PENNSYLVANIA GAME COMMISSION
WIND ENERGY VOLUNTARY COOPERATION AGREEMENT
FIRST ANNUAL REPORT
APRIL 18, 2007 – SEPTEMBER 30, 2008

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TABLE OF CONTENTS **PAGE(S)**

EXECUTIVE SUMMARY

The Pennsylvania Game Commission's (PGC) Wind Energy Voluntary Cooperative Agreement was drafted in February 2007 with the first companies entering into the Agreement on April 18, 2007. Of the 24 wind energy developers existing in Pennsylvania, 20 of them have signed the PGC Wind Energy Voluntary Cooperative Agreement, representing 71% of the known active and proposed wind projects in Pennsylvania. The Agreements have greatly improved the Commission's awareness of project proposals within Pennsylvania, allowing preliminary wildlife resource information to be taken into account before project development. The Agreement between the PGC and cooperators requires a minimum of one year of pre-construction surveys and two years of post-construction monitoring at wind sites. Effort level for surveys is determined by assigned risk levels designated by the PGC using criteria outlined in the Agreement. Pre-construction survey results at proposed wind sites in 2007 – 2008 have provided both cooperators and PGC with valuable information that is being used to help site wind projects throughout Pennsylvania by avoiding and minimizing impacts to local and regional wildlife resources. Highlights of pre-construction monitoring during the past year were the discovery of the second largest Indiana bat (*Myotis sodalis*) maternity colony and the discovery of a female lactating silver-haired bat (*Lasiurus noctivagans*) and maternity colony. Pre-construction protocols have not been followed completely which has caused difficulties in comparing and analyzing data. Post-construction monitoring by the cooperators' has been recently initiated and monitoring information is limited, thus few discernable trends or analysis can be noted as this time. The Commission's commitment to safeguard wildlife resources that may be impacted by wind energy development has compelled the Commission to examine post-construction monitoring on non-cooperator wind projects sites as well. Future data from post-construction surveys will be paramount in assessing potential adverse impacts from wind development projects and guide our future mitigation efforts. The main achievements thus far have included the new bat discoveries mentioned above, the abandonment and avoidance of some high potential risk areas by wind developers, and that fact that wind developers are starting to get the PGC involved early in the planning stages which is helping developers make better decisions in regards to siting wind facilities. The primary challenges that remain include encouraging non-cooperators to sign the Agreement, improving communication between the PGC, developers, and consultants, and making sure survey protocols are being adhered to. The Cooperative Agreement is coming up on its two-year anniversary; this report summarizes what has been learned so far and discusses future efforts. The format and apparent success of the PGC Wind Energy Voluntary Cooperative Agreement has been praised as a clear example of the ability of wind energy developers and natural resource agencies to partner both on a national and state level.

Please note: This report has been internally reviewed by PGC staff and was also given to all cooperators and members of the PA Wind and Wildlife Collaborative for comment before being finalized.

INTRODUCTION/BACKGROUND

Act 213 of 2004, the Alternative Energy Portfolio Standards Act, signed into law by Governor Edward G. Rendell on November 30, 2004, requires that 18% of the electricity sold to retail customers in Pennsylvania come from renewable and advanced energy sources within 15 years. One of the technologies that will compete for a substantial share of Pennsylvania's alternative energy market is wind power. To assist in the development of wind energy in Pennsylvania in an environmentally responsible manner, Governor Rendell convened the Pennsylvania Wind & Wildlife Collaborative, which is a compilation of wind industry developers, natural resource agencies, and varied nongovernmental organizations having a vested interest in wind development in Pennsylvania. For a full listing of the Collaborative partners and minutes of meetings, please go to Department of Conservation and Natural Resources (DCNR) website (http://www.dcnr.state.pa.us/info/wind/). Results from the Arnett et al. (2005) mortality study and David Brandes (2006) paper on "Wind Power Development and Raptor Migration in the Central Appalachians," documenting impacts to birds and mammals from wind energy development highlighted the Collaborative's immediate concerns. The Collaborative is chaired by John Quigley of the Pennsylvania DCNR.

The Pennsylvania Game Commission (PGC), under the direction of Bureau Director William Capouillez, sought to work collaboratively with wind energy developers (cooperators) in order to immediately address the related potential impacts to the Commonwealth's bird and mammal resources, which was the major topic of discussion and concern as noted by the members of the Collaborative. The PGC took the lead in addressing the need since birds and mammals are directly managed by the PGC, under its jurisdiction from Title 34 (Game and Wildlife Code), giving the authority to protect, propagate, manage and preserve the game or wildlife of this Commonwealth and to enforce, by proper actions and proceedings, the laws of this Commonwealth relating thereto.

The PGC and many of the wind energy developers were dedicated to promoting renewable energy initiatives and arriving at uniform guidance, in the absence of comprehensive state regulations, to determine how best to avoid, minimize, and/or potentially mitigate adverse impacts to wildlife resources. These common goals guided the PGC and wind energy developers to begin an intense effort on how to best avoid, minimize, and/or mitigate potential adverse impacts with specific intent to birds and mammals by way of setting in writing a more formal Agreement and protocol. Thus, the Cooperative Agreement was developed in an effort to standardize wildlife monitoring protocols and wildlife impact review methods associated with the development of wind energy projects in a mutually beneficial and flexible manner and with high regard to both parties' goals and objectives.

The need for the Cooperative Agreement came about largely due to the absence of comprehensive state regulation. In addition, Pennsylvania's current environmental review database does not take into consider the migratory pathways of birds and bats, both of which may be susceptible to impacts from wind energy development. This database is incomplete due to many private lands having never been surveyed for threatened or endangered species. Finally, there was an overall lack of data in regards to the impacts of wind energy development on wildlife. Prior to the inception of the Agreement, the PGC was not made aware of many of the Commonwealth's proposed wind sites and was not aware of wildlife surveys, if any, being

conducted. There remains a lack of data in regards to pre-construction surveys, post-construction mortality data, and the correlation, if any, between the two. Some wildlife surveys have been completed, but overall, the surveys completed were not done in a consistent fashion and comparing data between locations and determining effects on wildlife were nearly impossible.

The Cooperative Agreement was initially drafted within the PGC by staff from both the Bureaus of Wildlife Habitat Management and Wildlife Management having expertise in bats, birds, and threatened and endangered species of birds and mammals existing within PA as well as their related habitats. The Cooperative Agreement draft was then was presented to the PA Wind and Wildlife Collaborative, including the wind energy developers, for input. Upon the PGC setting the objectives and goals of the Agreement, the wind industry became instrumental in determining what surveys could best meet those goals and objectives without significant delay of the projects or exorbitant cost to the developers.

In order to implement the PGC Wind Energy Voluntary Cooperative Agreement, in 2007 the PGC created four limited term wildlife biologist positions dedicated to wind energy. Tracey Librandi Mumma is the statewide wind energy project coordinator based in Harrisburg in the Bureau of Wildlife Habitat Management. There are three field support positions, each of which is 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 with 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.

For an in depth review of the PGC Wind Energy Voluntary Cooperative Agreement and its accompanying protocols, go to the PGC's public website at www.pgc.state.pa.us. Click on "Forms and Program" located on the left-hand side of the home page and then click on the documents listed in the upper right hand box labeled "WEVCA."

COOPERATORS

On April 18, 2007, 12 cooperators entered into the Agreement: AES Headwaters Wind; AES Keystone Wind; Airtricity, Inc.; Competitive Power Venture, Inc.; Energy Unlimited; Freedom Wind Energy; Gamesa Energy USA; Iberdrola Renewable Energies USA; PPM Atlantic Renewable; ReEnergy; UPC Wind Management; and US Wind Force. Between April 18, 2007 and September 30, 2008, an additional eight cooperators entered into the Agreement for a total of 20 cooperators. The additional eight cooperators include Acconia Wind Energy USA; AMP-Ohio/MESA; BP Alternative Energy; Everpower Renewable; Forward and Lookout Windpower; Global Winds Harvest, Inc.; Laurel Hill Wind Energy; and Penn Wind. As of September 30, 2008, no Agreements had been terminated by either party (cooperator or PGC). In addition to those cooperators noted above, there are four additional wind energy developers in Pennsylvania that have active wind sites or are proposing development, which are not affiliated with the PGC Wind Energy Voluntary Cooperative Agreement. These companies are FPL Energy with five active wind sites, Reading Anthracite with two proposed wind sites, STK Renewables with three proposed wind sites, and Laurel Highlands Energy with five proposed

wind sites. There are an additional seven in early stages of project proposal for which the potential operator has not been identified.

The cooperators' wind projects represent 71% (53 of the 75) of the wind projects that the PGC was aware, as of September 30, 2008. Of these 53 projects, 17 were grandfathered into the Agreement meaning they were either planned for construction within one year of entering the Agreement or were already built, and thus required to perform post-construction surveys. Table 1 summarizes the status of wind energy projects in Pennsylvania as of September 30, 2008.

Table 1. Status of wind energy projects in Pennsylvania as of September 30, 2008.

	Cooperator	Non-cooperator	Total
Total projects	53	22	75
Active	5	5	10
MW active [a]	194	129	323
MW under construction [a]	272	0	272
Proposed	48	17	65
New	31	17	48
Grandfathered	17	N/A	17

[a] From www.awea.org as of 9/30/08, MW= megawatts

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

OBJECTIVES & GOALS

Pre-construction

Birds.--Pre-construction raptor, eagle, and bird survey protocols are found in Exhibit A of the PGC Wind Energy Voluntary Cooperative Agreement with level of effort determined by location of the project area and raptor risk level. Goals and objectives were designed to more adequately address the Bald and Golden Eagle Protection Act, the Migratory Bird Treaty Act, the Endangered Species Act, and various state regulations such as Title 34, Game and Wildlife Code. Potential raptor risk levels were assigned to various ridges and summits throughout the state based on published data and geographical features, but many locations were categorized with little data and may not have been classified correctly. Survey data collected in a standardized manner will be used to correct these misunderstandings and better protect the wildlife resources with proper risk assessments.

The migrating raptor and eagle survey goal is to assess risk to migrating raptors from development of wind power at a particular site in order to avoid, minimize, and mitigate adverse impacts. The two objectives are: (1) observe raptors to determine the number, height of flight, time of day, flight path, avoidance behavior, and species passing through the project area and zone of greatest risk and (2) use the survey data to make recommendations to decrease potential

adverse impacts to the wildlife resource. The need for standardized raptor migration counting methods have long been recognized so there has been a significant effort on the part of hawk watch sites to use the same basic methodology so comparisons can be made between sites and between years (Robbins 1975, Hussell and Inzunza 2008).

The breeding bird survey goal is to assess risk to bird species listed in the Pennsylvania Wildlife Action Plan, formally called the Comprehensive Wildlife Conservation Strategy (Williams et al. 2005), in order to avoid and minimize direct and indirect impacts to these species and their habitats and to evaluate the potential for habitat enhancement/mitigation measures. The footprint of a wind development project may permanently displace quality habitat of our nesting birds with long-term effects on breeding bird productivity, especially Bird Species of Conservation Concern that are sensitive to forest fragmentation. The three objectives are: (1) proactively evaluate critical wildlife resources that may cause risk to the future stability of project operation, (2) use the data to help develop and implement the most appropriate post-construction habitat reclamation and management for the site, and (3) determine if state listed species are present and if present then further coordination with the Commission is required in order to avoid, minimize, or mitigate potential impacts to the species or their habitat.

Bats.--Pre-construction bat survey protocols are found in Exhibit B of the PGC Wind Energy Voluntary Cooperative Agreement with level of effort determined by bat risk level. A PGC permit is required for all surveys that require the handling of bats. These techniques may include tasks such as harp trapping, mist netting, or telemetry. Failure to comply with permit requirements will result in permit revocation.

Potential hibernacula investigations are conducted because bat hibernacula are usually located in areas of high bat density and some may contain PA threatened or endangered bats. If multiple hibernacula exist in an area, travel corridors may also exist. Goals of the bat hibernacula surveys are: (1) determine if any hibernacula exist within the project area in order to avoid and minimize impacts to active hibernacula and the associated bat species due to project development and its operation and (2) determine if bat hibernacula exist within five miles of the project area that may induce additional avoidance and minimization measures due to anticipated adverse bat impacts from project operations. Bat hibernacula present within the project area are the responsibility of the cooperator to investigate. Those hibernacula within five miles of the project area are the responsibility of the PGC to investigate. Objectives of this goal include conducting a field review to locate and determine use of potential bat hibernacula in the project area and five mile buffer, surveying bat hibernacula for species presence and abundance in order to assess potential impacts to bat species during the planning phase of the project construction, and evaluating the potential to avoid, minimize, and mitigate adverse impacts to bats and or enhance their habitat from project construction and operations.

The bat acoustic monitoring goal is to determine the presence, activity, and temporal use of the project area by bats in order to avoid and minimize potential adverse impacts, and eventually assist in determining future mitigation level of effort or timing. This goal has two objectives: (1) surveys will be conducted to evaluate the levels of bat activity within the project area and determine their temporal patterns and (2) evaluate the potential to avoid and minimize

adverse impacts to bats based on their probable use of the project area during the project's construction and future operations.

The bat mist netting goals are to determine what bat species are present in the project area, especially those listed by the United States Fish & Wildlife Service and/or the PGC as threatened or endangered species such as Indiana bats (*Myotis sodalis*) and eastern small-footed myotis (*Myotis leibii*) as well as their potential use of the area for maternity colonies. The recommended mist netting protocol can be found in the USFWS Indiana Bat Draft Recovery Plan: First Revision (2007). Bat telemetry goals are to determine areas of high use, travel corridors, foraging areas, roost trees, and maternity colonies of all species of federally and state listed bats, and if determined by the PGC, other species of special concern such as reproductive female silver-haired bats (*Lasiurus noctivagans*).

Other mammals.--Mammals other than bats, such as Allegheny woodrats (*Neotoma magister*), that may be impacted by wind energy development are dealt with on a site specific basis. The PGC evaluates each project area for known locations of state listed species and potential for state listed species. If state listed species are known or found to exist within the project area then further coordination with the Commission is required in order to avoid, minimize, or mitigate potential impacts to the species and their habitat.

Post-construction

Post-construction mortality monitoring survey protocols are found in Exhibit C of the PGC Wind Energy Voluntary Cooperative Agreement. Mortality monitoring is required of all sites and depending on bat and raptor risk levels additional post-construction surveys (such as bat acoustics, raptor migration surveys, etc.) may be required. A PGC Special Use Permit is required to conduct post-construction monitoring. Failure to comply with the requirements of the Special Use Permit will result in permit revocation and violation of the PGC Wind Energy Voluntary Cooperative Agreement.

The goals of post-construction mortality monitoring are: (1) to obtain data collected under a standardized protocol for future comparison, (2) to accurately determine the direct mortality of bats and birds from each project operation, (3) to initiate measures to minimize or mitigate if levels are unacceptable and if needed, induce additional minimization or mitigation measures, and (4) to assess the predictive value of pre-construction monitoring, minimization and avoidance measures by comparing those results with post-construction mortality.

Determining the mortality of bats and birds has two objectives: (1) conduct mortality surveys in the most cost-effective and proficient manner and (2) provide a mechanism to evaluate the proficiency of the project's mortality survey methodology. Another objective within the post-construction goals is to revise, adapt, replace, or eliminate protocols or monitoring methods as needed based of their level of success. Further, post-construction monitoring is designed to be adaptive to appropriate adjustments being made based on monitoring protocol results and future effort as indicated by the acquired information.

RISK ASSESSMENTS & PGC REVIEW OF PROJECTS

The risk assessment assigned for bats and raptors dictates what surveys and level of effort are required. Risks associated with other species of special concern birds and mammals are addressed separately by species specific survey needs. The PGC, using the criteria listed in the Cooperative Agreement, determines the risk level for monitoring and survey efforts. The risk level may be adjusted based on new relevant information. As of September 30, 2008, three sites have had their bat risk level increased from low to high based on the results of pre-construction surveys. No sites have had their bat or raptor risk level decreased or raptor risk increased due to pre-construction survey results. Table 2 shows the raptor and bat risk assessments of the 75 wind projects as of September 30, 2008.

Table 2. Raptor and bat risk levels of the 75 Pennsylvania wind projects as of September 30, 2008.

Risk Level	Raptor	Bat
Low	24	25
Moderate	16	5
High	10	20
Not assessed yet	25	25

Risk assessments provided by the PGC are used to determine monitoring effort and to help developers determine wind turbine locations. Cooperators are encouraged to submit proposed project information earlier than 14 months prior to construction so that the PGC can help in the early planning stages in regards to avoiding and minimizing impacts to birds and mammals. Some cooperators that have submitted information on proposed projects more than 14 months in advance noted the benefit to their planning and investor processes. The cooperators were better equipped to make decisions in regards to whether or not to process with conceptual projects based on the information provided by the PGC.

PA WIND PROJECT SITE LOCATION

All of the 75 proposed and active wind sites are located in the Appalachian Plateau and Ridge and Valley regions of Pennsylvania (Figure 1). Wind developers initially targeted ridge tops but they have started to branch out into the northcentral part of Pennsylvania and onto some of the less prominent ridges and summits statewide. The northwest and southeast portions of Pennsylvania have not yet been targeted for wind development although this may change in the near future as the prime locations become developed and efforts of offshore wind development in the Great Lakes increase.

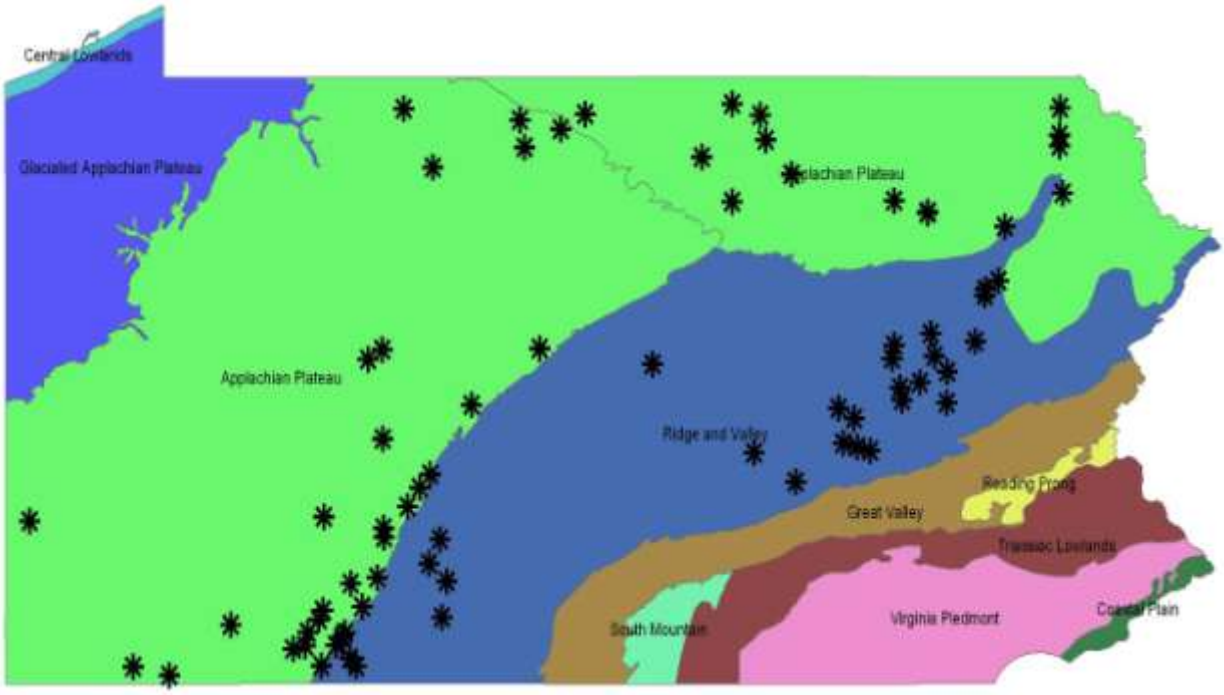

Figure 1. Wind projects (active and proposed) in Pennsylvania as of September 30, 2008.

The PGC classifies turbine configuration as one of the following: linear, linear groupings, clusters, and undetermined. "Linear" configuration is a single straight line of turbines. "Linear groupings" are more than one linear string of turbines. "Clusters" are turbines that are configured in non-linear groups or placed randomly within the project area. "Undetermined" configurations were those projects in which turbine configuration has not yet been established. There is one site that had only one turbine and thus a turbine configuration was not designated. The other 74 sites are broken down as follows: 20 linear, 11 linear groupings, 9 clusters, 34 undetermined. Of these known configurations, those projects within the Appalachian Plateau are 6 linear, 9 linear groupings, 9 clusters, and 20 undetermined, while those in the Ridge and Valley are 14 linear, 2 linear groupings, zero clusters, and 13 undetermined. There are three additional sites for which a physiographic region can not be determined based on known information.

Site locations are described as being ridgetop, escarpment, butte, or unknown. This determination is made by examining topographical maps. "Ridgetop" is described as being a long, narrow chain of hills or mountains. "Escarpment" is described as a transition zone involving a sharp, steep elevation differential, characterized by a cliff or steep slope. "Butte" is described as an isolated hill (or hills) with steep, often vertical sides and a small flat top. Site locations were designated by categories with the following frequencies: 23 ridgetop, 9 escarpments, 37 butte, and 6 unknown.

Elevation of wind projects in Pennsylvania ranged from 600 to 2820 feet above sea level; Pennsylvania's elevation ranges from sea level to 3,213 feet above sea level. Figure 2 shows the median elevation of the 75 wind sites, both active and proposed, in Pennsylvania.

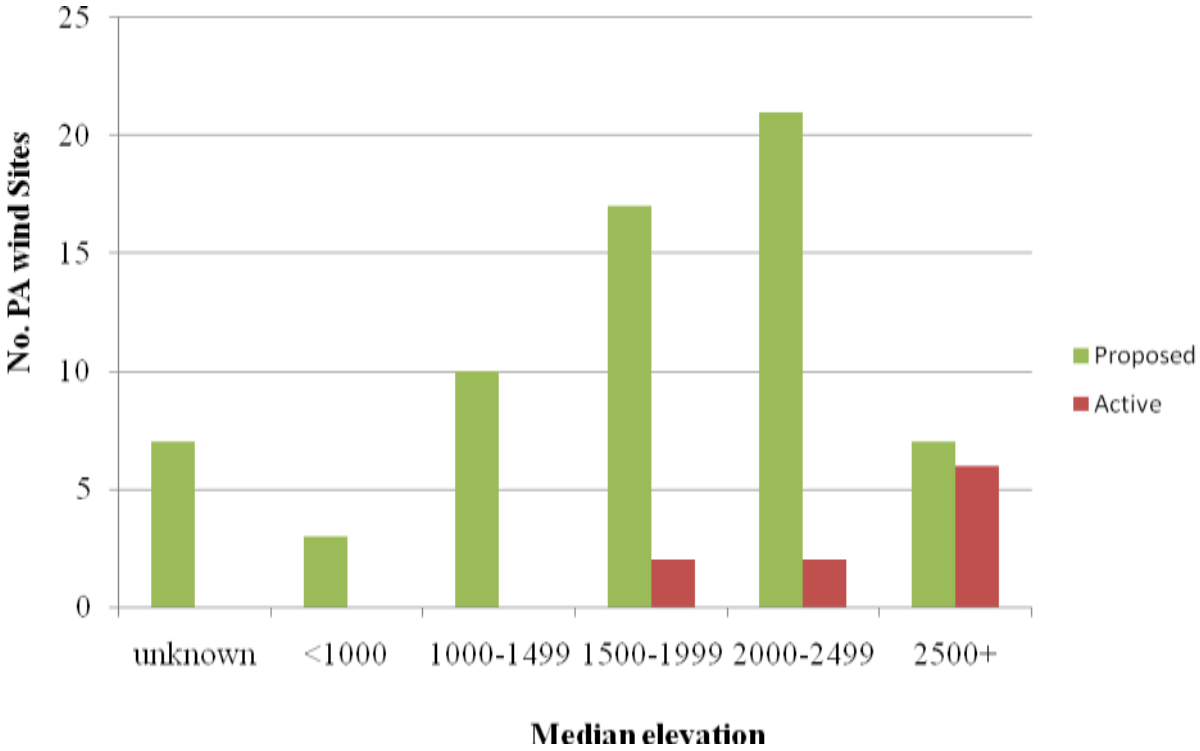

Figure 2. Median elevation of Pennsylvania's 75 active and proposed wind sites.

Land cover types vary across the state, but the primary land cover type for 84% of the wind energy development sites is deciduous forest; Pennsylvania's land cover statewide consists of 57% deciduous forest (Williams et al. 2005). Eight percent of sites have not been assessed because delineated project areas have not yet been submitted and the remaining 8% had primary land cover types that were either agricultural (hay, pastures, or row crops) or mining (mines or quarries). Further analysis of land cover types in relation to pre- and post-construction survey results is planned for the future.

SURVEY RESULTS SUMMARY

Table 3 shows the number of surveys both pre- and post-construction that were conducted in Pennsylvania since 2004. It is worthy to note that the PGC Wind Energy Voluntary Cooperative Agreement came into effect in April 2007, so most of the surveys done before April 2007 or during 2007, were not done following PGC standardized protocols. These inconsistencies have resulted in difficulties interpreting results and comparing results among sites. Site names and locations have been replaced with a site ID code in data summary tables to keep this information confidential as per the Cooperative Agreement.

Table 3. Summary of bird and mammal surveys completed on wind facilities in Pennsylvania, 2004 – 2008.

	2004	2005	2006	2007	2008	Total
Pre-construction						
Potential hibernacula investigations [a]	0	3	5	4	3	15
Bat acoustics	0	1	6	10	6	23
Bat mist netting	1	2	6	6	10	25
Bat telemetry	0	0	0	3	3	6
Breeding bird surveys	0	0	2	10	6	18
Fall raptor migration	1	1	6	9	4	21
Spring raptor migration	0	0	5	6	5	16
Woodrat[b]	0	1	3	2	2	8
Radar [c]	1	4	4	4	1	14
Post-construction						
Mortality (bird and bat)	1[d]	0	1[d]	1	4	7
Bat acoustics	0	0	0	0	3	3
Fall raptor migration	0	0	0	0	2	2
Spring raptor migration	0	0	0	0	0	0
Radar	0	0	0	0	1	1
Total numbers of surveys conducted	4	12	38	55	50	159

[a] Potential bat hibernacula surveys refer only to those conducted on the project area by the cooperator.
[b] State listed threatened Allegheny woodrats (*Neotoma magister*) surveys are requested by the PGC on sites that have known locations of woodrats on or near the project area.
[c] Survey not required by the Cooperative Agreement.
[d] Mortality surveys conducted prior to Cooperative Agreement not done as per the current protocol.

Based on all wind energy sites within Pennsylvania, twenty-one wind sites conducted one or more pre-construction wildlife surveys, and four sites have initiated post-construction surveys since the Agreement has been in place. The PGC is establishing databases to house the data to facilitate regional and statewide comparisons. Unfortunately, these databases remain incomplete due to the increased activity in wind energy development which has created an increase in the volume of work and strain on existing PGC staff resources.

For all pre-construction surveys, the PGC encourages all wind energy developers to have PGC staff involved in the selection of observation sites, acoustic detector locations, and other details of the studies. The PGC attempts to get on site during each survey at least once to answer questions, make sure the agreed upon monitoring protocols are being followed, and that the correct data sheets are being used and properly completed. Keeping the lines of communication open between consultant, wind energy developer, and the PGC is essential for recognizing and correcting problems as they arise instead of collecting a full season of data that are not standardized and unusable because it was not collected as per the approved protocol. PGC wind biologists were on proposed wind project sites to observe 22 pre-construction surveys (5 bat, 12

bird, 4 woodrat, and 1 radar) and all 4 post-construction surveys between October 2007 and September 30, 2008.

Pre-construction

Birds: Raptor and Eagle Migration Surveys.--Raptor migration varied across the state as expected. A summary of the results from pre-construction fall raptor surveys done from 2004 to present, that the PGC has received data from, are shown in Table 4. The total number of each species observed at each wind site was standardized by dividing total number of observed raptors by the total number of observation hours in order to calculate a measure of observed raptors per hour. The raptors per hour for each species, was then multiplied by 8 hours (one observation day) to get the daily passage rate. Raptors per hour varied for all sites regardless of the raptor risk level. Two sites (wind sites 2-1 and 35-1) had higher raptors per hour values than the other sites even though both were low raptor risk sites. Surveys done for a short period of time during peak migration of specific species may explain higher daily passage rates values. Both of these fall raptor migration surveys were conducted in September-October which is when broad-winged hawks migrate, and their effect on the results are demonstrated by the daily passage rate of broad-winged hawks. This effect also is illustrated for the higher daily passage rate values for American kestrels, bald eagles, and broad-winged hawks for wind site 35-1 whose raptor survey was done for a total of two days during these species' peak migration. One of the benefits of low raptor risk sites which are voluntarily conducting raptor migration surveys is that data is being collected on ridges and summits for which there was little or no previous raptor migration data.

Most sites that conducted fall raptor migrations surveys in 2007 observed at least one bald eagle. Generally, few bald eagles are seen at any site on any given day but have been increasing in the Northeastern states as bald eagle populations have recovered (Farmer et al. 2008). Fall 2007 raptor migration surveys have documented bald and golden eagles migrating through the northcentral and northeast portions of Pennsylvania. These data are corroborated by research being done by the National Aviary (Katzner et al. 2008). High risk raptor sites had higher daily passage rate values of golden eagles than moderate or low risk sites with the exception of low risk wind site 35-1. The high daily passage rate of golden eagles at wind site 35-1 could be skewed due to the fact that only two days of observation occurred at this site as compared to other sites' surveys having been conducted as for as long as 76 days. A second reason could be that perhaps golden eagle migration has been occurring at this area but had never been previously documented. Bald eagles were seen at all but one proposed site with the highest daily passage rate levels of bald eagles being represented by one low, one moderate, and one high potential raptor risk site. Turkey vultures and red-tailed hawks were the most common raptors seen per observation day during fall migration surveys whereas peregrine falcons and rough-legged hawks were the least observed.

A summary of the pre-construction spring raptor surveys done from 2006 – present, from which the PGC has received data from, are shown in Table 5. No spring raptor migration surveys were done prior to 2006. Total number of each species observed at each wind site was standardized by dividing total number of observed raptors by the total number of observation hours to get raptors per hour. The raptors per hour for each species, was then multiplied by 8 hours (one observation day) to get the daily passage rate. Turkey vultures and red-tailed hawks

were the most common raptors seen per observation day during spring migration surveys whereas peregrine falcons and merlins were the least observed.

Most sites did observe at least one bald eagle but, unlike the fall raptor surveys, it appears that bald eagle observations in the spring are related to raptor risk level. High risk sites tended to have larger numbers of bald and golden eagles observed compared to lower raptor risk sites, supporting the current PGC risk designations. Spring raptor migration surveys conducted in 2006-07 were done when the Agreement and protocols were being finalized and thus most surveys done during this time period did not follow the current protocol. Many of the surveys were done in April instead of March and were not done during times of day outlined in the protocol. The surveys that were conducted in March (wind sites 3-2, 3-4, 24-2, 2-19, and 4-3) observed golden eagles, compared to the sites that conducted spring migrations surveys in April – May that observed no golden eagles. This data supports the premise that spring raptor migration surveys need to be done as per the PGC's recommended protocols, in March, to include eagle migration (McWilliams and Brauning 2000, Brandes 1998, and Brodeur et al. 1996). The 2008 spring raptor migration surveys were not all conducted as per the PGC recommended protocols set forth in the Cooperative Agreement. Issues with the 2008 spring raptor migration surveys involved either cooperators not consulting with the PGC before conducting the surveys resulting in surveys not meeting the effort requirements for their risk level or cooperators not consulting with the PGC prior to the start of the survey season resulting in delayed starts to their monitoring efforts. Flight pathways and height for both fall and spring raptor migration surveys will be analyzed to determine if there are any patterns or trends in the coming years.

Table 4. Summary of pre-construction fall raptor migration surveys done at Pennsylvania wind sites, 2004 – present. Raptor species are designated by AMKE=American kestrel, BAEA=Bald eagle, BLVU=Black vulture, BWHA=Broad winged hawk, COHA=Cooper's hawk, GOEA=Golden eagle, MERL=Merlin, NOGO=Northern Goshawk, NOHA=Northern harrier, OSPR=Osprey, PEFA=Peregrine falcon, RSHA=Red shouldered hawk, RTHA=Red tailed hawk, RLHA=Rough legged hawk, SSHA=Sharp shinned hawk, TUVU=Turkey vulture, and unidentified raptor.

										Daily Passage Rate [a]																
Wind site	Risk	Year	Dates	No. days	Hours/ day	Total hours	Raptor/ hr	No. species	Total No. raptors	AMKE	BAEA [b]	BLVU	BWHA [c]	COHA	GOEA [d]	MERL	NOGO [e]	NOHA [f]	OSPR [g]	PEFA [h]	RSHA [i]	RTHA	RLHA	SSHA [j]	TUVU	Unidentified Raptor
3-2	H	2005	10/09-12/14	54	6.4	347.8	2.3	12	792	0.0	0.2	0.0	0.0	0.2	1.2	0.0	0.0	0.1	0.0	0.1	0.1	6.2	0.5	0.2	8.0	1.3
3-4	H	2007	8/25-12/14	67	7.6	507.0	1.5	15	2014	0.2	0.7	0.3	7.4	0.7	1.2	0.1	0.0	0.6	0.6	0.0	0.2	7.3	0.0	5.9	6.3	0.3
24-2	H	2007	8/24-12/14	67	7.1	478.1	2.8	14	1332	0.1	0.3	0.0	4.0	0.5	0.7	0.0	0.0	0.3	0.4	0.0	0.1	7.4	0.0	3.7	4.4	0.5
2-18	H	2007	8/26-12/14	76	7.7	586.0	2.1	16	1207	0.1	0.1	0.0	3.0	0.7	0.6	0.0	0.0	0.2	0.2	0.0	0.3	6.4	0.1	2.8	1.7	0.3
2-4	M	2007	9/10-12/18	51	6.1	309.8	1.4	15	419	0.8	0.1	0.0	1.2	0.1	0.1	0.2	0.1	1.1	0.0	0.0	0.2	1.7	0.1	0.5	3.7	1.0
2-5	M	2007	9/10-12/18	51	6.1	309.8	1.4	15	419	0.8	0.1	0.0	1.2	0.1	0.1	0.2	0.1	1.1	0.0	0.0	0.2	1.7	0.1	0.5	3.7	1.0
5-6	M	2006	9/15-11/14	28	7.3	205.6	3.0	14	616	0.5	0.7	0.0	1.6	0.9	0.1	0.9	0.0	0.2	0.5	0.4	0.1	5.0	0.2	7.0	5.3	0.5
2-2	L	2004	10/7-11/15	37	6.8	250.7	4.0	13	997	0.5	0.1	0.7	0.0	1.4	0.2	0.0	0.1	2.7	0.2	0.0	0.4	13.1	0.2	1.7	10.2	0.3
2-7	L	2006	9/1-11/15	33	7.4	245.3	2.3	13	552	0.1	0.1	0.6	1.8	0.4	0.1	0.1	0.0	0.1	0.3	0.0	0.0	2.1	0.0	0.8	10.7	0.9
2-15	L	2006	10/25-12/1	34	7.4	252.9	1.3	8	322	0.1	0.0	0.0	0.0	0.5	0.0	0.1	0.0	0.8	0.0	0.0	0.2	6.9	0.0	0.6	0.9	0.0
2-1	L	2006	9/14-10/13	10	6.0	59.75	10.4	10	622	1.2	0.4	0.0	46.9	0.4	0.0	0.0	0.0	1.9	0.8	0.0	0.3	4.2	0.0	5.9	20.5	0.9
5-15	L	2007	9/16-12/17	5	8.0	40.0	3.6	10	144	0.2	0.0	0.0	12.0	1.2	0.0	0.4	0.8	0.4	0.4	0.0	0.4	7.6	0.0	0.0	3.4	2.0
3-6	L	2007	9/17-12/16	14	7.8	108.5	1.4	10	147	0.0	0.1	0.0	5.8	0.2	0.2	0.0	0.1	0.1	0.0	0.0	0.1	2.3	0.0	0.2	1.5	0.1
35-1	L	2007	9/13-9/19	2	8.0	16.0	6.3	12	101	2.5	2.0	0.0	15.0	3.0	0.5	1.5	0.0	1.0	1.0	0.0	0.5	4.0	0.0	5.5	13.5	0.5
6-1	L	2006	9/1-11/15	62	7.2	444.5	4.6	16	2058	0.5	0.3	2.2	7.6	0.6	0.0	0.5	0.1	1.0	0.3	0.2	0.6	7.8	0.0	1.8	11.2	2.3
6-3	L	2006	9/1-11/15	62	7.2	444.5	4.6	16	2058	0.5	0.3	2.2	7.6	0.6	0.0	0.5	0.1	1.0	0.3	0.2	0.6	7.8	0.0	1.8	11.2	2.3

[a] Daily passage rate = (# raptors observed / total # observation hours)*8 hours
[b] PA state listed threatened; PA Wildlife Action Plan high level concern
[c] PA Wildlife Action Plan maintenance concern
[d] PA Wildlife Action Plan PA vulnerable
[e] PA Wildlife Action Plan PA vulnerable
[f] PA Wildlife Action Plan high level concern
[g] PA state listed threatened; PA Wildlife Action Plan PA vulnerable
[h] PA state listed endangered; PA Wildlife Action Plan high level concern
[i] PA Wildlife Action Plan maintenance concern
[j] PA Wildlife Action Plan maintenance concern

Table 5. Summary of pre-construction spring raptor migration surveys done at Pennsylvania wind sites, 2006 – present. Raptor species are designated by AMKE=American kestrel, BAEA=Bald eagle, BLVU=Black vulture, BWHA=Broad-winged hawk, COHA=Cooper's hawk, GOEA=Golden eagle, MERL=Merlin, NOGO=Northern Goshawk, NOHA=Northern harrier, OSPR=Osprey, PEFA=Peregrine falcon, RSHA=Red-shouldered hawk, RTHA=Red-tailed hawk, RLHA=Rough-legged hawk, SSHA=Sharp-shinned hawk, TUVU=Turkey vulture, and Unidentified raptor.

										Daily Passage Rate [a]															
Wind Site	Risk	Year	Dates	No. days	Hours/ day	Total hours	Raptor/ hr	No. species	Total No. raptors	AMKE	BAEA [b]	BLVU	BWHA [c]	COHA	GOEA [d]	MERL	NOGO [e]	NOHA [f]	OSPR [g]	PEFA [h]	RSHA [i]	RTHA	RLHA	SSHA [j]	TUVU	Unidentified Raptor
3-2	H	2006	2/25-3-31	34	7.5	254	0.8	12	223	0.09	0.25	0.03	0.00	0.09	1.48	0.00	0.00	0.31	0.03	0.00	0.38	1.79	0.13	0.13	2.01	0.28
2-7	L	2006	4/3-5/29	28	7.0	197	2.7	10	523	0.04	0.00	0.04	1.59	1.87	0.00	0.00	0.00	0.12	0.37	0.00	0.04	3.83	0.00	0.53	12.74	0.12
2-1	L	2006	4/6-5/10	7	5.7	40	4.9	10	196	2.20	0.00	0.00	3.60	0.40	0.00	0.00	0.40	2.80	0.20	0.00	0.80	6.20	0.00	1.60	21.00	0.00
6-1	L	2006	4/20-5/31	37	8.0	295	1.0	12	289	0.03	0.05	0.05	0.57	0.16	0.00	0.03	0.03	0.03	0.35	0.00	0.00	0.41	0.00	0.33	5.69	0.11
6-3	L	2006	4/20-5/31	37	8.0	295	1.0	12	289	0.03	0.05	0.05	0.57	0.16	0.00	0.03	0.03	0.03	0.35	0.00	0.00	0.41	0.00	0.33	5.69	0.11
3-4	H	2007	3/2-4/6	30	7.7	230	1.1	10	247	0.03	0.07	0.00	0.00	0.77	0.66	0.00	0.00	0.38	0.03	0.00	0.17	1.98	0.00	0.07	4.21	0.21
24-2	H	2007	3/1-4/6	32	7.3	232	1.6	14	372	0.17	0.21	0.21	0.00	0.41	0.72	0.10	0.07	0.28	0.03	0.00	0.38	2.31	0.07	0.31	7.13	0.41
2-18	H	2007	4/24-5/3	8	8.6	68.8	2.3	9	161	0.00	0.23	0.35	0.81	0.00	0.00	0.00	0.00	0.12	0.93	0.00	0.00	2.44	0.35	1.16	9.43	2.91
2-19	H	2007	3/10-4/13	25	7.1	177	5.0	13	894	0.23	0.05	0.50	0.00	0.32	0.36	0.32	0.00	0.27	0.18	0.00	0.41	5.96	0.14	0.77	29.01	1.85
35-1	L	2007	4/3-4/23	2	6.5	13	3.3	8	43	0.00	0.00	0.00	1.85	3.08	0.00	0.00	0.62	0.00	0.62	0.00	0.62	8.62	0.00	0.62	9.23	1.23
4-3	M	2007	2/27-4/6	34	6.8	230	6.8	14	1292	0.42	0.17	1.15	0.03	0.73	1.04	0.07	0.00	0.31	0.14	0.00	0.90	6.19	0.00	1.25	29.9	2.54
2-4	M	2008	3/11-3/31	15	7.6	114	0.9	10	101	0.42	0.07	0.07	0.14	0.00	0.00	0.00	0.00	0.70	0.00	0.00	0.21	1.26	0.07	0.07	3.86	0.21
2-5	M	2008	3/11-3/31	15	7.6	114	0.9	10	101	0.42	0.07	0.07	0.14	0.00	0.00	0.00	0.00	0.70	0.00	0.00	0.21	1.26	0.07	0.07	3.86	0.21

[a] Daily passage rate = (# raptors observed / total # observation hours)*8 hours
[b] PA state listed threatened; PA Wildlife Action Plan high level concern
[c] PA Wildlife Action Plan maintenance concern
[d] PA Wildlife Action Plan PA vulnerable
[e] PA Wildlife Action Plan PA vulnerable
[f] PA Wildlife Action Plan high level concern
[g] PA state listed threatened; PA Wildlife Action Plan PA vulnerable
[h] PA state listed endangered; PA Wildlife Action Plan high level concern
[i] PA Wildlife Action Plan maintenance concern
[j] PA Wildlife Action Plan maintenance concern

Birds: Breeding Bird Surveys.--Results of the breeding bird surveys (BBS) received by the PGC are found in Table 6. No BBS were conducted at proposed wind sites prior to 2006. Ten sites in 2007 conducted BBS, but few followed the PGC protocol making it difficult to compare survey results. There were six BBS done in 2008 of which the majority more closely followed the PGC's approved protocols than those conducted in 2007. However, survey difficulties did occur, the most common being that either the entire project area was not covered (usually because the project area had not yet been finalized) and that not all habitats were being assessed within the project area. Another problem with surveys not following protocol was that point counts were not being done at time periods recommended in the protocol (once in May and twice in June and that June visits were separated by at least one week. These inconsistencies probably lead to false conclusions about the status (absence or presence, migrant or breeding) of bird species listed in the Wildlife Action Plan (Williams et al. 2005) and the size of their populations at the site. From the limited data collected it is evident that area searches effectively document additional species in the project area that were not documented with point count methodology. Several species listed in Pennsylvania as either endangered, threatened, or species of special concern are more easily detected with area searches or specialized surveys than with point counts. Lastly, some survey reports were being submitted to the PGC without the accompanying data and completed data sheets that give veracity and accountability to the claims of the cooperators. The PGC continues to express to the cooperators the importance of consulting with the PGC to determine where point counts and area searches should be done prior to commencing BBS to insure that the entire area and all habitats are being covered to avoid having to redo or do additional surveys. The Agreement does not required post-construction BBS unless the PGC deems it necessary due to the presence of a threatened or endangered species or species of special concern. The PGC does recommend post-construction BBS, especially on sites where forest interior breeding birds have been documented in order to record whether those species observed prior to construction activities remain on site after construction has been completed.

Table 6. Summary of BBS done pre-construction at proposed wind sites in Pennsylvania, 2006 - 2007. "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.

		Survey dates				No. species										
Wind site	Year	Point count	Area search	No. point counts	No. area searches	Total	Point count	Area search	PA endangered	PA threatened	PA WAP[a]	Total No. individual records	No. species confirmed breeders	No. species probable breeders	No. species possible breeders	Habitats represented by species observed
2-1[b]	2006	6/1-2; 6/8-9	not in report	16	not in report	38	38	not in report	0	0	9	348	not in report	not in report	not in report	forest interior/ grassland/ successional
2-19[c]	2006	n/a	5/2 – 7/6	n/a	2	73	n/a	73	1	0	16	not in report	17	24	22	grassland/ forest edge
2-18[d]	2007	5/31; 6/7; 6/18-19	n/a	n/a	n/a	69	n/a	n/a	1	0	15	not in report	11	34	17	forest interior/ forest edge
2-4 & 2-5	2007	5/23-24; 6/6-7; 6/13-14	5/23-24; 6/6-7; 6/13-14	20	14	81	71	46	1	0	19	910	not in report	not in report	not in report	grassland/ forest
3-4	2007	5/8-9; 6/5-8	not in report	42	not in report	86	64	22	0	0	15	5876	14	22	34	forest interior/ forest edge
35-1	2007	5/23-24; 6/5-6; 6/19-22	5/23-24; 6/5-6; 6/19-22	34	13	97	91	52	1	0	20	1346	not in report	not in report	not in report	forest edge/ riparian/ wetland/ mixed forest/ field
24-2	2007	5/10-11	not in report	28	not in report	106	76	30	0	0	23	3567	12	27	52	grassland/ forest interior/ forest edge
2-7	2007	5/ 22-23; 6/27-30	4/23-24	28	not in report	95	53	not in report	0	0	20	1630	10	8	53	forest interior/ forest edge/ grassland
2-15	2007	5/19; 6/17-18	4/17, 4/27-28	18	not in report	97	not in report	not in report	1	1	18	2691	13	8	83	grassland/ forest interior/ forest edge
4-3	2007	5/ 20-21; 6/19-22	4/21-22	28	not in report	91	62	29	1	1	20	3099	11	9	47	forest interior/ forest edge

[a] Species listed in the PA Wildlife Action Plan (WAP), Williams et al. 2005.
[b] Survey did not follow BBS protocol in regards to dates of surveys, time spent observing, etc.
[c] Survey did not follow BBS protocol and area searches covered <25% of project area.
[d] Survey did not follow BBS protocol; no point counts conducted, instead transects were walked.

Bats: Potential Hibernacula Investigations.--The investigation of potential hibernacula within the project area is the cooperators' responsibility. Since the Cooperative Agreement has been in effect, no new bat hibernacula have been located by cooperators on proposed wind energy project areas. Table 7 shows how many known mines have been investigated within five miles of wind projects by PGC wind biologists in their respective region and hours spent conducting those investigating. Two of the mine features investigated in the NE/SE region were known bat hibernacula records that were 14 years old with no GPS coordinates available. Once located, these two features were trapped and both were found to contain bats. One hibernaculum contained the state listed threatened eastern small-footed myotis, reconfirming the bat species presence from the 14 year old record and confirming that the hibernaculum was one of concern according to the Cooperative Agreement. A mine feature in the NW/SW region was further investigated by trapping and two species of special concern northern long-eared myotis (*Myotis septentrionalis*) were caught.

Table 7. Potential bat hibernacula investigated by PGC wind biologists, by PGC region, through September 30, 2008.

Investigated by PGC staff	NW/SW	NC/SC	NE/SE	Total
No. mines within 5 mi of project area	115	126	6	247
Total hours spent investigating mines	132	112	29	273

Bats: Acoustic Monitoring.--Acoustic monitoring has proven to be the most challenging of all the surveys. Many problems have occurred during the data collection and analyses. One of the most common problems is detectors being operated from 7 pm until 7 am instead of the recommended PGC protocol of ½ before sunset until ½ after sunrise. This action was further complicated by varying success rates (percent of the time detectors are properly functioning and collecting data). However, survey success was improved later in the year as communication between the cooperators and the PGC improved in regards to making sure protocols were being followed. No acoustic surveys conducted in 2007 from which we have received data, followed the protocol exactly. The success rate of acoustic monitoring in 2007 varied between sites due to problems including memory card overload, vandalism, and malfunctioning detectors (Table 8).

Detector number and height vary between wind sites with most sites having two detectors at different heights; one at moderate level and the second at low or high level. Height levels fall in one of the following categories: ground level <5 m, low level 5 - 10 m, moderate level >10 - <40 m, and high level 40 - 50 m. Other variations included sites that have only one detector versus sites having three detectors at various heights. General trends from the limited bat acoustic data obtained by the PGC thus far include the big brown/hoary/silver-haired guild appearing to have greater activity at high detectors; red bats (*Lasiurus borealis*) and pipistrelles (*Perimyotis subflavus*) are found to have approximately the same activity level at all detector heights; and *Myotis* species are found to have greater activity at the low level detectors. From a seasonal perspective, bat activity has been shown to peak in late summer/early fall. Daily activity patterns show peaks in activity throughout the night, the first being in the first few hours after sunset and the second being during early morning, a few hours before sunrise. These activity peaks reinforce the importance of monitoring sites in the context of sunrise and sunset, rather than at a specific time. Preliminary data sets will be examined by the PGC in relation to the local cover type. Higher bat activity was noted to occur at a detector set up near an open

water pond versus those in forested areas at one proposed wind site location. The high level of bat activity concentrated at the open water pond can most likely be attributed to bat feeding activity.

The PGC determined that in order to make any kind of recommendation based on the data collected, the overall success rate at the sites should be at least 80%. This 80% minimum criteria threshold has prompted cooperators to target 80% success (80% of the nights with data being collected) since spring 2008, which is when the PGC initially received and reviewed the acoustic reports from 2007 and realized there was an existing problem. By having a target success percentage, the cooperator is encouraged to monitor the detectors more frequently. This ensures that problems are discovered and remedied as soon as possible, minimizing the risk of data loss and potential need to redo the survey. Only three sites had data for 80% of the nights for the July 15 - October 15, 2007 period, shown in Figure 3. Each of the three sites had at least two detectors, one moderate level (>10 - <40 m) and one high level (40+ m) detector per met tower. Data was standardized by determining bat calls/week/met tower using the moderate and high level detector data. Figure 3 also shows that, at least for these three sites, peak activity weeks varied among sites.

Table 8. Pre-construction bat acoustic surveys results, Pennsylvania, 2007. Success is defined as percent of nights detectors are functioning properly and collecting data.

Site ID	Initial bat risk[a]	Survey Dates	Average calls/night	Average calls/hr	Overall success rate (%)	No. detectors on site
5-15	high	7/14-11/15/07	10.8	3.04	32	1 at 1 location
2-4	low	9/10-10/21/07	3.6	0.34	75	2 at 1 location
2-5	low	9/10-10/21/07	3.6	0.34	12	2 at 1 location
3-6	low	7/10-11/11/07	2.5	0.21	84	4 (2 at 2 locations)
35-1	low	7/10-10/14/07	3.6	0.30	80	8 (2 at 3 locations and 1 at 2 other locations)
3-4	low	7/12-11/4/07	1.8	0.15	[b]	3 at 1 location
24-2	low	4/15-11/9/07	19	1.6	95	3 at 1 location

[a] Bat risk is the original bat risk assessment of the proposed project determined before pre-construction surveys were completed.

[b] Vandalism occurred at this site so success rate was not calculated.

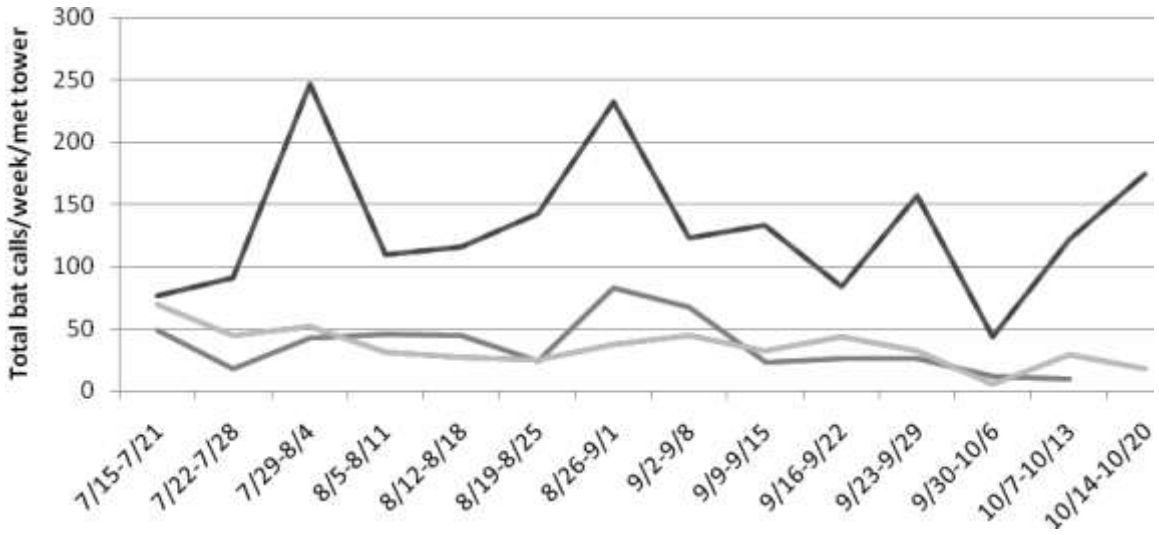

Figure 3. Total number of bat calls per week per met tower for three Pennsylvania wind sites that had data collected at least 80% of the nights from July 15 – October 15, 2007. Data from 2 detectors (moderate and high levels) per met tower were used to calculate weekly bat call totals. All three proposed sites were initially designed as low potential bat risk as per the Cooperative Agreement criteria.

Bats: Mist Netting.--Mist net surveys are being conducted based on the Cooperative Agreement criteria on high potential bat risk projects and also in response to U.S. Fish and Wildlife Service (USFWS) requests. Cooperators tend to complete this survey early on. Mist net surveys are of great value to the PGC in terms of showing what species are present in the project area and determining if breeding populations are present by way of juveniles and reproductive females captured. Additionally, mist net surveys can also provide critical information in regard to identifying threatened and endangered species since these species caught in mist nets can be fixed with transmitters and telemetry performed. As with the other surveys, consulting with the PGC, and if applicable, the USFWS prior to conducting mist netting surveys is critical in order to avoid having to redo or conduct additional surveys due to poor or not enough site locations. Additionally, early coordination ensures protocols are followed in regards to hours of survey, duration, and utilization of qualified surveyors. Some cooperators have learned this year that the mist net surveys they had completed in 2007 were unacceptable for one of the above reasons and are planning to conduct additional surveys in order to meet the Cooperative Agreement's criteria and get clearance from USFWS and/or PGC for their project.

The highlight of the mist net survey results was the discovery of a silver-haired bat maternity colony, the first record of the species breeding in Pennsylvania. Summary of mist netting results are shown in Table 9. No mist netting surveys were done on proposed wind sites prior to 2004. Bats per mist net site varied from 8.2 to 59.2 and were not correlated with bat risk level. Three sites captured seven species of bats (nine species of bats occur in Pennsylvania; two additional species are rare visitors from the South), and all sites were previously denoted as high bat risk; otherwise, the total number of species did not appear to be related to risk level.

Table 9. Wind energy project mist net survey results, 2004 – present. Bat species are designated by MYLU=*Myotis lucifugus*, MYSE=*Myotis septentrionalis*, EPFU=*Eptesicus fuscus*, PESU=*Perimyotis subflavus*, LABO=*Lasiurus borealis*, LACI=*Lasiurus cinereus*, LANO=*Lasiurus noctivagans*, MYLE=*Myotis leibii*, MYSO=*Myotis sodalis*, UNK = unknown (flew away before identified). The last row shows totals with the exceptions of No. of species and bats/mist net site which are averages of all sites.

Bat risk	Year	Dates of survey	No. sites	No. bats captured	No. species	MYLU	MYSE [a]	EPFU	PESU	LABO [b]	LACI [c]	LANO [d]	MYLE [e]	MYSO [f]	UNK	Bats/ mist net site
High	2004	7/28-8/5	6	170	6	31	12	103	4	16	0	0	3	0	1	28.3
High	2005	7/11-8/4	9	87	5	41	19	23	1	3	0	0	0	0	0	9.7
Low	2005	8/10-8/14	4	84	6	34	16	23	3	7	1	0	0	0	0	21.0
High	2006	7/30-8/4	10	138	4	13	75	41	0	9	0	0	0	0	0	13.8
Low	2006	8/3-8/5	5	103	5	19	37	38	0	8	1	0	0	0	0	20.6
Low	2006	8/10-8/12	4	71	4	34	24	11	0	2	0	0	0	0	0	17.8
Low	2006	7/9-7/12	4	66	5	18	6	24	0	14	4	0	0	0	0	16.5
Low	2006	8/5-8/6	4	62	5	14	28	15	1	4	0	0	0	0	0	15.5
Low	2007	7/18-8/6	28	429	6	197	174	44	0	10	1	3	0	0	0	15.3
High	2007	6/2-8/16	21	388	7	167	92	98	1	22	6	0	0	2	0	18.5
High	2007	7/7-7/17	13	107	6	50	39	10	1	5	2	0	0	0	0	8.2
Low	2007	7/31-8/5	8	250	4	73	22	146	0	9	0	0	0	0	0	31.3
Low	2007	6/20-6/25	7	65	4	23	30	11	0	1	0	0	0	0	0	9.3
Low	2007	8/7-8/9	5	200	6	60	17	82	2	36	3	0	0	0	0	40.0
High	2008	7/18-7/29	22	475	7	118	149	180	3	17	4	0	4	0	0	21.6
High	2008	7/20-7/27	13	255	4	57	60	124	0	13	0	0	0	0	1	19.6
Low	2008	8/9-8/14	11	198	6	86	39	65	1	5	1	0	0	0	1	18.0
High	2008	7/17-7/20	9	533	7	269	15	216	6	23	1	1	0	0	2	59.2
High	2008	7/17-7/18	3	45	5	7	24	8	4	2	0	0	0	0	0	15.0
			186	3726	5.4	1311	878	1262	27	206	24	4	7	2	5	21.0

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

Bats: Telemetry.--Six telemetry surveys have occurred since the Agreement has been in effect. Three surveys were done on Indiana bats (two in 2007 and one in 2008), two on eastern small-footed myotis (2008), and one on a silver-haired bat (2007). Information is being collected on foraging areas, roost locations, maternity colonies, and behaviors for these species via telemetry surveys. This information is and will be used to determine where to best site wind turbines in order to avoid potential adverse impacts. The 2007 telemetry surveys are summarized below and the 2008 reports have not yet been submitted to the PGC. Because the species these telemetry surveys were conducted on are endangered, threatened, or species of special concern and due to the confidentiality clause in the PGC Wind Energy Voluntary Cooperative Agreement, locations of these surveys will remain confidential.

The first telemetry survey was done April 10 – 22, 2007 on Indiana bats. Bats were trapped at a bat hibernaculum known to contain Indiana bats located near several proposed wind energy projects. This survey and the fall 2007 Indiana bat telemetry survey were both jointly funded by two cooperators. Fifteen Indiana bats (eight females and seven males) were radio-tagged and tracked. Three females and one male were lost before the end of the study. The remaining 11 were tracked on a northeast flight pattern to summer roost areas. Male bats migrated 2.1 - 7.8 miles from the hibernaculum and were tracked to 13 roost trees; tree species included: shagbark hickory, beech, locust, tulip poplar, maple, and some non-identifiable snags. Emergence counts were conducted at 10 of the trees resulting in no more than one bat observed from each. Female bats migrated 9.4 – 13.3 miles from the hibernaculum and were tracked to 25 different roost trees. Forty percent of trees used by females were shagbark hickory with the remaining species being sugar maple, white oak, red maple, red oak, ash, and some unidentifiable snags. Emergence counts were observed at 15 of the roosts, with seven roosts having greater than one individual observed and ranging up to a maximum of 37 individuals observed. Of particular significance, this telemetry survey documented the second largest Indiana bat maternity colony in Pennsylvania.

The second telemetry survey was conducted July 22 – 31, 2007 on a lactating female silver-haired bat. The bat was captured during pre-construction mist net surveys conducted on a proposed wind site. Three roost trees were located and an emergence count was done on one of the trees resulting in 24 individuals (including juveniles) observed. This silver-haired maternity colony is the first one ever documented in Pennsylvania. In addition to the roost tree locations, three foraging areas were also documented. One roost tree (not the maternity colony) and one foraging area were located in the area of the proposed project. As a result of this study the cooperator is working with the PGC to minimize potential impacts to this area. Part of the minimization effort of the cooperator will be to avoid these areas within the project area and to set up a post-construction survey targeting silver-haired bats to determine if any further minimization efforts are needed.

The third telemetry survey was conducted September 7 – October 3, 2007 on Indiana bats. Bats were trapped at the same hibernaculum that was trapped during the spring 2007 Indiana bat telemetry survey. Seventeen Indiana bats (eight females and nine males) were radio-tagged and tracked. Thirty roost tree locations were located; tree species included shagbark hickory, red oak, sugar maple, locust spp., and unidentifiable snags. Of the nine males tracked, four ventured 7.4 – 7.9 miles from the hibernaculum. The other five tended to cluster one mile east of the hibernaculum at a "staging area" and made several short visits to the

hibernaculum and then returned to the "staging area." Of the eight females tracked, four immediately entered the hibernaculum after release. One adult foraged 11.8 miles northeast for two nights before entering the hibernaculum and the remaining 3 females (all juveniles) foraged 10.3 – 11.1 miles northeast of the hibernaculum and had not yet entered the hibernaculum prior to the study's end.

Results of both the spring and fall 2007 Indiana bat telemetry surveys and 2007 silver-haired bat telemetry have been used by the cooperators who funded the work to adjust placement and number of turbines to avoid potential impacts to the species and their habitats. The PGC has and will continue to use this same information to advise other proposed wind energy projects where to avoid bats in this area, perhaps, without the need of having the proposed project perform additional surveys. Due to the discovery of the first reproductive female silver-haired bat, the PGC now recommends telemetry on other reproductive female silver-haired bats if captured during bat surveys.

Other mammals.--Of all the other mammal species of concern, one that has elevated levels of conflict with wind development is the Allegheny woodrat. 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 (which is determined by the PGC woodrat GIS model and field reviews). Allegheny woodrat habitat assessment surveys following protocols found in the *Allegheny Woodrat: the Environmental Review Process for Pennsylvania* (Mixon 2006). Since Pennsylvania lists the Allegheny woodrat state threatened, the PGC evaluates all wind sites for potential impacts to woodrats. The general operation of wind turbines is not known to negatively impact woodrats, it is the footprint of the project, including infrastructure and turbines that may fragment and/or destroy woodrat habitat. A consultant or PGC staff conducts a field visit if there is a question as to whether potential woodrat habitat is present. If the field review results document the presence of woodrat habitat, it is the cooperator's responsibility to conduct a full woodrat habitat assessment survey to document all woodrat habitats and confirm or deny the actual presence of the species. There were six woodrat surveys done on proposed wind sites through 2007. Only one proposed wind energy site was found to have active woodrat presence. For sites on which woodrats are found, PGC will work with the cooperator to avoid and minimize impacts to woodrats, and, where necessary, PGC requires post-construction monitoring in order to assess the impacts of wind development on woodrats and their habitats. Woodrat surveys pre- and post-construction will be conducted in the coming years on at least one wind energy site to assess the impacts of wind energy development on woodrats. The data from the 2008 woodrat surveys have not been submitted yet.

Post-construction

Post-construction surveys were conducted at one site in 2007 and at four sites in 2008. Data from the 2008 surveys was not available for this report. As required by the PGC, all post-construction monitoring requires a Special Use Permit issued by the PGC, to collect any carcasses. Special Use Permits were renewed or issued for all four sites conducting post-construction surveys in 2008.

Mortality.--The data reported from this first year (2007) of post-construction monitoring is unique because the mortality survey protocols were established before the Agreement was in

place. The protocols that were used in the 2007 study were the same protocols that were then incorporated into the Cooperative Agreement. A second reason this study was unique is that it was funded through the State Wildlife Grants (SWG) program. At the study's inception the Agreement was not in place and thus post-construction monitoring was not being conducted at operating PA wind sites. The SWG program funded this project based on the need for mortality data from wind sites since there was no Agreement in place at that time. Because SWG funding is available on a competitive basis and post-construction monitoring is now required for all sites under the Agreement, SWG funds are no longer being granted for sites which are conducting standard post-construction monitoring. Exceptions may only be allowed for post-construction monitoring that includes new research such as curtailment, improvements to monitoring protocols, etc.

Mortality searches were conducted daily at one site in 2007 from May 1 – November 17. Estimated mortality was calculated from daily searches conducted at 10 turbines using the estimator proposed by Erickson et al (2004) and was corrected for searcher efficiency and scavenger removal (SESR) resulting in a SESR-adjusted figure for each turbine.

To estimate the time that carcasses persisted in the study plots, average time a carcass was present in scavenger removal trials, *t*, was calculated. Because the trials were halted after 21 days, the data are right-censored, and this was compensated for by estimating the mean time to removal using a maximum likelihood estimator for *t* using the following formula:

$$\bar{t} = \frac{\sum_{i=1}^{s} t_i}{s - s_c}$$

where s = the number of test carcasses used in search trials, s_c = the number of test carcasses that remained in the study area at the end of the 21-day removal trial, and t_i = the number of days carcass i remains in the search area (censored at 21 in these trials). The probability that a carcass would be detected by searchers (p) was assessed through searcher efficiency trials. The estimate of p was calculated as the number of trial carcasses found by searchers divided by the total number of successful trials (excluding trials where the carcasses were not found by searchers and were also not found later that day by testers; these carcasses were assumed to be scavenged).

Erickson et al.'s (2004) mortality estimator calculates a per-turbine annual fatality rate (m) as:

$$m = \frac{\bar{c}}{\hat{\pi}}$$

where c is the mean number of carcasses observed per turbine, and $\hat{\pi}$ adjusts for both carcass removal and observer detection under the assumption that carcass removal times (t_i) follow an exponential distribution:

$$\hat{\pi} = \frac{\bar{t} \cdot p}{I} \cdot \left[\frac{e^{\frac{I}{\bar{t}}} - 1}{e^{\frac{I}{\bar{t}}} - 1 + p} \right].$$

This SESR corrected estimate was calculated separately for each turbine, using the averaged figures of *t* and *p*. Because searches were conducted daily, *I* (the search interval) = 1.

Individual SESR-adjusted mortality figures for each turbine were adjusted for searchable area using two different methods 1) dividing the mortality by proportion of area searched, and 2) a method used by Fiedler et al. (2007) using strata to correct for both proportion of searched area and distance from the turbine. To do this, GIS was used to delineate seven concentric circles at 10 m intervals from the turbine center. These circles defined seven different strata. GIS was then used to calculate the area in each stratum, and determined percentage of mortality occurring in each stratum at each turbine. Finally, the estimated total annual mortalities for the searched turbines were summed and adjusted for the proportion of turbines searched. The final result is an estimate of the total mortality. A 99% confidence interval for the corrected estimate of total mortality was determined by bootstrapping the trials of carcass persistence and efficiency. For the estimate of carcass persistence, the data from the carcass-removal trials were resampled 5000 times to generate a 90% confidence interval for this estimate. For the estimate of searcher efficiency, the data from the successful searcher efficiency trials were resampled 5000 times to generate a 90% confidence interval for this estimate. The two upper and then the two lower bootstrap values were substituted into the estimators to determine upper and lower 99% confidence limits for each estimate of total mortality.

The result of the first method was a mortality estimate of 43.1 bats/turbine/year (99% C.I., 40.2 - 47.8) and 1.7 birds/turbine/year (99% C.I., 1.6 - 1.9). The second method resulted in a bat mortality estimate of 30.1 bats/turbine/year (99% C.I., 28.1 - 33.4). The second method was only done on bats because there were no birds found in most strata. The only other Pennsylvania post-construction data available for comparison is the 6-week mortality study conducted at Meyersdale Wind Farm (Arnett 2005 and Arnett et al. 2008) that estimated the mean bat mortality to be 23 bats per turbine for that period.

PGC staff validated the identification of all carcasses. Bat carcasses found totaled 211 at the Pennsylvania site conducting mortality monitoring in 2007. Bat mortality by species was as follows: red bat 31.75%, hoary bat (*Lasiurus cinereus*) 28.91%, eastern pipestrelle 15.64%, silver-haired bat 14.22%, big brown bat (*Eptesicus fuscus*) 4.74%, and little brown bat (*Myotis lucifugus*) 4.74%. Late July through early August had the greatest bat mortality at this particular site in 2007 (Figure 4). This data shows eastern pipestrelle bats being as susceptible to mortality from wind turbine operations as the three migratory tree bats (red, silver-haired, and hoary).

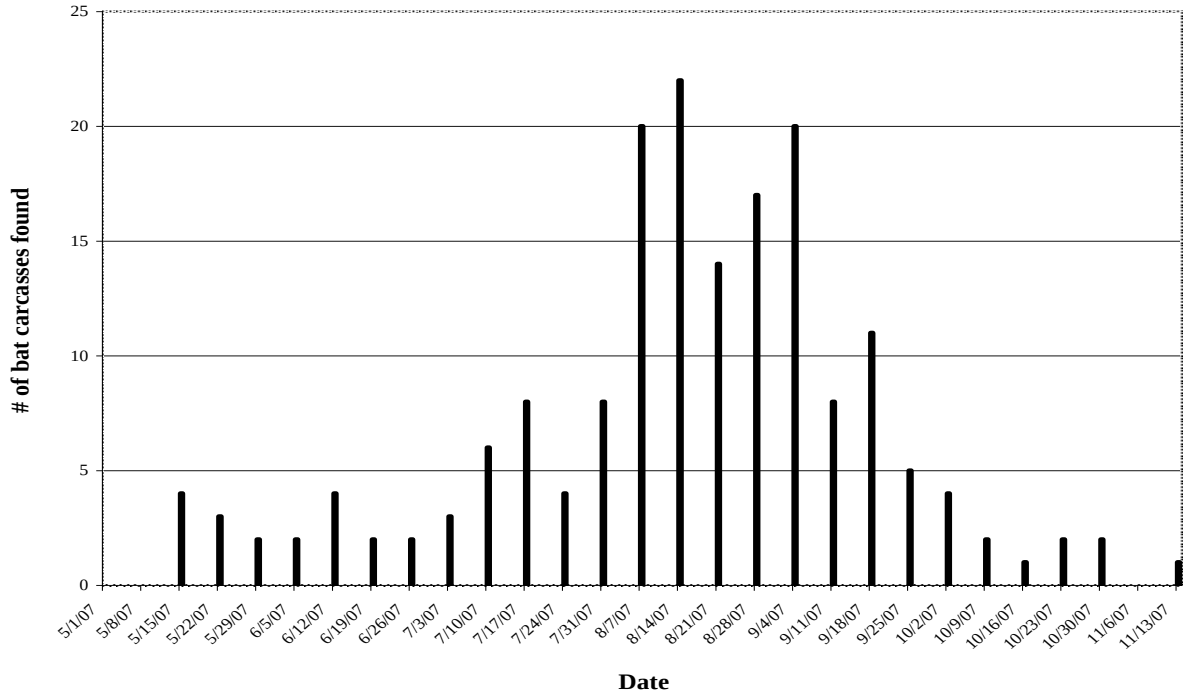

Figure 4. Seasonal patterns of bat mortality, by week, at the only Pennsylvania wind site conducting post-construction mortality searches in 2007.

Bird carcasses found at this site totaled 10: 3 red-eyed vireo (*Vireo olivaceus)*, 2 common yellowthroat (*Geothlypis trichas*), one each of magnolia warbler (*Dendroica magnolia*), ruby-throated hummingbird (*Archilochus colubris*), Tennessee warbler (*Vermivora peregrina*), golden-crowned kinglet (*Regulus satrapa*), and one bird carcass that was unidentifiable due to condition of the carcass. Number of bird carcasses detected by month was May (n=4), September (n=4), and August (n=2). The PGC will be analyzing bird mortality to determine if there is any correlation with migration timing and/or weather events.

Mortality in Relation to Turbine.--Ninety-five percent of detected bat fatalities fell within 50 m of the closest turbine and 88% of bat fatalities fell within 40 m (Figure 5). Carcasses were found in all directions from the turbines, although there were slightly fewer carcasses found towards the south (Figure 6). Based on the wind rose for this particular site the wind is coming from the northwest in the fall and winter months and from the south, at a much less significant component of overall wind, in the summer. All 10 bird carcasses were found between 0 - 40 m of the closest turbine; three between 0-10 m, four between 10-20 m, one between 20-30 m, and two between 30-40 m.

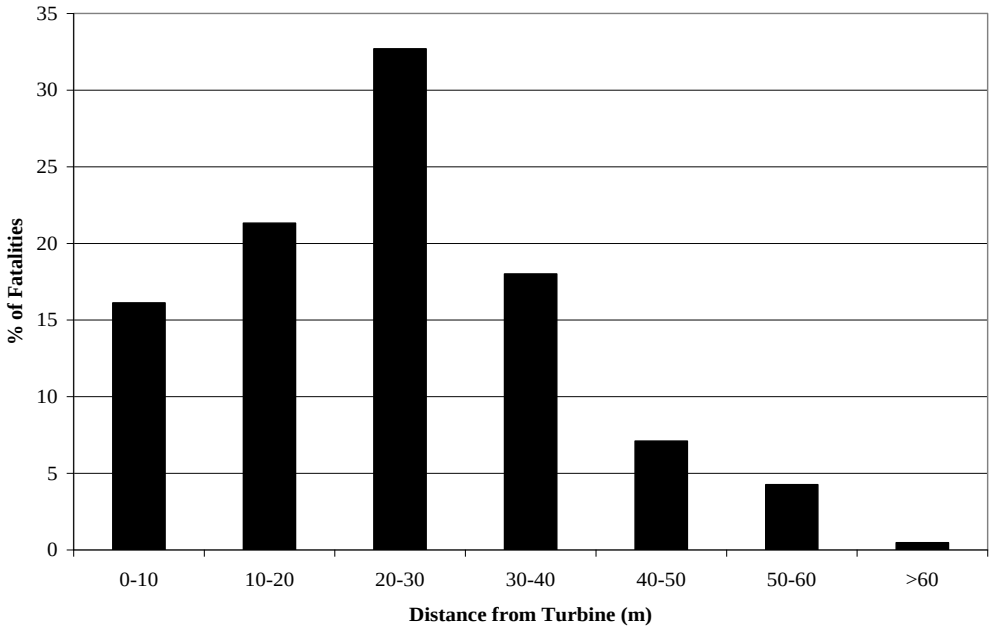

Figure 5. Distribution of bat carcasses as a function of distance from turbine at the one Pennsylvania wind site conducting post-construction mortality searches in 2007.

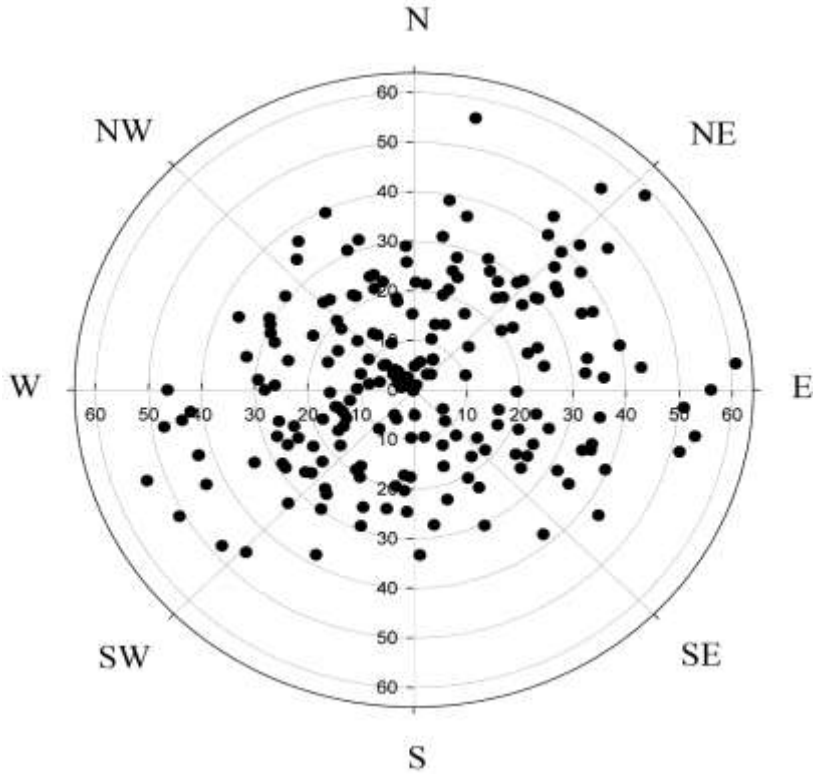

Figure 6. Spatial distribution of bat carcasses around turbines at the one Pennsylvania wind site conducting post-construction mortality searches in 2007. Distances for concentric circles are in meters from turbine center.

Searcher Efficiency.--Search efficiency trials were conducted at one site in 2007; the same site where the mortality and carcass removal trials occurred. A total of 258 searcher trials were conducted with at least 50 trials for each of the four searchers. Carcasses of both birds and bats were placed in random locations throughout the search area in all vegetation classes, and were blind to the searchers. Searcher efficiency averaged 25% with a range of 13 – 38%. For comparison, searcher efficiency at the Meyersdale mortality study in 2004 averaged 25% and ranged from 10-63% (Arnett 2005). Searcher efficiency has been found to lower in forested sites in the eastern United States and highest in more open habitats in the western United States and Canada (Arnett et al. 2008). The PGC will be analyzing this and future data sets to determine if there are any trends in regards to bat versus birds trials such as carcass coloration, fresh versus frozen carcasses, and quality of carcass (fresh, decomposed, intact, broken/wounded) that may be influencing searcher efficiency trials.

Carcass Removal.--Carcass removal trials were conducted at one site in 2007; the same site where the mortality and searcher efficiency trials occurred. Carcasses were placed in random locations throughout the search area in all vegetation classes, but were not blind to the searchers. A total of 55 carcass removal trials were done and the percent scavenged per day were as follows: 1 day = 14.5%, 2 days = 21.8%, 3 days = 23.6%, 4 days = 36.4%, 5 days = 40%, 6 days = 47.3%, and 7 days = 52.7%. After day one, there was a regular removal of carcasses by predators through day 13 (67.3%), after which no more were removed. Mean number of days carcasses lasted was 10.5. Through direct observation and motion-sensitive trail cameras, the following potential scavengers were identified at the site: black rat snake, turkey vulture, long-tailed weasel, opossum, raccoon, crow, blue jay, fisher, mouse, and chipmunk. For comparison, carcass removal at Meyersdale mortality study in 2004 (Arnett et al. 2005) was found to be 3% removed in 1 day and 16% by day 7. The PGC will be analyzing future data sets to determine if there are any trends in regards to bat versus birds trials such as carcass coloration, fresh versus frozen carcasses, and quality of carcass (fresh, decomposed, intact, broken/wounded) that may be influencing carcass removal.

Mortality - Weather Correlation.--The association between nightly weather conditions (wind speed and ambient temperature) and the subsequent number of bat carcasses found during mortality searches was investigated at one wind site in Pennsylvania during 2007. The daily mortality searches ran from May 1 through November 17, therefore the analyses included the interval from May 2 through November 17, 2007, for a total of 199 nights. Weather data were recorded from a height of 60 m at a meteorological tower. The original data were reported as mean values for 10-minute intervals for each 24 hours. The data was restricted to the time interval of 20:00 one day through 06:00 the next day; this 10-hour period was considered to be a "night" in the analyses. Bird mortality was not included in these analyses because too few bird carcasses were found for meaningful statistical analysis.

Because mortality searches were conducted each morning (from approximately 06:00 – 12:00), the daily mortality counts were associated with the previous night's weather conditions. The mean values for temperature and wind speed for each 10-hour night were calculated. In addition, methods used by Arnett (2005) were followed to determine the proportion of 10-

minute intervals each night that had mean wind speeds that were < 4 m/s and the proportion of 10-minute intervals each night that had mean wind speeds that were ≥ 6 m/s.

Associations between mean nightly wind speeds and temperatures and the subsequent bat mortality were assessed using Spearman rank correlations (r_s). Spearman rank correlations were also used to assess associations between the proportion of nightly intervals with mean wind speeds < 4 m/s and the proportion of nightly intervals with mean wind speeds ≥ 6 m/s and the numbers of bat carcasses found each day.

The result of the investigation showed that mortality was positively related to temperature and negatively related to wind speed (Table 10). In addition, mortality was positively related to the proportion of the night with wind speed < 4 m/s and negatively related to the proportion of the night with wind speed ≥ 6 m/s.

Table 10. Correlations between daily bat mortality and weather parameters at one wind site in Pennsylvania.

Comparison	Spearman's Correlation (r_s)	p-value
wind speed – bat mortality	-0.255	< 0.01
temperature – bat mortality	0.293	< 0.01
intervals with wind < 4 m/s – bat mortality	0.187	< 0.01
intervals with wind ≥ 6 m/s – bat mortality	-0.231	< 0.01

Can Mortality be Predicted?--It's too early to tell; the PGC does not yet have enough pre- and post-construction data to date for any site analysis to be conducted which could infer a mortality prediction model. It may take a few years to get to this point since most sites conducting post-construction monitoring now were grandfathered into the Agreement and thus may not have conducted pre-construction surveys for comparison. At this point in time, we do not have any data that correlates risk level and direct mortality.

Post-construction Raptor Migration Surveys.--Can raptor migration survey observation be correlated with mortality? Are raptors avoiding wind turbines? No post-construction raptor migration surveys were completed in 2007 therefore there is no data to report at this time.

Post-construction Bat Acoustic Surveys.--Can bat acoustic data be correlated with mortality? No post-construction bat acoustic surveys were completed in 2007 therefore there is no data to report at this time.

Other Post-construction Comments.—From May 1, 2007 through September 30, 2008, cooperators did not recorded any threatened or endangered bat or bird mortality, eagle mortality, or any large kills (>50 animals in a single day event) at surveyed wind facilities. With only one year of data for one site only, the PGC does not have enough information to make any general statements. A second year of mortality monitoring is occurring at this same site this year and there are three additional sites conducting mortality monitoring in 2008.

SIGNIFICANT FINDINGS FROM COOPERATORS' SURVEYS

During the first year of the Cooperative Agreement several new wildlife findings occurred. The first was the discovery of the second largest Indiana bat maternity colony in Pennsylvania during an Indiana bat telemetry project that was funded by two cooperators. The second discovery was of the first lactating silver-haired bat recorded in Pennsylvania and subsequent discovery of a silver-haired maternity colony. The specimen was caught during pre-construction mist net surveys conducted by a cooperator and was tracked to a roost tree that contained 24 individuals including juveniles.

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

BEST MANAGEMENT PRACTICES

As part of the Cooperative Agreement, cooperators agree to utilize, to the greatest extent possible, all reasonable and feasible generally accepted wind industry and PGC approved best management practices relevant to the conservation of wildlife resources during construction and subsequent operation of their wind energy facility. The PGC in cooperation with the PA Wind and Wildlife Collaborative is currently working on developing best management practices and evaluating those which currently exist. Once compiled and agreed upon by the PGC, PA Wind and Wildlife Collaborative, and current cooperators, these best management practices will be released. Therefore, at this time there are no best management practices to report.

AVOIDANCE, MINIMIZE, AND MITIGATION BY COOPERATORS

Avoidance

Since the PGC Wind Energy Voluntary Cooperative Agreement has been in place, three proposed wind sites have been abandoned by four different companies due to potential wildlife resource impacts. Two companies abandoned the same location due to its proximity to a hibernaculum containing the federally endangered Indiana bat. One site was abandoned due to its proximity to known waterfowl and raptor migration routes, and the third site was abandoned due to a combination of waterfowl and raptor migration routes and potential bat risk. All abandoned site were noted by the PGC risk assessment as being high risk due to potential risks to birds and/or mammals.

Minimization efforts from cooperators have included the following:

1. Reduction of overall project size to minimize wildlife impacts.
2. Additional evaluation and/or elimination of project areas within five miles of known hibernacula containing the federally protected Indiana bat.
3. Avoidance of existing forested landscape to the maximum extent possible.

4. Placement of turbines on reclaimed strip mine lands to avoid land clearing.
5. Elimination of planned turbines on ridge tops near raptor fly-ways.
6. Turbines set back 50 – 400 m off escarpments to minimize potential raptor collisions.
7. Movement of turbines 30 – 100 feet away from potential woodrat habitat.
8. Experiments with modifying turbine cut-in speed during specific periods of high risk to bats.

Mitigation efforts:
1. Plans to gate one hibernaculum of concern.
2. Funds to be contributed for land acquisition for a bird species of special concern habitat.

RESEARCH

Research done or in progress:

Three projects have been funded by the SWG program that are directly related to wind energy development's impacts on birds and mammals. The first and third are still in progress and the second has been completed. Where these project studies are conducted in proximity to the cooperators' projects, the PGC accepts the SWG study's results rather than requiring the cooperator to complete and pay for a similar study.

Assessing Conservation Needs of Eastern Golden Eagles in Pennsylvania.-- The goal of this research project is to collect information on where and how the unique eastern population of golden eagles migrates through Pennsylvania and to use these data to provide statewide maps showing the relative risk to eagles from development of wind power. These maps will provide a crucial tool for managers, policy makers and legislators to guide development of wind power throughout the state. (Todd Katzner, National Aviary, http://www.aviary.org)

Examination of Pre-construction Monitoring Techniques and Post-construction Mortality at a Proposed and an Active Wind Energy Site in Pennsylvania.--This project investigated pre-construction monitoring techniques and post-construction mortality of bats and birds at a proposed wind site and an active wind site. The proposed wind energy projects offered the opportunity to develop much needed pre-construction protocols and assessments of bat activity, measure site-specific changes in bat activity due to wind energy project development, and attempt to correlate biological and environmental variables to the wildlife impacts. (Howard Whidden, East Stroudsburg University)

Testing Solutions to Bat Fatalities by Wind Turbines: Proactive Response to Threats.--This is the first time in the United States a wind power facility is participating in a program designed to test deterrence and curtailment options to reduce the threat of wind turbines to bats. This work will ensure substantial and measurable progress in understanding patterns of activity and fatalities and implementing deterrence and curtailment options to reduce fatalities. (Ed Arnett, Bat Conservation International, http://www.batsandwind.org).

Suggested research needs:

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

1. Mitigation experiments (such as curtailment) at multiple sites – testing various treatments (cut-in speeds, time of year) and determining which are most effective for reducing mortality and at what economic cost to the industry.
2. Impacts to bat populations – determine population size of bat species (genetic studies) and how mortality from wind sites is affecting them; cumulative effects of mortality on bat populations; effects of habitat and landscape alteration on bat populations.
3. Migratory pathways of bats – little is known about migratory tree bats, which are being killed in the greatest numbers; more information is needed on these species in regards to where and when they migrate.
4. Improving mortality protocol – finding better ways to estimate mortality and at the same time keep the cost to industry down.
5. Improving mortality estimators – develop better estimators and techniques to determine impacts to bat populations.
6. Determine if there are any correlations between pre-construction surveys and post-construction mortality.
7. Determining why bats appear to be attracted to wind turbines – testing current hypotheses; identify attraction in order to reduce the appeal, if feasible.
8. Bat deterrents – evaluate current bat deterrents under different operating conditions and turbine characteristics at multiple sites in regards to reducing bat mortality and cost effectiveness.
9. Conduct monitoring on high risk priority wind facilities currently operating in Pennsylvania which are not cooperators' sites in an effort to correlate existing statewide data derived from cooperators' having sites located in general proximity.
10. Best management practices to avoid forest fragmentation and to manage vegetation at wind development facilities to best support Pennsylvania's Birds of Greatest Conservation Need and their habitats.

OVERALL SUCCESSES/CHALLENGES

Successes

1. Avoidance/abandonment of sites in some areas to avoid high mortality risk to wildlife.
2. Many cooperators are pro-active in terms of getting PGC input early in the planning stages – sharing of data between PGC and developers is helping developers make better decisions in regards to siting wind facilities.
3. There is a continuance of data being received by the PGC from pre-construction surveys which has resulted in improved site locations for wind turbines better reducing potential adverse impacts to wildlife resources.
4. There have been no threatened or endangered species fatalities, no large mortality events (>50 carcasses in a single day event); no eagle fatalities have been reported during the period of May 1, 2007 and September 30, 2008.
5. At least one developer has experimented with changing turbine cut-in speeds during specific high-risk periods; results of this have not yet been published.
6. PGC Agreement has been recognized on a national level with at least one neighboring state following a similar model. Ohio DNR has used the PGC Wind Energy Voluntary Cooperative Agreement as a model for their wind energy cooperative agreement which will allow for ease of data correlation across state boundaries.

Challenges

1. Some wind developers with proposed and/or active wind sites in Pennsylvania have not yet signed the Agreement and are not following suggested PGC monitoring and avoidance/minimization processes.
2. Developers are not always keeping the PGC updated as to the status of projects nor are they providing up-to-date maps; this inhibits the PGC's ability to provide a complete review of project areas. As a proposed solution, the PGC encourages developers to delineate larger potential project areas rather than smaller ones to ensure that all potential wildlife impacts are identified early on in the planning stages.
3. Protocols are not being followed completely. PGC strongly recommends that all cooperators and their consultants communicate with the PGC prior to commencing surveys to go over survey site locations and protocol details to ensure that the surveys are being done as per the Agreement and efficiently. The PGC not only attempts to provide guidance prior to the surveys starting, but also attempts to be on site for at least one day of every survey being conducted at each site to answer questions, provide guidance, and help to remedy any problems as soon as possible.
4. Sites conducting post-construction often do not have much pre-construction data to see if mortality can be predicted. The question of predictability will take several years to answer.
5. Keeping sites abandoned by responsible companies due to very high risk of wildlife impacts from being developed by a secondary company.

FUTURE

Wind energy development in Pennsylvania is increasing and, with the creation of the PGC Wind Energy Voluntary Cooperative Agreement, the PGC is gaining more and more information on the impacts to birds and mammals. Cooperators are continuing to conduct pre- and post-construction surveys gathering important data that is and will continue to be used to help lessen adverse impacts to wildlife from tower site locations. Information collected from this data provides much needed insight into which species are most at risk of impact from wind energy development and help all parties involved to better determine the best ways to avoid and minimize impacts to birds and mammals from wind energy development. As analysis continues on information produced from the Cooperative Agreement, both the industry and the PGC will be better equipped to develop meaningful best management practices to further protect and conserve the Commonwealth's wildlife resources.

The relationships between the PGC and cooperators are continuing to grow and communication is constantly improving. The PGC will continue to work with cooperators in all stages of wind energy development in regards to the safeguarding and conservation of birds and mammal resources. The PGC is currently working on databases to protect and house all of the information being gathered so that local, regional, site, and landcover type comparisons can be made. As mortality estimates come in from around the state, more information will be available reporting the impacts to birds and bats are occurring and probable from wind energy development in similar landscapes. Likewise, as data sets grow larger, the PGC will be able to better advise cooperators in regards to siting wind projects as well as mitigation methods for reducing mortality.

A woodrat study is being conducted at one Pennsylvania site by a cooperator to document whether woodrats are being impacted by that particular wind energy project. This study is being conducted one year pre-construction to get baseline data and then for several years post-construction. It will include trapping, telemetry, food availability, and predator presence. Additionally, the PGC is also working with other cooperators to conduct post-construction breeding bird surveys in order to document what effects habitat fragmentation has on forest interior breeding birds. In regards to mitigation efforts, a curtailment study commenced in 2007 at one of our cooperator's wind sites. The PGC is in the process of compiling best management practices in cooperation with the PA Wind and Wildlife Collaborative. The goal is to have them available before the 2009 PGC Wind Energy Voluntary Cooperative Agreement annual report. Finally, the PGC is committed to make sure all wind energy projects, including non-cooperators, are employing feasible measures of protection and minimization of adverse impacts, which are anticipated to occur to the Commonwealth's bat and bird resources. The PGC will continue to investigate the monitoring efforts and mortality of birds and bats at non-cooperator wind energy sites based on the PGC's limited resources, prioritized by project site location and risk assessment from the PGC's internal reviews.

The PGC recognized that each project is unique, and remains committed to all cooperators in keeping the Agreement both flexible and adaptive. As information and subsequent analysis continues resulting from data being generated from the Agreements, the PGC will work collaboratively with all the cooperators to incorporate proposed revisions. At this time, however, the PGC does not have enough data to support any changes to the Cooperative Agreement or protocols. There remains a lack of mortality data and most of the pre-construction data received until recently has not been collected following the current PGC protocols. Further, there remains a critical need to compare pre- and post-construction results from a few sites before making any major changes to the Agreement in regards to eliminating surveys or changing protocols. Encouragingly though, there has been a wealth of information on wildlife impacts from wind energy development already collected through the PGC Wind Energy Voluntary Cooperative Agreement. In short, the PGC's Wind Energy Voluntary Cooperative Agreement is successful and meets with its intended purpose. The Cooperative Agreement has allowed Pennsylvania to become one of the national leaders on determining and addressing wildlife impacts from wind energy development. Due to all the collaborative effort between the wind industry and PGC, the Agreement has and will continue to provide all involved parties with valuable information needed in order to best manage for wildlife at wind energy sites. Those wind companies that are cooperators have set an example that all should aspire to follow. These very cooperators that have proven to be partners in developing conscientious renewable energy with the highest regard to the Commonwealth's wildlife resources.

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