Highland New Wind Development, LLC
Attachments for April 27, 2006
Department of Environmental Quality Response

Tab #	***Document***
1	Camp Allegheny Photos
2.	Monongahela National Forest Website
3.	Photo Simulations
4.	Summary of Comments from DEQ Letter of March 1, 2006
5.	Study Proposal for Bat Migratory & Summer Foraging Survey
6.	Breeding Bird Study
7.	Supplemental Bird and Bat information
8.	American Wind Energy Association Post Altamont Progress
9.	Compilation of conclusions reached from available radar studies conducted last year in the eastern United States
10.	March 8, 2006 letter to Roger Kirchen /Department of Historic Resources
11.	Public Geological Information
12.	Positive attributes of Wind Energy / Resource System Group, Inc.

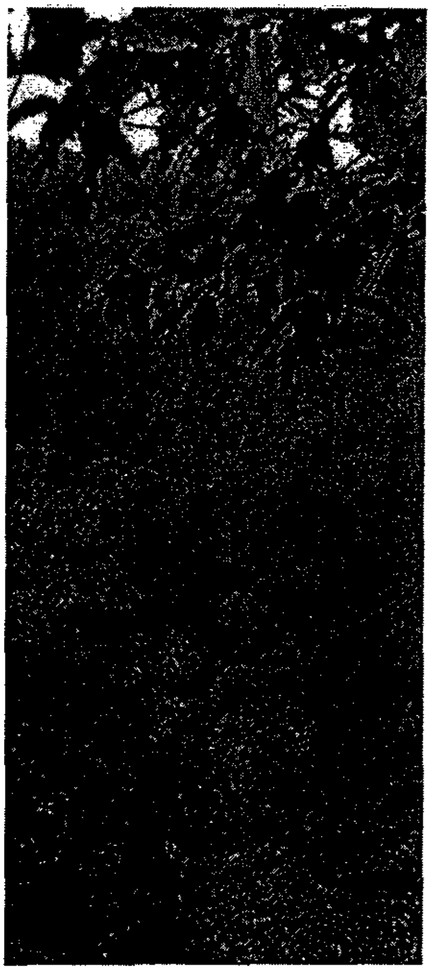
94977

Welcome to the Monongahela National Forest

200 Sycamo
Elkins W
Telephone: (304)636-1
Fax: (304)

Home
General Info
Universal Access
Recreation
Special Places
Visitors Centers
Forest Planning
Events
Seasonal
Opportunities
Credits
Contact Us

Special Places on our Forest



Cranberry Area:

- Cranberry Mountain Nature Center
- Cranberry Glades Botanical Area
- Falls of Hills Creek
- Highland Scenic Highway
- Williams River

Spruce Knob-Seneca Rocks National Recreatio

- Seneca Rocks Discovery Center
- Seneca Rocks
- Sites Homestead
- Spruce Knob
- Smoke Hole Canyon

Dolly Sods

- History
- Scenic Area
- Flora and Fauna

Gaudineer Scenic Area

Stuart Memorial Drive

Wilderness Areas

SUMMARY OF COMMENTS FROM
DEQ LETTER OF MARCH 1, 2006

Comment To Be Addressed:	***Response to Comment:***
1. The Phase 1 Avian Risk Assessment (Kerlinger and Guarnaccia, 2005; hereafter, Avian Assessment or Assessment) did not review significant and pertinent data collected at other sites in the Allegheny Mountains. Additional information within the physiographic region of the project is necessary.	Not true. There are many references to hawk migration sites, nesting birds, songbird migration, wintering birds, etc. in the report. Regarding hawk migration locations, significant hawk migration sites were researched and none were present on the Highland New Wind ridge or adjacent to that site. *- Kerlinger*
2. The Avian Assessment must include data in the Virginia Breeding Bird Atlas, published in 2001.	This resource will be consulted, once this volume is located. It went out of print several years ago, despite being published so recently, and is virtually unavailable. I will request the information from the author and/or the VDGIF. Please note that information/data from the VSO Foray, <u>is</u> present in the Phase I report on pages19-22. *- Kerlinger*
3. The use of the project site as a stopover point for song bird migrants warrants additional review of the potential impacts of the proposed wind turbines on nocturnal migrants.	This was explained adequately in the report. There is no special habitat at the Project Site that would attract more of these birds than the adjoining tens of thousands of acres of similar habitat. *- Kerlinger*
4. A Radar and Visual Study of Nocturnal Bird and Bat Migration at the Proposed Highland New Wind Development Project, Virginia, Fall 2005 (Plissner <u>et al</u>., 2006; hereafter, Radar Study or Study), does not include data for July and early August. Other studies have recommended that radar studies should start no later than the middle of July in order to capture the migration period. This should be addressed.	Data for July and August are not relevant for the study of night migrants. These birds peak in September and October, so peak migration season was included in the radar study. *- Kerlinger*
5. The Avian Assessment should review pertinent data on hawk migration in the Allegheny Mountain range.	A review of the literature and databases from <u>www.hmana.org</u>, <u>www.hawkcount.org</u>, Zalles and Bildstein 2000, and various other resources were consulted (see text pages 28-29). Hawk migration sites that were mentioned were those considered to be "significant" sites by experts and sites that were not mentioned are not deemed to support significant concentrations of birds. The data presented in the VDGIF letter for Allegheny Front are not from VA, WV, or MD. Instead, the author seems to have confused the Allegheny Front from PA with the

	same named ridge in WV (Bear Rocks) which is covered in the report. Note also that the author cherry-picked the data presented for Rockfish Gap. The totals for 2005 for two of the species were much higher than the average numbers for those sites (see Rockfish Gap website for details and averages). Note also that the Phase I report used the 15 year averages so as not to cherry-pick the lowest or highest counts. *- Kerlinger*
6. The Overview of the Current State of Knowledge of Bats with Specific Reference to the Potential Impacts of Wind Power, Highland New Wind Project (North East Ecological Services, 2006; hereafter, Overview) did not address use by bats of "watering holes" located on the ridges. This should be remedied since areas of water, even as small as road ruts, are very important to bats and are used extensively throughout the spring, summer, and fall.	'Watering holes', including road ruts, can be an important microhabitat feature, and there are several examples of forest-dwelling bats being captured in nets placed near these ephemeral resources. These resources were not addressed in my Impact Analysis because 1) there was no visible road ruts due to the snow cover at both sites, 2) both sites had perennial water systems within 1.0 km that would be more likely used by bats, and 3) most of the documentation of road rut usage occurs in intact forest habitats, not open habitats such as the Red Oak Knob site and the Tamarack Ridge site. The perception that they are used 'extensively throughout the spring, summer, and fall' has not been documented in the literature. *- Reynolds*
8. The impact analysis must consider the cumulative impacts of constructing the Highland Wind project within the Allegheny Mountain physiographic region. The cumulative impacts analysis should consider that there are already 88 wind turbines operating, 457 permitted, and 480 industrial wind turbines proposed or planned at 34 facilities within the Allegheny Highlands of Virginia, West Virginia, Maryland, and Pennsylvania.	A cumulative avian impacts analysis appropriately would only include those turbines that are erected to date, plus those that are proposed for the HNW project. With respect to collision impacts, the Highland New Wind site would perhaps impact 5 birds per turbine per year or a total of less than 100 birds per year (see page 109-111 in Kerlinger risk report). These birds would be distributed over perhaps 20-25 species, which means that between 4 and 5 birds per species would be impacted. These would, in all probability be the same species or types of species impacted at the Mountaineer, WV, or Buffalo Ridge, TN. For most of those species, the North American population exceeds 1 million birds and in some cases the number is in the tens to hundreds of millions. The addition of 5 fatalities of a given species is not likely to have an impact on the species. In Virginia, hunting harvests annually remove tens of thousands of individuals from species that are far less numerous

	than those likely to be impacted at the Highland New Wind site. For example, 20,000 Wood Ducks and 10,000 Ring-necked Ducks were shot in Virginia alone (from a total of 225,000 waterfowl harvested in 2003) in 2003, yet these numbers are sustainable and do not impact these species. Cumulatively, 338,000 Wood Ducks and 113,000 Ring-necked Ducks were shot in the Atlantic Flyway, again without any impact on the populations of these species. There are many similar examples, including species that are declining at rates of 1-3%, yet the VDGIF permits harvests of thousands of individuals for those species each year. With sanctioned harvests of this magnitude, from species that are generally less numerous than those impacted at wind turbines, it is highly unlikely that the Highland New Wind site impacts, even when combined with those from other wind power facilities, are likely to be biologically or cumulatively significant. *- Kerlinger*
9. DGIF recommends some additional assessments, monitoring, and mitigation, including but not limited to: • Field Surveys and assessment during bald eagle breeding season. • Winter use of the area by raptors including but not limited to bald- and golden eagles, and potential take by wind turbines.	Bald Eagles. There is no reason to suspect that Bald Eagle use of the site would put these animals at risk. It is important to note that not a single Bald Eagle has been impacted by a wind turbine to date. Furthermore, despite the presence of more than one thousand of turbines in MN, IA, IL, WI, and other Midwestern states, no Bald Eagle has been documented to be impacted. These animals also are not known to collide with communication towers, which have far greater impacts to birds than wind turbines. A winter survey of eagles is not necessary. Whereas it is possible that these birds may fly over the site on rare occasions, there use of the site will be minimal. If use were great, as is the case in the Altamont of California, or if these birds were actively foraging year round on site, such a survey might be warranted. However, there is little food or habitat to attract these birds, so they will not be present often or at undue risk at the project site. *- Kerlinger*

94136

STUDY PROPOSAL

for

BAT MIGRATORY AND SUMMER FORAGING SURVEY

HIGHLAND NEW WIND POWER PROJECT

For:

Highland New Wind Development, L.L.C.
1583 Ridgedale Road
Harrisonburg, VA 22801

Prepared by:

North East Ecological Services
325 Pleasant Street
Concord, NH 03301

03 January, 2006

BAT MIGRATORY AND SUMMER FORAGING SURVEY

OVERVIEW

Wind power in the United States has been gaining economic viability due to major technological advances, and is currently the fastest growing form of renewable energy in the United States (McLeish, 2002). Wind power is an environmentally-sustainable method of power generation, but the industry has been aware of the potential impact of wind turbines on birds for decades. Through both pre-construction and post-construction monitoring, biologists have established standard protocols for monitoring both resident and migratory bird species that may be impacted by wind turbine projects. These data have done a lot to ameliorate the impact of wind turbines for birds, but little attention had been paid to bats until the Mountaineer Wind Energy Center in West Virginia. The Mountaineer Wind Energy Center is a 44-turbine wind facility that began operation in 2002. As part of an ongoing biological survey, biologists discovered over 400 bats that had been killed by the turbines in each of the last two fall migratory seasons. The Mountaineer discovery has led to a major shift in focus on the impact of wind turbines on bats throughout southern Appalachia.

Prior to the Mountaineer survey, most biologists failed to consider the potential impact of wind turbines on bats. As a result, standard protocols for evaluating this impact have not yet been developed. NEES is at the forefront of developing these protocols, and it is our goal to continue developing innovative solutions that will become tomorrow's best practices.

PROJECT SUMMARY

The Highland New Wind Project proposal ('the Project') is for the construction and operation of a 19 turbine (estimated up to 38 MW capacity) wind farm in Highland County, Virginia. The project layout contains one turbine string running southwest-northeast along a 1.2 km stretch of Tamarack Ridge and a second turbine cluster located 1.5 km southeast on Red Oak Knob. The turbines on Red Oak Knob will be in multiple strings oriented southwest-northeast, west-east, and possibly northwest-southeast. Prevailing winds on both ridges typically come from the west.

RESEARCH POSSIBILITIES

In the report titled '*An Overview of the Current State of Knowledge of Bats with Specific Reference to the Potential Impacts of Wind Power*' dated 03 January 2006, I outlined a Phase I Risk Assessment for the Project. The research outlined in §4.1 through §4.6 of that document contained released pre-construction and post-construction reports from other wind development sites. Each of these reports had different objectives and methodologies, making it difficult to draw conclusions that would be informative for the Project. One potential use of these reports is to consider them as a chronological sequence of bat-related wind research, from biological assessment → pre-construction survey → post-construction survey. Considering the Appalachian projects to be biogeographically similar suggests that the Highland New Wind project, or at least the Tamarack Ridge site, will result in bat mortality of the same order of magnitude as the Meyersdale, PA and Mountaineer, WV sites.

Although no mortality of federally-endangered bats has documented to date, there are reasons for extra diligence in regards to the Project. First, data collected by the West Virginia DNR suggests that Virginia big-eared bats are using open agricultural sites at high altitude within the Alleghany Front. Second, radiotelemetry work from Virginia suggests some Indiana bats are migrating into Highland County within the vicinity of the Project site. Lastly, without regard to the elevation, the mature oak habitat and associated water at the Tamarack Ridge site would represent potential roosting habitat. It is unclear whether the high elevation of the site would preclude it from being used as roosting or foraging habitat.

PRE-CONSTRUCTION SAMPLING RECOMMENDATIONS

Spring 2006

Suggested research activities for the Spring 2006 season would be to monitor for migratory bats over the project area using long-term acoustic monitoring stations. This would involve the use of acoustic microphones mounted on meteorological towers on the project site. The microphones can be placed at multiple heights, including within the turbine rotor sweep zone using systems designed by NEES. The Red Oak Knob site may also be a potential study site for the use of a tethered dirigible built by NEES to monitor bat activity at various heights during peak migratory periods. For bats, the Spring 2006 period should include 15 March through 15 May, with peak migratory period probably occurring during the middle two weeks of April.

Summer 2006

Suggested research activities for the Summer 2006 season would be to identify the level of bat activity on the project area during the breeding season. Because of the open habitat, field surveys could be limited to the use of ground-based acoustic monitoring to document whether there is substantial bat activity at each site. If substantial activity was detected, further research could be conducted to document which species were utilizing the site and whether species of concern were roosting or foraging near the proposed project site. This addition research could include mist-netting and radiotelemetry. For bats, the Summer 2006 period should include 15 May through 15 August.

Fall 2006

Suggested research activities for the Fall 2006 season would be to replicate the sampling effort conducted during the Spring 2006 migratory season. Using the same sampling design for each migratory event facilitates data interpretation and provides a more accurate image of the migratory activity across the project site. For bats, the Fall 2006 period should include 01 August through 01 October, with peak migratory period probably occurring during the middle two weeks of August.

ACOUSTIC MONITORING PROTOCOL

Vertical Acoustic Array Design

Acoustic monitors have been used extensively to document bat activity in a variety of habitats. Although they have been used to monitor bat activity above the tree canopy (Bradshaw, 1993), long-term monitoring using vertical acoustic arrays is a technique developed by NEES to address bat mortality for wind power developers. We would use the existing meteorological tower ('met tower') at the Red Oak Knob site (50m tubular) and request the erection of a second tower at the Tamarack Ridge site. Met towers create an ideal sampling platform for the microphones for three reasons. First, they can reach 250 feet in height and therefore allow us to sample within the proposed rotor sweep zone. Second, the met tower is located within the proposed project area, thereby allowing us to sample for bat activity across the project site. Lastly, met towers have trails and service roads leading to them, and these trails and the edge habitat created by the clearing will provide ideal travel corridors to monitor ground-level bat activity.

Acoustic Monitoring Setup

Three acoustic monitors (Anabat II ultrasonic detectors: Titley Electronics) will be set up on the Met tower as shown below:

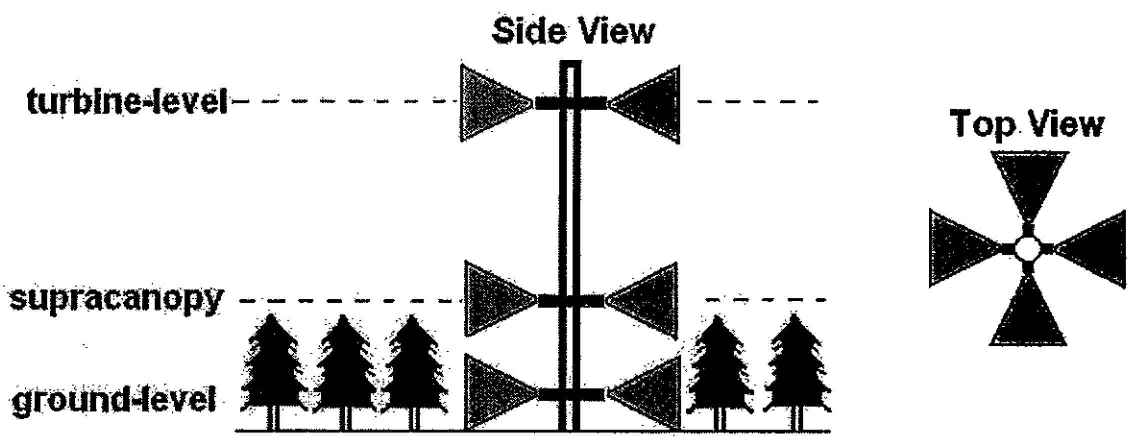


Image not to scale

Each detector will be attached to four microphones placed at each cardinal compass bearing (N,S,E, and W). Each microphone ring will sample the air space at ground level (roughly 10m above ground), supracanopy level (about 30m above ground), and turbine level (49m above ground). Each microphone will be capable of detecting the echolocation calls of approaching bats up to 20m away with a potential sampling volume of $254m^3$ (Larson & Hayes, 2000). The met tower will hold the ultrasonic microphones at altitude, while a shielded cable will transmit data from the microphone to the detector housing stored in a NEMA Type 4 weatherproof box placed on the tower near ground level. Each detector will be connected to a CF-ZCAIM (Titley Electronics) data processing and storage unit with at least 512MB of CF storage capacity (this will allow us to store approximately 15,000 individual bat passes). The detectors and ZCAIM units will be connected to a 12 volt power supply maintained by a 30W photovoltaic charging system.

Equipment Maintenance
NEES will provide two sets of three operating acoustic systems during the Spring and Fall migratory season, and from 6-9 operating acoustic systems during the Summer season. Each system will be contained within a weatherproof housing and powered by a photovoltaic power supply. Each acoustic detector (n=6) will be attached to a weatherproofed microphone housing attached to an electrically shielded data cable. NEES will also provide three sets of CF cards (3 x 6 = 18 cards); one set for the unit, one set for the weekly swap-out, and a third set in case of delays in shipping or downloading data cards.

CF cards will need to be swapped out by Highland New Wind personnel on a weekly basis, and records of each card switch will be maintained on a log sheet next to each unit. Records of maintenance will be maintained on a log sheet next to each unit. In the event of a system failure, Highland New Wind personnel should contact Scott Reynolds to coordinate system recovery or replacement.

NEES will download all data for analysis. Data from each microphone will be downloaded into separate folders (Low, Mid, High). For each microphone, individual days will be stored in separate folders identified by an eight character alphanumeric code identifying the date on which the data were downloaded using 'YYYYMMDD'. For example, data downloaded on May 16, 2006 from the ground microphone would be stored in the *Low* folder under the folder *20060516*. The first step in data processing will involve the elimination of all non-biological (pure tone constant frequency signals or periodic frequency modulated signals) and non-bat ultrasonic recordings. The remaining data will be analyzed for overall bat activity (total number of files stored), general activity index (average file buffer size), and qualitative species composition. Temporal analysis will also be conducted to look at activity by time of day and by season, and relative activity by microphone direction will also be investigated. A draft report on the Spring 2006 migration period will be completed by the end of August, 2006. A draft report on the Summer 2006 survey season will be completed by the end of Semptember, 2006. A draft report on the Fall 2006 migration period will be completed by the January, 2007.

POST-CONSTRUCTION IMPACT ANALYSIS
The need to document and understand the impact of wind resource development on bats has become an increasingly important priority, and most of these data have come from post-construction surveys at operating wind resource areas. Unlike the biological assessment and the pre-construction surveys, post-construction analysis quantifies the actual risk and impact of wind development on bats. For this reason, it is imperative that well-designed and extensive post-construction monitoring and impact analysis be performed at the Project site. This should include a carcass search protocol that will identify the distribution, species composition, and timing of all bat and bird mortality across the project site. The protocol should be appropriate for the size of the project and

the terrain over which the carcasses would be distributed. In addition to these conditions, a truly informative post-construction impact analysis should also include resources for impact mitigation through the development of adaptive management protocols (to account for meteorological influences on migratory behavior) and research into methods of reducing bat mortality ('deterrent technologies').

RECOMMENDATIONS

The suggested research activities outlined above will provide site-specific information that is critical to evaluate the potential impact of the Highland New Wind project site on bats. Further, these activities are consistent with the general recommendation of the U.S. Fish and Wildlife Service Interim Guidance documents for wind site development and the Bats and Wind Cooperative. Before undertaking this research, I would also strongly recommend a consultative meeting with the Virginia Department of Game and Inland Fisheries and the regional office of the U.S. Fish and Wildlife Service. The primary purpose of the meeting is 1) to develop informal relationships with the key contact personnel of each agency, 2) provide an opportunity for each agency to express their specific concerns about the project in a less litigious environment, 3) provide information to each agency that may diminish those concerns, 4) outline the specific research proposal to ensure that all parties understand how the final data set is interpreted, and 5) get support for the research protocol that can be presented to the State Corporation Commission. I have conducted these meetings on other wind development projects and without exception; they have proven to be invaluable for educating all parties and providing a clear and consistent understanding of the data that are generated. Such meetings were also been endorsed at a recent workshop by the American Wind Energy Association (Schwartz, 2004).

Another point that is often overlooked is the mitigation of risk to the developer as a result of the 'taking' of an endangered species. There are two pathways to reduce this risk under the Endangered Species Act. The first is the development of a Habitat Conservation Plan (HCP). This is written by the developer in consultation with the US Fish and Wildlife Service. Because it is an open-ended process (depending on the complexity of the issues involved and the volume of public feedback), the HCP is often a time-consuming process. However, it provides extensive protection to the developer in the event of an incidental take of an endangered species. The other potential pathway is through the use of a Section 7 consultation under the Endangered Species Act. A Section 7 formal consultation is activated when a federal agency with nexus over the project (such as the US Army Corps of Engineers) requests input from the U.S. Fish and Wildlife Service. This consultation results in the release of a Biological Opinion and Incidental Take Statement that 'permits' some level of take. This process is much shorter than an HCP (often within 120 days) but requires a formal consultation with another federal agency. If Highland New Wind Development, L.L.C. has obtained federal grant money or is planning on having Section 404 wetland issues, this nexus is already present. Although the thought of soliciting formal consultation with a federal agency may be daunting to some developers, the USFWS has formally endorsed wind power and they are charged with writing an Incidental Take Statement using the 'best available scientific and commercial data' (USFWS, 1998).

LITERATURE CITED

Bradshaw, P., 1993. The physical nature of vertical forest habitat and its importance in shaping bat species assemblages. Pp. 199-214. *In*: Barclay & Brigham (eds.) Bats and Forests Symposium. B.C. Ministry of Forests, Victoria, B.C.

Butchkoski, C., 2003. Indiana bat hibernacula surveys. Report prepared for the Pennsylvania Game Commission, Project Code 06714, 10 pp.

Findley, J.S. and C. Jones, 1964. Seasonal distribution of the hoary bat. *Journal of Mammalogy*, **45**: 461-470.

Fleming, T.H. and P. Eby, 2003. Ecology of Bat Migration. Pp. 156-208 *In*: T.H. Kunz and M.B. Fenton (eds.) Bat Ecology. The University of Chicago Press: Chicago, IL.

Hicks, A., 2003. Indiana bat (Myotis sodalis) protection and management in New York State: Fiscal Year April 01,2002 - April 01, 2003 Annual Report (Project W-166-E)

Johnson, J.B., 2004. Initial assessment for potential Indiana bat (*Myotis sodalis*) roosting and foraging habitat on the Roth Rock Project Area, Backbone Mountain, Garrett County, Maryland (submitted to Synergics Energy Services, LLC.)

Larson, D.J. and J.P. Hayes, 2000. Variability in sensitivity of Anabat II bat detectors and a method of calibration. *Acta Chiropterologica* 2: 209-213.

McLeish, T., 2002. Wind power. *Natural New England* 11: 60-65.

Neuweiler, G. 2000. The Biology of Bats. Oxford University Press: New York, NY, 310 pp.

Schwartz, Susan S., 2004. Proceedings of the Wind Energy and Birds/Bats Workshop: Understanding and Resolving Bird and Bat Impacts. Washington, DC. May 18-19, 2004. Prepared by RESOLVE, Inc., Washington, DC., September 2004.

USFWS, 1998. U.S. Fish and Wildlife Service Final Intra-Service Consultation Handbook. < http://www.fws.gov/endangered/consultations/s7hndbk/apdx-c-h.pdf>. Accessed 02 Jan 2006.

BREEDING BIRD STUDY
FOR THE
HIGHLAND NEW WIND POWER PROJECT
HIGHLAND COUNTY, VIRGINIA

Proposed Scope of Work and Budget

March 2006

Prepared for:

Highland New Wind Development, LLC

Prepared by:

CURRY & KERLINGER, LLC
1734 Susquehannock Drive
McLean, VA 22101
703-821-1404 + (fax) 703-821-1366
www.currykerlinger.com

Curry & Kerlinger, LLC propose to conduct a Breeding Bird Study for the Highland New Wind Power Project, Highland County, Virginia.

The purpose of the Breeding Bird Study is to provide a quantitative overview of the types of birds found to be using the habitat as nesting grounds on the project site. The object of the study is to identify the species, numbers of individuals, and distribution/location of those birds in the area where turbines are proposed. More specifically, the Breeding Bird Study is used to determine whether federal or state endangered or threatened species, or state species of special concern are present on site; and provide data on the type of species and numbers of birds that nest on and immediately adjacent to the site in an effort to determine the degree and magnitude of impacts, if any, that may result from the project. In addition, the Breeding Bird Study is a useful tool for determining turbine deployment location if nesting by listed or rare species is found within the project boundaries. Thus, the Breeding Bird Study can aid in the ultimate design and placement of the turbines to avoid sensitive nesting habitat.

As concluded in the Phase I Avian Risk Assessment, it was determined that the Highland New Wind project site contains some areas of potential nesting habitat for grassland and woodland nesting birds and some raptor species. It is likely that some individuals of these species will be displaced by development from current nesting areas. The Phase I assessment also suggested that there was suitable habitat on site that could, potentially, support nesting by state listed and, or rare species.

Breeding Bird Scope

The Breeding Bird Study starts with an initial overview of nesting habitat within a project area. Point count locations (observation points) are then established. At the Highland New Wind site, these sites will likely be close to or at the location of planned turbines. Once the observation points are established, the route (point to point) is then walked/driven by an avian expert, who samples each of the observation points. For each observation point a GPS location is recorded and staked or flagged with surveyors' tape. The number of observation points established is proportional to the size of a given wind power project or the amount of high quality habitat.

Each observation point is visited 3 times during the spring 2006 nesting season. Daily observations are made at each point during the peak hours of bird song and courtship display at their territories. This corresponds about 4:30 and 11:00 AM. Additional hours are spent on site each day, seeking out birds that may not sing or are less conspicuous than most other birds. Incidental observations are also made while walking/driving between point count locations. Each point count location is surveyed daily for at least 5 minutes during which all birds seen or heard are recorded. Observations are not made on days when there is heavy rain. Observations are made in light rain as long as birds can be clearly seen or heard singing.

When a bird is heard or seen, a species identification is made. The number of individuals seen and heard is then recorded on a data sheet. Also recorded are the approximate distance in meters and direction (8 cardinal directions – N, NE, E, etc.) of each bird from the point count location. The data collected during observation activities are entered into an Excel spreadsheet for later analysis. The data then include the date of an observation, the time of an observation, the point count number/location, the species, number of individuals, distance from a point count location, direction from the point count location, and other relevant information if necessary. The latter are collected particularly for rare, threatened, and endangered species.

Product: The final product of the Highland New Wind Breeding Bird Study will be a written report that details the findings and conclusions of the assessments. The Breeding Bird report is provided in both hardcopy and electronic format, and will be delivered in the PDF format to protect the integrity of the document. The written report may be used as is or it can be included as part of whatever application process is required or appropriate for a given project including federal (EA and EIS process for NEPA or other regulatory situations) and state level permitting.

Completion Date: A Breeding Bird Study will be instituted with the authorization of the client pursuant to the terms of this agreement. A site visit will be scheduled within 30 days of client authorization. A draft report is typically provided about 60 days following the site visit. Final drafts are generally available 1 week after review of the draft report has been completed by the client. The Breeding Bird Studies will be delivered in the PDF format to protect the integrity of the document.

Confidentiality Agreement: Information about this project is privileged between the Client – Highland New Wind Development, LLC, and Consultant - Curry & Kerlinger, LLC. Exceptions are to be agreed upon before information about the project is released.

93172

John Flora

From: John Flora

Sent: Wednesday, March 29, 2006 4:19 PM

To: 'Andrew Zadnik'; Rick Reynolds; Ray Fernald; Rene.Hypes@dcr.virginia.gov; efaschenbach@deq.virginia.gov

Cc: 'Scott Reynolds'

Subject: Bat meeting follow-up

Gentlemen,

I have added below the contact information for Jonathan Miles at JMU and George Hagerman at Virginia Tech so you may discuss with them your interest in cooperatively funding additional studies and maybe additional met towers. I provide those names simply because they both have a knowledge of and interest in wind energy, not because they have any funds available that I know of.

http://www.ari.vt.edu/People/hagerman.htm

Jonathan J Miles (faculty)
Integ. Science and Technology
ISAT 112
MSC 4102
office phone: +1 540 568 3044
e-mail: milesjj@jmu.edu

Tal McBride checked on the price of 80 meter towers which were not available when Mac started measuring the wind in 2000 with 40 meter towers. The price installed is about $50,000.

Scott Reynolds indicated he would be sending you his article soon.

Set forth below are the two 2 megawatt turbines that HNWD is most likely to use assuming the installation occurs in 2007.

http://www.gamesa.es/gamesa/modules/idealportal/uploadlink/G80_General_Characteristics.pdf

http://www.suzlon.com/2_MW_System_design.htm

Finally, Scott suggested that if you would like to check on his work in cooperation with USFWS on bat survey work you should contact Susi vonOettingen in the Concord office of USFWS.

I believe that covers the items we indicated we would provide to you when possible.

John

Keeler Obenshain PC
Serving a New Economy Across the Old Dominion

John W. Flora
90 North Main Street, Suite 201
Harrisonburg, Virginia 22803
www.kolawfirm.com
Direct Dial (540) 437-3111
Direct Fax (540)437-3101
E-mail: jflora@kolawfirm.com

28 January, 2006
D. Scott Reynolds
St. Paul's School
325 Pleasant Street
Concord, NH 03301
603-228-9308; FAX 603-229-4649; E-mail sreynolds@sps.edu

MONITORING THE POTENTIAL IMPACT OF A WIND DEVELOPMENT SITE ON BATS IN THE NORTHEAST

D. SCOTT REYNOLDS, [1] St. Paul's School, 325 Pleasant Street, Concord, NH 03301, USA

Abstract: Recent observations in the eastern United States suggest that bat communities can be at substantial risk of turbine-related mortality. Given that wind power development is the fastest growing energy sector in the world, there is an immediate need to develop survey protocols that can reliably assess the potential risk of future wind power development on both resident and migratory bat populations. I surveyed the Maple Ridge Wind Project site in New York during the spring migratory season and summer reproductive season using both acoustic monitoring and mist net capture techniques. Bat activity was low across the project site during the summer months. Bats observed at the site flew near the tree canopy, well below turbine height. Acoustic survey data collected during the spring migratory seasons suggest migratory behavior is highly episodic, being higher on warmer days with lower wind speeds. Accordingly, accurate measures of migratory behavior will require long-term data collection, and that acoustic monitoring using vertical acoustic arrays may be a valuable tool for measuring the risk of bat mortality at wind development sites.

---

[1] E-mail: sreynolds@sps.edu

Journal of Wildlife Management 00(0):000-000; 20XX

Key words: acoustic monitoring, Anabat, migration, *Myotis spp*, New York, Tug Hill Plateau, wind power.

Wind power has been gaining economic viability and is currently the fastest growing form of renewable energy in the United States (McLeish 2002). Although wind power generally is considered an environmentally-sustainable method of power generation, the potential mortality risk of wind development on migratory birds has been recognized for decades (Schmidt et al., 2003). Research into the causes and timing of avian mortality has led to the establishment of standard protocols for monitoring both resident and migratory bird species that may be impacted by wind turbine projects (Anderson et al. 1999). However, prior to the installation of the Mountaineer Wind Energy Center in the central Appalachians of West Virginia, little attention had been given to bat mortality at wind energy sites. As part of an ongoing avian survey at the Mountaineer site, biologists discovered over 400 dead bats over a short sample period during the 2003 fall migratory season, with total estimates for 2003 in excess of 2,000 bats (Kerlinger and Kerns 2004). A similar pattern of mortality was observed in the 2004 fall migratory season; although the total estimated mortality increased to over 4,000 bats (Arnett 2005). Data from Mountaineer and other wind development sites suggest that bats are at a much higher mortality risk than previously estimated, particularly in the eastern United States (Johnson 2005). In a survey of nine wind projects across the United States, Johnson (2005) observed that more than 90% of bat mortality occurred during the fall migratory season (August through October) and that migratory bats such as the hoary bat (*Lasiurus cinereus*), eastern red bat (*L. borealis*), and silver-haired bat (*Lasionycteris noctivagans*) accounted for greater than 80% of the total mortalities.

Due to the increased awareness of this risk, it has become critical to incorporate bat mortality risk assessment in wind development projects. However, the ability to generate reliable risk assessments is greatly hampered by the lack of baseline data on bat population distributions and densities throughout much of the United States. Furthermore, although many historic and anecdotal accounts of migratory behavior in bats exist (e.g., Saunders 1930, Terres 1956, Gifford and Griffin 1960), there are few studies on the migratory phenology of bats (Hall 1962, Davis and Hitchcock 1965, Tuttle 1976, Barclay 1984, Cryan 2003). Moreover, most of these are limited to the genus *Myotis* rather than the migratory tree-roosting bats, and none of these provide data on their migratory pathways or flight altitude of bats.

There are nine species of bats with geographic range overlap at this project site in western New York; the little brown bat (*Myotis lucifugus*), the northern long-eared bat (*M. septentrionalis*), the eastern small-footed bat (*M. leibii*), the Indiana bat (*M. sodalis*) the big brown bat (*Eptesicus fuscus*), the eastern pipistrelle bat (*Pipistrellus subflavus*), the silver-haired bat, the hoary bat, and the red bat. Although most bat communities in the Northeast are dominated by *Myotis* bats (Saunders and Barclay 1992, Sasse 1995, Hendricks et al. 2004), the combination of high latitude, lake-effect precipitation and wind from Lake Ontario, and the high elevation of the Tug Hill Plateau relative to the surrounding lowlands, may shift the community composition towards species such as the silver-haired bat and hoary bat (Barclay 1985, Ports and Bradley 1996), and preclude species such as the red bat that are typically found in lowland habitats (Carter et al.

2004). Locally, there was likely to be low levels of Indiana bats because of their preference for lowland riparian habitat (USFWS 1999), although there is increasing evidence that this species can be found at higher elevations in the central and southern Appalachians (Menzel et al. 2001, Britzke et al. 2003).

The main purpose of my study was to investigate spatial and temporal patterns of bat activity across a proposed wind energy project site during the summer breeding season and the migratory season to relate activity to potential bat mortality. A stronger understanding of bat activity levels prior to project construction could assist in turbine placement within the Maple Ridge wind project and help identify potential microhabitat features that would pose a risk of bat mortality at future wind development sites in the East. I specifically aimed to test three hypotheses regarding bat activity at the project site: 1) the physiogeography of the site would limit both the species diversity and total bat abundance at the project site, and 2) the bat community would be shifted towards species that are more commonly found at higher elevation (such as the hoary bat and silver-haired bat), and 3) the climate of the project site would shift the sex ratio of the bat community towards males that are not as energy-limited as reproductive females during the summer months.

STUDY AREA

The Maple Ridge Wind Project (PPM Energy, Portland OR and Horizon Wind Energy, Houston, TX) is a 198 turbine project that began construction in August 2005. The area encompasses approximately 67 km^2 within the Northeastern Highland Ecoregion or "Tug Hill Plateau" region of western New York (Omernik 1987).

Vegetation within the study area is Northern Hardwood Forest type (Eyre 1980), although much of the current regional land use is devoted to agricultural crops. The typical frost-free period in the plateau region is 100 – 120 days (NYSCO, 2006). High annual precipitation (110 cm) contributes to the maintenance of a variety of perennial streams that flow off the plateau into the surrounding lowlands (Penn State 1998). The Maple Ridge study site has a mean elevation of 545 m above sea level (asl), rising from 300 m asl at the eastern margin up to 600 m asl along the western edge of the plateau. The wind energy project is 32 km southeast of a Priority II hibernaculum for the endangered Indiana bat and wholly within the geographic distribution of the eastern small-footed bat, a New York State Species of Special Concern.

This combination of cropland, lowland forest, mixed hardwood forest, and slow-moving water make the Tug Hill Plateau, and the adjacent Black River watershed, potential roosting and foraging habitat for most of the bat species found in the Northeast. Research by Fenton and Downes (1981) along the Black River watershed has documented six species of hibernating bats, including the Indiana bat. Summer research also confirmed the presence of at least one migratory bat species, the hoary bat (B. Fenton, pers. comm.).

METHODS

One of the major goals of this study was to obtain a comprehensive survey of the bat community at the Maple Ridge wind project area. The two complementary techniques that provide the most accurate and comprehensive population surveys are mist net capture and acoustic monitoring (Hickey and Neilson 1995, O'Farrell and Gannon

1999, Murray et al. 1999, Kuenzi and Morrison 2003). Mist nets are the most reliable method for identifying bats in the field. However, mist nets are labor-intensive, have a small capture surface, and tend to produce a sampling bias towards low-flying species (O'Farrell and Gannon 1999). Furthermore, mist nets are readily detected by echolocating bats and therefore trapping success declines with repeated sampling (Brock and Kunz 1975). Acoustic monitoring has the advantage of sampling a much larger volume of space than mist nets and they do not exhibit a decline in trapping success over time. However, acoustic monitoring is not an accurate method of determining species abundance and is less reliable at species identification.

Summer Survey

Net Capture.-- Mist net captures are the most definitive method of documenting the presence of a species. I captured bats from 22 June through 05 July, 2004 using 38-mm, 50-denier mistnets (Avinet, Inc., Dryden, NY) at 24 sites throughout the project area. Netting sites were distributed throughout the project site and net locations were chosen to sample the full variety of available habitats. I used horizontal nets (ranging from 6 m-18 m in length by 2.6 m in height), canopy nets (both 6 m and 9 m in height by 3 m in width), and triple stack nets (9 m in length by 7.8 m in height) in a variety of habitats, including across woodland trails, along the edges of water sources (cattle ponds, creeks, and swamps), and along field edges. Nets were opened at sunset and monitored continuously until 0100. Captured bats were identified to species and age (adult or juvenile based on epiphyseal-diaphyseal fusion of the metacarpal-phalange joint; Anthony 1988) and reproductive condition (based on Racey 1988) was assessed. I also collected mensural data, including body size (forearm length, mm) and body mass. All bats were marked with numbered (e.g. NYDEC 01XXX), lipped aluminum forearm bands (Porzana, Ltd., East Sussex, UK) supplied by the New York Department of Conservation.

Acoustic Monitoring.-- Acoustic monitoring is a passive sampling system that should not influence bat behavior or generate avoidance responses. Acoustic monitoring uses ultrasonic microphones ('bat detectors') that are capable of detecting and recording the echolocation calls of bats in flight. The detection range of a typical bat detector (approximately 15 – 25 m) provides a much larger sampling area than a mist net. However, acoustic monitoring is less resolute to reliably identify species with overlapping acoustic signatures. This is particularly true for bats within the genus *Myotis* (Jones et al. 2004, Ahlen 2004; but see also Britzke et al. 2002).

I conducted acoustic monitoring during the summer of 2004 (23 June through 5 July) and the spring 2005 migratory season (10 April through 22 June). Acoustic monitoring sites were chosen to sample the full variety of available habitats available within the project area. In the summer sampling period, 35 sites in the wind project area were monitored for a single night from 1900 – 0700 using an Anabat 6.2 detector connected to a CF-ZCAIM data storage unit (Titley Electronics, Ballina, NSW Australia). Each detector microphone was mounted on a 1.5 m pole with the microphone facing the ground to prevent condensation from collecting on the microphone screen. Echolocation calls were reflected towards the microphone using a 10 cm x 10 cm lexan plate mounted at a 45-degree angle from horizontal. Therefore the sampling space was oriented parallel to the ground. Microphones were attached to the detector using a 3 m shielded video cable (Titley Electronics, Ballina, NSW Australia). Each detector and CF-ZCAIM unit was housed in a watertight storage box powered by a 12 V deep cycle battery. The microphones used in this study have been shown to detect the echolocation calls of approaching bats up to 11.6 m away with a potential sampling cone of 254 m^3 (Larson and Hayes 2000). Field testing for this study showed that all microphones detected a repeating ultrasonic signal (Bat Chirp; Reno, Nevada) from greater than 22 m.

I defined a 'bat pass' as any sequence of greater than 0.5 ms duration that had a least two separate calls (Thomas 1988, Gannon et al. 2003). A 'feeding buzz' was defined as a rapid series of echolocation calls that are characteristic of the attack phase of foraging insectivorous bats (Grindal et al. 1999). Data on maximum frequency, minimum frequency, changes in frequency with time, and call duration were collected from each call sequence. Species presence was determined by comparing these data with a dichotomous key I developed for species found within the northeastern United States. Due to the qualitative nature of the analysis and the similarity of calls between the *Myotis* species, our classification of these calls was restricted to genus. For similar reasons, calls that could not be confidently assigned to either the big brown bat (*E. fuscus*) or the silver-haired bat (*Lasionycteris noctivagans*) were assigned to the 'Efus-Lnoct' group (Betts 1998).

Migratory Activity

Acoustic Monitoring.-- I conducted acoustic monitoring during the spring 2005 migratory season (from April 10 through June 22) at two locations (Kabinski and Porter) in the northern section of the project site. Each site was sampled using Anabat 6.2 detectors set up on two separate vertical arrays. Each array was located on an existing 50 m meteorological tower that was located within the wind project area (Figure 1). Each tower was lowered to the ground in order to mount the acoustic array. Each array consisted of three microphones mounted at ground level (roughly 7 m above ground), supracanopy level (roughly 25 m above ground), and turbine level (50 m above ground). The turbine level microphones were oriented southeast into the prevailing wind. The ground microphone was oriented south towards the closest trail or linear landscape element in order to document the use of these features by commuting bats. The supracanopy microphones were oriented north towards the direction of the nearest known Indiana bat hibernacula located 31 km away in Watertown, NY. Each microphone was tested while the meteorological tower was on the ground, to ensure a minimum sampling distance of 20 m.

Microphones were attached to the Anabat detector using a shielded video cable with an integrated pre-amplifier. Each detector was connected to a CF-ZCAIM data storage unit. The Anabat detectors and data storage units were housed in NEMA Type-4 steel weatherproof boxes that were mounted to each meteorological tower. Each array was powered by a 12 V power supply attached to a 30 W photovoltaic charging system. Each array was programmed to monitor from 1900 through 0700.

Meteorological Data.--Meteorological data were collected using a NRG 200P anemometer and an 110S Temperature Sensor (NRG Systems, Hinesburg, VT) mounted on the Porter meteorological tower. Both instruments were mounted at 49 m above ground. Data on wind speed (m/s), wind direction, and temperature (C) were collected every minute and averaged for each 10 minute interval. These data were then used to generate daily averages, daily maximum, and daily minimum values for each measurement. Mean daily wind direction was converted into categorical data using eight compass bearings (N-NE, E-NE, E-SE, S-SE, S-SW, W-SW, W-NW, and N-NW). In addition, average values for each variable were calculated from 1900 through 0700 each day to generate 'nightly' average measurements.

Statistical Analyses

To examine temporal patterns of bat activity during the summer sampling periods, each night was partitioning into three equal-length periods; early (1900-2259), middle (2300-0259), and late (0300-0700). Sampling sites were categorized into five habitat types (trails and roads, rivers and creeks, ponds, fields, wetlands and marsh habitat). I examined summer bat activity using a 2-factor (sampling period x habitat type) general linear model with post hoc Tukey's multiple comparisons procedure. To examine temporal patterns of bat activity during the spring migratory sampling period, each night was partitioning into three equal-length periods; early (1900-2259), middle (2300-0259), and late (0300-0700). Seasonal variation in bat activity was investigated by dividing the sampling period into three equal-length intervals; early (10 April through 4 May), middle (5 May through 29 May), and late (30 May through 22 June). I examined the spring bat activity using a 3-factor (night period x sampling period x sampling height) general linear model with post hoc Tukey's multiple comparisons procedure. The analysis of the impact of weather conditions on spring migratory bat activity were limited to the 74-day sampling period (10 April through 22 June) where both activity data and meteorological data were collected. Because of the large number of days with no detectable bat activity (19 nights or 26% of the sampling days), activity data were categorized as none (0 bats/nights). low (1-2 bats/nights), medium (3-6 bats/nights), and high (> 6 bats/night). These categories were established *post hoc* to minimize group size variation. Meteorological variables were compared using Pearson correlation analysis to determine the degree of independence. For wind speed and ambient temperature, bat activity was analyzed by multiple comparison analysis using a general linear model with Tukey's multiple comparisons procedure. For the wind direction data, mean daily azimuth values were categorized into eight 45-degree segments. I analyzed for a non-random distribution of bat activity with respect to wind direction using a chi-squared goodness of fit test. For all statistical analyses, I used either either SAS (SAS Institute, Cary, NC) or Mini-Tab v13 (Minitab Inc., State College, PA).

RESULTS

Summer Survey

Net Captures.-- Mist netting was conducted at 24 sites, with a total sampling effort of 130 net-nights. These efforts resulted in the capture of 35 bats of three species, with a site-wide capture rate of 0.3 bats/net-night (Table 1). No bats were captured at 40% of the sample sites. Across the study area, 74% of all captured bats were male. One netting site produced eight female northern long-eared bats, including all seven lactating females from this species. Excluding this site from analysis, 96% of all bats captured were male.

No pregnant or post-lactating females were captured at the study site, nor were any juveniles of any species.

Acoustic Monitoring.-- Although acoustic monitoring was conducted using 35 stations across the project site, seven sites had technical problems or did not record data for the entire evening and were therefore excluded from analysis. A total of 4,259 bat passes were recorded during 208 detector-hours. However, activity levels were highly skewed across sample sites, with 39.0% of the sample sites had activity levels below 1.0 passes/hr. Therefore, although the mean activity level across the project site was 20.6 passes/hr, the median activity level was 6.2 passes/hr. Bat activity was significantly influenced by habitat ($F_{4,345}$=2.92, P=0.02), with ponds being the only habitat showing preferential use by the bats (Figure 2). There was no evidence that the relative activity between habitat types changed throughout the course of the night ($F_{2,345}$=1.54, P=0.22).

The acoustic data suggest the presence of at least four species of bats across the project site (Table 2). Bats in the genus *Myotis* accounted for almost 95.7% of the calls and 98.8% of all feeding buzzes. The big brown/silver-haired group represented 3.3% of the calls, and the migratory tree-roosting bats (red bat and hoary bat) accounted for 1.0% of the total activity. Temporal analysis of bat activity showed that most of the big brown/silver-haired group activity occurred early in the evening ($F_{4,355}$=2.91, P=0.02), with peak activity occurring at 2145 (Figure 3). In contrast, *Myotis* bats were detected throughout the night, with activity levels increasing during the early evening and declining gradually after midnight.

Migratory Activity

Acoustic Monitoring.-- During 5,328 hours of acoustic monitoring, a total of 459 bat passes were identified (Table 3) for an overall acoustic capture rate of 0.09 bat passes/hr. There was no difference in mean level of bat passes between the Kabinski and Porter sites ($F_{1,250}$=0.06, P=0.82), therefore these data were pooled. The nightly level of detectable bat activity was highly skewed to the right and had a median activity level of 2.0 bats/night (range: 0 - 125 bats/night). Although the activity levels were generally low, two high activity events were recorded. One event occurred on 20 April at the Kabinski array. During this event, 101 bat passes from eastern pipistrelles were recorded at the turbine microphone from 2130-2200. The second event occurred on 10 June at the Porter array. During this second event, 115 bat passes from *L. cinereus* were recorded at the ground microphone from 0530-0700. Excluding these two high-activity events, the big brown/silver-haired group and hoary bats were the two most commonly detected species groups, representing 54.4% and 24.5% of total bat passes, respectively. The *Myotis* spp. group, which contained the greatest number of potential bat species occurring at the project site, represented 19.0% of the total bat passes. Although there was bat activity throughout the sampling period, more bat passes were recorded during the late spring sampling period compared to the early spring ($F_{2,251}$=5.00, P=0.01). There was also a significant difference between species in the seasonal timing of acoustic activity (($F_{8,238}$=6.67, P=0.001). Calls from the two most commonly detected species groups, big brown/silver-haired bats and hoary bats, were rare during the early spring. Most of the activity in the big brown/silver-haired group occurred during the middle and late spring sampling periods, whereas most of the activity from hoary bats was detected during the late sampling period. The *Myotis* spp. group did not show any significant seasonal variation in activity.

There was a general decline in activity over the course of the night (Figure 4), with more bat passes detected early in the evening relative to the middle or late sampling periods ($F_{2,251}$=5.02, P=0.01). More bat passes were heard at the ground microphone (49% of total bat passes) compared to the supracanopy (34%) and turbine (17%) microphone ($F_{2,251}$=7.46, P=0.001). There was no interaction between the timing of bat activity and microphone height ($F_{4,251}$=0.51, P=0.73).

Meteorological Influence on Activity.-- Bat activity was negatively influenced by daily minimum wind speed (V_{min}: $F_{3,70}$=9.70, P<0.001) and daily mean wind speed (V_{ave}: $F_{3,70}$=3.32, P=0.03), but not daily maximum wind speed (V_{max}: $F_{3,70}$=0.59, P=0.63) or evening mean wind speed (V_{even}: $F_{3,70}$=0.40, P=0.75). Most of the migratory activity (medium and high levels) occurred at minimum wind speeds below 1.2±1.1 m/s, whereas days with no bat activity had a minimum wind speed of 3.4±1.4 m/s. Except for V_{max} and V_{min}, all the wind speed variables were highly correlated (r ≥0.35, P<0.001).

Temperature appeared to have a strong influence on migratory activity throughout the spring sampling period; however, all the temperature variables were highly correlated with each other (r ≥0.50, P<0.001). High migratory activity was most strongly influenced by daily maximum temperature (T_{max}: $F_{3,70}$=18.87, P<0.001), although daily mean temperature (T_{ave}: $F_{3,70}$=18.01, P<0.001), daily minimum temperature (T_{min}: $F_{3,70}$=3.48, P=0.02), and evening mean temperature (T_{even}: $F_{3,70}$=13.81, P<0.001) were also significant. Days with high bat activity had a mean maximum temperature of 23.9±4.4°C compared to 9.8±4.8°C for days with no bat activity.

During the spring migratory period, the prevailing wind direction at the Porter tower was from the south (mean azimuth of 175.3°). Variation in wind direction over the course of the migratory season had no detectable influence on bat activity ($\chi^2 = 18.2$, $P>0.50$), with the modal wind direction for all activity classes within the same range (225° - 270°).

DISCUSSION

Summer Survey

Net capture.-- My mist netting survey result of 0.3 bats per net-night (b/nn) was lower than other published population surveys, for example Clark et al 1987 (3.5 b/nn), Whitaker and Gummer 2001 (7.3 b/nn), and Brack et al. 2004 (0.6 b/nn). It is also lower than surveys conducted at other wind development sites, such as Gates et al. 2004 (1.5 b/nn) and Johnson and Strickland 2003 (1.0 b/nn). The low level of species diversity and the high proportion of males captured at the project site suggest that the Maple Ridge Wind Power site is marginal habitat for reproductive bats. The capture effort at the present study does not provide any evidence for the presence of the two species of concern (*M. leibii* or *M. sodalis*).

Acoustic Monitoring.-- The acoustic monitoring data shows that most of the bat activity was concentrated around the artificial ponds throughout the project site. This is consistent with previous studies that show several of these species concentrate their foraging activity around water (Fenton et al. 1980, Furlonger et al. 1987, Zimmerman and Glanz 2000, Menzel et al. 2001, Owen et al. 2003, Menzel et al. 2005). The median activity level across the project area was 6.2 passes per hour (p/h), with 39% of the sites having activity levels below 1.0 p/h. This is similar to other acoustic monitoring surveys in similar habitat and/or elevation from New York (17.3 p/h: Gannon and Sherwin 2001) and New Hampshire (0.7 p/h: Krusic 1995). It is also similar to the activity levels detected at other wind development sites in West Virginia (6.0 p/h: Johnson and Strickland 2003), Iowa (8.3 p/h: Jain 2005), and Ontario Canada (4.7 passes/hr: Fenton et al. 2004). Although total species diversity was higher based on acoustic monitoring, overall activity across the project site was relatively low.

Overview of Summer Survey.-- The summer data support the first hypothesis of lowered species diversity and overall activity level. The most likely cause of the low activity is the relatively higher elevations and correspondingly lower temperatures and higher precipitation of the Tug Hill compared to the adjacent river valley. Previous research has shown that total species diversity and the total number of individual bats decline with increasing elevation (Fenton et al. 1980, Thomas and West 1988, Krusic 1995, Grindal et al. 1999, Cryan et al. 2000, Brack et al. 2002). In fact, several studies have suggested that elevation is one of the primary predictive factors for explaining insectivorous bat distributions (Badgley and Fox 2000, Jaberg and Guisan 2001). Other studies have also found that low temperatures reduce bat activity (Negraeff and Brigham 1995, Vaughan et al. 1997). There was no strong evidence for the predicted shift in community composition towards species that are more commonly found at higher elevations (such as the silver-haired bat, big brown bat, and hoary bat), as they comprised only 8.6% of all captures (all big brown bats) and 4.3% of the acoustic passes (mostly hoary bats). Excluding the pond sampling sites, these bats comprised 8.4% of the acoustic passes.

The capture data collected at Maple Ridge site appears to be consistent with the general pattern towards male-biased sex ratios at high-elevation and high latitude sites (Fenton et al. 1980, Shump and Shump 1982, Barclay 1991, Sasse 1995, Grindal et al. 1999, Ford et al. 2002, Cryan et al. 2004). These data also are consistent with the general reduction in reproductive females captured at high elevation sites (Barclay 1991, Cryan et al. 2000). Therefore, the present study suggests that the Tug Hill Plateau does not contain a substantial resident bat population, and with the exception of northern long-eared bats, appears to be primarily used by males and non-reproductive females.

Migratory Activity

Acoustic Monitoring.-- Data from the acoustic array suggest that migratory activity across the project site is highly variable temporal component relative to the spatial component. This suggests that migratory bat activity may be relatively broad-fronted but episodic. The two large migratory events recorded during the present study are potentially very informative. First, they differed in timing by 51 days, suggesting that the migratory season for bats may be extensive. Some species, such as the big brown/silver-haired group and hoary bats, appear to migrate later in the season than *Myotis* spp. Second, the hoary bat event occurred early in the morning at the lowest microphone (7m above ground), suggesting migratory behavior is highly variable either between species or within species under different climactic conditions. The high quality of the calls, the large number of calls per pass (often greater than 20 calls/file), the extensive CF component of each call, and the lack of any shift in call characteristic typical of investigatory behavior or foraging, make me confident that these data represent a series of commuting individuals rather than multiple passes from the same individual (Reynolds. in prep.). If these data are typical of migratory 'flocks', then the use of quantitative species identification methods (Britzke and Murray 2000) may not be reliable using existing call libraries.

Although acoustic systems have been used to monitor bat activity above the tree canopy (Bradshaw 1993), there has been little effort to develop high-altitude acoustic monitoring (but see McCracken 1996, Fenton and Griffin 1997, Menzel et al. 2005). Long-term monitoring using vertical acoustic arrays is a new technique that could be better developed specifically to address bat mortality in relation to wind power development. Based on the data presented in this study, the use of meteorological towers (met towers) as an array platform shows promise for three reasons. First, met towers are sized to match the height of the wind turbines (currently up to 80 m in height), thereby allowing researchers to sample migratory behavior within the proposed rotor sweep zone. Second, met towers are located within the proposed project area up to three years prior to turbine installation, thereby allowing us to collect long-term site-specific data within the project area. Lastly, met towers have trails and service roads leading to them, and these trails and the edge habitat created by the clearing will provide ideal travel corridors to monitor ground-level bat activity.

The primary advantage of the method employed in this study is that acoustic monitoring can be conducted across a variety of habitats and in multiple configurations depending on the deployment of met towers. This study protocol also addresses two of the major concerns regarding many acoustic monitoring protocols: 1) the lack of vertical sampling, and 2) the lack of long-term monitoring (Hayes 2000). Without a high altitude microphone, it is likely that the large eastern pipistrelle migratory event would have been missed due to the inability to detect these calls from the ground. Additionally, without a complete season of monitoring effort, it is likely that both this high-activity event and the hoary bat migratory event would have been missed completely.

The main detraction of acoustic monitoring is the inability to identify species with overlapping acoustic signatures such as the *Myotis* bats found in the Northeast (Jones et al. 2004, Ahlen 2004). However, a primary goal of this study was to document the spatial and temporal distribution of the entire bat community and not just for an endangered species such as the Indiana bat. When species discrimination is conducted using conservative techniques, acoustic monitoring continues to be one of the best sampling methods available (Britzke et al. 2002).

The Influence of Weather on Bat Migratory Activity.-- One of the most promising methods of minimizing bat mortality is the development of an 'adaptive management plan' that would be able to curtail turbine activity during periods of peak bat migration activity. Recent data collected in West Virginia have suggested that bat migratory passage rates are higher during evenings with low wind speed (Arnett 2005). The present study found that most of the bat migratory activity occurred when the daily mean wind speeds were below 5.4 m/s. This is encouragingly close to the lowest economically useable wind speeds (the 'cut-in' speed) of a typical commercial wind turbine (DWIA, 2003). Temperature also had a significant influence of the migratory activity in the present study, with no detectable migratory activity when the daily mean temperature was below 10.5°C. Bats may be using these two meteorological indicators on different temporal scales, as temperatures during the night (between 1900 – 0700) significantly influenced migratory activity, but wind speeds during the night did not. The present study found that wind direction did not influence migratory activity. This may make sense if the bats are relying on low wind speed conditions during migration.

MANAGEMENT IMPLICATIONS

New York State has an aggressive renewable portfolio standard that dictates 25% green energy by 2012. Because New York has the highest wind ranking of any state in the Northeast (Pasqualetti 2004), it is believed that a large portion of that renewable energy could be generated with wind power. In order to ensure this wind development does not negatively impact bat populations, more effort needs to be made to establish survey protocols that are designed to answer the specific concerns of wind turbines. The Bats and Wind Energy Cooperative (BWEC), founded by the American Wind Energy Association, Bat Conservation International, the National Renewable Energy Laboratory and the U.S. Fish and Wildlife Service, was formed specifically to identify research priorities, to establish rigorous survey protocols, and develop solutions that will reduce the impact of wind development on bats (BCI, 2004).

Ground-based methodologies (including net capture and acoustic monitoring) are the primary survey technique used to evaluate bat populations, and these techniques will continue to be invaluable for measuring resident bat diversity, relative abundance, and habitat utilization. However, the use of ground-based acoustic monitoring (with a range of about 30 m) to assess the bat collision risk of modern turbines (with a minimum height of 35 m) seems to be illogical. More effort needs to be made to assess the direct threat to bats; namely the risk of migratory activity across the project site and whether non-migratory flight on the project site poses a significant threat of turbine collision. The development of BWEC is a critical first step to identify key research questions and help establish methodologies that answer those questions and generate data that can be compared across a region. The use of regional technical advisory groups may help state and federal agencies that are receiving multiple requests for wind development permits from multiple projects located within kilometers of one another. Given the high growth rate of wind development and the political pressure to obtain a clean and reliable energy source, quicker deployment of valid pre-siting survey protocols seem prudent.

ACKNOWLEDGEMENTS

This study could not have been completed without the field assistance of T. Boothby, M. Evans, B. Kenison, T. Farmer, S. McNulty, R. Nicoll, A. Oh, A. Piegdon, B. Shirley, L. Swart, M. Takagi, and R.Wilson. Technical and field assistance was also provided by T. Reed. I am also grateful for the guidance of R. Niver (US Fish and Wildlife Service) and A. Hicks (NY Department of Conservation), and the funding support from W. Moore (Flat Rock Wind Power). Lastly, I would like to thank A. Hicks,

J. Veilleux, and W. Ford for their extensive comments and suggestions that led to the many improvements in this manuscript.

LITERATURE CITED

Ahlen, I. 2004. Heterodyne and time-expansion methods for identification of bats in the field and through sound analysis. Pages 72-79 *in* R. Mark Brigham, et al., editors. Bat Echolocation Research: tools, techniques, and analysis. Bat Conservation International, Austin, Texas, USA.

Anderson, R., M. Morrison, K. Sinclair, and D. Strickland. 1999. Studying Wind Energy/Bird Interactions: A Guidance Document. National Wind Coordinating Committee, Washington, D.C., USA.

Anthony, E.L.P. 1988. Age determination in bats. Pages 47-58 *in* T.H. Kunz, editor. Ecological and Behavioral Methods for the Study of Bats. Smithsonian Institute Press, Washington, D.C., USA.

Arnett, E.B., editor. 2005. Relationships between bats and wind turbines in Pennsylvania and West Virginia: an assessment of bat fatality search protocols, patterns of fatality, and behavioral interactions with wind turbines. A final report submitted to the Bats and Wind Energy Cooperative. Bat Conservation International, Austin, Texas, USA.

Badgley, C. and D.L. Fox. 2000. Ecological biogeography of North American mammals: species density and ecological structure in relation to environmental gradients. Journal of Biogeography, 27:1437-1467.

Barclay, R.M.R. 1984. Observations on the migration, ecology, and behaviour of bats at Delta Marsh, Manitoba. Canadian Field Naturalist, 98: 331-336.

----- 1985. Foraging strategies of silver haired (*Lasionycteris noctivigans*) and hoary (*Lasiurus cinereus*) bats. Myotis, 23: 161-166.

----- 1991. Population structure of temperate insectivorous bats in relation to foraging behavior and energy demand. Journal of Animal Ecology, 60:165-178.

[BCI] Bat Conservation International. 2004. Bats and Wind Energy Cooperative Research. <http://www.batcon.org/wind/research.html>. Accessed 2005 Dec 30.

Betts, B.J., 1998. Effects of interindividual variation in echolocation calls on identification of big brown and silver-haired bats. Journal of Wildlife Management, 62: 1003-1010.

Brack, V., C. Stihler, R. Reynolds, C. Butchkoski, and C. Hobson. 2002. Effect of climate and elevation on distribution and abundance in the mideastern United States Pages 21-34 *in* A. Kurta and J. Kennedy, editors. The Indiana Bat: Biology and Management of an Endangered Species. Bat Conservation International, Austin, Texas, USA.

-----, J.O. Whitaker, and S.C. Pruitt. 2004. Bats of Hoosier National Forest. Proceedings of the Indiana Academy of Sciences, 113: 76-86.

Bradshaw, P. 1993. The physical nature of vertical forest habitat and its importance in shaping bat species assemblages. Pages 199-214 *in* R.M.R. Barclay and R.M. Brigham, editors. Bats and Forests Symposium. British Columbia Ministry of Forests, Victoria, British Columbia, Canada.

Britzke, E.R. and K.L. Murray. 2000. A quantitative method for selection of identifiable search-phase calls using the Anabat system. Bat Research News, 41: 33-34.

-----, K.L. Murray, J.S. Heywood, and L.W. Robbins. 2002. Acoustic identification. Pages 221-227 *in* A. Kurta and J. Kennedy, editiors. The Indiana bat: biology and and management of an endangered species. Bat Conservation International, Austin, Texas.

-----, M.J. Harvey, and S.C. Loeb. 2003. Indiana bat, Myotis sodalis, maternity roosts in the southern United States. Southeastern Naturalist, 2: 235-242.

Brock, C.E. and T.H. Kunz. 1975. A comparison of mist nets and ultrasonic detectors for monitoring flight activity of bats. Journal of Mammalogy, 56:907-911

Carter, T., M.A. Menzel, B.R. Chapman, and K.V. Miller. 2004. Partitioning of food resources by syntopic eastern red bats (*Lasiurus borealis*), seminole (*L. seminolus*) and evening (*Nycticeius humeralis*) bats. American Midland Naturalist 151: 186-191.

Clark, B.K., J.B. Bowles, and B.S. Clark. 1987. Summer status of the endangered Indiana bat in Iowa. American Midland Naturalist, 118: 32-39.

Cryan, P.M. 2003. Seasonal distribution of migratory tree bats (*Lasiurus* and *Lasionycteris*) in North America. Journal of Mammalogy, 84: 579-593.

-----, M.A. Bogen, and J.S. Altenbach. 2000. Effect of elevation on distribution of female bats in the Black Hills, South Dakota. Journal of Mammalogy, 81:719-725.

-----, M.A. Bogen, R.O. Rye, G.P. Landis, and C.L. Kester. 2004. Stable hydrogen isotope analysis of bat hair as evidence for seasonal molt and long-distance migration. Journal of Mammalogy 85:995-1001.

Davis, W.H. and H.B. Hitchock. 1965. Biology and migration of the bat, *Myotis lucifugus*, in New England. Journal of Mammalogy, 46:296-313.

[DWIA) Danish Wind Industry Association. 2003. Power density function. <http://www.windpower.org/en/tour/wres/powdensi.htm>. Accessed 01 Jan 2006.

Eyre, F.H. (ed.). 1980. Forest Cover Types of the United States and Canada. Society of American Foresters, Washington, DC, USA.

Fenton, M.B., C.G. van Zyll de Jong, G.P. Bell, D.G. Campbell, and M. LaPlante. 1980. Distribution, parturition dates, and feeding of bats in South-Central British Columbia. Canadian Field Naturalist, 94:416-420.

----- and C.M. Downes. 1981. A study of summer populations of the endangered Indiana bat, *Myotis sodalis*, near Watertown, New York. New York Department of Environmental Conservation Project E-1-5.

----- and D.R. Griffin. 1997. High-altitude pursuit of insects by echolocating bats. Journal of Mammalogy 78:247-250.

-----, C.J. van Zyll de Jong, C.P. Bell, D.B. Campbell, and M. LaPlante. 1980. Distribution, parturition dates, and feeding of bats in South-Central British Columbia. Canadian Field Naturalist, 94: 416-420.

-----, J. Blasko, C. Davy, E. Fraser, and E. Van Stam. 2004. Bat activity in the area of the proposed Royal Road site, Prince Edward County, Ontario. University of Western Ontario, London, Ontario, Canada.

Ford, W.M.. M. Menzel, J. Menzel, and D.J. Welch. 2002. Influence of summer temperature on sex ratios in eastern red bats (*Lasiurus borealis*). American Midland Naturalist, 147:179-184.

Furlonger, C.L., H.J. Dewar, and M.B. Fenton. 1987. Habitat use by foraging insectivorous bats. Canadian Journal of Zoology, 65: 284-288.

Gannon, W.L. and R.E. Sherwin, 2001. Bat survey work conducted at West Point Military Academy, New York 1999-2000. West Point, New York, USA., 38 pp.

-----, R.E. Sherwin and S. Haymond. 2003. On the importance of articulating assumptions when conducting acoustic studies of habitat use by bats. Wilson Society Bulletin 31:45-61.

Gates, J.E., J. Kerns, and J.B. Johnson. 2004. Risk and fatality assessment for birds and bats at the Backbone Mountain wind resource area, Garrett County, Maryland. Maryland Department of Natural Resources, Annapolis, Maryland.

Gifford, C. and D.R. Griffin. 1960. Notes on homing and migratory behavior of bats. Ecology 41:378-381.

Grindal, S.D., J.L. Morissette, and R.M. Brigham. 1999. Concentration of bat activity in riparian habitats over an elevational gradient. Canadian Journal of Zoology 77:972-977.

Hall, J.S. 1962. A life history and taxonomic study of the Indiana bat, *Myotis sodalis*. Scientific Publication 12. Reading Public Museum and Art Gallery, Reading, Pennsylvania, USA.

Hayes, J.P. 2000. Assumptions and practical considerations in the design and interpretation of echolocation monitoring studies. Acta Chiropterologica 2: 225-236.

Hendricks, W.D., R. Ijames, L. Alverson, J. Timpone, M. Muller, N. Nelson, J. Smelser. 2004. Notable roosts for the Indiana bat (*Myotis sodalis*). Pages 133-138. *in* K.C.

Vories and A. Harrington, editors. Proceedings of Indiana Bat & Coal Mining: A Technical Interactive Forum. U.S. Department of the Interior, Alton, Illinois, USA.

Hickey, M.B. and A.L. Neilson. 1995. Relative activity and occurrence of bats in Southwestern Ontario as determined by monitoring with bats. Canadian Field Naturalist, 109:413-417.

Jaberg, C. and A. Guisan. 2001. Modelling the distribution of bats in relation to landscape structure in a temperate mountain environment. Journal of Applied Ecology, 38: 1169-1181.

Jain, A.A., 2005. Bird and bat behavior and mortality at a northern Iowa windfarm. Master's Thesis, Iowa State University, Ames, Iowa., USA.

Johnson, G.D. 2005. A review of bat mortality at wind-energy developments in the United States. Bat Research News 46:45-49.

----- and M.D. Strickland. 2003. Biological assessment for the federally endangered Indiana bat (*Myotis sodalis*) and Virginia big-eared bat (*Corynorhinus townsendii virginianus*). NedPower Mount Storm LLC, Chantilly, Virginia.

Jones, G., N. Vaughan, D. Russo, L.P. Wickramasinghe, and S. Harris. 2004. Designing bat activity surveys using time expansion and direct sampling of ultrasound. Pages 83-89 *in* R. Mark Brigham, et al., editors. Bat Echolocation Research: tools, techniques, and analysis. Bat Conservation International, Austin, Texas, USA.

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

Krusic, R., 1995. Habitat use and identification of bats in the White Mountain National Forest. Master's Thesis: University of New Hampshire: Durham, NH., USA.

Kuenzi, A.J. and M. Morrison. 2003. Temporal patterns of bat activity in Southern Arizona. Journal of Wildlife Management, 67:52-64.

Larson, D.J. and J.P. Hayes. 2000. Variability in sensitivity of Anabat II bat detectors and a method of calibration. *Acta Chiropterologica* 2: 209-213.

McCracken, G.F. 1996. Bats aloft: a study of high-altitude feeding. Bats 14:7-10.

McLeish, T. 2002. Wind power. Natural New England 11:60-65.

Menzel, M.A., J.M. Menzel, T.C. Carter, W.M. Ford, J.W. Edwards. 2001. Review of the forest habitat relationships of the Indiana bat (*Myotis sodalis*). General Techical Report NE-284. U.S. Department of Agriculture, Newtown Square, Pennsylvania.

Menzel, J.M., M.A. Menzel, J.C. Kilgo, W.M. Ford, J.W. Edwards, and G.F. McCracken. 2005. Effect of habitat and foraging height on bat activity in the coastal plain of South Carolina. Journal of Wildlife Management, 69: 235-245.

Murray, K.L., E.R. Britzke, B.M. Hadley, and L.W. Robbins. 1999. Surveying bat communitics: a comparison between mist nets and the Anabat II bat detector system. Acta Chiropterologica, 1: 105-112.

Negraeff, O.E. and R.M.R. Barclay. 1995. The influence of moonlight on the activity of little brown bats (*Myotis lucifugus*). Zeitschrift fur Saugetierkunde, 60: 330-336.

[NYSCO] New York State Climate Office. 2006. The Climate of New York. <http://nysc.eas.cornell.edu/climate_of_ny.html>. Accessed 2006 January 28.

O'Farrell, M.J. and W.L. Gannon. 1999. A comparison of acoustic versus capture technique for the inventory of bats. Journal of Mammalogy, 80:24-30.

Omernik, J.M. 1987. Ecoregions of the conterminous United States: Annals of the Association of American Geographers 77:118-125.

Owen, S. M.A. Menzel, W.M. Ford, B.R. Chapman, K. Millar, J. Edwards, and P.B. Wood. 2003. Home-range size and habitat used by the northern myotis (*Myotis septentrionalis*). American Midland Naturalist, 150: 352-359.

Pasqualetti, M. 2004. Wind power. Environment, 46:22-40.

[Penn State] Penn State Earth System Science Center. 1998. Soil Information for MLRA 141-Tughill Plateau. <http://www.essc.psu.edu/soil_info/soil_lrr/mlra.cgi?141?>. Accessed 2005 Aug 25.

Petterssen, L. 2004. The properties of sound and bat detectors Pages 9-13 *in* R. Mark Brigham, et al., editors. Bat Echolocation Research: tools, techniques, and analysis. Bat Conservation International, Austin, Texas, USA.

Ports, M.A. and P.V. Bradley. 1996. Habitat affinities of bats from Northeastern Nevada. *Great Basin Naturalist*, **56**: 48-53.

Racey, P.A. 1988. Reproductive assessment in bats. Pages 31-45 *in* T.H. Kunz, editor. Ecological and Behavioral Methods in the Study of Bats. Smithsonian Institute Press, Washington, D.C. USA.

Sasse, B. 1995. Summer roosting ecology of cavity-dwelling bats in the White Mountain National Forest. Master's Thesis, University of New Hampshire, Durham, USA.

Saunders, W.E. 1930. Bats in migration. Journal of Mammalogy 11:225.

Saunders, M.B. and R.M.R. Barclay. 1992. Ecomorphology of insectivorous bats: a test of predictions using two morphologically similar species. Ecology, 73: 1335-1345.

Schmidt, E., A.J. Paggio, and C.E. Block. 2003. National Wind Technology Center Site Environmental Assessment: Bird and Bat Use and Fatalities - Final Report NREL/SR-500-32981. National Renewable Energy Laboratory, Golden, Colorado, USA.

Shump, K.A. and A.U. Shump. 1982. *Lasiurus cinereus*. Mammalian Species, 185:1-5.

Sokal, R.R. and F.J. Rohlf, 1981. Biometry. W.H. Freeman and Company, New York, USA.

Terres, J.T. 1956. Migration records of the red bat, *Lasiurus borealis*. Journal of Mammalogy 37:442.

Thomas, D.W. 1988. The distribution of bats in different ages of Douglas-fir forests. Journal of Wildlife Management, 52:619-626.

----- and S.D. West. 1988. Forest age associations of bats in the southern Washington Cascade and Oregon Coast Ranges. Journal of Wildlife Management, 52: 619-624.

Tuttle, M.D. 1976. Population ecology of the gray bat (*Myotis grisescens*): philopatry, timing and patterns of movement, weight loss during migration, and seasonal adaptive strategies. Occasional Papers of the Museum of Natural History 54:1-38.

[USFWS] U.S. Fish and Wildlife Service. 1999. Agency draft Indiana bat (Myotis sodalis) revised recovery plan. Fort Snelling, Minnesota.

Vaughan, N., G. Jones, and S. Harris. 1997. Habitat use by bats (Chiroptera) assessed by means of a broad-band acoustic method. Journal of Applied Ecology, 34: 716-730:

Whitaker, J.O. and S.L. Gummer. 1992. Hibernation of the big brown bat, *Eptesicus fuscus*, in buildings. Journal of Mammalogy 73: 312-316.

Zimmerman, G.S. and W.E. Glanz. 2000. Habitat use by bats in eastern Maine. Journal of Wildlife Management, 64: 1032-1040.

Presented at the April 2005 Joint Annual Meeting of the Wilson Ornithological Society and the Society of Field Ornithologists, Beltsville, Maryland.

APPALACHIAN RIDGE FOLLOWING BY NIGHT MIGRATING BIRDS? A TEST OF THE HYPOTHESIS USING MARINE SURVELLANCE RADAR IN THREE STATES. Paul Kerlinger, Curry & Kerlinger LLC, P.O. Box 453, Cape May Point, NJ 08212.

The hypothesis that night migrating birds fly at low altitudes, use updrafts, and follow ridges during fall over Appalachian ridges was tested at five sites, along four, high elevation (>820 m ASL; orientation ~ 215°) ridges using marine surveillance radar in horizontal and vertical modes. Migration traffic rate, flight direction and height of flight were collected by ABR, Inc. and Woodlot Alternatives, Inc. Mean migration rates were174 and 187 targets per km of migration front per hour (t/km/hr) in Pennsylvania, 188 t/km/hr in Maryland, and 229 and 241 t/km/hr in West Virginia. These rates are lower than would be expected if birds were concentrated along ridge-tops. Orientation of migrants varied greatly and migrants, on average, crossed ridges at oblique angles. Mean flight directions were 219° and 188° in Pennsylvania, 193° in Maryland, and 175° and 184° in West Virginia. Mean altitudes of migration were between 410 and 583 m at the five sites and few migrants flew below 125 m (~7-13%), too high for them to be using updrafts from winds deflected by the ridges. These findings are not consistent with predictions of the hypothesis that night migrants follow ridges or use updrafts along these ridges during fall, but are consistent with broad front migration through Appalachia.

American Wind Energy Association™

Wind and Wildlife: Learning from the Past, Changing for the Future

The wind industry is committed to, and has demonstrated, continual innovations leading to greater protection of the environment and wildlife. All current research shows that wind's impacts on wildlife are generally small. Modern wind turbines are far less harmful to birds than radio towers, tall buildings, airplanes, vehicles, pesticides and even house cats, and their effect on bats is also modest in most parts of the U.S.. Unlike fossil fuel power plants and other industrial processes, wind energy power plants do not release any harmful emissions that contribute to acid rain, global warming, mercury poisoning or other environmental effects that threaten wildlife.

Despite the minimal impact wind development has on bird populations generally, the industry takes potential impacts seriously and continues to assess ways in which wildlife impacts can be lessened. Since the first concerns about wind energy and wildlife were raised, the wind industry has taken numerous steps to address legitimate concerns and ensure problems are not repeated at other wind projects.

Learning the Lessons of Altamont Pass

- In 1994, shortly after raptor deaths in the Altamont Pass became a general concern, the wind energy industry joined with other stakeholders (government officials, environmental groups, utilities) to form the National Wind Coordinating Committee (NWCC), a multi-stakeholder collaborative aimed at addressing the wind/avian issue and other issues affecting the industry's future. NWCC has sponsored numerous meetings and academic papers to better understand wind energy's wildlife impacts, including updates to the environmental community about the latest wind-related research; events related to the biological significance of wind's impacts; and a wind project permitting handbook. More information on NWCC activities is available at http://www.nationalwind.org .
- In Altamont Pass—one of the oldest wind projects with many smaller turbines spaced relatively closely together—a number of studies were conducted to determine how avian and raptor impacts could be reduced, and these lessons were incorporated into later wind projects. Industry and government researchers looked at a wide variety of options, from painting turbine blades for increased visibility to better understanding raptor hearing and avoidance of wind turbines. Studies continue today to better understand how to reduce collisions in this region. One area of success was in sharply reducing raptor electrocutions. Information in the late 1990s led to a number of actions including insulating wires, covering some exposed infrastructure on poles, and installing overhead powerlines specifically designed to protect raptors. When new projects are built today, virtually all powerlines within the project area are buried.
- Recently, project owners in the Altamont Pass announced an "aggressive adaptive management" plan to cut raptor mortality by 35%. Project owners will shut down some

turbines in the winter, relocate or permanently remove about 100 of the highest risk turbines, remove some of the older non-operating infrastructure, and continue their commitment to repowering.

- Modern wind projects simply do not exhibit the raptor mortality that is seen in the Altamont. The Altamont Pass is a unique situation with distinct topography, raptor usage patterns, and older technology. Even later projects with high raptor use can be safe for birds. At Foote Creek Rim in Wyoming, pre-construction surveys found that golden eagles frequently used the mesa's edge for hunting. The wind farm developer voluntarily redesigned the site to move the planned turbines 50 meters away from the rim, and the subsequent number of eagle deaths at the site has been so small that the Technical Advisory Committee has been discontinued.

Building a Modern Wind Project

At a project built in 2003 in Benton County, Washington, pre-construction surveys conducted included aerial surveys for raptor nests, point counts to determine species present, fall and spring migration studies to determine area use, a literature review and outreach to local wildlife organizations such as the Audubon Society to understand any species of concern. Using these tools, wildlife biologists predicted relatively low avian impacts in the project area. Once the facility was constructed, operational monitoring included standardized fatality searches every two weeks in the fall, spring and summer, and once each month in the winter for one year. Results were adjusted for searcher efficiency and scavenging rates to get an accurate picture of mortality rates although some fatalities that may not have been turbine related were conservatively included. In addition to these efforts, a Technical Advisory Committee was formed to review the operating monitoring protocols and to recommend any mitigation efforts needed, which in this case, consisted of $75 per turbine every year for the life of the project to be given to a state fund for shrub-steppe habitat conservation. The number of raptor and other bird fatalities at the site has been very low. In its minimal impact on birds, the Benton County site is typical of modern wind projects around the U.S.

Establishing Consistent Survey Methods

- The next generation of wind projects after the California projects in the mid-1980s was built in Minnesota. Extensive wildlife surveys were conducted on Buffalo Ridge near Lake Benton, Minnesota, to determine the presence of avian species prior to construction. Additionally, as the three phases of the Buffalo Ridge wind project were completed, a Before/After Control/Impact (BACI) study was conducted, over a four-year period. This method allowed for comparison of bird fatalities and changes in bird use between a distinct control area without wind development and the Buffalo Ridge project areas. The Buffalo Ridge experience provided the basis for the wind industry's current study approaches. The full four-year report can be downloaded here: http://www.west-inc.com/reports/avian_buffalo_ridge.pdf

Conducting Impact Surveys

- Modern wind projects undergo a significant amount of review and study for a variety of factors before construction begins. In addition to measurements of the wind resource and the distance to sufficient electric transmission lines and roads, the industry also conducts surveys of wildlife in the area. Typically a wildlife consultant is retained, and efforts are made to contact state and federal fish and wildlife agencies and local wildlife groups (e.g., Audubon chapters, Izaak Walton League chapters) to identify any issues of possible concern. The consultant examines the proposed site and prepares a detailed report on impacts for review by the developer. If the expected impacts are acceptable, the project goes forward. Post-construction monitoring is often required under terms of the permit. This is done to validate that a wind project's impacts are not significantly greater than expected.

Mitigating Habitat Impacts

- Following a collaborative process with the wind industry, the environmental community, wildlife biologists and other interested parties, Washington State's Department of Fish and Wildlife developed guidelines to address wildlife impacts in general and impacts to habitat of specific concern in the state. The voluntary framework assigns a higher value to intact shrub-steppe habitat than to fragmented or already disturbed lands. A wind project developer is then expected to acquire and protect, through a conservation easement, land to mitigate the habitat loss associated with the project. This approach both encourages developers to build in more fragmented landscapes and provides the conservation community with an opportunity to preserve the most pristine areas of habitat for wildlife.

Responding to Issues as They Arise

- When an unexpected number of dead bats were found at one Eastern project in 2003, the wind industry immediately joined with Bat Conservation International (BCI), the U.S. Fish & Wildlife Service, and the National Renewable Energy Laboratory in what is planned as a three-year research effort to identify and quantify the problem and to explore ways to lessen impacts to bats. Several wind-energy companies are providing matching funds for the cooperative effort. BCI used some of that money to hire a full-time biologist who is coordinating the research work and ensuring that planned studies are formally peer-reviewed. Additional funds are raised for comprehensive field research and the distribution of those results. By working with BCI, the wind industry seeks to avoid the sometimes-adversarial relationships of industry and conservationists while also finding solutions acceptable to all sides as quickly as possible. http://www.awea.org/news/news040303bat.html

Following the realization that a problem existed with raptor kills in Altamont Pass, the wind industry has gone on to build a record that now spans more than a decade, of building projects across the U.S. that are safe for birds, and it has now responded rapidly to the discovery of a similar problem with bats in Appalachia. Given wind energy's very low environmental impact (no air or water pollution, no global warming pollutants, no waste) compared with other energy sources, it should remain the energy source of choice for anyone concerned about preserving the natural environment.

Table 1. Comparison of migration direction, passage (traffic) rate (targets per hour per kilometer of migration front), and percentage of targets within the rotor swept height (0-125 m AGL [0-410 feet). AGL = above ground level – during fall 2004 at the Project site and at several other Appalachian ridgetop sites in 2004 and other years. All studies were conducted by marine surveillance radar used in vertical and horizontal modes. Data for Mount Storm, WV from Cooper et al. 2004. Data from other sites is from Kerlinger (2005) or was presented as testimony to the Vermont Public Service Commission and can be found at www.easthavenwindfarm.com.

	Comparison Variables			
Appalachian Ridgetop Sites	**Mean Direction of Migration**	**Mean Passage Rate Per Kilometer**	**Mean Altitude of Flight (AGL)**	**Below Rotor Height (125 m)**
Highland New Wind, VA	204°	385 targets	442 m (1,450 feet)	11.5%
Liberty Gap, WV	175°	229 targets	548 m (1,797 feet)	8%
Mount Storm, WV	~165°	220 – 292 targets	427-472 m (1,401-1,548 feet)	~16%
Dans Mountain, MD	193°	188 targets	542 m (1,778 feet)	7%
Casselman, PA	219°	174 targets	436 m (1,430 feet)	8%
Martindale, PA	188°	187 targets	448 m (1,469 feet)	8%
Other Sites				
Chautauqua, NY	199°	238 targets	532 m (1,745 feet)	4%
Flat Rock, NY	184°	158 targets	415 m (1,361 feet)	8%
Prattsburgh, NY	177°	200 targets	365 m (1,197 feet)	9%
Searsburg, VT	194-223°	178 targets	503 m & 624 m (1,659 & 2,047 feet)	0.1-5.0%
Sheffield, VT	200°	114 targets	566 m (1,857 feet)	1%

Table 2. Comparison of migration direction, passage (traffic) rate (targets per hour per kilometer of migration front), and percentage of targets within the rotor swept height (0-125 m AGL [0-410 feet). AGL = above ground level – during spring 2005 at several other Appalachian ridgetop sites. All studies were conducted using marine surveillance radar used in vertical and horizontal modes. Data from Swallow Farm is from Plissner et al. (2005), prepared for St. Francis University in Pennsylvania.

	Comparison Variables			
Appalachian Ridgetop Sites	**Mean Direction of Migration**	**Mean Passage Rate Per Kilometer**	**Mean Altitude of Flight (AGL)**	**Below Rotor Height (125 m)**
Liberty Gap, WV	53°	457 targets	492 m (1,614 feet)	11%
Swallow Farm, PA	30°	146 targets	401 m (1,315 feet)	11-12%
Other Sites				
Chautauqua, NY	29°	395 targets	528 m (1,830 feet)	4%

Keeler Obenshain PC

JOHN W. FLORA
Attorney at Law

jflora@kolawfirm.com
Direct: (540) 437-3111

90 North Main Street, Suite 201
Post Office Box 1287
Harrisonburg, Virginia 22803

Phone: (540) 437-3100
Facsimile: (540) 437-3101
www.kolawfirm.com

March 8, 2006

VIA OVERNIGHT MAIL
Roger W. Kirchen, Archeologist
Department of Historic Resources
Office of Review and Compliance
2801 Kensington Avenue
Richmond, VA 23221

RE: Highland New Wind Development LLC
DHR File No. 2003-1027; State Project No. 06-011S

Dear Mr. Kirchen:

As a follow up to our telephone conversation, I have enclosed the most recent site development plans prepared to submit an erosion and sediment control plan to Highland County. Also enclosed is the preliminary boundary of the site consisting of approximately 217 acres, prepared by Dave Hiner. The total acreage controlled by the McBrides is about 4,000 acres, but the project site itself containing the turbines and the substation consists of approximately 217 acres.

As I mentioned to you in our telephone conversation, there is minimal ground disturbing activity planned since the existing roads will be the foundation for slightly improved roads to better access the site during the development stage. The buried electric line connection between the two project sites will be within the Allegheny Power easement for the 69 kV transmission line which is shown on the map. You can also see the Laurel Fork stream crossing and the two tributary crossings which are being reviewed as part of the joint permit application process. The applicant plans to directionally drill under those three streams which will eliminate the necessity for any permit.

The other ground disturbing will occur when the substation is built and the towers are constructed for the turbines. Again, however, the ground disturbance by actual construction is minimal. The tower foundation is shown on sheet 2 and, as you can see, takes up a 50' x 50' space and, at least at this time, we will be utilizing no more than 19 turbines. It could be, by the time construction commences, maybe one or two less turbines depending upon the increased technology and capacity factors available.

Please let me know if this satisfies your concern about a comprehensive site plan.

Very truly yours,

John W. Flora

Enclosures
JWF/mn/89159

The 220-acre Highland New Wind Energy Project Site is located within the Valley and Ridge Physiographic Province of Virginia, which consists of northeast-southwest trending ridges and valleys underlain by folded and faulted Paleozoic rocks.

Surface lithologies at the site were determined from the *Geologic Map of the Virginia Portion of the Staunton 30 x 60 Minute Quadrangle* (Radar and Wilkes, 2001) published by the Virginia Department of Mines, Minerals and Energy Division of Mineral Resources. According to this map, Tamarack Ridge and the majority of Red Oak Knob are underlain by the Hampshire Formation of Devonian age. This formation consists of interbedded shale, mudstone, siltstone, sandstone, and some conglomerate. Dusky to grayish red colors predominate. The Hampshire Formation is not reported to contain macrofossils in Highland County.

The Hampshire Formation is underlain by the Foreknobs Formation, which is of Devonian age out crops on the eastern side of Red Oak Knob. The Foreknobs Formation consists of interbedded sandstone and siltstone with some minor shale, and is mapped as the Chemung Formation in other parts of the Eastern U.S. Colors range from brownish red to brownish gray. In contrast to the overlying Hampshire Formation, the Foreknobs Formation contains abundant marine fossils.

The existence of caves on the project site has not been reported in the literature, and the landowner reports that he has never encountered caves on the project site during the entire period of his ownership.

References

Radar, E.K., and Wilkes, G.P. 2001. Geologic Map of the Virginia Portion of the Staunton 30 X 60 Minute Quadrangle. Virginia Division of Mineral Resources Publication 163. Map.

R|S|G INC.
RESOURCE SYSTEMS GROUP, INC.

Preliminary Report: Estimation of Nitrogen Oxide Avoided Emission Rates Resulting from Renewable Electric Power Generation in the New England ISO System

Prepared for:

Environmental Resources Trust and Connecticut Smart Power

April 2006

55 Railroad Row, White River Junction, Vermont 05001

TABLE OF CONTENTS

PREFACE

This is a preliminary version of the report intended for use by CT Smart Power. A final version of the report will be completed as soon as additional data becomes available. The final version will include the analysis of additional examples of the renewable energy technologies. This will make the final analysis more representative. The avoided emission results are principally determined by the emissions profiles of the displaced fossil fueled generation units that are not likely to change significantly in the final version. However, it is possible that additional data on both the renewable generation sources and updated information on some of the fossil fuel sources may alter the final avoided emission rates. The final version of this report will also include additional supporting information.

INTRODUCTION AND PURPOSE OF THE REPORT

The purpose of this report is to provide an estimate of the avoided nitrogen oxide (NOx) emissions, which result from the generation of electric power from selected renewable energy sources in New England. This has been prepared to assist Connecticut Smart Power in its program to obtain NOx credit for renewable electric power sources in the Connecticut State Implementation Plan (SIP) for compliance with the National Ambient Air Quality Standard for ozone. These avoided emissions occur because renewable electric generation sources have low marginal operating costs and therefore become "must run" generation. They typically displace generation at fossil fuel plants with higher marginal operating cost in the ISO New England system. They do not displace generation at nuclear power plants, hydro power plants or other renewable energy plants. The displaced fossil fuel generation has higher NOx emissions than the renewable power generation. Based on the EPA SIP Guidance[1], emissions reductions of NOx, which is a cap and trade managed pollutant, can only be assured by the allocation of NOx allowances to the renewable generator (or renewable energy purchaser) from a renewable energy set-aside. These allowances are set-aside from the total pool of allowances in the state and are retired based on the emission reduction allowance. Otherwise the fossil fueled generator would transfer the unused allowances and no net reduction in emissions would occur.

This analysis therefore may provide guidance in establishing an appropriate allowance rate set-aside for specific renewable energy sources or for renewable electricity in general. However, it is allocation and retirement of allowances that insures that NOx emission reductions take place. Therefore, the CT DEP may allocate allowances at a higher or lower rate based on its own analysis or consideration of specific public policy objectives, which may include strategies to recognize the benefits of collateral reduction of other air pollutants such as sulfur dioxide, particulate matter, mercury, and carbon dioxide.

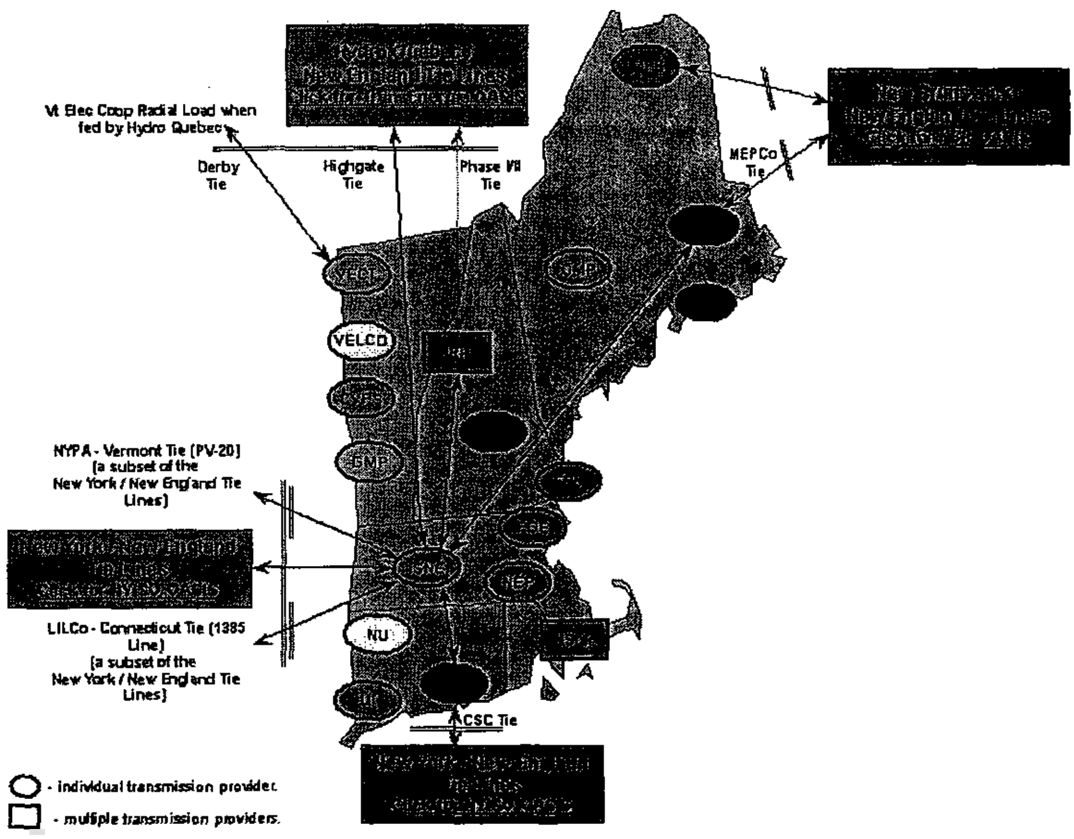
---

[1] U.S. Environmental Protection Agency, *Guidance on State Implementation Plan (SIP) Credits for Emission Reduction Measures from Electric-sector Energy Efficiency and Renewable Energy Measures*, August 2004 (cited as *EPA SIP Guidance*). For a copy of this document, see http://www.epa.gov/ttn/oarpg/t1/memoranda/ereseerem_gd.pdf.

ISO NEW ENGLAND POWER MARKET

ISO New England is the independent system operator responsible for the administration of the electric power market for the six New England states. This is operated as a single market. Although there are some transmissions constraints, this analysis treats the market as uniform. ISO New England dispatches the generating units in New England based on market offering prices to meet the hourly load and the operating reserve necessary for system reliability. It also manages the import and export of power between New England and the adjoining power market areas. (See Figure 1)

Figure 1; The ISO New England System



Source: ISO New England

In this analysis the import and export of power is not considered. All displaced generation by renewable sources is assumed to occur in New England. Likewise transmission constraints are not considered. Neither of these simplifying assumptions is likely to significantly affect the results at this level and for the purposes of the report. However, power imports and transmission constraints may affect the avoided emissions for specific projects.

METHODOLOGY

There are several methods available for estimating the avoided emissions in any power market area. These methods are briefly reviewed in Appendix A of this report, which is based on a more detailed evaluation conducted by Resource Systems Group as part of the DOE Mid-Atlantic Regional Office Pilot Project.[1] Additional reviews of this subject have been provided by Synapse Energy Economics for the Ozone Transport Commission[2] and other studies are in progress by Synapse Energy Economics, Inc. and Global Energy Technologies Foundation.

The methodology used in this report is the time matched and generation-weighted average of the emissions of plants that are variably dispatched to meet changing demand. This is a refinement of the generation-weighted average approach which was used in the New Jersey Report. It matches the hour by hour output of the renewable energy source with the generation of units in the ISO New England system.

The wind, photovoltaic and landfill gas generation data are derived from performance data on facilities. The data are for the hourly electric generation for a one year period. The wind data are based on the performance of nine complete annual records of wind turbines, plus partial records of other turbines in mountainous interior areas of New England. The photovoltaic data are based on the performance of a standard silicon PV system using Typical Meteorological Years (TMY2) solar radiation data compiled by NREL for Hartford and Bridgeport CT. The landfill gas generation data are a simulation of the performance of typical systems. On average landfill gas has no systematic daily or seasonal variation that would affect the matching. Additional data on other wind and PV systems and locations are expected to become available shortly to supplement the analysis for the final report.

The renewable electric generation data for each source type are then matched by a database program against the hourly generation of the variably dispatched fossil fuel units at plants listed in table B.1 This determines which fossil fuel plants are operating when the renewable power is being produced. This

---

1 *Report on the Clean Energy/ Air Quality Integration Initiative Pilot Project of the US DOE Mid-Atlantic Regional Office for New Jersey, March 2006. (Public release pending US DOE)*

2 Synapse Energy Economics, Inc. Predicting Avoided Emissions from Policies that Encourage Energy Efficiency and Clean Power, prepared for the Ozone Transport Commission, June 2002.

forms the basis for matching and creating the set of generation units in each hour which can be displaced. The hourly generation records for all the fossil fuel plants are not available but they have been estimated by using the hourly CO2 emissions from the CEMs. The generation calculation is based on the average CO2 emission rates per MWh reported to the EPA. The hourly emission rates for NOx are derived from the CEM data reported to EPA. The average NOx avoided emissions are then based on a generation weighted average of the emissions at units which are operating at each hour. The results are reported for the ozone season (May 1 to September 30) and then for the year.

RESULTS

The preliminary results of the analysis are given in Table 1. These average avoided emission rates apply to the whole of New England for 2005 and are based on the methodology described above and the set of fossil fueled generating plants listed in Appendix B. They are based on renewable generation located in New England without regard to location. Actual renewable energy project location can be expected to affect the avoided emission rate, especially in areas with significant transmission constraints such as Southwestern Connecticut and parts of Maine.

TABLE 1: AVOIDED NOX EMISSION RATES IN THE ISO NEW ENGLAND MARKET AREA FROM WIND, PHOTOVOLTAIC AND LANDFILL GAS ELECTRIC POWER GENERATION IN 2005.

	Wind Avoided Emissions NOx lbs/MWh	Photovoltaic Avoided Emissions NOx lbs/MWh	Landfill Gas Avoided Emissions NOx lbs/MWh
Annual Average	0.78	0.78	0.78
Ozone Season Average	0.62	0.62	0.62

Landfill gas generation systems not only produce electricity but also produce NO_x emissions of their own and reduce emissions that would be produced by the alternative disposal of that landfill gas (typically flaring). In such cases, it is necessary to calculate the *net* avoided emissions – the emissions produced by the landfill gas engine, minus the avoided emissions from generation of fossil-fuel fired electricity, plus the emissions that would be avoided by burning rather than flaring the landfill gas. This is project specific.

CONCLUSIONS AND COMPARISONS

The preliminary average avoided NOx emission rate for the ozone season is 0.62 lb/MWh and the annual average is 0.78 lb/MWh for 2005 The ozone season average is lower than the rate of 0.79 lbs/MWh (on peak) but higher than the 0.29 lbs/MWh (off peak) marginal emissions rates for 2003 which were calculated using the IREMM dispatch model for ISO New England.[1] These differences may be in part due to the larger natural gas component in the fossil fueled generation in 2005. There are also significant methodological differences between the two studies. However, the results from this analysis are generally similar in magnitude to the ISO New England report for 2003. Both New England rates are lower than the 1.65 lb/MWh calculated by similar methods for New Jersey for 2005. This difference is primarily due to a greater proportion of coal in the New Jersey fossil fuel generation.

[1] ISO New England, 2003 NEPOOL Marginal Emission Rate Analysis December 2004

APPENDIX A: COMPARISON OF ALTERNATIVE METHODOLOGIES TO CALCULATE AVOIDED NO_X EMISSIONS

This description is based in part on Appendix 4 of the Report on the Clean Energy/ Air Quality Integration Initiative Pilot Project of the US DOE Mid-Atlantic Regional Office for New Jersey, March 2006.

To model the avoided emissions or marginal emission reductions, several methods may be employed. These include:

1) A complete grid-system dispatch analysis;
2) A system mix analysis;
3) A surrogate plant analysis;
4) A generation-weighted average of variably dispatched plants;
5) A time matched and generation-weighted average of variably dispatched plants.

1) A ***complete grid-system dispatch analysis*** considers the dispatch order and scheduling of specific combustion units at each facility in detail, providing the most comprehensive estimate of the avoided emissions. An analysis of this type may be based on historical data or on a proprietary unit dispatch model. This approach allows for time matching the EE/RE measures with the actual generation of variably dispatched units. This is very time and resource intensive and is hard to justified solely for the purpose of validating an avoided emissions rate stipulated in a State NO_x trading regulation. However, this detailed approach can be justified to provide accurate estimates of displaced NO_x emissions resulting from a large renewable energy project, such as a large wind farm.[1] The use of a proprietary economic unit dispatch models also makes this approach non-transparent which may create problems for public agencies in reviewing the results.

2) The ***system mix analysis*** takes the generation weighted average of all the plants in the electric generating system. This is a simple method. However this includes nuclear and hydro power plants that are almost never displaced by EE/RE measures. As a result, this approach significantly under estimates the emissions displacement, which occurs almost entirely at fossil fueled plants.

3) The ***surrogate plant analysis*** calculates the emissions of the next new plant or unit that is likely to be added to the electric grid as a basis for determining what emissions would be avoided if the demand were reduced by energy efficiency measures or displaced by renewable energy generation. In New England,

---

[1] See National Renewable Energy Laboratory, "Model State Implementation Plan (SIP) Documentation for Wind Energy Purchase in State with Renewable Energy Set-Aside," http://www.eere.energy.gov/windandhydro/windpoweringamerica/sips.asp

the most likely new plant in recent years would be a combined cycle natural gas plant with best available NO_x control technology. The result is a very low NOx avoided emission rate. This approach is unrealistic in the short term because actual generation and energy efficiency displacement are spread across a wide range of fossil fueled generation units, some of which have relatively high NO_x emission rates. This approach may provide a reasonable estimate of the long term avoided emissions if current trends continue. However, the actual mix of plants may be very different in the future depending on fuel prices and public policy.

4) The ***generation-weighted average of the emissions of plants that are variably dispatched*** to meet changing demand. This is a reasonable approximation of the marginal emission rate without the time and cost of a complete grid-system dispatch analysis. This method was used in the New Jersey Report.[1]

5) The ***time matched and generation-weighted average of the emissions of plants that are variably dispatched*** to meet changing demand. This is a refinement of the generation-weighted average approach. It matches the hour by hour output of the renewable energy source with the generation of units in the ISO New England System. The method is computationally intensive and requires the use of CEM CO2 data to approximate the hourly generation data for individual units as that data are not normally available. It should provide a better approximation of the marginal emission rate without the time and cost of a complete grid-system dispatch analysis.

The variably dispatched plant data were obtained from the U.S. EPA and U.S. Energy Information Administration (EIA) sources. The EPA Emissions & Generation Resource Integrated Database (eGRID) 2002 was used to generate the base list of New Jersey power plants. This was also the source of the emissions and generation data. The emissions data in eGRID 2002 are based on data collected in 2000.

The list of facilities used for this assessment and their associated NO_x emission rates, generation, and primary fuel are included in Table B.1. Small facilities have very little contribution to the estimate, but the team included them based on the criteria of primary fuel. It is noteworthy that while the primary fuel is listed for each facility, many facilities operate subordinate units that burn other fuels, often contributing to varying emission rates among a fuel group.

---

[1] *Report on the Clean Energy/ Air Quality Integration Initiative Pilot Project of the US DOE Mid-Atlantic Regional Office for New Jersey, March 2006. (Public release pending US DOE)*

APPENDIX B

The list of facilities used for this assessment and their primary fuels are included in Table B.1. The primary fuel is listed for each facility, however, some facilities operate subordinate units that burn other fuels, often contributing to varying emission rates among a fuel group. The analysis was conducted at the individual unit level.

The variably dispatched plant data was obtained from the U.S. EPA CEM data and U.S. Energy Information Administration (EIA) sources and supplemented by generation company websites. The EPA Emissions & Generation Resource Integrated Database (eGRID) 2002 was used to generate the base list of New England power plants. This was also the source of base emissions and generation data. The emissions data in eGRID 2002 are based on data collected in 2000. The NOx emissions data and the CO2 emissions data used to derive hourly generation data were from EPA CEM database.

TABLE B.1: LIST OF FOSSIL FUELED POWER PLANTS USED IN THE ANALYSIS.

Name	State	Fuel Types
NRG - DEVON	CT	Other Oil, Pipeline Natural Gas
NRG - MONTVILLE	CT	Pipeline Natural Gas
NRG-NORWALK HARBOR	CT	Other Oil, Residual Oil
BRIDGEPORT HARBOR	CT	Residual Oil
J C MCNEIL	VT	Pipeline Natural Gas
FPLE MASON LLC	ME	Residual Oil
WILLIAM F WYMAN	ME	Residual Oil
MYSTIC STATION	MA	Residual Oil
NEW BOSTON	MA	Pipeline Natural Gas
BLACKSTONE STATION	MA	Pipeline Natural Gas
KENDALL STATION	MA	Pipeline Natural Gas
CANAL	MA	Diesel Oil
MOUNT TOM STATION	MA	Coal
SOMERSET OPERATIONS	MA	Other Oil, Other Oil
BRAYTON POINT STATIO	MA	Pipeline Natural Gas
SALEM HARBOR STATION	MA	Residual Oil
CEEMI-W. SPRINGFIELD	MA	Other Oil, Pipeline Natural Gas
POTTER CC	MA	Diesel Oil
CLEARY FLOOD	MA	Residual Oil
MERRIMACK STATION	NH	Coal
SCHILLER STATION	NH	Residual Oil
MANCHESTER STREET	RI	Pipeline Natural Gas
STONY BROOK ENERGY C	MA	Pipeline Natural Gas
NEW HAVEN HARBOR STA	CT	Pipeline Natural Gas

NEWINGTON STATION	NH	Pipeline Natural Gas
LYNN STATION	MA	Residual Oil
BELLINGHAM	MA	Pipeline Natural Gas
INDECK PEPPERELL	MA	Pipeline Natural Gas
ALGONQUIN WL COGEN	CT	Pipeline Natural Gas
AES THAMES	CT	Coal
MASSPOWER	MA	Pipeline Natural Gas
LOWELL COGEN	MA	Pipeline Natural Gas
PITTSFIELD GENERATIN	MA	Pipeline Natural Gas
CAPITOL DIST. ENERGY	CT	Pipeline Natural Gas
OCEAN STATE POWER	RI	Pipeline Natural Gas
DARTMOUTH POWER ASST	MA	Pipeline Natural Gas
PAWTUCKET POWER	RI	Pipeline Natural Gas
PFIZER INC.	CT	Pipeline Natural Gas
OCEAN STATE POWER	RI	Pipeline Natural Gas
UAE LOWELL POWER LLC	MA	Pipeline Natural Gas
PRATT&WHITNEY COGEN	CT	Pipeline Natural Gas
SPRAGUE PAPERBOARD	CT	Pipeline Natural Gas
MILFORD POWER	MA	Pipeline Natural Gas
MIT	MA	Pipeline Natural Gas
DIGHTON POWER	MA	Pipeline Natural Gas
ANDROSCOGGIN COGEN	ME	Pipeline Natural Gas
BERKSHIRE POWER	MA	Pipeline Natural Gas
BRIDGEPORT ENERGY	CT	Pipeline Natural Gas
TIVERTON POWER	RI	Pipeline Natural Gas
MAINE INDEPENDENCE	ME	Pipeline Natural Gas
MILLENNIUM POWER FAC	MA	Pipeline Natural Gas
RUMFORD POWER	ME	Pipeline Natural Gas
RHODE ISLAND RISE	RI	Pipeline Natural Gas
MILFORD POWER FAC	CT	Pipeline Natural Gas
LAKE ROAD GENERATING	CT	Pipeline Natural Gas
AES GRANITE RIDGE	NH	Pipeline Natural Gas
BUCKSPORT CLEAN ENER	ME	Pipeline Natural Gas
ANP BELLINGHAM	MA	Pipeline Natural Gas
BLACKSTONE ENERGY	MA	Pipeline Natural Gas
WESTBROOK ENERGY CEN	ME	Pipeline Natural Gas
FORE RIVER FACILITY	MA	Pipeline Natural Gas
WALLINGFORD ENERGY	CT	Pipeline Natural Gas
NEWINGTON ENERGY	NH	NULL

RESOURCE
SYSTEMS GROUP
INCORPORATED

PROSPECTIVE ENVIRONMENTAL REPORT FOR CLIPPER WIND POWER

Prepared for Clipper Wind Power

Under Contract with Environmental Resoucres Trust

April 2003

331 Olcott Drive, White River Junction, Vermont 05001

TABLE OF CONTENTS

1.0 INTRODUCTION

The prospective Clipper Wind Power Environmental Report for Maryland documents savings in air emissions from using Clipper Wind Power, which replaces power that would otherwise have been generated to supply the demand. This report is based on the expected sale of Clipper Wind Power, and air emissions of power plants where generation will be displaced by the use of Clipper Wind Power.

This report is preliminary and is intended to be indicative of the emissions savings from the use of wind power beginning in 2004 based on current and recent historical data as well as estimates of displacement provided by load serving entities.

2.0 METHODOLOGY

There are no significant air emissions from the generation of wind power, therefore the savings estimate is based on the combined air emissions of the generation displaced by Clipper Wind Power. Air emission calculations are based on the direct emissions only and do not consider emissions associated with the extraction or transportation of fuels or disposal of wastes.

Based on information provided by load serving entities in the PJM area, the power displaced by Clipper Wind Power is generated in the PJM and PJM West areas. Although nuclear power is a significant source of electricity in this area, no nuclear power is displaced because nuclear operating costs are so low that they are operated to the maximum extent possible and are not displaced by any additional sources. Similarly there are small amounts of hydro-power and other renewable sources in the region but none will be displaced by wind power.

Displacement occurs among a set of plants that are on a variable dispatch schedule so that the actual generation rises and falls with the demand. These plants are fossil fueled and are primarily coal and natural gas fired units. Some of these coal plants may have a base-load capacity and a variable dispatch capability also. Figure 1 shows the location of plants that are used in the displacement calculations and Table 1 lists the plants with their primary fuels. The two groupings in Table 1 represent two displacement areas considered in the analysis. Table 1 also includes a column entitled 'Nameplate Capacity (MW)'. This column refers to the maximum amount of power a plant could generate at 100% load.

Table 1: Plants in Each Grouping

Groupings		State	Plant Name	Plant Code (Orispl)	Primary Fuel	Nameplate Capacity (MW)
Maryland, Pennsylvania, and W. Virginia Group	Maryland Group	MD	Notch Cliff	1555	Natural Gas	144
		MD	Perryman	1556	Natural Gas	405
		MD	Riverside	1559	Natural Gas	244
		MD	Westport	1560	Natural Gas	122
		MD	Domino Sugar Corp	54795	Natural Gas	10
		MD	Panda Brandywine L P	54832	Natural Gas	289
		MD	Brandon Shores	602	Coal	1370
		MD	C P Crane	1552	Coal	416
		MD	H A Wagner	1554	Coal	1059
		MD	R Paul Smith Power Station	1570	Coal	110
		MD	Chalk Point	1571	Coal	2647
		MD	Dickerson	1572	Coal	930
		MD	Morgantown	1573	Coal	1548
		MD	Aes Warrior Run	10678	Coal	229
		MD	Luke Mill	50282	Coal	65
		PA	Hunterstown	3110	Natural Gas	58.8
		PA	Mountain	3111	Natural Gas	53.2
		PA	York Cogen Facility	54693	Natural Gas	69
		PA	Allegheny Energy Unit 8 & 9	55377	Natural Gas	88
		PA	PPL Brunner Island	3140	Coal	1567
		PA	Hatfield's Ferry	3179	Coal	1728
		PA	P H Glatfelter Co	50397	Coal	110
		WV	Albright	3942	Coal	178
		WV	Fort Martin	3943	Coal	1152
		WV	Harrison	3944	Coal	2052
		WV	Rivesville	3945	Coal	110
		WV	Mt Storm	3954	Coal	1681
		WV	North Branch	7537	Coal	80

Figure 1: Location of Coal and Natural Gas Plants included in Analysis.

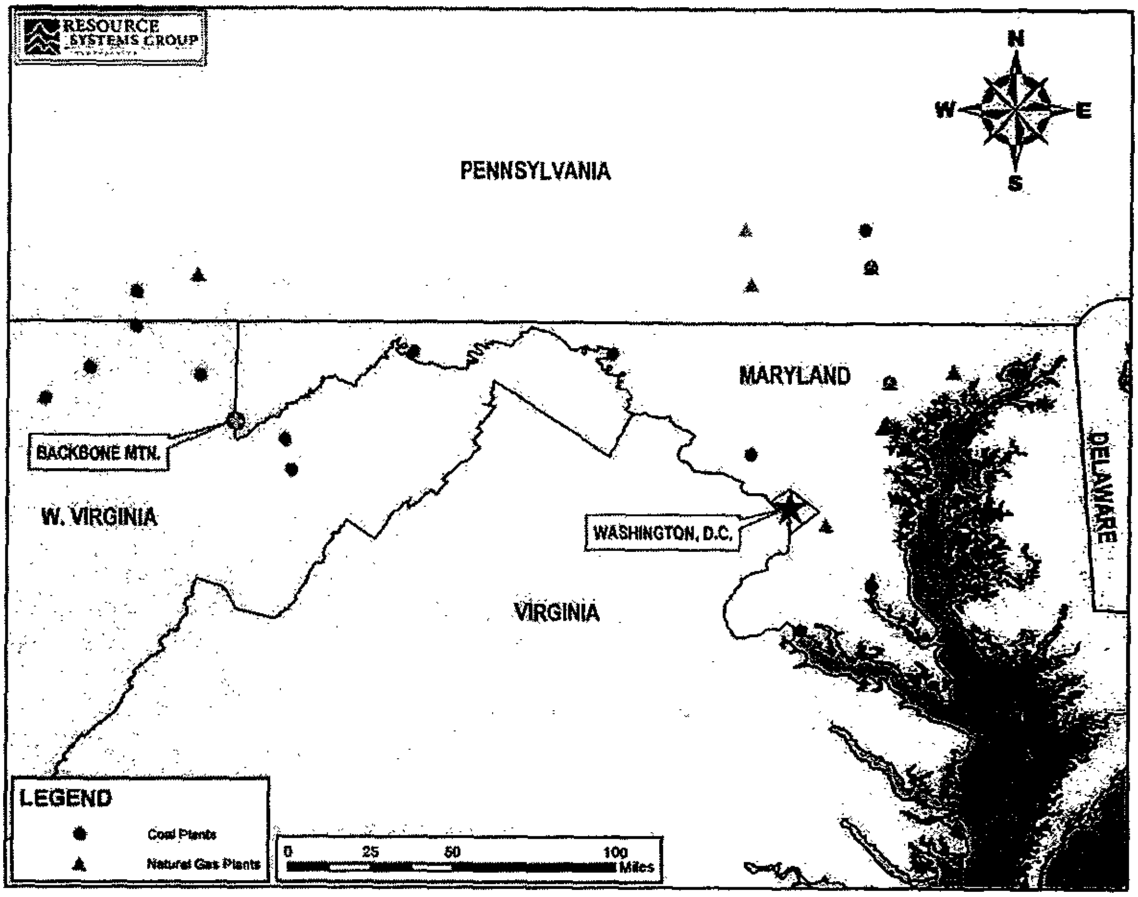


Figure 1 also shows the location of the proposed Clipper Wind site labeled "Backbone Mtn."

3.0 RESULTS

The displaced emissions for carbon dioxide, nitrogen oxides and sulfur dioxide from all these plants and from a subset of plants in Maryland only are given in Table 2. These are given in lb/MWh. Emissions displacement or savings for the complete project can be estimated by multiplying by the expected total wind generation.

Table 2: Displaced Emissions

Pollutant	MD Group	MD, PA, and WV Group
	lbs/MWh	lbs/MWh
CO_2	1329.08	1374.60
NOx	3.06	3.13
SO_2	8.34	8.83

Displaced emissions are based on the continuous emission monitors (CEM) for carbon dioxide, nitrogen oxide and sulfur dioxide from those plants in the displacement group. The average displaced emissions are calculated from the generation weighted emission rates of the plants. Generation data is taken from reports to the U.S. Energy Information Administration for the most recent twelve month period that is available. This is typically through late 2002. Emission rates are taken from the EPA CEM data and are adjusted to the most recent twelve month period based on generation data by fuel. In cases where there were obvious errors in the reported emissions, values were calculated with emission rates from a previous year for the facility in question.

The displacement calculation is based on the average percentages of coal and natural gas providing the on demand power during each of the three weekly time periods as given in the Table 3 along with the percentage of total wind power generation available during each of the three time periods. This data is for the PJM area but it is also believed to be representative of the nearby areas of PJM west. This information was provided by load serving entities in the PJM area.

Table 3: Contribution of Coal and Natural Gas Fired Power Plants to Variable Demand in the PJM Area and the Percentage of Wind Power at Specific Time Periods.

Time Period	% Coal	% Natural Gas	% Wind Match
Mon-Sun 8hr /day (7x8 = 56hr)	80%	20%	35%
Sat-Sun 16hr/day (2x16 = 32 hr)	50%	50%	22%
Mon-Fri 16 hr/day (5x16 = 80 hr)	30%	70%	43%