk, RLHA=Rough-legged hawk, SSHA=Sharp-shinned hawk, TUVU=Turkey vulture, and Unidentified raptor.

										Percent in Flight							
Wind Site	Raptor Risk	Year	Dates	# days	hrs/ day	total observation hours	raptors/ hr	total # raptor spp	total # raptors observed	OSPR[f]	PEFA[g]	RSHA[h]	RTHA	RLHA	SSHA[i]	TUVU	Unidentified Raptor
2-2	L	2004	10/7-11/15	37	6.8	251	4.0	13	997	0.5	0.0	1.3	41.3	0.5	5.4	32.2	0.9
3-2	H	2005	10/09-12/14	54	6.4	348	2.3	12	792	0.3	0.6	0.6	33.8	2.8	1.1	43.7	7.2
2-7	L	2006	9/1-11/15	33	7.4	245	2.3	13	552	1.6	0.2	0.0	11.8	0.0	4.2	59.6	4.9
2-15	L	2006	10/25-12/1	34	7.4	253	1.3	8	322	0.0	0.3	1.6	68.0	0.0	6.2	8.4	0.0
2-1	L	2006	9/14-10/13	10	6.0	60	10.4	10	622	1.0	0.0	0.3	5.0	0.0	7.1	24.6	1.1
6-1	L	2006	9/1-11/15	62	7.2	445	4.6	16	2058	0.8	0.5	1.7	21.0	0.1	4.9	30.4	6.2
6-3	L	2006	9/1-11/15	62	7.2	445	4.6	16	2058	0.8	0.5	1.7	21.0	0.1	4.9	30.4	6.2
5-6	M	2006	9/15-11/14	28	7.3	206	3.0	14	616	2.3	1.5	0.5	20.9	0.8	29.2	21.9	1.9
5-15	L	2007	9/16-12/17	5	8.0	40	3.6	10	144	1.4	0.0	1.4	26.4	0.0	0.0	11.8	6.9
3-6	L	2007	9/17-12/16	14	7.8	109	1.4	10	147	0.0	0.0	1.4	21.1	0.0	2.0	14.3	1.4
35-1	L	2007	9/13-9/19	2	8.0	16	6.3	12	101	2.0	0.0	1.0	7.9	0.0	10.9	26.7	1.0
2-4	M	2007	9/10-12/18	51	6.1	310	1.4	15	419	0.2	0.2	1.4	15.8	0.5	5.0	34.1	8.8
2-5	M	2007	9/10-12/18	51	6.1	310	1.4	15	419	0.2	0.2	1.4	15.8	0.5	5.0	34.1	8.8
4-3	M	2007	8/24-12/14	74	7.9	584	0.9	13	514	1.0	0.0	0.2	14.0	0.2	8.8	38.3	1.9
3-4	H	2007	8/25-12/14	67	7.6	507	1.5	15	2014	1.9	0.0	0.6	23.1	0.1	18.5	20.0	1.0
24-2	H	2007	8/24-12/14	67	7.1	478	2.8	14	1332	1.7	0.0	0.4	33.1	0.2	16.6	19.8	2.0
2-18	H	2007	8/26-12/14	76	7.7	586	2.1	16	1207	1.0	0.2	1.9	38.8	0.3	16.9	10.0	1.7
5-14	L	2008	9/23-12/14	5	8.2	41	3.3	11	137	0.7	0.0	0.7	29.2	0.0	9.5	14.6	17.5
2-25	L	2008	9/16-12/15	10	8.0	80	2.6	9	209	0.0	0.0	0.5	18.2	0.0	1.4	34.9	23.9
6-10	M	2008	9/3-11/24	28	5.6	158	1.7	12	276	4.3	0.0	1.8	10.9	0.0	11.2	8.0	0.0
6-12	H	2008	8/15-12/15	76	7.7	1170	2.8	16	3268	1.6	0.2	0.7	17.1	0.0	21.0	18.8	0.6
6-11	H	2008	8/15-12/15	76	7.9	598	6.6	16	3940	2.3	0.6	1.3	21.0	0.1	14.0	23.3	1.4
2-24	L	2009	8/31-10/22	10	8.0	80	2.8	11	220	0.0	0.0	0.0	7.3	0.0	5.5	45.5	7.3
2-9	M	2009	8/15-12/15	77	8.1	623	0.3	7	167	0.6	0.0	0.0	24.6	0.0	9.0	55.7	1.2
							3.1		8080	1.9	0.4	1.0	18.7	0.0	16.1	22.5	1.8

[a] Pennsylvania threatened; Pennsylvania Wildlife Action Plan high level concern; [b] Pennsylvania Wildlife Action Plan maintenance concern; [c] Pennsylvania Wildlife Action Plan PA vulnerable; [d] Pennsylvania Wildlife Action Plan PA vulnerable; [e] Pennsylvania Wildlife Action Plan high level concern; [f] Pennsylvania listed threatened; Pennsylvania Wildlife Action Plan Pennsylvania vulnerable; [g] Pennsylvania endangered; Pennsylvania Wildlife Action Plan high level concern; [h] Pennsylvania Wildlife Action Plan maintenance concern; [i] Pennsylvania Wildlife Action Plan maintenance concern.

APPENDIX B: Summary of pre-construction spring raptor migration surveys done at Pennsylvania wind sites, 2006 – present. Raptor species are designated by AMKE=American kestrel, BAEA=Bald eagle, BLVU=Black vulture, BWHA=Broad-winged hawk, COHA=Cooper's hawk, GOEA=Golden eagle, MERL=Merlin, NOGO=Northern Goshawk, NOHA=Northern harrier, OSPR=Osprey, PEFA=Peregrine falcon, RSHA=Red-shouldered hawk, RTHA=Red-tailed hawk, RLHA=Rough-legged hawk, SSHA=Sharp-shinned hawk, TUVU=Turkey vulture, and Unidentified raptor.

										Percent in Flight								
Wind Site	Risk	Year	Dates	Days	hrs/ day	total hrs	raptors/ hr	total No. raptor spp.	Total No. raptors	AMKE	BAEA[a]	BLVU	BWHA[b]	COHA	GOEA[c]	MERL	NOGO[d]	NOHA[e]
3-2	H	2006	2/25-3-31	34	7.5	254.1	0.9	12	223	1.3	3.6	0.4	0.0	1.3	21.1	0.0	0.0	4.5
2-7	L	2006	4/3-5/29	28	7.0	196.5	2.7	10	523	0.2	0.0	0.2	7.5	8.8	0.0	0.0	0.0	0.6
2-1	L	2006	4/6-5/10	7	5.7	40.0	4.9	10	196	5.6	0.0	0.0	9.2	1.0	0.0	0.0	1.0	7.1
6-1	L	2006	4/20-5/31	37	8.0	295.2	1.0	12	289	0.3	0.7	0.7	7.3	2.1	0.0	0.3	0.3	0.3
6-3	L	2006	4/20-5/31	37	8.0	295.2	1.0	12	289	0.3	0.7	0.7	7.3	2.1	0.0	0.3	0.3	0.3
3-4	H	2007	3/2-4/6	30	7.7	230.0	1.1	10	247	0.4	0.8	0.0	0.0	8.9	7.7	0.0	0.0	4.5
24-2	H	2007	3/1-4/6	32	7.3	232.3	1.6	14	372	1.3	1.6	1.6	0.0	3.2	5.6	0.8	0.5	2.2
2-18	H	2007	4/24-5/3	8	8.6	68.8	2.3	9	161	0.0	1.2	1.9	4.3	0.0	0.0	0.0	0.0	0.6
2-19	H	2007	3/10-4/13	25	7.1	177.3	5.0	13	894	0.6	0.1	1.2	0.0	0.8	0.9	0.8	0.0	0.7
4-3	M	2007	02/27-4/6	34	6.8	230.1	5.6	14	1292	0.9	0.4	2.6	0.1	1.6	2.3	0.2	0.0	0.7
35-1	L	2007	4/3-4/23	2	6.5	13.0	3.3	8	43	0.0	0.0	0.0	7.0	11.6	0.0	0.0	2.3	0.0
2-18	H	2008	3/4-4/25	38	7.8	295.3	1.3	14	388	0.8	2.6	0.0	0.3	0.3	2.1	0.3	0.0	1.0
6-12	H	2008	3/5-4/25	38	10.5	398.0	0.6	15	246	7.3	9.3	6.5	27.6	12.2	0.4	0.4	0.4	2.8
6-11	H	2008	3/1-4/25	42	7.2	301.0	1.8	13	550	3.6	6.7	0.9	44.9	7.3	0.2	0.0	0.4	4.0
2-4	M	2008	3/11-3/31	15	7.6	114.0	0.9	10	101	5.9	1.0	1.0	2.0	0.0	0.0	0.0	0.0	9.9
2-5	M	2008	3/11-3/31	15	7.6	114.0	0.9	10	101	5.9	1.0	1.0	2.0	0.0	0.0	0.0	0.0	9.9
3-6	L	2008	3/10-3/29	6	7.7	46.0	1.6	5	74	1.4	0.0	0.0	0.0	0.0	1.4	0.0	0.0	0.0
									5989	1.6	1.7	1.4	7.2	3.4	2.3	0.3	0.2	2.0

[a] Pennsylvania threatened; Pennsylvania Wildlife Action Plan high level concern; [b] Pennsylvania Wildlife Action Plan maintenance concern; [c] Pennsylvania Wildlife Action Plan Pennsylvania vulnerable; [d] Pennsylvania Wildlife Action Plan PA vulnerable; [e] Pennsylvania Wildlife Action Plan high level concern; [f] Pennsylvania listed threatened; Pennsylvania Wildlife Action Plan Pennsylvania vulnerable; [g] Pennsylvania listed endangered; Pennsylvania Wildlife Action Plan high level concern; [h] Pennsylvania Wildlife Action Plan maintenance concern; [i] Pennsylvania Wildlife Action Plan maintenance concern.

APPENDIX B (continued): Summary of pre-construction spring raptor migration surveys done at Pennsylvania wind sites, 2006 – present. Raptor species are designated by AMKE=American kestrel, BAEA=Bald eagle, BLVU=Black vulture, BWHA=Broad-winged hawk, COHA=Cooper's hawk, GOEA=Golden eagle, MERL=Merlin, NOGO=Northern Goshawk, NOHA=Northern harrier, OSPR=Osprey, PEFA=Peregrine falcon, RSHA=Red-shouldered hawk, RTHA=Red-tailed hawk, RLHA=Rough-legged hawk, SSHA=Sharp-shinned hawk, TUVU=Turkey vulture, and Unidentified raptor.

										Percent in Flight							
Wind Site	Risk	Year	Dates	Days	hrs/ day	total hrs	raptors/ hr	total No. raptor spp.	Total No. raptors	OSPR[f]	PEFA[g]	RSHA[h]	RTHA	RLHA	SSHA[i]	TUVU	Unidentified Raptor
3-2	H	2006	2/25-3-31	34	7.5	254.1	0.9	12	223	0.4	0.0	5.4	25.6	1.8	1.8	28.7	4.0
2-7	L	2006	4/3-5/29	28	7.0	196.5	2.7	10	523	1.7	0.0	0.2	18.0	0.0	2.5	59.8	0.6
2-1	L	2006	4/6-5/10	7	5.7	40.0	4.9	10	196	0.5	0.0	2.0	15.8	0.0	4.1	53.6	0.0
6-1	L	2006	4/20-5/31	37	8.0	295.2	1.0	12	289	4.5	0.0	0.0	5.2	0.0	4.2	72.7	1.4
6-3	L	2006	4/20-5/31	37	8.0	295.2	1.0	12	289	4.5	0.0	0.0	5.2	0.0	4.2	72.7	1.4
3-4	H	2007	3/2-4/6	30	7.7	230.0	1.1	10	247	0.4	0.0	2.0	23.1	0.0	0.8	49.0	2.4
24-2	H	2007	3/1-4/6	32	7.3	232.3	1.6	14	372	0.3	0.0	3.0	18.0	0.5	2.4	55.6	3.2
2-18	H	2007	4/24-5/3	8	8.6	68.8	2.3	9	161	5.0	0.0	0.0	13.0	1.9	6.2	50.3	15.5
2-19	H	2007	3/10-4/13	25	7.1	177.3	5.0	13	894	0.4	0.0	1.0	14.8	0.3	1.9	71.9	4.6
4-3	M	2007	2/27-4/6	34	6.8	230.1	5.6	14	1292	0.3	0.0	2.0	13.8	0.2	2.8	66.5	5.7
35-1	L	2007	4/3-4/23	2	6.5	13.0	3.3	8	43	2.3	0.0	2.3	32.6	0.0	2.3	34.9	4.7
2-18	H	2008	3/4-4/25	38	7.8	295.3	1.3	14	388	0.5	0.5	1.5	11.9	0.3	1.8	76.0	0.3
6-12	H	2008	3/5-4/25	38	10.5	398.0	0.6	15	246	4.9	0.4	2.4	11.8	0.0	3.7	7.7	2.0
6-11	H	2008	3/1-4/25	42	7.2	301.0	1.8	13	550	5.1	0.0	1.5	12.4	0.0	5.5	0.9	6.7
2-4	M	2008	3/11-3/31	15	7.6	114.0	0.9	10	101	0.0	0.0	3.0	17.8	1.0	1.0	54.5	3.0
2-5	M	2008	3/11-3/31	15	7.6	114.0	0.9	10	101	0.0	0.0	3.0	17.8	1.0	1.0	54.5	3.0
3-6	L	2008	3/10-3/29	6	7.7	46.0	1.6	5	74	0.0	0.0	0.0	23.0	0.0	1.4	63.5	9.5
									5989	1.6	0.1	1.6	14.6	0.3	2.9	55.2	3.9

[a] Pennsylvania listed threatened; Pennsylvania Wildlife Action Plan high level concern; [b] Pennsylvania Wildlife Action Plan maintenance concern; [c] Pennsylvania Wildlife Action Plan Pennsylvania vulnerable; [d] Pennsylvania Wildlife Action Plan Pennsylvania vulnerable; [e] Pennsylvania Wildlife Action Plan high level concern; [f] Pennsylvania listed threatened; Pennsylvania Wildlife Action Plan Pennsylvania vulnerable; [g] Pennsylvania listed endangered; Pennsylvania Wildlife Action Plan high level concern; [h] Pennsylvania Wildlife Action Plan maintenance concern; [i] Pennsylvania Wildlife Action Plan maintenance concern.

APPENDIX C: Summary of breeding bird surveys done pre-construction at proposed wind sites in Pennsylvania, 2006 - present. "Not in report" designation means the information was not specifically provided in the survey report but does not mean that particular information was not collected.

Wind Site	Survey Year	Point Count Dates	# Point Counts	Area Search Dates	# area searches	Comments	Total # species	# PA endangered species	# PA threatened species	# PA WAP species	Total # individual records	Habitat
2-1	2006	June 1-2; 8-9	16	not provided in report	not provided in report	Point counts were not conducted in May and point counts did not adequately cover project area	38	0	0	9	348	forest interior/ grassland/ successional
2-19	2006	N/A	N/A	May 2 - July 6	2	Point counts and area searches did not adequately cover project area; survey conducted off project area	73	1	0	16	not in report	grassland/ forest edge
2-4 & 2-5	2007	May 23-24; June 6-7; 13-14	20	May 23-24; June 6-7; 13-14	14	Area searches were not conducted in mid-March to April period	81	1	0	19	910	grassland/ forest
3-4	2007	May 8-9; June 5-8	42	not provided in report	not provided in report	Second round of point count were not conducted in June	86	0	0	15	5876	forest-interior/ forest edge
35-1	2007	May 23-24; June 5-6; 19-22	34	May 23-24; June 5-6; 19-22	13	Area searches were not conducted in mid-March to April period	97	1	0	20	1346	field/ forest edge/ riparian/ wetland/ mixed forest
24-2	2007	May 10-11	28	not provided in report	not provided in report	Two rounds of point counts were not conducted in June 1 – July 10	106	0	0	23	3567	grassland/ forest-interior/ forest edge
2-18	2007	May 31; June 7; 18-19	N/A	N/A	N/A	Neither point counts nor area searches were conducted; transects walked	69	1	0	15	not in report	forest interior/ forest edge
2-7	2007	May 22-23; June 27-30	28	April 23-24	not provided in report	Area searches not conducted in May or June nor were second round of point counts in June 1 – July 10	95	1	0	20	1630	forest-interior/ forest edge
2-15	2007	May 19; June 17-18	18	April 17, 28-28	not provided in report	Area searches were not conducted in May or June nor were second round of point counts in June 1 – July 10	97	1	1	18	2691	grassland/ forest-interior/ forest edge
4-3	2007	May 20-21; June 19-22	28	April 21-22	not provided in report	Area searches were not conducted in May or June nor were second round of point counts in June 1 – July 10	91	1	1	20	3099	forest-interior/ forest edge

APPENDIX C (continued): Summary of breeding bird surveys done pre-construction at proposed wind sites in Pennsylvania, 2006 - present. "Not in report" designation means the information was not specifically provided in the survey report but does not mean that particular information was not collected.

Wind Site	Survey Year	Point Count Dates	# Point Counts	Area Search Dates	# area searches	Comments	Total # species	# PA endangered species	# PA threatened species	# PA WAP species	Total # individual records	Habitat
5-18	2007	June 9-11; June 29-30; July 3-4	33	N/A	N/A	May point counts were not conducted	52	0	0	5	1986	forest-interior/ forest edge
5-15	2008	May 31, June 19, June 27	10	N/A	N/A		26	0	0	4	190	reclaimed strip mine/ forest
5-14	2008	May 28-30; June 17-18; June 25-26	31	May 28; June 18; June 26	1		42	0	0	4	not provided in report	reclaimed strip mine/ forest
3-6	2008	May 20-21; June 10 & 13; June 24-25	28	May 20-21; June 10 & 13; June 24-25	13	No area searches were conducted during the mid-March to April period	82	0	0	16	980 (point count only)	forested/ agriculture
2-25	2008	May 28-29; June 6-9; June 26-28	30	June 7-8; June 27-28	6	No area searches were conducted during the mid-March to April and May periods	74	0	0	9	1437	forested/ agriculture
2-25	2009	June 16-19; June 25-28	36	N/A	N/A	May point counts were not conducted	51	0	0	8	679	forested/ agriculture
4-3	2009	May 21; June 4; June 18	11	Apr 16; May 21; June 4; June 18	2		77	1	1	18	494	forest-interior/ forest edge
6-12	2009	May 27-30; June 11-14; June 23-26	56	May 27-30; June 11-14; June 23-26	not provided in report	No area searches were conducted during the mid-March to April period	35	0	0	5	1578	forest - interior/ forest edge
2-9	2009	May 27; June 3; June 10	3	N/A	N/A		40	0	0	5	239	forested
13-1	2009	May 18-20; June 1-3, 5; June 15-17, 19	47	April 14-15, 17; May 18-20; June 1-3, 5; June 15-17, 19	9		107	1	0	25	2735	field/ forest edge/ riparian/ mixed forest/ reclaimed strip mine

APPENDIX C (continued): Summary of breeding bird surveys done pre-construction at proposed wind sites in Pennsylvania, 2006 - present. "Not in report" designation means the information was not specifically provided in the survey report but does not mean that particular information was not collected.

Wind Site	Survey Year	Point Count Dates	# Point Counts	Area Search Dates	# area searches	Comments	Total # species	# PA endangered species	# PA threatened species	# PA WAP species	Total # individual records	Habitat
2-5	2009	N/A	N/A	April 30; May 28; June 7	3	Area searches were only conducted in one of each of the three survey periods	24	0	0	4	48	forested
6-10	2009	May 28-31; June 9-11; June 23-25	115	N/A	N/A		69	2	0	12	2761	reclaimed strip mine/ forest

APPENDIX D: Pennsylvania Wildlife Action Plan priority bird species detected during point counts at Pennsylvania wind sites, 2006 - 2009.

	Species habitat*	2-1 *2006*	2-4 & 2-5 *2007*	3-4 *2007*	35-1 *2007*	24-2 *2007*	2-18 *2007*	2-7 *2007*	2-15 *2007*	4-3 *2007*	5-15 *2008*	5-18 *2008*	5-14 *2008*	3-6 *2008*	2-25 *2008*	2-25 *2009*	4-3 *2009*	6-12 *2009*	2-9 *2009*	13-1 *2009*	6-10 *2009*
Northern Bobwhite	Human associated farmland types; scattered shrubs and briars, interspersed with moderately dense herbaceous or grassy vegetation in south central PA																		X		
American Bittern	Wetland, especially extensive emergent marshes																				X
Great Blue Heron	Along calm freshwater & usually nest in trees near water		X		X					X							X				
Osprey	Rivers, lakes, ponds wetlands. Nests on large trees, snags, and man-made platforms																X				
Sharp-shinned Hawk	Nests in forests usually with conifers		X											X			X			X	
Red-shouldered Hawk	Indicator of higher quality and large-scale forests. Extensive lowland, deciduous, or mixed forest, interspersed with small openings and marshes		X	X	X	X	X													X	
Broad-winged Hawk	Indicator of large-scale forests; Coniferous deciduous forests or mixed deciduous forests		X	X	X	X				X							X			X	
American Woodcock	Early successional habitat, moist fields, thickets, forest clearings and seeps, brushy swamps						X		X												
Black-billed Cuckoo	Groves of trees, forest edges, & thickets, frequently near water		X	X	X	X	X	X	X	X				X			X			X	X
Common Nighthawk	Barren grounds, nests on roof of buildings					X															
Eastern Whip-poor-will**	Early to mid successional and open, forested habitats near clearings			X						X	X		X		X		X				
Chimney Swift	Urban settings & mature forests		X		X	X	X	X	X	X							X		X		
Red-headed Woodpecker	Savannah-like forests, parks, swamps						X		X											X	
Yellow-bellied Flycatcher	Boreal conifer forests, swamps, and streamside wetlands. Restricted to higher elevations (greater than 1700 feet). Indicator for high quality forest ecosystems						X														

*See Appendix C for site habitat descriptions

**sensu Chesser et al. 2010

APPENDIX D (continued): Pennsylvania Wildlife Action Plan priority bird species detected during point counts at Pennsylvania wind sites, 2006 - 2009.

	Species habitat*	2-1 *2006*	2-4 & 2-5 *2007*	3-4 *2007*	35-1 *2007*	24-2 *2007*	2-18 *2007*	2-7 *2007*	2-15 *2007*	4-3 *2007*	5-15 *2008*	5-18 *2008*	5-14 *2008*	3-6 *2008*	2-25 *2008*	2-25 *2009*	4-3 *2009*	6-12 *2009*	2-9 *2009*	13-1 *2009*	6-10 *2009*
Acadian Flycatcher	Indicator of high quality riparian forests, including hemlock ravines in northern counties; Unfragmented riparian deciduous forest in south; riparian hemlock forest in north		X			X	X	X		X							X			X	
Alder Flycatcher	Wet shrubby habitats including brushy swamps, alder bogs, edges of beaver ponds, and wet meadows with woody vegetation				X									X						X	
Willow Flycatcher	Low-level shrub swamp, wet meadow, and brushy habitats along streams and edges of ponds and marshes; sometimes dry upland sites				X										X						
Yellow-throated Vireo	Indicator of forests with tall canopies; Variety of edge habitats in mature & mixed deciduous forests						X														
Blue-headed Vireo	Mature, unfragmented, mixed, and conifer forest with structural diversity		X	X	X	X	X	X		X				X		X	X		X	X	X
Bank Swallow	Riparian, nest in colonies		X																		
Winter Wren	Conifers & mixed forests, riparian habitat, brush. Indicator for high quality forest/old growth									X							X				
Swainson's Thrush	Mature conifers & mixed forest, primarily at higher elevations (greater than 1700')					X		X	X	X		X					X				
Wood Thrush	Indicator of high quality forests; Interior & edges of deciduous & mixed forests, generally in cool, moist sites, often near water	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X
Brown Thrasher	Thickets, early successional forests, barrens, old fields. Indicator of early successional habitats.	X			X	X			X						X		X			X	X
Blue-winged Warbler	Early successional forest, thickets, barrens, rights-of-way corridors				X		X							X							
Black-throated Blue Warbler	Indicator of high quality forests with structural diversity		X	X	X	X	X	X		X		X		X		X	X		X	X	X
Black-throated Green Warbler	Old growth conifer forests; sensitive to edge	X	X	X	X	X	X	X		X		X		X	X	X	X	X	X	X	X

*See Appendix C for site habitat descriptions

**sensu Chesser et al. 2010

APPENDIX D (continued): Pennsylvania Wildlife Action Plan priority bird species detected during point counts at Pennsylvania wind sites, 2006 - 2009.

	Species habitat*	2-1 *2006*	2-4 & 2-5 *2007*	3-4 *2007*	35-1 *2007*	24-2 *2007*	2-18 *2007*	2-7 *2007*	2-15 *2007*	4-3 *2007*	5-15 *2008*	5-18 *2008*	5-14 *2008*	3-6 *2008*	2-25 *2008*	2-25 *2009*	4-3 *2009*	6-12 *2009*	2-9 *2009*	13-1 *2009*	6-10 *2009*
Blackburnian Warbler	Mature conifers & mixed forest; Tall canopy coniferous/mixed forest with vegetation over 18 meters and densely foliated crowns.		X	X	X		X													X	X
Prairie Warbler	Brushy second growth, dry scrub, low pine-juniper, mangroves, pine barrens, burned-over areas, and sproutlands	X	X		X		X				X			X				X		X	X
Blackpoll Warbler	High elevation, spruce-dominated wetlands and forests		X		X			X	X								X			X	X
Cerulean Warbler	Extensive mature riparian & mountain forests			X		X		X												X	X
Worm-eating Warbler	Mature deciduous or mixed deciduous/coniferous forest w/ patches of dense understory usually on steep slopes			X		X				X							X	X			X
Louisiana Waterthrush	Indicator of high quality riparian forests and excellent stream habitat; Riparian forests; forest interior species sensitive to edge effect																			X	
Canada Warbler	Forests, especially cool forests w/ a dense understory, conifer & scrub-shrub swamps			X					X	X				X			X		X		
Yellow-breasted Chat	Thickets, early successional forests, barrens. Indicator for early successional forest/thickets														X						
Scarlet Tanager	Forest interior species sensitive to edge effect - Deciduous & mixed deciduous/coniferous woodlands, especially mature forests	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Grasshopper Sparrow	Indicator for large-scale grasslands; grassland obligate species	X	X			X			X						X	X				X	
Henslow's Sparrow	Grasslands, agricultural fields, reclaimed strip mines	X			X																
Bobolink	Moist meadows and fields of hay, clover, alfalfa, and other herbaceous vegetation	X	X		X	X			X	X				X	X		X			X	
Eastern Meadowlark	Indicator species for large-scale grasslands; prairies, pastures, hayfields, and fallow lands	X	X		X	X			X											X	
Upland Sandpiper	Grasslands, agricultural fields, reclaimed strip mines								X												
# POINT COUNTS		16	20	42	34	28	n/a	28	18	28	10	33	31	28	30	30	11	56	3	47	115
TOTAL WAP PRIORITY SPECIES		**9**	**18**	**13**	**20**	**18**	**16**	**11**	**12**	**16**	**4**	**5**	**3**	**12**	**9**	**6**	**20**	**5**	**7**	**21**	**13**
TOTAL SPECIES RECORDED		43	71	64	90	77	69	52	68	61	26	58	35	65	62	45	90	35	40	90	70

*See Appendix C for site habitat descriptions

**sensu Chesser et al. 2010

APPENDIX E: Wildlife Action Plan priority bird species detected during area searches at Pennsylvania wind sites, 2006 - 2009.

WAP species	Species Habitat*	2-19 *2006*	2-4 & 2-5 *2007*	3-4 *2007*	35-1 *2007*	24-2 *2007*	2-7 *2007*	2-15 *2007*	4-3 *2007*	5-14 *2008*	3-6 *2008*	2-25 *2008*	4-3 *2009*	6-12 *2009*	13-1 *2009*
American Black Duck	Wetlands, lakes, & ponds				X										
Great Blue Heron	Calm freshwater; usually nest in trees near water	X	X								X				
Northern Bobwhite	Human associated farmland types; scattered shrubs and briars, interspersed with moderately dense herbaceous or grassy vegetation in south central Pennsylvania														
American Bittern	Wetland, especially extensive emergent marshes														
Broad-winged Hawk	**Indicator of large-scale forests**; Coniferous deciduous forests or mixed deciduous forests	X			X		X								X
Northern Goshawk	Extensive forest						X								
Osprey	Rivers, lakes, ponds wetlands. Nests on large trees, snags, and man-made platforms						X		X						
Red-shouldered Hawk	**Indicator of higher quality and large-scale forests**. Extensive lowland, deciduous, or mixed forest, interspersed with small openings and marshes				X								X		
Sharp-shinned Hawk	Nests in forests usually with conifers						X		X						X
American Woodcock	Early successional habitat, moist fields, thickets, forest clearings and seeps, brushy swamps	X				X									
Solitary Sandpiper	Wherever water collects, including parking lots, lawns, and ditches; grassy and muddy shorelines of marshes, woodland streams, pastures and rivers	X				X	X								
Black-billed Cuckoo	Groves of trees, forest edges, & thickets, frequently near water	X										X			
Common Nighthawk	Barren grounds, nests on roof of buildings														
Eastern Whip-poor-will*	Early to mid successional and open, forested habitats near clearings														
Chimney Swift	Urban settings & mature forests			X									X		
Red-headed Woodpecker	Savannah-like forests, parks, swamps														
Olive-sided Flycatcher	Clearings within old-growth coniferous forests, sphagnum bogs, burned over forest, swampy lake edges, and beaver meadows	X													
Acadian Flycatcher	**Indicator of high quality riparian forests**, including hemlock ravines in northern counties; Unfragmented riparian deciduous forest in south; riparian hemlock forest in north											X			
Alder Flycatcher	Wet shrubby habitats including brushy swamps, alder bogs, edges of beaver ponds, and wet meadows with woody vegetation				X	X									
Willow Flycatcher	Low-level shrub swamp, wet meadow, and brushy habitats along streams and edges of ponds and marshes; sometimes dry upland sites												X		X
Yellow-throated Vireo	**Indicator of forests with tall canopies**; Variety of edge habitats in mature & mixed deciduous forests		X			X	X								
Blue-headed Vireo	**Mature, unfragmented, mixed, and conifer forest with structural diversity**		X		X		X					X			X
Bank Swallow	Riparian, nest in colonies														
Winter Wren	Conifers & mixed forests, riparian habitat, brush. Indicator for high quality forest/old growth						X	X							X
Swainson's Thrush	Mature conifers & mixed forest, primarily at higher elevations (greater than 1700')	X													
Wood Thrush	**Indicator of high quality forests**; Interior & edges of deciduous & mixed forests, generally in cool, moist sites, often near water		X		X		X				X	X	X	X	X
Brown Thrasher	Thickets, early successional forests, barrens, old fields. Indicator of early successional habitats.	X	X	X			X		X			X			X

*See Appendix C for site habitat descriptions

**sensu Chesser et al. 2010

APPENDIX E (continued): Wildlife Action Plan priority bird species detected during area searches at Pennsylvania wind sites, 2006 - 2009.

WAP species	Species Habitat*	2-19 *2006*	2-4 & 2-5 *2007*	3-4 *2007*	35-1 *2007*	24-2 *2007*	2-7 *2007*	2-15 *2007*	4-3 *2007*	5-14 *2008*	3-6 *2008*	2-25 *2008*	4-3 *2009*	6-12 *2009*	13-1 *2009*
Blue-winged Warbler	Early successional forest, thickets, barrens, rights-of-way corridors														
Black-throated Blue Warbler	**Indicator of high quality forests with structural diversity**	X											X		X
Black-throated Green Warbler	Old growth conifer forests; sensitive to edge		X		X		X				X	X			X
Blackburnian Warbler	Mature conifers & mixed forest; Tall canopy coniferous/mixed forest with vegetation over 18 m and densely foliated crowns.				X	X									
Prairie Warbler	Brushy second growth, dry scrub, low pine-juniper, mangroves, pine barrens, burned-over areas, and sproutlands	X	X								X				
Blackpoll Warbler	High elevation, spruce-dominated wetlands and forests								X						
Cerulean Warbler	Extensive mature riparian & mountain forests	X													X
Worm-eating Warbler	Mature deciduous or mixed deciduous/coniferous forest w/ patches of dense understory usually on steep slopes						X								
Louisiana Waterthrush	**Indicator of high quality riparian forests and excellent stream habitat**; Riparian forests; forest interior species sensitive to edge effect						X					X	X		
Kentucky Warbler	Forests, especially those w/ shrubby understory. Indicator for high quality forest w/ structural diversity						X								
Canada Warbler	Forests, especially cool forests w/ a dense understory, conifer & scrub-shrub swamps					X									
Yellow-breasted Chat	Thickets, early successional forests, barrens. Indicator for early successional forest/thickets														X
Scarlet Tanager	**Forest interior species sensitive to edge effect** - Deciduous & mixed deciduous/coniferous woodlands, especially mature forests	X	X		X						X	X	X		X
Grasshopper Sparrow	**Indicator for large-scale grasslands**; grassland obligate species	X	X							X					X
Henslow's Sparrow	Grasslands, agricultural fields, reclaimed strip mines				X										
Bobolink	Moist meadows and fields of hay, clover, alfalfa, and other herbaceous vegetation	X	X	X	X						X				X
Eastern Meadowlark	**Indicator species for large-scale grasslands**; prairies, pastures, hayfields, and fallow lands	X			X						X	X			X
Pine Siskin	Northern boreal forest, preferring open stands of spruce and pine interspersed with birch and maple hardwood												X		
TOTAL WAP PRIORITY SPECIES		**15**	**10**	**3**	**12**	**6**	**14**	**1**	**4**	**1**	**7**	**9**	**8**	**1**	**15**
TOTAL SPECIES RECORDED		64	45	22	54	30	63	25	29	9	48	43	44	9	72

*See Appendix C for site habitat descriptions

**sensu Chesser et al. 2010

APPENDIX F: Wind energy project mist net survey results, 2004 – present. Bat species are designated by MYLU=*Myotis lucifugus*, MYSE=*Myotis septentrionalis*, EPFU=*Eptesicus fuscus*, PESU=*Perimyotis subflavus*, LABO=*Lasiurus borealis*, LACI=*Lasiurus cinereus*, LANO=*Lasiurus noctivagans*, MYLE=*Myotis leibii*, MYSO=*Myotis sodalis*, UNK = unknown (flew away before identified). The last row shows totals with the exceptions of number of species and bats/mist net site which are averages of all sites.

Wind Site	Bat risk	Year	Dates of survey	No. sites	No. bats captured	No. species	MYLU	MYSE [a]	EPFU	PESU	LABO [b]	LACI [c]	LANO [d]	MYLE [e]	MYSO [f]	UNK	Bats/ mist net site
2-2	High	2004	7/28-8/5	6	170	6	31	12	103	4	16	0	0	3	0	1	28.3
5-6	High	2005	7/11-8/4	9	87	5	41	19	23	1	3	0	0	0	0	0	9.7
24-3	Low	2005	8/10-8/14	4	84	6	34	16	23	3	7	1	0	0	0	0	21.0
2-7	High	2006	7/30-8/4	10	138	4	13	75	41	0	9	0	0	0	0	0	13.8
2-10	Low	2006	8/5-8/6	4	62	5	14	28	15	1	4	0	0	0	0	0	15.5
2-4	Low	2006	7/9-7/12	4	66	5	18	6	24	0	14	4	0	0	0	0	16.5
24-1	Low	2006	8/10-8/12	4	71	4	34	24	11	0	2	0	0	0	0	0	17.8
2-14	Low	2006	8/3-8/5	5	103	5	19	37	38	0	8	1	0	0	0	0	20.6
2-19	High	2007	7/7-7/17	13	107	6	50	39	10	1	5	2	0	0	0	0	8.2
24-2	Low	2007	6/20-6/25	7	71	4	23	32	12	0	1	0	0	0	0	3	10.1
35-1	Low	2007	7/18-8/6	28	429	6	197	174	44	0	10	1	3	0	0	0	15.3
2-18	High	2007	6/2-8/16	21	388	7	167	92	98	1	22	6	0	0	2	0	18.5
2-1	Low	2007	7/31-8/5	8	250	4	73	22	146	0	9	0	0	0	0	0	31.3
3-4	Low	2007	8/7-8/9	5	200	6	60	17	82	2	36	3	0	0	0	0	40.0
4-3	High	2008	6/27-7/2	5	23	5	5	15	1	0	1	0	0	1	0	0	4.6
4-3	High	2007	7/25-7/30	4	201	4	69	13	110	0	9	0	0	0	0	0	50.3
5-18	High	2008	5/29-8/3	50	574	6	146	104	306	0	12	4	0	2	0	0	11.5

[a] Pennsylvania Wildlife Action Plan responsibility species
[b] Pennsylvania Wildlife Action Plan maintenance concern
[c] Pennsylvania Wildlife Action Plan maintenance concern
[d] Pennsylvania Wildlife Action Plan high level concern
[e] Pennsylvania state listed threatened; PA Wildlife Action Plan immediate concern
[f] Pennsylvania state and federally listed endangered; PA Wildlife Action Plan immediate concern

APPENDIX F (continued): Wind energy project mist net survey results, 2004 – present. Bat species are designated by MYLU=*Myotis lucifugus*, MYSE=*Myotis septentrionalis*, EPFU=*Eptesicus fuscus*, PESU=*Perimyotis subflavus*, LABO=*Lasiurus borealis*, LACI=*Lasiurus cinereus*, LANO=*Lasiurus noctivagans*, MYLE=*Myotis leibii*, MYSO=*Myotis sodalis*, UNK = unknown (flew away before identified). The last row shows totals with the exceptions of No. of species and bats/mist net site which are averages of all sites.

Wind Site	Bat risk	Year	Dates of survey	No. sites	No. bats captured	No. species	MYLU	MYSE [a]	EPFU	PESU	LABO [b]	LACI [c]	LANO [d]	MYLE [e]	MYSO [f]	UNK	Bats/ mist net site
6-6	High	2008	7/17-7/29	5	64	5	7	39	15	1	2	0	0	0	0	0	12.8
2-9	High	2008	9/3 - 9/4	3	44	4	24	3	16	1	0	0	0	0	0	0	14.7
5-15	High	2008	7/17-7/18	3	45	5	7	24	8	4	2	0	0	0	0	0	15.0
24-2	Low	2008	8/9-8/14	11	198	6	86	39	65	1	5	1	0	0	0	1	18.0
6-12	High	2008	7/20-7/27	13	255	4	57	60	124	0	13	0	0	0	0	1	19.6
2-18	High	2008	6/16-6/28	21	228	7	67	75	66	0	11	0	1	2	2	4	21.6
5-14	High	2008	7/18-7/29	22	475	7	118	149	180	3	17	4	0	4	0	0	21.6
3-6	Low	2008	6/21-8/10	21	525	7	260	207	25	1	27	3	2	0	0	0	25.0
6-11	High	2008	7/17-7/20	9	533	7	269	15	216	6	23	1	1	0	0	2	59.2
5-14	High	2009	5/15-8/13	19	298	6	158	52	58	15	8	0	0	7	0	0	15.7
3-18	Low	2009	7/23-8/8	38	629	6	252	289	19	0	23	26	20	0	0	0	16.6
3-2	Low	2009	6/23-7/1	19	145	4	27	111	5	0	0	0	2	0	0	0	7.6
3-4	Low	2009	7/11-7/16	21	256	5	40	29	171	1	9	0	0	0	0	6	12.2
13-1	Low	2009	7/27-8/14	36	410	6	45	81	249	1	24	1	0	0	0	9	11.4
2-24	High	2009	7/31-8/14	18	173	5	37	48	71	5	12	0	0	0	0	0	9.6
2-25	Mod	2009	7/23-8/15	32	326	7	38	159	96	3	21	8	0	1	0	0	10.2
2-5	Low	2009	7/9-7/18	13	269	6	178	37	40	1	12	1	0	0	0	0	20.7
				491	7897	5.4	2664	2142	2511	56	377	67	29	20	4	27	18.7

[a] Pennsylvania Wildlife Action Plan responsibility species
[b] Pennsylvania Wildlife Action Plan maintenance concern
[c] Pennsylvania Wildlife Action Plan maintenance concern
[d] Pennsylvania Wildlife Action Plan high level concern
[e] Pennsylvania state listed threatened; PA Wildlife Action Plan immediate concern
[f] Pennsylvania state and federally listed endangered; PA Wildlife Action Plan immediate concern

Pennsylvania Game Commission (PGC) Endorsed Best Management Practices for Pennsylvania Wind Energy Facilities

Overview and Objective

These are Best Management Practices (BMPs) for Wind Energy Facilities in Pennsylvania. They do not stand alone and are an element of the Pennsylvania Game Commission's (PGC) Wind Energy Voluntary Cooperative Agreement.

These BMPs are designed for use by developers and operators to establish a goal for best-in-class wind energy development/operation in Pennsylvania. They offer a set of practices to ensure the proper construction/operation of wind energy in Pennsylvania.

The BMPs should be applied to each project site. Although they establish best in class goals, they do not constitute regulatory standards or development obligations. Technical and economic feasibility, as well as wildlife and environmental resource management, should be considered in applying these BMPs. In addition, regulations and landowner rights and agreements shall take precedence where they apply.

The following BMPs are recommended for the construction, operation, and decommissioning of wind energy facilities. Please note the following:

a. Siting BMPs are not included because siting in regards to birds and mammals is addressed within the other sections of the PGC Wind Energy Voluntary Cooperative Agreement.

b. BMPs found within the PGC Wind Energy Voluntary Cooperative Agreement are not included in the below list (such as conducting one-year pre-construction and two-years post-construction surveys to assess impacts to birds and mammals).

c. Only BMPs that fall under the PGC jurisdiction in that they relate to the protections of birds and mammals and their habitats, are included.

d. Wind developers typically lease and do not own the land on which they develop wind projects; therefore private landowner's land use plans have been taken into consideration in the development of these BMPs.

e. Revisit the BMPs as needed to discuss new information and operational protocols identified during ongoing mitigation studies.

A. CONSTRUCTION

1. To the extent practicable, avoid and minimize impacts to important habitats not protected under the Pennsylvania Natural Diversity Inventory environmental review process, such as those identified in the Pennsylvania Wildlife Action Plan (WAP), that provide critical habitats for Species of Greatest Conservation Need (SGCN). SGCN are listed in WAP Tables 10.6, 10.7 and individual SGCN/habitat associations are defined in WAP Tables 12.5, 14.9, 15.3, 16.3. 17.2, 19.3, 20.3, 21.8, 22.4 (Williams, L., et al., editors. 2005. Pennsylvania Comprehensive Wildlife Conservation Strategy. Pennsylvania Game Commission and Pennsylvania Fish and Boat Commission. Version 1.0. Harrisburg, Pennsylvania, USA).

2. To minimize habitat fragmentation during construction of the project site, locate facilities (such as tower footprint, collector cable routes, t-line, access road, substation, etc.) in or adjacent to existing ROW and disturbed areas and minimize the number and length of access roads, using existing roads to the fullest extent practicable.

3. Each project will have a designated point of contact for environmental and public inquiries.

4. Each project will designate representatives to ensure compliance with project permits and approvals by employees and contractors.

5. Use tubular turbine towers or best available technology to reduce ability of birds to perch and to reduce risk of collision. Turbines should be a non-obtrusive color, such as white, off-white or gray, monopole design.

6. Avoid guyed towers (i.e. communication and meteorological) at wind energy project sites. If guy wires are necessary, bird flight diverters or high visibility marking devices should be used.

7. Wind turbines should not be permanently artificially lighted, except to the extent required by the FAA or other applicable authority. Employ only red, or dual red and white strobe, strobe like, or flashing lights, not steady burning lights, to meet FAA requirements for visibility lighting of wind turbines, permanent met towers, and communication towers (see Gehring et al. 2009)[1]. Only a portion of the turbines within the wind project should be lighted, and all pilot warning lights should fire synchronously.

8. Keep lighting at both operation and maintenance facilities and substations to the minimum required.

    a. Use lights with motion or heat sensors and switches to keep lights off when not required.

[1] Gehring, J., P. Kerlinger, A. M. Manville II. 2009. Communications towers, lights, and birds: successful methods for reducing the frequency of avian collisions. Ecological Applications 19: 505-514.

b. Lights should be hooded downward and directed to minimize horizontal and skyward illumination.

9. Wind turbines should not display advertising, except for reasonable identification of the turbine manufacturer, facility owner and operator to minimize impacts to wildlife.

10. Minimize, to the extent practicable, the area disturbed during construction. Each turbine clearing area should be five acres or less and post-construction turbine cleared area should be less than two acres per turbine or minimum for operation and/or maintenance.

11. Electrical collection systems between turbines should be buried below plow depth where feasible, and if possible co-located with roadways where practicable.

12. To reduce avian collisions, place low and medium voltage connecting power lines associated with the wind energy development underground to the extent possible, unless the burial of the lines is prohibitively expensive (i.e. where shallow bedrock exists) or where greater adverse impacts to biological resources would result.

    a. Overhead lines may be acceptable if sited away from high bird crossing locations, such as between roosting and feeding areas or between lakes, river, and nesting habitats. To the extent practicable, they should be marked in accordance with Avian Power Line Interaction Committee (APLIC) collision guidelines.
    b. Overhead lines may be used when they parallel tree lines, employ bird flight diverters, or are otherwise screened so that collision risk is reduced.
    c. Above-ground low and medium voltage lines, transformers and conductors should follow the 2006 or most recent APLIC "Suggested Practices for Avian Protection on Power Lines."

13. All infrastructure should be constructed in as small an area as is practical.

14. Segregate topsoil for use in reclaiming temporarily disturbed areas. Upon completion of construction activity, areas to be reclaimed should be planted within the first growing season to achieve 70% re-vegetation. Incorporate native plants into the reseeding mix where consistent with permits and applicable regulations. Soil supplements (lime, fertilizer, and/or mulch) should be added as needed and are the responsibility of the operator.

15. To the extent practicable, measures should, be implemented during construction to avoid the introduction and spread of invasive species by following applicable local policies for noxious weed control which may include: cleaning vehicles and equipment arriving from areas with known invasive species issues, using locally sourced topsoil, and monitoring for and rapidly removing noxious weeds. Project construction areas to be reclaimed should be re-vegetated with appropriate non-invasive seed mixes, incorporating native species where consistent with permits and applicable regulations.

B. OPERATIONS

1. Reduce project road access to extent practical and consistent with safety needs, environmental concerns, legal requirements and the requests of the landowner.

2. Reduce vehicle collision risk to wildlife by instructing project personnel to drive at appropriate speeds, be alert for wildlife, and use additional caution in low visibility conditions.

3. Instruct employees, contractors, and site visitors to avoid harassing or disturbing wildlife, particularly during reproductive seasons.

4. Implement a Wildlife Incident Reporting System for the life of the project. A Wildlife Incident Reporting System is a specific set of processes, procedures and training for monitoring, responding to, and reporting bird or mammal injuries and fatalities to the Pennsylvania Game Commission.

5. On project maintained land, limiting mowing to the fullest extent possible between April 1 and July 31.

6. Each site should have a Spill Protection, Control, and Countermeasure plan in place as required under Pennsylvania Department of Environmental Protection regulations to avoid and minimize impacts to wildlife.

C. DECOMMISSIONING

1. Except where otherwise required by an applicable regulation or an agreement with the landowner, the facility owner and operator should, at its expense, complete decommissioning of the wind energy facility within eighteen (18) months after the end of the useful life of the facility to reduce the likelihood of additional wildlife collisions with the non-operational structures.

2. Except where otherwise required by an applicable regulation or an agreement with the landowner, decommissioning should include removal of all facilities, including turbine foundations to a depth of 36 inches except that facilities may be left in place at the request or with the consent of the landowner.

3. During decommissioning of the wind energy facility, additional wildlife habitat loss should be minimized by utilizing existing ROWs and previously disturbed corridors to the fullest extent practicable.

4. Prior to decommissioning, and in coordination with the landowner, the facility owner and operator should develop a re-vegetation plan that favors Pennsylvania native plant species in order to enhance the wildlife habitat value of the project area.