Bats and Wind Energy Cooperative 5th Science and All Committees Meeting

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2018 Workshop Proceedings

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Table of Contents

Executive Summary

Overview
The Bats and Wind Energy Cooperative (BWEC or Cooperative) is an alliance of experts from government agencies, private industry, academic institutions, and non-governmental organizations that cooperate to develop and disseminate solutions to reduce to the greatest extent practicable or, where possible, prevent mortality of bats at wind energy facilities.

The BWEC is overseen by the American Wind Energy Association (AWEA), the Association of Fish and Wildlife Agencies (AFWA), Bat Conservation International (BCI), the National Renewable Energy Laboratory (NREL), the U.S. Department of Energy (USDOE), the U.S. Fish and Wildlife Service (USFWS), and the U.S. Geological Survey (USGS). BWEC's Oversight, Science Advisory, and Technical Advisory Committees met at NREL's National Wind Technology Center from June 5–7, 2018 for the *5th Science and All Committees Meeting* to examine progress of the BWEC, review existing monitoring and minimization strategies, discuss emerging issues, assess the effectiveness of BWEC, and establish priorities for the Cooperative for the years 2018 to 2021.

Presentations
BWEC committee members heard presentations on and discussed the following topics:

- Industry challenges and opportunities related to bats
- Population analyses of bats
- Fatality estimation
- Bat behavior and movement patterns
- Operational minimization
- Deterrent technologies
- BWEC strategic plan 2018–2021
- BWEC business

Research Priorities and Emerging Issues
The BWEC discussed priorities for 2018–2021 in the following categories. Further detail on a wider range of possible activities are included later in this report. Discussions were informed by BWEC progress to date, BWEC participant research initiatives, and guest presentations. The priorities developed were designed to inform Oversight Committee decision-making and did not represent final decisions on specific activities. The priority categories are:

- Population estimation, modeling, and data collection
- Fatality estimation, modeling, and sampling
- Bat behavior at the turbine- or facility-scale
- Bat behavior at the landscape-scale
- Operational minimization
- Deterrent technologies
- Other issues: expand network of international partners, monitor offshore wind development, dissemination and training, pre-post construction fatality risk relationship, explore policy options for implementation of practicable impact reduction strategies, monitor distributed wind development

1.0 Introduction

The Bats and Wind Energy Cooperative (BWEC or Cooperative) is an alliance of experts from government agencies, private industry, academic institutions, and non-governmental organizations that cooperates to develop and disseminate solutions to reduce to the greatest extent practicable or, where possible, prevent mortality of bats at wind energy facilities.[1]

The BWEC is overseen by the American Wind Energy Association (AWEA), the Association of Fish and Wildlife Agencies (AFWA), Bat Conservation International (BCI), the National Renewable Energy Laboratory (NREL), the U.S. Department of Energy (USDOE), the U.S. Fish and Wildlife Service (USFWS), and the U.S. Geological Survey (USGS). BWEC seeks solutions to identified problems and to provide scientifically credible recommendations for standardizing protocols, methodologies, and research designed to reduce risk to bats and support long-term, responsible wind energy development.

The BWEC is managed by a Program Coordinator (BCI), with direction from an Oversight Committee. 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 objectives.

Members of all three BWEC Committees met at the National Wind Technology Center in Boulder, Colorado from June 5–7, 2018 for the *BWEC 5th Science and All Committees Meeting*. The meeting purpose was to examine progress of the BWEC, review existing impact reduction strategies, discuss emerging issues, assess the effectiveness of BWEC, and establish priorities for the Cooperative. Invited speakers offered presentations and participated in conversations on population analysis, fatality estimation, impact reduction strategies, and bat behavior and migration. Patrick Field and Rebecca Gilbert, of the Consensus Building Institute, facilitated the meeting.[2]

The lists of priorities produced 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, financing, or roles and responsibilities. Furthermore, these priorities are intended for stakeholders as a whole, and BWEC itself does not and cannot implement all priorities.

This document is a summary of the BWEC meeting, including presentations, discussions, and 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 at: www.batsandwind.org.

[1] The first two paragraphs of this introduction are taken from the BWEC Charter, as revised in April 2017.

[2] See the Final Participant List, included as Appendix 1.

2.0 Overview and BWEC Research

2.1 Industry challenges and opportunities related to bats

Michael Speerschneider (AWEA) described the history and current state of wind energy development in the United States. The wind industry is growing quickly. There are over 500 wind-related manufacturing facilities in 43 states, employing over 105,000 people. The Renewable Electricity Production Tax Credit (PTC) has aided this growth, however, installations may decrease in the future as the PTC ramps down. New agreements to secure power are being explored as utilities and private corporations seek to diversify their energy portfolios.

Projections of wind energy growth by 2030 indicate potential overlap with the ranges of multiple species of concern. The issue is that there is uncertainty in defining risk and regulations do not necessarily account for the overall benefits to the species. This can result in costly impact mitigation or prevention measures that could significantly lower the return on investment (ROI) of a project and could make it more difficult to attract investors for new projects.

Mr. Speerschneider described seven areas of challenge and opportunity to discuss wildlife and siting for the industry:

- Research and analytics
- Communications
- Policy and regulatory
- Federal affairs
- Standards
- Legal
- State affairs

Mr. Speerschneider highlighted the Wind Wildlife Research Fund (WWRF) as an opportunity to leverage existing research entities to focus on developing cost-effective solutions. The WWRF will support solutions-orientated scientific research through collaborative funding. This funding will come primarily from three sources: (A) WWRF members fees; (B) project-specific funds from a subset of participating WWRF members; and, (C) other contributors such as the U.S. Department of Energy (DOE), foundations, and NGOs. The AWEA Board supports this effort. Details and partnerships are still being worked out. AWEA hopes to have this fund online by 2019. Its next steps include:

- Recruiting members
- Discussing “organizational details”
- Identify research needs
- Raise funds for research

Meeting participants discussed the following issues

Communicating challenges and successes: The wind industry cannot be the only entity talking about efforts to reduce wildlife impacts; it is not the sole source of wildlife impacts and zero impact is not achievable. The industry needs to communicate actions that have benefited wildlife. It may be incumbent on NGOs and other "neutral" entities to communicate what the industry is doing to reduce wildlife impacts and how any impacts from wind relate to overall species health, so the information is not discounted.

- Operating at low speeds: Industry is beginning to develop projects in areas with lower wind speeds and operating in times with lower wind speeds. These technology and operational changes may put bats at more risk.
- Tradeoffs between monitoring and operational mitigation costs: Could permitting requirements be changed to allow some monitoring funds to be transferred to wildlife conservation? The concern is excess monitoring costs that provide little clear new information or value to wildlife conservation.

2.2 BWEC review and current research (2015–2018)

Cris Hein (BCI) reviewed research priorities identified at the 2015 BWEC workshop and what steps had been taken to address these priorities in the intervening three years. The research priority categories included:

- Pre- and post-construction monitoring
- Fatality estimation and monitoring
- Bat behavior at various scales
- Operational strategies to reduce impact
- Ultrasonic acoustic deterrents
- Population estimation and modeling
- International and emerging issues

Workshop participants then discussed where the collaboration has made progress and where it has encountered barriers:

Progress made

- Learned more about deterrent options.
- Developed a new fatality estimator.
- Compiled impact reduction strategies. This effort can help communicate BWEC's progress.
- Continued to find common ground (e.g., partners learning how to coordinate site access for researchers on private land).
- Learned more about curtailment strategies and deterrents, particularly their costs and financing. BWEC has helped make these strategies more palatable to industry and more effective for conservation goals.
- Advanced knowledge about the potential impacts of offshore wind energy development on bats.

Barriers encountered

- Gaining a better understanding of how impact reduction strategies are being implemented across the industry, rather than site-to-site. What is the path to broad-scale implementation?
- Development of a decision support tool to help ease complex trade-offs.
- Developing a decision process for ending BWEC projects/efforts that are not yielding results. For example, at what point should BWEC decide certain deterrents will not work and re-allocate that funding elsewhere?
- Clarifying the economic goal needed for industry to implement impact reduction technologies. BWEC should support research that moves technologies closer to implementation.
- Understanding the implications of an industry that is moving into lower wind speed areas and intermittent wind areas.
- Exploring options as older wind farms are redeveloped with newer technology (i.e., repowering).
- Answering remaining questions about specific drivers of mortality and how a better understanding of drivers can inform impact reduction strategies.
- Gaining a better understanding of how fatality rates vary between turbines with different ramp-up profiles.
- Gaining a better understanding of the management goal and offset options. How can industry address conservation needs without reaching a zero-take limit, which is highly infeasible?
- Understanding the full impact of wind energy on bats and solving the population viability analysis challenge. Need to know current bat population sizes and understand the proportion of bats killed across the U.S. to determine a viable take level.
- Collaborating more with Canadian and Mexican researchers to better understand population trends across North America.
- Understanding at what spatial-scale bats are attracted to wind turbines.

3.0 BWEC and Partner Updates

BWEC committee members and invited speakers provided presentations to update meeting participants on BWEC progress and new developments. Each set of presentations was followed by a facilitated discussion, in which participants asked questions, made comments, and offered suggestions.

3.1 Population analysis of bats

3.1.1 Regulatory status of bats, WNS update, and regulatory challenges

Rachel London (USFWS) presented a status update on the spread of White-Nose Syndrome (WNS) in U.S. bat populations and the regulatory status of two bat species. WNS is diagnosed by the presence of lesions caused by a psychrophilic fungus named *Pseudogymnoascus destructans* (Pd). Few wildlife diseases have affected as many species over such a large geographic area, in such a short period time, with as much impact on populations. Since the first official identification of the disease in 2007 in New York State, WNS has reached bat colonies from Newfoundland to Washington State. In total, 10 species have been confirmed with WNS in North America. An additional five species have been found with Pd on them but without documented disease. Pd has been found on both hibernating and migratory bats. Little brown, northern long-eared, and tricolored bats have exhibited the greatest declines in affected areas. Disease models predict the continued spread of WNS across North America with all hibernating bat species potentially at risk. The long-term impacts to bat population dynamics are uncertain.

U.S. coordination around WNS happens at multiple levels and with federal partners in Canada. Both countries have developed their own National Plans to organize their responses to WNS. USFWS leads the U.S. national response. The primary areas of response are:

1. *Containment* – Slow the spread by reducing risk of human-assisted transmission.
2. *Management* – Focused on “treatment” (e.g., vaccines, antifungal applications).
3. *Research* – Improve our understanding of disease mechanisms to facilitate conservation.
4. *Outreach* – Inform natural resource managers, the public, stakeholders, and the conservation community.

In a related effort, the North American Bat Monitoring Program (NABat) is a continent-wide program to monitor bats from local to range-wide scales, which grew out of the WNS National Plan. This program provides reliable data to promote effective conservation decision-making and long-term viability of all bat populations.

This unified and collaborative WNS partnership has made tremendous progress since 2007. They understand many risk factors of WNS and have a variety of tools being tested and applied in the field to conserve the most susceptible bats. This collaborative model is being used as a model for other networks to address wildlife fungal outbreaks. USFWS is working to improve communication and coordination between WNS researchers and bat-wind energy researchers.

Only two bat species are listed on the National Listing work plan:

- *Tricolored bat* – USFWS received a petition for listing this species in June 2016. The agency is conducting a species assessment and is still accepting information for this document. The revised National Listing work plan projects a 2023 listing decision.
- *Little brown bat* – USFWS has not received a petition for listing this species. Without a petition, the agency has discretion to assess a species status. The little brown bat may be included on the National Listing work plan at the agency’s discretion.

3.1.2 Potential population effects of wind energy development on bats

Winifred Frick (BCI) presented the results of a 2017 paper on potential population impacts to hoary bats from wind turbines. The paper sought to answer the question, “Do fatalities from wind turbines threaten population viability of bats?” The paper focused on hoary bats because they have the highest reported fatality rates, yet basic demographic rates and population size are unknown. This gap is because they are hard to study because of their roosting and migratory behaviors.

In 2014, USFWS led an expert elicitation workshop to estimate continental population size and demographic rates (survival and fecundity). These estimates fed into a model – described in the 2017 paper – that estimates the population-level impact of wind turbine mortality on hoary bats. The model employed two key assumptions about fatality rate: (1) fatality rate of 128,469 bats/year; and (2) fatalities held constant at 2014 MW capacity levels. The model did not account for increasing capacity or minimization. The model generated projections for four metrics for hoary bats:

1. Population stability
2. Population declines
3. Population persistence
4. Probability of extinction

Model results indicated that annual population growth rates must be higher (approximately 6% per year), especially at low population sizes, to compensate for mortality associated with wind energy turbines for populations to remain stable and persist. The 2017 paper concluded that over a range of realistic possibilities, current levels of fatalities from wind turbines can cause substantial and rapid population declines and an increased risk of extinction. If there are 2.5 million hoary bats and the population growth rate is 1%, this could result in a 90% decline in population in 50 years.

Next steps for this research effort are to try to answer the following questions:

- How much does future build-out change the forecast?
- Can minimization (curtailment, deterrents, siting) change the forecast?
- By how much do we need to reduce fatalities?

3.1.3 Additional indicators of bat population size

Erin Baerwald (University of Regina) and Robert Barclay (University of Calgary) presented results of on-the-ground efforts to determine if populations of tree-roosting bats are declining. Research focused on three species of tree-roosting bats (silver-haired, eastern red, hoary) because of the estimated 500,000 annual fatalities, of which 79% are migratory tree-roosting bats. These bats, as well as aerial insectivores, face four primary challenges: climate change, habitat loss, pesticide use, and wind energy. The study controlled for operational changes by only including sites in their dataset that held operations constant.

To study population trends of the 3 bat species, researchers looked at four metrics: fatality rates at wind turbines over time, capture rates, acoustic detection rates, and rabies submission rates. Hoary bat results showed a 32% decline in fatalities at sites, more declines than increases for capture rates and acoustic detection rates, and a 76% decline in rabies submission rates. Eastern red bat results showed a 40% decline in fatalities at sites, more declines than increases for capture rates and acoustic detection rates, and a 58% decline in rabies submission rates. Silver-haired bat results showed a non-significant 7.3% decline in fatalities at sites; mixed, non-significant results for capture rates and acoustic detection rates; and a 58% decline in rabies submission rates. Overall, the study found mostly significant declines of fatality rates at wind turbines over time, mixed results for capture and acoustic detection rates, and declines in rabies submission rates for all three species. These results suggest background levels of population decline in hoary and red bats and unclear trends for silver-haired bats. These results indicate that the Frick et al. (2017) model, which assumes increasing populations, may be too conservative.

<u>3.1.4 AWWIC database</u>

Taber Allison (AWWI) described the American Wind Wildlife Information Center (AWWIC) database and presented some results of data aggregation projects to date. This effort has not moved toward analysis, modeling, or cumulative assessments yet. The database has public and confidential sides and includes all data associated with a post-fatality study (e.g. carcass counts, search efficiency, carcass persistence). Confidentiality concerns are slowing the addition of site-specific location data. As a workaround, the database is using USFWS regions to show data. There are 22 species in the database thus far. The database currently contains only U.S. species. The database can support research on regional variation in bat fatality species composition and within-region variation in fatalities, although it does not contain data on per species fatality data. AWWI published a technical report in August 2018 (https://awwi.org/resources/awwic-bat-technical-report/). Now that the database is up and running, there are opportunities to re-visit old research questions (e.g., fatality rate calculations using GenEst).

<u>3.1.5 Discussion and tentative priority objectives and research needs</u>

- Role and jurisdiction of BWEC – What is BWEC's proper role? When does BWEC step in and/or lead on an issue? BWEC also plays a role by setting priorities and coordinating research. This can help encourage others, such as university researchers, to work on the topics BWEC prioritizes. State agencies may not have this capacity.
- Refining the population impact model – Can the model include parameters related to minimization, increased capacity, habitat loss, climate change, and pesticide use? If so, is this where resources would be best spent? There may be a bigger pay off for pursuing minimization and mitigation options than parameterizing this model.
- Need for management goals – It is hard to set targets and draft strategies if the management goals are not clear.
- Research as mitigation – Is research a mitigation tool for wind? Would regulators allow industry to bring resources toward WNS research as mitigation? Industry may be more willing to partner on this research if there was a regulatory path for it.
- Behavior modifications versus declining populations – Is there any indication that we can differentiate behavior modifications from declining populations? *The three metrics indicate fewer bats are being detected. The most parsimonious explanation is that there are fewer bats to be killed; many things would have to happen for bats to change their behavior at the population-scale. Thermal studies are not suggesting that bats change their behavior, although these observations are limited to the turbine-scale.*
    - Some research shows bats may perceive turbines as resources – could this be a mechanism for learning?
- Bat ages – We need more information about what age bats are being killed (e.g., juveniles, breeding adults). Few studies have separated these out.
- WNS data complication – Does WNS complicate the results for rabies submission rates impacted because there were more submittals in the northeast during this time period?

We can use little brown bats to calibrate the results. We saw that the proportion of migratory tree bats was smaller proportion of the submittals.

- Genetic tools to estimate population size and historic variation – What role could BWEC play in moving genetic analysis approaches forward and should it list genetic approaches as a research priority?
- Need for coordination around tissue samples for DNA analysis – BWEC could help coordinate a sample collection network. BWEC would need to prioritize this to move it forward. Costs would include paying a program manager, genetic analysis costs, freezers, cross-border permits, and database maintenance. Location data for samples would be needed to fully utilize this approach.

3.2 Fatality estimation

3.2.1 Generalized fatality estimator (GenEst)

Manuela Huso (USGS) presented on the development of a generalized fatality estimator called GenEst. GenEst can help address the major challenges of estimating detection probability and accounting for non-detection. An unbiased estimator can help researchers (1) test efficacy of methods to reduce fatality, (2) predict fatality from pre-construction or post-construction data, and (3) estimate population-level effects. After years of different researchers creating their own estimators, GenEst was developed collaboratively to give users one estimator, relieving confusion over estimator choice. This estimator allows users to compare different model results to each other and choose the model they want to use. It allows for direct comparisons between sites, turbines, and species groups. The tool guides the user to select the best assumptions for their project and provides a flexible output. There is no need for a substantial change in data collection methods when using this tool. The estimator can be used for a variety of applications including solar, power lines, and bycatch. The tool, however, does not give evidence of absence. Detection rate for an individual is carcass-specific because the probability of finding it depends on its size and color, the conditions when it was found (e.g., vegetation, season), and how much time has passed since the last search. Next steps include beta testing, adding the DWP module (which is currently input by the user), comparing GenEst to other estimators, and translating the tool to other languages for more global use.

3.2.2 Protocol for fatality monitoring using roads and pads

Manuela Huso (USGS) presented a proposal to develop a standardized protocol for collecting fatality data on the roads and pads (R&P) around wind turbines. This proposal seeks to address three existing data challenges that are preventing researchers from knowing which bats are most affected by wind turbines: (1) available data is not representative, (2) available estimates do not cover the same area and have different searchable areas, and (3) available estimates are based on different and sometimes inappropriate assumptions. A new approach to monitoring fatalities could result in a representative sample of the facilities in the US as wind power increases, enabling an unbiased estimate of fatality from this representative sample of facilities.

The proposal for a standardized R&P protocol would entail:

- Search every road and pad of
    - Every turbine

- At every facility
- Every 7 days (+/-)
- All year (+/-)

- Conduct Searcher Efficiency and Carcass Placement trials only on roads and pads
- Standardize data collection forms
- Standardize trial protocol
- Standardize search protocol
- Submit data to a public repository

This protocol would yield a representative sample, use newly developed tools (e.g., GenEst), have better annual coverage, have accurate spatial coverage, and be less costly than the current protocols. In short, it would generate usable information with less effort. Industry-wide advantages of using this protocol include:

- Highest detection per area searched
- Trials in only one visibility class (how terrain affects visibility of carcasses) saves money
- Unbiased estimates of fatality
- Full coverage of turbine population
- Spatial and temporal patterns can inform siting
- More easily standardized across facilities

<u>3.2.3 Discussion and tentative priority objectives and research needs</u>

GenEst

- How will GenEst users report their decisions about which models they selected to regulators? *A user could provide the model results generate by the tool. If they chose a model the tool did not select, they would have to justify this choice to regulators.*
- The Department of Energy likely has translation resources and connections with international statisticians to verify the GenEst translation is done correctly.
- Can you use past data to see if the GenEst tool works, potentially to standardize older data? *We are working with West and BCI to assemble datasets to test this.*
- We should beta test the GenEst tool and revisit it as a group in a few years.
- BWEC should track how the GenEst tool is used in the field and who is using it. Adoption is key.
- GenEst could possibly provide some information to stakeholders on siting projects to reduce bat impact. One option would be to reanalyze older studies using GenEst to determine habitat types or regions that have higher versus lower fatalities.

R&P protocol

- Does the facility size factor into fatality estimates using the R&P protocol? *No, you would search each R&P regardless of the number of turbines. The difference would be in the trials.*
- How would this protocol apply to sites with few mortalities and few turbines? *The results would have a large confidence interval but it would give us a ballpark estimate of whether that site is of concern. The advantages probably outweigh the downsides.*

- Would carcass persistence be lower on R&P than in vegetation? *Possibly but it's harder to find carcasses in vegetation. You could adjust your search frequency to address the persistence problem.*
- Is this protocol designed for compliance or non-compliance monitoring? *It could be used for compliance monitoring. This protocol could be useful if everyone used it and regulators were willing to integrate regionally across facilities.*
- Pitching industry management on this protocol could be challenging. Costs and effort vary for activities related to the WEGs and permitting compliance. Companies may not want to pay for monitoring species they don't have to address. The value proposition of this protocol seems to be estimating what population effects are resulting from wind turbines and how we could collectively use this information to inform siting and operational strategies.
- Is there still a weak correlation between pre-construction bat behavior and post-construction fatalities? *Yes.* But if the dynamic doesn't change, why should those resources go toward monitoring instead of conservation? If we identify a pattern, shouldn't that be enough? *We are still having difficulty measuring the effects of minimization strategies, so we need tools to measure their effectiveness. There is value in monitoring.*
- Can you determine evidence of absence with the R&P protocol? Companies are always concerned with permit compliance. *This tool would work for a world where compliance was monitored regionally, not just at the facility level. Evidence of absence would not be required at that point because the estimates would tell us if we are approaching the limit of allowable kills. If more bats were killed than the permitted number, adaptive management strategies would be triggered for all of the sites, not just the site where the most recent bat was killed.*
- How does the R&P methodology account for potential biases for prevailing wind direction? *We have models that interact with the wind direction and rely on facilities with roads coming from different directions. This protocol would probably not work if all the roads ran in the same direction (e.g., east to west).*
- How does this protocol dovetail with the AWWIC dataset? At what point is additional data needed? Would past R&P data be invalidated as turbine technology changes? *If the AWWIC regional estimates show bats are congregating in an area, we can look for patterns in those turbine types, siting, etc.*
- The R&P protocol could work for WEGs and possibly birds.

3.3 Bat behavior and movement patterns

<u>3.3.1 Using infrared imaging to study behavior of bats near turbines</u>
Paul Cryan (USGS) and Michael Schirmacher (BCI) presented a status update on the development of infrared imaging technology for tracking bat activity around turbines. Their research goal is to develop practical, long-term, cost-effective methods for tracking seasonal and nighttime activity around turbines. After experimenting with different equipment and positioning, they found that thermal imaging surveillance cameras mounted on the turbine pile generate a robust dataset. Current work is focused on trying to automate data processing and set validation procedures. Thermal imaging yields a higher detection rate, is cheaper than field

counts of fatalities, and produces comparable, temporal, and seasonal resolution, but requires extensive processing of large amounts of data.
This technology is also being used to track bat activity around a turbine in 3-D. It was originally designed to assess how bats were responding to deterrents but it has many other applications including:

- Understanding how bats approach wind turbines
- Locating fatalities on the ground
- Improving understanding of species-specific activity (when combined with acoustics)
- Detecting strikes at onshore and offshore wind turbines
- Matching bat activity with time, temperature, wind speed, etc.
- Refining curtailment strategies
- Informing deterrent placement decisions
- Developing and Informing risk models
- Comparing turbine models

Acoustic data can also be paired with thermal imaging to improve our understanding of vocalization patterns and refine acoustic technology.

3.3.2 Current understanding of bat movement patterns and methods to track bats
Ted Weller (USFS) presented data collection techniques he and Liam McGuire (Texas Tech University) are using to study bat migration. Information about bat movement is important for siting decisions and assessing cumulative risk faced by individual animals. Current understanding of tree bat migration is based on Paul Cryan's 2003 paper that used museum records to generate hypotheses about the timing, location, and routes taken during seasonal movements. This work, however, has some limitations. To build a better picture of migration, Ted and Liam suggest employing a variety of different techniques and technologies:

- Automated radiotelemetry https://motus.org/ (Some of these systems can be used to study a variety of animals [e.g., eagles, bats, antelope], spreading costs over a number of different studies)
- GPS tracking for larger bodied species
- Mark/re-sight or recapture
- Passive acoustic records (The Bat Acoustic Monitoring Portal (BatAMP) is a user-friendly resource for archiving the results from any type of acoustic monitoring.)
- Compiling and visualizing capture and fatality records
- Endogenous biomarkers such as stable isotopes in bat fur

As these techniques and technologies are further refined, and data sources are compiled, researchers need to determine if their data can show generalizable movement patterns with management applications. Ted emphasized that researchers can use some of these datasets to see the big picture of migrations while also tracking individual movements to understand finer-scale patterns. This information could be useful for refining fatality reduction strategies or to inform project siting.

3.3.3 Discussion and tentative priority objectives and research needs

- Where should money and time be spent for these different monitoring methods and what is the best sequencing?

- What is the value proposition for industry to help fund this research? Is there a value in knowing this information for industry? Industry would be interested in knowing what the conditions were for high fatality events. Industry is less concerned about where bats are found. Temporal migration may be of interest to industry because it may be able to inform smart curtailment. Industry could help coordinate data collection.
- Radiotelemetry receivers could be installed on met towers to gather data on movement and potential risk questions.
- BatAMP can add value to acoustic surveys. Movement data may allow us to decide we don't need to collect additional data and can shift that funding elsewhere.
- A major impediment to using facilities for migration data collection is the researchers themselves; it's a lot of effort. BWEC can help by providing information on the best methods to use.
- We need better information on bat routes and established corridors. What is the threshold for an established corridor.
- Even if a method doesn't have clear applications today, researchers should continue to development work where possible. As offshore wind deployment ramps up, we should have a research system ready to go.

3.4 Offshore wind energy development and bats

<u>3.4.1 Bat activity patterns offshore</u>

Trevor Peterson (Stantec) presented an overview of known offshore bat activity and recommendations for industry and researchers to consider as offshore wind energy facilities are built out. Historic literature has scattered accounts of bats offshore that extend back to the 19th century. These bats were long-distance migratory species and were often found in the fall, though not associated with storms. Regional acoustic monitor arrays in the Great Lakes, Gulf of Maine, and the mid-Atlantic – in addition to surveys on NOAA research vessels – provide more information about offshore bat activity. Overall, researchers recorded over a half million individual detector passes and categorized 340,000 calls to species or species group. Levels of activity were highly seasonal with most (86%) of detections occurring between July 15 and October 15. Bat activity decreased as the distance from mainland increased and most activity occurred during warmer temperature periods with low wind speeds. Most nights, however, had no activity, indicating how infrequently risk appears to occur in offshore regions. Each of the three species of tree bats surveys showed somewhat distinct trends in when they were active.

During construction of the Block Island Wind Farm (~6.1 km off coast), acoustic detectors were deployed from August 2–17 on two jack-up vessels. During that time 1,546 bat passes were recorded, with up to 596 passes recorded during a single night. Activity occurred almost exclusively during nights with low wind speed and warm temperatures (>64 °F). 85% of calls were assigned to a species. Of those, eastern red bats accounted for 90%, hoary bats accounted for 9%, and silver-haired bats accounted for 1%. One pass was labeled as a big brown bat and no passes were identified as *Myotis*. Following construction, detectors and a combined radar/thermal-daytime camera system were deployed on some of the turbine platforms. The overall purpose of the system is to detect collisions and (as able) assess local behavioral adaptations to the turbine structure. These data were collected in January and the results of the analysis were only recently submitted for review. Nanotags (MOTUS) have also been used to track bat activity offshore in recent years.

These data and monitoring networks could be used in an adaptive management process to better manage collision risk at offshore wind farms. As onshore, the presence of spinning turbine blades poses a risk of collision, but they also likely provide a unique source of attraction. The greater the isolation of the site, or distance from shore, the more risks are diminished. New structures in the offshore environment, however, may create a different risk due to this attraction. Offshore turbines do not appear to pose a continuous, year-round risk to bats. Most importantly, any period of bat activity – or risk – can be further narrowed to times of specific low wind and warm temperature weather conditions.

Outstanding research questions include:

- Are bats attracted to the turbines and how might attraction contribute to fatalities?
- What is the magnitude of offshore fatality?
- Do larger turbines increase collision risk?
- Does risk vary with project size?

To answer these questions, Trevor made the following recommendations:

- Assess risk (bat presence and fatality) during the installation of wind turbines (e.g., does risk increase once a turbine is operational?)
- Expand nanotag survey (MOTUS) effort
- Conduct regional acoustic surveys in the Pacific, Gulf of Mexico, and Hawaiian coasts
- Install and maintain long-term acoustic monitoring stations
- Develop options for adaptive/risk management.

A Department of Energy report on this monitoring data is available at: http://tethys.pnnl.gov/publications/long-term-bat-monitoring-islands-offshore-structures-and-coastal-sites-gulf-maine-mid.

Participants offered the following questions and comments in the discussion:

- Did you see a difference in passes between types of detectors (e.g., ships, buoys)? *There is less frequent bat activity where no land exists; we see more passes when there is some structure in the environment.*
- We need to know what scale of attraction is happening.
- We need to know the fate of these bats. Nanotags can tell us more than acoustics. It can help us tease out migratory patterns versus resident activity.
- What can we learn about bat migration from the three regions? *The sites we used limit the conclusions we can draw. Individual sites can influence results.*
- What research on this topic is being done in Europe? *Some work has been done in the North Sea with acoustics, but I don't know of much fatality data. Research has mostly focused on birds because detecting bat fatalities require particular cameras. Europe's regulatory regime does more predictive, conservative modeling for collisions. If the risk is acceptable, they do not require monitoring.*
- Are these bats overshooting the coast, or are they just getting lost? *We've tried to look at timing to see if there are patterns. We did see a pattern of bats arriving and stopping*

over for the day. We did not see bats only arriving far offshore late at night. The consistency with which they show up suggests it is not an accident. Perhaps bats are following the food.

- We need more research on whether bats are being killed by offshore turbines.
- We need more research to assess the potential of predicting risk offshore, given that it seems offshore activity is infrequent, it may also be focused and, therefore, predictable based on weather.
- We could possibly look to bird research to better understand where bats are going offshore.
- I am concerned bats are not being considered during the rapid development of offshore wind. I rarely see information about bats at offshore wind conferences. *I think they are being considered, DOE has done some research, and we work closely with BOEM and other agencies. USFWS is working on some offshore guidance and bats are included in that document. We should see what data are available in the MARCO and NROC data portals.*
- Do we have any idea of the anticipated magnitude of risk with a full offshore build out? *This is an open question.*
- Does BWEC need to increase its coordination about offshore wind?

3.5 Operational minimization

3.5.1 Overview of operational minimization

Michael Schirmacher (BCI) gave an overview of operational minimization. In 2013, Arnett et al. summarized ten operational minimization studies and found a potential reduction in bat fatalities by feathering prior to generating electricity and reductions when cut-in speeds are increased by as little as 1.5 m/s. Subsequent studies have sought to clarify the cost and attempt to make operational minimization more cost-effective. Studies tested how facilities could use wind speed, wind direction, and temperature to practice informed operational minimization. Studies have also sought to develop an operational decision framework.

Researchers found that “traditional or blanket” operational minimization was effective and generally resulted in <1% power loss, and current smart curtailment strategies (e.g. windspeed and temperature) can reduce fatalities, though with annual power loss up to 1.20%. Some curtailment strategies result in a higher loss in annual power production and but did not lower fatalities significantly. AWEA best management practices call for feathering turbine blades up to the manufacturer’s cut-in speed, particularly into the fall when temperatures are above 10 degrees Celsius. There is limited data indicating the effectiveness of this strategy. A study in Indiana reported an average 36% (12.4–53.8%: 90% CI) reduction in bat fatalities when feathering turbine blades up to the manufacturer’s cut-in speed. However, there was no observed reduction for hoary bats. In addition, this strategy likely varies by turbine model, and is unlikely to reduce fatalities for turbines that are already designed to be feathered to the cut-in speed (e.g., GE, Mitsubishi). More information is needed to relate effectiveness of operational minimization for individual species. Data will likely need to be pooled because of a limited sample size. Some work has been done to tally fatalities of endangered species, threatened species, and species under review for different operational minimization treatments.

3.5.2 Cost of feathering and raising cut-in speeds

Chris Farmer (DNV GL) presented the results of studies looking at the costs of feathering and raising cut-in speeds. Studies found that moving to higher cut-in wind speeds significantly increases energy losses. The impact is greater at low wind speed sites where more time is spent at curtailed wind speeds. Technology advances and cost reductions mean lower wind sites are being developed, which could result in larger equivalent energy losses due to bat curtailment. Project owners must also contend with seasonal and diurnal wind resource variations and power price variation which add variability to the revenue implications of curtailment.

Key factors affecting operational bat curtailment losses are:

- Bat curtailment regime (e.g., cut-in wind speed, seasonal coverage, temperature parameters)
- Mean wind speed of project
- Wind resource available during curtailment
- Energy price during curtailment.

Observed operational data covering 15 project years showed annual production losses up to 3.5% at varying cut-in speeds. Data suggest reduced incremental fatality reductions with cut-in values above 4.5 m/s. These projects are also vulnerable to site-specific factors. This analysis was run for a small number of farms with fixed pricing. To understand the true range of revenue loss, this analysis should also be run for farms with real-time pricing. Regardless of the market (fixed Power Purchase Agreement or merchant), the cost of energy varies by site, so revenue losses will depend on the value of the power the site gives up when it curtails.

This research generates two key questions:

- Can smart curtailment strategies help minimize fatalities and energy losses?
- How do we minimize the overall environmental impact (i.e., balancing fatality reduction with greenhouse gas emission)?

3.5.3 Peak fatality analysis

Manuela Huso (USGS) presented on efforts to develop an algorithm to improve operational curtailment (i.e., smart curtailment). The research objective is to minimize bat fatality while maximizing power generation. The study looked at the number of carcasses found daily for 15 non-curtailed turbines from April to November 2013. This yielded a calculation of carcasses/turbine/night. Categorical and Regression Trees (CART) was used to spilt data by explanatory variables to maximize distinction in response (carcasses/turbine/night) between two parts: current night and prior night. The explanatory variables included wind speed, temperature, precipitation, and barometric pressure. Note that the study assumed curtailment occurred all night and power loss was calculated with that assumption. The researchers looked for indicators of “high risk” nights and power losses if the turbines had been curtailed during high risk nights. This strategy can be tested on existing datasets that meet certain criteria (e.g.

daily searchers for at least 2 years that identify fresh fatalities). Industry may be able to use this study to inform minimization strategies to be more cost-effective.

3.5.4 Developing algorithms using bat activity and weather

Trevor Peterson (Stantec) presented on efforts to manage the risk of bat fatality with acoustics through bat activity-based informed curtailment. Researchers and industry want a cost-effective curtailment strategy, so it can be widely implemented. Currently, fatality data are costly and coarse (i.e., temporally imprecise and imperfect detection rates). Different data is required to improve the understanding of the mechanisms influencing risk to bats in the rotor-swept zone. Acoustics are ideally suited for adaptive management. Acoustic bat detectors provide an efficient, inexpensive way to determine precisely when bats are active near the rotor-swept zone. This time stamp allows researchers to compare bat activity with variables like temperature and wind speed. If relationships between these variables are sufficiently consistent, researchers can accurately predict risk based on the time of night, temperature, and wind speed – metrics which are already measured at each turbine and which are substantially easier to monitor than bat activity.

Between 2011 and 2015, researchers proceeded through a series of iterations of curtailment design, evaluation, and validation using cumulative acoustic datasets. These datasets were used to predict the percentage of bat passes that would be protected each year based on a particular curtailment plan. They found that predicted and actual exposure of bat activity to turbine operation were closely aligned. They also demonstrated that the amount of exposed bat activity during an interval of time was a significant predictor of the probability of finding a carcass during turbine searches following the interval. This suggests that industry may not need to monitor real-time risk; rather, they can use the past year's risk patterns. Results suggest that exposed bat activity is a valid measure of risk. The relationship of bat activity to temperature and wind speed was highly stable from year to year; most activity occurred at lower speeds and higher temperatures.

This research produced a template for activity-based smart curtailment. This curtailment strategy would entail assessing the distribution of activity (and risk), optimizing curtailment to target high risk, and predicting and evaluating the effectiveness of curtailment. Curtailment should be matched to bat activity. Operators can compare curtailment options and optimize them to a site using three metrics:

- Effectiveness (number of bat passes protected/total bat passes)
- Cost (power loss due to curtailment + cost of implementation)
- Efficiency (power loss when bats are active/total power loss from curtailment)

Next steps for this effort include studying consistency among sites, spatial and seasonal variations in relationships with conditions, and establishing sample sizes for stable predictions.

3.5.5 EPRI's Turbine Integrated Mortality Reduction (TIMR)

Mark Hayes (Normandeau Associates) presented an overview of the Electric Power Research Institute (EPRI)'s Turbine Integrated Mortality Reduction (TIMR) approach to reducing bat fatalities at wind energy facilities. The TIMR approach combines acoustic information from

Remote Bat Acoustic Technology (ReBAT) mounted on the turbine with environmental information (e.g., wind speed) to make near-real-time risk predictions. The system uses an on-site server to process the acoustic and environmental data, then make risk estimates and curtailment decisions. These decisions are then conveyed to the wind energy facility's Supervisory Control and Data Analysis (SCADA) unit, which implements the curtailment actions. Network security is a key priority for this system.

A field study of the TIMR system in southern Wisconsin yielded the following conclusions:

- TIMR results in significant reductions in all species fatalities
- The system is effective for Myotis (~91% reduction)
- The system is simple and generalizable (statistical models are not necessary)
- Results may vary with how acoustically active bats are
- The system reduced curtailment time by 48% over a "blanket" 7.0m/s curtailment strategy.

EPRI has several proposals for deployments in North America. They are seeking a validation study location/group in North America and are exploring a possible European study and/or deployment through an international partnership with APEM (UK). EPRI is starting to look at how various possible operational minimization approaches compare (e.g., TIMR vs blanket curtailment). The local wind regime and bat species assemblage will be key to these decisions and will vary across ecoregions, and in the offshore environment. Mark is also trying to make his data and code transparent and publicly available.

<u>3.5.6 Discussion and tentative priority objectives and research needs</u>

Major themes of the impact reduction strategies discussion are summarized below:

- How robust does the dataset for mortality reduction need to be? Is it important to know the exact percentage reduction from different strategies, particularly as industry has adopted many strategies already? Is more research worth the money if there is little change and hoary bats are still being killed?
- Industry and BWEC need guidance from regulators on their desired management goals and mortality reduction targets. Regulatory uncertainty is delaying decisions.
- Should curtailment regimes be standardized? Some participants do not think this is worth pursuing because it may be impractical and risk the equipment warranty.
- What role should manufacturers play in addressing fatalities? Manufacturers need to know there is a market for a product or capacity to devote research and development money. There must be a business case.
- How should priorities and resources be allocated between reactive regulatory compliance and proactive conservation? Industry will consider what is cost-effective (e.g., take permit process, curtailment strategy).
- What are the best strategies for industry, given currently listed species and species that may become listed in the future? Also need to consider the implications of future build-out. Industry is doing so much on avoidance and mitigation already – how should they be regulated for listed species?
- What is BWEC's role? For example, should BWEC focus on developing and testing strategies/tools and compiling data sets, and AWEA demonstrates the value proposition

for industry to use these tools? Broad industry adoption requires cost-effective strategies and tools.
- In what situations and for how long is monitoring appropriate and cost-efficient?
- Should voluntary industry implementation of best management practices be tracked and audited long-term?

3.6 Deterrent technologies

3.6.1 GE's acoustic deterrent

Myron Miller (General Electric (GE)) and Brad Romano (Invenergy, LLC) presented an overview of GE's ultrasonic bat deterrent technology. The GE ultrasonic device is a high-speed air jet that provides a wide frequency sound range, broad coverage, and reliability compared to typical electrical transmitter systems. The system can be configured to emit constant and pulse signals to deter bats from wind turbines. 3D thermal imaging data showed that bats that fly through a treated airspace have simpler, straighter flight paths than those passing through the same air space when the deterrent is off. The current noise envelope is 40 m. Carcass data show a 30–40% (90% CI) reduction in all-bat estimated fatality rates, and all study turbines were feathered below cut-in, so the reductions due to deterrence could be in addition to any reductions due to feathering. Tests concluded that the pulse signal system gives similar effectiveness on non-eastern red bats species, but it is more costly, so GE is moving forward with the constant signal system. The prototype system is ready for deployment and can be installed on GE and non-GE turbines. GE's commercialization plan depends on regulatory guidance and market interest.

3.6.2 NRG's acoustic deterrent

Cris Hein (BCI) and Brogan Morton (NRG Systems) presented an overview of NRG Systems' ultrasonic acoustic deterrent technology. Since 2006, BWEC has investigated the potential of ultrasonic acoustic deterrents to reduce bat fatalities at wind turbines. Since 2015, several BWEC studies have tested the NRG Systems' deterrent at three farms in Ohio, Texas, and Ontario. The NRG Systems deterrent device has six frequency subarrays and remote communication capacity to ease the uploading process and run diagnostics. The 2017 study results showed that

- NRG Systems' device eliminated many of the issues from previous generation deterrents (e.g., overheating, water entry), such as those designed by Deaton Engineering.
- Deterrents did not significantly reduce overall bat fatalities; deterrent had the opposite effect on eastern red bats but showed a significant reduction for Brazilian free-tailed bats. Within species, the effects can vary between sites.
- Further research is needed on placement of the deterrents, species behavior and echolocation, and sound pattern and intensity.

3.6.3 Dim-UV light technology

Paul Cryan (USGS) presented on an experimental dim-UV deterrent technology that is in an early testing phase. The motivation for this research is the finding that bats do not appear to be learning from encounters with wind turbines. Something is attracting them to turbines regardless of the deterrents used. This experimental technology is designed to deter bats by changing how they see turbines: dim ultraviolet light is flickered on the turbine tower to indicate, “this is not a tree”. Early tests showed that fewer bats were present when researchers flickered ultraviolet light on landscape structures. This technology is being testing at the NWTC for one year and is using infrared cameras to generate data on bat, bird, and insect interactions with blades.

3.6.4 Deterrent technology synthesis and next steps

Major deterrent technology discussion themes are summarized below:

- DOE is currently funding two projects to see if two different types of deterrents mounted on turbine blades (passive whistle and sound-emitting) are effective.
- Deterrent deployment requires optimizing the air space covered around a turbine. More funding is required to cover all risk areas to determine where deterrents are best placed. Some participants questioned whether this is where money is best spent.
- There is concern that deterrent researchers are “pushing” bats out to the blade tips as they seek to determine the best deterrent placement.
- Could deterrents be tested on smaller turbines to achieve complete air space coverage?
- What other early technology is available but needs support? How can BWEC track emerging technologies? Clarity about regulations is also needed to grow certain technology.
- More research is needed on the results of projects that combine deterrent and curtailment options.
- USFWS may struggle to accept some of these technologies as approved minimization strategies for specific species (e.g. listed species) due to small sample sizes. Researchers should consider conducting species-specific deterrent research.
- DOE supports regular webinars on blade deterrent technology. Jocelyn Brown-Saracino can provide more information on these webinars.

4.0 Priorities for 2019-2021

The draft lists of prioritized actions and activities produced during the meeting were designed to inform Oversight Committee decision-making; this prioritization did not represent decisions on specific projects, plans, roles and responsibilities, or financing. After the workshop was held, the priority tables were refined, and participants had a second chance to rate importance, length of time, and feasibility. Hence, these tables reflect the cumulative sense of BWEC developed at and after the workshop. Comments and themes from the facilitated BWEC participant discussion appear under each priority category.

4.1 Population estimation, modeling and data collection

In 2018, BWEC determined that no population research effort was a top priority. However, the BWEC does believe that until largescale datasets like the NABat are developed, activities like modeling population estimates, genetics, and carcass collection would be useful. BWEC generally supports efforts that consider the possible multiple stressors on bat populations (i.e., wind, habitat loss, climate change, etc.).

Comments from participant discussion included:

- While the industry may not be responsible for establishing better population data, the current lack of reasonable population estimates hampers industry and regulators in knowing precisely how much and to what degree to implement mitigation measures.
- Increasing the “positive” (i.e., curtailment strategies) and “negative” parameters in the population modeling will help increase support for and use of such models.
- Though BWEC should not lead the creation of a unified approach to tissue sampling and storage across projects, it should monitor this effort and provide support where it can, since carcasses are already collected, and if maintained, may offer valuable information in the years to come.

4.1 Population estimation, modeling and data collection						
Priority[a]	**Time[b]**	**Feasibility[c]**	**Objective**	**Action**	**Who**	**Notes**
3	**3**	**D**	*Use population estimation tools to estimate population impacts to better inform the context of turbine-caused bat fatalities and effectiveness of minimization strategies*	• Support the development of new or refinement of existing population models, while recognizing their limitations and estimation capabilities • Include curtailment, existing capacity and build out, non-wind factors and genetic archaic/historic population estimates, where possible, into models to account for the range of parameters. • Estimate population sizes for additional bat species	Bat Community Experts in population analyses	• Better precision of existing or new population estimates • Further conversations on the strengths and limitation of existing publications related to the population level impact of wind energy and other sources
2	**2**	**M**	*Support collection of genetic and demographic data*	• Support the creation of a unified approach to tissue sampling and storage across projects and regions • Track and connect researchers who are focused on genetic analysis seeking to determine species populations	Wind-Wildlife Community	• Data used to refine or create populations estimates which provides context for impacts • Coordinate among researchers to connect and align efforts
2	**2**	**M**	*Synthesize available genetic and population analysis data*	• Summarize existing approaches and what does it take to accomplish each approach • Summarize available data on bat population status and trends	Bat Community Experts in population analyses	• Add gaps in understanding and next steps for research and data collection

[a]Priority: Scale of 1–5, with 1 being the highest priority. [b]Time: Complete within the designated number of years (1–3).
[c]Feasibility: Easy (E), Medium (M), or Difficult (D).

4.2 Fatality estimation, modeling, and sampling

In 2018, BWEC determined two top priorities for fatality estimation, modeling, and sampling. These are advancing the investment in refining GenEst and making GenEst widely available through effective promotion.

Comments from participant discussion included:

- We need to think quickly about how best to socialize GenEst so it is taken up widely across states, projects, and developers. The missing piece may be a “scholarship” fund to help agencies, for example, attend trainings.
- We need to be clear what the goal of a standard sampling protocol would be. Industry is concerned that monitoring for monitoring’s sake will cost money and not help conserve bats.
- The purpose of this work could be to develop a common regional understanding of fatalities to estimate population effects across individual projects and improve the efficiency and effectiveness of sampling in new areas and regions where existing data may not be representative of new conditions, sites, or species. Participants also noted a desire to standardize methods for impact reduction experimental studies; the Sinclair and DeGeorge (2016) paper lays out an approach.[3]

4.2 Fatality estimation, modeling, and sampling						
Priority[a]	**Time[b]**	**Feasibility[c]**	**Objective**	**Action**	**Who**	**Notes**
1	**1**	**E**	*Update the generalized fatality estimator (GenEst)*	• Update with new modules	USGS and GenEst Committee	• GenEst released October 2018. • Add new modules (e.g., Density-weighted proportion calculations
1	**1**	**E**	*Promote use of GenEst*	• Provide rollout and training for GenEst • Follow up after release to assess who is using it, how it is being used and what improvements might be needed	AWWI, BCI, NREL & USGS	• Socialize stakeholders on use and benefits of GenEst • Conduct workshops and webinars to train end users

[3] Sinclair, K, and E. DeGeorge. 2016. Framework for testing the effectiveness of bat and eagle impact-reduction strategies at wind energy projects. NREL technical report NREL/TP-5000-65624.

2	**2**	**M**	*Explore the development of a standard, valid, and efficient sampling method that is broadly applicable to generate comparable data among sites*	• Explore a "roads and pads" search protocol • Conduct an economic analysis to estimate cost implications of wide-spread adoption of such a sampling method • Determine if a road & pad analysis is suitable for rare events	USGS & Wind Wildlife Community	• Intent is to: 1) reduce costs associated with existing monitoring requirements; 2) standardize monitoring protocols across sites; 3) have a valid, replicable tool across international boundaries; and, 4) assess temporal and spatial patterns across projects • As new methodologies are developed, ensure acceptance by the wind wildlife community,
2	**1**	**M**	*Use existing fatality data & continue to collect data to answer large-scale questions (e.g., cumulative fatality)*	• Analyze fatality data across projects from large datasets to aggregate overall fatalities and fatalities across species, regions, and other parameters • Coalesce ideas on how to use data, what data to collect, etc.	Wind-Wildlife Community	• e.g. AWWIC database • Obtain less biased cumulative estimates • Ensure bias data are included (e.g., SE & CP) • How much data are necessary
3	**1**	**E**	*Use GenEst to refine existing data sets*	• Where appropriate, use GenEst to re-estimate fatalities in subsample of reports to increase consistency • Conduct simulations showing how GenEst compares to different circumstances (e.g., high SE, low CR)	BCI, USGS, & AWWI	• Determine how original estimates compare to GenEst results • Not intended to change previous rules or commitments
3	**3**	**D**	*Conduct pre- and post-construction studies in novel circumstances to develop baseline data on patterns of activity and impacts*	• Identify where there are data gaps and conduct studies in understudied regions (e.g., southeast US), offshore, or associated with new technology (i.e., larger turbines)	Wind-Wildlife Community	• What is the impact of new wind turbines and development in new areas where a paucity of data exists
3	**2**	**M**	*Use a systematic sampling framework to randomly sample data for meta-analysis*	• Use NABat sampling framework to select wind energy related data for cumulative analysis	USGS	• Minimizes sampling bias in previous cumulative estimates

[a]Priority: Scale of 1–5, with 1 being the highest priority. [b]Time: Complete within the designated number of years (1–3).
[c]Feasibility: Easy (E), Medium (M), or Difficult (D).

4.3 Bat behavior at the turbine- or facility-scale

In 2018, BWEC determined three top priorities for understanding bat behavior at turbine- or facility-scale. These are developing a decision framework for behavioral studies to prioritize what research questions could or should be answered through behavioral studies, advancing the use of thermal videography to understand bat activity near wind turbines, and monitoring, supporting, and testing strike detection technologies.

Comments from participant discussion included:

- It is important that industry support for such studies be placed in the context of questions that can lead to answering key policy or management questions.
- Efforts should be made to continue to track the development of real-time detection technologies, but BWEC should not make this its own priority.

4.3 Bat behavior at the turbine- or facility-scale						
Priority[a]	**Time[b]**	**Feasibility[c]**	**Objective**	**Action**	**Who**	**Notes**
1	**1**	**E**	*Develop a decision framework for behavior studies*	• Develop a list of research questions for behavioral studies (primarily focused on using thermal video cameras) that are ranked by species, priority and timeframe and what methods/tools or suite of such may be best suited to answer such questions	BCI, USGS, USFS	• Questions include: Can thermal video cameras be used to 1) quantify bat-turbine interactions; 2) compare behavior among treatments or new technologies; 3) correlate observed bat collisions with wind speed, blade speed, temperature, etc.; 4) assess the location of collisions relative to blade length and height, and 5) refine placement and orientation of deterrent technology?
1	**2**	**D**	*Use thermal videography to understand bat activity and behavior near wind turbines*	• Conduct experimental studies to refine how thermal videography can be used to answer specific questions	USGS & BCI	• Tied to #1

2	**2**	**M**	*Refine thermal videography field, analysis, and modeling methodology*	• Refine equipment, methods, processing and modeling, including 3D analysis	BCI, USGS, Univ of Hawaii	• Tied to #1 • Consider how to use in conjunction with other methods (e.g., acoustics or fatality estimation surveys.
1	**2**	**D**	*Monitor strike detection technology or real-time fatality detection studies*	• Follow, support, and test efforts to develop fatality detection tools that can identify timing and conditions of impacts	Wind-Wildlife Community	• Support efforts on integrated detection & strike indication system (e.g., BatFinder, BAMM) • Pair with other technologies to get ID species, etc.

[a]Priority: Scale of 1–5, with 1 being the highest priority. [b]Time: Complete within the designated number of years (1–3).
[c]Feasibility: Easy (E), Medium (M), or Difficult (D).

4.4 Bat Behavior at the landscape-scale

In 2018, BWEC decided to separate bat behavior studies between the turbine- or facility-scale and landscape-scale. The former may lead to potential refined curtailment or deterrent strategies, whereas the latter may lead to potential siting criteria or considerations. The BWEC determined that this is not the highest priority area but tracking and supporting others' efforts to use PIT tags, MOTUS, and other technologies to better understand movement and behavior over the landscape would be beneficial.

4.4 Bat Behavior at the landscape-scale						
Priority[a]	**Time[b]**	**Feasibility[c]**	**Objective**	**Action**	**Who**	**Notes**
2	**2**	**D**	*Increasing knowledge of bats temporal & spatial movement over the landscape*	• Identify studies that advance the understanding of temporal and spatial movements of bats across the landscape to inform minimization strategies • Encourage wind-wildlife community to place MOTUS or other receivers on met towers or other structures on sites to gather movement data across sites • Continue tagging larger numbers of bats, to determine movement patterns and potentially fatality rates	Wind-Wildlife Community Bat Community	• Consider a larger & coordinated effort to purchase and position MOTUS towers • Use PIT tags and provide readers to every wind energy facility conducting monitoring to supplement other means of gathering movement data • Continue to use existing GPS/Geolocater tags to better understand bat movement patterns
2	**2**	**D**	*Increase understanding of landscape-scale features and bat fatalities*	• Compile data to conduct spatial modeling to determine if landscape scale features relate to bat fatalities in predictable and meaningful ways	Wind-Wildlife Community	• May be useful in siting wind energy development in areas of low risk
3	**2**	**M**	*Collect and interpret acoustic data appropriately and include in BatAmp and NABat programs*	• Work with industry, USGS and USFS to provide data collected during pre-construction acoustic monitoring to other efforts	Wind-Wildlife Community Bat Community	• Connect interested stakeholders to address privacy protections. • Noted that models only as good as the input data (i.e., errors in acoustic call detection, etc.)

3	**2**	**M**	*Synthesize available data related to bat movement patterns*	• Use existing publications to synthesize available data on stable isotope analyses, and tracking data related to bat movements across N. America	Wind-Wildlife Community Bat Community	• Associate movement patterns with weather and landscape variables when possible

[a]Priority: Scale of 1–5, with 1 being the highest priority. [b]Time: Complete within the designated number of years (1–3).
[c]Feasibility: Easy (E), Medium (M), or Difficult (D).

4.5 Operational minimization and smart curtailment

In 2018, BWEC determined two top priorities for operational minimization and smart curtailment, given the work done on these strategies over the last several years. These priorities include summarizing the range, effect, and particular context of curtailment strategies, and gaining an understanding of their use and adoption across sites, projects, and the industry as a whole.

Comments from participant discussion included:

- We have a much larger number of projects in place since the BMPs were written and yet do not fully know who is doing what and to what degree. We need a more comprehensive strategy.
- We need to think about more species-specific priorities. For instance, do we want to understand curtailment strategies' impacts on species of concern like eastern red bats and hoary bats, or how these strategies are working in the regions of greatest wind energy development?
- We should consider testing certain deterrent technologies and operational strategies together. Are there meaningfully combined effects?

4.5 Operational minimization and smart curtailment						
Priority[a]	**Time[b]**	**Feasibility[c]**	**Objective**	**Action**	**Who**	**Notes**
1	**1**	**M**	*Summarize results from Curtailment Strategies*	• Summarize effectiveness of operational minimization efforts and studies, uncertainties, co-variates, and variation among species • Assess commonalities and difference among impact reduction strategies with respect to species/regions • Quantify industry implementation of operational minimization strategies • Identify barriers to adoption, and means to increase adoption and use	BCI	• BCI will work with BWEC partners to accumulate data for synthesis • BCI will develop draft and submit to BWEC for review

1	**1**	**D**	*Replicate recent "smart" curtailment studies*	• Expand recent experiments in "smart" curtailment across landscapes, species and turbine models to develop a robust set of conclusions regarding smart curtailment efforts related to reductions in bat fatality and costs • Develop and standardize metrics and parameters for reporting • Refine parameters such as timing, acoustic data (e.g., TIMR), and weather variables related to curtailment, peak fatalities, and peak power production	Wind-Wildlife Community	
3	**2**	**D**	*Verify impact of feathering up to the manufacturer's cut-in speed*	• Study effectiveness of feathering up to cut-in speed for different species and turbine models	Wind-Wildlife Community	
2	**3**	**D**	*Impact Reduction Decision Support Tool*	• Consider feasibility of a support tool to assist in designing practicable operational minimization strategies	AWEA, USDOE, USFWS, BCI	

[a]Priority: Scale of 1–5, with 1 being the highest priority. [b]Time: Complete within the designated number of years (1–3).
[c]Feasibility: Easy (E), Medium (M), or Difficult (D).

4.6 Deterrent technologies

In 2018, BWEC determined three top priorities for deterrent technologies: monitor and support the advancement of deterrent technologies by various other actors, determining the volume of signal coverage around the turbine, and advance our understanding of species-specific effectiveness of deterrents.

Comments from participant discussion included:

- A concern regarding the spatial coverage of deterrents and whether deterrents are keeping bats from the blades or simply shifting bats and their collision risk to the outer portions of the blades.
- We should consider various combinations: combining acoustic deterrent tests with video thermal infrared technology to try and identify specific behavioral changes or testing certain deterrent technologies and operational strategies together.
- We need to understand if deterrents are working, to what extent, and if combinations with curtailment strategies are effective enough to be used for actual conservation. We also need to understand if these strategy combinations will be sufficient for regulators to approve as a strategy in reducing take of species of concern.
- There remains interest in strategies that do not merely reduce bat interactions with turbines but effectively deter them from the arrays altogether (i.e., the potential of dim UV lights).

4.6 Deterrent technologies						
Priority[a]	**Time**[b]	**Feasibility**[c]	**Objective**	**Action**	**Who**	**Notes**
1	**3**	**D**	*Advance deterrent technologies*	• Conduct experimental studies to assess the effectiveness of technologies • Monitor and disseminate emerging technologies	Wind-Wildlife Community	• Enhance studies by incorporating 3D thermal videography
1	**2**	**D**	*Advance understanding of the effective range of ultrasonic acoustic deterrents*	• Work with technology providers to consider cost-effectives ways for greater coverage around the wind turbine • Conduct a study using smaller wind turbines where coverage is complete	Wind-Wildlife Community	

1	**3**	**D**	*Advance species-specific knowledge*	• Encourage and support species-specific assessment of the effectiveness of deterrent technologies • Conduct ground-based studies to determine deterrent effects on specific species prior to large-scale studies	Wind-Wildlife Community	• Given some species may be more at risk and may be managed under different regulatory approaches, it is important to understand species-specific reactions
2	**3**	**D**	*Study effectiveness of combined methods*	• Conduct experimental studies using combined approaches (e.g., curtailment and deterrents OR combination of deterrents to determine optimal combinations for reducing overall fatality or fatality of specific species)	Wind-Wildlife Community	
2	**3**	**D**	*Advance early stage UV*	• Conduct further development and testing of UV technology	USGS	• Follow progress of USGS study at the National Wind Technology Center

[a]Priority: Scale of 1–5, with 1 being the highest priority. [b]Time: Complete within the designated number of years (1–3).
[c]Feasibility: Easy (E), Medium (M), or Difficult (D).

4.7 Other issues

In 2018, BWEC determined that the top priority in this category is to provide education and outreach to the industry, regulators, and consultants to ensure they are aware of the latest methodologies, equipment, and statistical analyses.

Comments from participant discussion included:

- We need to continue to expand our international partners. We could do this by inviting more observers to these meetings and considering our international network for science. Bat populations do not care about political boundaries and best practices – this is dictated more by policy, regulation, and practice within a country or region.
- We are learning more about offshore bat populations and want to make sure BWEC connects with offshore wind developers and regulators to ensure bats are considered.
- Can BWEC play a role in helping regulators understand the limited value of pre-construction monitoring as it relates to predicting post-construction fatality risk, and perhaps help the industry and regulators focus resources on activities that directly affect conservation?

4.7 Other issues						
Priority[a]	**Time[b]**	**Feasibility[c]**	**Objective**	**Action**	**Who**	**Notes**
2	**2**	**M**	*Expand network of international partners*	• Expand international membership on BWEC committees • Conduct webinars for international stakeholders • Participate in key international activities and meeting • Collaborate on research projects	BCI, WREN, Barclay & Medellin	
3	**3**	**E**	*Monitor off-shore wind development*	• Compile research related to bats and offshore wind energy development • Advance monitoring strategies for offshore wind (e.g.., acoustics, thermal cameras and strike detection) • Engage with Offshore stakeholders (e.g., BOEM, offshore developers, states, and Pacific Ocean Energy Trust)	Wind-Wildlife Community	• Use knowledge of land-based impacts to inform potential bat impacts off-shore

1	**3**	**M**	*Dissemination & Training*	• Conduct webinars and training sessions to educate the wind/wildlife community on the latest methodologies, equipment and statistical analyses	BCI, AWWI, USGS, NREL, AFWA	
3	**3**	**M**	*Pre-Post Relationship*	• Reassess pre- and post-construction risk assessment and provide guidance	Wind-Wildlife Community	
2	**2**	**M**	*Explore policy options for implementation of practicable impact reduction strategies*	• Compile policy options worth exploring to incentivize implementation of impact reduction strategies	Wind-Wildlife Community	• Candidate Conservation Agreement with Assurances • Pre-listing Voluntary Agreements
5	**3**	**E**	*Monitor distributed wind development*	• Assess impacts of small-scale wind on bats	Wind-Wildlife Community	

[a]Priority: Scale of 1–5, with 1 being the highest priority. [b]Time: Complete within the designated number of years (1–3).
[c]Feasibility: Easy (E), Medium (M), or Difficult (D).

5.0 BWEC Business

5.1 Making BWEC more effective

Participants engaged in a discussion of what BWEC is doing well and how it could be more effective at advancing wind-wildlife research and collaboration. The participants identified the following successes to date, areas for improvement, and other considerations. Overall, DOE reminded participants that building out an entirely new domestic industry and managing its associated impacts is a multi-decade enterprise and not to be discouraged because in less than one decade all essential questions have not been answered.

Successes To-Date

- Established research priorities
- Identified and tested various solutions
- Stimulated testing and development for several minimization strategies, such as UAD technology.
- Synthesized the state of science
- Developed and supported innovative tools
- Built a collaborative, neutral forum for industry, government, and researchers to talk about site access and identify common challenges
- Drove research to address problems
- Used flexibility to do things government alone might not be able to do

Areas for Improvement

- Disseminating our work (e.g., more frequent newsletter, webinars, webinars summarizing BWEC workshops, website upgrade, broaden distribution list, present at meetings)
- Finding a broader audience for the information we have
- Improving understanding of how to interact with BWEC
- Increasing international collaboration, knowledge sharing, and ensure appropriate representatives attend BWEC workshops
- Matching frequency of meetings/webinars with pace of research
- Translating research papers to other languages for other countries that are building out their wind infrastructure

Other considerations

- How big should BWEC be? Could more people observe and participate in workshops?
- Can we crosswalk our old priorities with today's thoughts – are and what are we learning?
- What is the right mix of established research and cutting-edge ideas to include in BWEC workshops?
- Consider holding preparatory webinars in the weeks leading up to BWEC workshops. This could help participants focus more on discussion and come with targeted questions for presenters
- How should BWEC take credit for activities or define its own projects?

5.2 BWEC business meeting

Pat Field (CBI) facilitated a discussion on BWEC business. Participants discussed adding more members to BWEC committees. Pros included: increasing amount and quality of feedback on reports, increasing international expertise on the technical advisory committee, and adding missing expertise. Cons included: creating a group that is unwieldy, science advisors may require funding support, and increased risk of unbalanced representation.

<u>5.2.1 Meeting Format</u>
Participants provided feedback on the meeting format. Suggestions included: tiered meetings, committee business only on day three, require alternates, and have larger working groups. Other membership considerations discussed were:

- What is the appropriate duration of commitment by a member?
- How should BWEC plan for leadership transitions?
- How are BWEC members bringing information back to their constituents?
- How are committees engaging internally and with each other between BWEC meetings?
- Consider other governance models – how could BWEC involve non-voting members?
- Meeting format covered a lot of material but may have shortchanged some conversations because focus was on information presentation. Pre-meeting webinars could help.
- Consider increasing discussion time (e.g., felt like rushed priority setting)
- Give presenters more clarity about what they should present
- Consider panel topic approach in place of presentations
- Participants should provide more feedback on the agenda in advance. Poll for hot topics early, rather than sending a strawman agenda. Ask stakeholders for priority topics as well.
- Provide time at beginning for discussion of broader issues

<u>5.2.2 BWEC Funding</u>

Participants heard about BCI's financial information for coordinating the BWEC. 2018 finances will likely be the lowest funding to date. This is due to BWEC having no significant research projects.

Participant discussion focused on:

- Concern that companies will send their funds to the newly industry-developed WWRF instead of BWEC. BWEC should become a WWRF grant seeker regardless.
- Industry needs to discuss how money should be allocated for projects versus activities/support. Overhead is frequently necessary for good overall work.
- Industry values a one-stop-shopping approach to funding; they are less interested in working with several organizations simultaneously.
- Should BWEC include in its financial reports, projects that other groups do to advance BWEC priorities? This could show total cost to complete priorities.

Appendix A: Final Agenda

Bats and Wind Energy Cooperative 5th Science and All Committees Meeting
5–7 June 2018
National Wind Technology Center, Louisville, CO

Agenda

Meeting Purpose: To review progress of the Bats and Wind Energy Cooperative (BWEC), review progress toward priorities established at the 2015 meeting, discuss emerging issues, and establish priorities for the next 3–4 years.

Reception: Monday 4 June 2018

19:00–21:00 **Social hosted by Ed Arnett-provided by BCI**

Day One: Tuesday 5 June 2018

07:30–08:00 **Check-in & breakfast-provided by NREL**
Day 1 at Omni Hotel: PINE ROOM

08:00–08:10 **Welcome & introductions**
Jocelyn Brown-Saracino (USDOE)

08:10–08:20 **Review purpose of meeting, agenda, ground rules**
Pat Field (CBI)

08:20–08:40 **Industry challenges & opportunities related to bats**
Michael Speerschneider (AWEA)

- Status of wind development in the US
- Industry efforts around monitoring, regional habitat conservation plans, and other efforts
- Current challenges and worries

08:40–09:10 **BWEC review & current research (2015–2018)**
Cris Hein (BCI)

- Has the BWEC met the research goals established in 2015?

09:10–09:40 **Facilitated discussion on BWEC past & ongoing research**
Pat Field (CBI)

- What have we learned over the last three years with high certainty, some certainty, some significant questions and uncertainty?
- What are likely key gaps, questions, or uncertainties we may want to fill in the coming 3 years (of course, to be detailed in the workshop)?

09:40–09:50 **BREAK**

POPULATION ANALYSIS OF BATS

09:50–10:10 **Regulatory status of bats, WNS update & regulatory challenges**
Rachael London (USFWS)
- How has WNS spread over the past couple of years?
- Are there species being considered for listing by USFWS?

10:10–10:30 **Potential population effects of wind energy development on bats**
Winifred Frick (BCI)
- Should this be revised to include current & future buildout?
- How would this change with minimization strategies applied?
- Should we examine other species?

10:30–10:50 **Additional indicators of bat population size**
Erin Baerwald (Univ. of Regina) & Robert Barclay (Univ. of Calgary)
- Do these indicators support our current understanding of bat populations?

10:50–11:10 **AWWIC Database**
Taber Allison (AWWI)
- Who has access to the database?
- What data are included in the database?
- What types of studies should we pursue?

11:10–12:00 **Facilitated discussion on population status of bats**
Pat Field (CBI)
- What are the different approaches to estimating population?
- What is the best use of large databases?
- Can we tell if wind is having a significant impact on populations?
- What data and funding are needed to expedite this issue?
- Any new important priority areas of research?

12:00–12:15 **Tentative Priority Objectives and Research Needed 2019-2021**
- What are the priority objectives, research, and organizations?

12:15–13:15 **LUNCH-Catered lunch onsite-provided by NREL**

FATALITY ESTIMATION

13:15–13:35 **Generalized Fatality Estimator (GenEst)**
Manuela Huso (USGS)
- Can we achieve suitable accuracy & precision with this estimator?
- Under what circumstances can this estimator be used?

13:35–13:50 **Facilitated discussion on GenEst**
Pat Field (CBI)
- Will use of GenEst change monitoring protocols?

- How will GenEst influence effort/cost?

13:50–14:05	**Protocol for fatality monitoring using roads and pads** Manuela Huso (USGS) • Can we achieve suitable accuracy & precision with this methodology? • Under what circumstances can this method be applied?
14:05–14:20	**Facilitated discussion on roads and pads monitoring** Pat Field (CBI) • Is there good rational for this new monitoring protocol? • Will this change the cost of monitoring? • Any new important priority areas of research?
14:20–14:35	**Tentative Priority Objectives and Research Needed 2019-2021** • What are the priority objectives, research, and organizations?
14:35–14:45	**BREAK**

BAT BEHAVIOR & MOVEMENT PATTERNS

14:45–15:15	**Using infrared imaging to study behavior of bats near turbines** Paul Cryan (USGS), Marcos Gorresen (Univ. of Hawaii) & Michael Schirmacher (BCI) • What is the process to detect & identify targets? • What are the pros/cons of 3D processing & mapping?
15:15–15:35	**Facilitated discussion on using infrared imaging to study bats** Pat Field (CBI) • What are the benefits & limitations to using this equipment/software? • Are there alternative placement options to optimize observations? • How can we capture fatality events with thermal cameras? • What other methodologies should be paired with thermal cameras? • How can behavioral studies be used to inform minimization strategies?
15:35–15:55	**Discuss behavioral research strategy** • Comments on draft strategy provided prior to the meeting
15:55–16:05	**BREAK**
16:05–16:35	**Current understanding of bat movement patterns and methods to track bat** Ted Weller (USFS) & Liam McGuire (Texas Tech Univ.) • What do we know about bat movement patterns • What tools can we use to track bat movement patterns • What data are available in the Bat Acoustic Monitoring Portal • What level of information is needed for the database

16:35–17:05 **Facilitated discussion on technologies for bat movement patterns & siting**
Pat Field (CBI)
- Can these studies inform siting decisions?
- Can these studies inform minimization strategies?
- Are the data useful in assessing risk?
- Are there other existing or emerging technologies?
- What are the pros/cons of these technologies?

17:05–17:20 **Tentative Priority Objectives and Research Needed 2019-2021**
- Any new important priority areas of research?
- What are priority objectives, research, and organizations?

17:20–17:30 **Day 1 wrap-up**
Pat Field (CBI)

18:30–20:30 **Group dinner**

Day 2: Wednesday 6 June 2018

07:00 **Gather in hotel Lobby & Drive to NWTC**
Shuttle will depart hotel at 07:15

07:30–08:00 **Check-in & breakfast-provided by NREL**
Bring your driver's license, and for foreign nationals your Passport and Visa

08:00–08:10 **Agenda for day 2**
Pat Field (CBI)

IMPACT REDUCTION STRATEGIES

08:10–08:35 **Overview of operational minimization**
Michael Schirmacher (BCI)
- Since 2013 Synthesis, how has the research advanced?
- Are there species-specific differences in effectiveness?

08:35–08:50 **Cost of feathering & raising cut-in speeds**
Carl Ostridge & Chris Farmer (DNV GL)
- How much influence does year-to-year variation in wind resources have?
- How much influence would you expect variable PPA pricing to have?

08:50–09:10 **Peak fatality analysis**
Manuela Huso (USGS)
- How are you determining 'peak' fatality?
- Is this a site-specific analysis or can it be applied regionally?

09:10–09:30	**Developing algorithms using bat activity & weather** Trevor Peterson (Stantec) • What are the benefits & limitations to using acoustic detectors? • What technology should be used for recording and analyzing data? • How many detectors are needed & where should they be positioned?
09:30–09:50	**EPRI's TIMR** Mark Hayes (Normandeau) • How many detectors are needed & where should they be positioned? • What technology should be used for recording and analyzing data? • What are the next steps?
9:50–10:00	**BREAK**
10:00–11:00	**Facilitated discussion on operational minimization** Pat Field (CBI) • What is an acceptable cost/benefit ratio? • What is needed to optimize strategy to reduce cost? • Are there different levels of implementation for different species? • Can a strategy be implemented across a region? • Is curtailment compatible with industry trends in turbine design? • Any new important priority areas of research
11:00–11:15	**Tentative Priority Objectives and Research Needed 2019-2021** • What are the priority objectives, research, and organizations?
11:15–11:45	**GE's acoustic deterrent: results & technology update** Brad Romano (Shoener Environmental, Inc.) & Kevin Kinzie (GE) • What are the results from the latest research? • What is the status of the technology? • What are the next steps?
11:45–12:15	**NRG's acoustic deterrent: results & technology update** Cris Hein (BCI) & Brogan Morton (NRG) • What are the results from the latest research? • What is the status of the technology? • What are the next steps?
12:15–13:15	**LUNCH-Catered lunch onsite-provided by NREL**
13:15–13:35	**Dim-UV light technology** Paul Cryan (USGS) & Marcos Gorresen (University of Hawaii) • What are the results from the latest research? • What is the status of the technology? • What are the next steps?
13:35–14:35	**Facilitated discussion on deterrent technology** Pat Field (CBI)

- What R&D remains?
- How does the cost of deterrents compare to operational minimization?
- What are the priorities to study (e.g., placement, frequency pattern)?
- Are there more effective signals than sound or light that we should explore?
- Are deterrents compatible with industry trends in turbine design?

14:35–14:50 **Tentative Priority Objectives and Research Needed 2019-2021**
- What are the priority objectives, research, and organizations?

14:50–15:00 **BREAK**

15:00–15:20 **Offshore wind energy development & bats**
Trevor Peterson (Stantec)
- What are the bat activity patterns offshore?
- What research is ongoing or planned?

15:20–15:45 **Facilitated discussion on offshore wind energy development**
Pat Field (CBI)
- How can we monitor bat activity & fatality offshore?
- What is BWEC's role?
- What are reasonable responses to addressing the concerns?

15:45–16:45 **Making BWEC more effective**
Pat Field (CBI)
- Who has BWEC research reached and to what use or end?
- How can we improve the impacts and influence of BWEC research?
- How can we effectively expand international partnerships?

16:45–17:00 **Day 2 wrap-up**
Pat Field (CBI)

18:30–20:30 **Group Dinner**

Day 3: Thursday 7 June 2018

07:00 **Gather in hotel Lobby & Drive to NWTC**
Shuttle will depart hotel at 07:15

07:30–08:00 **Check-in & breakfast provided by NREL**
Bring your driver's license, and for foreign nationals your Passport and Visa

08:00–10:30 **Facilitated discussion on BWEC strategic plan for next 3 years**
- Review draft priorities and objectives for each research category.
- Discuss, hone, and rank the priority objectives and research.
- How do we address remaining questions & sequence research in time.

- Who should take the lead on priorities?

10:30–10:50	**BREAK**
10:50–12:00	**BWEC Business Meeting** Pat Field (CBI) • Review/Revise Charter • Committee membership • Financials & sources of funding • New business
12:00–13:00	**LUNCH- Catered lunch onsite-provided by NREL** **NABat Monitoring Program** Brian Reichert (USGS)
13:00	**Adjourn meeting**
13:15 onward	**NREL Tour**

Appendix B: List of Participants

Oversight Committee
AWEA: Michael Speerschneider
AFWA: Mark Humpert
BCI: Kevin Pierson (In lieu of Mylea Bayless)
NREL: Robert Thresher
USDOE: Jocelyn Brown-Saracino
USFWS: Rachael London
USGS: Mona Khalil

Science Advisory Committee
AWWI: Taber Allison
TRCP: Ed Arnett
U. of Calgary: Robert Barclay
USGS: Paul Cryan
USGS: Manuela Huso

Technical Advisory Committee
MAP Royalty: Sam Enfield
Nossaman, LLP: John Anderson
NextEra Energy: Jim Lindsay
USFWS: Tim Sullivan
VT Fish and Wildlife Dept: Scott Darling

BWEC Coordination
BCI: Cris Hein
BCI: Michael Schirmacher

Facilitation
CBI: Pat Field
CBI: Rebecca Gilbert

Invited Speakers
BCI: Winifred Frick
DNVGL: Chris Farmer
DNVGL: Carl Ostridge
GE: Myron Miller
GE: Kevin Kinzie
Normandeau: Mark Hayes
NRG Systems: Brogan Morton
Shoener Environmental, Inc.: Brad Romano
Stantech: Trevor Peterson
Stantech: Steve Pelletier
Univ. of Regina: Erin Baerwald
USFS: Ted Weller

Invited Guests
Avangrid Renewables: Laura Nagy
Avangrid Renewables: Matt Becker
Defenders of Wildlife: Joy Page
Defenders of Wildlife: Pasha Feinberg
Invenergy: Erin Lieberman
NREL: Elise DeGeorge
NREL: Bethany Straw
NextEra Energy: Janine Bacquie
USDOE: Raphael Tisch