Are tree bats actively foraging at wind turbines in the southern Great Plains?

Cecily Foo, Dr. Victoria Bennett, Dr. Dean Williams, and Dr. Amanda Hale

Department of Biology, Texas Christian University, Fort Worth, USA (CF, DW, AH); School of Geology, Energy and the Environment, Texas Christian University, Fort Worth, USA (VB)

INTRODUCTION

In 2013, the wind energy industry supplied 4.5% of the electrical energy consumed in the U.S. By 2030, the Department of Energy intends for this to increase to 20% (USDOE 2015). The expansion of wind energy has resulted in high fatality rates of insectivorous, migratory tree bats in North America, particularly hoary (Lasiurus cinereus), eastern red (Lasiurus borealis), and silver-haired (Lasionycteris noctivagans) bats. Most of these fatalities occur from July through September, which coincides with the fall migratory season of these species. Wind energy impacts to these species could have long-term population-level impacts (Kunz et al. 2007, Arnett and Barerwalt 2013).

The reasons why bats are coming into contact with wind turbines are still not well understood (see Cryan and Barclay 2009), but one hypothesis is that they may provide bats with a resource, such as consistent foraging opportunities due to aggregations of invertebrates that can be found on the light-colored turbine towers (Long et al. 2013). In order to investigate this hypothesis, we compared the invertebrate species found in the stomachs of bats collected during fatality monitoring at a wind farm to the species of invertebrates present on the turbine towers.

METHODS

Study site – Wolf Ridge Wind, LLC, a 75-turbine facility (112.5 MW) owned and operated by NextEra Energy Resources in north-central Texas (Fig. 1)

Bat carcass collection & dissection
• Eastern red and hoary bat carcasses collected during July and August of 2013 and 2014 as a part of ongoing fatality monitoring at the site (Fig. 2a)
• Esophagi, stomachs, and intestines were removed and preserved in 70% ethanol (Fig. 2b)

Figure 2. Bat carcasses were collected and dissected to remove digestive systems. A hoary bat (a) and an eastern red bat (b) collected during fatality monitoring surveys at Wolf Ridge. Carcasses were dissected and their digestive systems were removed (c).

Genetic analysis of stomach contents
• We extracted DNA from each sample using DNEasy mericon food kits (QUIAGEN)
• We amplified a 156 bp section of the Cox1 region of mitochondrial DNA using polymerase chain reaction (PCR) with arthropod-specific primers
• PCR products were run on a gel, purified, inserted into pGEM vectors, and cloned using bacteria grown on plates
• From each sample, 29 colonies containing recombinant clones were picked and amplified using PCR with vector-specific primers
• These products were sequenced using the BigDye v.1.1 kit and run on the ABI 3130XL Genetic Analyzer
• Sequences were aligned and processed through Barcode of Life Data System to identify the stomach contents to the lowest taxonomic level based on percentage match
• We constructed phylogenies to estimate how many different unknown species were found in all of the samples and how closely related they were to our known invertebrates

 Figure 1. Wolf Ridge Wind, LLC. Wolf Ridge is located in north-central Texas. Turbines where invertebrate surveys were conducted are indicated by a yellow circle.

Invertebrate sampling
• We used paired light traps and malaise trapping at 6 turbines on the wind farm for a total of 46 trap nights in July and August of 2015 (Fig. 1, Fig. 3)
• Survey data from 2012 and 2013 were also included to determine if the invertebrate assemblage has changed over time and to use in comparison to our stomach samples

Figure 3. Paired light traps (a) and malaise trapping (b) were used to sample invertebrates at turbine towers.

RESULTS & CONCLUSIONS

Bat carcasses
• We analyzed the stomach contents from 69 bat carcasses collected during fatality searches at Wolf Ridge (n = 45 eastern red bats and 24 hoary bats)

Genetic analyses
• We identified 83 species of invertebrates in the stomach samples
• Seven invertebrate orders were represented in our data set, but crickets (Orthoptera) and moths (Lepidoptera) were most common
• While we found all seven orders in eastern red bat stomachs, hoary bats only had prey items belonging to Orthoptera, Lepidoptera, and Coleoptera (beetles)
• The invertebrate species found most commonly in the stomachs have also been documented at Wolf Ridge (Table 1)

Table 1. The most common invertebrate species found in genetic analyses of bat stomach contents. The six species in the table below were found in five or more stomach samples. All six species were collected in invertebrate surveys at Wolf Ridge in 2015; some species were also collected in previous years.

<table>
<thead>
<tr>
<th>Voucher</th>
<th>Order</th>
<th>Species</th>
<th>Found in number of bat stomachs (n = 69)</th>
<th>Collected at Wolf Ridge in:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VX100</td>
<td>Orthoptera</td>
<td>Gryllus spp.</td>
<td>48 (69.6%)</td>
<td>✓</td>
</tr>
<tr>
<td>VX333</td>
<td>Lepidoptera</td>
<td>Spodoptera frugiperda</td>
<td>18 (26.0%)</td>
<td>✓</td>
</tr>
<tr>
<td>VX334</td>
<td>Lepidoptera</td>
<td>Euchromius ocella</td>
<td>6 (8.7%)</td>
<td>✓</td>
</tr>
<tr>
<td>VX337</td>
<td>Lepidoptera</td>
<td>Blepita canadinalis</td>
<td>6 (8.7%)</td>
<td>✓</td>
</tr>
<tr>
<td>VX342</td>
<td>Lepidoptera</td>
<td>Helicoverpa zea</td>
<td>5 (7.2%)</td>
<td>✓</td>
</tr>
<tr>
<td>VX343</td>
<td>Lepidoptera</td>
<td>Penicroma saucia</td>
<td>5 (7.2%)</td>
<td>✓</td>
</tr>
</tbody>
</table>

Conclusions and future directions
• We know that the invertebrate assemblage at Wolf Ridge is abundant and diverse
• We know bats are eating the species of invertebrates present at Wolf Ridge, suggesting that the bats are using the wind turbines as a foraging resource
• We are trying to determine if the species of invertebrates present at Wolf Ridge have stayed consistent over time and are examining changes between invertebrate surveys in July and August compared to changes in bat diets between July and August (based on when carcasses were collected)
• If we can conclusively establish that bats are using wind turbines as a foraging resource and are foraging just prior to their deaths, steps may be taken to determine if there are practical and effective strategies to reduce foraging opportunities for bats at wind turbines, which may help reduce bat mortality at wind turbines globally

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REFERENCES