PENNSYLVANIA GAME COMMISSION
WIND ENERGY VOLUNTARY COOPERATION AGREEMENT
THIRD 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
enXco	02/08/2011
Stony Creek Wind Farm, LLC	08/03/2011
Seldom Seen Wind, LLC	08/26/2011
North East Wind I, LLC	02/25/2012

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. In 2007, the Pennsylvania Game Commission (PGC) worked collaboratively with the wind industry to develop a Voluntary Wind Energy Cooperative Agreement (Cooperative Agreement) to further understand, avoid, minimize, and mitigate potential impacts to wildlife and its habitat from wind energy development. 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 December 31, 2011.

- A total of 33 wind energy developers are signatories of the Cooperative Agreement, representing 70% of wind projects in Pennsylvania, and 76% of the total number of developers who have active operations in Pennsylvania. See the *Cooperators* section for further information.

- Over 250 wildlife surveys have been conducted by Cooperators since 2004. At least one pre-construction survey was conducted at 46 wind sites, and post-construction surveys were initiated at 16 sites. See *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. Data from pre-construction surveys suggest that spring surveys may provide similar migration data as fall surveys during a shorter timeframe. However, to date no post-construction eagle mortality has been documented at any Pennsylvania wind site and overall raptor mortality is low regardless of raptor risk. See *Birds: Fall and Spring Raptor Migration Survey Results* section for more details.

    - Acoustic surveys conducted at high risk sites indicate that a large majority (69%) of all bat activity occurred from July 1 to September 30. Additionally, at sites that followed protocols 60% of all bat activity documented occurred within the first five hours of nightly monitoring. This information is important to determine the best times to implement minimization efforts. See *Bat: Acoustic Monitoring* section for more details.

    - Telemetry surveys conducted on eastern small-footed (*Myotis leibii*) and Indiana bats (*Myotis sodalis*) continue to provide new capture locations, roost locations, and foraging and home ranges 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.

- The average estimated bat mortality for surveys that followed PGC protocol was 25 bats/turbine/year (5 – 59). Hoary bats (*Lasiurus cinereus*) comprised the largest proportion (31%) of bat mortality documented at cooperating wind facilities. Adult bats were documented more often than juvenile bats (83% adult: 12% juvenile), and male bats were found more often than female bats (59% male: 29% female. The majority of all bat mortality (76%) occurs between July 1 and September 30. See *Bat Mortality* section for more details.

- The average estimated bird mortality for surveys that followed PGC protocol was 4 birds/turbine/year (1 – 10). Passerines continue to account for the largest proportion (73%) of bird mortality at wind sites. Overall, raptor mortality is low throughout Pennsylvania, 3% of the total bird mortality. See *Bird Mortality* section for more details.

- Cooperators documented one large mortality event in October 2011. This Cooperator completed two years of standardized mortality monitoring and the mortality event was later discovered incidentally by maintenance workers. A total of 258 birds, including 24 state endangered blackpoll warblers (*Setophaga striata*), and two bats were discovered at one turbine. The event is believed to be related to all night lighting at a nearby substation and weather conditions. It is believed that implementing the lighting Best Management Practices would have greatly reduced the bird mortality during this event. See *Large Mortality Events* section for more details.

- Thirty-one state endangered bird mortalities at five sites were documented between 2007 and 2011; 29 blackpoll warblers and two yellow-bellied flycatchers (*Empidonax flaviventris*). All of the endangered bird mortalities 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 of mortalities. The PGC is working with cooperators to mitigate for these documented fatalities. In September 2012, upland sandpipers (*Bartramia longicauda*) were downgraded to Pennsylvania endangered and Northern harriers (*Circus cyaneus*) were listed as Pennsylvania threatened. See *Threatened and/or Endangered Species Mortality: Birds* for more details.

- Cooperators documented the first state and federally endangered Indiana bat mortality at a Pennsylvania wind facility. One juvenile female Indiana bat fatality was documented in September 2011. This site had been previously ranked as low risk to bats by the PGC. The nearest known Indiana bat hibernaculum is over 10 miles from the project. This event may indicate an increased risk to cave bats farther than the five miles currently assessed under the Cooperative Agreement. See *Threatened and/or Endangered Species Mortality: Bats* section for more details.

- Nine Seminole bat (*Lasiurus seminolus*) fatalities were documented between 2007 and 2011 at six wind sites. All suspected Seminole bats were sampled and sent

for genetic analysis to confirm species identification. The sites are located throughout the state implying Seminole bats are not limited to any one portion of the state. These results indicate that Seminole bats may frequent Pennsylvania more than previously believed. See *Bat Mortality* section for more details.

- Data collected over the past five years throughout Pennsylvania provided bat activity and mortality patterns. The majority of bat activity (69%) and mortality (79%) occurs between July 1 and September 30. This finding is important because if adjustments to cut-in speeds are needed, July 1 to September 30 will provide the greatest benefit to bats while minimizing costs to operators.

- One alternative research project, a two-year evaluation of the effectiveness of ultrasonic acoustic deterrents, was completed by a Cooperator in 2010. The study found a reduction of bat mortality at turbines where acoustic deterrents were used compared to control turbines where no acoustic deterrents were used. While the results are promising, several limitations were observed during the study including humidity and deterrent malfunctions. See *Research* section for more details.

- After five years of data collection and implications of white nose syndrome, the PGC recognizes that updates to the Cooperative Agreement are necessary. Thus, a Cooperators meeting to discuss changes to current surveys and standards will occur in early 2013. At that time, the PGC and Cooperators will identify and discuss necessary changes. See *Future* section for more details.

- The PGC strongly encourages Cooperators to implement the Best Management Practices of a Wildlife Incident Reporting System (WIRS) for each wind facility in Pennsylvania. The WIRS provides a detailed process for monitoring, response to, and reporting of wildlife injuries and fatalities after the completion of standard mortality monitoring. A WIRS allows for detection of special events such as raptor or threatened and endangered species mortality, as well as large mortality events.

The collaborative efforts of the wind industry and the PGC in Pennsylvania are an unprecedented effort to develop conscientious renewable energy with regards to wildlife impacts. Data collected by Cooperators continue to be used to develop methods to avoid and minimize negative impacts to the Commonwealth's wild birds and mammals. Cooperators should be commended for their efforts and have set an example that all industries 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, 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 mammals, birds, 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 each 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. These positions have been plagued by vacancies resulting in partial staffing for the majority of the past five years however, the Commission is hopeful the program will be full staffed in 2013.

This report summarizes pre- and post-construction survey data gathered by Cooperators through December 31, 2011. For an in-depth review of the Cooperative Agreement and its accompanying protocols, and background information on the Cooperative Agreement, visit the PGC's public website at ***www.pgc.state.pa.us***, click on "Wildlife", "Habitat Management", and then click on "Wind Energy."

COOPERATORS

The first Cooperators entered into the Cooperative Agreement on April 18, 2007. **Currently, a total of 33 wind developers have signed on to the Cooperative Agreement** (listed on page iii). As of June 30, 2012, no Agreements had been terminated by either party (Cooperator or PGC).

The Cooperators' wind projects represent 70% (70 of the 100) of the wind projects that the PGC was aware of through June 30, 2012 (Table 1). Of the 70 Cooperator-owned projects, 16 were grandfathered into the Agreement (14 active sites and two proposed sites), 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. Status of wind energy projects in Pennsylvania as of June 30, 2012.

	Cooperator	Non-Cooperator	Total
Active	16	5	21
• Mega-Watts	829	129	958
• Total turbines	431	87	518
Proposed	54	25	79
• New	52	25	77
• Grandfathered	2	N/A	2
Total projects	70	30	100

NON- COOPERATORS

There are seven 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 (two proposed wind sites), OwnEnergy (one proposed wind site), Laurel Highlands Energy (three proposed wind sites), HEW Group LLC (one proposed site), and Vox Energy Solutions (one proposed site). There are an additional 16 sites in early stages of project proposal for which the potential developer has not been identified.

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 only developer that has not signed into the Cooperative Agreement, that currently has active wind facilities in Pennsylvania, is Florida Power & Light Energy's subsidiary, NextEra Energy Resources. 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. 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 wildlife 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 (Capouillez and Librandi Mumma 2008) and 2nd (Librandi Mumma and Capouillez 2011) Summary Reports 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 dictate 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 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 to 2011, bat risk level increased from low to high at six sites based on pre-construction surveys that resulted in the discovery of threatened or endangered species. Two sites had their bat risk level decreased because of changes in their project areas. Additionally, between 2007 and 2011, four sites had their raptor risk level increased based on bald and/or golden eagle presence, and two sites had the raptor level decreased based on revisions to their project areas (Table 2).

Table 2. Raptor and bat risk levels of the 100 Pennsylvania wind projects as of June 30, 2012.

Risk Level	Raptor	Bat
Low	50	52
Moderate	35	10
High	15	38
Not assessed yet	0	0

Risk assessments also help developers site their wind energy projects. Cooperators are encouraged to submit proposed project information greater 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 greater 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 details on efforts made by developers to best avoid and minimize impacts to wildlife.

PENNSYLVANIA WIND PROJECT SITE LOCATION

All 100 proposed and active wind sites in Pennsylvania are located in one or more of the following physiographic provinces: Appalachian Plateaus, Ridge and Valley, Piedmont, and Central Lowland (Figure 1). Initially, high elevation ridge tops were targeted for wind development but as these areas become more developed less prominent ridges and summits are targeted. Wind developers have begun to target portions of northwest and southeast Pennsylvania for wind development.

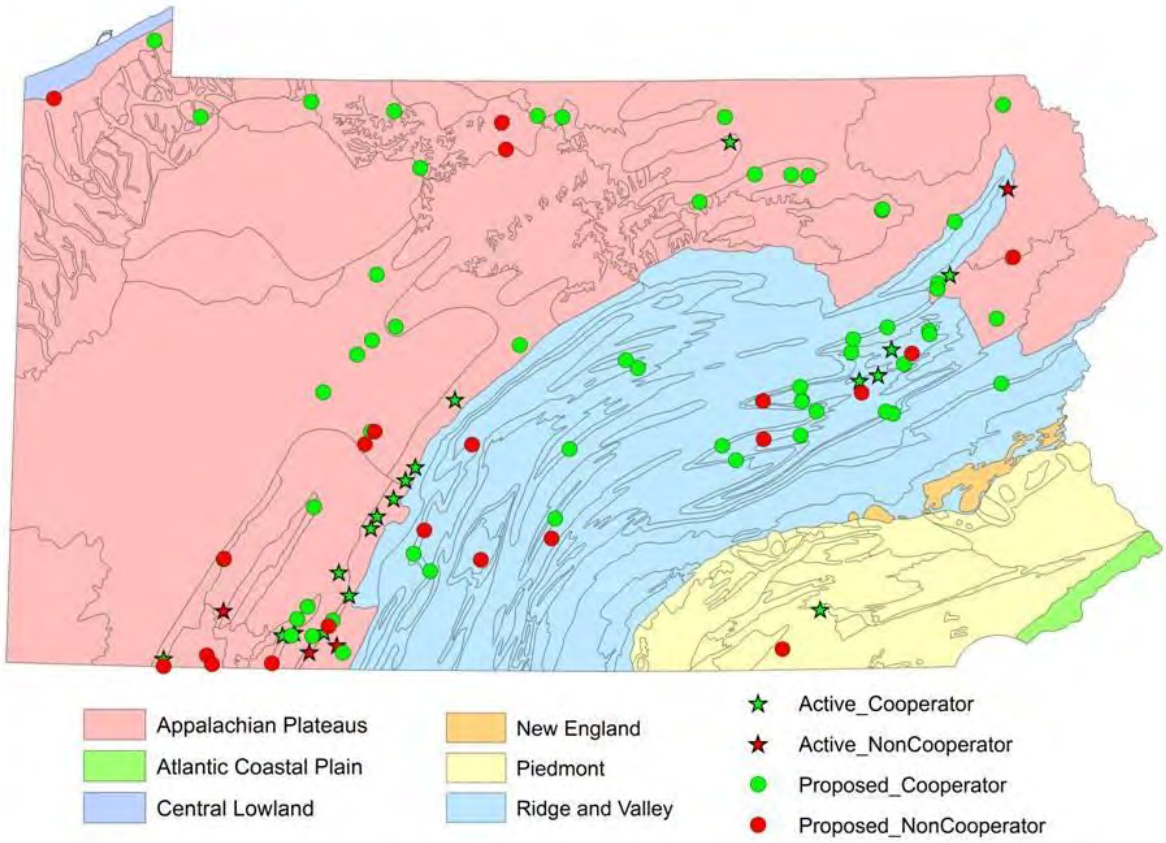

Figure 1. Pennsylvania wind projects (active and proposed) by physiographic province and cooperator status, as of June 30, 2012.

The PGC classifies turbine configuration as one of the following: linear, linear groupings, clusters, and undetermined (Table 3). "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 are those projects in which turbine configuration has not yet been established.

Site locations are described as ridgetop, escarpment, butte, or unknown. This determination is made by examining topographical maps. "Ridgetop" is a long, narrow chain of hills or mountains. "Escarpment" is a transition zone involving a sharp, steep elevation differential, characterized by a cliff or steep slope. "Butte" is 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: 45 ridgetop, 10 escarpments, 39 butte, and 7 unknown.

Table 3. Turbine configuration of 100 Pennsylvania wind projects as of June 30, 2012

Physiographic Province	Clusters	Linear	Linear Groupings	Undetermined
Appalachian Plateau	7	20	8	24
Appalachian Plateau/Central Lowlands	0	0	0	2
Piedmont	0	1	0	1
Ridge and Valley	1	11	7	18
Total	8	32	15	45

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 78% of all active and proposed wind energy project areas are in this landcover type. The forested landcover on wind energy facilities consists of 63% deciduous dominated, 4% evergreen dominated, and 11% mixed deciduous and evergreen forests. Agricultural land accounts for an additional 16% of landcover on wind energy facilities, comprised of row crops and hay/pasture/grass fields. Developed areas consisting of urban, cave and industrial areas make up 5% of the landcover and the remaining 1% consists of wetlands and open water.

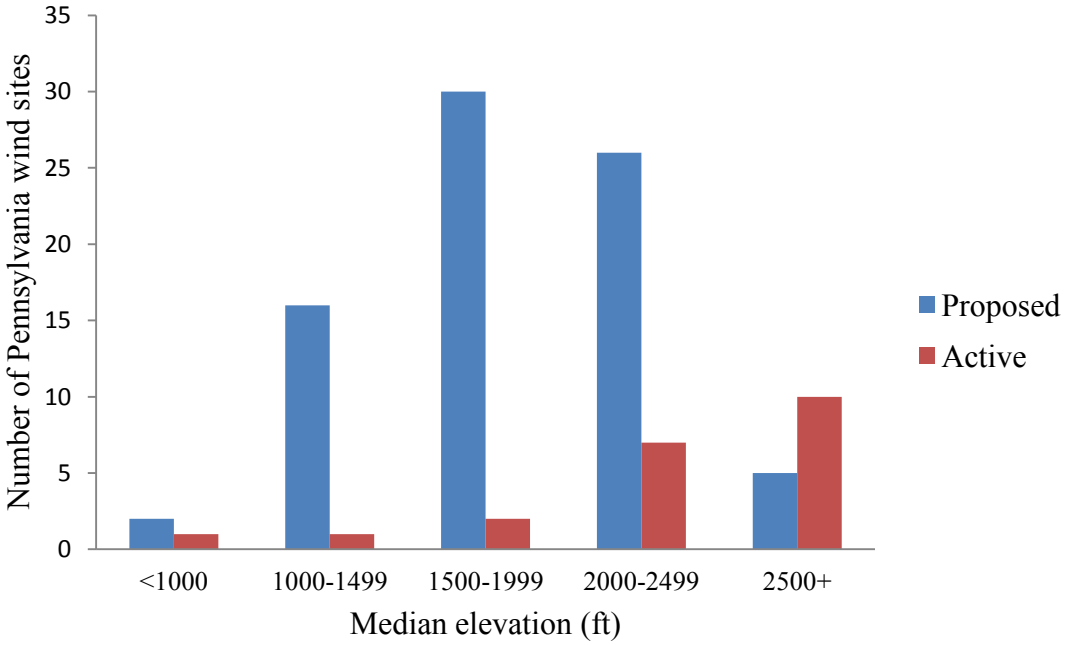

Figure 2. Pennsylvania wind projects (active and proposed) by median elevation (feet), as of June 30, 2012.

SURVEY RESULTS SUMMARY

Two hundred seventy four 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 among sites. Site names and locations have been replaced with site identification codes in data summary tables to preserve the confidentiality of this information as is required per the Cooperative Agreement. Since the Cooperative Agreement has been in place, Cooperators have funded one or more pre-construction wildlife surveys at 46 wind sites and post-construction surveys have been initiated at 16 sites, resulting in more than 120,000 hours of surveys.

Table 4. Summary of bird and mammal surveys completed at wind facilities in Pennsylvania, 2004 – 2011.

	2004	2005	2006	2007	2008	2009	2010	2011	Total
Pre-construction									
Potential Hibernacula Investigations[a]	0	2	5	4	3	7	2	1	24
Bat Acoustics	0	2	3	9	9	8	3	2	36
Bat Mist-netting	1	2	5	7	11	8	3	3	40
Bat Telemetry	0	0	0	3	4	1	1	0	9
Breeding Bird Surveys	0	0	2	9	4	7	4	3	29
Fall Raptor Migration	1	1	6	9	5	4	2	2	30
Spring Raptor Migration	0	0	5	6	7	1	1	0	20
Mammal Species of Concern Surveys[b]	0	1	3	2	6	5	1	0	18
Bird Species of Concern Surveys[c]	0	1	6	1	1	4	1	4	18
Post-construction									
Mortality (bat and bird)	1[d]	0	1[d]	1	4	6	8	5	26
Bat Acoustics	0	0	0	0	3	2	1	0	6
Fall Raptor Migration	0	0	0	0	2	1	4	1	8
Spring Raptor Migration	0	0	0	0	0	1	3	1	5
Breeding Bird Surveys	0	0	0	0	0	0	0	0	0
Radar	0	0	0	0	2	0	0	0	2
Other[e]	0	0	0	0	0	1	1	1	3
Total	3	9	35	51	59	57	35	23	274

[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 endangered 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 and curtailment.

For pre-construction surveys, the PGC encourages wind energy developers to have PGC staff involved in the selection of observation sites 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 standardized monitoring protocols are being followed, and the correct data sheets are used and properly completed. Open lines of communication between consultant, developer, and the PGC are essential for recognizing and correcting problems as they arise to avoid the collection of a full season of data that are unusable data. PGC biologists have observed only 59 of 224 (26%) pre-construction surveys between October 1, 2007 and June 30, 2012 (Table 5). Due to vacancies within the PGC wind program and last minute coordination from developers and consultants, the PGC has not been able to achieve its goal of observing one day or night of each survey. However, from 2007-2011, PGC staff visited all 12 sites where post-construction monitoring was conducted.

Table 5. Number of bat, bird, and other (woodrat, radar, etc.) pre-construction surveys observed by PGC between October 1, 2007 and June 30, 2012.

Pre-Construction Surveys Observed	1st Summary Report 10/1/07 - 9/30/08	2nd Summary Report 10/1/08 - 6/30/10	3rd Summary Report 7/1/10 - 6/30/12	Total 10/1/07 - 6/30/12
Bat Surveys	5	12	7	24
Bird Surveys	12	11	3	26
Other Surveys	5	3	1	9
Total Surveys Observed	22	26	11	59

Pre-Construction Results

Birds: Fall raptor migration survey results

Raptor migration varied across the state as expected. A total of 28 pre-construction fall raptor surveys were completed at 29 proposed sites between 2004 and 2011 (Appendix A). Each survey represented one wind site with the exception of two surveys (2-4 & 2-5 and 6-1 & 6-3) and an additional site (6-10) was surveyed twice. One raptor survey was conducted at sites 2-4 & 2-5 and 6-1 & 6-3, each encompassing both wind sites. These sites are combined in Appendix A because they represent the same data and will be counted as one site. To determine percent of flight for each raptor species the total number of each species observed was divided by the total number of all raptors observed at the site, not just the rotor swept zone (as data specific to the rotor swept zone was not available from all survey reports). Overall, the raptor risk levels did not correspond to the total raptor species observed, the total number of raptors observed, or the raptors observed per hour. Some low and moderate raptor risk sites recorded greater total number of raptors and raptors per hour than did high raptor risk sites. Sites with few previous observations were designated as low risk due to lack of information, this provides opportunity for low risk sites to have greater raptor migration than high risk sites as data is collected. The PGC uses known ridges that experience varying amounts of raptor migration to determine the raptor risk (Table 1 of Exhibit A in the Wind Energy Voluntary Cooperative Agreement). There were 13 fall raptor surveys conducted at low raptor risk wind sites. Two of these sites (2-1 and 35-1) documented higher raptors per hour than many high risk sites. However, half of the raptors observed at these sites consisted of broad-winged hawks (*Buteo platypterus*; 18%) and

turkey vultures (*Cathartes aura*; 33%) which were the most commonly observed species during fall raptor surveys.

Bald eagles were observed during 22 of 28 surveys. Bald eagles were not observed at four low raptor risk sites and two moderate risk sites. Fourteen of 28 surveys experienced increased bald eagle migration rates. Increased bald eagle migration is defined as greater than or equal 1% of raptor flight. One percent was used as the threshold for increased eagle migration based on historical data from hawk watch sites across Pennsylvania (Hawk Migration Association of North America 2012). Eleven of the 14 surveys with increased bald eagle migration were at high or moderate risk sites and three were at low risk sites. The increased bald eagle migration at three low risk sites does not necessarily indicate a major migration corridor. Low raptor risk sites are not required to conduct fall raptor monitoring, and many conduct abbreviated surveys. All three low risk sites which observed increased bald eagle migration conducted surveys of two, five, and 10 days respectively, far shorter than a full survey season. These shorter surveys may have resulted in low overall raptor numbers, leading to individual eagles representing a larger proportion of the raptor migration. Generally, few bald eagles are seen at any site on any given day, while the number of bald eagles in the Northeastern states has increased as populations recover (Farmer et al. 2008). Additionally, nesting pairs of bald eagles in Pennsylvania have been increasing 10-15% per year for the last 20 years (Gross 2010). Bald eagles comprised 3.3% of the total raptors observed during all fall raptor migration surveys.

Golden eagles (*Aquila chrysaetos*) were observed at 20 of 28 raptor surveys. The eight sites that did not document golden eagles included four low, three moderate, and one high risk site. Four of the sites did not document any golden or bald eagles (two low risk and two moderate risk). Ten of the 28 surveys experienced golden eagle migration rates greater than or equal to 1%; eight high or moderate risk (site 2-4 and 2-5 were surveyed with one raptor survey) and three low risk sites. Again, one percent was used as the threshold for eagle migration based on historical data from hawk watch sites across Pennsylvania (Hawk Migration Association of North America 2012). The increased golden eagle migration at low risk sites should be interpreted with caution since a full season of raptor migration surveys was not required for these sites. The three low risk sites documenting increased golden eagle migration only surveyed for two, five, and 14 days respectively. Golden eagles comprised 1.0% of the total raptors observed during all fall raptor migration surveys.

Turkey vultures (33% of total raptors observed), red-tailed hawks (*Buteo jamaicensis*; 18%), and broad-winged hawks (18%) were the three most common raptors observed during fall migration surveys. Unlike the majority of hawk watch sites in Pennsylvania where fall count data is dominated by broad-winged and sharp-shinned hawks (*Accipiter striatus*), turkey vultures were the most frequently observed species during these 30 surveys. Northern goshawks (*Accipiter gentilis)* were the least observed raptors (0.1% of total raptors observed) followed by rough-legged hawks (*Buteo lagopus*; 0.2%) and Pennsylvania endangered peregrine falcons (*Falco peregrinus*; 0.2%). These three species are also observed in low numbers at hawk watch sites throughout Pennsylvania (Hawk Migration Association of North America 2012). Only two raptor species were observed at all 28 fall raptor migration surveys: red-tailed hawks and turkey vultures.

Birds: Spring raptor migration survey results

Eighteen spring raptor migration surveys were conducted between 2006 and 2011 at 20 sites (Appendix B). With the exception of two surveys, each survey represented one wind site. Two surveys comprised of two wind sites each; sites 6-1 and 6-3 were surveyed with one survey and sites 2-4 and 2-5 were surveyed with one survey and are combined in Appendix B and will be counted as one site. To determine percent in flight for each species, the total number of each species observed was divided by the total number of all raptors observed at each site, not just in the rotor swept zone (as data specific to rotor swept zone was not available from all survey reports). Raptors per hour varied for all sites regardless of the raptor risk level. Six surveys were conducted on low raptor risk sites. Low risk sites were either located on a ridge or mountain designated as low risk in Appendix A of the Wind Energy Voluntary Cooperative Agreement or on a ridge or mountain for which no raptor migration data exists. Low risk raptor sites are not required to perform raptor migration surveys however, the PGC encourages low risk sites to conduct abbreviated raptor surveys targeting peak migration periods. It should be noted that data from these abbreviated surveys tend to show inflated numbers of raptors observed per hour because the surveys only occur on a few days during peak migration periods.

Bald eagles were observed during 14 of 18 spring raptor surveys. The four surveys where bald eagles were not observed were at sites with low risk to raptors. The highest percent of bald eagles was 9% of raptors in 2009 at site 6-12 (high raptor risk). Ten of the 18 surveys observed greater or equal to 1% bald eagles during their spring surveys; nine sites were high or moderate, and one was low risk. The low risk site conducted an abbreviated survey recorded low numbers of raptors overall, inflating the percentage of bald eagles. Bald eagles comprised 1.8% of the total raptors observed during all spring raptor migration surveys.

Golden eagles were observed at nine of 18 surveys. The nine surveys that did not observe golden eagles consisted of five low, two moderate, and two high risk sites. The highest percentage of golden eagles was in 2006 when 21% were observed at site 3-2 (high raptor risk). Six sites observed greater than or equal to 1% golden eagles during spring raptor surveys; five sites were high or moderate, and one site was low risk to raptors. Again the low risk site conducted an abbreviated survey resulting in low raptor observations overall. Golden eagles comprised 1.9% 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 was a low risk site that only conducted surveys during six days in March, possibly skewing the percentage compared to other sites that conducted surveys throughout March. Turkey vultures (56%), red-tailed hawks (14%), and broad-winged hawks (6%) were the three most common raptors observed during spring migration surveys. Peregrine falcons and northern goshawks were the least observed (0.1%), followed by merlins (0.2%) and rough-legged hawks (0.3%). Only three raptor species were observed during all spring raptor migration surveys: sharp-shinned hawks, red-tailed hawks, and turkey vultures.

Fifteen of the 18 of the spring raptor surveys observed at least one bald or golden eagle. Spring eagle observations are related to the raptor risk level, unlike the fall raptor surveys. High risk

sites yielded higher counts of bald and golden eagles than low risk sites, supporting the PGC's pre-construction risk assessment designations.

There continue to be variations in raptor migration among species and seasons. During 18 fall surveys greater than or equal to 1% bald or golden eagles were documented. However, only five of these surveys documented increased proportions of both bald and golden eagles. Spring surveys were similar, with 13 surveys documenting greater than or equal to 1% bald or golden eagles, but only three had increased percent of both bald and golden eagles**. For overall eagle migration, fall and spring surveys provided similar results. Of the 13 sites that documented increased percent for eagles during spring surveys, 12 also documented increased percent for eagles during corresponding fall surveys.** Seven additional fall surveys documented increased percent for eagles, but did not conduct corresponding spring surveys. One additional survey documented increased percent for eagles during fall, but not during corresponding spring surveys. However, this site was low risk and only conducted two days of spring surveys. The short survey period could have missed eagles migrating through the area. These data suggests that spring surveys may provide similar eagle migration data to fall surveys in a shorter timeframe as well as support conducting spring raptor surveys first, and fall raptor surveys only if significant eagle migration is noted.

Sites with the highest bald eagle flights varied between spring and fall surveys. Of the 14 sites that experienced increased bald eagle flights during fall surveys, five documented increases during corresponding spring surveys, four did not document increases during spring surveys, and five did not conduct corresponding spring surveys.

For golden eagles, sites with increased percentages were similar between spring and fall surveys. Of the nine surveys that observed increased percent of golden eagles in the fall, six also observed increased percent during spring. Two of the nine sites from the fall did not observe increased percent in the spring, however both sites conducted shortened surveys (two and 15 days respectively). The final survey that experienced increased percent for golden eagles in the fall was at a site that did not conduct any corresponding spring raptor surveys. Two high risk sites (3-2 and 3-4) experienced the highest percent in flight of golden eagles for both spring and fall.

Raptor migration surveys showed similar results of bald and golden eagle migration as research conducted by Todd Katzner et al. (2008) which show bald and golden eagles using northcentral and northeast Pennsylvania as migratory routes. These studies show that bald and golden eagles are migrating northward through Pennsylvania. However, these raptor surveys do not show the large number of eagles migrating such as is noted at hawk watch sites throughout Pennsylvania. Four sites have had their raptor risk increased, however only one site increased due to the results of the raptor surveys. Two sites had their raptor risk increased because of the golden eagle data collected through the research of Katzner et al. (2008) and one site was increased because of the discovery of an eagle nest in the vicinity of the project.

Several low risk sites documented greater total number of raptors observed than some high and moderate risk sites. Low risk sites 6-1, 6-3, and 2-1 experienced greater total raptors observed than many high and moderate risk sites during both fall and spring surveys implying they are

located along previously unknown raptor migration corridors. However, these sites also had longer survey duration, which could explain the increased total raptor count.

Birds: Breeding Bird Survey Results

A total of 29 breeding bird surveys were conducted between 2006 and 2011 at 24 proposed wind sites (Appendix C). No breeding bird surveys were conducted at proposed wind sites prior to 2006. Five sites conducted more than one year of surveys because the protocol was not followed, the project area was not adequately covered, or changes to the project area required additional points. Breeding bird surveys consisted of point counts, area searches, or a combination of point counts and area searches.

The 29 breeding bird surveys consisted of 26 point count surveys and 19 area search surveys. Ten sites recorded at least one Pennsylvania threatened or endangered bird species during point counts (Appendix D) and two sites detected at least one Pennsylvania threatened or endangered bird species during area searches (Appendix E). All of the point counts and area searches documented at least one WAP priority bird species (Appendices D & E). The number of species detected varied considerably for both point counts (26 to 90) and area searches (9 to 78).

The state-listed endangered birds observed during breeding bird surveys included yellow-bellied flycatcher (*Empidonax flaviventris*), blackpoll warbler (*Setophaga striata*), American bittern (*Botaurus lentiginosus*), and upland sandpiper (*Bartramia longicauda*). All of the blackpoll warbler and yellow-bellied flycatcher observations were deemed to be migrants based on the lack of appropriate breeding habitat in the area. The observations of American bitterns were auditory and resonated from outside of the proposed project area. One site also documented upland sandpipers during breeding bird surveys. A habitat suitability index was requested to delineate suitable habitat in the vicinity of the project area. The PGC has not yet received the results of the index for all potential habitat at this site. The state-listed threatened species observed during breeding bird surveys include ospreys (*Pandion haliaetus*) and Northern harriers. The osprey observations were of individuals flying over, and not of confirmed breeders. Two sites documented Northern harriers during breeding bird surveys prior to becoming listed as threatened. For confirmed breeding threatened and endangered species, the PGC will work with the Cooperator to best avoid the area, minimize negative impacts, and mitigate for any negative impacts to the species and its habitat. The PGC will be tracking all of the sites that have documented migrant or breeding 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 (*Setophaga caerulescens)*, black-throated green warbler (*Setophaga virens*), worm-eating warbler (*Helmitheros vermivorum*), and scarlet tanager (*Piranga olivacea*) (Pennsylvania Game Commission 2005). The PGC will continue to investigate how changes in habitat type affect the bird communities documented at wind sites.

The PGC breeding bird protocols were designed to target breeding seasons of threatened, endangered, and Wildlife Action Plan species of special concern birds. Failure to follow protocols was a consistent issue from 2006 to 2009 with 15 of 22 surveys not adhering to PGC protocols (see "Comments" in Appendix C). However, since 2010 all breeding bird surveys conducted have followed the protocols provided in Exhibit A of the Cooperative Agreement.

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 located on a proposed project prior to commencing the surveys. Coordination with the PGC prior to surveys will help to ensure the entire project 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 however the PGC has recommended post-construction breeding bird surveys when the presence of threatened, endangered, or species of special concern species have been documented on the project area. However, none of the sites for which the PGC has requested post-construction breeding bird surveys have gone to construction or are in the first year of post-construction monitoring. Thus, no post-construction breeding bird survey data has been provided to the PGC.

Birds: Bird Species of Special Concern Survey

Bird species of special concern surveys conducted at proposed wind sites have included bald eagle nest surveys. Surveys conducted targeting Pennsylvania endangered species include short-eared owl presence/absence surveys, upland sandpiper surveys, and blackpoll warbler and yellow-bellied flycatcher habitat 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. Results of bird species of special concern surveys from 2007 to 2009 were summarized in the 1st and 2nd summary reports (Capouillez and Librandi Mumma 2008, Librandi Mumma and Capouillez 2011).

Between 2010 and 2011, upland sandpiper surveys were conducted at two sites. Both sites conducted a habitat suitability index, which identified suitable habitat. Both sites then conducted presence/absence surveys on the suitable habitat. One site did not find any upland sandpipers using the area. The second site found upland sandpipers in the area and the Cooperator is currently working with the PGC to determine strategies to avoid, minimize, and mitigate any negative impacts.

One site conducted blackpoll warbler and yellow-bellied flycatcher habitat surveys in 2011. These surveys resulted from observations of each species during pre-construction breeding bird surveys. The observations were believed to be migrant birds, but because the species were observed during the breeding season, the PGC requested habitat surveys to determine if suitable habitat existed on the project area. The habitat survey did not indentify any habitat on or near the project area that met specific criteria, such as wetland size and/or elevation, needed for breeding habitat supporting the conclusion the birds were migrants.

Bats: Potential Hibernacula Investigations

The investigation of potential hibernacula within the project area is the Cooperators' responsibility. Potential hibernacula include features such as abandoned mines, subsidence areas, and abandoned buildings. Since the Cooperative Agreement has been in effect, the PGC received reports from 24 sites that conducted potential bat hibernacula investigations. Eight of the 24 sites identified potential bat hibernacula on the project area that subsequently needed to be sampled for bats. At these eight proposed wind sites, 81 potential bat hibernacula features were sampled. One of the features investigated 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 federal and state endangered species. Nineteen of the 81 features trapped documented at least one northern long-eared bat (*Myotis septentrionalis*), a species of special concern. The other features trapped did not result in evidence of being a hibernaculum of concern. A hibernaculum of concern is currently defined as a hibernaculum which houses a large number of bats (1000+ in an internal survey or 100+ captured via trapping), one that supports a diverse number of bat species (four or more species), or which houses the state threatened eastern small-footed bat (*Myotis leibii*) or the state and federally listed endangered Indiana bat.

The PGC investigates potential bat hibernacula within five miles of the proposed project area. Since the Cooperative Agreement has been in effect, a total of 556 mine features were investigated by PGC staff. A total of 39 features were identified as potential bat hibernacula. Five of these features were trapped and none identified as a hibernaculum of concern. The PGC plans to trap the remaining features in the future, as time and resources allow.

Since the Cooperative Agreement was implemented in 2007, white-nose syndrome has devastated cave dwelling bat species in the northeastern United States, including Pennsylvania. Interior hibernacula counts are used in Pennsylvania to monitor trends in cave dwelling bats. Interior hibernacula surveys pre- and post-exposure of white-nose syndrome in Pennsylvania have revealed an overall decline of 98% of cave dwelling bat species (Turner et al. 2011). Because of the effects of white-nose syndrome on resident bat species, the criteria for hibernacula of concern should be revised. The current criteria for defining hibernacula of concern should be updated to reflect the overall 98% decline in Pennsylvania cave dwelling bat species attributed to white-nose syndrome.

Bats: Acoustic Monitoring

We received reports and data from 30 pre-construction bat acoustic surveys conducted at 24 individual sites between 2005 and 2011. Cooperators used the following models of bat acoustic detectors to conduct pre-construction bat acoustic surveys (No. surveys): Pettersson D500x (3), Anabat II (16), Anabat SD1 (3), AR 125 (3), and five used both Anabat II and Anabat SD1. Calls per hour varied between 0.1 and 5.6 per project with an average of 1.0 calls/hour and a standard deviation of 1.4. Since 19 of the 30 surveys did not adhere to PGC protocol these summary statistics should be interpreted with caution. Deviations from the PGC protocol were previously summarized in the 2nd summary report (Librandi Mumma and Capouillez 2011) and thus will not be discussed here. The average number of calls/hour for the 11 surveys that did follow protocol ranged from 0.1 - 4.7, with an average of 1.2 and a standard deviation of 1.4.

Caution should be used when interpreting these data because differences in technology and detection zones of the various acoustic detectors make comparing them difficult.

The number of detectors at each project varied, ranging from 1 to 36 detectors with an average of 5. Likewise, the height of detectors deployed varied. Height level of detectors 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 = 50%, low = 27%, moderate = 50% and high = 67%. Nineteen of the 30 surveys (63%) used multiple detectors at different heights and 11 surveys (37%) used detectors at one height only. Of the 11 surveys using detectors at only one height, five were used at ground level, and six were used at high level.

In addition to requiring that acoustic detectors on all MET towers be installed as close to the rotor swept 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 19 surveys that did not follow protocol, 50% did not survey from 30 minutes prior to sunset to 30 minutes following sunrise every day, 67% did not survey within the correct dates, and 29% did not have at least one detector on a MET tower at the highest level (40+m). The correct dates of a survey is dictated by the site's 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.

Between 2005 and 2007 only seven of 14 surveys had detectors that were operational for the entire survey period. This prompted the PGC to implement an 80% detector success rate (i.e. 80% of the nights with detectors operational and able to collect data). In 2008, the first year Cooperators targeted the 80% detector success rate, four of nine surveys did not meet the 80% detector success threshold because of equipment failure, memory card issues, and battery failures. Eight acoustic surveys were completed since 2009, of which all have achieved detector success of at least 80% (92%). Only two acoustic surveys were completed between 2010 and 2011, both achieved detector success of 92% each.

Of the 30 pre-construction bat acoustic surveys performed, only eight followed the PGC protocols by deploying a minimum of one high level detector, surveying the correct times and season, and achieving 80% detector success. Using data from these eight sites, some general trends can be derived. **An average of 69% (60% - 82%) of all bat activity at three high bat risk sites occurred between July 1 and September 30** (Figure 3). Only three high risk sites were included in this seasonal analysis since these sites followed all protocols and were required to collect acoustic data from April 1 to November 15. Of the low and moderate sites, bat activity peaked between August and September, with sharp decreases in bat activity beginning in October. These data suggest that any efforts to minimize bat mortality should be focused between July 1 and September 30.

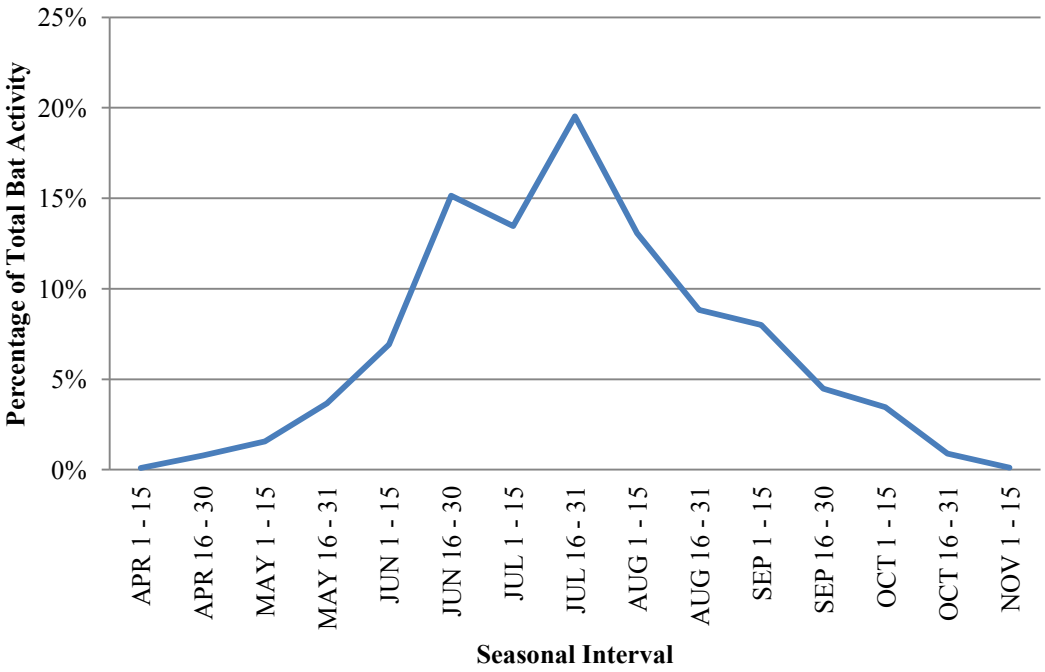

Figure 3. Seasonal patterns of bat activity at three high bat risk Pennsylvania wind sites observed during pre-construction acoustic monitoring, 2007-2011.

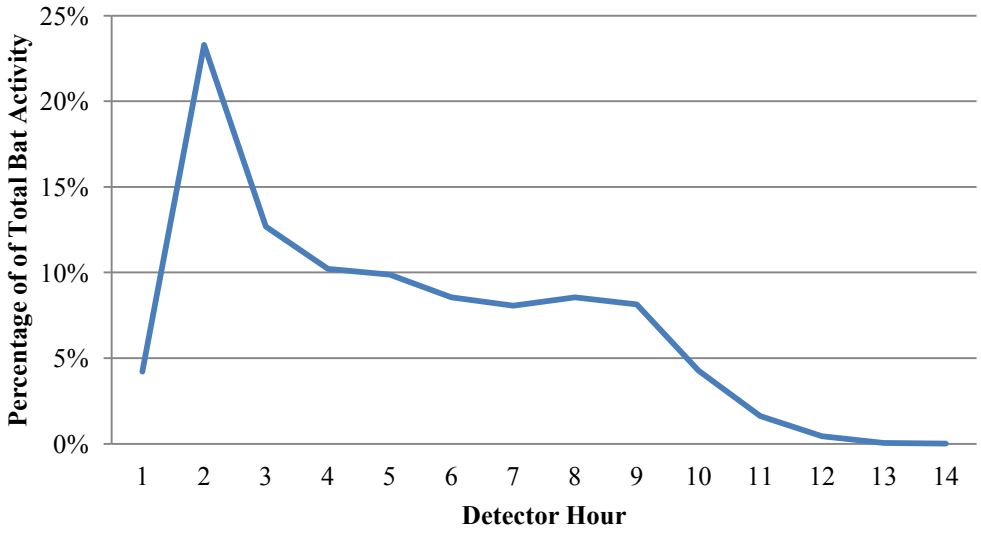

Figure 4. Hourly bat activity at eight Pennsylvania wind sites observed during pre-construction acoustic monitoring, 2007-2011.

The data also shows that 59% (range 48% - 69%) of the documented bat activity occurred when wind speeds were less than 6 meters per second (Figure 5). Additionally, 76% (range 72% - 92%) of bat activity occurred when wind speeds were less than 7 meters per second, which corresponds with the U.S. Fish and Wildlife Service's 6.9 meters per second cut in speed

recommendation for sites with increased risk to endangered Indiana bats (Beech Ridge Energy LLC 2012). Because the PGC protocol does not designate which species or species groups should be identified, the species data provided to the PGC is not standardized. This limits the ability of the PGC to determine species activity or species detection rates for these sites.

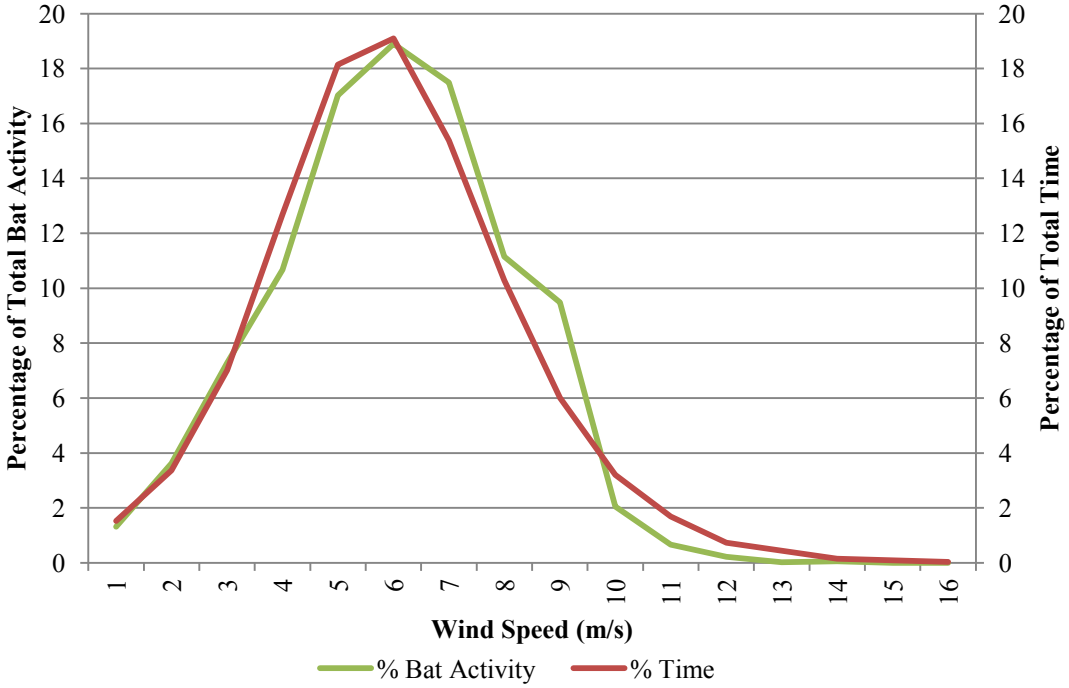

Figure 5. Bat activity by wind speed at eight Pennsylvania wind sites observed during pre-construction acoustic monitoring, 2007-2011.

In response to inconsistencies with reporting of bat acoustic data, the PGC released *Best Management Practices for Acoustic Monitoring at Pennsylvania Wind Energy Facilities* in 2011. These management practices provide detailed instructions on what to report and how to fill out the datasheets. No sites have completed pre-construction acoustics since the Acoustic BMP's have been released, however these management practices are anticipated to reduce the inconsistencies in reporting that will provide a more robust dataset for analysis.

In early 2012 the U.S. Fish & Wildlife Service released its draft Rangewide Indiana Bat (Myotis sodalis) Summer Survey Guidelines for review. The PGC provided the Service with comments regarding the draft protocol. In addition, Cooperators were asked to provide the PGC with raw acoustic bat call data from pre-construction surveys so the PGC could test the new automated bat call software. All Cooperators submitted their acoustic bat call files to the PGC however, delays in release of the automated software has prevented the PGC from completing an in depth review of the software. The PGC anticipates providing the Service with comments once the PGC has completed its review of the software in 2013.

Bats: Mist Net Surveys

Mist net surveys are conducted based on the Cooperative Agreement criteria for 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 what cave species are present in the project area and indicate breeding populations, if juveniles or reproductive females are captured. Two sites in 2010 had their bat risk increased from low to high because of threatened and/or endangered species captured during mist netting. In addition, mist net surveys provide critical information about threatened and endangered species because telemetry is conducted on these species if captured. 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. The PGC has rejected surveys that did not follow protocol. Thus some Cooperators 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. Between 2004 and 2011 the PGC received results from 39 bat mist net surveys conducted on 33 wind sites in Pennsylvania. Six sites conducted two years of mist net surveys; three sites changed their project areas and sampled the new areas of the proposed project, two sites did not adequately sample the project area, which required additional netting, and one site captured a threatened and/or endangered species, which required additional netting for telemetry. On average, five bat species were captured during each survey (range 4 – 7 species). Between 2004 and 2011 mist net effort averaged 12 bats per 1000 units of effort (range 3 – 45 bats). A unit effort is defined as one square meter of net in place for one hour. In other words, it took 1000 square meters of nets in place for one hour to capture 12 bats. Mist net effort in Pennsylvania has decreased significantly since the onset of white nose syndrome. From 2010 to 2011 mist net success averaged 5 bats/1000 units of effort, a 58% decrease. Cave bats (little brown (*Myotis lucifugus*), big brown (*Eptisicus fuscus*), Indiana, tri-colored (*Perimyotis subfavus*), long-eared (*Myotis septentrionalis*), and small-footed bats) generally comprises the majority of bats captured during mist-netting. Overall, effort required to capture cave bats has increased significantly while the effort needed to capture migratory tree bats (red (*Lasiurus borealis*), hoary, and silver-haired bats (*Lasiurus noctivagans*)) has remained steady. Mist net capture rates are not anticipated to correlate with bat risk levels because the capture rates are reliant on site specific mist net locations. Mist net surveys are designed to determine the presence or absence of threatened and endangered species, which is a means to obtain specimens for telemetry. Captures of threatened, endangered, and species of special concern bats during mist net surveys have provided valuable information about foraging areas, roost locations, and maternity colonies for these species (see *Bat: Telemetry* section below).

Bats: Telemetry

Nine 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. Since 2007, telemetry was conducted on 44 bats; 34 individual Indiana bats and 10 individual eastern small-footed bats. Because the species with transmitters attached 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 was submitted for inclusion in the Pennsylvania Natural Diversity Inventory (PNDI) so that it can be used to better site other development projects.

Between 2010 and 2011, one bat telemetry survey was conducted. At one site in 2010, five small-footed bats were captured however only one male met the minimum weight criteria to be a candidate for telemetry. The bat was tracked for four days, documenting two roost locations; one in a talus pile and the second on the wall of a mine. An emergence count at the talus pile roost location showed no evidence of a maternity colony. Due to the location of the roost location on the mine wall, an emergence count was not conducted. The home range (95% minimum convex polygons) for this male was estimated to be 150 acres (60.79 hectares) and the core habitat (50% fixed kernel utilization distribution) was about 0.05 acre (0.02 hectare).

Some of the information gathered during the Indiana bat telemetry surveys associated with wind energy projects revealed that female bats tend to travel farther from roosts to hibernacula than male bats. Fall trapping at one hibernaculum indicated that female Indiana bats travelled up to 11.8 miles from roost tree to hibernaculum during fall swarming. Additionally, over 71 Indiana bat roosts were identified, including the state's second largest maternity colony. It was also noted that male Indiana bats tended to forage in forested hilly terrain and use smaller riparian areas compared to females which tended to forage in flatter areas and use larger riparian areas. Telemetry studies of eastern small-footed bats associated with wind energy projects have revealed over 14 roost locations including one maternity location. Home ranges of eastern small-footed bats ranged from 150 acres to over 3,400 acres. This species utilized deciduous forests primarily for foraging. Roost locations were identified in rocky outcroppings within the forest, strip mines, spoil piles, and on cliffs.

Telemetry survey results were used by Cooperators to avoid and minimize potential impacts to the species and their habitats. Avoidance and minimization methods used by Cooperators include adjusting the placement and/or number of turbines, relocation of proposed turbine strings, and the abandonment of portions of project areas to avoid impacts to listed bat species. For sites where impacts could not be completely avoided, mitigation by Cooperators includes installation of bat gates at known hibernacula to protect hibernating bats from disturbance and plans to create eastern small-footed bat roosts.

Mammals of Special Concern: Allegheny Woodrat

The state listed threatened Allegheny woodrat (*Neotoma magister*) inhabits steep rocky/talus slopes, boulder fields, and/or caves in a forest interior matrix within the Appalachian mountain areas where many wind sites are proposed. The operation of wind turbines is not known to negatively impact woodrats directly however, the footprint of the project, including infrastructure and turbines, may fragment and/or destroy their habitat and travel corridors. Woodrat habitat assessment surveys are required if there are known historic 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* (Pennsylvania Game Commission 2008). The purpose of the habitat assessment survey is to delineate woodrat habitat and to document the presence of all old and new woodrat sign (e.g. food caches, latrines).

Fifteen woodrat habitat assessment surveys have been completed on proposed wind sites between 2007 and 2011. Only three proposed wind sites have documented woodrat sign; one site documented both fresh and old sign and two sites 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. Pre-construction surveys were completed in 2009. The results of the pre-construction woodrat monitoring revealed a total population estimate of 25 woodrats on the project area. The capture of juvenile woodrats also confirmed breeding on the project area. Post-construction surveys commenced in 2012 and will continue annually until 2016. The Cooperators for sites that documented old woodrat sign have adjusted their project areas to exclude disturbing the area where old woodrat sign was observed thereby avoiding potential impacts. 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.

Mammals of Special Concern: Northern Flying Squirrel

In Pennsylvania, state listed endangered northern flying squirrels (*Glaucomys sabrinus*) are found in habitats characterized by mature mixed deciduous-hemlock stands or around stands of pure conifer that contain large, mean = 17 inch dbh (44.9cm), conifers and many snags (~10 snags/acre; Mahan et al. 1999, Mahan et al. 2010). Similar to woodrats, direct impacts from wind turbine operation is not known, but impacts from construction in the form of habitat removal and fragmentation have the potential to negatively affect northern flying squirrels. At this time the PGC does not have a presence/absence survey protocol established for northern flying squirrels, however a habitat assessment is used to delineate any potential habitat. A total of seven proposed wind sites have had potential impact to northern flying squirrels or their habitat. One site with potential northern flying squirrel habitat has completed a habitat assessment thus far and identified potential habitat. The Cooperator for the site has adjusted their project area by micrositing turbines and utilizing pre-existing trails for construction to minimize potential impacts to this area. As with other potential impacts to state threatened or endangered species, the PGC will work with the Cooperator to avoid and minimize impacts to northern flying squirrel habitat.

Post-construction Results

The PGC requests a minimum of two years of post-construction mortality surveys at each site. In some circumstances, such as endangered species mortality, exceptionally high mortality rates, or failure to follow established protocols, the USFWS and/or the PGC may request a third year of mortality monitoring. Since 2007, one site completed three years of mortality monitoring, however the site did not follow protocols the first year, and thus the PGC did not accept the results. Two sites are conducting an additional third year of monitoring in 2012 due to threatened or endangered species mortality. A total of 24 surveys (a survey is defined as one year of mortality monitoring at one site) were conducted at 12 wind sites in Pennsylvania between 2007 and 2011 (Table 6). The PGC requires that all sites conducting post-construction monitoring acquire a PGC Special Use Permit so that bird and bat carcasses, including state listed species, can be collected. The Bureau of Wildlife Protection issues the Special Use 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 Special Use Permit lists the effective and expiration dates, study methods, reporting requirements, etc. All 12 sites were issued Special Use Permits to conduct post-construction monitoring surveys and no Special Use Permits have been revoked.

Mortality

Mortality searches were conducted daily from April 1 – November 15 for all sites with low or moderate raptor risk, with the exception of the one site in 2007 that conducted daily mortality searches between May 1 and November 17. Three of the four high raptor risk sites conducted mortality surveys daily from March 1 – December 15, concurrent with raptor migration surveys. One high raptor risk site conducted surveys from April 1 – December 15 because the site was not accessible in March due to heavy snow cover.

PGC staff validated the identification of all carcasses from all surveys, with few exceptions. Estimated mortality was calculated from daily searches conducted at ten turbines, or 20% of turbines, whichever was greater at each site. The Erickson et al. (2004) estimator, which corrects for searcher efficiency and scavenger removal (SESR) biases, was used to calculate mortality estimates for birds and bats. There are a few different estimators used currently, but for standardization, the PGC asks that all sites use the Erickson estimator to allow for comparisons among sites. However, because the Erickson estimator likely results in an underestimation of mortality, the mortality estimates provided in Table 6 should be considered minimum estimates, rather than the total mortality occurring on wind sites.

Bat Mortality

A summary of bat mortality estimates for the 12 sites that conducted mortality searches between 2007 and 2011 can be found in Table 6. All Cooperators are required to report mortality estimates derived from the Erickson method (Erickson et al 2004). The PGC was unable to determine what percentage of mortality was due to direct collision versus 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 19 surveys that followed PGC protocol was 25 (range 5 – 59).***

A Friedman's Test was used to compare bat mortality among risk categories. Results showed no statistical difference among the risk groups in terms of mortality (Q = 2.9221, p = 0.2320). Some sites designated as low bat risk had higher estimated bat mortality than sites designated as high bat risk. Site 24-1, which was designated as low risk, had the highest estimated bat mortality at 59 bats per turbine per year. Based on data collected thus far, the extent of bat mortality cannot be predicted based on current bat risk levels. Furthermore, bat risk designations do not correlate with threatened and endangered species mortality. Five high risk bat sites have completed mortality monitoring and documented no threatened or endangered species. However, one Indiana bat fatality was documented at a low bat risk site (see *Threatened and/or Endangered Species Mortality: Bats* section).

Table 6. Summary of bat mortality estimates for the 12 sites that conducted mortality searches in 2007-2011. Bat risk, H = high, M = moderate, L = low; CI = confidence interval. Gray boxes indicate no data was provided to the PGC.

Site Code	Bat Risk	Year	PGC Protocol Followed?	Estimated Bats/Turbine/ Year	95% CI Low	95% CI High	Estimated Bats/MW/Year
6-3	H	2007	Yes	30[a]			21
6-3	H	2008	Yes	27[b]			17
2-2	H	2008	Yes	19	15	23	22
2-2	H	2009	Yes	13	10	16	22
2-14	L	2008	No[c]	7	2[e]	13[e]	3
2-14	L	2009	Yes	7	4	12	3
2-10	L	2008	No[c]	16	7[e]	29[e]	8
2-10	L	2010	Yes	5	3	7	2
2-4	L	2009	Yes	29	20	38	12
2-4	L	2010	Yes	32	17	47	13
5-5	M	2009	No[d]	13	7	21	7
5-5	M	2010	Yes	11	6	15	5
24-3	L	2009	No[d]	12	1	5	6
24-3	L	2010	Yes	38	8	68	19
24-3	L	2011	Yes	19	13	27	10
6-1	H	2009	Yes	28	25	32	15
6-1	H	2010	Yes	29	25	32	14
35-1	L	2010	Yes	22	15	30	15
35-1	L	2011	Yes	11	8	14	7
24-1	L	2010	Yes	59	39	78	29
24-1	L	2011	Yes	30	23	39	15
2-19	H	2010	Yes	31	20	41	21
2-19	H	2011	Yes	14	8	21	10
6-16	L	2011	No[d]	32			20

[a] Alternate analysis provided by developer, originally reported 43 bats/turbine/year
[b] Alternate analysis provided by developer, originally reported 34 bats/turbine/year
[c] Operational issues at site; less than 10 turbines searched
[d] Various aspects of PGC protocols were not followed
[e] 90% confidence interval

Mortality estimates varied between years for most sites. The general trend appears to be higher overall bat mortality during the first year of monitoring (mean=33, standard deviation=12.7) followed by lower mortality the second year of monitoring (mean=23, standard deviation=9.5). However the difference in mortalities between years is not statistically significant (U (11) =148, p = >0.05). Eight of the 11 sites that have completed multiple years of mortality monitoring have greater mortality the first year compared to subsequent years. Four of the eight sites did not follow PGC protocols during the first year of mortality monitoring reducing the confidence in the

first year mortality estimate. It is unknown why there appears to be reduced mortality during the second year of monitoring. Potential explanations include bats recognizing and avoiding turbines, the mortality from the first year reducing the overall number of bats thereby reducing the mortality during subsequent years, and natural fluctuations of populations of bat species. Three of the 11 sites that have completed multiple years of mortality monitoring showed an increase in bat mortality from year one to year two. One of these three sites (Site 24-3) did not follow PGC protocols during the first year of surveys, and a decrease in bat mortality occurred between the second and third year of monitoring. Because PGC protocols were not followed the first year, it is difficult to determine if the increase in bat mortality the second year was accurate or if the mortality estimate for the first year was low due to deviations from the PGC protocols.

A total of 2,820 bat carcasses were found during standardized searches at Pennsylvania wind sites conducting mortality monitoring between 2007 and 2011. The majority of bat carcasses found during standardized searches since 2007 were adult males (Figure 6). One site (6-16) had much higher than average female mortality, with females making up 43% of carcasses found. This site has not yet completed the second year of monitoring. Likewise, two sites (6-1 and 6-16) had higher than average juvenile mortality compared to other sites. In 2009, 25% of all bats documented at site 6-1 were juveniles however, only 8% of bat mortalities found at this site during the second year of monitoring were juveniles. In 2011, site 6-16 documented 51% of all bats found during monitoring were juveniles; this site has not yet conducted a second year of mortality monitoring. The greater proportions of juvenile mortality at these sites could be indicative of a maternity colony in the vicinity of the project, however because one site was low risk and the second site was grandfathered in to the Cooperative Agreement, no mist-net surveys were conducted to verify the presence of a maternity colony.

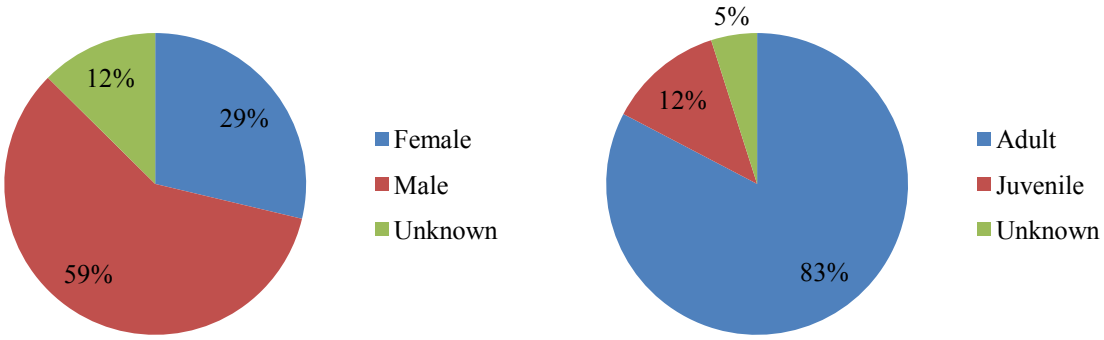

Figure 6. Sex and age composition of all bat mortality documented during standard searches at the wind sites that followed PGC protocol, 2007-2011.

Migratory tree bats (hoary, red, silver-haired, and Seminole (*Lasiurus seminoles*) bats) comprised 76% of all documented mortality, while cave bats (tri-colored (*Perimyotis subflavus*), little brown, big brown, northern long-eared, and Indiana bats) comprised 23% of all documented mortality, and 1% of all documented mortality was unknown due to degraded carcass condition which precluded species identification. Migratory tree bats were the majority of bat species documented each year consistently from 2007 (Table 7).

Table 7. Percent composition of migratory tree bats and cave bats found during daily searches at Pennsylvania wind sites during mortality surveys conducted in 2007-2011, by year (No. sites conducting mortality monitoring), and overall.

	Percent (%) of Total Bat Mortality					
	2007 (1)	2008 (4)	2009 (6)	2010 (8)	2011 (5)	2007-2011 (12)
Migratory Tree Bats	75	74	61	83	81	76
Cave Bats	24	25	38	16	18	23
Unknown Bats	1	1	1	1	1	1

Species composition of migratory tree bats varied among years (Table 8), with the majority of migratory tree bats documented being Hoary bats. Seminole bats were the least frequently found tree bat at Pennsylvania wind sites. Nine adult Seminole bats (5 males, 3 females, and one unknown sex) were found at six different wind sites. All suspected Seminole bats were sampled and confirmed via genetic analysis. The six sites represented five different regions of Pennsylvania, which indicates Seminole bats may frequent Pennsylvania more than previously thought. Between 2007 and 2009 tri-colored bats were the most commonly documented cave bat species found at Pennsylvania wind sites. Between 2009 and 2010 the proportion of tri-colored bats dropped significantly. Similarly the proportion of little brown bats declined during the same time period. This is most likely attributed to the effects of white nosed syndrome. While white nosed syndrome is believed to have first surfaced in Pennsylvania in 2009, the effects of the fungus were not realized on the bat populations until 2010. Interestingly, the proportion of big brown bat mortality documented at Pennsylvania wind sites has increased. The increased proportion of big brown bat mortality may be attributed to big brown bats being less susceptible to white nose syndrome (Turner et al. 2011). Therefore, because overall numbers of big brown bat mortalities are not decreasing at the same rate as little brown bats, their proportions are increasing.

Table 8. Percent species composition of bat carcasses found during daily searches at Pennsylvania wind sites during mortality surveys conducted in 2007-2011, by year (No. sites conducting mortality monitoring), and overall.

	Percent (%) of Total Bat Mortality					
	2007 (1)	2008 (4)	2009 (6)	2010 (8)	2011 (5)	2007-2011 (12)
Hoary	31	34	27	30	39	31
Eastern Red	33	18	15	39	26	28
Silver-haired	12	22	19	14	16	16
Seminole	0	0	<1	<1	<1	<1
Tri-colored	16	14	15	4	3	8
Little Brown	4	8	17	6	4	8
Big Brown	3	2	6	6	11	6
Northern Long-eared	0	0	<1	0	0	<1
Indiana	0	0	0	0	<1	<1
Unknown	1	1	1	1	1	1

Species composition varied among sites (Table 9). Generally hoary, red, or silver-haired bats were the most frequently documented bat species. Interestingly, species composition also varied between years for most sites. For example, site 2-10 documented a majority of hoary and silver-haired bat mortalities during the first year of monitoring, however red bats consisted of the majority of bat species documented during the second year of monitoring. It is currently unknown whether a site's yearly variation in species composition is due to species' population trends or if the variation could be attributed to operational impacts.

Table 9. Percent composition of bat carcasses found during standardized searches at Pennsylvania wind sites during mortality surveys conducted in 2007-2011, by site, and overall. Threatened and endangered species are not listed in the table due to the sensitivity of the data. One Indiana bat fatality has been documented at a Pennsylvania wind site between 2007 and 2011. LACI = Hoary bat, LABO = Eastern red bat, LANO = Silver-haired bat, MYLU = Little brown bat, PESU = Tri-colored bat, EPFU = Big brown bat, MYSE = Northern long-eared bat, LASE = Seminole bat, UNK = Unknown.

Site	Year	LACI	LABO	LANO	MYLU	PESU	EPFU	MYSE	LASE	UNK
6-3	2007	31	33	12	4	16	3	0	0	1
6-3	2008	36	19	19	6	16	2	0	0	1
2-2	2008	33	17	26	10	12	3	0	0	1
2-2	2009	30	14	24	17	11	3	0	2	0
2-14	2008	40	0	20	0	0	20	0	0	20
2-14	2009	38	16	19	9	6	3	3	0	6
2-10	2008	24	18	24	18	18	0	0	0	0
2-10	2010	18	42	6	12	3	0	0	0	18
2-4	2009	31	21	22	11	9	5	0	0	1
2-4	2010	34	42	10	5	5	4	0	0	0
5-5	2009	20	22	32	12	4	10	0	0	0
5-5	2010	35	24	35	0	2	4	0	0	0
6-1	2009	20	10	13	24	24	8	0	0	<1
6-1	2010	35	29	12	5	10	10	0	<1	0
24-3	2009	48	14	18	9	9	2	0	0	0
24-3	2010	34	38	20	4	1	2	0	1	0
2-19	2010	26	44	10	10	2	6	0	0	1
2-19	2011	41	24	17	2	6	7	0	<1	1
24-1	2010	32	41	14	3	3	8	0	0	1
24-1	2011	51	25	13	1	3	5	0	0	1
24-3	2011	43	27	12	9	4	5	0	0	0
35-1	2010	24	43	16	9	1	7	0	1	1
35-1	2011	32	27	27	3	0	10	0	0	0
6-16	2011	12	29	8	4	0	47	0	<1	0
	Overall	31	28	16	8	8	6	<1	<1	<1

Two sites (6-1 and 6-16) documented greater that 50% of cave bats during mortality monitoring. Site 6-1 documented mortality comprised of 56% cave bats during the first year of mortality monitoring. During the second year of monitoring in 2010, only 25% of the total bat mortality was cave bats. This dramatic decrease in cave bat mortality is most likely attributed to the effects of white-nose syndrome; however the overall mortality observed remained similar as there was an increase in migratory tree bat mortality during the second year. Site 6-16 also documented a greater that average proportion of cave bat mortality in 2011, specifically big brown mortality. This site has not yet conducted the second year of mortality monitoring, so a comparison between years is not possible. This site also experienced higher than average juvenile and female bat mortality, which may indicate a maternity colony in the area. No known hibernacula exist in the area of this site, and no mist net surveys were required pre-construction of this site due to its low bat risk designation. However the site is located near a waterway that could serve as a travel and/or foraging corridor to bats, likewise the site is in the relative vicinity of an urban area that may contain undocumented maternity colonies in attics or abandoned buildings.

Overall 23% of the bat mortality consisted of cave bats; little brown bats (8%), tri-colored bats (8%), big brown bats (6%), Indiana bats (<1%), and northern long-eared bats (<1%) (Table 9). Threatened and endangered species are not listed in Table 9 due to the sensitivity of the data. One Indiana bat fatality has been documented at a Pennsylvania wind site between 2007 and 2011, see the *Threatened and/or Endangered Species: Bats* section for more information. More than 50% of documented mortality consisted of cave bats at two sites (6-1 and 6-16). Site 6-1 documented high cave bat mortality during the first year only and the second site (6-16) has not yet completed the second year of post-construction mortality monitoring. White nose syndrome research in the vicinity of site 6-1 located several previously unknown bat hibernacula in close proximity to the site, explaining why the majority of bat fatalities were cave bats during the first year of monitoring. Site 6-16 is not located near any known bat hibernacula however the project is in the vicinity of an urban area, which may contain undocumented maternity colonies. An additional four sites documented greater than average proportions of cave bat species, although not a majority. Sites 2-10, 2-14, 2-2, and 5-5 all had higher than average proportions of little brown, tri-colored, or big brown bat mortality. Sites 2-14, 2-2, and 5-5 have identified hibernacula containing these three species within five miles of the project. Additionally all of the sites that experienced greater than average proportions of cave bat mortality have streams, rivers, or ponds in the vicinity of the project. Overall, less than one percent of bat carcasses found were classified as unknown. Unknown bat carcasses were typically in poor condition (disintegrated, missing parts of the carcass that contain key identification characteristics, etc.) which precluded the ability to identify to the species level. Sites 2-10 and 2-14 show unknown bat carcasses at a much higher proportion than other sites. This can be attributed to the low overall bat mortality at these sites, which results in the few unknown bat carcasses representing a large proportion of species composition.

Distributions of bat mortality by Julian date are shown in Figure 7. Julian date was chosen to standardize the data because 2008 was a leap year.

Seasonal distribution of bat mortality varies among species, however the peak of mortality of all species tend to occur in the fall (Figure 8). Note that Indiana and northern long-eared bats are

not represented in the figure. One mortality has been documented for each species, both of these mortalities occurred in September.

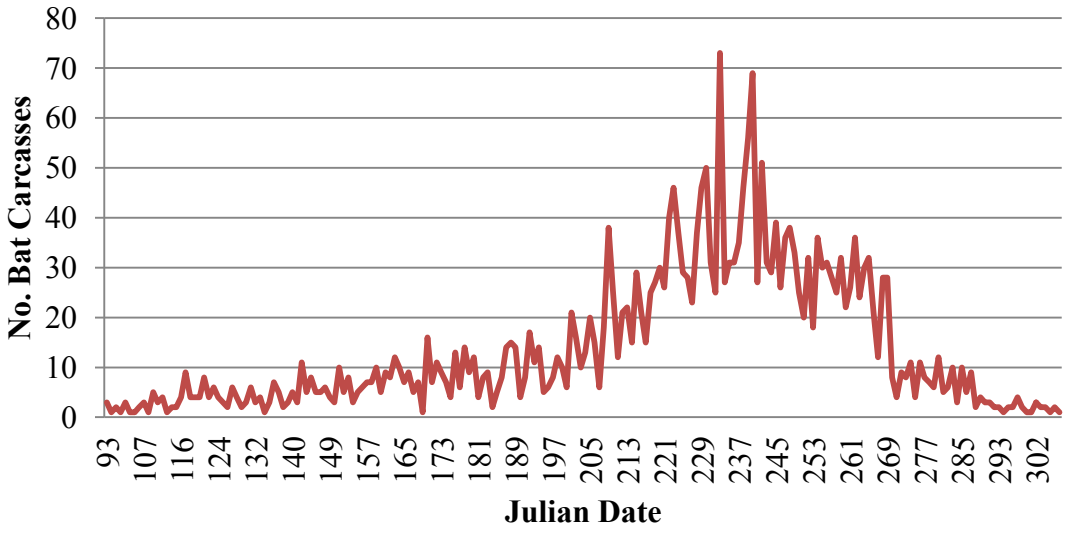

Figure 7. Patterns of bat mortality, by Julian date, for the bat carcasses found at the 12 wind sites that conducted post-construction mortality searches in Pennsylvania, 2007-2011.

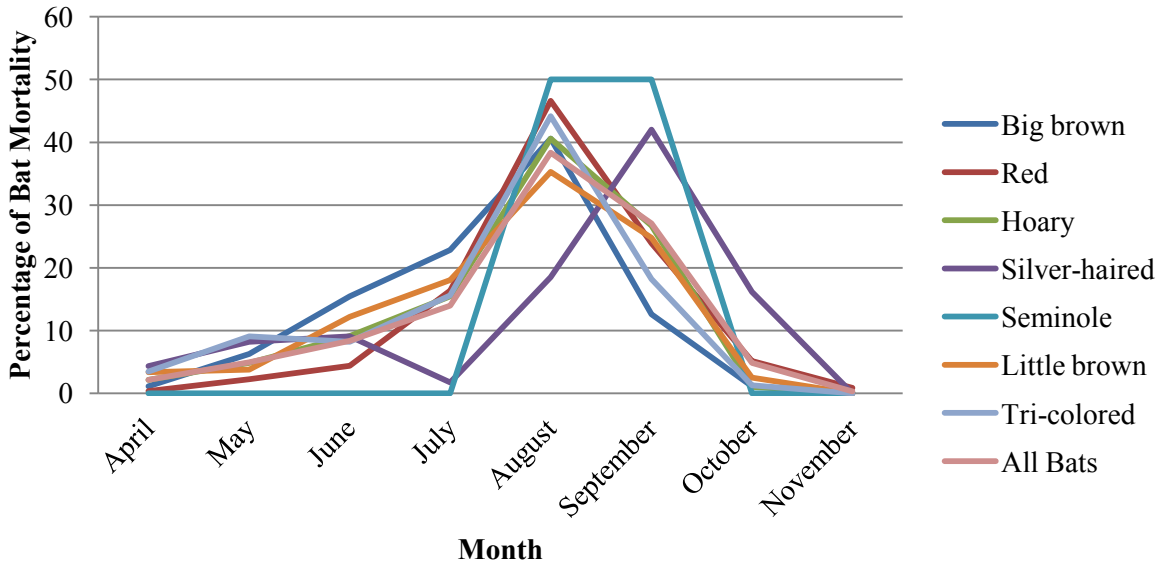

Figure 8. Distribution of bat mortality by species and month, 2007-2011.

Ninety-eight percent of all bat mortality occurred between May and October, whereas 79% mortality occurred between July and September (Table 10). There is some variation in peak mortality among species. Mortality peaks in early August for all bat species except the silver-haired bat, which peaks in September. The later peak in mortality of silver-haired bats are similar to other studies that demonstrate migration times of migratory tree bats (Dzal et al 2009,

McGuire et al 2012). Because Seminole bats represent a very small sample size, it is difficult to determine peak mortality for this species. However, all of the Seminole bat mortalities at Pennsylvania wind sites have occurred in August and September. These data suggest that minimization efforts focused between July 1 and September 30 would maximize the effectiveness of such efforts, thereby reducing the risk to all bat species.

Table 10. Percent of species composition by bi-weekly time period for bat carcasses documented during standardized searches at Pennsylvania wind facilities from 2007-2011.

	Percent (%) of Species Composition										
Bi-weekly Period	Big brown	Red	Hoary	Silver-haired	Seminole	Little brown	Northern long-eared	Indiana	Tri-colored	Unknown	Total
April 1 - April 14	0	0	1	1	0	0	0	0	0	4	0
April 15 - April 30	1	<1	2	4	0	3	0	0	3	0	1
May 1 - May 14	0	0	2	4	0	0	0	0	4	0	2
May 15 - My 31	6	2	3	4	0	3	0	0	5	0	3
June 1 - June 14	7	2	3	6	0	6	0	0	3	4	4
June 15 -June 30	9	3	6	3	0	6	0	0	5	9	5
July 1 - July 14	4	5	5	1	0	8	0	0	8	0	6
July 15 - July 31	18	11	10	1	0	10	0	0	7	0	9
August 1 - August 14	22	16	16	2	17	14	0	0	15	0	14
August 15 - August 31	18	30	24	16	33	22	0	0	30	22	25
September 1- September 14	6	12	17	19	33	15	100	0	12	30	15
September 15 - September 30	6	11	10	23	17	10	0	100	6	27	12
October 1 - October 14	1	4	1	14	0	2	0	0	1	0	4
October 15 - October 31	1	2	0	2	0	1	0	0	1	4	1
November 1 - November 14	0	1	0	0	0	0	0	0	0	0	0
November 15 - November 30	0	0	<1	0	0	0	0	0	0	0	0

Mortality trends are similar between migrating and cave bat species with 80% of all migratory bat and 78% of all cave bat mortality occurring between July 1 and September 30, peaking in August (Figures 7, 8, and 9). These results also support focusing minimization efforts on July 1 to September 30 to reduce the risk to all bat species. Less than 3% of the total bat mortality occurred in the months of April and November. April bat mortality occurred at all 12 sites that conducted mortality monitoring between 2007 and 2011. The following species were found during the April bat mortality surveys: hoary, silver-haired, red, tri-colored, big brown, and little brown. Of the 12 sites, seven documented cave bat mortality in April. Four of the seven sites that documented cave bat mortality in April were high risk and three low risk. No cave bats were documented during mortality monitoring in November, only hoary and red bats. 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 indicate the presence of a nearby hibernaculum. 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.

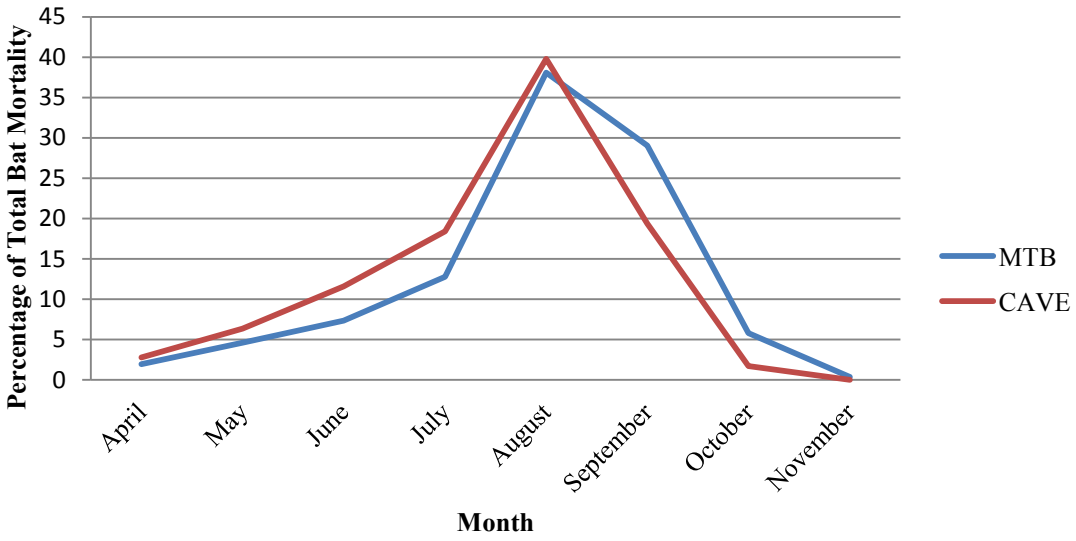

Figure 9. Distribution of bat mortality by month.

Because bat risk levels are determined by presence or absence of threatened and endangered species, the PGC recommends that the post-construction mortality monitoring survey period remain April 1 – November 15 for high risk sites. Of the cave bat mortality, which occurred during April, 78% occurred at high risk sites, which are designated as such due to the presence of hibernacula within five miles of the project. The data provides some evidence to show that bats entering or exiting hibernacula are at risk. 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 potential risks to birds.

Bird Mortality

An average of 4 birds/turbine/year died for 19 surveys that followed PGC protocol was (1 – 10). Bird mortality estimates varied by site and among years of monitoring (Table 11). Of the 11 sites that conducted more than one year of mortality monitoring, five sites experienced increased bird mortality during the second year of monitoring, two sites experienced decreases, and four sites went unchanged. However the changes in bird morality between years for each site were not statistically significant, except for site 2-4 ($X^2 = 5.14$, $p = 0.0233$). The reason for the increased bird mortality for the first year at site 2-4 is unknown as the landcover and topography is similar to other wind facilities in Pennsylvania.

Although raptor risk is determined by known raptor migration, features used by raptors are often similar to those used by other birds. A Freidman's test was used to compare bird mortality among raptor risk groups. Interestingly, there appears to be a weak correlation between raptor risk and estimated bird mortality ($Q = 5.1473$, $p = 0.0763$). A Wilcoxon test revealed that low and medium risk were similar ($S = 66.5$, $p = 0.4569$), medium and high risk were similar ($S =$

64.0, $p = 0.1961$), but low and high risk are different ($S = 79.0$, $p = 0.0083$). Although there is a weak association between the estimated bird mortality and raptor risk, the extent of bird mortality cannot be predicted using raptor risk.

Table 11. Bird mortality estimates for the 12 sites that conducted mortality searches in 2007-2011. Raptor risk, H = high, M= moderate, L=low; CI = confidence interval. Gray boxes indicate information that was not included in the annual report for that site.

Site Code	Raptor Risk	Year	PGC Protocol Followed?	Estimated Birds/Turbine / Year	95% CI Low	95% CI High	Estimated Birds/MW/Year
6-3	L	2007	Yes	2			1
6-3	L	2008	Yes	2			1
2-2	L	2008	Yes	2	1	4	2
2-2	L	2009	Yes	4	3	6	3
2-14	M	2008	No[a]	7	4[c]	10[c]	3
2-14	M	2009	Yes	5	3[c]	7[c]	2
2-10	M	2008	No[a]	1	0[c]	3[c]	1
2-10	M	2010	Yes	2	1	3	1
6-1	L	2009	Yes	2	1	3	1
6-1	L	2010	Yes	2	1	3	1
5-5	M	2009	No[b]	1	0	2	1
5-5	M	2010	Yes	1	0	2	1
2-4	M	2009	Yes	10	3	12	5
2-4	M	2010	Yes	3	1	4	1
24-3	H	2009	No[b]	3	1	5	1
24-3	H	2010	Yes	3	1	4	1
24-3	H	2011	Yes	3	1	4	1
35-1	L	2010	Yes	2	1	3	2
35-1	L	2011	Yes	3	2	4	2
24-1	H	2010	Yes	4	1	7	2
24-1	H	2011	Yes	7	3	12	3
2-19	H	2010	Yes	3	1	6	2
2-19	H	2011	Yes	5	1	8	3
6-16	H	2011	No[b]	5			2

[a] Operational issues at site; less than 10 turbines searched
[b] Various aspects of PGC protocols were not followed
[c] 90% confidence interval

A total of 409 bird carcasses were found during standardized searches at Pennsylvania wind sites during mortality monitoring between 2007 and 2011. Overall bird mortality was composed of mostly Passeriformes (73%), the remaining 27% were Galliformes (4%), Accipitriformes (3%),

Piciformes (2%), Cuculiformes (2%), Anseriformes (1%), Apodiformes (1%), Columbiformes (1%), Charadriiformes (1%), Gruiformes (<1%), Coraciformes (<1%), and 12% unknown birds (Appendix G). Overall the composition of bird Order remains consistent, with Passeriformes comprising the majority of bird carcasses documented each year (Table 12).

Table 12. Percent composition of bird carcasses found during daily searches at Pennsylvania wind sites during mortality surveys conducted in 2007-2011, by year (No. sites conducting mortality monitoring), and overall.

	Percent (%) of Total Bird Mortality					
Bird Order	2007 (1)	2008 (4)	2009 (6)	2010 (8)	2011 (5)	2007-11 (12)
Accipitriformes*	0	2	2	6	0	3
Anseriformes	0	0	2	0	0	1
Apodiformes	10	0	2	1	1	1
Charadriiformes	0	0	1	3	0	1
Columbiformes	0	2	2	1	0	1
Coraciiformes	0	0	0	0	1	0
Cuculiformes	0	4	3	1	0	2
Galliformes	0	2	4	5	6	4
Gruiformes	0	0	1	0	1	0
Passeriformes	80	70	72	66	81	73
Piciformes	0	3	1	3	2	2
Unknown	10	17	10	14	8	12

*sensu Chesser et al. 2010

Red-eyed vireos (*Vireo olivaceus*) were the most frequently documented passerine species as well as overall bird species (25%) observed as mortalities at Pennsylvania wind sites. Red-eyed vireos are considered common and abundant in Pennsylvania that can be attributed to its ability to successfully utilize a variety of habitats. Results from the Pennsylvania Breeding Bird Atlas (Brauning 1992) report red-eyed vireo observations in every county of Pennsylvania. Unlike other passerines such as the golden-crowned kinglet (*Regulus satrapa*) and magnolia warbler (*Setophaga magnolia*), red-eyed vireo mortality is not limited to migration periods. Red-eyed vireo mortality has been documented from May to October. The exact reason for the increased mortality of red-eyed vireos is not understood, however it could be attributed to overall species abundance in Pennsylvania, life history as a bird that inhabits the upper forest canopy, and breeding in the vicinity of wind turbines, which raises the risk throughout spring, summer, and fall. Golden-crowned kinglets, magnolia warblers, and ruby-crowned kinglets (*Regulus calendula*) were also documented in higher numbers compared to other passerines at Pennsylvania wind sites. Mortality of these species is limited to spring and fall migration periods of April to May and September to November. Overall the mortality of these species can most likely be attributed to wind sites being constructed on ridges historically used as migration pathways however it remains unknown why certain species appear to be more at risk than others are.

Bird taxonomic Order composition varied among sites and by year for each site (Table 13). The variation of composition appears dramatic for some sites; however the small sample size exaggerates this in general. For example, if one year a site had 25% Anseriformes and the second year had 0% Anseriformes, the 25% may account for one bird. Passeriformes were documented at all sites between 2007 and 2011. Passeriformes were found during all surveys except one site (2-10) in 2008. Site 2-10 documented only one bird mortality in 2008, which could not be identified to species due to the condition of the carcass.

Table 13. Composition of bird Orders found during standardized searches at Pennsylvania wind sites during mortality surveys conducted in 2007-2011, by site, and overall.

		Order											
Site Code	Year	Accipitriformes	Anseriformes	Apodiformes	Charadriiformes	Columbiformes	Coraciiformes	Cuculiformes	Galliformes	Gruiformes	Passeriformes	Piciformes	Unknown
6-3	2007	0	0	10	0	0	0	0	0	0	80	0	10
6-3	2008	6	0	0	0	6	0	0	0	0	82	0	6
2-2	2008	0	0	0	0	0	0	6	0	0	57	6	31
2-2	2009	0	0	7	3	3	0	0	0	0	76	0	11
2-14	2008	0	0	0	0	0	0	8	8	0	76	0	8
2-14	2009	0	0	4	0	0	0	4	7	4	70	0	11
2-10	2008	0	0	0	0	0	0	0	0	0	0	0	100
2-10	2010	0	0	0	17	0	0	0	8	0	42	0	33
2-4	2009	0	6	0	0	4	0	4	2	0	76	0	8
2-4	2010	0	0	8	0	0	0	0	8	0	84	0	0
5-5	2009	0	0	0	0	0	0	0	33	0	33	17	17
5-5	2010	25	0	0	0	0	0	0	0	0	50	25	0
24-3	2009	30	0	0	0	0	0	0	0	0	50	0	20
24-3	2010	17	0	0	0	0	0	8	8	0	59	0	8
24-3	2011	0	0	0	0	0	0	0	18	6	53	0	23
6-1	2009	0	0	0	0	0	0	7	0	0	80	0	13
6-1	2010	0	0	0	0	9	0	0	0	0	91	0	0
35-1	2010	14	0	0	5	0	0	0	9	0	48	5	19
35-1	2011	0	0	4	0	0	4	0	0	0	85	7	0
24-1	2010	0	0	0	0	0	0	0	0	0	91	9	0
24-1	2011	0	0	0	0	0	0	0	8	0	84	0	8
2-19	2010	4	0	0	0	0	0	0	0	0	68	0	28
2-19	2011	0	0	0	0	0	0	0	3	0	88	0	9
6-16	2011	0	0	0	0	0	0	0	0	0	100	0	0
	Overall	3	1	1	1	1	<1	2	4	<1	73	2	12

Between 2007 and 2011, five of the 12 sites conducting mortality monitoring documented raptor mortality. Eleven raptor mortalities have been documented; one broad-winged hawk, seven red-tailed hawks, and three turkey vultures. Of the five sites that documented raptor mortality, two were high risk, one moderate risk, and two low risk. The raptor fatalities were documented in March, April, May, July, October, and November. An additional 13 raptor casualties were found incidentally, consisting of one American kestrel, two broad-winged hawks, one Cooper's hawk, seven red-tailed hawks, and two unknown hawks. Incidental raptor fatalities were documented in March, April, May, July, September, and November. There does not appear to be any relationship between PGC raptor risk and raptor mortality (r (3) = 0.30, $p > 0.05$) as several low risk sites documented mortality while some high risk sites did not.

Forty-eight percent of bird mortality was between June and September and 86% of mortality occurred between May and October (Table 14). Bird mortality is spread throughout the survey season (Figure 10); however there was a significant statistical difference in bird mortality between each month (X^2=235, p = < 0.01). May and September are peaks in the bird mortality, corresponding to migration periods. However, September's mortality is significantly higher than mortality documented in May (X^2 = 12, p = < 0.01).

Table 14. Bird mortality by month found during standardized searches at 12 Pennsylvania wind sites conducted 2007-2011.

Month	Percentage of Bird Mortality
March	<1
April	10
May	16
June	5
July	7
August	8
September	28
October	22
November	4
December	0

There was little to no bird mortality in March and December, however bird mortality was documented in April (10%) and November (4%). Surveys have been requested at high risk raptor sites in March and December in an attempt to document all bird mortality that may be occurring during raptor migration, particularly eagles to correspond to concurrent raptor migration surveys. However, no eagle mortality was documented at any Pennsylvania wind site, and only one raptor mortality has been found during March and November. Additionally weather conditions at wind sites during these months are harsh, often resulting in several missed search days. Based on data collected over the past five years, extended mortality monitoring in March and December is not warranted due to the absence of carcasses, weather conditions, and safety issues.

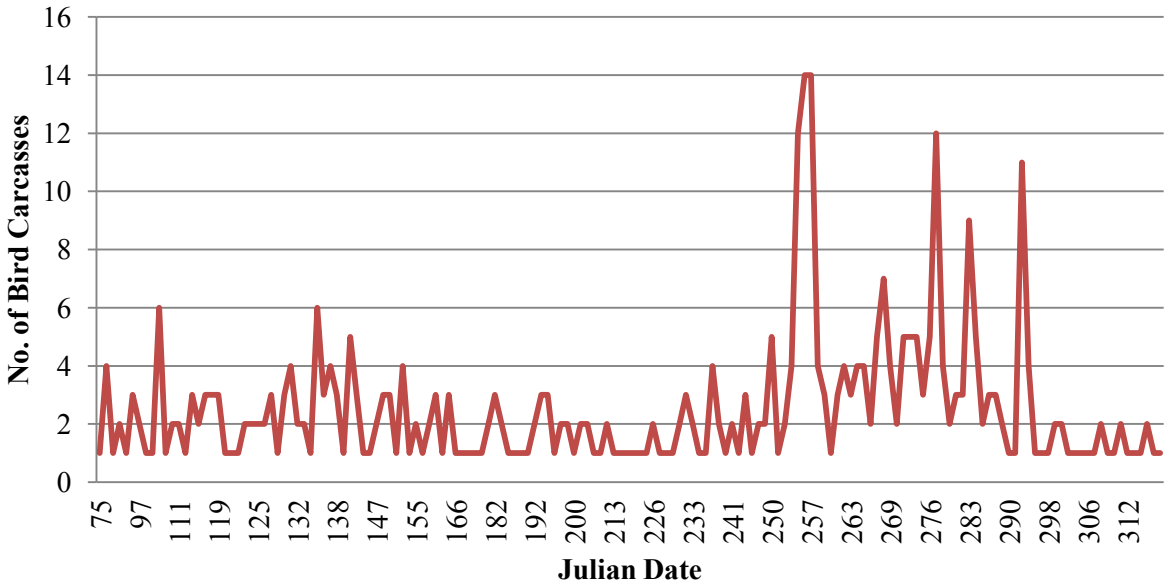

Figure 10. Bird mortality, by Julian date, at 12 wind sites that conducted post-construction mortality searches in Pennsylvania, 2007-2011.

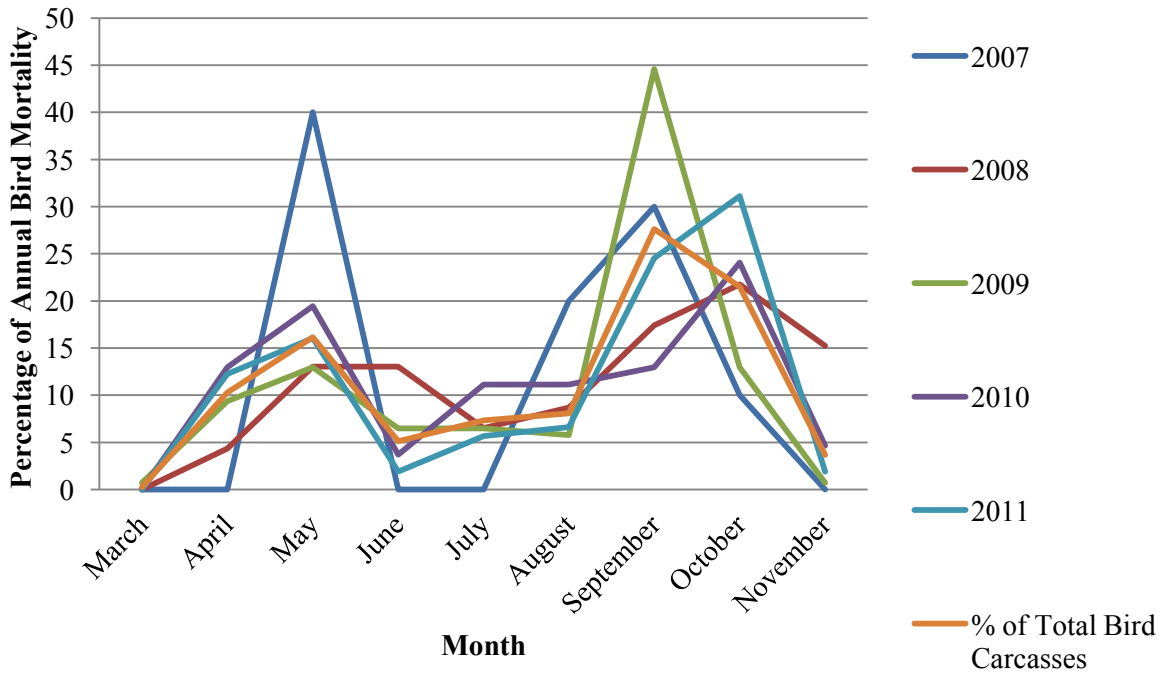

Figure 11. Bird mortality by month, by year, and overall, 2007-2011.

Mortality in Relation to Turbine

Ninety-six percent of detected bat carcasses found during standardized searches occurred within 50 meters of the closest turbine and 85% of the bird carcasses occurred within 50 meters. Eighty-seven percent of bat fatalities fell within 40 meters of the closest turbine and 71% of bird fatalities were found within 40 meters (Figure 12). Current PGC protocols require a 120m x 120m search plot centered on the turbine. This size search plot provides for complete coverage of 60 meters around the turbine, with greater distance at the corners of the search plot. Rarely is the entire 120m x 120m search plot considered searchable due to steep terrain, water sources, and thick vegetation. Based on the data collected since 2007, the PGC recommends that the search plot remain 120m x 120m to ensure that the majority of bird and bat carcasses are available to be located.

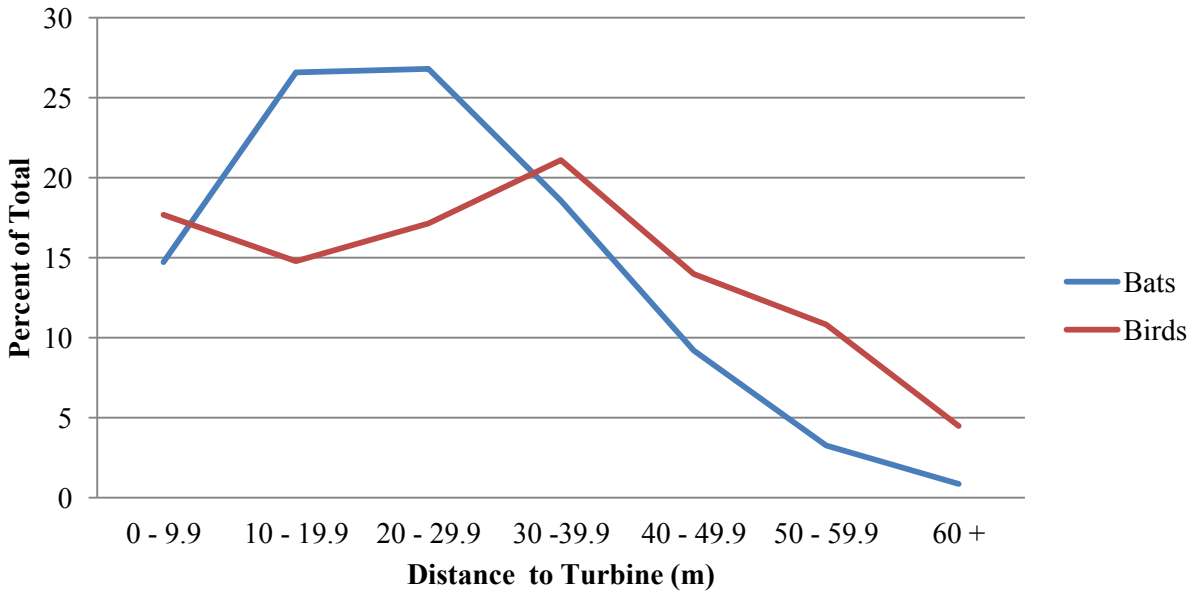

Figure 12. Distance from turbines of bird and bat carcasses found during standardized searches at the 12 Pennsylvania wind sites that conducted mortality monitoring from 2007-2011.

Bird carcass distribution in all four quadrants surrounding the turbines was statistically equal (X^2 = 6.65, $p > 0.05$) (Figure 13). Distribution of bat carcasses appear slightly skewed to the east of the turbines (X^2 = 54.71, $p < 0.01$). This is most likely attributed to a predominately western aspect of the prevailing winds. There was no statistical difference between the number of bat carcasses found north or south of the turbine, however there was a statistical difference between the number of bats found in the northeast compared to the southeast (X^2 = 7.78, p = <. 001). Although more carcasses were found in the northeast quadrant of the search plot, the difference only amounted to 3% of all of the carcasses found. Because bird mortalities are occurring equally in all directions surrounding the turbine, and the increased bat mortality in the northeast quadrant of the search plot accounts for such a low percentage of the total bat mortality, these data do not support shifting the search plot off of the turbine or searching only certain quadrants of the search plot.

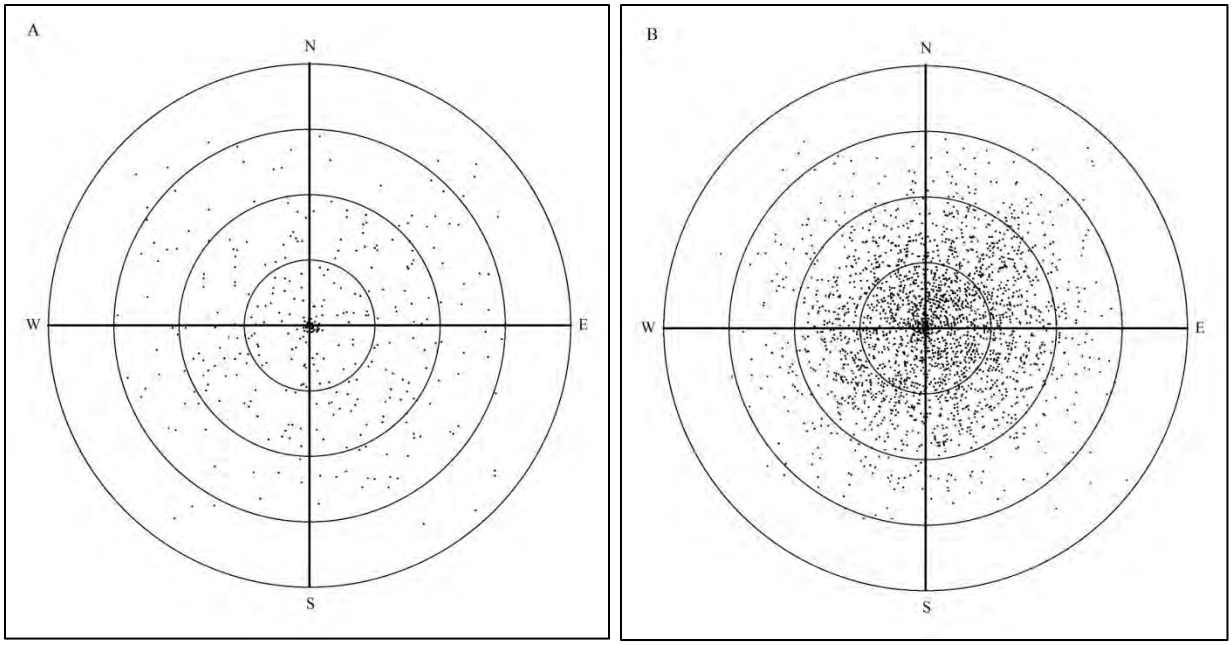

Figure 13. Spatial distribution of bird (A) and bat (B) carcasses found during standard searches in 2007-2011 at the 12 Pennsylvania wind sites. Concentric circles are at 20 meter intervals from turbine center.

Searcher Efficiency

Searcher efficiency trials were conducted at all 12 sites. Carcasses of birds and bats were placed in random locations throughout the search area in 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 rates varied among sites, years, and visibility classes, and also between bat and bird carcasses (Table 15 & 16).

Overall, searcher efficiency rates were slightly higher for birds than for bats (Table 15). Searcher efficiency rates for bats averaged 32% (range 15 - 70%) for 11 sites that reported searcher efficiency; while for birds it averaged 39% (range 15 – 70%) for 12 sites that reported searcher efficiency rates. The increased searcher efficiency rate for birds could be attributed to the overall larger size of birds compared to bats and brighter coloration making for easier observation.

Searcher efficiency rates varied among sites (Table 15). This variation is not likely attributed to searcher differences. There was also variation in searcher efficiency for the same searcher among years for each site. This is most likely attributed to the ability of the individual searcher to locate carcasses. The range of individual searcher efficiency is not always provided to the PGC. The searcher efficiency range for individuals varied greatly among all consultants.

Table 15. Searcher efficiency rates (percent) for bats and birds and range of average searcher efficiency of searchers at 12 Pennsylvania wind sites during standardized surveys conducted in 2007-2011. Grey boxes indicate no data provided to the PGC.

		Bats		Birds	
Site Code	Year	SE % Average (1-day)	Range of SE by Searcher	SE % Average (1-day)	Range of SE by Searcher
6-3	2007	25		23	
6-3	2008	31		64	
2-2	2008			52	
2-2	2009			46	
2-14	2008	17	27-50	23	35-100
2-14	2009	24	10-50	30	0-78
2-10	2008	17	11-50	23	18-100
2-10	2010	38	33-50	40	34-50
2-4	2009	47		53	
2-4	2010	35		27	
5-5	2009	30		48	
5-5	2010	30		44	
24-3	2009	15		15	
24-3	2010	33		59	
24-3	2011	27		27	
6-1	2009	46		45	
6-1	2010	70		70	
35-1	2010	20	20-20	42	24-55
25-1	2011	24	20-28	36	21-46
24-1	2010	28		28	
24-1	2011	30		18	
2-19	2010	41		35	
2-19	2011	26		30	
6-16	2011	29	6-100	70	0-100

Searcher efficiency also varied among visibility classes (Table 16). Searcher efficiency trials were to test the searchers ability to locate carcasses in all visibility classes. As expected, searcher efficiency was generally highest for visibility class I. Again there was also variation in searcher efficiency for visibility classes between the first and second year of a site. There also appears to be a slight difference in searcher efficiency between birds and bats in each visibility class.

Table 16. Searcher efficiency (SE) rates for bats and birds by visibility (vis.) class at 12 Pennsylvania wind sites during standardized surveys conducted in 2007-2011. Grey boxes indicate no data provided to the PGC.

		Bat SE				Bird SE			
Site Code	Year	Vis. Class 1	Vis. Class 2	Vis. Class 3	Vis. Class 4	Vis. Class 1	Vis. Class 2	Vis. Class 3	Vis. Class 4
6-3	2007	30			11	22			29
6-3	2008	35			6	64			64
2-2	2008								
2-2	2009								
2-14[a]	2008	100	35	35	0	100	35	35	0
2-14[a]	2009	34	18	20	13	34	18	20	13
2-10	2008	50	19	11	0	50	18	31	0
2-10	2010	48	30	29	57	47	52	29	21
2-4	2009	71	41	24		89	64	20	
2-4	2010	74	25	1		77	21	0	
5-5	2009								
5-5	2010	59	40	11	10	87	52	20	0
24-3	2009								
24-3	2010	62	42	11	32	50	80	71	25
24-3	2011	61	36	14	0	100	13	33	13
6-1	2009								
6-1	2010								
35-1	2010	33	31	7	0	65	38	10	13
35-1	2011	48	21	14	4	70	17	25	17
24-1	2010	63	28	10	2	63	36	0	14
24-1	2011	81	35	10	0	50	0	0	0
2-19[a]	2010	83	55	20	4	83	55	20	4
2-19[a]	2011	64	31	9	2	64	31	9	2
6-16	2011								

[a] Sites 2-14 and 2-19 provided combined bird and bat searcher efficiency rates for each visibility class, which are shown in Table 16.

It appears there are several factors that influence searcher efficiency rates. The habitat at each turbine (i.e. proportions of each visibility class) can impact overall searcher efficiency. For example, a site that is predominately Visibility Class 4 would be expected to have a lower searcher efficiency rate than a site that is predominately Visibility Class 1. This may explain the decrease in a site's searcher efficiency rates from the first to second year, as vegetation regenerates and visibility decreases. It appears that individual searcher efficiency is the most influential factor in searcher efficiency rates. Ensuring search personnel are well trained and experienced is the most effective method to obtaining quality searcher efficiency rates for more accurate mortality estimates.

With few exceptions, all carcasses must be validated by the PGC before being used in searcher efficiency trials, and only carcasses in fair or excellent condition are returned by the PGC for use in trials. In order for this verification to occur, all carcasses are frozen. This precludes the ability of the PGC to determine trends regarding fresh versus frozen carcasses and quality of the carcass that may be influencing the searcher efficiency. However, it is imperative that the identification of carcasses are correct thus the PGC does not allow for carcasses to be used for searcher efficiency and/or carcass removal trials until they are validated by the PGC.

Carcass Removal

Carcass removal trials were conducted at all sites to monitor for removal by scavengers. Carcasses were placed in random locations throughout the search area in all vegetation classes, but were not blind to the searchers. Carcasses were left in place for a minimum of 14 days and monitored for scavenger removal. Because the carcasses were monitored for a minimum of 14 days, the data is right censored which was compensated for by estimating the mean time to removal using a maximum likelihood estimator.

Carcass removal at all sites for bat carcasses averaged 12 days (4 - 34) and 13 days (4 – 48) for bird carcasses (Table 17). Average time for scavenger removal at those sites that followed protocol was 14 days for bat carcasses (6 – 34) and 13 days for bird carcasses (5 – 25). A list of previously identified scavenger species can be found in the 2nd summary report (Librandi Mumma and Capouillez 2011).

Seven of the 12 sites that conducted scavenger removal trials documented carcasses persisting longer the second year of monitoring compared to the first. Four sites experienced shorter persistence times the second year of monitoring. One site has not yet completed a second year of monitoring so no comparison can be made. It is unclear why some sites have higher scavenger rates than others. Carcass removal can be influenced by over seeding trial carcasses. Smallwood et al. 2010 noted that placing too many trial carcasses near wind turbines, which already supply scavengers with carcasses, may cause scavengers to be unable to remove the trail carcasses. This oversaturation results in inflated carcass removal times. Carcass removal times are most likely influenced by relative populations of scavengers around these wind sites.

With few exceptions, all carcasses must be validated by the PGC before being used in carcass removal trials, and only carcasses in fair or excellent condition are returned by the PGC for use in trials. This precludes the ability to determine trends regarding fresh versus frozen carcasses and quality of the carcass that may be influencing scavenger removal.

The PGC has been asked by Cooperators if the frequency of mortality monitoring can be reduced to less than daily searches based on site specific carcass removal rates. The carcass removal rates reported (Table 17) are averaged for the entire mortality monitoring season however scavenger removal rates throughout the entire monitoring period are not consistent. Data from sites that reported carcass removal by season revealed no trends; increased carcass removal occurred randomly throughout the monitoring year. Additionally, of the 12 sites that have conducted post-construction mortality monitoring and carcass removal trials, all have documented some amount of carcasses removed during the first night of a trial. The majority of the carcass removal trials completed in Pennsylvania were placed in groups, meaning batches of

carcasses are placed at one time, with several batches being placed throughout the monitoring season. The PGC attempted to minimize oversaturation by limiting the number of carcasses allowed to no more than 20 trial carcasses placed throughout the site during one time. However, Smallwood et al (2010) demonstrated that by using less than 10 trial carcasses on the site at one time, oversaturation was reduced and carcass removal rates increased. These results could imply that the PGC may need to reduce the maximum number of carcasses placed at any given time in the future. Although the PGC validates all carcasses before use in trials with few exceptions, research conducted by Arnett (2005) found that fresh carcasses were removed almost twice as fast as frozen carcasses at one study site. Hence, wind sites using frozen carcasses for trials may be documenting longer carcass removal rates than is actually occurring with turbine mortality carcasses. This idea further supports the PGC's belief that search frequency intervals should not be increased solely on the average carcass removal averages.

Table 17. Average scavenger removal rates for bats and birds at 12 Pennsylvania wind sites conducted in 2007-2011.

Site Code	Year	PGC protocols followed?	Bat SR average (days)	Bird SR average (days)
6-3	2007	Yes	10	10
6-3	2008	Yes	13	13
2-2	2008	Yes	32	13
2-2	2009	Yes	23	5
2-14	2008	No[a]	5	5
2-14	2009	Yes	9	17
2-10	2008	No[a]	4	4
2-10	2010	Yes	8	6
6-1	2009	Yes	10	14
6-1	2010	Yes	6	6
5-5	2009	No[b]	9	13
5-5	2010	Yes	15	16
2-4	2009	Yes	11	11
2-4	2010	Yes	34	25
24-3	2009	No[b]	4	4
24-3	2010	Yes	10	7
24-3	2011	Yes	13	14
35-1	2010	Yes	9	9
35-1	2011	Yes	7	8
24-1	2010	Yes	10	10
24-1	2011	Yes	10	13
2-19	2010	Yes	23	25
2-19	2011	Yes	11	16
6-16	2011	No[b]	6	48

[a] operational issues at site; less than 10 turbines searched
[b] various aspects of PGC protocols were not followed

Incidental Mortality

Incidentals are defined as carcasses found outside scheduled search times and/or designated search plots during. An incidental can be reported by anyone including maintenance personnel at any turbine on the site, not just in the vicinity of a searched turbine. The species and percentages of the birds and bats found during scheduled searches versus incidental finds are similar (Tables 18 and 19), suggesting that the searched turbines are an accurate representation of the wind site. However, there were slightly more tri-colored and little brown bats found as incidentals than during standard searches. This is most likely attributed to one site (6-1) which searched additional turbines for carcasses for use in searcher efficiency and carcass removal trials. The seasonal distribution of incidental bat mortality follows a similar pattern to that of standardized searches with a large majority of bat mortality between July 1 and September 30 (84%). The peak of bat mortality in August, accounting for 45% of the total incidental bat mortality. While incidental trends appear similar to trends identified via standardized searches, these trends should be interpreted with caution as incidental carcasses are not collected via standardized protocols.

Table 18. Composition of bat carcasses identified through standard searches and found incidentally from 2007-2011.

Bat Species	Standard Searches	Incidental Finds
Hoary	31%	32%
Eastern Red	28%	25%
Silver-haired	16%	13%
Tri-colored	8%	12%
Little Brown	8%	11%
Big Brown	6%	5%
Unknown	1%	1%
Northern long-eared	<1%	0%
Seminole	<1%	<1%

Fifty-six different bird species have been found as incidental mortalities between 2007 and 2011. Overall, birds of unknown species were the most frequently found (24%) followed by red-eyed vireo (11%), blackpoll warbler (7%), ovenbird (6%), and rose-breasted grosbeak (6%). The species composition is biased to one location due to a large mortality event in which 73% of all incidental bird carcasses were found. Excluding the large mortality event, 39 bird species were found as incidental mortalities with the most frequently observed species being red-eyed vireo (14%), Unknown (14%), rose-breasted grosbeak (12%), and red-tailed hawk (7%). The red-tailed hawks are large and relatively easy to see, making their incidental mortalities more likely to be found by maintenance workers outside of the search areas and times compared smaller birds.

Incidental mortality was documented during all months of mortality monitoring, from March through November. Excluding data from the large mortality event, incidental bird mortality is the highest in May (18% of total incidental mortality) and September (19% of total incidental mortality), which corresponds to the spring and fall migration periods, while August had the least accounting for 6% of the total incidental bird mortality. Species diversity among incidental

mortality varied throughout the months with the greatest diversity documented during the month of May (16 species) and March and November documented the least (5 species each).

Table 19. Composition of bird mortality identified through standard searches versus incidentals, those found outside standard search areas and times from 2007-2011.

Bird Order	Standard Searches	Incidental Finds
Passeriformes	73%	65%
Unknown	12%	24%
Galliformes	4%	4%
Accipitriformes*	3%	3%
Cuculiformes	2%	2%
Piciformes	2%	0%
Apodiformes	1%	1%
Columbiformes	1%	<1%
Anseriformes	1%	<1%
Charadriiformes	1%	<1%
Gruiformes	<1%	<1%

*sensu Chesser et al. 2010

Post-construction Raptor Migration Survey

One goal of the Wind Energy Voluntary Cooperative Agreement is to determine if any post-construction raptor migration observations can be correlated with mortality. Post-construction raptor surveys were completed at eight wind sites between 2007 and 2011. There were five spring raptor surveys and eight fall raptor surveys completed (Appendix H). Species composition observed varied by site and season.

The presence of turbines does not appear to influence the overall number of raptors using the ridge or the species composition. Two of the eight sites that conducted post-construction raptor surveys also completed pre-construction raptor surveys (6-16 and 2-4). Site 6-16 observed less raptors overall during post-construction surveys compared to pre-construction surveys for both spring and fall. Species composition for site 6-16 was similar between pre and post-construction with turkey vultures being the most prevalent species during spring surveys followed by black vultures (*Coragyps atratus*) and red-tailed hawks; during the fall surveys turkey vultures were again the most prevalent species followed by black vultures, then bald eagles. Site 2-4 also documented similar species composition during both pre and post-construction surveys with turkey vultures and red-tailed hawks being the most prevalent during spring surveys and turkey vultures, red-tailed hawks, and broad-winged hawks being the most prevalent during fall surveys. Site 2-4 documented similar overall raptor numbers between pre and post-construction surveys.

Three high raptor risk wind sites found raptor mortality during standardized mortality monitoring while conducting concurrent post-construction raptor surveys. One site (24-1) documented one turkey vulture fatality during spring raptor surveys. Two sites documented raptor mortality during fall raptor surveys; site 24-3 found two red-tailed hawks during standard mortality

monitoring and site 2-19 found one turkey vulture. Interestingly, the raptor species being killed are not the most frequently observed species at each at these sites. Site 24-1 documented one turkey vulture during spring raptor monitoring; the most prevalent species observed was red-tailed hawk.

Pre- and post-construction raptor migration survey results have similar implications. First, the PGC assigned raptor risk levels were not good indicators of the overall number of raptors observed during migration surveys. For example, high raptor risk site 24-1 observed the least number of migrating raptors during spring surveys. On the other hand, moderate raptor risk site 2-14 observed more raptors than several high raptor risk sites during fall surveys. Also similar to pre-construction surveys, post-construction survey results cannon be correlated with raptor fatality (r (8) = 0.24, p = 0.50). Site 24-1, which observed the fewest raptors during spring surveys, documented raptor mortality. Conversely, site 6-16 observed high numbers of raptors, yet did not document any raptor mortality.

Post-construction Bat Acoustic Surveys

Another goal of the WEVCA is to determine if post-construction bat acoustic data can be correlated with mortality. A total of six post-construction bat acoustic surveys have been performed at Pennsylvania wind sites between 2007 and 2011. Results of the five post-construction bat acoustic surveys between 2007 and 2009 are summarized in the 2nd summary report (Librandi Mumma and Capouillez 2011).

Of the six post-construction bat acoustic surveys performed between 2007 and 2011, two surveys had issues with turbines not operating during the survey, one survey had issues with acoustic detectors not operating, and two surveys did not survey the entire April 1 to November 15 season. Additionally, detectors were not all placed in the rotor swept zone or at the same height, making comparisons between sites and mortality data challenging.

In 2010 one moderate bat risk site (5-5) conducted post-construction bat acoustics following PGC protocols. This site was grandfathered into the Cooperative Agreement and thus was not obligated to perform pre-construction bat acoustic surveys. Therefore, no comparison of bat activity could be performed between pre and post-construction surveys. Because the exact time of bat mortality is not known, and relative "freshness" of a carcass is subjective, it is difficult to determine if any correlation exists between bat activity and mortality for each night. A Pearson product-moment correlation coefficient was computed to assess the relationship between biweekly bat activity observed and biweekly bat mortality for the site. There was a positive correlation between bat mortality and bat activity at this site (r = 0.83, n = 15, p = <0.01), so as overall bat activity increased so did bat mortality. A correlation between bat activity and mortality by species was precluded because of a lack of species specific acoustic data. These results should be taken with caution since the bat activity at this site was monitored at 10 meters, well below the rotor swept zone where bat mortality occurs. However, these results are similar to sites that did monitor bat activity closer to the rotor swept zone by having increased bat activity during July, August, and September, which corresponds to when the majority of bat mortality occurs throughout the state. The results from this site support targeting minimization efforts between July 1 and September 30 to maximize the effectiveness.

Post-construction Radar Surveys

Two post-construction radar surveys have been performed at Pennsylvania wind sites between 2007 and 2011 and are summarized in the 2nd summary report (Librandi Mumma and Capouillez 2011). The Cooperative Agreement does not currently request radar surveys and no additional radar surveys have been performed in Pennsylvania.

Post-construction Woodrat Surveys

A multi-year woodrat study is being conducted at one Pennsylvania site by a Cooperator to determine the potential effects of disturbing habitat in proximity to an active population area. This site conducted pre-construction surveys to obtain baseline data and will be conducting several years of post-construction surveys. The post-construction studies commenced in 2012 and will include trapping, telemetry, food availability, and predator presence. The purpose of this study is to compare the pre- and post-construction results to identify whether wind turbine construction and/or operation has any impacts on Allegheny woodrats.

Threatened and/or Endangered Species Mortality: Birds

Five sites documented a total of 31 state endangered bird mortalities between 2007 and 2011, including: three state endangered bird mortalities in 2009 (two blackpoll warblers and one yellow-bellied flycatcher), three in 2010 (three blackpoll warblers), and 25 in 2011 (24 blackpoll warblers and one yellow-bellied flycatcher). Four of the 31 state endangered bird mortalities were documented during scheduled searches and 27 were incidentals, of which 24 were at the large mortality event (see *Large Mortality Events* section). All 31 of the state endangered bird mortalities 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 of the blackpoll warbler fatalities occurred in September and October, with the two yellow-bellied flycatcher fatalities found in August and September.

All five sites that documented state endangered bird mortality are currently working with the PGC on mitigation. Upon notification of an endangered bird mortality the site is required to provide an incident report that includes the species of the mortality, weather patterns during the night prior to discovery, any special or critical habitat in the area of the project, and documentation of Best Management Practices were implemented prior to the mortality. The PGC does not currently have a standard mitigation method, however most sites opt for compensatory mitigation for the protection of the state endangered species and their habitat.

Threatened and/or Endangered Species Mortality: Bats

In 2011, one state and federally endangered Indiana bat was documented at Duke Energy's North Allegheny wind facility. A juvenile female bat was found by searchers on September 26, 2011. Upon species confirmation by the PGC and USFWS, North Allegheny wind site curtailed all night time operation of the turbines until November 15, 2011. No bat mortality was reported while night time curtailment was implemented. Because Indiana bats are federally listed species, the PGC defers to USFWS. Duke Energy is currently in consultation with the USFWS and is developing a Habitat Conservation Plan as part of the process of obtaining incidental take coverage.

Due to the Cooperative Agreement and particularly the Cooperators' effort to avoid and minimize potential impacts, the PGC has not filed any formal actions against any Cooperators for any of the endangered bird or bat mortalities and are working with the Cooperators to mitigate for these fatalities.

The PGC has been petitioned to list little brown, tri-colored, and northern long-eared bats in Pennsylvania. The PGC requested public comments regarding the potential listing of these species via the PA Bulletin. Based on comments received, the PGC decided on October 4, 2012 not to pursue listing of these species at this time, as it was determined that additional research is needed. While Pennsylvania is not currently pursuing the listing of these three species, the USFWS is undertaking a species review to determine if the eastern small-footed, little brown, and northern long-eared bats warrant protection under the Endangered Species Act. In regards to mortality of the above bat species at Pennsylvania wind energy facilities, no eastern small-footed bat mortality has been documented, 8 of the 12 sites currently operating have documented tri-colored bat mortality, one site has documented northern long-eared bat mortality, and all sites have documented little brown bat mortality. In the event that these species are added as state or federally listed species, further coordination with the PGC and USFWS will be required to determine methods to further minimize mortality to these species.

Large Mortality Events

There was one large mortality event in October 2011. It was the only large mortality event documented between 2007 and 2011. On October 7, 2011 the PGC was notified of a possible large mortality event at one wind site. This site had already completed two years of monitoring and was not conducting mortality monitoring in 2011. The PGC visited the site on October 7th and 11th and collected 258 bird and 2 bat carcasses. The PGC investigated the incident and concluded the event was caused by lighting conditions at or near the turbine in combination with a low cloud ceiling during peak bird migration. This conclusion was based on the mortality occurring only at the turbine nearest to the lighted substation, as well as no other large mortality events observed at any other wind facilities in the vicinity. At the time of the mortality event, this particular site was not following the PGC's endorsed Best Management Practices pertaining to lighting;

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

The lighting at a nearby substation was lit with photovoltaic sodium vapor lights instead of being on a switch or using motion or heat sensor lighting. Bird mortality caused by weather and lighting is well documented. Mannville (2000) noted that low cloud ceilings can cause migrating birds to fly at lower altitudes increasing the chance of collision with large structures. Additionally, Gehring et al (2009) found that birds can become disoriented by steady burning light refraction causing the birds to circle closer and closer to the light. Another large bird mortality caused by all night lighting at a substation and inclement weather conditions was documented during the same time of year at a facility in West Virginia (Steelhammer 2011).

However, unlike the mortality event in Pennsylvania, the bird deaths in West Virginia were believed to be caused by exhaustion and collisions with the substation as opposed to the turbines. The PGC concluded that the large mortality event that occurred in Pennsylvania could have been greatly reduced, if not prevented, if the above Best Management Practices pertaining to lighting had been fully implemented. The Cooperator is working with the PGC to mitigate for the mortalities as well as ensure the BMP's are implemented to prevent further mortality.

The bird species documented at the large mortality event are: 18% Unknown, 9% blackpoll warbler, red-eyed vireo, and ovenbird (*Seiurus aurocapilla*), 8% rose-breasted grosbeak, 7% gray catbird (*Dumetella carolinensis*), Swainson's thrush (*Catharus ustulatus)*, and unknown thrush, 4% wood thrush (*Hylocichla mustelina*), 3% unknown warbler and yellow-billed cuckoo (*Coccyzus americanus*), 2% gray-cheeked thrush (*Catharus minimus*), magnolia warbler, and common yellowthroat (*Geothlypis trichas*), 1% bay-breasted warbler (*Setophaga castanea*), black-throated blue warbler (*Setophaga caerulescens*), Tennessee warbler (*Oreothlypis peregrina*), black-throated green warbler (Setophaga virens), chestnut-sided warbler (*Setophaga pensylvanica*), indigo bunting (*Passerina cyanea*), and mourning warbler (*Geothlypis philadelphia*), <1% Cape May warbler (*Setophaga tigrina*), common moorhen (*Gallinula chloropus*), house wren (*Triglodytes aedon*), northern parula (*Setophaga americana*), Philadelphia vireo (*Vireo philadelphicus*), scarlet tanager (*Piranga olivacea*), unknown duck, and Wilson's warbler (*Cardellina pusilla*).

The large percentage of unknown carcasses was due to the poor condition of the carcass upon collection. Because this site was not conducting mortality monitoring no special use permit was issued granting this Cooperator permission to collect the carcasses. The PGC was notified of the large mortality event on a Friday before a long holiday weekend. Not all of the carcasses were collected before the weekend, and due to construction surrounding the substation, many carcasses were crushed by vehicle traffic over the long weekend.

The bat species documented include one little brown and one red bat. Bats do not appear to be impacted as significantly as birds by lighting and inclement weather conditions. This could be because bats rely on echolocation more than vision for navigation, which would eliminate the lighting effects on the bats. Additionally, bats are generally not as active in poor weather. Voigt et al (2011) noted that bats use more energy when flying in rainy conditions.

CORRELATION BETWEEN PRE-CONSTRUCTION BREEDING BIRD SURVEYS AND POST-CONSTRUCTION MORTALITY

The PGC does not have sufficient data at this time to determine any relationship between pre-construction breeding bird surveys and breeding bird mortality. For the 12 sites that the PGC has mortality data on, ten sites were grandfathered into the Cooperative Agreement and thus did not conduct breeding bird surveys, and two sites conducted breeding bird surveys but did not adhere to the PGC's protocols. The common issues with the breeding bird surveys included surveying during different times and following different methods, resulting in data that cannot be correlated with mortality. One site that conducted pre-construction breeding bird surveys documented a state endangered species (migrant not breeding), but did not document any mortality of this species. The second site, which conducted pre-construction breeding bird

surveys, documented a state endangered species (migrant not breeding) and documented this species during mortality monitoring. A habitat survey was conducted at this site for the endangered bird species in question and it was determined that because of a lack of suitable breeding habitat and the time of year when the mortality occurred, the bird was a migrant. Two sites conducted post-construction breeding bird surveys in 2012, which will allow comparison to pre-construction breeding bird surveys to determine any effects of the turbines on breeding birds.

CAN MORTALITY BE PREDICTED?

The PGC does not yet have enough pre- and post-construction data to develop a mortality prediction model to estimate the extent of bird or bat mortality. Most of the sites in operation were grandfathered into the Cooperative Agreement and not required to conduct pre-construction monitoring. Of the few sites that are operational and did conduct pre-construction monitoring, deviations from standardized PGC protocols make comparisons nearly impossible.

Raptors

Between 2007 and 2011 a total of 24 raptors were found during mortality monitoring, 11 during standardized searches and 13 as incidentals. Of the 12 sites that conducted post-construction mortality monitoring, seven have completed pre-construction raptor surveys. There does not appear to be any correlation between the total number of raptors observed during pre-construction raptor surveys and raptor mortality (r (7) = 0.12, p = 0.75), nor is there a correlation between raptors per hour observed during pre-construction surveys and raptor mortality (r (7) = 0.28, p = 0.45). Likewise, there does not appear to be any correlation between total number of raptors observed during post-construction raptor surveys and mortality (r (8) = 0.24, p = 0.50) nor between raptors per hour observed during post-construction raptor surveys and mortality (r (8) = 0.01, p = 0.90). Based on data collected during raptor surveys from 2007 to 2011, there is no indication that large numbers of migrating raptors will lead to large numbers of raptor mortality. Additionally, the raptor mortality that has been documented was not limited to migration periods, which indicates that residential raptors may be at risk in the vicinity of operating turbines. Therefore, pre-construction and post-construction raptor migration surveys do not appear to be good indicators of raptor mortality.

Birds

Of the 12 sites that have conducted mortality monitoring between 2007 and 2011, only three sites conducted pre-construction breeding bird surveys. One site conducted breeding bird surveys before the protocols of the WEVCA were implemented, therefore the methods for this survey did not follow PGC protocols. During pre-construction breeding bird surveys a total of 57 species were observed at this site. A total of 23 species of birds were documented during mortality monitoring. Only nine species were observed during both pre-construction surveys and mortality monitoring. Red-eyed vireos were the most prevalent species found during mortality monitoring and were the second most abundant species observed during breeding bird surveys. Both of the other sites conducted point counts following PGC protocols, however did not follow protocols during area searches. During point counts these sites recorded 79 and 93 bird species and documented 23 and 25 bird species during mortality monitoring. Red-eyed vireo fatalities were the predominate species found during mortality searches at both sites. During breeding bird surveys red-eyed vireos were the fourth and second most frequently observed species

respectively. At this time, the PGC does not have sufficient data to determine if pre-construction breeding bird surveys can predict mortality. Based on the results of three sites, neither the species composition nor the extent of mortality could be predicted based on pre-construction breeding bird survey results. However, trends in bird mortality data throughout Pennsylvania indicate the majority of bird mortality (76%) occurs during the months of April, May, September, and October.

Bats

The PGC does not have enough standardized pre-construction data or a model to predict the extent of bat mortality at wind sites. However the data does show trends on when bat activity is the greatest. Four pre-construction acoustic surveys that followed the PGC protocols and deployed acoustic detectors above 40m showed that 69% of all bat activity occurred between July 1 and September 30 (range 60% to 82%). The one post-construction acoustic survey conducted in 2010 yielded similar results in which the majority of the acoustic bat calls recorded occurred during the same time frame. This corresponds to the 24 post-construction mortality surveys in which 79% of all bat mortality was found between July 1 and September 30. Based on data collected between 2007 and 2011 the PGC cannot predict the extent of bat mortality for a given site. However the PGC can predict that the majority of bat mortality will occur between July 1 and September 30 and thus minimization efforts should be employed during this timeframe to obtain the greatest effect.

WILDLIFE INCIDENT REPORTING SYSTEM

One of the Best Management Practices endorsed by the PGC is the implementation of a Wildlife Incident Reporting System (WIRS) for each wind facility in Pennsylvania. The WIRS is a plan for site employees to receive training in monitoring, response, and reporting of wildlife injuries and fatalities after the completion of standard mortality monitoring. A WIRS is not a substitute for standard mortality monitoring, but rather an organized reporting system for incidental mortality. The WIRS provides additional data that can be used to determine trends in mortality as well as document any important events, such as a threatened or endangered species mortality or large mortality event. The importance of this reporting system is best demonstrated by the large mortality event that occurred in 2011, after standard mortality monitoring concluded. The PGC is currently working with all Cooperators that have active wind sites to make sure they have a WIRS implemented prior to the completion of their 2 years of post-construction mortality monitoring.

CONTRIBUTIONS TO OTHER WIND RELATED STUDIES

A total of 369 samples (100 tissues and 269 hair) were collected from 140 bat carcasses found at Pennsylvania wind sites in 2010 and 2011. The samples were 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) or David Nelson of the University of Maryland Center for Environmental Science Appalachian Laboratory for use in

various ongoing bat genetic studies. Since 2007, the PGC has submitted 1,478 (593 tissues and 885 hair) bat samples from wind energy facilities for research use.

SIGNIFICANT FINDINGS FROM COOPERATORS' SURVEYS

Significant findings from Cooperators' surveys conducted from 2007 to 2009 can be found in the 2nd summary report (Librandi Mumma and Capouillez 2011). The following significant findings occurred in 2010 and 2011.

A total of nine confirmed Seminole bat fatalities were documented at Pennsylvania wind sites between 2007 and 2011 at six different wind sites. All suspected Seminole bats were sampled and sent for genetic analysis to confirm species identification. Three bats were confirmed in 2009, four were confirmed in 2010, and two were confirmed in 2011. These wind sites were located throughout the state, which implies that Seminole bats are not limited to any one portion of the state. These results may indicate that Seminole bats, while rare, inhabit Pennsylvania more than previously believed. See the Post-Construction: Bats section for more information.

In 2011 Pennsylvania experienced its first state and federally endangered Indiana bat mortality at a wind facility. A juvenile female was discovered on September 26, 2011. This site was previously ranked by the PGC as low risk to bats. The nearest known Indiana bat hibernaculum is over 10 miles from this project. A radio telemetry study of 17 Indiana bats during fall swarming showed that both male and female bats travel greater than 5 miles from the hibernaculum during swarming. This event and radio telemetry results suggest an increased risk to cave hibernating bats further than the five miles currently assessed under the Cooperative Agreement, especially during the fall swarming period. See the *Threatened and Endangered Species Mortality* section for additional information.

In 2011 Pennsylvania experienced its first large mortality event at a wind facility. The large mortality event was believed to be caused by dusk to dawn lighting at a substation, within close proximity to a turbine, in combination with inclement weather conditions. This mortality event supports the PGC's Endorsed Best Management Practices, which include lighting practices. It is believed that implementing the lighting Best Management Practices could have greatly reduced the bird mortality during this event. See the *Large Mortality Events* section for additional information.

Data collected over the past five years has provided bat mortality patterns. The majority of all bat mortality occurs between July 1 and September 30. These data show that the July 1 to September 30 timeframe is consistent throughout Pennsylvania, not just regionally. This finding is important because if adjustments to cut-in speeds are needed, this timeframe will provide the greatest benefit to bats while minimizing costs to operators.

AVOIDANCE, MINIMIZATION, AND MITIGATION BY COOPERATORS

Avoidance efforts

Since 2007, several proposed wind sites have been abandoned in Pennsylvania due to potential wildlife impacts. Several more sites were abandoned with no specific reason given. The PGC supports wind developers who recognize negative impacts to wildlife and do not proceed with development of those areas. However, many of the sites abandoned by wind developers for wildlife reasons are targeted by other wind developers who do not recognize the potential negative impacts.

Minimization efforts

In addition to the minimization efforts listed in the 2nd summary report (Librandi Mumma and Capouillez 2011) Cooperators have also used the following:

1. Minimizing impacts to core forested areas by utilizing pre-existing roadways and infrastructure.
2. Elimination of planned turbines near known bat hibernacula and roost areas.
3. Implementing riparian buffers to protect sensitive habitats and travel corridors.
4. Following seasonal timbering restrictions to minimize direct impacts to bat species and breeding birds.
5. Minimizing impacts by using pre-construction survey results to avoid and minimize impacts to bat roosts and foraging areas.

Mitigation efforts

Plans for monetary compensation to be used for protection of endangered species have been proposed by developers who have documented endangered species mortality. The PGC is working with these developers to determine what level of compensation is appropriate for these mortalities and will use these funds to purchase and/or enhance habitat for endangered species.

RESEARCH

Research conducted between 2007 and 2009 are summarized in the 1st and 2nd summary reports (Capouillez and Librandi Mumma 2008, Librandi Mumma and Capouillez 2011). There was one research project conducted since 2009.

Evaluating the effectiveness of an ultrasonic acoustic deterrent for reducing bat fatalities at wind turbines (Arnett et al. 2011) – The goal of this project was to test the effectiveness of ultrasonic acoustic deterrents for reducing bat mortality at wind turbines. The study occurred at two Pennsylvania wind farms between 2009 and 2010. The study found that between 2 and 64% fewer bats were documented at turbines where acoustic deterrents were deployed than at control sites with no acoustic deterrents. The researchers note several limitations such as influences of humidity and malfunctioning acoustic units, which may have reduced the overall effectiveness of the treatments. The results are encouraging and the researchers plan to use the information gathered during this study to modify and improve the acoustic deterrent and conduct further research in the near future.

Suggested research needs:

There has been a tremendous amount of information regarding wind energy impacts on wildlife presented since the Cooperative Agreement began in 2007, however there is still research needed to better help avoid and minimize these impacts. Some research topics still needed include:

1. Mitigation experiments – One curtailment study has been completed in Pennsylvania. The results show that increased cut-in speeds reduce overall bat mortality. Future research needs include curtailment at various sites to determine if this method is effective state-wide or if it is site specific. Various cut-in speeds and time of year should also be tested so Cooperators can optimize the protection to bats while minimizing the monetary costs.
2. Impacts to bat populations – Population estimates are needed to determine how much mortality can be sustained. In the absence of a bat population estimates, some sort of index is needed to determine trends.

OVERALL SUCCESSES/CHALLENGES

Successes

1. Avoidance or abandonment of high risk sites to avoid wildlife impacts.
2. Pro-active Cooperators are seeking PGC input earlier in their planning stages and for pre-construction surveys. This early coordination helps developers make better decisions regarding wind facility siting.
3. Cooperators are implementing the PGC approved Best Management Practices. These practices are helping to further avoid and minimize potential negative impacts to wildlife.
4. Research on minimization efforts such as bat deterrents and curtailment shows promise to reduce bat mortality at operational wind sites.
5. Pre- and post-construction data assists in avoiding and minimizing potential impacts, as well as documenting the extent of impacts from operations. This data is used to assist with determining methods to best minimize operational impacts to wildlife.

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.
2. Some Cooperators are not updating the PGC on the status of projects, as in providing up-to-date maps; this inhibits the PGC's ability to provide a complete review of project. As a proposed solution, the PGC encourages Cooperators to delineate larger initial project areas rather than smaller ones to ensure that all potential wildlife impacts are identified early on in the planning stages.
3. Protecting sites that were abandoned by responsible developers due to very high risk of wildlife impacts from being developed by less concerned developers.
4. PGC staff observing at least one day/night of each survey conducted. Because of vacancies in the PGC wind program and last minute survey coordination by developers, it has been difficult to observe all surveys conducted. These visits give the consultant the opportunity to

ask questions and the PGC the opportunity to verify that the standardized protocols are being adhered to.

5. Some Cooperators continue to submit survey work plans last minute. The work plans should be submitted to the PGC at least one month prior to the start of the surveys. This enables the PGC to review the work plan to ensure that it fulfills the purpose of the surveys.
6. Determining what is an acceptable level of bat mortality, taking into account all cumulative effects on bat trends, which can sustain healthy resident and migratory bat populations.
7. Working with Cooperators to implement some level of voluntary curtailment. For sites that documented high bat mortality, site specific data should be used to determine when to increase cut in speeds to minimize the economic cost and risk to wildlife.
8. Develop methods to avoid and minimize bird mortality. Estimated bird mortality is much lower than bats, however it appears that Passerines are the birds most at risk from wind energy. Much research has been conducted on methods to avoid and minimize bat mortality, however little has been done to determine methods for reducing bird mortality.

FUTURE

Since the implementation of the Cooperative Agreement, the PGC has garnered a vast amount of information from pre-and post-construction surveys. A total of 45 sites have provided data from either pre- and/or post-construction surveys. Information collected from these surveys provides 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.

The PGC is committed to making sure all wind energy projects are employing feasible measures to protect and minimize adverse impacts, to the Commonwealth's bat and bird resources. The Best Management Practices are employed at many sites to the maximum extent practicable and are further reducing negative impacts to wildlife.

Because of the unprecedented decline in cave hibernating bats due to white nose syndrome several bat species have been petitioned to be added to the federal and state endangered species lists. If additional bat species get listed, Cooperators that continue to work with the PGC to avoid and minimize impacts to bats will be better able to deal with new regulations than non-Cooperators.

The PGC recognizes that each project is unique and remains committed to all Cooperators to keep the Cooperative Agreement both flexible and adaptive. ***After five years of data collection and the implications of white nose syndrome, the PGC recognizes that updates to the Cooperative Agreement are necessary. Thus, a Cooperators meeting to discuss changes to current surveys and standards will occur in 2013. At that time the PGC and Cooperators will identify and discuss necessary changes.*** In addition, the PGC and Cooperators, at that meeting will determine what if any, additional data analysis is needed and how best to complete the additional data analysis.

The PGC's Wind Energy Voluntary Cooperative Agreement was created to avoid, minimize and mitigate for negative impacts of wind energy development on wildlife. Through the collaborative efforts of the wind industry in Pennsylvania and the PGC, we continue to find ways

to meet these goals. The Cooperative Agreement has allowed Pennsylvania to become one of the national leaders in determining and addressing wildlife impacts from wind energy development. The Cooperators should be commended for their efforts and have set an example that all industries should aspire to follow.

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APPENDICES

APPENDIX A: Summary of pre-construction fall raptor migration surveys done at Pennsylvania wind sites, 2004 – 2011. 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 UNRA=Unidentified raptor.

Wind Site	Raptor Risk	Year	Dates	# days	Avg. hrs/ day	Total observation hours	Raptors/ hr	Total # raptor spp	Total # raptors observed
2-2	L	2004	10/7-11/15	37	7	251	4.0	13	997
3-2	H	2005	10/09-12/14	54	6	348	2.3	12	792
6-1 & 6-3	L	2006	9/1-11/15	62	7	445	4.6	16	2058
2-1	L	2006	9/14-10/13	10	6	60	10.4	10	622
2-7	L	2006	9/1-11/15	33	7	245	2.3	13	552
2-15	L	2006	10/25-12/1	34	7	253	1.3	8	322
5-6	M	2006	9/15-11/14	28	7	206	3.0	14	616
3-4	H	2007	8/25-12/14	67	8	507	4.0	15	2014
24-2	H	2007	8/24-12/14	67	7	478	2.8	14	1332
2-18	H	2007	8/26-12/14	76	8	586	2.1	16	1207
35-1	L	2007	9/13-9/19	2	8	16	6.3	12	101
3-6	L	2007	9/17-12/16	14	8	109	1.4	10	147
5-15	L	2007	9/16-12/17	5	8	40	3.6	10	144
2-4 & 2-5	M	2007	9/10-12/18	51	6	310	1.4	15	419
4-3	M	2007	8/24-12/14	74	8	584	0.9	13	514
6-11	H	2008	8/15-12/15	76	8	598	6.6	16	3940
6-12	H	2008	8/15-12/15	76	8	1170	2.8	16	3268
5-14	L	2008	9/23-12/14	5	8	41	3.3	11	137
5-8	L	2008	9/7-10/31	9	4	36	2.4	5	86
2-25	L	2008	9/16-12/15	10	8	80	2.6	9	209
5-18	L	2008	10/15 - 11/7	5	6	32	1.9	7	61
6-10	M	2008	9/3-11/24	28	6	158	1.7	12	276
6-16	H	2009	8/18-12/15	77	8	647	10.4	14	6733
2-24	L	2009	8/31-10/22	10	8	80	2.8	11	220
6-10	M	2009	8/19-12/15	81	8	617	2.2	16	1367
2-9	M	2009	8/15-12/15	77	8	623	0.3	7	167
3-17	H	2011	8/15 - 12/15	79	8	631	2.6	15	1618
6-22	M	2011	8/15-12/15	75	7	1068	3.6	15	3839
								Total	33758

APPENDIX A (continued): Summary of percent in flight for pre-construction fall raptor migration surveys done at Pennsylvania wind sites, 2004 – 2011t. 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 UNRA=Unidentified raptor.

	Percent in Flight																
Wind Site	AMKE	BAEA[a]	BLVU	BWHA[b]	COHA	GOEA[c]	MERL	NOGO[d]	NOHA[e]	OSPR[f]	PEFA[g]	RSHA[h]	RTHA	RLHA	SSHA[i]	TUVU	UNRA
2-2	1.6	0.4	2.3	0.0	4.3	0.5	0.0	0.3	8.4	0.5	0.0	1.3	41.3	0.5	5.4	32.2	0.9
3-2	0.0	1.1	0.0	0.0	1.3	6.6	0.0	0.1	0.8	0.3	0.6	0.6	33.8	2.8	1.1	43.7	7.2
6-1 & 6-3	1.4	0.9	5.9	20.4	1.5	0.0	1.4	0.1	2.7	0.8	0.5	1.7	21.0	0.1	4.9	30.4	6.2
2-1	1.4	0.5	0.0	56.3	0.5	0.0	0.0	0.0	2.3	1.0	0.0	0.3	5.0	0.0	7.1	24.6	1.1
2-7	0.4	0.4	3.4	9.8	2.4	0.4	0.4	0.0	0.7	1.6	0.2	0.0	11.8	0.0	4.2	59.6	4.9
2-15	0.9	0.0	0.0	0.0	5.3	0.3	0.6	0.3	8.1	0.0	0.3	1.6	68.0	0.0	6.2	8.4	0.0
5-6	2.3	3.1	0.0	6.8	3.9	0.3	3.9	0.0	0.6	2.3	1.5	0.5	20.9	0.8	29.2	21.9	1.9
3-4	0.6	2.1	0.8	23.2	2.3	3.6	0.2	0.0	1.9	1.9	0.0	0.6	23.1	0.1	18.5	20.0	1.0
24-2	0.4	1.4	0.0	17.9	2.2	3.0	0.2	0.1	1.1	1.7	0.0	0.4	33.1	0.2	16.6	19.8	2.0
2-18	0.7	0.7	0.2	18.4	4.0	3.5	0.2	0.2	1.2	1.0	0.2	1.9	38.8	0.3	16.9	10.0	1.7
35-1	5.0	4.0	0.0	29.7	5.9	1.0	3.0	0.0	2.0	2.0	0.0	1.0	7.9	0.0	10.9	26.7	1.0
3-6	0.0	0.7	0.0	53.1	2.0	2.0	0.0	0.7	1.4	0.0	0.0	1.4	21.1	0.0	2.0	14.3	1.4
5-15	0.7	0.0	0.0	41.7	4.2	0.0	1.4	2.8	1.4	1.4	0.0	1.4	26.4	0.0	0.0	11.8	6.9
2-4 & 2-5	7.2	1.0	0.0	11.5	1.0	1.0	1.4	1.0	10.0	0.2	0.2	1.4	15.8	0.5	5.0	34.1	8.8
4-3	1.2	0.8	11.7	19.1	1.4	1.0	0.0	0.0	0.6	1.0	0.0	0.2	14.0	0.2	8.8	38.3	1.9
6-11	1.1	6.3	7.3	16.6	1.8	0.9	0.3	0.3	1.5	2.3	0.6	1.3	21.0	0.1	14.0	23.3	1.4
6-12	1.4	1.4	6.2	27.0	2.0	0.7	0.3	0.1	0.9	1.6	0.2	0.7	17.1	0.0	21.0	18.8	0.6
5-14	1.5	0.0	0.0	4.4	16.8	1.5	0.0	1.5	2.2	0.7	0.0	0.7	29.2	0.0	9.5	14.6	17.5
5-8	0.0	0.0	0.0	7.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.2	25.6	0.0	4.7	45.3	16.3
2-25	0.5	0.0	6.2	6.7	5.3	0.0	0.0	0.0	1.0	0.0	0.0	0.5	18.2	0.0	1.4	34.9	23.9
3-18	0.0	1.6	0.0	0.0	1.6	0.0	0.0	0.0	19.7	0.0	1.6	0.0	59.0	1.6	0.0	6.6	8.2
6-10	6.5	1.8	5.1	36.6	7.6	0.0	0.4	0.0	5.8	4.3	0.0	1.8	10.9	0.0	11.2	8.0	0.0
6-16	1.1	8.3	18.0	0.6	0.3	0.0	0.2	0.0	0.1	0.4	0.1	0.1	1.5	0.0	0.0	69.1	0.3
2-24	15.9	1.4	3.2	6.8	2.3	0.5	0.9	0.0	3.6	0.0	0.0	0.0	7.3	0.0	5.5	45.5	7.3
6-10	3.1	1.7	3.1	8.6	2.9	0.7	0.1	0.5	1.7	1.6	0.0	2.5	27.9	0.0	13.8	30.4	1.3
2-9	0.0	0.0	0.0	4.8	1.8	0.0	0.0	0.0	2.4	0.6	0.0	0.0	24.6	0.0	9.0	55.7	1.2
3-17	1.2	0.8	0.1	51.8	1.7	0.0	0.1	0.1	0.7	1.1	0.2	0.9	20.3	0.0	6.4	8.3	3.6
6-22	2.4	1.8	4.2	32.9	2.4	0.2	0.4	0.0	0.4	1.7	0.0	0.2	13.0	0.0	15.2	25.1	0.1
Total	1.5	3.3	6.5	17.9	2.0	1.0	0.4	0.1	1.5	1.3	0.2	0.8	18.0	0.2	10.4	33.1	1.9

[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 threatened; [f] Pennsylvania 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 – 2011. 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 UNRA=Unidentified raptor.

Wind Site	Risk	Year	Dates	Days	Avg. hrs/ day	Total hrs	Raptors/ hr	Total No. raptor spp	Total No. raptors
3-2	H	2006	2/25-3-31	34	7.5	254	0.9	12	223
6-1 & 6-3	L	2006	4/20-5/31	37	8.0	295	1.0	12	289
2-7	L	2006	4/3-5/29	28	7.0	197	2.7	10	523
2-1	L	2006	4/6-5/10	7	5.7	40	4.9	10	196
24-2	H	2007	3/1-4/6	32	7.3	232	1.6	14	372
2-18	H	2007	4/24-5/3	8	8.6	69	2.3	9	161
3-4	H	2007	3/2-4/6	30	7.7	230	1.1	10	247
4-3	M	2007	2/27-4/6	34	6.8	230	5.6	14	1292
2-19	H	2007	3/10-4/13	25	7.1	177	5.0	13	894
35-1	L	2007	4/3-4/23	2	6.5	13	3.3	8	43
6-12	H	2008	3/5-4/25	38	10.5	398	0.6	15	246
6-11	H	2008	3/1-4/25	42	7.2	301	1.8	13	550
2-18	H	2008	3/4-4/25	38	7.8	295	1.3	14	388
5-18	M	2008	3/3-5/29	16	6.3	100	1.8	9	177
2-4 & 2-5	M	2008	3/11-3/31	15	7.6	114	0.9	10	101
3-6	L	2008	3/10-3/29	6	7.7	46	1.6	5	74
6-16	H	2009	3/3-4/1	22	7.9	174	5.8	12	1006
2-24	L	2010	3/17-5/5	10	8.0	80	3.1	10	248
								Total	7030

APPENDIX B (continued): Summary of percent in flight 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 UNRA=Unidentified raptor.

	Percent in Flight																
Wind Site	AMKE	BAEA[a]	BLVU	BWHA[b]	COHA	GOEA[c]	MERL	NOGO[d]	NOHA[e]	OSPR[f]	PEFA[g]	RSHA[h]	RTHA	RLHA	SSHA[i]	TUVU	UNRA
3-2	1.3	3.6	0.4	0.0	1.3	21.1	0.0	0.0	4.5	0.4	0.0	5.4	25.6	1.8	1.8	28.7	4.0
6-1 & 6-3	0.3	0.7	0.7	7.3	2.1	0.0	0.3	0.3	0.3	4.5	0.0	0.0	5.2	0.0	4.2	72.7	1.4
2-7	0.2	0.0	0.2	7.5	8.8	0.0	0.0	0.0	0.6	1.7	0.0	0.2	18.0	0.0	2.5	59.8	0.6
2-1	5.6	0.0	0.0	9.2	1.0	0.0	0.0	1.0	7.1	0.5	0.0	2.0	15.8	0.0	4.1	53.6	0.0
24-2	1.3	1.6	1.6	0.0	3.2	5.6	0.8	0.5	2.2	0.3	0.0	3.0	18.0	0.5	2.4	55.6	3.2
2-18	0.0	1.2	1.9	4.3	0.0	0.0	0.0	0.0	0.6	5.0	0.0	0.0	13.0	1.9	6.2	50.3	15.5
3-4	0.4	0.8	0.0	0.0	8.9	7.7	0.0	0.0	4.5	0.4	0.0	2.0	23.1	0.0	0.8	49.0	2.4
4-3	0.9	0.4	2.6	0.1	1.6	2.3	0.2	0.0	0.7	0.3	0.0	2.0	13.8	0.2	2.8	66.5	5.7
2-19	0.6	0.1	1.2	0.0	0.8	0.9	0.8	0.0	0.7	0.4	0.0	1.0	14.8	0.3	1.9	71.9	4.6
35-1	0.0	0.0	0.0	7.0	11.6	0.0	0.0	2.3	0.0	2.3	0.0	2.3	32.6	0.0	2.3	34.9	4.7
6-12	7.3	9.3	6.5	27.6	12.2	0.4	0.4	0.4	2.8	4.9	0.4	2.4	11.8	0.0	3.7	7.7	2.0
6-11	3.6	6.7	0.9	44.9	7.3	0.2	0.0	0.4	4.0	5.1	0.0	1.5	12.4	0.0	5.5	0.9	6.7
2-18	0.8	2.6	0.0	0.3	0.3	2.1	0.3	0.0	1.0	0.5	0.5	1.5	11.9	0.3	1.8	76.0	0.3
5-18	2.8	1.7	0.0	1.7	0.0	0.0	0.0	0.0	0.6	0.0	0.0	2.8	10.2	0.6	1.1	73.4	5.1
2-4 & 2-5	5.9	1.0	1.0	2.0	0.0	0.0	0.0	0.0	9.9	0.0	0.0	3.0	17.8	1.0	1.0	54.5	3.0
3-6	1.4	0.0	0.0	0.0	0.0	1.4	0.0	0.0	0.0	0.0	0.0	0.0	23.0	0.0	1.4	63.5	9.5
6-16	2.8	2.4	23.3	0.0	0.2	0.0	0.0	0.0	0.4	0.2	0.2	0.1	5.7	0.1	0.1	64.5	0.1
2-24	2.4	1.6	1.6	12.1	1.6	0.0	0.4	0.0	0.0	1.2	0.0	0.0	14.1	0.0	3.2	57.3	4.4
Total	1.8	1.8	4.5	6.3	2.9	1.9	0.2	0.1	1.6	1.2	0.1	1.4	13.6	0.3	2.4	56.3	3.5

[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 threatened; [f] Pennsylvania 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 C: Summary of breeding bird surveys done pre-construction at proposed wind sites in Pennsylvania, 2006 – 2011. "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	No. Point Counts	Area Search Dates	No. Area Searches	Comments	Total No. Species	No. PA Endangered Species	No. PA Threatened Species	No. PA WAP Species	Total No. Individual Records	Habitat
2-1[a]	2006	June 1-2; 8-9	16	not in report	not in report	Point counts not conducted in May and the survey did not adequately cover the project area	38	0	0	9	348	forest interior/ grassland/ successional
2-19[b]	2006	N/A	N/A	May 2 - July 6	2	Point counts and area searches did not adequately cover the project area; survey conducted off project area	73	0	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 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 in report	not in report	Second round of point counts 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 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 in report	not in report	Two rounds of point counts not conducted in June	106	0	0	23	3567	grassland/ forest-interior/ forest edge
2-18[c]	2007	May 31; June 7; 18-19	N/A	N/A	N/A	Neither point counts or area searches conducted; transects walked	69	1	0	16	not in report	Forest-interior/ forest edge
2-7	2007	May 22-23; June 27-30	28	April 23-24	not in report	Area searches not conducted in May or June nor were second round of point counts in June 1 - July 10	95	1	1	20	1630	forest-interior/ forest edge/grassland
2-15	2007	May 19; June 17-18	18	April 17-27; May 19; June 17-18	not in report	Area searches 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 in report	Area searches 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 information was not collected.

Wind Site	Survey Year	Point Count Dates	No. Point Counts	Area Search Dates	No. Area Searches	Comments	Total No. Species	No. PA Endangered Species	No. PA Threatened Species	No. PA WAP Species	Total No. Individual Records	Habitat
5-15	2008	May 31; June 19; June 27	10	N/A	N/A		26	0	0	4	190	reclaimed mine/ forest
5-18	2007	June 9-11; June 29-30; July 3-4	33	N/A	N/A	May point counts not conducted	58	0	0	5	1986	forest-interior/ forest edge
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 in report	reclaimed 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 conducted during the mid-March to April period	82	0	0	16	980 (p.c. 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 conducted during the mid-March to April and May period	74	0	0	9	1437	forested/ agriculture
2-25	2009	June 16-19; June 25-28	36	N/A	N/A	Second year of survey conducted to survey new project areas. May point counts 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	Second year of survey conducted to adequately cover the project area.	90	1	1	20	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 in report	No area searches 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	7	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 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	No. Point Counts	Area Search Dates	No. Area Searches	Comments	Total No. Species	No. PA Endangered Species	No. PA Threatened Species	No. PA WAP Species	Total No. Individual Records	Habitat
2-5	2009	N/A	N/A	April 30; March 28; June 7	3	Area searches conducted only in new locations. Searches 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		70	2	0	13	2761	reclaimed mine/ forest
2-24	2010	May 14-16; June 8-11; June 20-22	58	April 30; May 21; June 23	2		89	0	1	19	1938	mixed forest/agriculture/reclaimed grassy/shrub
2-36	2010	May 18-21; June 2-5; June 17-19	38	N/A	N/A		84	0	1	20	1727	agriculture/forest edge/reclaimed mine
3-18	2010	May 14-31; June 1-10; June 15-23	181	April 27; May 20; June 17-23	5		117	2	1	26	2815	deciduous forest/ coniferous forest/ agriculture
3-18	2011	May 11-20; June 6-11; June 20-25	59	April 28; May 18; June 10-23	2	Second year of surveys completed to survey new project areas.	103	0	1	24	3820	deciduous forest/agriculture/ pasture/reclaimed mine
3-17	2011	May 7-21; June 1-9; June17-25	100	April 27-28: May 22-23; June 13-14	6		96	1	0	23	5220	mixed forest/field/edge/ riparian
2-27	2010	May 22-25; June 6-10; June 20-23	48	N/A	N/A		83	0	0	22	1905	forested/wetlands/ reclaimed mine
2-27	2011	N/A	N/A	April 25-26; May 24-25; June 11-12	6	Second year of surveys completed to survey new project areas.	78	0	0	15	721	forested/wetlands/ reclaimed mine

APPENDIX D: Pennsylvania Wildlife Action Plan priority bird species detected during point counts at Pennsylvania wind sites, 2006 - 2011.

	Wind Site *Survey Year*																								
WAP Species	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*	2-24 *2010*	2-36 *2010*	3-18 *2010*	2-27 *2010*	3-18 *2011*	3-17 *2011*
Acadian Flycatcher		X			X	X	X		X							X			X		X		X	X		X
Alder Flycatcher				X									X						X		X	X		X	X	X
American Bittern[1]																				X						
American Woodcock						X		X																X		X
Bank Swallow		X																								
Black-billed Cuckoo		X	X	X	X	X	X	X	X				X			X			X	X	X		X	X	X	
Blackburnian Warbler		X	X	X		X													X	X	X		X	X	X	X
Blackpoll Warbler[1]		X		X			X	X								X			X	X			X			X
Black-throated Blue Warbler		X	X	X	X	X	X		X		X		X		X	X		X	X	X	X	X	X	X	X	X
Black-throated Green Warbler	X	X	X	X	X	X	X		X		X		X	X	X	X	X	X	X	X	X	X	X	X	X	X
Blue-headed Vireo		X	X	X	X	X	X		X				X		X	X		X	X	X	X	X	X	X	X	X
Blue-winged Warbler				X		X							X										X		X	X
Bobolink	X	X		X	X			X	X				X	X		X			X		X	X	X		X	
Broad-winged Hawk		X	X	X	X				X							X			X		X		X	X		X
Brown Thrasher	X			X	X			X						X		X			X	X		X	X	X	X	
Canada Warbler			X					X	X				X			X		X			X		X	X	X	X
Cerulean Warbler			X		X		X												X	X			X		X	X
Chimney Swift		X		X	X	X	X	X	X							X		X			X					
Common Nighthawk					X																					
Eastern Meadowlark	X	X		X	X			X											X		X	X	X		X	
Eastern Whip-poor-will			X						X	X		X		X		X										
Grasshopper Sparrow	X	X			X			X						X	X				X		X	X		X	X	
Great Blue Heron		X		X					X							X					X	X				X
Golden-winged Warbler																							X	X	X	

[1] Pennsylvania endangered

[2] Pennsylvania threatened

APPENDIX D (continued): Pennsylvania Wildlife Action Plan priority bird species detected during point counts at Pennsylvania wind sites, 2006 - 2011.

	Wind Site *Survey Year*																								
WAP Species	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*	2-24 *2010*	2-36 *2010*	3-18 *2010*	2-27 *2010*	3-18 *2011*	3-17 *2011*
Henslow's Sparrow	X			X																		X				
Kentucky Warbler																						X		X	X	X
Louisiana Waterthrush																			X		X					
Northern Bobwhite																		X								
Northern Harrier[2]																						X	X		X	
Osprey[2]																X										
Pine Siskin																										X
Prairie Warbler	X	X		X		X				X			X				X		X	X		X	X		X	
Prothonotary Warbler																								X		
Red-headed Woodpecker						X		X											X			X		X		X
Red-shouldered Hawk		X	X	X	X	X													X				X		X	
Scarlet Tanager	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Sharp-shinned Hawk		X											X			X			X			X	X			X
Swainson's Thrush					X		X	X	X		X					X										
Upland Sandpiper[1]								X													X					
Willow Flycatcher				X										X							X	X	X	X	X	X
Winter Wren									X							X							X	X	X	
Wood Thrush	X		X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X
Worm-eating Warbler			X		X				X							X	X			X			X	X	X	X
Yellow-bellied Flycatcher[1]						X																	X			
Yellow-breasted Chat														X								X	X		X	X
Yellow-throated Vireo						X																X		X		X
# POINT COUNTS	**16**	**20**	**42**	**34**	**28**	**n/a**	**28**	**18**	**28**	**10**	**33**	**31**	**28**	**30**	**30**	**11**	**56**	**3**	**47**	**115**	**58**	**38**	**122**	**48**	**37**	**100**
TOTAL WAP PRIORITY SPECIES	**9**	**18**	**13**	**20**	**18**	**16**	**11**	**12**	**16**	**4**	**5**	**3**	**12**	**9**	**6**	**20**	**5**	**7**	**21**	**13**	**19**	**20**	**26**	**22**	**24**	**23**
TOTAL SPECIES RECORDED	**43**	**71**	**64**	**90**	**77**	**69**	**52**	**68**	**61**	**26**	**58**	**35**	**65**	**62**	**45**	**90**	**35**	**40**	**90**	**70**	**85**	**84**	**89**	**83**	**79**	**87**

[1] Pennsylvania endangered

[2] Pennsylvania threatened

APPENDIX E: Wildlife Action Plan priority bird species detected during area searches at Pennsylvania wind sites, 2006 - 2011.

	Wind Site *Survey Year*																		
WAP species	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*	2-24 *2010*	3-18 *2010*	3-18 *2011*	3-17 *2011*	2-27 *2011*
Acadian Flycatcher											X					X			
Alder Flycatcher				X	X														
American Bittern																			
American Black Duck				X															
American Woodcock	X				X													X	X
Bank Swallow																		X	
Black-billed Cuckoo	X										X								
Blackburnian Warbler				X	X											X	X	X	
Blackpoll Warbler[1]								X											
Black-throated Blue Warbler	X											X		X		X		X	X
Black-throated Green Warbler		X		X		X				X	X			X	X	X	X	X	X
Blue-headed Vireo		X		X		X					X			X		X	X	X	X
Blue-winged Warbler																			X
Bobolink	X	X	X	X						X				X	X				X
Broad-winged Hawk	X			X		X								X					X
Brown Thrasher	X	X	X			X		X			X			X					
Canada Warbler					X											X	X		X
Cerulean Warbler	X													X					
Chimney Swift			X									X							
Common Nighthawk																			
Eastern Meadowlark	X			X						X	X			X	X				
Eastern Whip-poor-will																			
Grasshopper Sparrow	X	X							X					X	X				X
Great Blue Heron	X	X								X						X			

[1] Pennsylvania endangered

[2] Pennsylvania threatened

APPENDIX E (continued): Wildlife Action Plan priority bird species detected during area searches at Pennsylvania wind sites, 2006 - 2011.

	Wind Site *Survey Year*																		
WAP species	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*	2-24 *2010*	3-18 *2010*	3-18 *2011*	3-17 *2011*	2-27 *2011*
Henslow's Sparrow				X															
Kentucky Warbler						X													
Louisiana Waterthrush						X					X	X							
Northern Bobwhite																			
Northern Goshawk						X													
Olive-sided Flycatcher	X																		
Osprey[2]						X		X											
Pine Siskin												X							
Prairie Warbler	X	X								X									
Red-headed Woodpecker																			
Red-shouldered Hawk				X								X							
Scarlet Tanager	X	X		X						X	X	X		X		X	X	X	X
Sharp-shinned Hawk						X		X						X		X		X	X
Solitary Sandpiper	X				X	X													X
Swainson's Thrush	X																		
Willow Flycatcher												X		X					
Winter Wren						X	X							X			X		
Wood Thrush		X		X		X				X	X	X	X	X		X			X
Worm-eating Warbler						X										X		X	X
Yellow-breasted Chat														X					
Yellow-throated Vireo		X			X	X												X	X
TOTAL WAP PRIORITY SPECIES	**15**	**10**	**3**	**12**	**6**	**14**	**1**	**4**	**1**	**7**	**9**	**8**	**1**	**15**	**4**	**11**	**6**	**10**	**15**
TOTAL SPECIES RECORDED	**64**	**45**	**22**	**54**	**30**	**63**	**25**	**29**	**9**	**48**	**43**	**44**	**9**	**72**	**32**	**62**	**30**	**67**	**78**

[1] Pennsylvania endangered

[2] Pennsylvania threatened

APPENDIX F. Wind energy project mist net survey results, 2004 – 2011. 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). Bat risk is designated by H=High, M=Moderate, and L=Low.

Wind Site	Bat Risk	Year	Dates of Survey	No. Sites	No. Bats Captured	No. Species	MYLU	MYSE[a]	EPFU	PESU	LABO[b]	LACI[b]	LANO[c]	MYLE[d]	MYSO[e]	UNK	Bats/ 1000 Units of Effort[f]
2-2	H	2004	7/28-8/5	6	170	6	31	12	103	4	16	0	0	3	0	1	20
5-6	H	2005	7/11-8/4	9	87	5	41	19	23	1	3	0	0	0	0	0	14
24-3	L	2005	8/10-8/14	4	84	6	34	16	23	3	7	1	0	0	0	0	17
2-7	H	2006	7/30-8/4	10	138	4	13	75	41	0	9	0	0	0	0	0	11
2-10	L	2006	8/5-8/6	4	62	5	14	28	15	1	4	0	0	0	0	0	10
2-4	L	2006	7/9-7/12	4	66	5	18	6	24	0	14	4	0	0	0	0	8
24-1	L	2006	8/10-8/12	4	71	4	34	24	11	0	2	0	0	0	0	0	9
2-14	L	2006	8/3-8/5	5	103	5	19	37	38	0	8	1	0	0	0	0	16
2-19	H	2007	7/7-7/17	13	107	6	50	39	10	1	5	2	0	0	0	0	5
2-18	H	2007	6/2-8/16	27	388	7	167	92	98	1	22	6	0	0	2	0	10
4-3	H	2007	7/25-7/30	7	201	4	69	13	110	0	9	0	0	0	0	0	23
24-2	L	2007	6/20-6/25	7	71	4	23	32	12	0	1	0	0	0	0	3	10
35-1	L	2007	7/18-8/6	28	429	6	197	174	44	0	10	1	3	0	0	0	10
2-1	L	2007	7/31-8/5	8	250	4	73	22	146	0	9	0	0	0	0	0	21
3-4	L	2007	8/7-8/9	5	200	6	60	17	82	2	36	3	0	0	0	0	23
4-3	H	2008	6/27-7/2	5	23	5	5	15	1	0	1	0	0	1	0	0	4
5-18	H	2008	5/29-8/3	50	574	6	146	104	306	0	12	4	0	2	0	0	9
6-6	H	2008	7/17-7/29	5	64	5	7	39	15	1	2	0	0	0	0	0	5
2-9	H	2008	9/3 - 9/4	3	44	4	24	3	16	1	0	0	0	0	0	0	13
5-15	H	2008	7/17-7/18	3	45	5	7	24	8	4	2	0	0	0	0	0	11
2-18	H	2008	6/16-6/28	21	228	7	67	75	66	0	11	0	1	2	2	4	8

[a] PA Wildlife Action Plan responsibility species

[b] PA Wildlife Action Plan maintenance concern

[c] PA Wildlife Action Plan high level concern

[d] PA state listed threatened; PA Wildlife Action Plan immediate concern

[e] PA state and federally listed endangered; PA Wildlife Action Plan immediate concern

[f] Unit of effort is defined as 1 square meter of net in place for one hour

APPENDIX F (continued): Wind energy project mist net survey results, 2004 – 2011. 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 of the table shows column totals with the exceptions of No. Species and Bats/1000 Units of Effort being column averages. Bat risk is designated by H=High, M=Moderate, and L=Low.

Wind Site	Bat Risk	Year	Dates of Survey	No. Sites	No. Bats Captured	No. Species	MYLU	MYSE[a]	EPFU	PESU	LABO[b]	LACI[b]	LANO[c]	MYLE[d]	MYSO[e]	UNK	Bats/ 1000 Units of Effort[f]
6-12	H	2008	7/20-7/27	13	255	4	57	60	124	0	13	0	0	0	0	1	14
5-14	H	2008	7/18-7/29	22	475	7	118	149	180	3	17	4	0	4	0	0	14
6-11	H	2008	7/17-7/20	9	533	7	269	15	216	6	23	1	1	0	0	2	45
24-2	L	2008	8/9-8/14	11	198	6	86	39	65	1	5	1	0	0	0	1	15
3-6	L	2008	6/21-8/10	21	525	7	260	207	25	1	27	3	2	0	0	0	30
2-24	H	2009	7/31-8/14	18	173	5	37	48	71	5	12	0	0	0	0	0	9
5-14	H	2009	5/15-8/13	19	298	6	158	52	58	15	8	0	0	7	0	0	10
3-2	L	2009	6/23-7/1	19	145	4	27	111	5	0	0	0	2	0	0	0	14
13-1	L	2009	7/27-8/14	36	410	6	45	81	249	1	24	1	0	0	0	9	9
3-4	L	2009	7/11-7/16	21	256	5	40	29	171	1	9	0	0	0	0	6	10
3-18	L	2009	7/23-8/8	38	629	6	252	289	19	0	23	26	20	0	0	0	10
2-5	L	2009	7/9-7/18	13	269	6	178	37	40	1	12	1	0	0	0	0	13
2-25	M	2009	7/23-8/15	32	326	7	38	159	96	3	21	8	0	1	0	0	7
6-10	L	2010	5/24-7/5	43	238	7	20	118	63	4	23	5	0	5	0	0	3
2-27	L	2010	5/19-5/28	13	116	6	41	32	35	0	4	0	1	3	0	0	5
2-36	L	2010	5/16-5/22	6	58	4	24	14	17	0	3	0	0	0	0	0	5
3-17	L	2011	7/9-7/20	25	227	5	7	59	126	0	34	1	0	0	0	0	5
3-18	L	2011	7/30-8/1	13	132	6	21	71	30	1	8	1	0	0	0	0	7
				600	**8668**	**5**	**2777**	**2436**	**2782**	**61**	**449**	**74**	**30**	**28**	**4**	**27**	**12**

[a] PA Wildlife Action Plan responsibility species

[b] PA Wildlife Action Plan maintenance concern

[c] PA Wildlife Action Plan high level concern

[d] PA state listed threatened; PA Wildlife Action Plan immediate concern

[e] PA state and federally listed endangered; PA Wildlife Action Plan immediate concern

[f] Unit of effort is defined as 1 square meter of net in place for one hour

Appendix G. Species composition by common and scientific name of total bird mortality documented at Pennsylvania wind sites, 2007-2011.

% of Bird Mortality	Common Name	Scientific Name	% of Bird Mortality	Common Name	*Scientific Name*
25	Red-eyed Vireo	*Vireo olivaceus*	1	Turkey Vulture	*Cathartes aura*
12	Unknown Bird		1	Killdeer	*Charadrius vociferus*
7	Golden-crowned Kinglet	*Regulus satrapa*	1	Black-billed Cuckoo	*Coccyzus erythropthalmus*
4	Magnolia Warbler	*Setophaga magnolia*	1	American Crow	*Lophostrix cristata*
4	Ruffed Grouse	*Bonasa umbellus*	1	American Robin	*Turdus migratorius*
2	European Starling	*Sturnus vulgaris*	1	Common Yellowthroat	*Geothlypis trichas*
2	Ruby-crowned Kinglet	*Regulus calendula*	1	Philadelphia Vireo	*Vireo philadelphicus*
2	Red-tailed Hawk	*Buteo jamaicensis*	1	Pine Warbler	*Setophaga pinus*
2	Unknown Warbler		1	Rose-breasted Grosbeak	*Pheucticus ludovicianus*
1	Blue-headed Vireo	*Cyanophaia bicolor*	1	Tennessee Warbler	*Vermivora peregrina*
1	Ruby-throated Hummingbird	*Archilochus colubris*	1	Warbling Vireo	*Vireo gilvus*
1	Mourning Dove	*Zenaida macroura*	<1	Broad-winged Hawk	*Buteo platypterus*
1	Blackburnian Warbler	*Setophaga fusca*	<1	Blue-winged Teal	*Anas discors*
1	Black-throated Blue Warber	*Setophaga caerulescens*	<1	Wood Duck	*Aix sponsa*
1	Black-throated Green Warbler	*Setophaga virens*	<1	Chimney Swift	*Chaetura pelagica*
1	Swainson's Thrush	*Catharus ustulatus*	<1	American Woodcock	*Scolopax minor*
1	Unknown Vireo		<1	Belted Kingfisher	*Megaceryle alcyon*
1	Veery	*Catharus fuscescens*	<1	Ring-necked Pheasant	*Phasianus colchicus*
1	Yellow-bellied Sapsucker	*Sphyrapicus varius*	<1	Wild Turkey	*Meleagris gallopavo*
1	Yellow-billed Cuckoo	*Coccyzus americanus*	<1	Sora	*Porzana carolina*
1	American Redstart	*Setophaga ruticilla*	<1	Baltimore Oriole	*Icterus galbula*
1	Cedar Waxwing	*Bombycilla cedrorum*	<1	Black-and-white Warbler	*Mniotilta varia*
1	Wood Thrush	*Hylocichla mustelina*	<1	Brown-headed Cowbird	*Molothrus ater*

Appendix G (continued): Species composition by common and scientific name of total bird mortality documented at Pennsylvania wind sites, 2007-2011.

% of Bird Mortality	Common Name	Scientific Name	% of Bird Mortality	Common Name	Scientific Name
<1	Blue Jay	*Cyanocitta cristata*	<1	Indigo Bunting	*Passerina cyanea*
<1	Blackpoll Warbler	*Setophaga striata*	<1	Mourning Warbler	*Geothlypis philadelphia*
<1	Barn Swallow	*Hirundo rustica*	<1	Northern Parula	*Setophaga americana*
<1	Bobolink	*Dolichonyx oryzivorus*	<1	Northern Waterthrush	*Seiurus noveboracensis*
<1	Brown Creeper	*Certhia americana*	<1	Palm Warbler	*Setophaga palmarum*
<1	Brown Thrasher	*Toxostoma rufum*	<1	Red-breasted Nuthatch	*Sitta canadensis*
<1	Blue-winged Warbler	*Vermivora pinus*	<1	Red-winged Blackbird	*Agelaius phoeniceus*
<1	Chipping Sparrow	*Spizella passerina*	<1	Song Sparrow	*Melospiza melodia*
<1	Common Raven	*Corvus corax*	<1	Swainson's Warbler	*Limnothlypis swainsonii*
<1	Chestnut-sided Warbler	*Setophaga pensylvanica*	<1	Tree Sparrow	*Spizella arborea*
<1	Eastern Bluebird	*Sialia sialis*	<1	Winter Wren	*Troglodytes troglodytes*
<1	Eastern Phoebe	*Sayornis phoebe*	<1	White-throated Sparrow	*Zonotrichia albicollis*
<1	Eastern Towhee	*Pipilo erythrophthalmus*	<1	Yellow-bellied Flycatcher	*Empidonax flaviventris*
<1	Eastern Wood-pewee	*Contopus virens*	<1	Yellow-throated Warbler	*Setophaga dominica*
<1	Field Sparrow	*Spizella pusilla*	<1	Yellow Warbler	*Setophaga petechia*
<1	Great-crested Flycatcher	*Myiarchus crinitus*	<1	Yellow-shafted Flicker	*Colaptes a. auratus*
<1	Gray Catbird	*Dumetella carolinensis*	<1	Unknown Flycatcher	
<1	Henslow's Sparrow	*Ammodramus henslowii*	<1	Unknown Woodpecker	
<1	House Sparrow	*Passer domesticus*			

Appendix H. Summary of post-construction spring and fall raptor migration surveys completed at Pennsylvania wind sites, 2007 – 2011. 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, SSHA=Sharp-shinned hawk, TUVU=Turkey vulture, and UNKN=Unidentified raptor.

					Percent in Flight															
Wind Site	Raptor Risk	Year	Survey	Total No. Raptors	AMKE	BAEA[a]	BLVU	BWHA[b]	COHA	GOEA[c]	MERL	NOGO[d]	NOHA[e]	OSPR[f]	PEFA[g]	RSHA[h]	RTHA	SSHA[i]	TUVU	UNKN
24-3	H	2009	Spring	346	2	1	0	0	5	4	0	0	1	0	0	1	33	7	46	0
5-5	M	2010	Spring	175	5	16	1	0	3	2	0	1	5	1	1	2	7	3	31	22
24-1	H	2010	Spring	18	17	6	0	0	6	17	0	0	0	0	0	0	39	0	11	6
2-4	M	2010	Spring	190	2	2	0	0	1	1	0	1	3	0	1	2	24	1	57	7
6-16	H	2011	Spring	863	0	5	32	0	0	0	0	0	0	1	0	0	5	0	55	2
2-14	M	2008	Fall	1056	0	0	1	20	2	0	0	0	1	1	0	1	10	8	48	7
2-10	M	2008	Fall	778	0	1	0	9	3	0	0	0	2	1	0	0	23	1	48	11
5-5	M	2009	Fall	630	1	4	1	31	2	1	1	0	4	5	1	1	21	11	10	3
24-1	H	2010	Fall	874	2	1	1	48	2	0	1	0	2	2	1	3	12	6	16	3
24-3	H	2010	Fall	814	2	2	0	27	3	1	1	0	2	1	0	1	26	8	22	2
2-4	M	2010	Fall	327	4	0	0	14	4	0	0	0	13	0	1	1	22	5	34	2
2-19	H	2010	Fall	3127	2	1	0	50	4	1	0	0	1	0	0	1	21	11	4	4
6-16	H	2011	Fall	1629	4	9	10	5	0	0	0	0	0	0	0	0	3	1	66	0

[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 threatened; [f] Pennsylvania 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.