Texturizing Wind Turbine Towers to Reduce Bat Mortality (DE-EE0007033)

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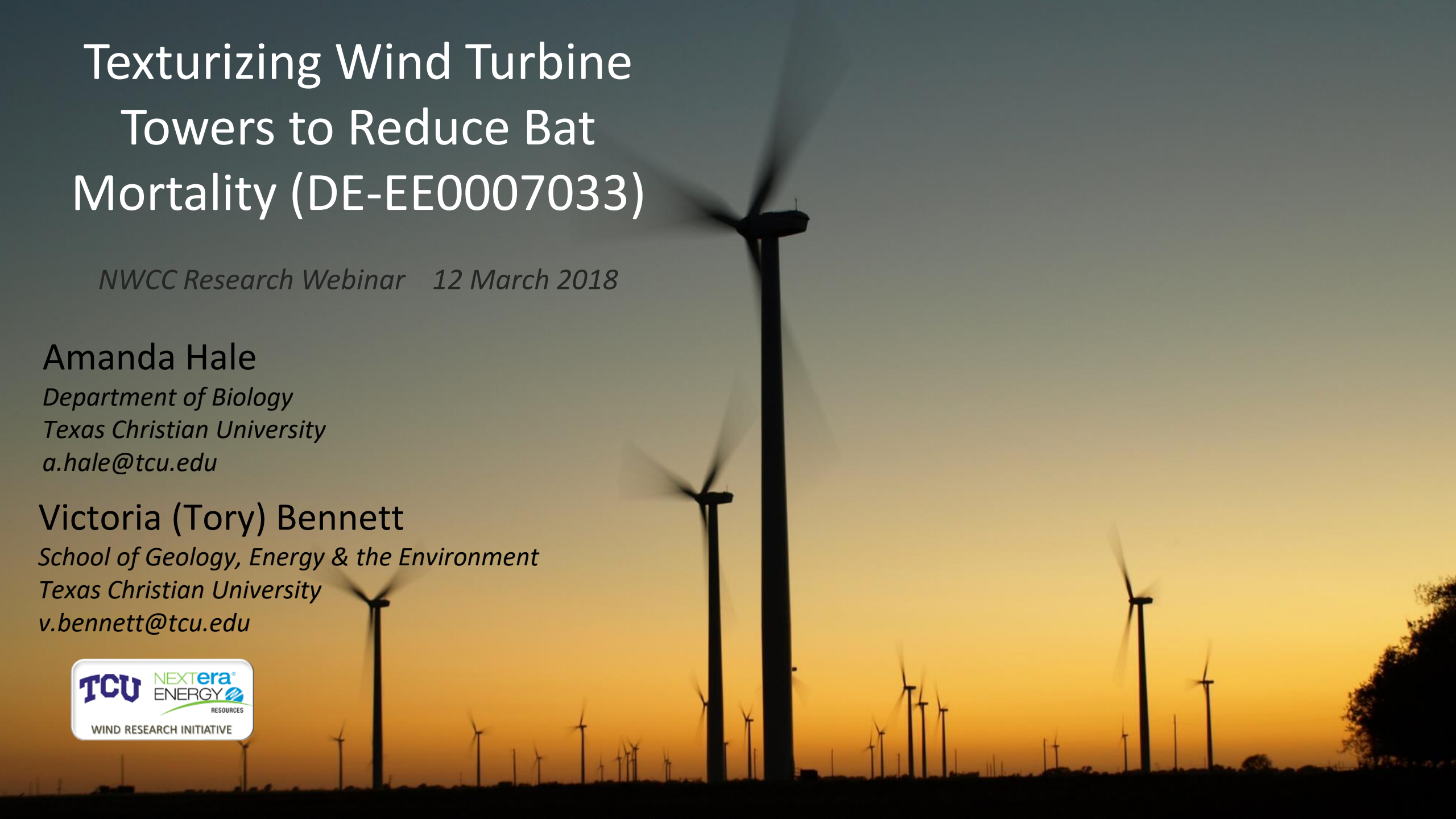


Outline

- Project Background
- Technical Approach and Key Findings
- Project Status and Availability of Results

Texturizing Wind Turbine Towers (DE-EE0007033): Project Goals

Goal: develop a wind turbine tower coating that

1) bats show little or no interest in approaching,
2) can be applied to currently deployed wind turbine towers and to towers as they are constructed,
3) is economically feasible to produce and apply, and
4) ultimately contributes to a reduction in bat mortality at utility-scale wind facilities.

Target market: existing wind farms, turbine manufacturers, and wind farm developers

Commercialization efforts would focus on:

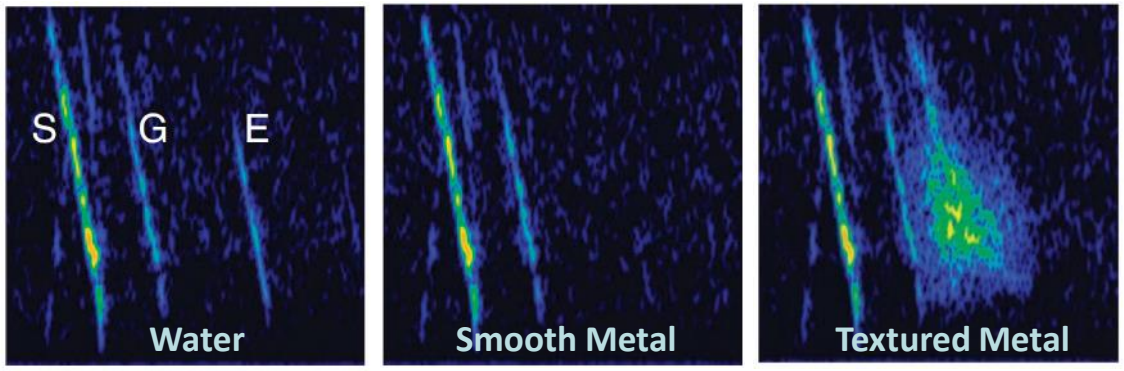
1) geographic areas with a high risk for bat mortality, and
2) areas with threatened and endangered species

>52,000 land-based wind turbines currently in operation in the U.S. that are within the range of bat species that may be impacted by mortality

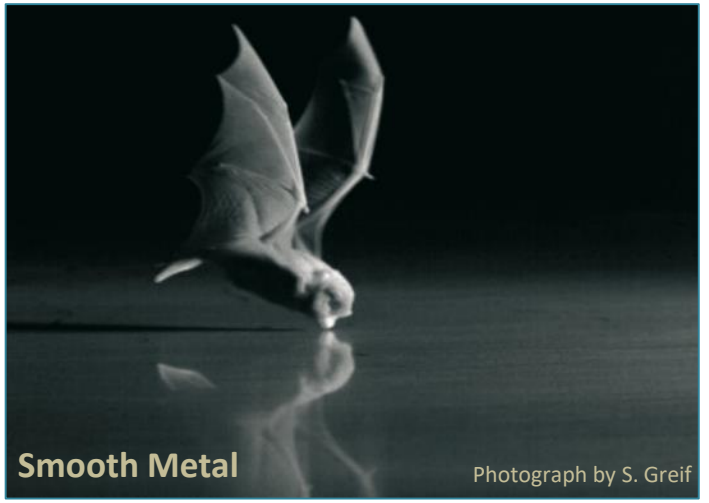
Texture coating is based on the water misperception hypothesis

Greif & Siemers (2010) showed:

1) Water recognition is innate in bats
2) Bats exhibit repetitive drinking behavior on smooth surfaces
3) Bats cannot effectively distinguish water from smooth surfaces



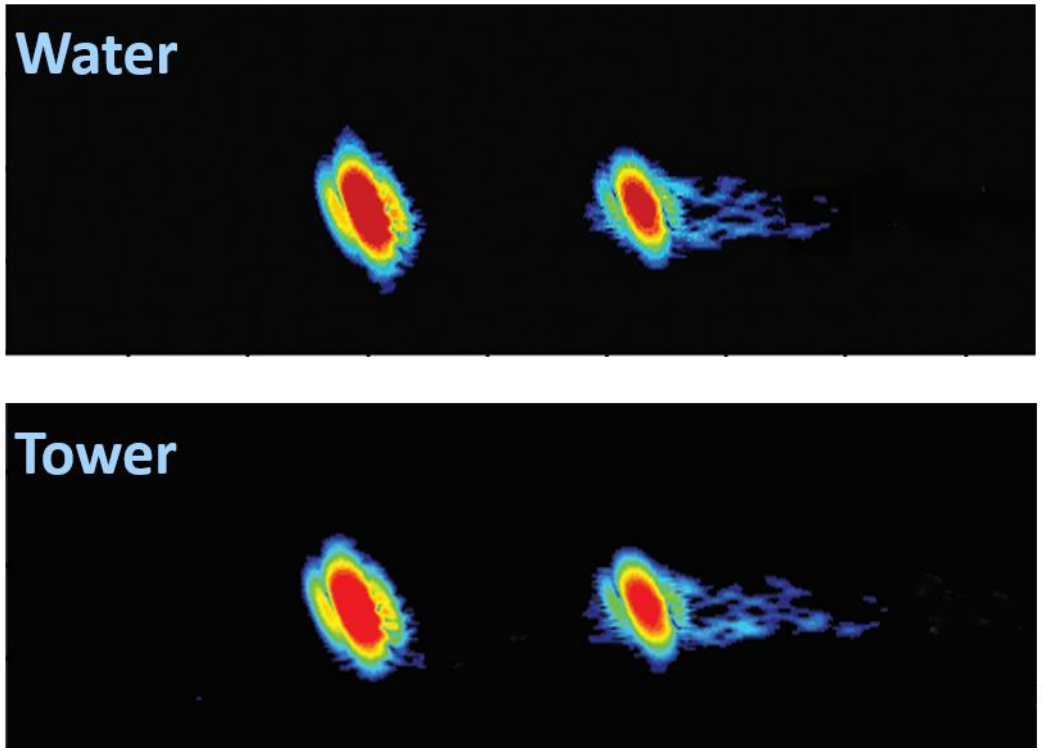
Spectrograms from three surfaces demonstrating echo structure compared to source call



Could water misperception be contributing to bat fatalities?

1. Playback experiment showed that smooth tower surfaces produced echoes that were indistinguishable from water.

Maybe

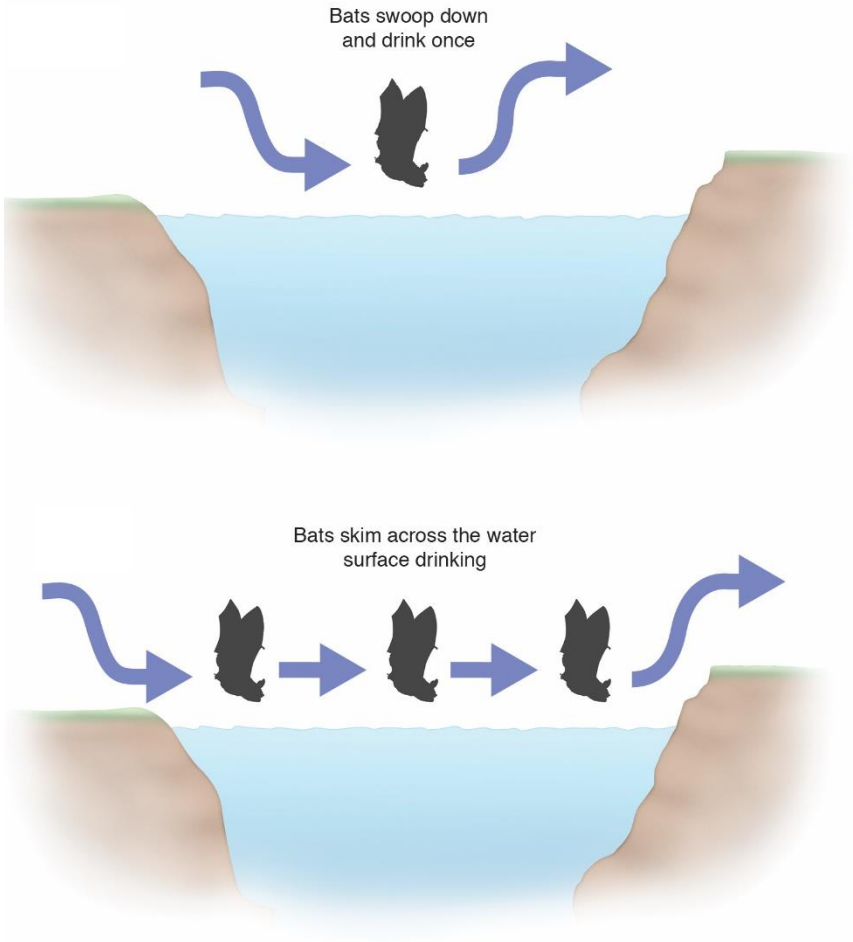


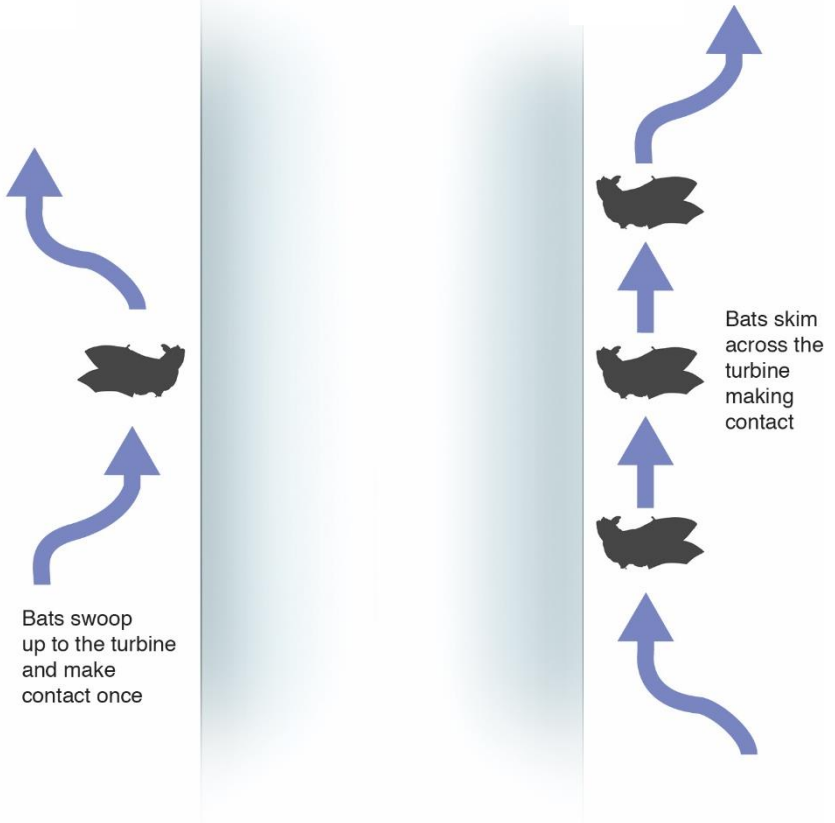
McAlexander 2013

Could water misperception be contributing to bat fatalities?

2. Night vision surveys showed bats approaching tower surfaces as they did ponds.

Maybe





McAlexander 2013

Could water misperception be contributing to bat fatalities?

3. Preliminary flight room experiments (2014): will bats attempt to drink from flat metal surfaces?

From smooth surfaces, yes.

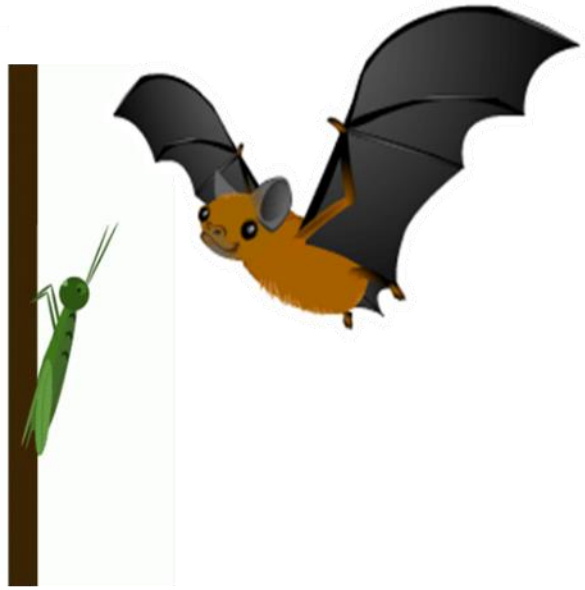
From textured surfaces, no.

Bienz 2016

Texture coating is also based on the acoustic mirror effect

- Detection of surface-based prey using echolocation is facilitated by smooth backgrounds such as water surfaces and smooth leaves

  Siemers et al. 2005, Clare & Holderied 2015



- Bats can switch foraging strategies when it is efficient for them to do so

  Todd & Waters 2007

For this hypothesis to be feasible:

- Prey items must be on or very close to turbine towers, and
- Bats must be able to switch from an aerial hawking to a gleaning foraging strategy

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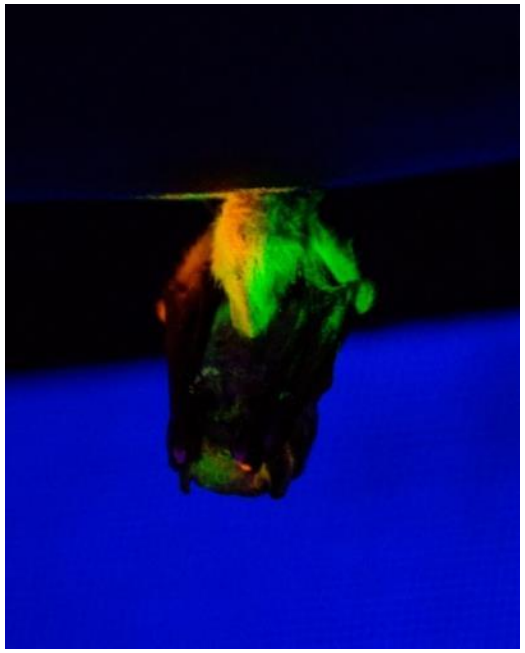
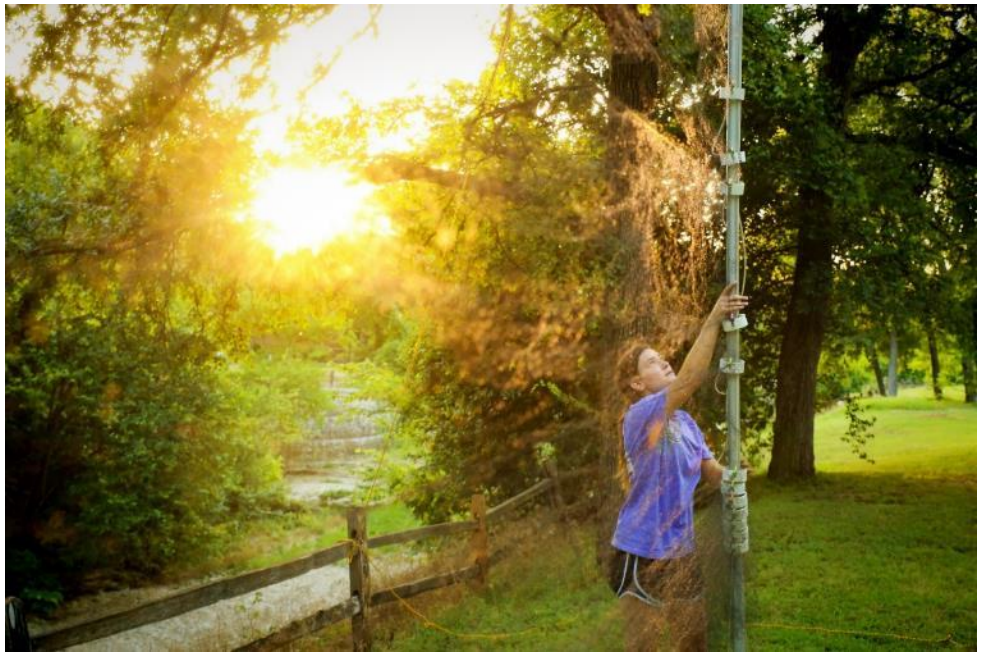
Technical Approach

BP1: Tasks 1 and 2 (2015-2016)

- Texture coating development
- Behavioral experiments with wild-caught bats in a flight facility (Phase I)



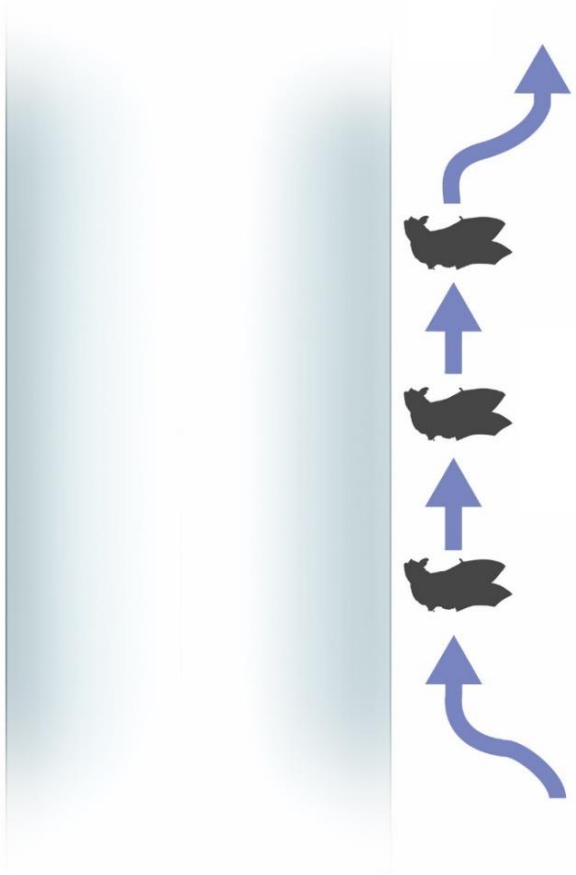


Flight Room Experiments: Phase 1 - 2015

Will bats attempt to drink from a curved surface?

n = 5 *Lasiurus borealis*

n = 36 *Nycticeius humeralis*



Bienz 2016

Flight Room Experiments: Phase 1 - 2015

Will bats attempt to drink from a curved surface?

From smooth surfaces, yes.

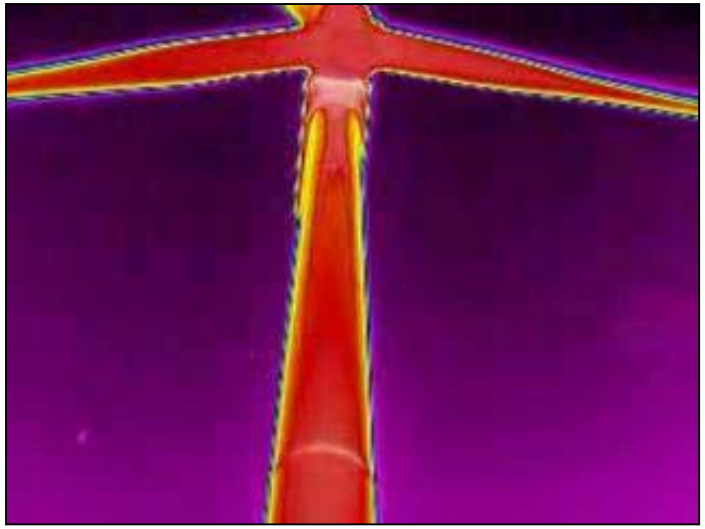
From textured surfaces, no.

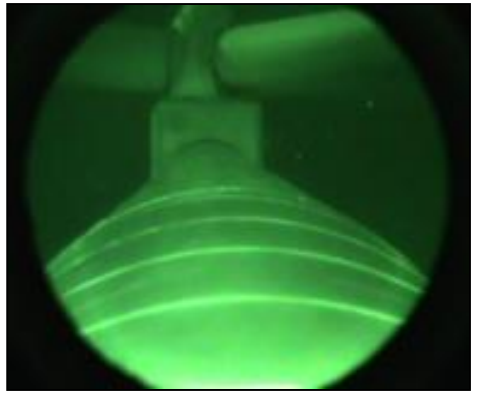
Bienz 2016

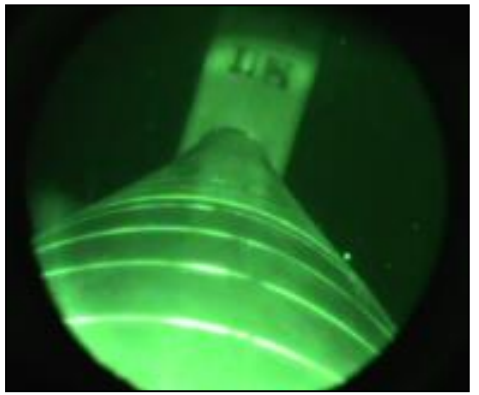
Technical Approach Continued

BP2: Tasks 3 and 4 (2016)

- Behavioral experiments with wild-caught bats in a flight facility (Phase II)
- Feasibility study at smooth turbine towers







Flight Room Experiments: Phase 2 - 2016

What about vertical surfaces?

Bat activity was significantly lower at texture-treated compared to smooth vertical surfaces in the bat flight facility.

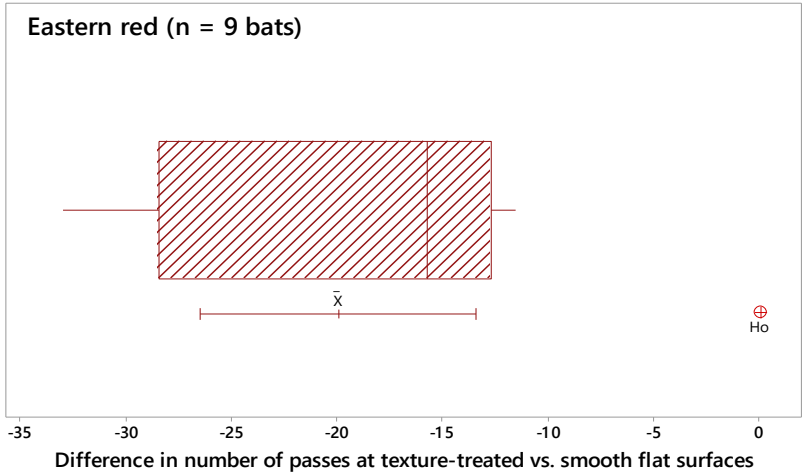
- Passes ≤1 m from the surface
- Contacts

Flight Room Experiments: Phase 2 - 2016

n = 16 *Lasiurus borealis*

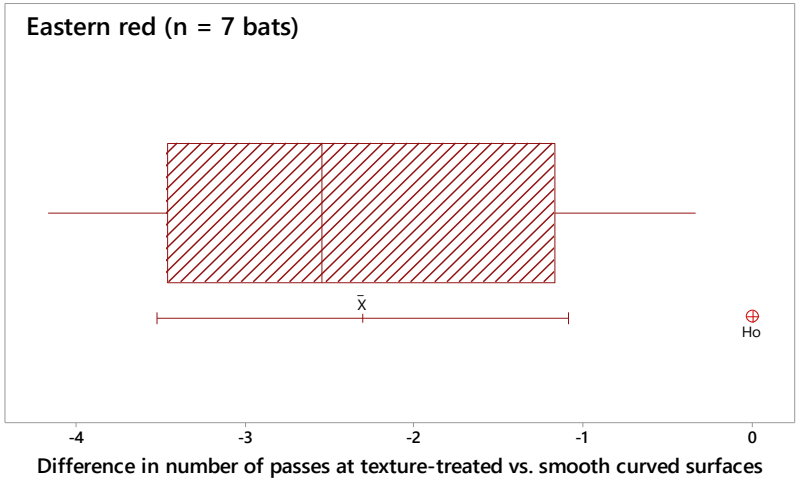
- *L. borealis* made significantly fewer passes ≤1 m of texture-treated compared to smooth surfaces.
- *L. borealis* made very few contacts with any of the vertical surfaces.

Flat surfaces



- 95% CI: 26.5 to 13.4 fewer passes per 10 min

Curved surfaces



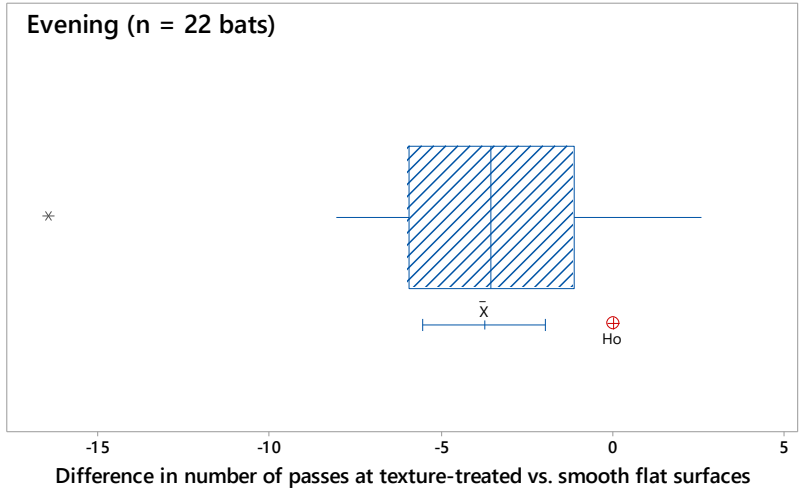
- 95% CI: 3.5 to 1.1 fewer passes per 10 min

Flight Room Experiments: Phase 2 - 2016

n = 36 *Nycticeius humeralis*

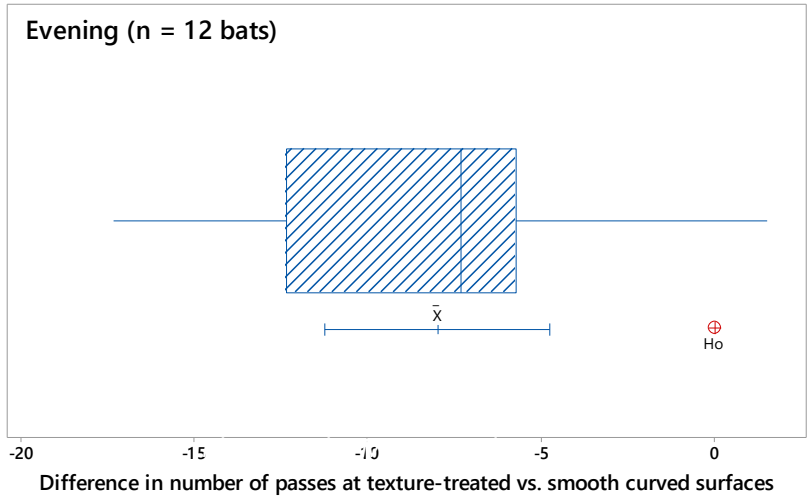
- *N. humeralis* made significantly fewer passes ≤1 m of texture-treated compared to smooth surfaces.
- *N. humeralis* made significantly fewer contacts with the texture-treated compared to the smooth surfaces.

Flat surfaces



- 95% CI: 5.6 to 2.0 fewer passes per 10 min

Curved surfaces

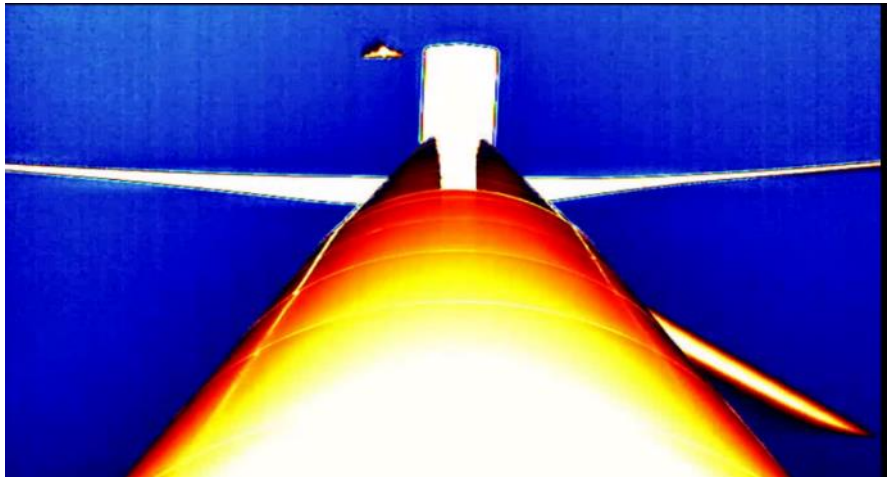


- 95% CI: 11.2 to 4.8 fewer passes per 10 min

Feasibility Study

Objective: Monitor bat activity at operational wind turbine towers (3-5 pairs) from June to mid-August 2016

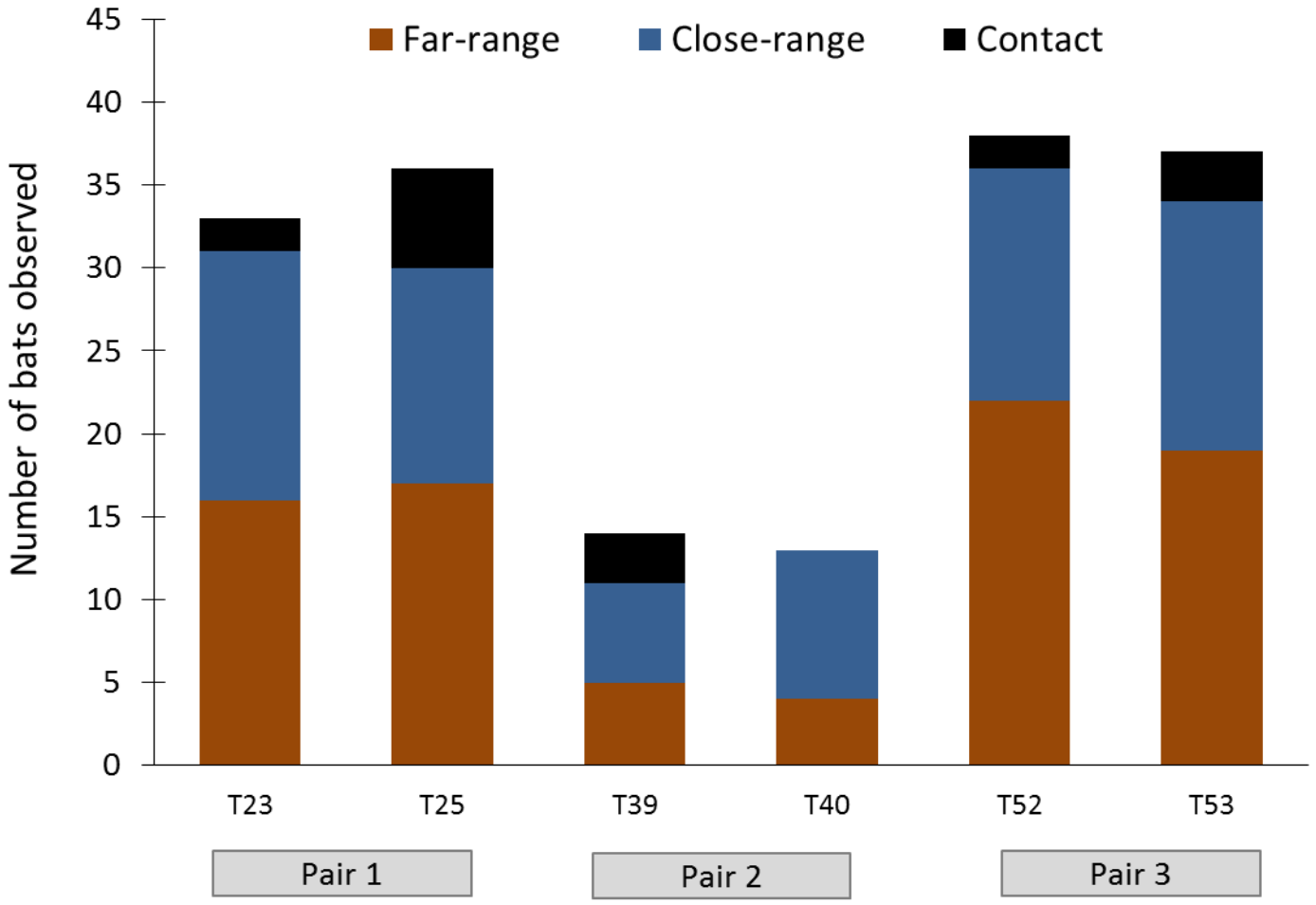
1. Are bats interacting with the smooth tower surfaces?
   - How many bats are present?
   - What types of behavior do they exhibit?
2. What is the best set-up for the high-definition cameras, night vision technology, thermal cameras, and ultrasonic bat detectors?



- On 21 nights at 3 turbine pairs in 2016, we observed 171 bats with our cameras and recorded 181 bat calls

Feasibility Study Continued

- At all turbine pairs we observed bats interacting with turbine towers in a variety of ways
- From this study we developed a protocol for the field test in 2017



Technical Approach Continued

BP2: Tasks 5, 6, and 7 (2017)

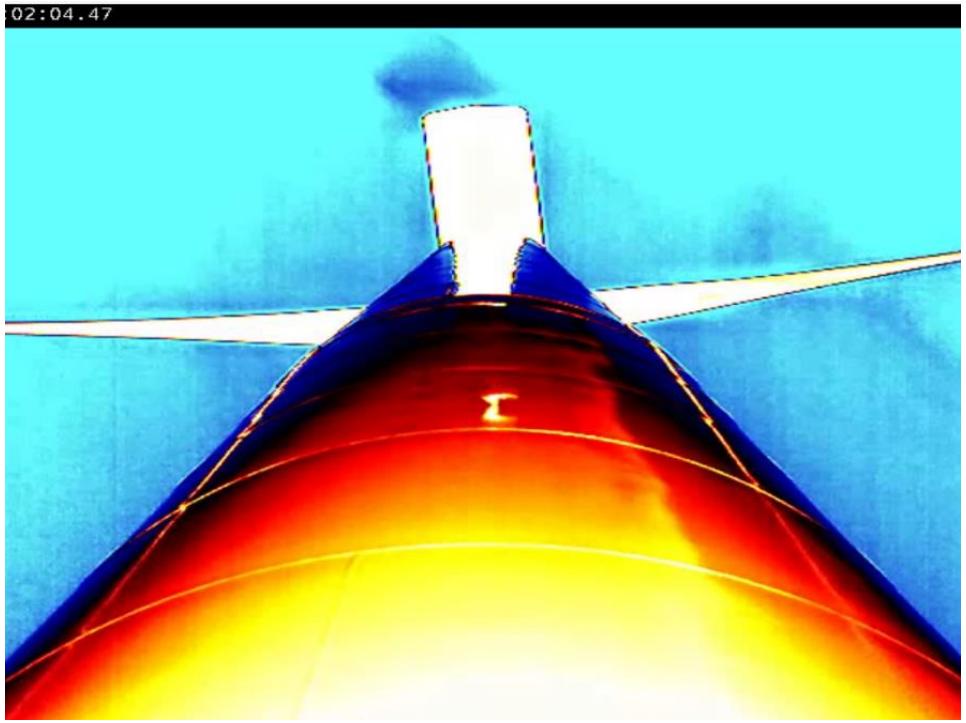
- Coating application to turbine towers
- Bat activity surveys at smooth and texture-treated turbines
- Final analysis and report writing

- Completed texture coating application to 2 turbine towers in June 2017.

Field Test: 2017

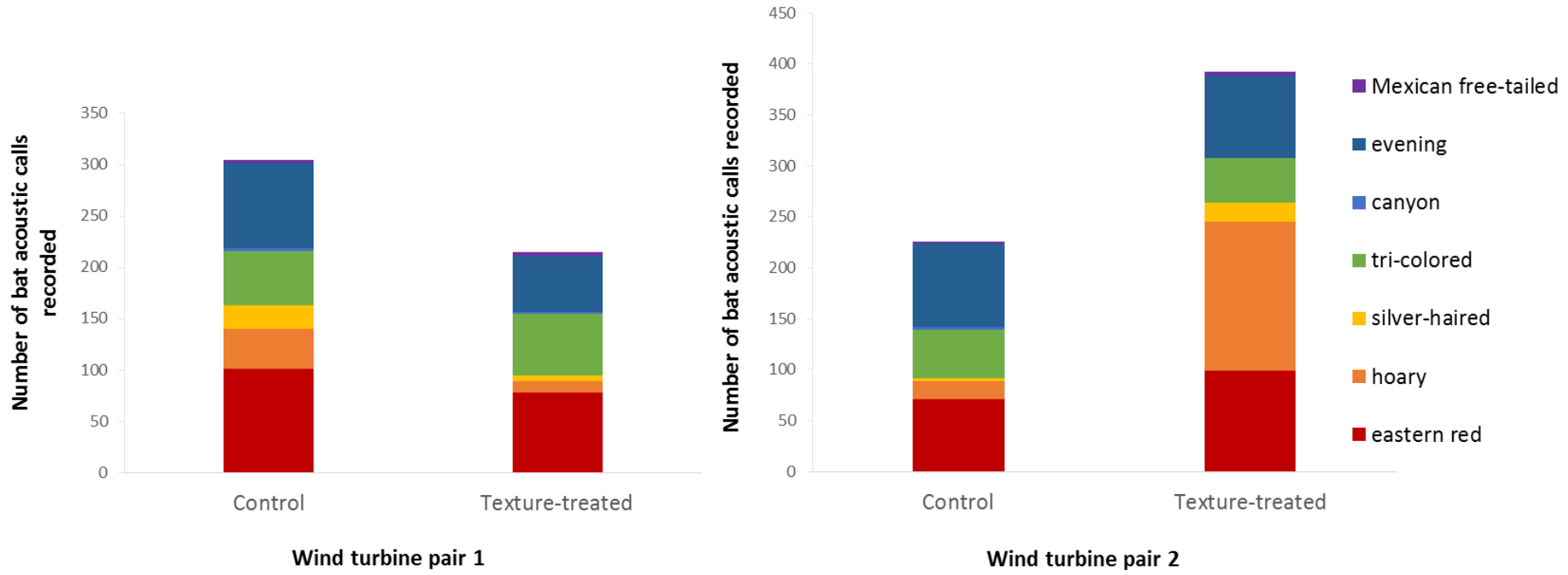
- Completed bat activity surveys at turbines from May - September

Prediction: Bat activity would be higher at smooth compared to texture-treated towers



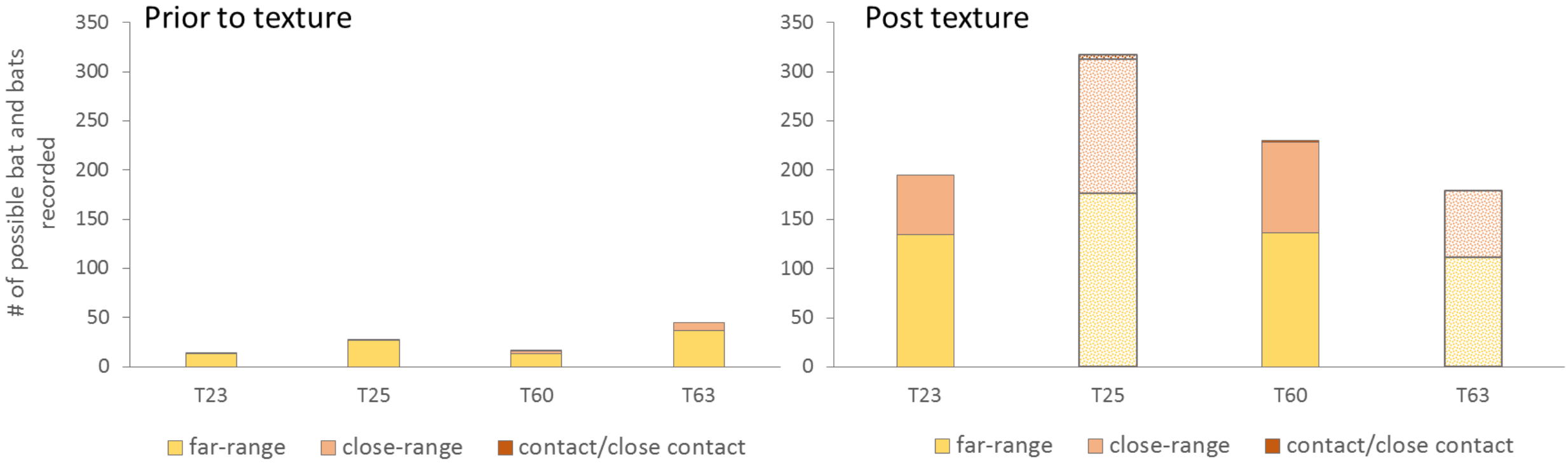
Field Test: 2017 Continued

- Surveys started in May 2017
  - Baseline activity at smooth towers
  - Activity at smooth and texture-treated towers
- Recorded 1,215 bat calls at turbine towers during the survey period



Field Test: 2017 Continued

- Surveys started in May 2017
  - Baseline activity at smooth towers
  - Activity at smooth and texture-treated towers
- Observed 1,030 bats at the turbine towers during the survey period



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Project Status and Availability of Results

- Our final technical report is due to the DOE this week
- Plan on submitting the results from the texture coating development process and the flight room trials for publication in peer-reviewed journals in 2018
- We are working with NextEra Energy Resources to develop a study plan for a possible second season of bat activity surveys at the experimental turbine towers in 2018
  - Additional season will increase the sample size and allow us to more fully understand the effect of the texture coating
  - Pending these results, we will continue to work with our research partners to determine if a larger-scale field test is necessary while simultaneously working on commercialization efforts.