Bats and Wind Energy Cooperative
3rd Science and All Committees Meeting

10-13 January 2012

Austin, TX

2012 Workshop Proceedings

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Executive Summary

The Bats and Wind Energy Cooperative (BWEC – www.batsandwind.org) is an alliance of state and federal agencies, private industry, academic institutions, and non-governmental organizations that cooperates to develop solutions to minimize or, where possible, prevent mortality of bats at wind power turbines. It is an initiative founded by Bat Conservation International (BCI), the U.S. Fish and Wildlife Service (USFWS), the American Wind Energy Association (AWEA), and the Department of Energy's National Renewable Energy Laboratory (NREL). New members include the Department of Energy (DOE) and the U.S. Geological Survey (USGS). BWEC's Oversight, Science Advisory, and Technical Advisory Committees met in Austin, Texas from January 10-13, 2012 to review BWEC's progress, discuss emerging issues, determine approaches and feasibility for modeling bat populations and mortality factors, and revise priorities for the Cooperative.

Research Priorities and Emerging Issues

Over the course of the 3.5-day meeting, BWEC committees discussed potential research priorities, tasks, and roles in the categories noted below. The discussion was informed by BWEC progress to date, existing research commitments, and high priority research needs. The priorities and tasks discussed were designed to inform Oversight Committee decision-making, and did not represent final decisions on specific activities, priorities, or roles.

Synthesis and Meta-Analysis – Given the information collected over the last several years, it was agreed that existing data and information should be coalesced and synthesized in order to answer key research questions. Specific, high priority questions articulated included: factors influencing nightly variability in species presence and fatality; correlation between pre-construction acoustic activity and post-construction fatality; correlation between post-construction acoustic activity and post-construction fatality on a nightly basis; and species-specific fatality rates.

Operational Mitigation – It was agreed that optimizing operational mitigation for minimizing bat fatalities and minimizing turbine downtime remained a high priority research area. The highest priority tasks identified were: drawing lessons from a synthesis analysis of data from existing sites; working to delineate preliminary operational mitigation considerations for regions not yet studied; conducting additional site-based studies; informing study design for other sites, as appropriate; disseminating information to stakeholders through webinars and other means; and incorporating a synthesis of weather factors and bat presence into operational mitigation synthesis reports.

Population Estimation, Modeling and Data Collection – It was agreed that BWEC should continue to support efforts to estimate, model, and collect data on bat populations. The highest priority tasks identified were: provide additional population data for those species most affected by wind power; and validate parameters for population models to maximize efficacy and refine models. BWEC's primary roles in these and other population research priorities identified were to fundraise, identify partners, engage researchers with appropriate expertise, and collect data.

Deterrents – It was agreed that BWEC should continue working to identify how to deter bats from wind turbines, but that the high costs associated with developing and field-testing deterrent devices raised questions about whether BWEC should continue leading this work. Accordingly, the highest priority deterrent activities identified were: 1) advancing the video monitoring approach to turbine-bat surveillance being led by USGS; 2) understanding deterrent effects on bat behavior to determine what frequencies and periodicity deter which bat species; and 3) working with turbine manufacturers and engineers on further research and development.

Post-Construction Protocols – It was agreed that BWEC and its partners could make important contributions to developing and disseminating protocols for post-construction monitoring. The highest priority tasks identified were: review existing protocols and guidance information, and then develop protocols and methods agreed to by BWEC committees for the Cooperative's post-construction studies; disseminate these BWEC protocols; and support USGS efforts to refine, publish and disseminate information on the low frequency monitoring and density estimator approaches being developed.

Emerging Issues - BWEC committee members identified the below emerging issues associated with bats and wind energy. While these issues are not necessarily BWEC research priorities, BWEC should stay apprised of developments in these areas, and engage in them as cost opportunities arise:

- *International Work* – It was agreed that BWEC should expand its network of international partners, with the main objectives of providing capacity building and transferring knowledge (both to and from others).
- *Offshore Wind* – It was agreed that BWEC should inform and engage on offshore wind-related bat issues as appropriate, particularly in light of BWEC's knowledge and experience regarding impacts of land-based wind development on bats.
- *Endangered Species* – It was agreed that BWEC should work to provide additional science and consultation for key issues related to bat species that are currently or expected to become listed as threatened or endangered.
- *Regional Expansion of Wind* – Wind development continues to expand to regions for which little or no data are available. BWEC could help fill data gaps, which might be identified more clearly through BWEC's synthesis and meta-analysis work.

- *Small-Scale Wind* – Little research has been done on issues associated with small-scale wind, for example with regard to impacts of lower turbine height and more scattered turbines across landscapes. It was agreed that BWEC should be prepared to engage on this issue as deployment grows and opportunities arise.

Chapter 1: Introduction

About BWEC and the 3rd Science and All Committees Meeting

The Bats and Wind Energy Cooperative (BWEC – www.batsandwind.org) is an alliance of state and federal agencies, private industry, academic institutions, and non-governmental organizations that cooperates to develop solutions to minimize or, where possible, prevent mortality of bats at wind power turbines.[1] It is an initiative sponsored by Bat Conservation International (BCI), the U.S. Fish and Wildlife Service (FWS), the American Wind Energy Association (AWEA), and the Department of Energy's National Renewable Energy Laboratory (NREL). The BWEC recently added the Department of Energy (DOE) and the U.S. Geological Survey (USGS) as new members. BWEC seeks solutions to identified problems and provide scientifically credible recommendations for standardizing protocols, methodologies, and research to safeguard both bats and wind energy protocols.

To further its work, BWEC is organized and managed by a Program Coordinator, with oversight and direction from an Oversight Committee consisting of representatives from the founding, and recently added organizations. BWEC's Scientific Advisory Committee is composed of scientists who are leading experts on bat behavior and ecology or in other relevant fields, and who provide technical and scientific guidance to the Program Coordinator and Oversight Committee. BWEC's Technical Advisory Committee is composed of experts and stakeholders from relevant industries, non-governmental organizations, and government agencies with wildlife management responsibilities, who provide insight on the feasibility and implementation of BWEC's objectives.

Members of all three BWEC Committees met in Austin, Texas from January 10-13, 2012 for the BWEC 3rd Science and All Committees Meeting. The meeting purpose was to examine progress of the Bats and Wind Energy Cooperative (BWEC), discuss emerging issues, determine approaches and feasibility for modeling bat populations and mortality factors, and establish priorities for the Cooperative. Guest scientists offered presentations and participated in conversations on population modeling, and guests from Deaton Engineering and General Electric participated in discussions on deterrents. The meeting was facilitated by Patrick Field and Elizabeth Fierman, of the Consensus Building Institute.[2]

[1] The first two paragraphs of this introduction are taken from the BWEC Charter, as revised in November 2011.

[2] See the Final Participant List, included as Appendix 2.

Meeting Agenda and Overview

The meeting agenda[3] was structured to allow ample time for conversation, both to discuss specific presentations and to allow for collaborative prioritization of research needs and tasks. The format consisted primarily of presentations and facilitated plenary discussions, with one time block dedicated to detailed discussion of potential priorities in small breakout groups.

After introductions and welcomes from Nina Fascione and Ed Arnett, of BCI, the morning of Day 1 (January 10) focused on updates on BWEC progress and ongoing research projects; the afternoon focused on initial discussion of emerging issues and potential research priorities. The morning of Day 2 (January 11) was spent continuing discussions regarding potential research priorities, and then the afternoon was spent on presentations and discussion of bat population estimation and modeling. The morning of Day 3 (January 12) was spent first in plenary discussion of population modeling feasibility and needs, and then in breakout groups to address potential research areas in more depth; the afternoon was spent reporting out from breakout groups and beginning to specify actions and priorities. The morning of Day 4 (January 13) was spent with BWEC committee members only. The Committees discussed how to refine and further prioritize the actions and priorities identified during previous days, and also discussed miscellaneous BWEC business.

Ultimately, the Oversight Committee will take final decisions on BWEC priorities and activities moving forward. The lists of prioritized actions and activities that were produced and finalized in draft form by the end of the meeting were designed to inform Oversight Committee decision-making; they did not represent decisions on specific projects, plans, roles and responsibilities, or financing.

Workshop Proceedings Document

This document is a summary of the BWEC workshop proceedings, including presentations, discussions, and draft priorities identified. It is intended to synthesize comments, questions, ideas and presentations offered over the course of the BWEC meeting. Accordingly, it is organized by topic, rather than in chronological order, and aims to group together thematically similar discussion items. It may be best reviewed together with presenters' PowerPoint presentations, many of which are available as hyperlinks from the agenda attached as Appendix 1.

[3] See the Final Agenda, included as Appendix 1.

Chapter 2: BWEC and Partner Updates

BWEC committee members, partners, and guest scientists provided presentations to update meeting participants on BWEC progress and new developments in population modeling and other research. Each presentation was followed by a facilitated discussion, in which participants asked questions, made comments, and offered suggestions. The presentations are briefly summarized below. Key themes from facilitated discussions that do not appear in subsequent chapters are included in bullet format.

BWEC's History, Progress and Next Steps

BWEC was formed in December 2003, and has made significant progress in conducting priority research and disseminating research findings. Overall, bats are now being considered more by the public, industry and decision makers. The last BWEC Science Meeting was held in 2008, and resulted in 4 priority topics: operational mitigation and deterrents, post-construction studies, pre-construction studies, and population analysis. Moving forward, BWEC plans to continue working in these categories, and also to increase work with international partners and to potentially engage in emerging issues.

Operational Mitigation and Deterrents

BWEC has completed one operational mitigation study. Key findings were: 44–93% fewer bats were killed at turbines with cut-in speeds raised between 5.0–6.5 m/s; no difference between treatments; and 0.3 to approximately 1% annual power loss with cut-in speeds raised between 5.0 and 6.5 m/s, respectively. BWEC has two additional site-specific studies planned and contracted, which will test current knowledge about cut-in speeds, timing of night, and other operational mitigation variables. An economic assessment was completed for the site study already done, and will need to be done for the upcoming studies. A priority is to compare economic assessments for operational mitigation with those of deterrents.

BWEC has been working with Deaton Engineering to develop deterrent devices. The goal of this work is to determine the potential to generate a disorienting or uncomfortable airspace around turbines to deter bats. Initial lab and field tests from 2006 to 2010 indicated that the devices do decrease bat activity and fatality. The devices being developed have already gone through several design iterations, but require additional R&D, and design improvements to enhance their performance, particularly their ability to withstand environmental conditions. A long-term goal is to conduct a more robust field test, which would involve deployment of more devices and improvements to the study design. Such a test would be costly, however. The current devices cost approximately $7,740 per turbine, with 8 devices per turbine

needed (not including labor, insulation and other costs). The devices use about 1.5 amps of energy per 120-volt turbine, or around 70 watts per device, which is a small proportion of the energy that turbines produce.

- Operational Mitigation and Deterrents should be discussed and considered as separate categories in the future.

Pre-Construction Acoustic Monitoring

BWEC currently has several pre-construction acoustic projects underway. The main goals of this work are to assess levels and patterns of bat activity, relate activity to weather variables and, ideally, use this information to help determine fatality risk. Temporal and spatial variation and differences in activity related to weather have been observed among project sites, and are consistent with other studies. There is some evidence of pre-activity and post-fatality relationship. Most studies in North America and Europe indicate that bat activity is highest during low wind periods. BWEC will likely do additional pre-construction studies moving forward, using multiple tools. Another next step is to coalesce and analyze existing data from BWEC studies and other projects. There also is a need to consider migration routes and calculate risk over wide geographic areas.

Post-Construction Monitoring

Post-construction monitoring studies have been underway in partnership with USGS, using mounted detectors and daily fatality searches. The goal is to develop predictive models of activity and fatality, both in terms of weather variables and turbine-specific activity. Although this work is ongoing, key findings so far include: no consistent relationships between turbine fatalities and habitat covariates (e.g., distance to water or forest edge) within facilities, but a landscape-scale relationship among facilities with proximity to mountains in Canada (Baerwald and Barclay 2009); a strong pattern of fall mortality (with some regional evidence of mortality in spring and summer); the need to consider different species separately because of differing biology; taller turbines yield higher bat fatalities (Barclay et al. 2007, Baerwald and Barclay 2009, 2011); and relationships between fatalities and low wind conditions. Upcoming projects likely will include additional post-construction monitoring at certain sites. BWEC has not yet completed a formal post-construction monitoring protocol, which was one of the priorities set in 2008, but has contributed to the development of other protocols (e.g., NWCC Methods and Metrics, USFWS guidelines). Next steps include: to coalesce existing literature, including updated regional estimations and projections; publish a protocol/methods paper; and use carcasses more effectively to advance science.

Bat-Turbine Video Monitoring

USGS is taking the lead on developing a video system to improve researchers' ability to observe bats flying around turbines. This work should allow researchers to better estimate fatality, assess risk, infer bat absence, correlate bat presence with site and sampling covariates, and understand social behavior near turbines. Investigating the underlying causes of bat activity at turbines may also help researchers determine any operational changes that could reduce potential bat attraction to turbines. Given the amount of footage gathered from field tests, automated analysis is being used to extract data on targets, including data on velocity and direction. The goal is to further automate this system so that it can extract bat movement only, which will further facilitate the analysis. Other next steps are to reduce the costs associated with this work, increase the camera resolution, and use the system at other sites.

- Additional work should assess whether video monitoring relates to activity recorded by acoustic detectors. This would involve comparing data from acoustic detectors and video cameras.
- If it were established that bats always echolocate at turbines, then these data could potentially lead to turbines designed to stop automatically if they pick up specific bat calls. This strategy may be applied for Hawaiian hoary bats, for example.

US Fish and Wildlife Service Wind Turbine Guidelines

The USFWS released the agency's Wind Turbine Guidelines in their final format for the federal register March 23,i 2012. USFWS is planning to offer trainings on the guidelines beginning in September 2012, and to offer one-hour overview presentations on the guidelines in the meantime. Ideally, and if budget permits it, trainings will target mixed groups to help ensure that different stakeholders receive and interpret the guidelines in a consistent way.

New Developments in Estimating Fatalities

There are several fatality estimators being developed to account for fatalities despite imperfect observation, and to help manage challenges of estimating open populations. BWEC should note in particular the weighted density approach being developed by USGS. This approach takes into account the higher density of carcasses close to turbines, and the tapering density moving further away from turbines. As a result, it allows for more accurate estimates of how many carcasses will not be found because they are either in unsearchable areas within a plot or are outside of a plot altogether, which in turn can lead to better fatality estimates and potentially lower monitoring costs.

- Reanalyzing existing data on fatality distributions at specific sites might be helpful, assuming the data are accurate.
- This technique might allow for more incorporation of data collected outside of a formalized search (though it is still important to account for the carcass removal process and probability of persistence).

White-nose Syndrome Update: Current Status, Science and Response

White-nose Syndrome (WNS) is dramatically affecting hibernating bats. It is caused by a fungus (*Geomyces destructans; Gd*). Although *Gd* strains exist in Europe, it is not associated with bat mortality or sickness there (i.e. WNS). It is generally accepted that *Gd* was brought to North America by human means, either through trade or travel. It was first discovered in North America in 2006 in New York. Since then, the geographical range and the number of affected sites have grown exponentially. Mortality rates are unprecedented and are presumed to have major impacts on species. One of the species affected, the Indiana bat (*Myotis sodalis*), is already federally listed as endangered. Three other species have been petitioned for listing (eastern small-footed [*M. lebii*], northern long-eared [*M. septentrionalis*], and little brown [*M. lucifugus*] bats). There are 25 bat species that hibernate in conditions under which *Gd* grows; if we see decline in all of these, it would dramatically impact the North American ecology. There is a broad, coordinated response to WNS underway, which includes research, education and outreach. U.S. government agencies that are heavily involved in this work include the USFWS, the U.S. Forest Service, and the Bureau of Land Management; Congress has appropriated some funds for WNS too. A new partner website - www.whitenosesyndrome.org - will be the point source for up to date information.

- Scientists could potentially look at what is different about European bats that makes them resistant to *Gd* while North American bats are so susceptible to it. Although Europe and North America do not have the same species, there are some that are genetically similar.
- WNS is likely to increase pressure to reduce other anthropogenic sources of bat mortality, including wind.

Population Analysis

Population analysis was also selected as a priority topic in 2008, and has progressed primarily through the work of scientists from various academic institutions; these guest scientists updated BWEC committees on their progress (see below). A next step for BWEC is to assist with convening a workshop with WNS experts to investigate population modeling efforts for bats in North America, in April 2012.

Considerations for Modeling Bat Populations: Lessons Learned from other Species of Wildlife

Modeling is generally an iterative process to help manage complex systems, like populations. It involves several steps: developing a conceptual model, formulating a quantitative model, evaluating the model before it is applied, and applying the model and adjusting as necessary. Finding the "right" or "best" model depends on the objective. Model development should take into account the relative amount of data available and the relative level of understanding; modeling is usually best when using a relatively low amount of data. More complex models don't necessarily help researchers learn more.

Using Genetic Analyses to Estimate Effective Population Size and Model the Population Genetic Effects of Wind Turbine Related Mortalities

Population genetics work can help scientists understand what proportion of bat populations wind turbine-related fatalities represent. Genetic approaches can help manage data deficiencies that inhibit the use of traditional demographic approaches, and also can help researchers understand past population processes and population structure. Scientists at Western Michigan University and Grand Valley State University are using genetic data to estimate Effective Population Size (Ne), which refers to the size of the population that contributes genes to the next generation. It is typically smaller than the census population size (Nc), though the difference varies greatly. Ne can be estimated using temporal changes in allele frequencies, which estimates shorter-term Ne across the time period sampled, and using coalescent simulations of genealogies, which allows estimates of longer-term average Ne. The latter approach has been used to produce very preliminary results on eastern red bat (*Lasiurus borealis*) population size, composition, historical trends and historical use of migration pathways.

Genetic work also is being used to try to monitor populations over time, which can help researchers understand how turbine-related mortalities impact bat populations. The idea of this approach is to take a sample from the current population and model how a population decline (perhaps 1-10% from wind turbines, recognizing that 10% is probably extreme) plays out after various numbers of generations. A key finding from modeling efforts shows that population diversity remains relatively stable until it suddenly collapses; the trend holds for even higher levels of population loss, but diversity collapses much more quickly.

Overall, genetics can help scientists understand historic population levels; the geographic limits of distinct populations; the pattern of gene flow (which is particularly helpful for mapping migratory species); and whether there are sex-specific differences in ecology. There is more work to be done, including refining model parameters.

- Challenges with genetic approaches include:
    - Estimating θ (nucleotide polymorphism for mitochondrial and nuclear DNA), mutation rates, and other model parameters.
    - Establishing the relationship between Ne and Nc
    - Getting large enough sample sizes from a wide regional range
- Genetic modelers have examined eastern red bats, but may assess other species given appropriate samples sizes (20-25 from a single site for sequence-based analyses, and 30-50 per site for allele frequency studies). Different approaches may be required for different species.
- If genetic data could provide information on recent population declines, it would allow bat conservationists to consider whether current losses are sufficient to sustain population growth as opposed to maintaining current population levels.

Development of Population Models to Evaluate Significance of Wind Turbine Bat Fatalities

Population models are being developed at UC Santa Cruz to evaluate the significance of wind turbine bat fatalities. This requires knowing what proportion of the population is being killed by turbines. Rmax, or the maximum per capita growth rate that a population can experience, can be used to estimate the maximum proportion of a population that can be removed before population growth is negatively impacted. This approach, traditionally used in game harvest management, theoretically can be used to understand whether turbines have a population level impact and can be modeled using a variety of parameters. This modeling has yielded preliminary results indicating that current fatality levels may not pose immediate threats range-wide for species considered to date (e.g. eastern red bat), although for some species the impact of WNS complicates this assessment. It is important to "under-harvest" bats, given the levels of uncertainty in their demographic processes, true population size, cumulative impact from other sources of mortality, and the ecosystem services bats provide. At the same time, it is helpful to reframe current thinking to focus on the degree of harvest that is sustainable and justified given the benefits of wind energy. Key next steps are to determine population sizes, to incorporate updated harvest rate information, and build a spatially explicit version of the model.

- Other sources of mortality can also be factored into this model, for example through adult and juvenile survival rates.
- It is important to understand the factors that influence the most important model parameters, such as WNS.
- Uses of this approach include:
    - Determining acceptable level of incidental take for species for which there are very good population size estimates (e.g. Indiana bat), with the caveat that this approach looks at the *maximum* that can be taken without impacting population growth.
    - If this model could be downscaled, it could provide information about the impacts of removing individuals from specific sites, including the potential for local extinction events.

- Challenges with this approach include:
    - Accurately estimating model parameters
    - Accurately estimating populations at the regional and local levels (so far work has mainly focused on range-wide populations.)

Estimating Fatalities of Rare Species: Evidence of Absence versus Absence of Evidence?

Work is being led by USGS on how to determine take for rare species, given the high likelihood of not finding carcasses during fatality searches. Statistical tools can estimate the probability of finding carcasses. The primary factors influencing whether carcasses are found are: searchable/searched area; proportion persisting; proportion observed; fraction of turbines searched (assuming one round of searches). Of these, increasing the fraction of turbines searched is a high priority (training also could potentially bring some improvement in proportion observed). Work on this is just beginning and needs improvement. The goal of this work is to help ensure that the maximum take is not exceeded for rare species by increasing confidence that the probability of detecting a carcass is high.

- Search intervals may be less important, unless the site has a high scavenging rate.
- This is likely to be helpful for stakeholders who are concerned about the costs associated with daily searches and the need to search 100% of turbines.
- Another variable to account for is searchers' ability to correctly identify species found.

Chapter 3: Synthesis and Meta-Analysis

Synthesis and meta-analysis was identified early in the meeting as an important focus of BWEC efforts in the immediate future, particularly because analyzing existing data sets can help answer a variety of research questions without requiring large amounts of time and funding. Another benefit is that many BWEC partners could engage in this work, although specific division of roles and responsibilities was not discussed in depth. Initial ideas for the substance, purpose and other aspects of this category of work were outlined in early plenary discussions, and then further refined in a breakout group discussion. The breakout group produced a priorities worksheet that was discussed in plenary. This chapter synthesizes key themes from both the facilitated and small group discussions, and also includes the priorities worksheet as "finalized" by the end of the meeting.

Results of Facilitated and Small Group Discussions

- Synthesis and meta-analysis reports will help answer high-priority research questions from existing data sets. This will require working on topics for which there is enough existing high quality data and information.

- Work that could supplement or build on synthesis and meta-analysis includes:
    - A predictive model for pre-construction and post-construction linkages, based on meta-analysis findings
    - Using data gathered to develop a database

- Key challenges for synthesis and meta-analysis are:
    - Ensuring quality and consistency of data, to avoid introducing error into data sets
    - Accessing all of the existing data that is needed
    - Data gaps

- Potential topics for synthesis and meta-analysis include:
    - Identifying co-variants influencing nightly variability in species presence and/or fatality, including weather variables and others.
    - Relating pre-construction acoustic activity and post-construction fatality is extremely important. This analysis could help illuminate whether pre-construction monitoring can predict risk. It also may help determine whether pre-construction activity can be used to predict the timing and conditions (i.e. temperature and wind speed) under which species are most active, which would help

industry decide more precisely when to curtail. One goal of this analysis should be to broadly characterize sites in terms of high and low risk so that mitigation can be built in development plans for high-risk sites up front.
    - Correlating post-construction acoustic activity with post-construction fatalities is also important, particularly in determining whether activity relates to fatality. This work may be helpful in conjunction with population monitoring work, and for "fine-tuning" curtailment.
    - Determining species-specific fatality rates.
    - Determining if predictions of risk by species can be made, and if so with what precision. This could involve: looking at where different species are and when; potentially testing species distribution models on a regional basis using acoustic data and occupancy models; and focusing on species for which data are needed for population modeling. As a by-product, this work could provide basic summary information on things like sex ratio of fatality and age.
    - Determining connections between fatality rates and turbines themselves, with the caveat that it can be difficult to discern fatalities from turbine characteristics versus site characteristics.
    - Identifying sites with long-term counts of carcasses and assimilating those data for longitudinal review, for population estimation purposes.
    - Operational mitigation RPM and other turbine characteristics analysis.
    - Looking at the best methods for assessing and comparing fatalities, for example per operating hour versus per operating hour below different speeds.

- Once data sets are amassed, they can be used to cover many topics and questions of interest. Accordingly, prioritizing among the potential topics identified is in a sense an exercise in prioritizing which data sets to collect first.

The above suggestions were articulated as specific research questions in the breakout group and then refined and prioritized in subsequent plenary sessions. Specific steps for conducting the synthesis and meta-analysis, along with key benefits / objectives and a potential timeframe were also proposed. These details are outlined on the prioritization worksheet below.

Synthesis and Meta-Analysis Prioritization Worksheet

What is the Objective of the Research in a few short sentences?	Answer the following key questions (**bold** indicates high priority): **1. What factors influence nightly variability in species activity and/or fatality (co-variants such as weather factors)?** **2. Is fatality correlated to pre-construction activity, and if so how and what factors influence variation in the relationship?** **a. Does pre-construction acoustic activity predict post-construction fatality?** **b. Does pre-construction acoustic activity predict species presence, especially presence of rarer species?** **3. Does post-construction acoustic activity relate to post-construction fatalities at a turbine or nightly basis?** **4. What are species-specific fatality rates? Basic summary information on sex ratio of fatalities, age.** 5. What factors explain variation in fatalities among sites (spatial and temporal factors)? a. Can we predict / define characteristics of low and high-risk sites at least as a rough guide? b. To what accuracy? 6. Does activity pre-construction differ from activity post-construction? 7. Can we predict risk by species using fatality and/or acoustic data? 8. Identify sites that had long-term counts of carcasses, assimilate data for longitudinal review.

What are the benefits of conducting such research?	• Fine tune curtailment practices • Increase understanding of broad and specific temporal and spatial patterns • Optimize resources / funding

Who are key partners for the research?	• BCI, universities, consultants, AWWI

What are the key technical tasks and milestones?	1. First take stock of the data already available (publicly and through BWEC partners) and identify data / information gaps 2. Identify who owns any missing data and reach out to them (including industry and agencies) 3. Conduct a simple analysis using existing information 4. If necessary, conduct a follow up analysis generated by re-analyzing raw data using consistent procedures

What are key barriers and challenges?	• Getting the data to be made publicly available • Data gaps • Variation in how data were collected (variation in experimental design, sampling variation) • How good do we need to be at differentiating risk (how wrong do we allow ourselves to be)?

Rough estimate of cost & resources (staff) needed	TBD
Rough estimate of time to completion	Within 6 months (for first pass analysis)

What are immediate next steps?	• Establish criteria/quality requirements for including data in a particular analysis • Define metrics

Chapter 4: Operational Mitigation

Operational mitigation was identified early in the meeting as an important ongoing priority for BWEC. A key objective of BWEC's operational mitigation work is to optimize operational mitigation for minimizing bat fatalities and maximizing turbine operations (i.e. reducing turbine downtime). Initial ideas for outstanding questions to be answered, methods for answering them, BWEC roles in operational mitigation work, and other aspects of this category were outlined in early plenary discussions, and then further refined in a breakout group discussion. The breakout group produced a priorities worksheet that was then discussed and further refined in plenary. This chapter synthesizes key themes from both the facilitated and small group discussions, and also includes the priorities worksheet as "finalized" by the end of the meeting.

Results of Facilitated and Small Group Discussions

- The goals of BWEC's work on operational mitigation should include:
  - Optimizing operational mitigation for minimizing bat fatalities and maximizing turbine operations
  - Distilling lessons learned for utilizing curtailment in the short-term
  - Helping people understand the tools and options available for minimizing or avoiding fatalities

- It is clear that operational mitigation reduces bat fatalities. What is most needed is to continue working with industry stakeholders on broad scale implementation, including building costs into project plans from the outset.

- Given that BWEC is already contracted to do two site-based studies (in Vermont and West Virginia), it makes sense to use these studies to further refine knowledge about optimizing operational mitigation.

- Outstanding questions and areas to investigate with regard to operational mitigation, including through the site-based studies, include:
  - What cut-in speeds should be used?
  - Which are the most important times of night to curtail?
  - Parsing out a full set of parameters for when to curtail, including time of year and various weather variables, would be helpful; this work could potentially be combined or coordinated with the synthesis and meta-analysis work, including analysis of correlation between acoustic activity and fatality. We might be able to combine efforts with others trying to refine when a bat of interest will be in the area of a turbine.
  - At what speeds are blades harmful to bats? Investigate RPMs and tip speeds to determine this.

- There may be a way to combine the site-based studies with the USGS video monitoring work.
- Correlating acoustic data to curtailment on the nacelle
- Partial feathering, also called low-speed idling
- Do techniques need to be species-specific?

- Existing studies and data sets could also be synthesized and analyzed, to help answer the above questions, distill lessons learned for operational mitigation and for operational mitigation study design, and identify information gaps.

- Meeting industry's desire for boundaries on when to curtail is very complicated, given the complexities of bat biology, differences among species, and geographical variation. There likely will not be one prescription for every species or even for a whole region.

- Compiling reliable cost estimates, both for existing and potential sites, might be helpful for convincing industry to use operational mitigation. As a side benefit, this work could set a benchmark for comparison with other mitigation strategies, including deterrents. It is difficult, however, to compare operational mitigation costs, given differences among sites / projects, market value, variation in wind speed, etc.

- Stakeholders that need to be engaged in discussions about operational mitigation include:
  - *Industry* – need broad scale implementation, which will require broader acceptance of operational mitigation. If companies are conducting curtailment studies, there may be opportunities for BWEC to inform their study design, to ensure rigor and consistency.
  - *Turbine manufacturers* – manufacturers need to know the biological and environmental factors that can be integrated into mechanical engineering needs associated with operational mitigation; can program existing scada systems or design new systems.
  - *Utilities and other energy buyers* – operators need flexibility from these stakeholders in order to curtail. For example, breaking power-purchase agreements or other energy provision obligations for curtailment can be very costly.
  - *Lenders* – if operational mitigation were seen as less unusual and ultimately beneficial for lowering project liability, lenders might be less likely to walk away from project investments or tack on additional loan costs.
  - *Federal and state agencies* – BWEC can provide information and lessons learned to regulators to help inform study design and other aspects of operational mitigation.
  - *International partners* – they might be able to provide information about characteristics, conditions, and species relationships relative to operational mitigation implementation outside of the US.

- As information is generated about operational mitigation, it is very important to use webinars and other means to disseminate it as widely as possible, including internationally. Ultimately, BWEC's role should shift from that of doing operational mitigation work to that of informing others on how to do it. For example, we could produce information on how BWEC does operational mitigation studies, and use it to inform others.

More specific details and priorities with regard to the steps and areas of interest outlined above, along with roles and responsibilities and proposed timeframes are outlined on the prioritization worksheet below.

Operational Mitigation Prioritization Worksheet

Goal: Optimize operational mitigation (OM) for minimizing bat fatalities and maximizing turbine operations. H = High Priority, M = Moderate Priority, L = Low Priority.

Priority	Time Frame	Action	Details	BWEC Role & Partners	Notes
H	Short-term	Existing site synthesis	• 4 sites include Casselman, Fowler, Alberta, Mt. Storm (RPM, wind speed, fatalities) • Add 5th Canadian site • Lessons and limitations from doing OM studies (study design lessons learned) • Lessons learned for OM and limitations	BCI lead, with Robert Barclay and WEST Inc.	Limitations include: missing other regions; differentiation of cut in speeds in practice; review acoustic data at nacelle at Casselman and fatality data
H	Short-term	Preliminary considerations for other regions	• Initial review of biological information on species and operational mitigation for regions not covered under current studies (southeast, southwest, west) • Working with international partners to consider species, regions, and OM study opportunities	BCI Lead	

H	Short-term	Site-based studies	• Conduct West Virginia and Vermont studies, along similar parameters for each • Involves ½ night (5 hours after dusk, then 5 hours more), 5.0 and 6.5 m/s, or even just one cut-in speed, and bat fatality monitoring. Review met data to parse wind speeds and maximize time.	BCI	Consider incorporating weather data into fatality and RPM data; need for video monitoring to better correlate actual events. VT site stat. power limited; low RPM feathering?
H	Short-term	Inform on Study Design and other sites	• Work with BLM on OM study design for any appropriate projects • Work with others doing this kind of work (other federal agencies, states, others)	BLM-BCI and others	
H	Medium-term	Webinars and other means	• Once synthesis reports complete, disseminate knowledge through various avenues, including international • Conveying and working with equipment manufacturers	BCI, DOE, AWWI, NWCC	
H	Medium-term	Incorporate Weather Synthesis Report	• Incorporate broad synthesis of weather factors and bat presence into OM synthesis reports	BCI	
M	Medium-term	Update Synthesis Reports	• Update synthesis reports with new data from NV, WV, and VT sties	BCI	
M	Medium-term	Inform	• Inform on other studies on other sites • Role of industry to offer sites for study to be considered	BCI, others	Does BCI need a FTE or $$ to contribute to this activity? Role of industry in doing research? Willingness

					of industry to use sites for OM studies?
L	Long-term	Integration and Synthesis on OM	Integrate data and synthesize from multiple sites over multiple years	BCI, others	

Chapter 5: Deterrents

Deterrents were identified as an important area of research, although costs associated with continuing to develop and test deterrent devices raised questions about whether this should be the highest priority use of BWEC's limited resources. Ultimately, it was decided that the highest priorities in this area dealt with refining understanding of deterrent effects, by seeking to answer questions both about the devices themselves and about bat behavior. Deterrents were discussed several times in plenary, but not in break out groups. They were nevertheless summarized in a priority worksheet that was further refined by the full group on day 4. This chapter synthesizes key themes from the facilitated discussions, and also includes the priorities worksheet as "finalized" by the end of the meeting.

Results of Facilitated Discussions

- We should ensure that the devices deter bats before investing heavily in them. Outstanding questions and covariates to consider with regard to deterrents include:
    - *Wind direction* - some migratory bats may be looking for tailwinds, and there is some indication that this may impact some bats. This is relevant for deterrents and for operational mitigation.
    - *Predominant direction of bat approach to turbines* – this is an important factor to consider for maximizing deterrent device effectiveness, given that ultrasonic devices are very directional. The USGS video work might inform this question.
    - *Deterrent device frequency range* – it may be possible to narrow the frequency range emitted to better tailor the devices to frequencies to which bats respond, and to increase impact on lower frequency bats.
    - *Deterrent device placement* - hub mounting transducers and directing them along the blade could help with low frequency bats, while putting a device on the tower could help keep low flying bats from flying up in the rotors. This approach might help reduce the number of devices and transducers required. Since devices don't appear to be significantly additive in terms of how far out the

sound is projected, maybe the devices can be spread out to increase effect and distance. Bat behavior needs to be taken into account with regard to optimal device placement.
    - *Geographical use of deterrents* – since humidity impacts the effectiveness of the deterrent devices, it may be worth focusing future tests on more arid areas if partners can be found in those areas.
    - *Modulated versus constant sound* – does this make a difference to bats?
    - *How do device reflector plates impact sound and frequency range?*
    - *Spectrum of noise generated by turbines* – better understanding this could help determine whether there is a frequency generated that needs to be eliminated, rather than a device needed to drive bats away.
    - *"Technical specs" of the bat echolocation system* - what is the acoustic sound power level emitted by a bat, and what is the return sound power level the bat hears? What are the best studies available on this topic?
    - *What are bats attracted to, and what might push them away from it?*
    - *Do the effects of deterrents diminish over time due to habituation?*

- The USGS video monitoring work could be helpful for answering several deterrence questions, so it is a priority for this category.

- Other than the existing devices, there might be other deterrent technologies to look into. For example:
    - Use of radar systems as a deterrent
    - UV lasers to illuminate turbines and change how turbines appear to bats
    - A device designed to mimic sounds that bats avoid

- Key considerations with regard to deterrent costs include:
    - Uncertainties regarding repair cost and maintenance make it difficult for industry to adopt deterrents.
    - Scaling up production would reduce cost per device.
    - Comparing the costs of deterrence versus the cost of operational mitigation is an important priority. Right now, operational mitigation appears to be generally more economical and reliable than deterrents, and easier to factor into overall project costs. This might mean that deterrents are best used when operational mitigation either won't work or comes at a greater cost.

- BWEC has to decide whether to continue with expensive R&D and field-testing in light of its limited resources. It might be worth doing a thorough cost benefit analysis around whether BWEC should continue with the device work and if so when and where.
    - Pros of continuing the deterrence research include:

        - A more expansive deterrent experiment alongside a curtailment experiment would shed light on the comparative the effectiveness of these approaches.
        - Industry is interested in deterrent research, especially in light of expected additional ESA listings.
    - Cons of continuing the deterrent research include:
        - A comparative deterrence / curtailment experiment might be difficult to organize and fund.
        - There may already be others doing similar work in other regions and sectors - it might be better to try to pool efforts.
        - Dissemination and analysis of existing information is a more important need than additional deterrent research.
        - Since it's clear that operational mitigation works, BWEC should focus on convincing stakeholders to incorporate it into initial project plans and financial estimates, as appropriate.
    - BWEC's role should be to help test and refine what others develop, rather than spearheading device R&D work.

- Others BWEC might partner / engage with on deterrents work include:
    - Acoustic experts – they could help refine the frequencies and periodicities that should be used.
    - Industry counterparts - they have better ability to spearhead R&D work and a strong interest in certainty around deterrent performance. (It would be easier, though, to get industry to take the lead in R&D *after* they are certain deterrents work.)
    - Engineers and manufacturers - they could work on improving design if given the right specifications.

More specific details and priorities with regard to the steps and areas of interest outlined above, along with objectives and roles and responsibilities, are outlined on the prioritization worksheet on the following page.

Deterrents Prioritization Worksheet

H = High Priority, M = Moderate Priority, L = Low Priority.

Priority	Title	Objectives	Details	BWEC Role & Partners
H	Turbine-Bat surveillance	Advance infrared camera approach to collecting and analyzing data on bat-turbine interaction	Analyze existing data gathered in initial field tests; gather data at two test sites; consider what learned and how might be applied to future study	USGS lead;
H	Delineating Deterrent	Determine what frequencies (Hz) and periodicity deter	Determine if a narrow range of frequency matters; test pulsing versus regularized emissions, etc.; consider	BCI lead with science advisors Jones and

	Effects on Bat Behavior	which bats	literature and data for how might be affecting bats/species, what bats hear; captive work (?)	Szewczak
H	Deterrent Device Viability	Determine if existing device can be improved to function sufficiently for scale up study on impacts on fatalities	1) Share results with industry and gauge industry interest in continuing; 2) engage experts to assess potential viability of device; 3) if #1 and #2 affirmative, improve ruggedness of device; field test to determine ability to function over a season, variable weather; consider costs with scale up; 4) consider tailoring frequencies to bat search frequencies; 5) consider alternative devices/options (i.e. passive in blade) as well and needs per varying regions/species; 6) share lessons learned from Gareth in future.	BWEC role and BCI's lead in transition; role of industry important; others include Deaton Engineering; turbine manufacturers, acoustical experts, aeroacousticians
L	Scope scaled-up deterrent study	Determine scope and feasibility of additional field study	Identify scope, cost, hypothesis, value add, and potential funding for scaling up deterrent device study to some 30 to 40 turbines; consider how much of equipment (rotor, etc.) must be covered	BCI lead
L	Other Deterrents	Early scoping of range of potential deterrents	Through literature review; interviews, other means, develop white paper on range of deterrence probable options from radar to visible light	BCI lead

Chapter 6: Population Estimation, Modeling and Data Collection

Bat population research, including population estimation, modeling and data collection, was identified as important for putting bat fatalities in context and evaluating effectiveness of mitigation strategies. After being updated on research and advances in population modeling efforts, participants discussed next steps, priorities, and roles and responsibilities, in plenary and in a breakout group. The breakout group produced a priorities worksheet that was then discussed and further refined in plenary. This chapter synthesizes key themes from both the facilitated and small group discussions, and also includes the priorities worksheet as "finalized" by the end of the meeting.

Results of Facilitated and Small Group Discussions

- Population work can help us answer the key question, do fatalities matter? Related questions include:
    - What is the significance of fatalities to populations?
    - What are the populations in terms of delineation and size?
    - What are the cumulative effects of multiple wind sites along migratory routes?
    - What are population trends, range-wide and ideally also regionally and locally?
    - What are risk profiles of specific species, such as Indiana and hoary bats (*Lasiurus cinereus*), during breeding season versus migration season?
    - Can we better characterize bat migration behaviors and patterns of movement across landscapes?

- Population modeling should take into account changes in fatality due to increasing numbers of wind projects. It might make sense to use the 2030 wind goal for population work.

- Long-term (i.e. 10 year) monitoring efforts / carcass counts would help with assessing the significance of bat fatalities for whole bat populations. But, they are expensive and industry may be reluctant to commit to them. Ideas for ways to deal with this issue include:
    - Use long-term data even if it has gaps, since this might be more feasible and less expensive than continuous monitoring.
    - Look into whether developers could get mitigation "points" for contributing a site to a study, to help with permitting.
    - Instead of using consultants for long-term monitoring, use graduate students or others who are less expensive.
    - Seek opportunities to reduce long-term data collection costs. For example, if statistical analysis can allow us to search smaller portions of plots, that would make each year of post-construction monitoring cheaper and therefore easier to do for longer.

- Key next steps and needs for population modelers include:
    - Continuing the genetic research by using microsatellite data and applying the methodology to other species.
    - Seeking synergy among modeling efforts – for example, the ecological and genetic modeling potentially could be combined into a single model, and occupancy modeling might help to evaluate the models.
    - Validate model parameters, particularly annual fecundity estimates, ratio between effective and census populations, and mutation rates.
    - Provide population estimates for species of interest, including listed species and species most impacted by wind. This is not limited to North American species.
        - There is tension between focusing on bats most impacted by turbines versus species that are either listed or likely to be listed soon. Listed species are in many ways driving industry, and the legal issues associated with them are important. But, there are other groups already looking at their populations. The bats most impacted by wind (i.e. hoary bat) may be closest to the sustainable maximum take rate, and other groups are not looking at them.
    - Consider whether we need a way to estimate regional and local populations, or whether range-wide estimates are sufficient.
    - Work on population trends, potentially using time series data, acoustic monitoring stations, and/or bat monitoring stations.
    - Re-assess methods available for monitoring population and managing the associated data, for example by aligning our work with similar efforts underway for WNS; considering new techniques we could use; and thinking about collating existing data and using it for BWEC purposes.

- BWEC should maintain a supportive role in population research, while BWEC's partners (including the experts in attendance, the WNS working group, and others) should take the lead on analyzing data and writing reports. BWEC's roles could include:
    - Collect field data
    - Develop data collection protocols
    - Initiate nationwide citizen monitoring of summer roosts, to work on understanding bat activity across the nation.
    - Work with partners to corral and analyze existing data to help answer questions around carrying capacity, population trends, etc.
    - Help disseminate findings / information from population work
    - Facilitate efforts to build synergy among population modeling efforts.
    - Helping secure sites willing to participate in long-term (i.e. 10 years) carcass counts
    - Help with funding proposals
    - Support efforts to set up alternative methods of detecting population trends

Additional details with regard to the areas of interest outlined above are provided on the prioritization worksheet below.

Population Estimating, Modeling and Data Collection Prioritization Worksheet

Goal: Estimate overall populations of key bat species affected by wind development in order to determine sustainable yield for species. H = High Priority, M = Moderate Priority, L = Low Priority.

BWEC Roles: fundraise, identify right partners, engage researchers with appropriate expertise, data collection

Priority	Action	Details	BWEC Role & Partners
H	Provide additional population data for additional species affected by wind power	• Species: hoary (*priority*), silver-haired (*Lasionycteris noctivagans*), eastern red, tri-colored (*Perimyotis subflavus*), yellow (*Lasiurus* spp.), and species of interest for other reasons (ESA and WNS like Indiana, little brown bats) • Use existing data • Consider how to collect systematically hair/tissue from existing monitoring programs and provide appropriate methods/protocols for doing so for sample collection for genetic work for new regions and species • Consider international species affected by wind power and put population geneticists in touch across country boundaries • Disseminate results via BWEC	BCI and other partners; BCI support role in terms of information/data collection, fundraising; lead, analysis and reports by Partners (Grand Valley State, Western MI, Santa Cruz); for WNS species, WNS working group lead
H	Validate parameters for population models to maximize efficacy and refine model	• Refine annual fecundity estimates (synthesizing data on breeding females, collecting new data potentially) • Estimate effective (Ne) to full population (N) ratio with population(s) with decent census numbers, if possible • Better estimates of mutation rates with existing data sets	BCI and other partners; BCI support role in terms of information/data collection, fundraising; lead, analysis and reports by Partners (Grand Valley State, Western MI, Santa Cruz); for WNS species, WNS working group lead

		• Calculate wind built out to 2020 or 2030 and not just present • Refine model, considering adult and juvenile survival as well, and how to account for non-find fatalities/threats	
M	Reassessing methods for monitoring populations	• Consider work aligned with WNS already happening • Consider new techniques possible • Existing monitoring; at least collate data that many are gathering already	BCI and other partners; Cooperate with USFWS and USGS efforts
L	Population trends (population change over time)	• Time series data from carcass collection. Minimum of 5 to 10 sites, higher fatalities, over 10 years (annual counts, consistent protocols, in higher fatality sites, consider sites with some years already) • Consider more refined methodologies for collection to reduce costs • Consider operator-led longer term regular collection • Setting up acoustic monitoring sites where known migration occurring for longitudinal data • Setting up bat monitoring stations, like bird banding stations, catch, mark, follow over time	BCI work with Industry and Consultants to collect data
L	Better characterize migration behaviors of species across the landscape	• Logistical challenges are numerous, but, opportunities to radio track, from satellite technology, more local-scale, use acoustic data. Can undertake migration season habitat modeling. Distinct features seasonally? • Consider western species and opportunities for collection as parts of projects permitted on federal lands and/or monitoring along key migration pathways	BCI and other partners

Chapter 7: Post-Construction Protocols

Post-construction protocols were identified early in the meeting as an important area in which BWEC could make a contribution. The potential content, structure and overall approach to protocols and their development were discussed several times in plenary, but not in breakout groups. They were nevertheless summarized in a priority worksheet that was further refined by the full group on day 4. This chapter synthesizes key themes from facilitated discussions, and also includes the priorities worksheet as "finalized" by the end of the meeting.

Results of Facilitated Discussions

- The objectives of BWEC protocol-related efforts include:
    - Help clarify minimum standards / expectations for what to do and what not to do around bats and wind energy
    - Help agencies apply consistent standards, and in turn provide clearer guidance for industry
    - Help agencies issue proactive guidance and recommendations
    - Help identify comparable sites and risk conditions, to minimize the need for intensive monitoring

- Any protocol work BWEC does should build on existing, valid methodologies, so we should start by reviewing existing protocols. Existing protocols to look at include the NWCC Methods and Metrics document, the PA and OH Wind Guidelines, and Canadian protocols, in addition to BWEC study designs employed.

- BWEC protocols also should be living documents that can incorporate emerging scientific findings, technologies, needs, etc.

- There are several ways BWEC could approach protocol development, including:
    - A tiered approach that makes clear what the best approach is but also outlines alternatives for when that approach is not affordable or feasible.
    - Develop sets of options for how to answer key questions - this might be more appropriate for BWEC than pushing a particular policy or approach.
    - On the other hand, offering multiple methodologies can lead to disagreement about the results, whereas a single standardized protocol can better help build credible data.
    - BWEC could focus first on generating a list of questions that require protocols for answering them.

- BWEC protocols could focus on what not to do - laying out minimum standards might be an easier way to provide a common denominator.
- Overall, BWEC's goal should be to allow for some flexibility in gathering data, but not so much that people are doing it poorly or reinventing the wheel when good methodology is available.

- With regard to protocol format, there was discussion as to whether we should produce protocols to be published in peered reviewed literature outlets or less formal white papers. Protocols published in the literature have more scientific credibility, but they are more fixed and may be best suited to studies and their findings. White papers are easier, focus more on disseminating information than advising agencies, and are more easily updated. White papers could be vetted by the science advisors to boost their credibility and then published on BWEC's website.

- Another issue is consistent application of protocols, whether or not they are generated by BWEC. BWEC could host workshops and convene stakeholders as a means to build consistency in protocol application.

- BWEC post-construction protocols could cover the following topics / issues:
  - *Key factors in post-construction monitoring* - including defining the searchable area, identifying appropriate searcher efficiency measurements, scavenging methods, and fatality estimators.
  - *How to characterize site risk* – characterizing sites as high, medium or low risk would be helpful to regulators and industry, especially for calculating probability of needing operational mitigation; estimating potential avoidance, mitigation, and compensation costs; and determining whether a site is viable. Characterizing high-risk sites might be most important.
    - This type of risk characterization is a big challenge, however, especially in light of the various types of risk and contextual factors to be accounted for.
    - BWEC may not want to go down a policy route around establishing risk zones, but it might be able to inform such policy.
  - *How to read and review study design proposals* – this would be especially helpful for agency staff.
  - *Which techniques are appropriate for which species* – this could help distinguish protocols necessary, for example, for detecting a rare event (e.g. finding an Indiana Bat) versus detecting more common fatalities.

- BWEC and its partners should help disseminate protocol information, for example through bat working groups and potentially a DOE webinar on NWCC's Methods and Metrics guidelines. Disseminating new information also can help others update existing protocols.

More specific details and prioritization with regard to the ideas outlined above are described on the prioritization worksheet below.

Post-Construction Protocols Prioritization Worksheet

H = High Priority, M = Moderate Priority, L = Low Priority.

Priority	Title	Objectives	Details	BWEC Role & Partners
H	Review of Existing Information	Build from existing work	Review USFWS Wind Energy Guidelines, NWWC Methods and Metrics and Nocturnal studies compilations; state and provincial protocols such as OH, PA; international examples	BCI lead
H	Make explicit current BWEC protocols and methods for its studies	Make explicit BWEC best practices	Tease out BWEC post-construction monitoring protocols already embedded in various BWEC study protocols; BWEC peer review; Consider regional differences, standard versus rare occurrence monitoring. Topics include: • Side search methods • Carcass searches • Search efficiency measurements • Define searchable area • Minimum sample size requirements • Scavenging methods • Fatality estimator calculator • Density estimator • Other?	BCI lead
H	Disseminate best BWEC protocols	Make widely available	Publish in some fashion either self or via journal (at least for methods); update protocols over time; make widely available; confer with NWCC to share as well as with interagency work groups, other communications means	
H	Low Frequency monitoring and Density estimator	Refine, publish and disseminate best methods	Refine and publish methods on density estimator and zero search techniques	USGS lead; BWEC assist

M	Best Post-Construction Monitoring Practices		Convene stakeholders to discuss best post-construction monitoring practices	NWWC lead; BWEC participate

Chapter 8: Emerging Issues

Several emerging issues for bats and wind energy were identified over the course of the meeting. In general, these were issues that BWEC should stay apprised of, and potentially engage in as a partner, but in most cases they do not necessarily represent immediate BWEC priorities. Emerging issues were discussed several times in plenary, but not in breakout groups. They were nevertheless summarized in a priority worksheet that was further refined by the full group on day 4. This chapter synthesizes key themes from the facilitated discussions, grouping discussion topics by emerging issue. It also includes the priorities worksheet as "finalized" by the end of the meeting.

Results of Facilitated Discussions

- Overall, BWEC's roles with regard to emerging issues could include:
    - Information dissemination.
    - Help surface what important emerging issues are and keep stakeholders informed about them
    - Convene other stakeholders

International Work

- BWEC should expand and improve international collaboration, including with Mexico, Canada, South Africa and Europe. The objectives of this effort include:
    - Expand BWEC's network of international partners
    - Capacity building and knowledge transfer for international partners
    - Learn from international partners
    - Expand potential funding sources

- Ideas for improving international collaboration include:
    - Involving individual scientists in the partnership development effort, including BWEC science advisors
    - Adding international members to BWEC committees
    - Using the 2014 International Bat Conference in Costa Rica, and other such international activities, as opportunities to develop international partnerships
    - Develop a framework for how to engage internationally and with which key audiences

- Conduct webinars and seminars with and for international partners on key topics
- Host interns from developing countries to help with research and then take what they learn back home
- Engage partners in places where wind is developing quickly, especially China and India

- There is an effort underway to form a collaborative similar to BWEC in Mexico that includes regulators, NGOs and industry. Collaborating with and learning from BWEC could definitely be helpful, both substantively and in terms of partnership development.

- There might be synergies between BWEC's international work and USFWS' growing international division.

- When engaging others, it is important to have feedback loops that keep BWEC members aware of what is being done at an individual level. Oversight committee calls and BWEC newsletters can be useful for keeping everyone informed.

Offshore Wind

- It is clear that offshore wind is a major emerging topic that BWEC needs to engage in, or at least stay up to speed on. But it might be lower priority, and something BWEC should approach as a partner rather than a lead. BWEC has potentially applicable terrestrial expertise to contribute, but offshore wind stakeholders and players are different.

- BWEC roles / activities could include:
  - Participate in workshops on offshore wind
  - Help coordinate research and collaboration among the stakeholders involved in offshore wind
  - Engage international partners who are further along in developing offshore wind
  - Participate in studies, for example around bat biology and behavior offshore
  - Develop a conceptual framework for thinking about bats and offshore wind – e.g. what is different from on-land wind; what questions we should be asking; what information gaps we need to fill; differences between coastal, near-shore and off-shore, etc.

- One thing that makes offshore so important is that it is not clear how we could do post-construction monitoring – that means we need to get offshore wind right *before* the turbines go up.

- DOE can put BWEC in touch with grantees doing offshore wind work, including OSU and others.

Endangered Species

- This is a key issue which will have a huge impact on industry; it is driving many industry decisions right now.
- White Nose Syndrome (WNS) is a major underlying issue with regard to Indiana bats and new species listings.
- Population modeling work will be valuable for this topic, especially for understanding acceptable levels of fatality.
- BWEC could pay a role in providing additional science related to species that are either currently listed or likely to be listed. Roles / activities could include:
    - Help develop species-specific risk profiles and mitigation recommendations that industry and agencies could use
    - Participate in specific HCP development as appropriate
    - Analyze pre-WNS data on prevalence for myotic species, to the extent possible
    - Consider particular methods for managing low probability occurrences
    - Develop a list of options for off-site mitigation approaches
    - Engage and help inform Recovery Teams

Other Emerging Issues

- Other emerging issues identified were:
    - Regional expansion of wind
    - Upcoming technological changes (e.g. taller turbines, turbines that operate at lower wind speeds)
    - Alternative turbine designs
    - Barotrauma and non-lethal impacts of getting hit by blades (although it's not clear how we could look at that)
    - Small wind - there is very little data on wildlife response to wind at a small scale, and on the impacts of scattered positioning of small turbines. BWEC could do some monitoring at small wind sites, review small wind work being done in Europe, and potentially partner with DOE on its small wind initiatives.

Additional details and prioritization of the above emerging issues are outlined on the prioritization worksheet below.

Emerging Issues Prioritization Worksheet

Area	Objectives	Details
International	Expand network of international partners; expand potential funders; build capacity and transfer knowledge to others; learn from others	• Expand Committees to include more international members • Develop a framework for how to engage internationally (key audiences, means to engage, etc.) • Conduct webinars with and for international partners on key topics • Participate in key international activities • Reach out for partners in Africa, India, China, and Latin America • Host interns from abroad
Off-Shore Wind	Inform and engage on this issue given terrestrial knowledge and experience	• Participate in advisory capacity in Oregon State University study • Engage Ingmar Ahlen, Sweden, on this issue; work with others studying bat behavior/prevalence offshore • Consider technology on land for monitoring for off-shore, early monitoring opportunities, considerations for congregation • DOE coordinate PIs on bat-relevant off-shore wind research • Participate in workshops on this topic with others • Feedback mechanism when BWEC members participate in conversations (oversight calls, BWEC e-newsletter) • Invite BOEM to participate in some fashion
Endangered Species	Provide additional science for key issues related to current and likely-listed endangered species	• Participate in specific HCP development as appropriate • Analyze pre-WNS data on prevalence on species of Myotis, to extent possible • Consider particular methods for low probability occurrences (low population species interaction with turbines) • Develop list and approaches to off-site mitigation options • Inform FWS on preparing incidental take statements regarding bats: procedures for assessing take, etc. • Engage and help inform Recovery Teams

Regional expansion of wind		• Synthesis of all existing data will help identify data gaps per region
Small scale wind	Engage this issue as it arises	• Consider how to consider bat impacts regarding small scale wind (limited analysis to date) • Questions/issues include: current data on height didn't go low enough for low height, small scale turbines; likely also to be less concentrated, scattered across landscape, cumulative effects; capacity contribution as not as significant as large scale wind to date • DOE can provide review of various technologies • Obtain Sterling U. study on micro-turbine impacts on bats/birds

Appendix 1: Final Agenda

Bats and Wind Energy Cooperative
3rd Science and All Committees Meeting
10-13 January 2012, Austin, TX

Final Agenda

MEETING PURPOSE: To examine progress of the Bats and Wind Energy Cooperative (BWEC), discuss emerging issues, determine approaches and feasibility for modeling bat populations and mortality factors, and establish priorities for the Cooperative.

Pre-Workshop: Monday, January 9, 2012
7:00-9:00 pm Evening Reception at the Cedar Door (201 Brazos, Austin, TX 78701)

Day One: Tuesday, January 10, 2012

8:00-8:15 am **Welcome**
Nina Fascione, Executive Director, Bat Conservation International

Introductions
BWEC Committee Representatives, invited technical experts, guests

8:15-8:30 am **Review Purpose of Meeting, Agenda, Ground Rules**
Pat Field, Facilitator
- Purpose of meeting
- Review agenda
- Review ground rules for meeting discussions

Background and Updates

8:30-9:15 am **Where have we been? BWEC – A Review of Eight Years of Progress**
Ed Arnett, BCI
- Overview of partnership, past studies, key findings, and progress (15 min. presentation, 30 min. questions)

http://www.batsandwind.org/pdf/BWEC_Overview_Arnett.pdf

9:15-10:15 am **What are we doing now? A Review of Current BWEC Research Projects**
Cris Hein and Michael Schirmacher, BCI; Manuela Huso and Paul Cryan, USGS
http://www.batsandwind.org/pdf/BWEC_Update_Hein.pdf

- Review of the key current projects, partnerships, and activities of the collaborative

(30 min. presentations [20 for Cris, 10 for Paul] 30 min. questions)

10:15-10:30 am **BREAK**

Deterrents and Fatalities

10:30-12:15 pm **Deterrents**

Ed Arnett, BCI

- Overview of deterrent research and findings from 2009-10 field test

http://www.batsandwind.org/pdf/BWEC_Deterrents_Arnett.pdf

Ed Deaton and Pete Garcia, Deaton Engineering

- 2010-11 research and development and future direction for deterrent research

http://www.batsandwind.org/pdf/BWEC_Deterrents_Deaton.pdf

Discussion:

- What have we learned to date?
- What are the future possible directions for research?

(45 min. presentations [15 for Ed A, 30 for Ed D]; 60 min. questions

12:15-1:00 pm **Lunch (Served On Site)**

1:00-1:45 pm **New Developments in Estimating Fatalities**

Manuela Huso, USGS

- Estimators, area adjustments, density-weighting
- Fatality estimation software
- (30 minute presentation; 15 minutes questions

http://www.batsandwind.org/pdf/BWEC_Estimator_Work_Huso.pdf

Emerging Issues

1:45-3:30 pm **Emerging Issues**

- Scope the range of emerging issues
- Talk through each briefly to name what the issue(s) is and what role BWEC might have in it?
- Ed Arnett, John Anderson to name initial possibilities
  - Offshore wind
  - Indiana bats and wind energy
  - International growth and partnerships

3:30-3:45 pm **BREAK**

Discussion and Synthesis of Existing and Emerging Issue Research

3:45-5:00 pm **Facilitated Discussion**
Pat Field, Facilitator

- Review 2008 research plan relative to Day 1 presentations and discussion
- Discuss future directions for research: what are the key gaps or uncertainties? Why is it important to learn more?
- What research beyond our current obligations should we keep at? If so, how?
- What new research topics should we consider undertaking?

5:00 pm **Adjourn - Dinner on your own**

Day Two: Wednesday, January 11, 2012

8:00-8:30 am **Observations, Insights, Questions from Day One**
Pat Field, Facilitator

- Review and summary of Day 1
- Organize for the morning into break out groups on
- Undertake prioritization/ranking exercise, if needed

8:30 - 10:45 am **Breakout Groups to Detail Further Research**

- Detail potential future research projects in small groups
- Utilize format provided: what is the objective of the research and its potential benefits, what are the key technical tasks, challenges or barriers, partners, funding needs, key milestones and immediate next steps
- Prepare report out

10:45-11:00 am **BREAK**

11:00-12:00 pm **Report from Breakouts**

12:00 pm-1:30 pm **Lunch (Served on Site; WNS presentation by Mylea Bayless, BCI)**
http://www.batsandwind.org/pdf/BWEC_WNS_Update_Bayless.pdf

Population Modeling

1:30-1:45 pm **Review Purpose of Meeting, Agenda, Ground Rules**
Pat Field, Facilitator

1:45-3:45 pm **Approaches to Modeling Bat Populations:**

Considerations for Modeling Bat Populations: Lessons Learned from other Species of Wildlife

Bill Grant, Texas A&M University
http://www.batsandwind.org/pdf/BWEC_Modeling_Grant.pdf

Estimating Effective Population Size Using Genetic Analyses
Maarten Vonhof, Western Michigan University
http://www.batsandwind.org/pdf/BWEC_Vonhof.pdf

Modeling the population genetic effects of wind turbine-related mortalities in red bats
Amy Russell, Grand Valley State University
http://www.batsandwind.org/pdf/BWEC_Russell.pdf

Development of Population Models to Evaluate Significance of Wind Turbine Bat Fatalities
Winifred Frick, University of Santa Cruz and Boston University
(100 min. presentations; 20 min. questions; time for questions between each presentation)
http://www.batsandwind.org/pdf/BWEC_Frick.pdf

3:45-4:00 pm **BREAK**

4:00- 4:45 pm **Estimating Fatalities of Rare Species: Evidence of Absence vs. Absence of Evidence**
Manuela Huso, USGS
(30 minute presentation, 15 minutes questions)

4:45-5:30 pm **Open Discussion on Presentations and Key Issues to Address and Prioritize**

- Other sources of mortality?
- How to address cumulative impacts?
- What are research needs to be addressed?

5:30 pm **Adjourn**

6:30 pm **Hosted Reception and Dinner at Max's Wine Dive (207 San Jacinto Boulevard, Austin, TX 78701)**
Special Guest: Dr. Merlin Tuttle, Founder - BCI and co-founder of BWEC

Day Three: Thursday, January 12, 2012

9:00-9:15 am **Observations, Insights, Questions from Day Two**
Pat Field, Facilitator

9:15-10:30 **Feasibility of Modeling Bat Populations and Outstanding Research Needs**
Group discussion – Review 2008 Plan and Data Gaps

- What are the opportunities and constraints of modeling bat populations?
- How do we link genetic and conventional population modeling approaches?
- Identify some potential, specific topics for future research
- Divide into break out groups to sketch such topics

10:30-10:45 **Break**

10:45-11:45 **Breakout Groups**
Sketch out a potential topic, considering technical feasibility, cost, and value

11:45-12:30 **Advising on Feasibility**
- Brief report outs
- Given this exploration, is such modeling feasible and desirable?
- If so, which research needs identified most need to be addressed?
- Next steps?

12:30-1:30 pm **Lunch (Served On Site)**

Putting it all Together

1:30-3:00 pm **Development of Research Priorities, Research Plan of Action, Next Steps**
- Briefly review specific research topics named to date during our sessions
- Discuss range of choices
- Rank order such topics in a ranking exercise
- Move to break out groups to further detail and refine prioritized research topics/areas of focus

2:45 – 3:00 **BREAK**

3:00 pm **Breakout Groups:**
Honing Research Priorities, Plans of Action, Next Steps

5:15-5:45 pm **Brief summation and Adjourn**

Day Four: Friday, January 13, 2012

8:00-10:00 am **BWEC BUSINESS MEETING (Committees Only)**
- Debrief and discuss previous sessions
- Review approaches developed (summarized overnight be team)
- Discuss meeting outcomes and next steps for research plan

10:00-10:15 am **Break (some members depart for airport)**

10:15-12:00 pm **BWEC BUSINESS MEETING (Continued)**

- Review/Revise Charter
- Membership updates
- Financials and continued funding sources
- Discuss BWEC workshop at AWEA Siting Conference
- Discuss new business and next steps

12:00 pm **ADJOURN MEETING**

Appendix 2: Final Participant List

FINAL PARTICIPANT LIST

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