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State of Vermont
Agency of Natural Resources

Deborah L. Markowitz
Agency Secretary

Christopher Recchia
Deputy Secretary

September 25, 2012

As Secretary of the Agency of Natural Resources, I am aware of the great public interest in Vermont Wind's application for an Endangered and Threatened Species Takings permit. The Agency received many letters, emails, and phone calls, and staff collected comments from a well attended public hearing. Much of the interest in this permit is, no doubt, fueled by an interest in revisiting the debate on the costs and benefits of wind energy. The question as to whether this project is in the public good, however, has already been decided by the Vermont Public Service Board in 2007, and subsequently affirmed by the Vermont Supreme Court in 2009. What is before the Agency today is only an application to take endangered species as governed by statute.

Vermont's endangered species statute authorizes the taking of listed species. The agency will consider the reason the permit is being requested, the possible impacts to the species that would result from the proposed action, and the plan for conservation or mitigation of the impact. It also allows the agency to place limits on the taking and to require mitigation. In making this decision the Agency considered the comments received from the public as well as from the Vermont Endangered Species Committee and relied on the advice of agency scientists whose job it is to design and implement the recovery plan for the listed species.

In order to grant a takings permit, the Secretary must find that one (or more) of the five statutory reasons to allow a taking of a member of a species that has been listed as threatened or endangered exists in the particular situation. One of those bases is "economic hardship." Under this criteria, individuals and businesses may take an otherwise protected species in order to allow for the orderly development of the state. Twenty-six taking permits have been issued so far this year.

Vermont Wind provided evidence that if they were to shut down every night from May to November, the only way to ensure no bats would be taken, they would see a 25% drop in revenue. This significant drop in revenue would clearly constitute "economic hardship."

When reviewing a permit application, Agency biologists provide advice on the potential impact to the species from the proposed taking as well as whether or how such takings could be avoided or minimized and what, if anything, would constitute sufficient mitigation. In examining the effect the takings will have on the species as a whole, agency scientists determined that the number of listed bats potentially taken will likely be less than 0.1% of the entire population in the state. Should the project take more bats than provided for in the permit, the Agency has the authority to impose greater restrictions, including shutting the facility down completely when the chance of taking listed bats is high.

The permit issued today requires Vermont Wind to limit the operation of its turbines during the times of year when bats are most likely to be injured. The proposed operational adjustments have been shown to be extremely effective. In order to mitigate the impact on the bats that are taken, Vermont Wind will be partnering with the Vermont Fish and Wildlife Department, the U.S. Fish and Wildlife Service, Bat Conservation International, and Texas Tech University, to fund and undertake a rigorous scientific study to measure the efficacy of such measures and, if possible, devise strategies to improve them. The results of this study will not only assure that fewer bats will be harmed at Vermont Wind, but will also inform and guide other wind facilities in Vermont and the region.

In response to all this advice, and public participation, I have issued a Takings Permit which reflects the collective wisdom of the commentators. The permit includes conditions that will not only minimize the taking of listed bats by this project and provide critical information to help conserve bats across the region, but will also assure that the Agency retains the authority to address any take that exceeds what is provided for in the permit.

Lastly, many who have reached out to the Agency have a sincere interest in the conservation and protections of bat species. Because the primary threats to Vermont's endangered bats are not wind energy projects, but other factors such as the disease called White-nose Syndrome, disturbance to hibernating bats in caves and mines, and persecution by homeowners and household pets, I want the public to know that there are actions each of us can do at home to help Vermont's bat population. Vermonters can contribute to the protection of endangered bats by reporting bat colonies in their houses to the Department of Fish and Wildlife, seeking assistance from the Department in order to avoid conflicts with bats in ways that do not harm them, not entering caves and mines during the fall and winter when bats are hibernating, and by supporting the Department and other organizations, such as Bat Conservation International, that are working to address the devastating effects of White-nose Syndrome.

For more information and ways to help, visit:
http://www.vtfishandwildlife.com/wildlife_bats_gotbats.cfm

Sincerely,
Deborah L. Markowitz,
Secretary

VERMONT

Agency of Natural Resources

103 South Main Street, Center Building
Waterbury, VT 05671-0301
802-241-3600

Endangered & Threatened Species Takings Permit

Statutory Authority: 10 V.S.A. Section 5408

1. Permittee
Joshua Bagnato
Vermont Wind, LLC
1868 New Duck Pond Road
Sheffield, VT 05866
617 -960-1909, jbagnato@firstwind

2. Permit Period
Effective Date: 9/25/2012
Expiration Date: 12/31/2014
Authorization # EH-2012-24
Amendment # 0

3. Principal Officer: Paul Gaynor

4 .Subpermitee(s): None.

5. Authorized Species: Little Brown Bat (*Myotis lucifugus*), Northern Long-eared Bat (*Myotis septentrionalis*), Eastern Small-footed Bat (*Myotis leibii*), Tri-colored Bat (*Perimyotis subflavus*) (if it is listed as threatened or endangered during the Permit Period).

6. Authorized Activity: To operate a 16 turbine (40 MW) wind energy project (the 'Project").

7. Location Where Authorized Activity May Be Conducted: Sheffield, VT.

8. Findings

A. The Permittee seeks an Endangered and Threatened Species Takings Permit under 10 V.S.A. § 5408 to operate a 40 MW wind energy project in Sheffield, Vermont. The Project of consists of 16 2.5 MW wind turbines. The turbines have 80 meter tall masts, four turbines have a rotor diameter of 96 meters with a rotor-swept area of 7,238 meters squared, and twelve turbines have a rotor diameter of 93 meter with a rotor-swept area of 6,793 meters squared. The Project lies on a forested ridge comprised of deciduous hardwood trees.

B. The Project was issued a Certificate of Public Good (CPG) by the Vermont Public Service Board (PSB), in Board Docket 7156 on August 8, 2007. The Project must operate in accordance with the issued CPG. These conditions include operational curtailments, feathering the turbine blades, during certain times of the year and in certain weather conditions in order to minimize bat fatalities as described in Findings S.-V. below.

C. The Project was permitted prior to the documentation of White-nose Syndrome (WNS) in Vermont in January 2008. The disease subsequently devastated populations of cave bat species, resulting in the listing of the little brown bat and northern long-eared bat in 2011 and the forthcoming listing of the tri-colored bat.

D. The species listed in Section 5 hibernate in caves or mines during the winters, but emerge from hibernation between March and May and enter hibernation in October-November. (See http://www.esf.edu/aec/adks/mammals/littlebrownbat.htm). The populations of each of the listed species is regional in nature, meaning that summer and winter populations migrate to and from adjoining states/provinces such as New York, New Hampshire, Massachusetts, and Quebec. During the non-hibernating period, these bats are active in flight meeting their biological needs. Flight activity in proximity to wind turbines makes bats vulnerable to mortality by collision with the blades or by barotrauma caused by rapid changes in pressure from being swept up into the rotors.

E. Pre-construction surveys were conducted by Woodlot Alternatives, Inc. to measure bat activity at the Project site from April to October in 2004, 2005 and 2006. Over the course these three years, 778 nights of acoustic data and nearly 10,000 sequences were recorded at numerous locations throughout the Project area. Of these calls, approximately 25% could be positively attributed to Myotids (i.e., bats of the genus *Myotis)*. Approximately 45%-50% of the recorded calls were classified as high-frequency unknown calls, most likely from Myotids. Thus it is possible that approximately 70% - 75% of the recorded calls could be attributed to Myotids.

F. During the 2011 and 2012, the Vermont Fish and Wildlife Department (VFWD) collected and documented maternity colony information on the two species of bats that typically roost during the summer in buildings and structures - both little brown bats and big brown bats. To date, the VFWD has documented approximately 2200 adult females and juvenile little brown bats in 16 summer maternity colonies in Vermont, nearly all of which have been located in western Vermont. No maternity colonies have been located in northeastern Vermont. While there are undocumented little brown bat maternity colonies remaining, current information suggests the distribution of Vermont's little brown bat population is heavily weighted to the western region of the state.

G. In the summer of 2012, the VFWD counted 2222 little brown bats in Vermont. In light of known population dynamics, this places the minimum known population of little brown bats in Vermont at approximately 3200. The actual number is likely significantly larger due to the number bats that were not actually observed and counted by VFWD staff.

Takings

H. The Permittee has applied for an annual take of a maximum of 4 little brown bats, 1 northern long-eared bat, 1 tri-colored bat, and 1 eastern small-footed bat.

I. There is substantial evidence that the operation of turbines of the size utilized by the Project will result in the taking of the species listed in Section 5 of this permit. Fatalities of bats have been recorded at wind facilities worldwide (Erickson et al. 2002, Durr and Bach 2004, Kunz et al. 2007, Arnett et al. 2008). Bat fatalities at wind energy facilities are considered to be especially high at wind facilities on forested ridges in the eastern U.S. such as the Project (Arnett et al. 2008).

J. The level of take of each species will vary based on both abundance and possible species-specific characteristics that influence their vulnerability to collisions with wind turbines.

K. Small-footed bat fatalities from wind turbines have yet to be documented, yet little brown bats and tri-colored bats are shown to be susceptible to collisions with wind turbines.

L. Little brown bats have been killed at 19 of 20 wind energy facilities for which data is available in the Northeast. Little brown bats comprised approximately 15% of bat fatalities in the Northeast and 17% of observed bat fatalities at wind facilities in New England.

M. Information from little brown bat mortality data from three operating wind projects in New England (Mars Hill, ME; Stetson, ME; and Lempster, NH) between 2007 and 2010 indicates that approximately .43 little brown bats per turbine/per year were estimated to be taken by the three projects. This data was recorded from projects operating prior to the population-reducing effects of WNS. These projects did not operate under any curtailment procedures.

N. Evidence from recent research on the use of the operational adjustments to reduce bat fatalities as described in Section 11 of this permit indicate that such operational adjustments should result in an estimated reduction in bat fatalities of between 44% and 93% (Arnett et al. 2010). As a result, the Project's estimated take of .43 little brown bats/turbine/year should be reduced by at least 50%, yielding a calculated estimated potential take of .215 little brown bats per turbine, per year. By deriving an estimated take of little brown bats from fatality data collected prior to WNS and by applying only a 50% reduction in bat fatalities from operational adjustments, the estimated take of .215 little brown bats/turbine/year is extremely conservative.

O. Threats to the listed species, including the little brown bat, include loss of summer and winter roosts, pesticides, and persecution (Kunz and Fenton 2003).). From January through August 2012, a minimum of 9 reported taking of little brown bats took place in Vermont residences as a result of exposure, or potential exposure, to rabies. WNS has become the most significant threat to bat species, particularly the little brown bat (Frick et al. 2010).

Economic Impact

P. The PSB found that, "due to the regional nature of the power pool, a project that addresses regional need for power would comply with the statutory standard. [Firstwind's] Project would contribute to meeting the regional need for power generally while also helping to meet the region's need for renewable power." PSB Docket 7156, Order of 8/8/2012 at 29.

Q. In order to avoid all takings of listed species, the facility could not operate during the times when the listed bats species are active, from ½ hour before sunset to sunrise, April 1 through October 30.

R. The Permittee states that, "The resulting loss in generation and revenue from this amount of curtailment would be approximately 25% on an annualized basis or approximately 45% of the revenue expected during the hypothetical curtailment period. A 25% loss in revenue for the life of the project presents an economic hardship to the project that would make it uneconomical to operate over the long-term."

Avoidance and Minimization

S. Results from recent studies in Pennsylvania (Arnett et al. 2010), Canada (Baerwald 2008, Baerwald et al. 2009), and in Germany (O. Behr, University of University of Erlangen, unpublished data) indicate that changing the turbine "cut-in speed" (i.e., wind speed at which wind generated electricity enters the power grid) from the normal to higher cut-in speeds (between 5 and 6.5 m/s) resulted in substantial reduction in bat fatalities compared to normally operating turbines (44–93% reduction in fatality among studies to date).

T. The Permittee will implement operational adjustments during the period from June 1 through September 30 as a means of reducing fatalities of listed bat species.

U. The Permittee will curtail operation for up to 120 nights (June 1 to September 30) when ambient air temperature is greater than 9.5 degrees C (49 degrees F) and wind speeds are equal to or below 6 m/s (13.4 mph). Curtailment will occur during nights (½ hour before sunset to sunrise) when bats are active.

V. The Permittee has established a research cooperative, comprised of the U.S. Fish and Wildlife Service, VDWF, Bat Conservation International, Bat-Wind Energy Cooperative, and Texas Tech University, to develop and implement operational adjustments using a necessary experimental design that will allow the Project minimize fatalities of listed bat species following the study period.

Mitigation

W. The mortality data from the research will be informative in determining the confidence intervals around mortality estimates for the listed species. This may inform future take levels for ensuing permits.

X. The Permittee has entered into a partnership with the U.S. Fish and Wildlife Service (USFWS), Bat Conservation International, Texas Tech University, and the Vermont Fish and Wildlife Department (FWD) to evaluate the success of the curtailment protocols described in "EVALUATING AVIAN AND BAT POST-CONSTRUCTION IMPACTS AT THE SHEFFIELD WIND FARM, VERMONT," Revised April 2012. Its contents incorporated herein by reference. In conducting this evaluation, the Permittee is contributing significant financial resources to study methodologies that exceed the requirements of the stipulation and the CPG.

Y. To mitigate the take of bats, the Permittee shall undertake significant fatality studies that will require expansion of the turbine searches from the 600 required for bird fatality surveys by the CPG to daily searches of all 16 turbines during the operational adjustment experimental design (June 1 – September 30). This, alone, will require approximately 1952 turbine searches. These studies will significantly contribute to the knowledge and understanding of bat fatality rates at the more northern latitudes and the efficacy of operational adjustments. The results of the research will contribute to knowledge about the role of operational adjustments in reducing bat fatalities both in Vermont and in adjoining states within which the region's little brown bat population may hibernate or summer.

Advice of the Endangered Species Committee

A. On August 17, 2012, the Secretary received and reviewed the advice of the Endangered Species Committee. That advice has been considered and incorporated, in large part, into this permit.

Hearing

B. On August 27, 2012 the Secretary held a public hearing in Sheffield, Vermont to hear comments on the application. Approximately 45 persons attended the hearing, provided verbal comments, submitted written comments, and asked questions of Agency staff.

9. Statutory Determination

10 V.S.A. § 5408(a) provides: "[A]fter obtaining the advice of the Endangered Species Committee, the Secretary may permit, under such terms and conditions as the Secretary may prescribe by rule any act otherwise prohibited by this chapter done for any of the following purposes: scientific purposes; to enhance the propagation or survival of a species; economic hardship; zoological exhibition, educational purposes; or special purposes consistent with the purposes of the federal Endangered Species Act."

The Permittee has requested an Endangered and Threatened Species Taking Permit for the following purpose: Economic Hardship.

The state of Vermont recognizes the value which plants, fish and wildlife in their natural environment have for public enjoyment, ecological balance, and scientific study. *See* 1981, No. 188 (Adj. Sess.), § 1(a).

The state of Vermont recognizes the need for protection and preservation of these plants, fish and wildlife in their natural environment. *Id.*

The General Assembly of Vermont intends that the species of wildlife and wild plants normally occurring within this state which may be found to be threatened or endangered within the state should be accorded protection as necessary to maintain and enhance their numbers. *Id.* at §

1(b).

The General Assembly of Vermont intends that the state should assist in the protection of species of wildlife and wild plants which are determined to be threatened or endangered elsewhere pursuant to the federal Endangered Species Act. *Id.*

The General Assembly intends to allow for the orderly development of the state without undue economic hardship being caused by the provisions of this act providing for the power of issuances variances. *Id* at § 1(c).

10 V.S.A. § 5408(a) authorizes the Secretary to permit the taking of a listed species to lessen economic hardship.

In this case, to determine whether there is sufficient "economic hardship," the Secretary examined the nature and size of hardship, whether the economic activity associated with the Project has a public benefit and the impact of the taking on the state's population of the listed species

The Secretary weighed the takings against the economic hardship imposed by restricting the operation of the wind generation facility to times that would ensure that no listed species would be taken. In this instance, for the Project to ensure that there would be no takings of endangered bats the turbines would have to be immobilized from April to September from ½ hour before sunset to sunrise. See Findings P.-Q. The Permittee proffers, under the pains of perjury, that an operation regime of that design would result in a, "25% loss in revenue for the life of the project presents an economic hardship to the project that would make it uneconomical to operate over the long-term." Finding R. The Agency agrees that this meets the "economic hardship" standard. *See* 10 V.S.A. § 5408(a).

In examining whether the Project has a public benefit, the Secretary determined that this question has been decided by the Public Service Board and affirmed by the Vermont Supreme Court. The Court stated that:

> The Board repeatedly and expressly found that the project would result in an economic benefit to the state and its residents. As explained by the Board, the project would create new jobs, increase tax revenue, generate substantial lease payments to the owners of the land on which the project was located, and draw on local sources for construction materials. It would also result in significant tax and mitigation payments to the Town of Sheffield, as well as confer a benefit on all ratepayers in New England.
>
> In re Amended Petition of UPC VERMONT WIND, LLC, for a Certificate of Public Good, Pursuant to 30 V.S.A. § 248, et al., 185 Vt. 296, 301.

In examining the impact of the proposed takings, the Secretary considered the Agency bat biologist's determination that a take of this magnitude will not be biologically significant over time if sufficient mitigation is undertaken. If the Projects takes the maximum number of little brown bats authorized under this permit, it will likely represent no more than approximately 0.1% of the population of little brown bats in Vermont. See Findings G. and N.

In reviewing whether the Mitigation is sufficient to offset the takings, the Secretary considers whether such mitigation will be "in the best interest of the species." 10 V.S.A. § 5408 (f)(1)(B). Here, the Permittee is contributing significant funds to undertake critical studies in order to study the effectiveness of operations protocols and will be participating in a cooperative effort to conserve bat populations generally. See Findings S.-Y. The information gained from these studies is expected to yield information that will allow this and future wind energy projects to avoid the Takings of listed species. See Finding Y. A more precise understanding of what protocols are effective in decreasing the mortality will result in an overall net benefit to the species.

Pursuant to 10 V.S.A. § 5408(a), the ANR Secretary hereby determines, based upon the findings detailed above and after receiving advice from the Endangered Species Committee, that the proposed activity is consistent the purposes of the 10 V.S.A. ch. 123. An Endangered and Threatened Species Takings Permit is authorized, as conditioned below.

10. General Conditions & Authorizations

A. General conditions set out in 10 V.S.A. ch. 123 are hereby made a part of this permit. All activities authorized herein must be carried out in accord with and for the purposes described in the application submitted. Continued validity or renewal of this permit is subject to complete and timely compliance with all applicable conditions, including the filing of all required information and reports.

B. The validity of this permit is expressly conditioned upon compliance with all applicable federal and state laws, regulations, and permits.

C. This permit does not confer upon the permittee the authority to conduct research without the acquiring necessary landowner permission including, but not limited to, state lands.

D. By acceptance of this permit, the Permittee and its heirs, successors and assigns agree to provide the Agency of Natural Resources with unrestricted access, at reasonable times to the animal or plant specimens and/or animal or plant parts collected under this permit, and otherwise ensuring compliance with this permit.

E. The Agency maintains continuing jurisdiction over this activity, and may, at any time, order the permittee to undertake remedial measures if necessary to ensure the protection and conservation of listed species.

F. This permit is not valid for Federal and/or State endangered and threatened species not identified in section 5.

G. The permit is valid for use by the named Permittee and subpermittees(s) only and may be revoked by the Secretary at any time for cause or for violations of any terms or conditions of this permit or state wildlife law.

H. The Permittee shall carry this permit whenever performing authorized activities.

11. Specific Conditions & Authorizations

Minimization

I. The Permittee shall feather the blades of the wind turbines for up to 120 nights (June 1 to September 30) when ambient air temperature is greater than 9.5 degrees C (49 degrees F) and wind speeds are equal to or below 6 m/s (13.4 mph). Curtailment will occur during nights (generally ½ hour before sunset to sunrise) when bats are active.

J. The Permittee shall implement an experimental design testing the effectiveness of operational curtailment consistent with the research design as detailed in "EVALUATING AVIAN AND BAT POST-CONSTRUCTION IMPACTS AT THE SHEFFIELD WIND FARM, VERMONT," Revised April 2012.

K. Upon the completion of the experimental research on operational adjustments at the Project site, operational adjustments for all turbines as described I. above will remain in effect for the remainder of the Permit Period, unless otherwise authorized by the Secretary of the Agency of Natural Resources.

Mitigation

L. The Permittee shall participate in a research cooperative to conduct bat fatality monitoring as described in "EVALUATING AVIAN AND BAT POST-CONSTRUCTION IMPACTS AT THE SHEFFIELD WIND FARM, VERMONT," Revised April 2012. Such surveys include daily searches at 8 randomly selected turbines from the 16 total available turbines from April 1 through May 31 and then from October 1-31 each year of the study (all turbines will be searched during the operational mitigation study from June 1 to September 30 each year of the study). Personnel trained in proper search techniques will conduct the carcass searches. Searchers will walk at a rate of approximately 10–20 m/min. along each transect searching both sides out to 3 meters on each side for casualties.

M. Any state threatened or endangered bat species that are found dead are not to be used for carcass removal or searcher efficiency trials until each carcasses is photographed with a digital camera and those that cannot be positively identified in the field will be retained and frozen for later identification to eliminate the possibility of misidentifying a threatened or endangered species. Collection or possession of federal endangered, threatened, or protected species will be coordinated with the USFWS and FWD.

N. Following completion of the research to evaluate the efficacy of operational adjustments on reducing bat fatalities, the Permittee shall work with the VFWD to identify other means of mitigating for the take of state listed bat species in ensuing permits. The Secretary may require the Permittee to participate in a comprehensive strategy to mitigate for the take of listed bats by wind energy facilities in Vermont, as a part of this or any subsequent permit(s).

O. VFWD staff shall be granted access to the study site to conduct observations of the methodology and the implementation of the study protocols.

Authorizations

P. This permit allows the taking of up to 4 little brown bats, 1 northern long-eared bat, 1 tri-colored bat, and 1 eastern small-footed bat, annually.

Q. Each take of a listed bat will be reported to the Secretary of the Agency of Natural Resources (with a copy to VFWD Permits Specialist) within 72 hours of each occurrence. Should the take exceed the annual take limit as established in this permit, the Secretary of the Agency of Natural Resources may require additional strategies to reduce take of listed species, provided the Secretary determines it does not interfere with the research objectives up to, and including, the cessation of operation of the Project ½ hour before sunset to sunrise April 1 through October 30, all dates inclusive.

12. Reporting Requirements

R. Any mortality of a listed bat species related to the activities authorized under this permit shall be reported in writing to the Secretary of the Agency of Natural Resources (with a copy to VFWD Permits Specialist) within 72 hours of each occurrence.

S. Reports detailing all bat fatalities shall be submitted to the Secretary on or by December 31 of each year of the permit.

T. The Permittee shall accommodate requests by Department staff for additional information from collection activities (e.g., copies of original field sheets, computerized data in usable format). Reports of results of any subsequent analyses and copies of subsequent publications resulting from the collections made under this permit shall be forwarded to the Vermont Fish & Wildlife Department.

Issued by: ***Deborah L. Markowitz*** Date: ***September 25, 2012***
Deb Markowitz, Secretary
Agency of Natural Resources

Appeals:

Renewable Energy Projects – Right to Appeal to Public Service Board

If this decision relates to a renewable energy plant for which a certificate of public good is required under 30 V.S.A. §248, any appeal of this decision must be filed with the Vermont Public Service Board pursuant to 10 V.S.A. §8506. This section does not apply to a facility that is subject to 10 V.S.A. §1004 (dams before the Federal Energy Regulatory Commission), 10 V.S.A. §1006 (certification of hydroelectric projects) or 10 V.S.A. Chapter 43 (dams). Any appeal under this section must be filed with the Clerk of the Public Service Board within 30 days of the date of this decision; the appellant must file with the Clerk an original and six copies of its appeal. The appellant shall provide notice of the filing of an appeal in accordance with 10 V.S.A. 8504(c)(2), and shall also serve a copy of the Notice of Appeal on the Vermont Department of Public Service. For further information, see the Rules and General Orders of the Public Service Board, available on line at www.psb.vermont.gov. The address for the Public Service Board is 112 State Street, Montpelier, Vermont, 05620-2701 (Tel. # 802-828-2358).

All Other Projects – Right to Appeal to Environmental Court

Pursuant to 10 V.S.A. Chapter 220, any appeal of this decision must be filed with the clerk of the Environmental Court within 30 days of the date of the decision. The Notice of Appeal must specify the parties taking the appeal and the statutory provision under which each party claims party status; must designate the act or decision appealed from; must name the Environmental Court; and must be signed by the appellant or their attorney. In addition, the appeal must give the address or location and description of the property, project or facility with which the appeal is concerned and the name of the applicant or any permit involved in the appeal. The appellant must also serve a copy of the Notice of Appeal in accordance with Rule 5(b)(4)(B) of the Vermont Rules for Environmental Court Proceedings. For further information, see the Vermont Rules for Environmental Court Proceedings, available on line at www.vermontjudiciary.org. The address for the Environmental Court is 2418 Airport Road, Suite 1, Barre, VT 05641 (Tel. # 802-828-1660).

EVALUATING AVIAN AND BAT POST-CONSTRUCTION IMPACTS AT THE SHEFFIELD WIND FARM, VERMONT

A Proposal and Budget Submitted By

Dr. Edward B. Arnett, [1] Co-Director of Programs, Bat Conservation International, [2] Austin, Texas; and Adjunct Professor, Department of Natural Resources Management, Texas Tech University, Lubbock, Texas

and

Dr. Mark C. Wallace, Professor and Chair in Wildlife Management, Department of Natural Resources, Texas Tech University, Lubbock, Texas

Revised April 2012

[1] – Lead principal investigator for field studies; earnett@batcon.org ; [2] – Lead contracting organization with First Wind

EVALUATING AVIAN AND BAT POST-CONSTRUCTION IMPACTS AT THE SHEFFIELD WIND FARM, VERMONT

Dr. Edward B. Arnett, Co-Director of Programs, Bat Conservation International, Austin, Texas; and Adjunct Professor, Department of Natural Resources Management, Texas Tech University, Lubbock, Texas

and

Dr. Mark C. Wallace, Professor and Chair in Wildlife Management, Department of Natural Resources, Texas Tech University, Lubbock, Texas

BACKGROUND

Although wind-generated electricity is renewable and generally considered environmentally clean, fatalities of bats and birds have been recorded at wind facilities worldwide (Erickson et al. 2002, Durr and Bach 2004, Kunz et al. 2007, Arnett et al. 2008). Bat fatalities at wind energy facilities are considered to be especially high at wind facilities on forested ridges in the eastern U.S. (Arnett et al. 2008). These fatalities raise concerns about potential impacts on bat populations at a time when many species of bats are known or suspected to be in decline (Racey and Entwistle 2003, Winhold et al. 2008) and extensive planning and development of wind energy is increasing worldwide (EIA 2008, Kunz et al. 2007).

With few exceptions, most post-construction fatality surveys conducted to date at terrestrial wind facilities have been relatively short-term (e.g., one year or in some cases only one field season) and longer-term studies are needed to elucidate patterns and develop predictive models for estimating fatalities (Arnett et al. 2007a). Data previously collected at operating wind projects indicates that a substantial portion of bat fatalities occur during relatively low-wind conditions over a relatively short period of time during the summer-fall bat migration period (Arnett 2005, Arnett et al. 2008). Thus, some curtailment of turbine operations during these conditions and during this period of time has been proposed as a possible means of reducing impacts to bats (Kunz et al. 2007, Arnett et al. 2008). However, the effectiveness of operational curtailment to mitigate bat fatalities has not been well studied. Results from recent studies in Pennsylvania (Arnett et al. 2009a), Canada (Baerwald 2008, Baerwald et al. 2009), and in Germany (O. Behr, University of University of Erlangen, unpublished data) indicate that changing the turbine "cut-in speed" (i.e., wind speed at which wind generated electricity enters the power grid) from the normal to higher cut-in speeds (between 5 and 6.5 m/s) resulted in substantial reduction in bat fatalities compared to normally operating turbines (50–87% reduction in fatality among studies to date). Altering turbine operations on such a partial, limited-term basis poses operational and financial difficulties for project operators, but may ultimately prove sufficiently feasible and effective at reducing impacts to bats. To that end, more studies are needed across a range of environmental conditions and different cut-in speeds to fully assess the efficacy of curtailment to reduce bat kills and the economic implications.

Impacts on avian communities also are of concern at wind energy projects (Erickson et al. 2002). Although fatalities of birds generally are low at wind facilities studied to date, especially in relation to bat fatalities (Barclay et al. 2007), relatively few studies of bird fatalities have been conducted in forested habitats in the eastern U.S.

Vermont Wind, LLC ("Vermont Wind") a subsidiary of First Wind has constructed a wind energy facility in Caledonia County, Vermont, known as the Sheffield Wind Farm. Operation of the Sheffield Wind Farm began in October 2011. Per a stipulation between Vermont Wind and the Vermont Agency of Natural Resources, the Company has agreed to:

1. Operational curtailment for up to 120 nights (1 June to 30 September) when ambient air temperature is >9.5 degrees C (49 degrees F) and wind speeds ≤6 m/s (13.4 mph). Curtailment will only occur during night (generally ½ hr before sunset to sunrise) when bats are active.

2. A maximum of three years of post-construction bird and bat mortality searches during spring and fall migration periods. During the three-year period, a maximum of 600 turbine searches (i.e., one search at a single turbine) is required under the stipulation, although more searches could be conducted if approved by the Company.

Here, we present a proposal and budget to address each of these requirements. Our proposed methodology follows that of the lead PI's extensive protocol development and research on the subject in Pennsylvania (Arnett et al. 2009a, 2009b).

STUDY AREA

The Sheffield Wind Farm (herein referred to as "the Site") is a 40 MW wind power project located in Caledonia County, Vermont (Figure 1), and consists of 16 Clipper 2.5 MW wind turbines. All the turbines have 80 m tall masts, but four turbines have a rotor diameter of 96 m with a rotor-swept area of 7,238 m^2 and twelve turbines have 93 m rotor diameters with a rotor-swept area of 6,793 m^2. The Site lies on a forest ridge compromised of deciduous hardwood trees.

Figure 1. General location of the proposed Sheffield Wind Farm in Caledonia County, Vermont.

POST-CONSTRUCTION FATALITY SEARCH METHODS

We designed and will implement a 2-3-year post-construction study of bird and bat fatality rates at the Site to determine its impact, if any, on birds and bats. This study will begin in April 2012. The following methods are a modification of those described by Arnett et al. (2009b) and generally follow the recently adopted standard protocols by the Pennsylvania Game Commission (PGC 2007) under the auspices of their cooperative agreement with wind energy companies and developers (http://www.pgc.state.pa.us/pgc/lib/pgc/programs/voluntary_agreement.pdf). Our primary objectives for fatality searches are to:

1. Conduct daily fatality searches, determine searcher efficiency and scavenger removal rates to adjust number of carcasses found, and estimate bat and bird fatality rates at the Site.
2. Evaluate patterns of post-construction bat and bird fatality in relation to wind speed, temperature, rotor speed, and other factors and assess the predictability of fatality based on these factors.

Delineation of Carcass Search Plots and Habitat Mapping

We will attempt to delineate a rectangular plot that is 126 m east-west by 120 m north-south (60 m radius from the turbine mast in any direction) centered on each turbine to be sampled; this area will represent the maximum possible search area for this study (see Figure 2 for an example from Arnett et al. 2009b). Transects will be set 6 m apart within each plot and observers will search 3 m on each side of the transect line; thus, the maximum plot in the east-west direction could be 126 m. However, the area cleared of forest at this site is highly varied and, thus, we will delineate and map the actual area available for searching at each turbine plot (Figure 2). The area searched will be used to standardize results and adjust fatality estimates (Arnett et al. 2009b). The number of transect lines and length of each line will be recorded for each plot and habitat along each transect line will be mapped. We will record the percent ground cover, height of ground cover, type of habitat (vegetation, brush pile, boulder, etc), and the presence of extreme slope within each search plot and collapse these habitat characteristics into visibility classes that reflect their combined influence on carcass detectability (Table 1, following PGC 2007).

Fatality Searches

We will conduct daily searches at 8 randomly selected turbines from the 16 total available turbines from 1 April through 31 May and then from 1 to 31 October each year of the study (all turbines will be searched during the operational mitigation study from 1 June to 30 September each year of the study). Personnel trained in proper search techniques will conduct the carcass searches. Searchers will walk at a rate of approximately 10–20 m/min. along each transect searching both sides out to 3 m on each side for casualties. Search area and speed may be adjusted by habitat type after evaluation of the first searcher efficiency trial. Searches will be abandoned if severe or otherwise unsafe weather (heavy rain, lightning, etc.) conditions are present; searches will resume that day if weather conditions permit. Searches will commence at or near sunrise and we anticipate that it should take no more than 1–1.5 hours to survey the search area around each turbine depending on topography and vegetative conditions. All turbines will be searched within 8 hr after sunrise.

Field Data Recording

Data recorded for each search at turbines will include date, start time, end time, observer, and weather data. We will use weather data (e.g., temperature, wind direction, and wind speed) collected from the meteorological tower and wind turbines at the site to correlate fatalities determined to have occurred the previous night with weather variables for that night.

When a dead bat or bird is found, the searcher will place a flag near the carcass and continue the search. After searching the entire plot, the searcher will return to each carcass to record information on a fatality data sheet, including date, time found, species, sex and age (where possible), observer name, identification number of carcass, turbine number, perpendicular distance from the transect line to the carcass, distance from turbine, azimuth from turbine, habitat surrounding carcass, condition of carcass (entire, partial, scavenged), and estimated time of death (e.g., <1 day, <2 days). The field crew leader will be responsible for confirming all species identifications at the end of each day. Rubber gloves or an inverted plastic bag will be used to handle all carcasses to reduce possible human scent bias for carcasses later used in scavenger removal trials. Carcasses will be placed in a plastic bag and labeled. Most (~90%) of fresh carcasses will be redistributed on the same day for scavenging trials, while the remaining carcasses will be frozen for future use in searcher efficiency trials (see below).

Any federally or state threatened or endangered species (e.g., Indiana bat, small-footed myotis, little brown bat etc.) that are found dead will not to be used for carcass removal or searcher efficiency trials and all carcasses of *Myotis* will be photographed with a digital camera and those that cannot be positively identified in the field will be retained and frozen for later identification to eliminate the possibility of misidentifying a threatened or endangered species. Collection of state or federal endangered, threatened, or protected species will be coordinated with the USFWS and State Agencies. Also, evaluation of bats with white-nosed syndrome will be coordinated with the agencies.

Fatalities found by maintenance personnel and others not conducting the formal searches within the searched turbine plot will not be collected and only reported to the field crew leader, who will leave these bats in place until they are either 1) found by the scheduled searcher; 2) scavenged; or, 3) disintegrate beyond recognition. For the later two situations, the crew leader will record these fatalities as incidentals. Fatalities found outside of searched turbines plots, at meteorological towers, the substation or along roads by any crew member will be recorded as an incidental; those found under these circumstances by maintenance personnel will be reported to the crew leader who will record these as incidentals.

Figure 2. Sample carcass search plot at a wind turbine depicting the maximum plot size of 126 m east-west and 120 m north-south, 6 m wide transect lines (searched 3 m on each side), unsearchable area (black), and area encompassed by easy (white), moderate (light tan), difficult (dark tan), and very difficult (brown) visibility habitat (from Arnett et al. 2009b).

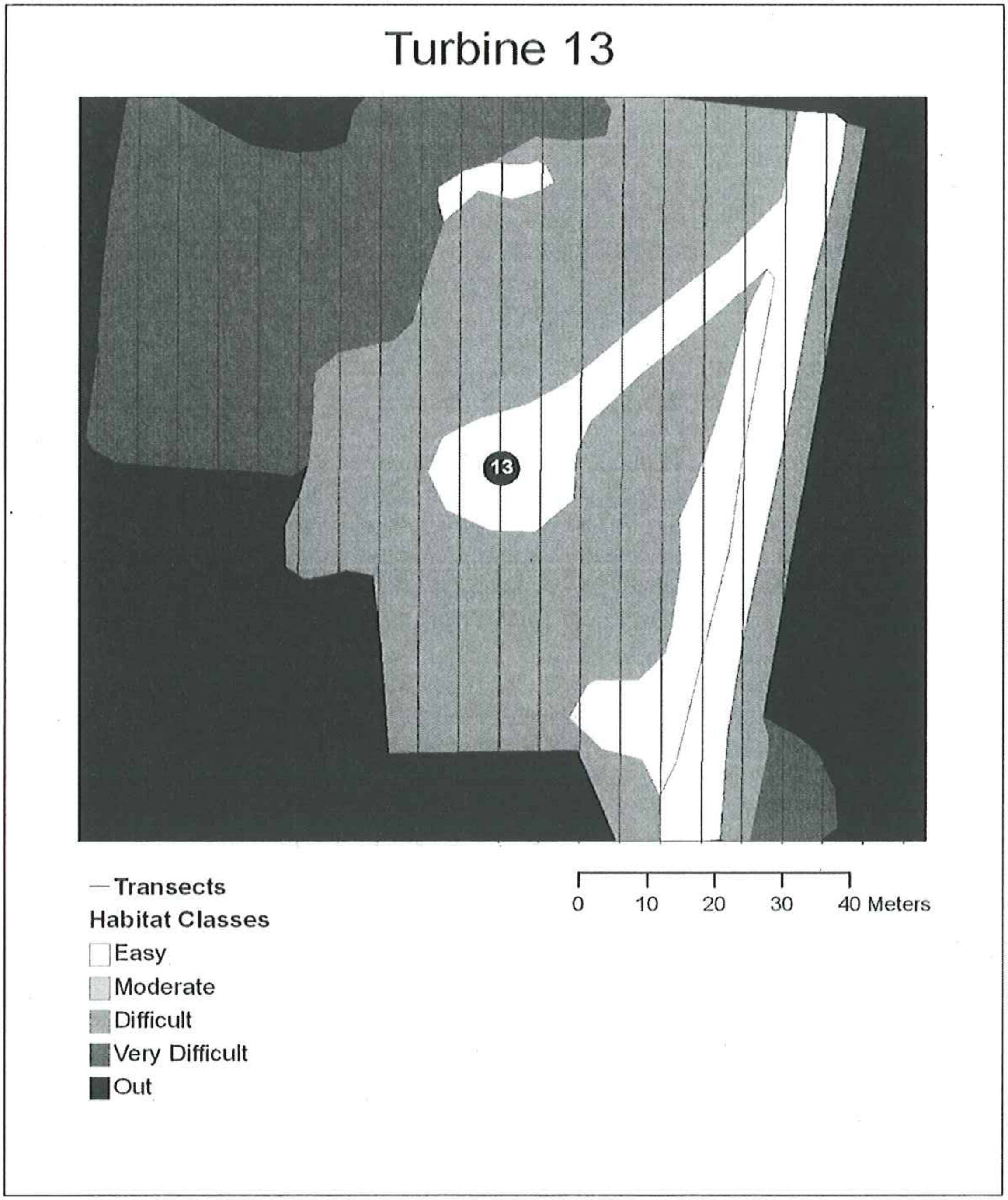


Table 1. Habitat visibility classification scheme to be used during this study (following PGC 2007, Arnett et al. 2009b). Visibility classes may be adjusted to the next lower class if slope>25% or brush piles >2 m in diameter are present within the search area along the transect line being classified (following Kerns et al. 2005).

% Vegetative Cover	Vegetation Height	Visibility Class
≥90% bare ground	≤15 cm tall	Class 1 (Easy)
≥25% bare ground	≤15 cm tall	Class 2 (Moderate)
≤25% bare ground	≤25% >30 cm tall	Class 3 (Difficult)
Little or no bare ground	≥25% >30 cm tall	Class 4 (Very Difficult)

Field Bias Trials

Searcher efficiency and removal of carcasses by scavengers will be quantified to adjust the estimate of total bat fatalities for detection bias. We will conduct bias trials throughout the entire study period and searchers will not be aware of which turbines are to be used or the number of carcasses placed beneath those turbines during trials. Prior to the study's inception, we will use EXCEL to generate a list of random turbine numbers and random azimuths and distances (m) from turbines for placement of each bat used in bias trials.

We anticipate using only fresh killed bats for searcher efficiency and carcass removal trials during this study. At the end of each day's search, the field crew leader will gather all bats and then redistributed only fresh bats at predetermined random points within any given turbine's searchable area. Data recorded for each trial carcass prior to placement will include date of placement, species, turbine number, distance and direction from turbine, and visibility class surrounding the carcass. We will attempt to distribute trial bats equally among the different visibility classes throughout the study period (easy, moderate, and difficult [difficult and very difficult will likely be combined]). We will attempt to avoid "over-seeding" any one turbine with carcasses by placing no more than 4 carcasses at any one time at a given turbine.

Because we plan to use fresh bats for searcher efficiency trials and carcass removal trials simultaneously, we will not mark bats with tape or some other previously used methods (see Kerns et al. 2005) that could impart human or other scents on trial bat carcasses. Rather, we will remove the outer toe on both rear feet from each trial bat so as to distinguish them from other fatalities landing nearby or if scavengers pulled the trial bat away from its original random location. Also, since we will take wing punches from carcasses, the small hole in the wing will also serve as a marker for trial bat carcasses. Each trial bat will be left in place and checked daily by the field crew leader or a searcher not involved with the bias trials; thus, trial bats will be available and could be found by searchers on consecutive days during daily searches unless they are previously removed by a scavenger. We will record the day that each bat is found by a searcher, at which time the carcass will remain in the scavenger removal trial. If, however, a carcass is removed by a scavenger before detection by a searcher, it will be removed from the searcher efficiency trial and used only in the removal data set. When a bat carcass is found, the searcher will inspect the toes on the rear feet and the wings to determine if a bias trial carcass has been found. If so, the searcher will contact the field crew leader and the bat will be left in place for the carcass removal trial. Carcasses will be left in place until removed by a scavenger or they decomposed to a point beyond recognition, at which time the number of days after placement will be recorded.

For bird trials, we will likely use a combination of previously frozen specimens and fresh killed carcasses found beneath turbines for searcher efficiency and carcass removal trials during the study because we expect to find few fresh killed birds. In the event that a collection permit cannot be secured by the USFWS to handle migratory birds, non-migratory birds will be used in these trials. We will use the same general methods described above using either fresh or frozen bird carcasses, but will need to mark individuals by placing a piece of duct tape with a unique number inside the mouth of each bird carcasses; we will do so with gloves and tweezers so as to leave as little human-imparted scent as possible. We will attempt to determine any differences in searcher efficiency and carcass removal rates between fresh and frozen carcasses if samples sizes allow for such an analysis; otherwise, we will assume no difference in our analysis.

Statistical Methods for Estimating Fatalities

Carcass persistence/removal. Estimates of the probability that a bat or bird carcass is not removed in the interval between searches will be used to adjust carcass counts for removal bias. Removal will include scavenging, wind or water, or decomposition beyond recognition. In most fatality monitoring efforts, it is assumed that carcass removal occurs at a constant rate that is not dependent on the time since death; this simplifying assumption allows us to estimate fatality when search intervals exceed one day. The length of time a carcass remains on the study area before it is removed is typically modeled as an exponentially distributed random variable. The probability that a carcass is not removed during an interval of length I can be *roughly* approximated as: $r = \exp(-0.5 * I / t)$. The multiplier of 0.5 is based on the assumption that fatality is approximately constant in the interval between searches and the probability of removal over the entire interval (when some animals died at the beginning of the interval, others near the end), can be approximated by the probability of removal half way through the search interval. We will fit carcass persistence/removal data for both bats and birds to an interval-censored parametric failure time model, with carcass persistence time modeled as a function of visibility class, and will use an alpha of 0.05 to determine if there was a statistically significant effect among visibility classes for removal of bat carcasses.

Searcher efficiency. Estimates of the probability that a carcass will be seen by an observer during a search will be used to adjust carcass counts for observer bias. The failure of an observer to detect a carcass on the search plot may be due to its size, color, or time since death, as well as conditions in its immediate vicinity (e.g., vegetation density, shade). In most fatality monitoring efforts, because we cannot measure time since death, it is assumed that a carcass' observability is constant over the period of the search interval, which it likely is not. In this study, searches will be conducted daily and carcass persistence times may be long, thus providing an opportunity for a searcher to detect a carcass that is missed on a previous search. Searcher efficiency trial carcasses will be placed on search plots and monitored for at least 20 days. The day on which a bat carcass is either observed or removed by a scavenger will be recorded. After accounting for carcasses removed before a searcher had the chance of observing them, data will be fit to a logistic regression model with odds of observing a carcass given that it persisted modeled as a function of visibility class. We will use an alpha of 0.05 to determine if there is a statistically significant effect among visibility classes.

Density of carcasses and proportion of area surveyed. The density of bat carcasses will be modeled as a function of distance from the turbine, following methods described by Arnett et al. (2009a, b). The actual area surveyed within a plot will differ among turbines; density of carcasses is known to diminish with increasing distance from the turbine (e.g., Kerns et al. 2005), so a simple adjustment to fatality based on area surveyed would likely lead to over estimates, because unsearched areas tend to be farthest from turbines. Carcasses will be "binned" into 2 m rings (Figure 3) extending from the turbine edge out to the theoretical maximum plot distance, and we will combine data from all turbines to calculate carcass density (number of carcasses/m^2) in each ring. These data will be modeled as a conditional cubic polynomial to estimate a function that will be used to relate density to distance from turbine; this function will be used to weight each square meter in the plot. The density-weighted fraction of each plot that is actually searched will, thus, be used as an area adjustment to per-turbine fatality estimates rather than using a simple proportion.

Fatality estimates. We will adjust the number of bat and bird fatalities found by searchers by estimates of searcher efficiency and of the proportion of carcasses expected to persist unscavenged during each interval using the following equation:

$$\hat{f}_{ijk} = \frac{c_{ijk}}{\hat{a}_i * \hat{p}_{jk} * \hat{r}_{jk} * \hat{e}_{jk}}$$

Where:

$\hat{f}_{ijk}$ is the estimated fatality in the k^{th} visibility class that occurred at the i^{th} turbine during the j^{th} search;

c_{ijk} is the observed number of carcasses in the k^{th} visibility class at the i^{th} turbine during the j^{th} search;

a_i is the density-weighted proportion of the area of the i^{th} turbine that was searched;

$\hat{p}_{jk}$ is the estimated probability that a carcass in the k^{th} visibility class that is on the ground during the j^{th} search will actually be seen by the observer;

$\hat{r}_j$ is the probability than an individual bird or bat that died during the interval preceding the j^{th} search will not be removed by scavengers; and

$\hat{e}_j$ is the effective interval (i.e., the ratio of the length of time before 99% of carcasses can be expected to be removed to the search interval).

The value for $\hat{p}_{jk}$ is estimated through searcher efficiency trials with estimates given above; $\hat{r}_j$ is a function of the average carcass persistence rate and the length of the interval preceding the j^{th} search; and $\hat{r}_j$, $\hat{e}_j$ and $\hat{p}_{jk}$ are assumed not to differ among turbines, but differ with search interval (*j*) and visibility class (*k*).

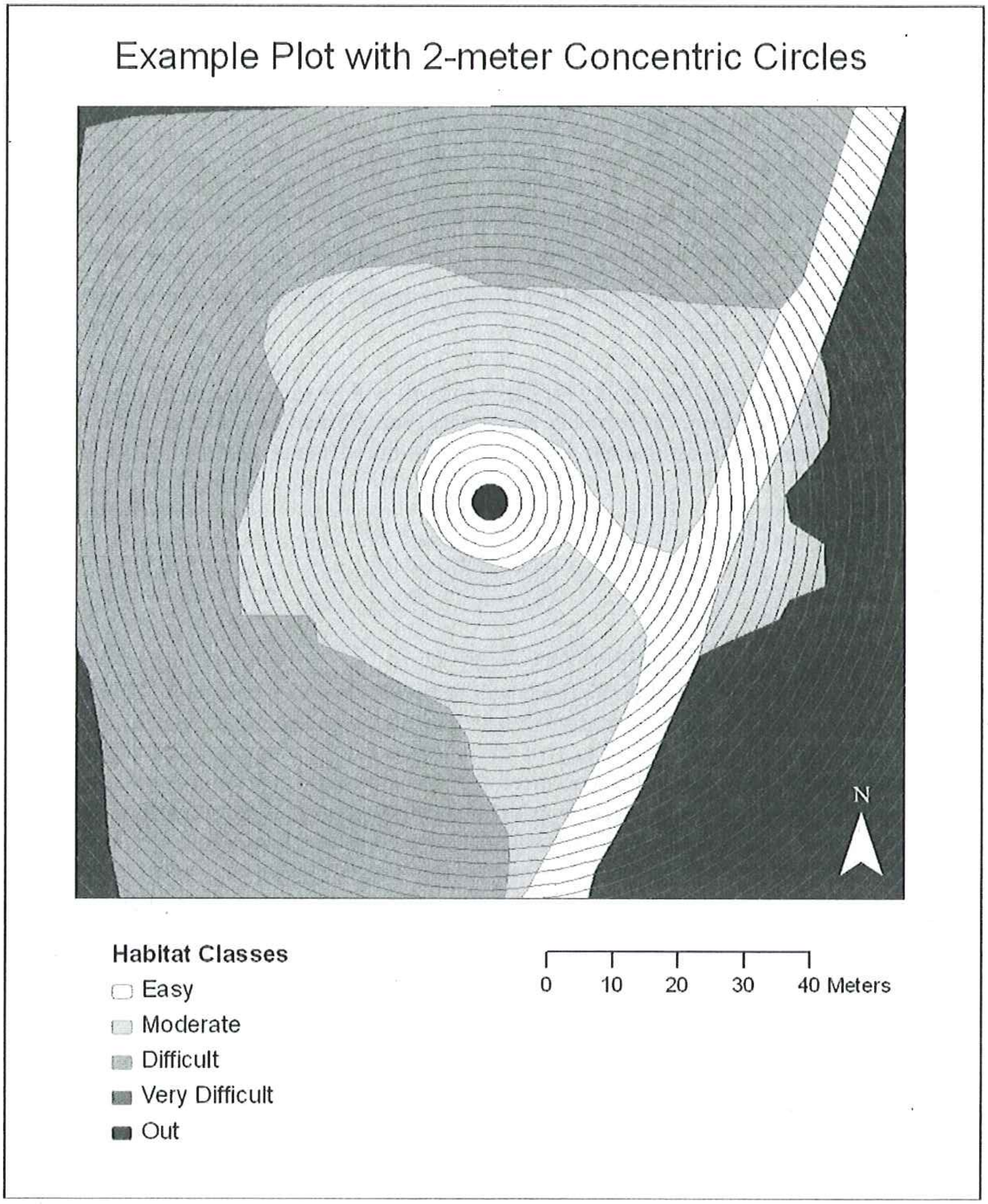
The estimated annual per turbine fatality for bats and birds will be calculated using a newly derived estimator by M. Huso, Oregon State University (unpublished data, manuscript in press; herein referred to as the MH estimator). The equation for the MH estimator for this study is:

$$\hat{f} = \frac{\sum_{i=1}^{10}\sum_{j=1}^{n_i}\sum_{k=1}^{3}\hat{f}_{ijk}}{10}$$

where n_i is the number of searches carried out at turbine *i*, 1= 1, …, 10, and $\hat{f}_{ijk}$ is defined above. The per turbine estimate and confidence limits will be divided by the estimated function described above to adjust for actual density-weighted area searched and multiplied by the total number of turbines at the Site (n = 16) to give total annual fatality estimates (Cochran 1977). This estimate assumes that no fatalities occurred during the winter, i.e. prior to April and after November. No closed form solution is yet available for the variance of this estimator, so 95% confidence intervals of this estimate will be calculated by bootstrapping (Manly 1997). Searcher efficiency will be estimated from a bootstrap sample (with replacement) of searcher efficiency data, carcass persistence estimated from a bootstrap sample of carcass persistence data, and these values will be applied to the carcass data from a bootstrap sample of turbines to estimate average fatality per turbine. This process will be repeated 1,000 times. The 2.5th and 97.5th quantiles from the 1,000 bootstrapped estimates will form the 95% confidence limits of the estimated fatality.

Fatalities in relation to weather and turbine operation. We will use weather data (e.g., temperature, wind speed) collected from wind turbine anemometers to correlate the number of bat fatalities (and birds if sample sizes are sufficient) determined to have occurred the previous night with weather variables for that night. The number of fresh bat (or bird) kills at a turbine will be modeled as a Poisson distributed variable using a generalized mixed model with turbine

Figure 3. Hypothetical carcass search plot for a wind turbine illustrating 2 m rings extending from the turbine edge out to the theoretical maximum plot distance and a depiction of "easy" searchable area (shaded area within line drawing) in the plot, used to develop weights for adjusting fatalities.



as a random effect and explanatory variables as fixed effects. We will calculate an autoregressive parameter to indicate correlation from day-to-day, so as to determine if data from consecutive days within turbine can be assumed to be independent, thus allowing use of AIC to compare models with different explanatory variables (Burnham and Anderson 2002). To determine relationships between bat fatality and weather variables, we will use regression to predict the number of fresh bat (or bird) fatalities found at a site in relation to wind speed, temperature, and relative humidity. Assuming AIC is appropriate for model selection, we will determine the "best" model by using the small sample size variant of Akaike's Information Criterion (AIC_c; Burnham and Anderson 2002). Model probabilities (Akaike weights [w_i]; probability that the i-th model is actually the best approximating model among the candidate set, given the data) also will be calculated. For the null model and all models in the 95% confidence set ($\sum w_i \geq 0.95$), we will present the AIC_c difference (AIC_c between each model and the best approximating model) and will consider all models <2.0 AIC units from the best model to be strongly competing models warranting discussion relative to biological inferences (Burnham and Anderson 2002). For inferences about each parameter in every model fit, we will calculate the Wald's χ^2 statistic and p-value using standard statistical procedures for logistic regression models (Ramsey and Schafer 1997). All analyses will be performed in SAS® (Version 9.1, SAS Institute 2007).

OPERATIONAL MITIGATION METHODS

We will implement an experiment testing the effectiveness of operational curtailment on reducing bat fatality at wind turbines at the Sheffield Site. We will implement this experiment for up to 120 nights (1 June to 30 September) each year and on each night when ambient air temperature is >9.5 degrees C (49 degrees F) and wind speeds ≤6 m/s (13.4 mph). Curtailment will only occur during night (generally ½ hr before sunset to sunrise) when bats are active. Our objectives for this study will be to 1) determine the difference in bat fatality at turbines with different changes in the cut-in-speed relative to fully operational turbines, and 2) determine the economic costs of the experiment and estimated costs for the entire project area under different curtailment prescriptions and timeframes.

Experimental Design and Hypotheses

All 16 turbines will be used for the operational mitigation experiment. There will be two turbine treatments: 1) fully operational and 2) cut-in speed at 6.0 m/s. Each treatment will have eight replicates on each night of the experiment. We will use a randomized block design (Hurlbert 1984) and treatments will be randomly assigned to turbines each night of the experiment for an equal number of nights at each turbine, with the night when treatments are applied being the experimental unit.

On any given night, there will likely be little variation in the wind speed among turbines (M. Huso, unpublished data), so we assume that wind speeds will be the same at all turbines on any night. The GE 2.5 MW turbines to be used in this experiment generally do not rotate at low wind speeds and "feather" when winds are <4.0 m/s (i.e., turbine blades are pitched parallel with the wind and free-wheel at very low rotation rates). Thus, the actual application of the curtailment treatment will be dependent on the ambient wind speed on each night. Considering 3 levels of ambient wind speed (<4.0 m/s, 4.0-6.0 m/s, >6.0 m/s), Table 2 presents conditions of turbines under both of these treatments and wind speeds. When wind speeds are <4.0 or >6.0 m/s, all turbines will be in the same operational condition and no curtailment treatments will be in effect for those times; only when wind speeds are between 4.0 and 6.0 m/s will there be any treatments actually effective. When wind

Table 2. Examples of possible turbine conditions ("feathered" or "rotating") under different treatments and wind conditions at the Sheffield Wind Farm in Caledonia County, Vermont. Under the treatment condition when wind is <4.0 m/s, we expected all turbines to be feathered with no rotation.

Treatment	**Wind Speed (m/s)**		
	<4.0	**4.0-6.0**	**> 6.0**
6.0 m/s	Feathered/ No rotation	Feathered/ No rotation	No feathering/ Full rotation
Fully Operational	Feathered/ No rotation	No feathering/ Full rotation	No feathering/ Full rotation

Table 3. Predicted bat activity levels under different treatments and wind conditions (based on analyses in Arnett et al. 2006, 2007b) and predicted fatality levels at the Sheffield Wind Farm in Caledonia County, Vermont.

Treatment	Wind Speed (m/s)		
	< 4.0	4.0-6.0	> 6.0
6.0 m/s			
Activity	High	Moderate	Low
Fatality	None	None	Low
Fully Operational			
Activity	High	Moderate	Low
Fatality	None	High	Low

speeds are low, bat activity is expected to be high (Table 3; e.g., Arnett et al. 2006, 2007b), and when winds are <4.0 m/s none of the turbines will be expected to rotate so we expect no fatalities during these periods at any of the treated turbines because all turbines will likely be feathered below the cut-in speed (Table 3). When wind speeds are >6.0 m/s, bat activity is expected to be low (e.g., Arnett et al. 2006, 2007b) and all turbines will be rotating so we expected fewer fatalities during these nights as well, and hypothesize there will be no differences among treatments (Table 3). When wind speeds are 4.0-6.0 m/s, bat activity is expected to be moderate to high and the turbines with the assigned 6.0 m/s treatment will not be rotating, so we expect no fatalities at these turbines, but potentially high fatalities at the unfeathered, fully operational turbines under these wind conditions.

Wind speed varies throughout the night, thus changing the effective treatment application throughout the night. In addition, fatalities will only be observed at the end of the night and it is impossible to determine when and under exactly what conditions of wind speed when a fatality occurs. Our design actively accounts for this effect by maintaining balance of replicates of each treatment on each night and reassigning treatment to turbines each night. Also, the measure of fatality for a treatment will be the sum of all fresh bat fatalities (i.e., those determined to have occurred the night prior to the search) found at a given turbine following a particular treatment assignment, thereby evenly distributing the effect of varying wind speed within a night and among nights across all turbines and treatments in the study.

Fatality Searches

We will conduct daily searches at all turbines starting on 1 June and continuing through 30 September. We will use the same methods for fatality searches, searcher efficiency, and carcass removal described above for the 8 turbines being searched daily as part of the post-construction study at the Site.

Statistical Methods for Evaluating Curtailment

Comparison of Treatments. The experimental unit in the first analysis will be the turbine-night and turbines will be considered a random blocking factor. The total number of fatalities estimated to have been killed the previous night, herein referred to as "fresh" fatalities, in each treatment at each turbine will be modeled as a Poisson random variable and fit to a Generalized Linear Mixed Model using PROC GLIMMIX in SAS v9.1 (SAS Institute 2007) with turbine as the blocking factor. If at the end of the study we determine there is an imbalance in the design and assignment of treatments, we will model the data with an offset of the number of days a treatment occurred within a turbine.

Comparison of Curtailment Turbine Bat Fatalities with Other Turbines Searched. For our second analysis, the turbine will be the experimental unit, with 8 turbines receiving the curtailment treatment, 8 the control (i.e., fully operational at all times). We will use all carcasses found at a turbine to estimate the total number of bat fatalities that occurred at each turbine during the time period the curtailment study is implemented. We will calculate fatality estimates using the methods and analytical procedures described above in the previous section on estimating fatalities. We will compare fatalities from the 8 turbines searched for other project objectives with the curtailment turbines using one-way analysis of variance with each turbine as the experimental unit and $\log_e$ (estimated total fatalities) as the response (SAS Institute 2007).

Financial Costs of Curtailment

At the end of the experiment, we will work with staff at Vermont Wind to evaluate how much power loss occurs by comparing daily output of the curtailed turbines with the output of turbines that were not curtailed; power loss will be projected for each change in cut-in speed studied and for 1) the study period and, 2) the total annual output. We also will extrapolate these power losses to evaluate the true economic loss for the project as if a particular curtailment treatment had been applied to all 16 turbines at the Site (½ hour before sunset to sunrise for the number of days studied). We will project power loss for the change in cut-in speed studied during the study period and for the entire annual output. In addition to the lost power revenues, Vermont Wind also will incur costs for staff time to set up the processes and controls and to implement the curtailment from the company's offsite 24-hour operations center.

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PROJECT MANAGEMENT APPROACH

We propose managing and implementing this project under the auspices of the Bats and Wind Energy Coöperative (BWEC) and Texas Tech University (TTU), in partnership with First Wind. Bat Conservation International, serving as liaison to the BWEC, would be the contracting organization with First Wind and will subcontract and administer funds accordingly to TTU. Dr. Arnett and a M.S. student (Colleen Martin) will serve as the Project and Field Managers for the studies. Ms. Martin would use data gathered for her thesis research that would be produced independent of and in addition to progress and annual reports, and she will work under the direction and oversight from Drs. Arnett and Wallace, who will serve as co-advisors on Ms. Martin's M.S. graduate committee. Dr. Arnett will spend time in the field with Ms. Martin throughout the project and Dr. Wallace will manage all aspects of her M.S. program and serve as the liaison for TTU for this project. The BWEC Scientific Advisory Committee will serve as key advisors and peer-reviewers of study proposals, reports and publications for this project. Additionally, Ms. Martin's graduate committee at TTU will assist with design of the study and review of all reporting. Thus, our unique team of experts and peer-reviewers would offer an unprecedented level of expertise and credibility and should greatly enhance the project and relationships with other TAC members, Vermont agencies, and the public.

DELIVERABLES AND SCHEDULE

Table 4 provides a proposed schedule of events and deliverables for this project for each year, which may be adjusted based on discussions with BWEC, TTU graduate Committee, and First Wind. We will plan to meet with the Company and State Agency staff at least once per year; conference calls and webinars also will likely be conducted during the project. Additional meetings can be scheduled as needed. We also will meet with Vermont Wind operations and senior staff as requested.

Progress/annual reports will be prepared and submitted to Vermont Wind at least 30 days prior to their public submission. We anticipate progress reports in July and November each year of the study that will focus on work accomplished and key findings. A draft annual report will be prepared and submitted in February each year of the study. A draft final report for this project, all data and years of study, is anticipated in spring 2014. The student's M.S. thesis, independent of the final report, and defense will follow in fall 2014. Publications from this project will follow thereafter.

Table 4. Proposed schedule of activities and deliverables for field research, meetings, reports, and M.S. student coursework for the Sheffield Wind Farm, Caledonia County, Vermont.

ACTIVITY	Year and Season [a]											
	2012				2013				2014 (potential) [d]			
	W	Sp	Su	F	W	Sp	Su	F	W	Sp	Su	F
Draft Study Plan	X											
Revise and finalize study plan		X										
Graduate Committee Meetings	X	X			X							
Bird/Bat Fatality Searches		X		X		X		X		X		X
Curtailment Study and Searches			X				X				X	
Data Analysis [b]					X				X			
Progress Reports [c]			X	X			X	X			X	X
Annual Reports [c]					X				X			
Final Report											X	
Publication Preparation/Submission											X	X
Course Work	X	X			X	X			X	X		X
Oral and Written Exams									X			
Thesis and Defense												X

[a] F = fall, October-December; W = winter, January-March; Sp = spring, April-May; Su = June-September
[b] Primary time for data analysis will be late fall and winter each year, but some analyses will occur throughout the year (e.g., point count data analyzed immediately upon completion).
[c] Progress/annual reports will be finalized with Vermont Wind, but suggested dates are mid-July and mid-November each year
[d] The need and scope of a third year of studies will be determined in consultation with VTANR, USFWS and BCI once the second year is completed.