Efficacy of Operational Curtailment and Deterrents on Reducing Bat Fatality at Wind Facilities

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MITIGATION OPTIONS

Operational Mitigation...
Curtailment during high risk periods that may be predictable
What’s the Evidence...

Why curtail if bats hit non-moving turbines?

Do bats strike stationary objects?

YES...BUT...

Frequency and magnitude of events are very different from birds...
Collisions with Towers

Bats are NOT birds!!!

<table>
<thead>
<tr>
<th>Site</th>
<th>Birds</th>
<th>Bats</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topeka, KS</td>
<td>&gt; 1000</td>
<td>5</td>
</tr>
<tr>
<td>Nashville, TN</td>
<td>336</td>
<td>2</td>
</tr>
<tr>
<td>Colombia, MO</td>
<td>658</td>
<td>1</td>
</tr>
<tr>
<td>North Dakota</td>
<td>561</td>
<td>5</td>
</tr>
</tbody>
</table>

Provided by P. Cryan, USGS
What's the Evidence: Turbine Data

Mountaineer

No bats killed at the only non-operational turbine at Mountaineer

mean = 10.6 bats found/turbine

Meyersdale

mean = 13.1 bats found/turbine
What’s the Evidence: Turbine Data

Casselman, PA  23 April - 23 October 2008

- 20 days when turbines were down
- One old hoary bat found

No bats killed at non-moving turbines

Thermal images indicated that bats appear to be attracted to and investigate both moving and non-moving blades
Majority of bats killed in PA, TN, WV were on low wind nights (Arnett et al. 2008, Fiedler 2004)

Proportion of the night when winds were $>6$ m/s negatively associated with bat fatalities
Hypothetical Curtailment at Mountaineer and Meyersdale

Assuming that:

• all turbines were non-operational on nights when median wind speed was <6 m/s (sunset to sunrise)

85% fatalities at Mountaineer occurred on those nights (24 of 43 nights)

82% fatalities at Meyersdale (19 of 42 nights)
Does changing cut-in speed reduce fatality of bats?
Curtailment Studies:

Study conducted in Germany in 2006

Turbine cut-in changed to 5.5 m/s

~50% reduction of bat fatalities
Study in southern Alberta by Baerwald and Barclay in 2007

Demonstrated 52% reduction in fatalities when turbine cut-in speed was changed to 5.5 m/s
## Chapter 2. Operational Mitigation Studies and Deterrents

### A. Priority Research Tasks

<table>
<thead>
<tr>
<th>Priority Action</th>
<th>Key Technical Tasks</th>
<th>Performers/Partners</th>
<th>Key Milestones/Schedule</th>
<th>Resources/Funding</th>
<th>Immediate Next Steps</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Develop a study plan and experimental designs for operational mitigation and</td>
<td>Prepare plan &amp; have reviewed by Science Advisory Committee</td>
<td>BWEC &amp; cooperative scientists</td>
<td>Draft ASAP</td>
<td>About $10K needed</td>
<td>Implement curtailment experiment ASAP, put team &amp; schedule together</td>
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<tr>
<td>- deterrent research</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>2. Conduct mitigation experiments at multiple sites</td>
<td>Standardized protocol, Range of geographic locations including high mortality and</td>
<td>BWEC &amp; cooperative scientists</td>
<td>Ideal Study - one</td>
<td>TBD</td>
<td>Need to recruit industry partners</td>
</tr>
<tr>
<td></td>
<td>species</td>
<td></td>
<td>large wind farm with control, deterrent, and feathering treatments.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Begin or continue field trials of existing deterrent device (with fatality</td>
<td>Develop proposal</td>
<td></td>
<td>Proposal this spring;</td>
<td>TBD</td>
<td>Limit use of thermal imaging cameras to remove problem of reviewing extensive footage</td>
</tr>
<tr>
<td>searches)</td>
<td></td>
<td></td>
<td>field work this summer/fall</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Conduct economic analysis and financial assessment of mitigation (What are</td>
<td>Use study data to perform financial analysis</td>
<td>Industry analysts</td>
<td>TBD</td>
<td></td>
<td>Need to recruit industry partners</td>
</tr>
<tr>
<td>the costs to industry?)</td>
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</table>
Implemented experimental test of fully operational turbines and those with two different cut-in speeds (5 m/s, 6.5 m/s)

Sampled from 26 July to 10 October 2008 at Iberdrola’s Casselman Wind Project in south-central Pennsylvania

Objective: Quantify reductions in bat fatality relative to economic costs of curtailment
10 Sampled daily 23 April - 15 November

Experiment - 12 sampled daily 26 July - 10 October
Fully operational
Cut-in speed at 5.0 m/s
Cut-in speed at 6.5 m/s
Fully operational

Cut-in speed at 5.0 m/s

Cut-in speed at 6.5 m/s

Re-randomized and assigned treatments EACH night...night was the experimental unit in analysis
Measures of curtailment effect

1. Comparison of fresh killed bats among treatments

2. Comparison of all bat fatalities found from 12 “experimental” turbines and 10 turbines (“PGC study” surveyed during same time period

Relationships between bat fatalities and operational hours, wind speed, etc.
Preliminary Results!!

- 75 days of sampling
- Total of 52 bats found (no corrections!) and 32 fresh carcasses

Fresh Fatalities/Treatment

<table>
<thead>
<tr>
<th>Full Operation</th>
<th>5.0 m/s</th>
<th>6.5 m/s</th>
</tr>
</thead>
<tbody>
<tr>
<td>23</td>
<td>3</td>
<td>6</td>
</tr>
</tbody>
</table>
82% mean reduction (56-92%)

2.2 - 12.8 times more fatalities when fully operational vs curtailed
\( p=0.0001 \)

0.1 - 2.2 times more fatalities when curtailed at 6.5 vs 5 m/s
\( p=0.36 \)
VERY Preliminary Results!!!

PGC Study vs Experimental Turbines

Total of 108 bats found at 10 fully operational turbines and 52 at curtailed turbines

We have not yet modeled operational hours, wind, etc. yet....stay tuned!
Conclusions and Next Steps:

Pattern suggests findings are similar to other studies...

Complete analysis, including financial calculations
Conclusions and Next Steps:

Develop study plan for further efforts to evaluate changes in cut-in speed
How Much is Enough?

Financial and biological thresholds?

50% reduction?

75% reduction??

96.3% reduction???
MITIGATION OPTIONS

Technological...
Deter or alert the bats...
Can we generate a disorienting or uncomfortable airspace around turbines that will deter bats?
Current Findings

In the lab: captive bats unable to catch prey with device on

At ponds in the field: ~90% reduction within 12m of device

Sustained effect at ponds, i.e., no indication of habituation
Field Test Results - 2007
multiple nights of treatment
Deploying on Turbines

Spot beam Pattern
High penetration “keep out” for rising bats

Vertical Doughnut Pattern
Encompassing Turbines “keep out”

Horizontal Doughnut Pattern
“Barrier”
15 deg
Turbine Experiment with Deterrent

- Thermal Infrared Imaging used to evaluate activity of bats and response to deterrents on turbines

- Mixed results: one experiment showed significant reduction in bat activity at treated turbine compared to control; second experiment showed no difference
Deterrents – Next Steps

Compare fatalities between treated and untreated turbines at wind facilities.
CAUTION!!!

We currently **DO NOT** have a functional device that can be deployed at operating wind facilities

More field experimentation is required
Ultrasound attenuation is a big issue!

Generate an ultrasound fence?
We MUST develop a system that is easily maintained at facilities...
Many thanks to:

John Hayes, University of Florida
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Joe Szewczak, Humboldt State University

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Field crews!!!

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Iberdrola Renewables