Hawaiian hoary bat monitoring

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University of Hawai'i at Hilo

Proposed and on-going research

- Reforestation mitigation assessment
- Video monitoring of bat activity & behavior
- Bat density and population size estimation

Completed monitoring study

- Bat activity & behavior at wind turbines

Reforestation and habitat enhancement

does mitigation offset bat take?

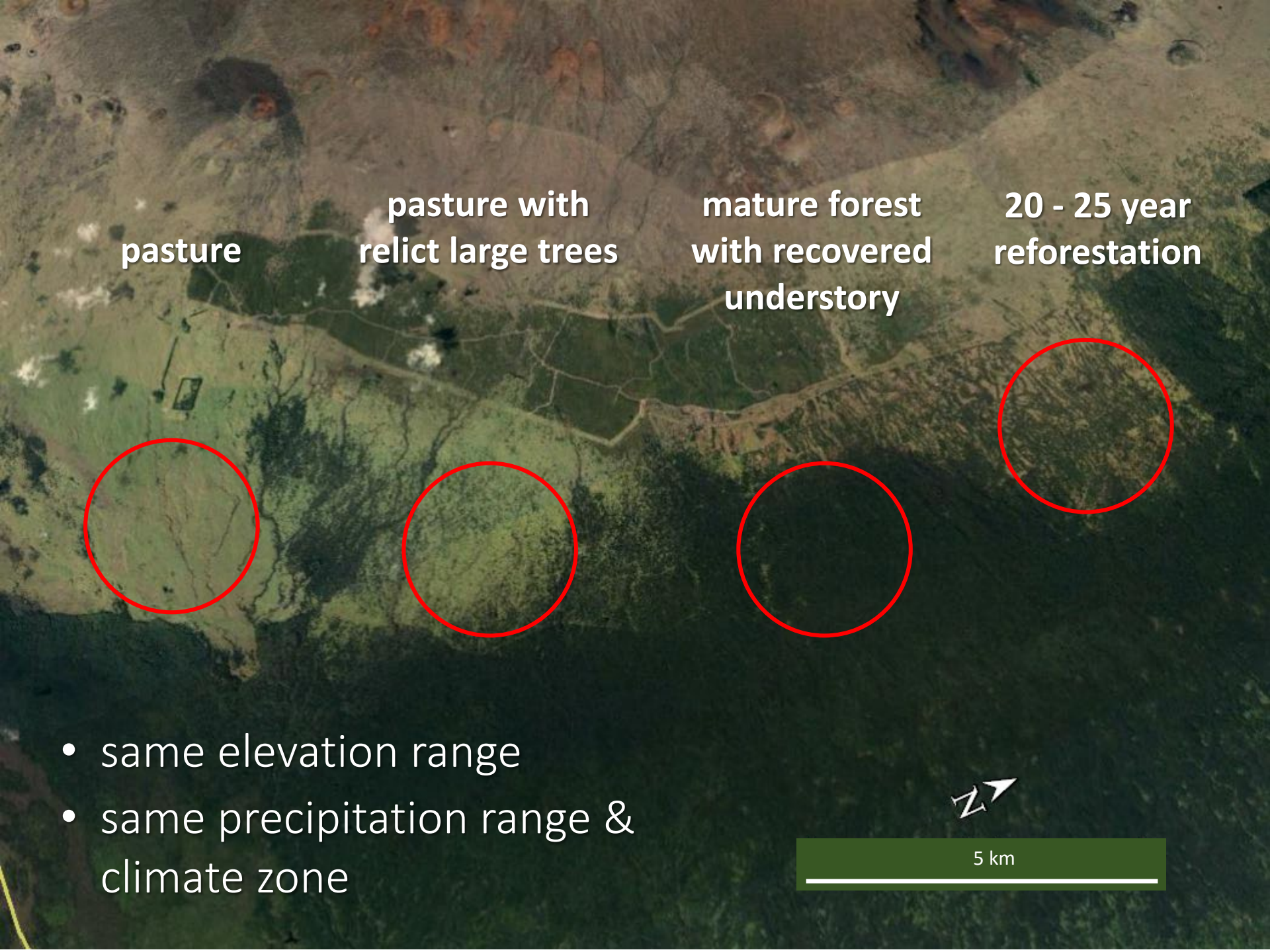
↓

does reforestation affect bat habitat quality?

↓

insect prey availability and bat use

- assess insect biomass and composition
- assess bat activity rates and behavior
- compare land-cover types
- sample at landscape scale



- same elevation range
- same precipitation range & climate zone

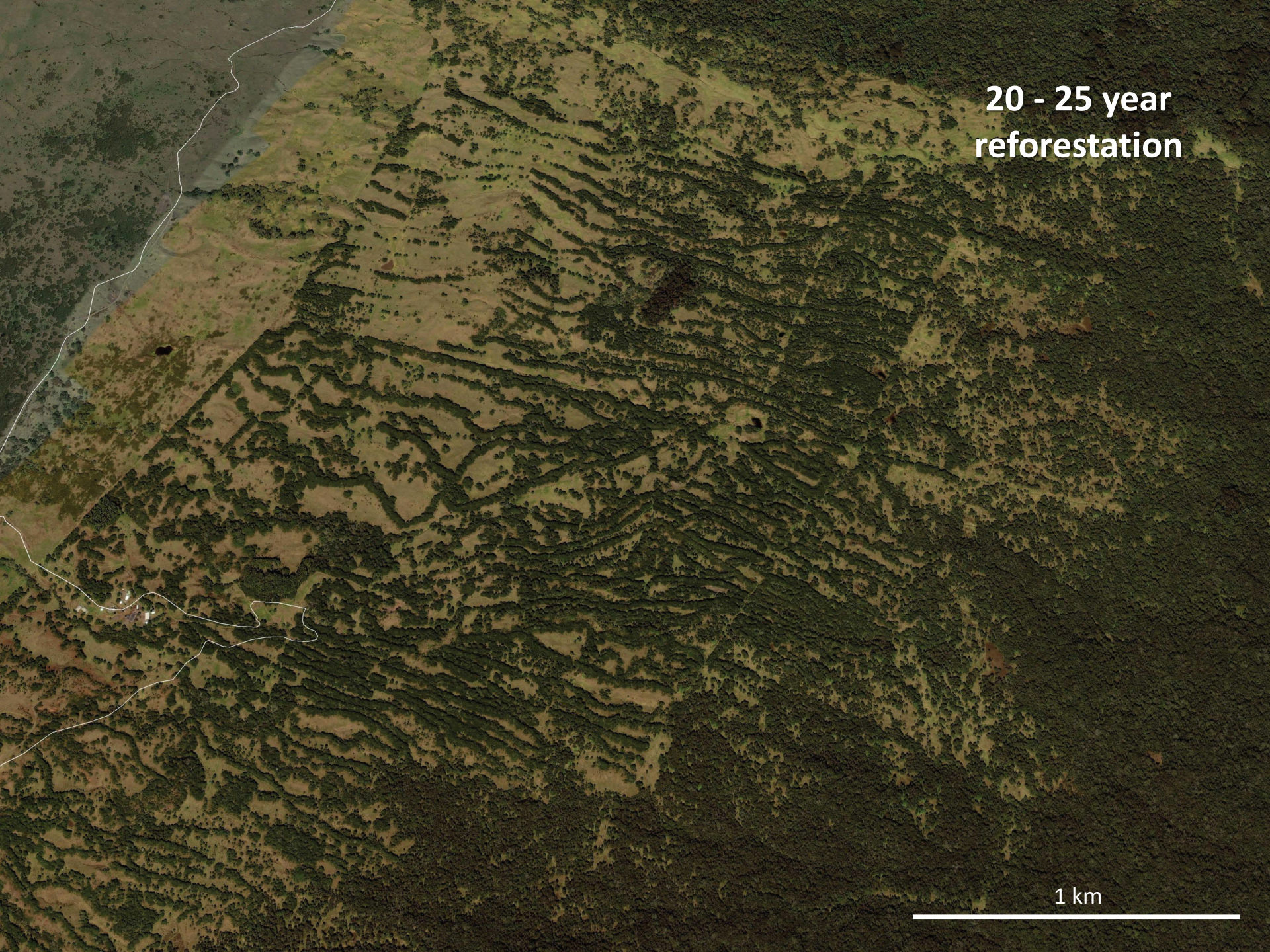
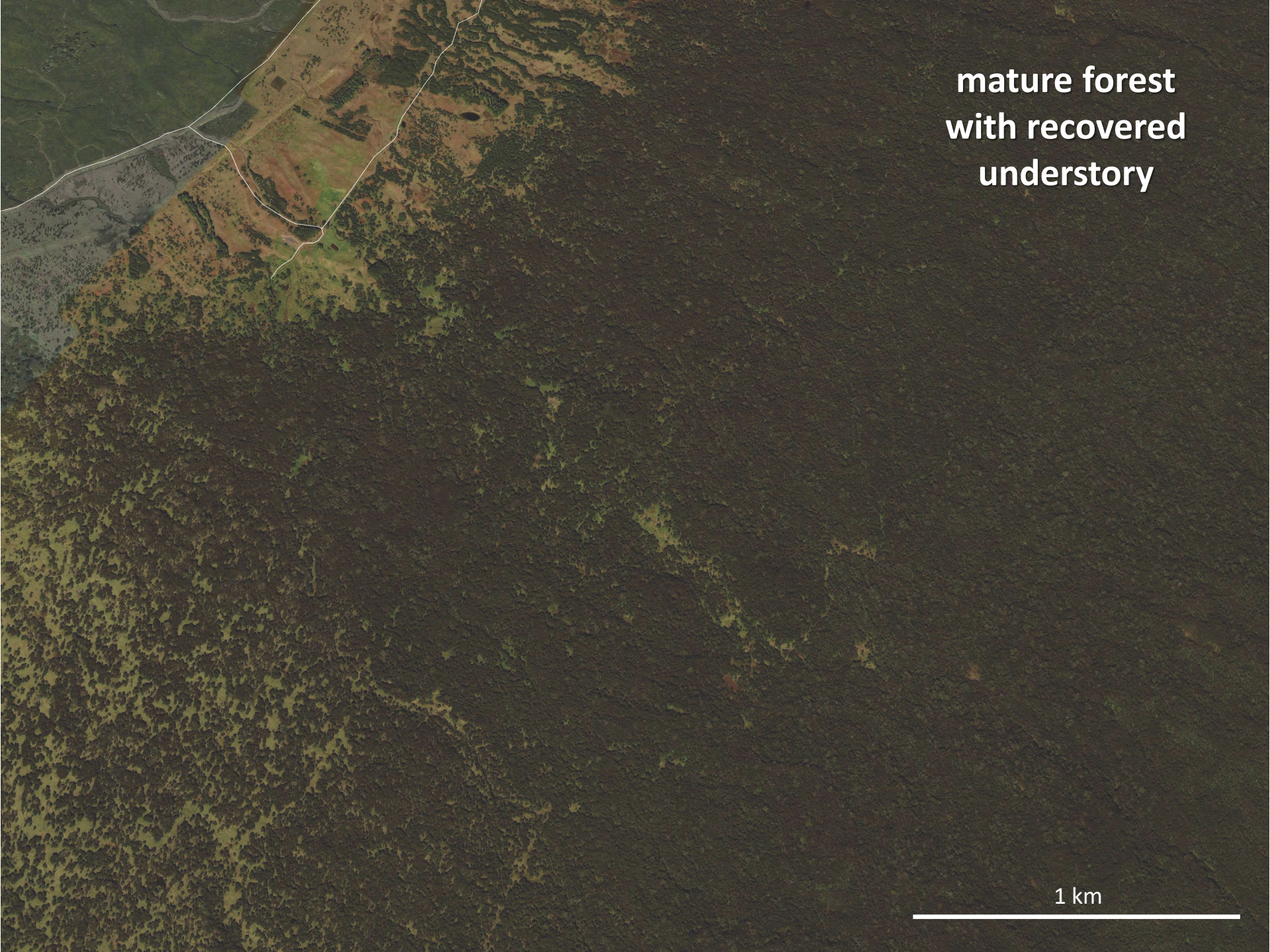

20 - 25 year
reforestation
1 km

Photo: S. Yelenik


mature forest
with recovered
understory
1 km

pasture
1 km

malaise / light trap

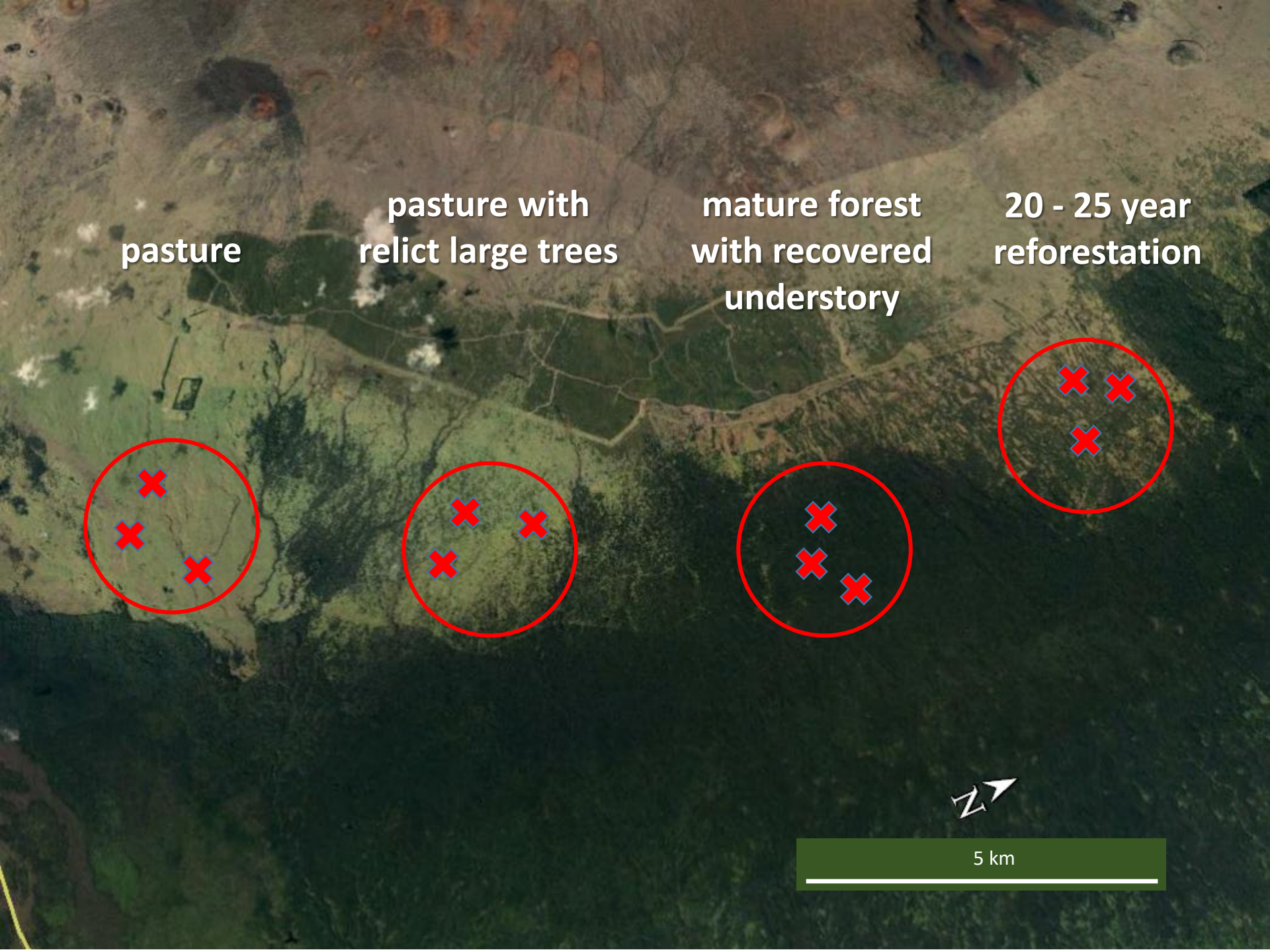
thermal camera

acoustic detector

alternating horizontal and vertical profiles

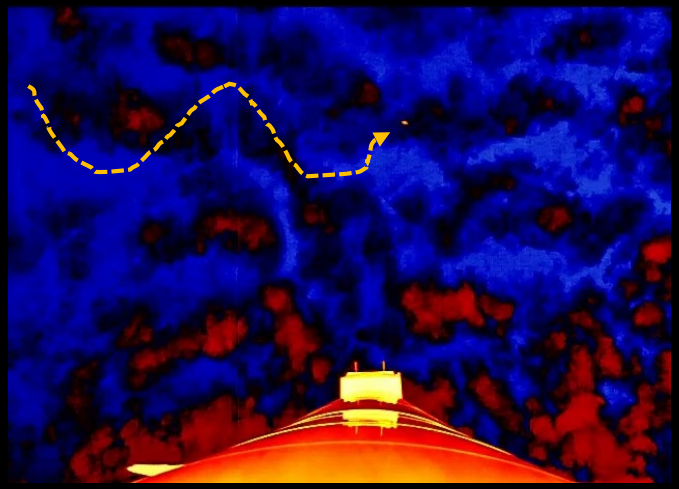
regular time intervals

detection range:
insects ≈500m
bats >1km


pasture
pasture with relict large trees
mature forest with recovered understory
20 - 25 year reforestation
N
5 km

Video monitoring of bat activity & behavior

thousands hours of recordings….
what's that speck?



- USGS-FORT and National Renewable Energy Laboratory
- open-source software tools for surveillance video
- computer-vision with machine learning
- automate real-time detection, classification, tracking and counting of flying animals against dynamic backgrounds (clouds and moving turbine blades)
- publication later in 2020 & further development (e.g., NABat)
- long-term monitoring, deterrent tests, and offshore application

Camera 55 2015-08-23 02:29:12

Bat density and population size estimation

how many bats are there?

↓

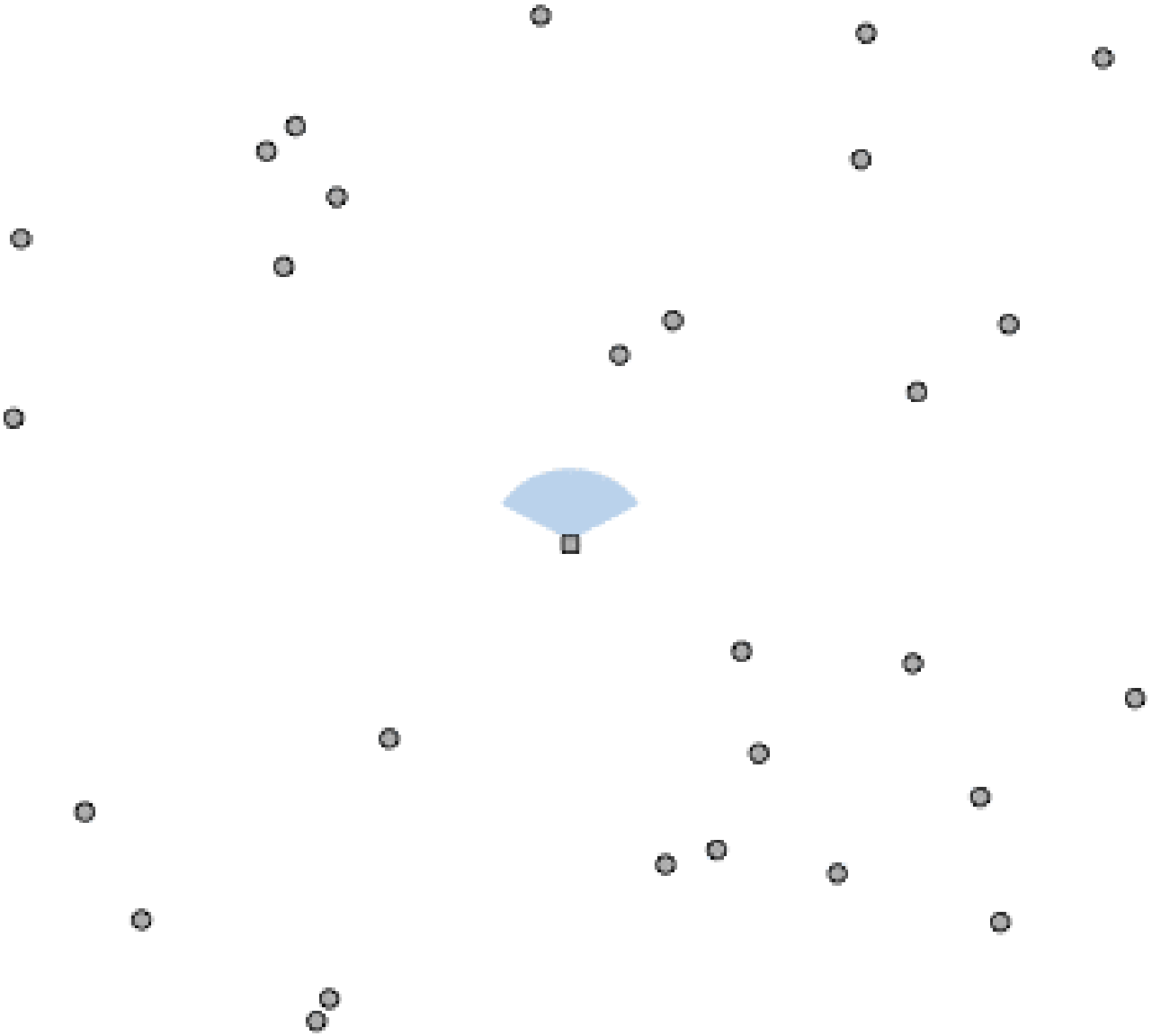
generate multiple local density estimates

↓

extrapolate to habitat area

- density estimation with “camera trapping” (thermal video or acoustic detectors)
- random encounter model (REM), space to event (STE)
- unmarked animals (no info needed on number or identity tracking)

Camera trap



https://figshare.com/articles/Animation_for_A_generalised_random_encounter_model_for_estimating_animal_density/1321223/1

Video monitoring of bat activity & behavior

Milchram et al. 2020. Estimating population density of insectivorous bats based on stationary acoustic detectors: A case study. Ecology and Evolution.

…. *but how to validate model estimates???*

Applied REM model to video detections → **estimated 2 to 8 bats/km^2**

→ validate with radar sampling of targets within ~1 km radius

- identify habitat strata
- spatially balanced design
- large oversample
- **paired** thermal video and acoustic detector
  - correlation → correction for acoustic-only samples in follow-up studies

Video and acoustic monitoring of bat activity & behavior at wind turbines

Hawaiian hoary bat (*Lasiurus cinereus semotus*) behavior at wind turbines on Maui. Gorresen et al. In review. Technical Report HCSU-093
https://doi.org/10.5066/P937H9LQ

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Objectives

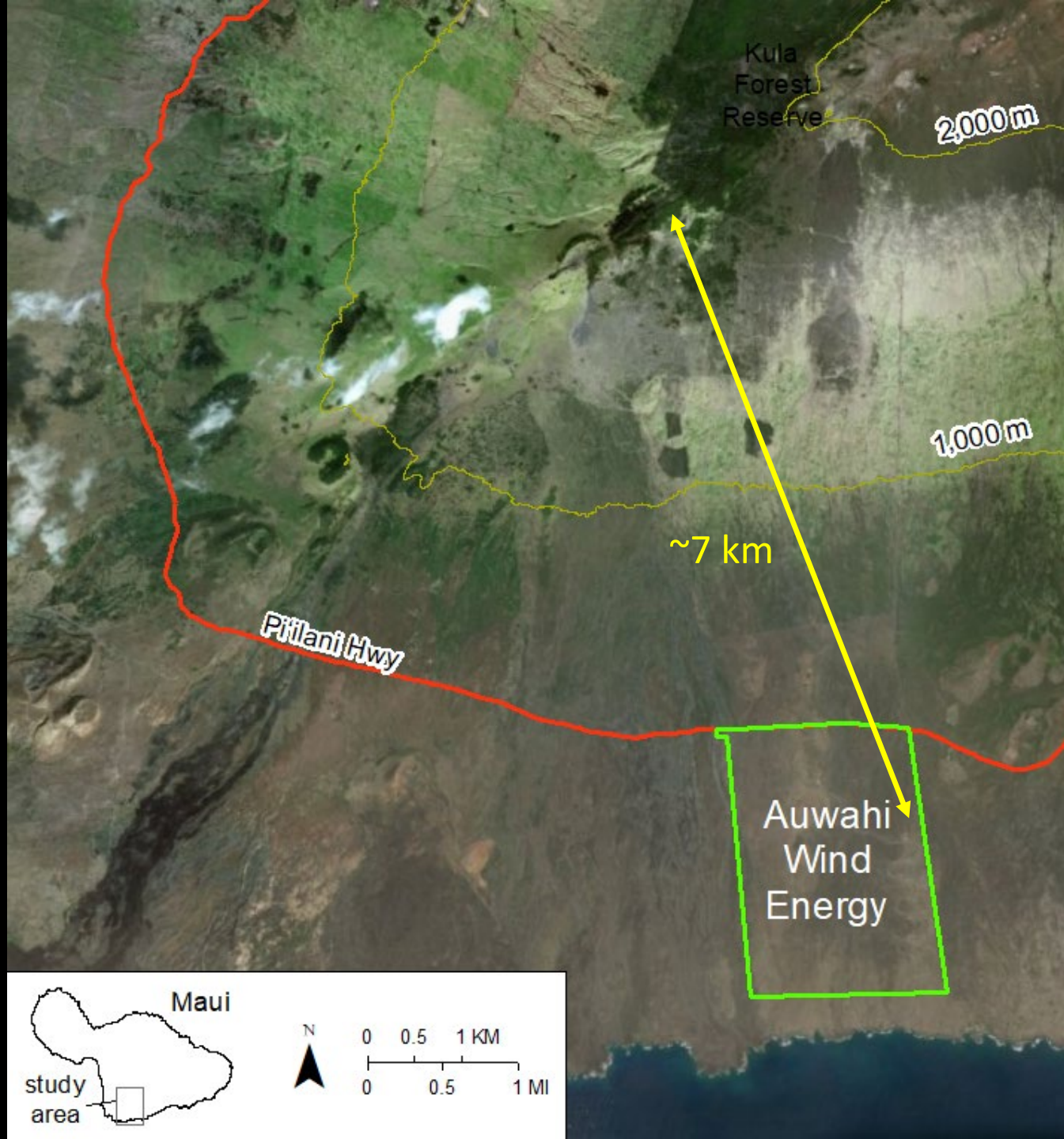
- *investigate behavior of bats interacting with turbine*
- *relationship of bat activity and wind speed*
- *reliability of acoustic monitoring to determine presence*

southeast Maui
Auwahi Wind Energy

4 turbines
August – November 2018

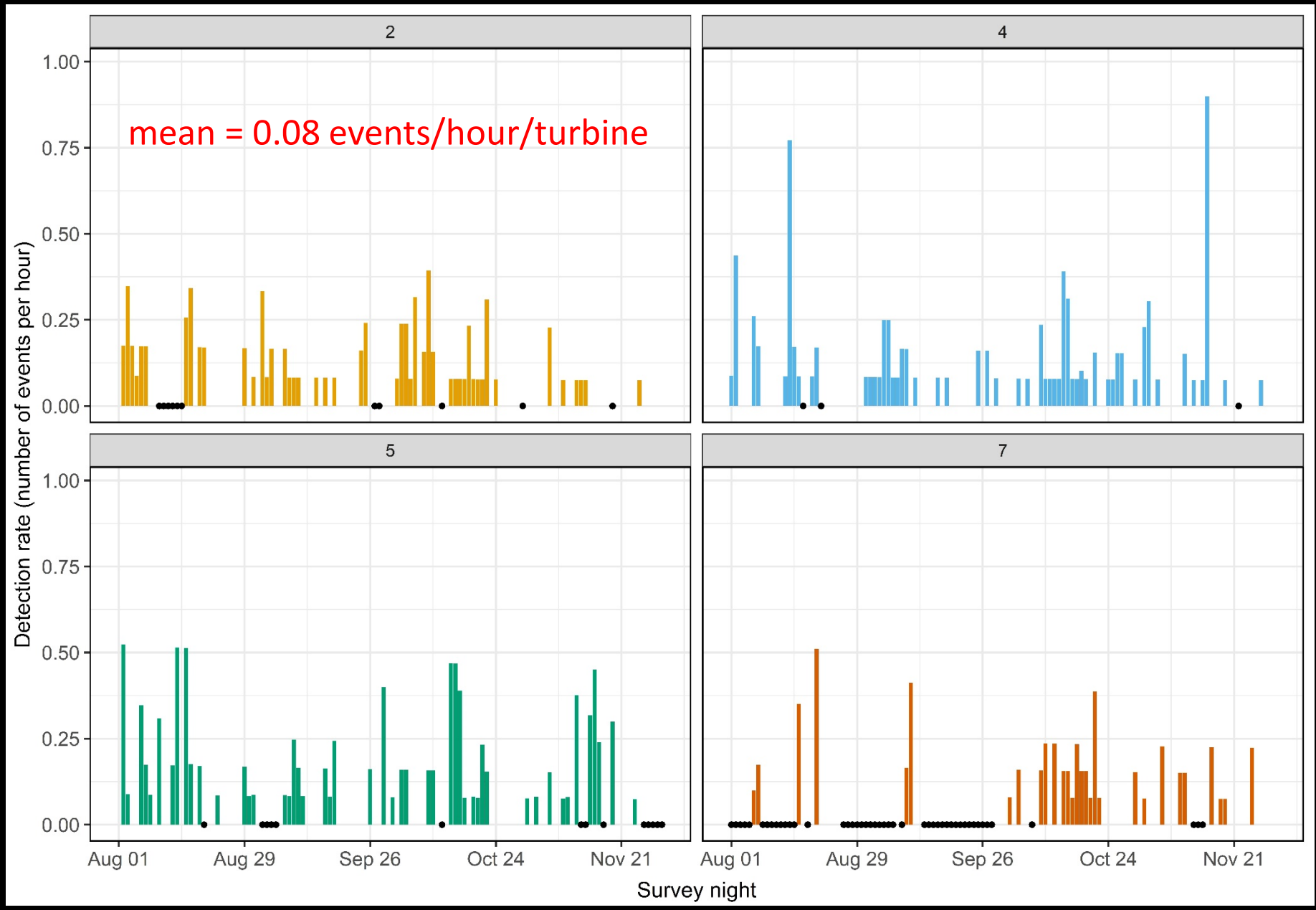
Video
412 turbine-nights
(5,000 hours)

Acoustic
247 turbine-nights
(3,000 hours)

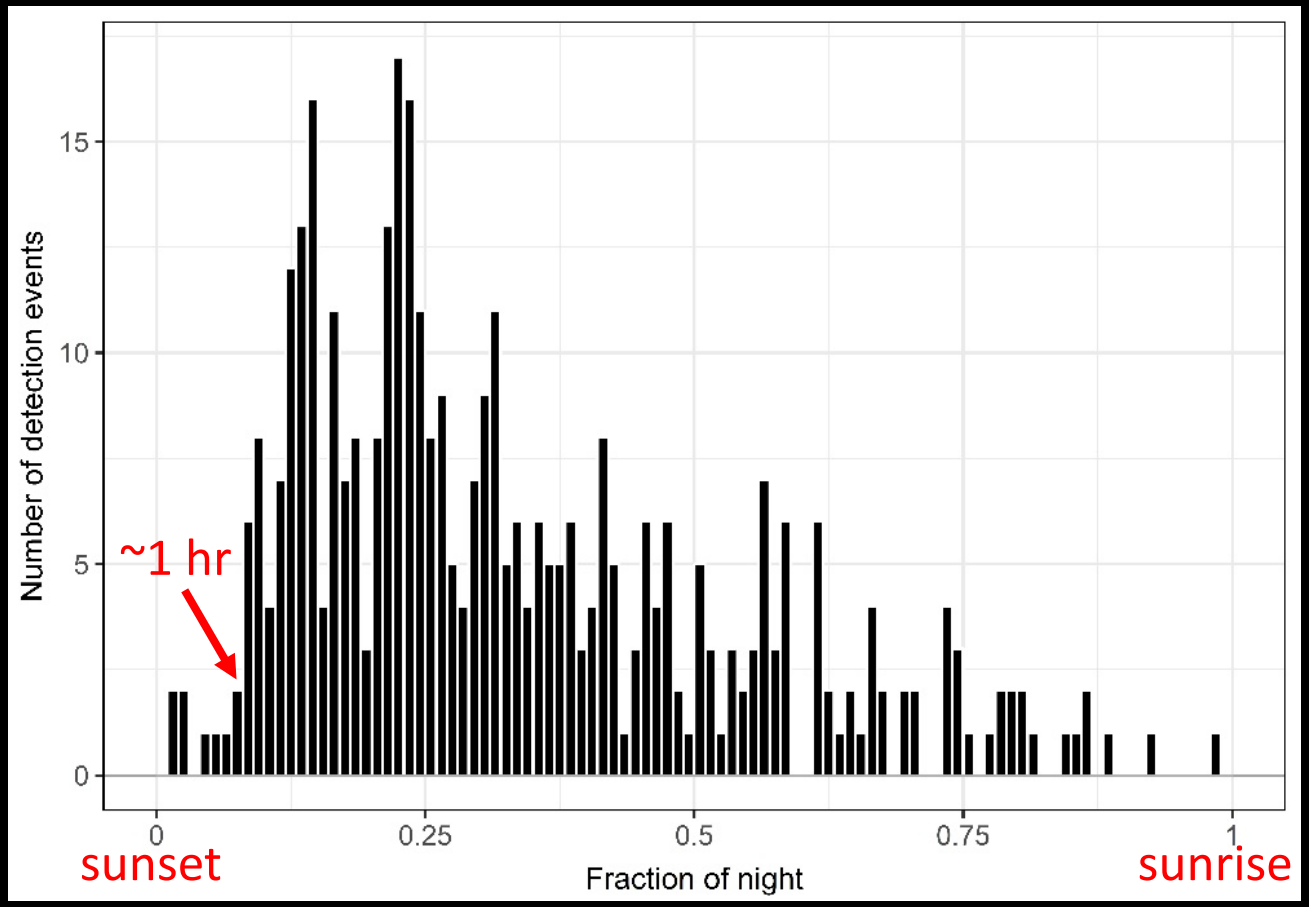


Turbine 7 2018-11-01 22:10:19

Detection over time

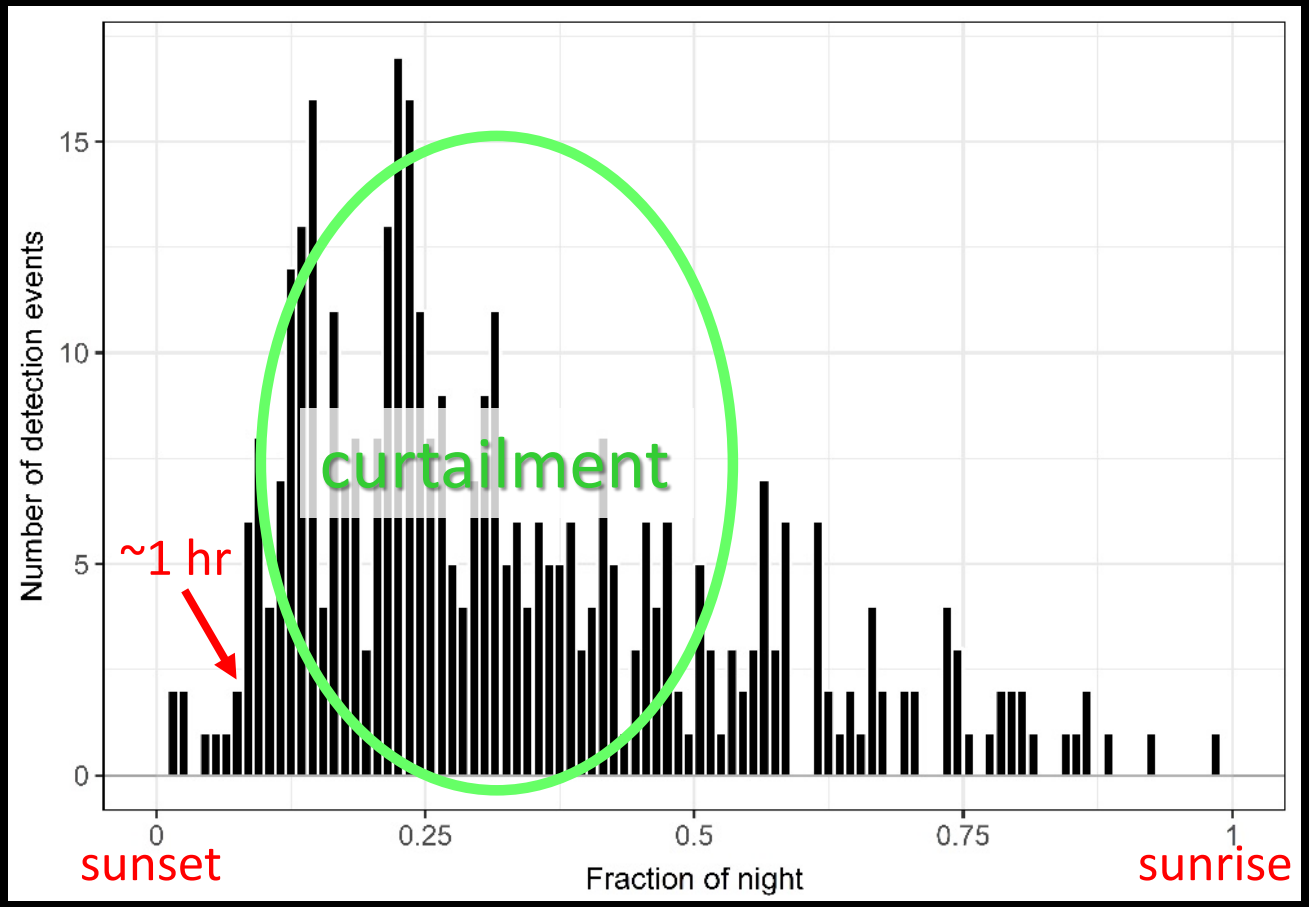


Time of night



- late arrival (>1 hour past sunset); no pre-dawn bump
- ¾ detections before middle night
- consistent over Aug-Nov period

Time of night



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- ¾ detections before middle night
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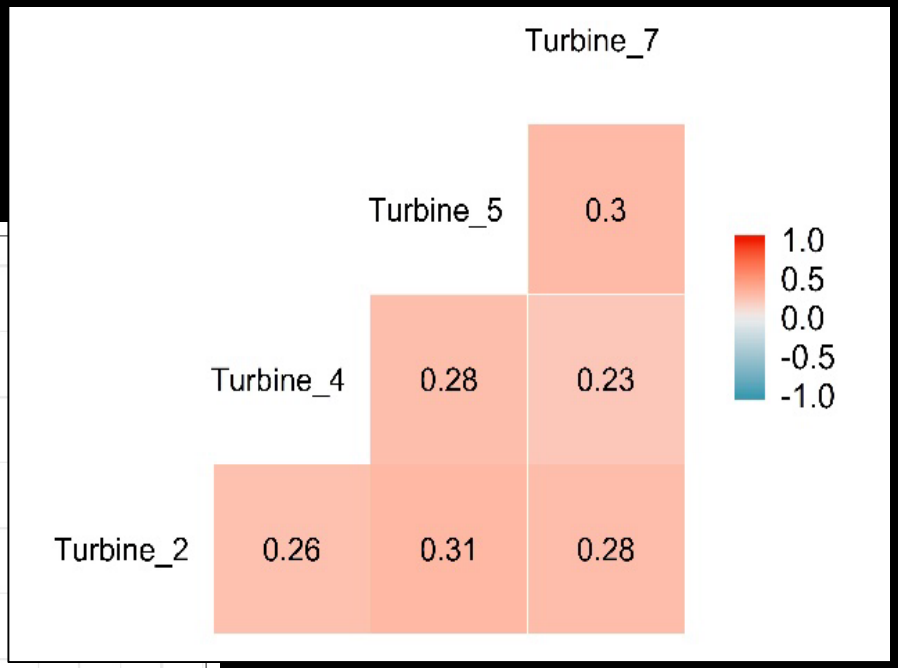
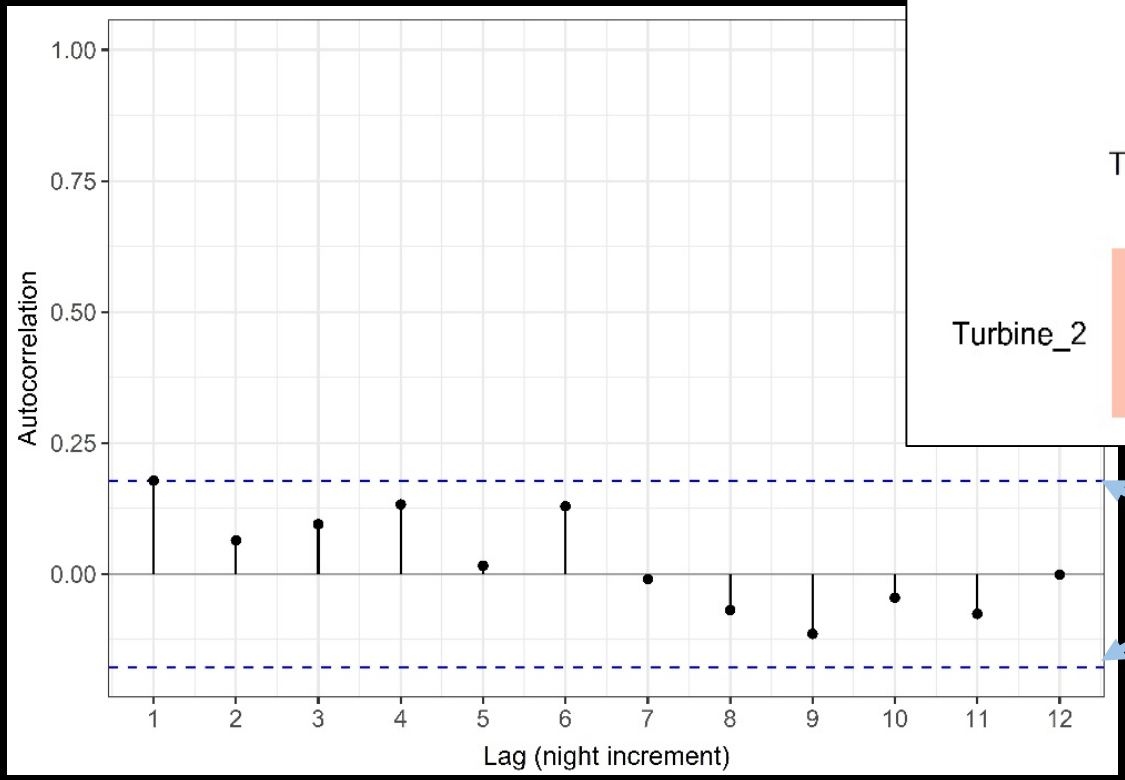
Spatial correlation



Temporal correlation

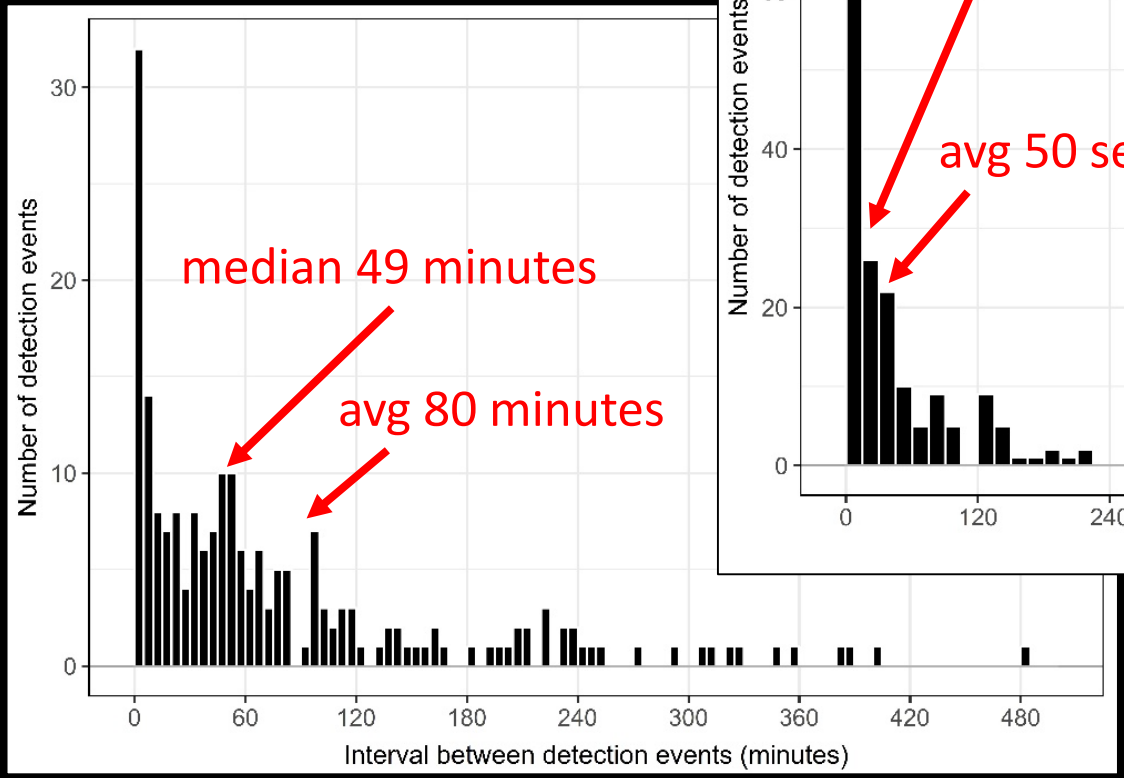


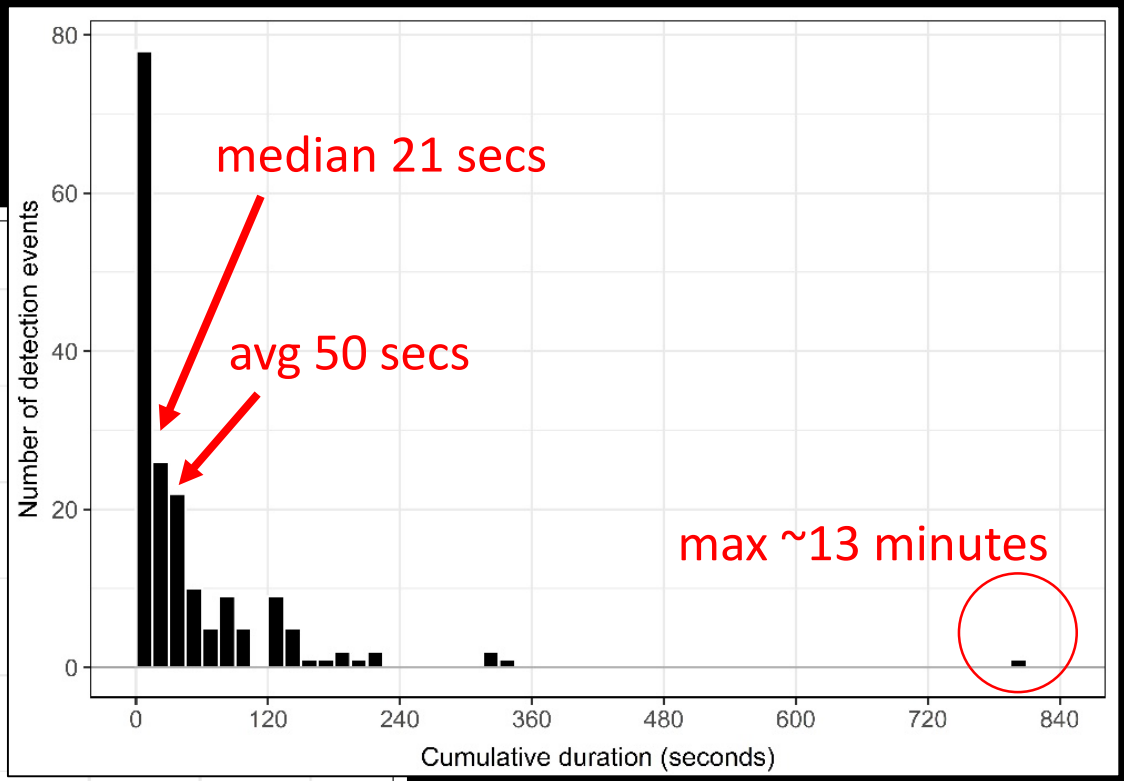
significance thresholds

- weak temporal correlation
- modest spatial correlation

Detection duration

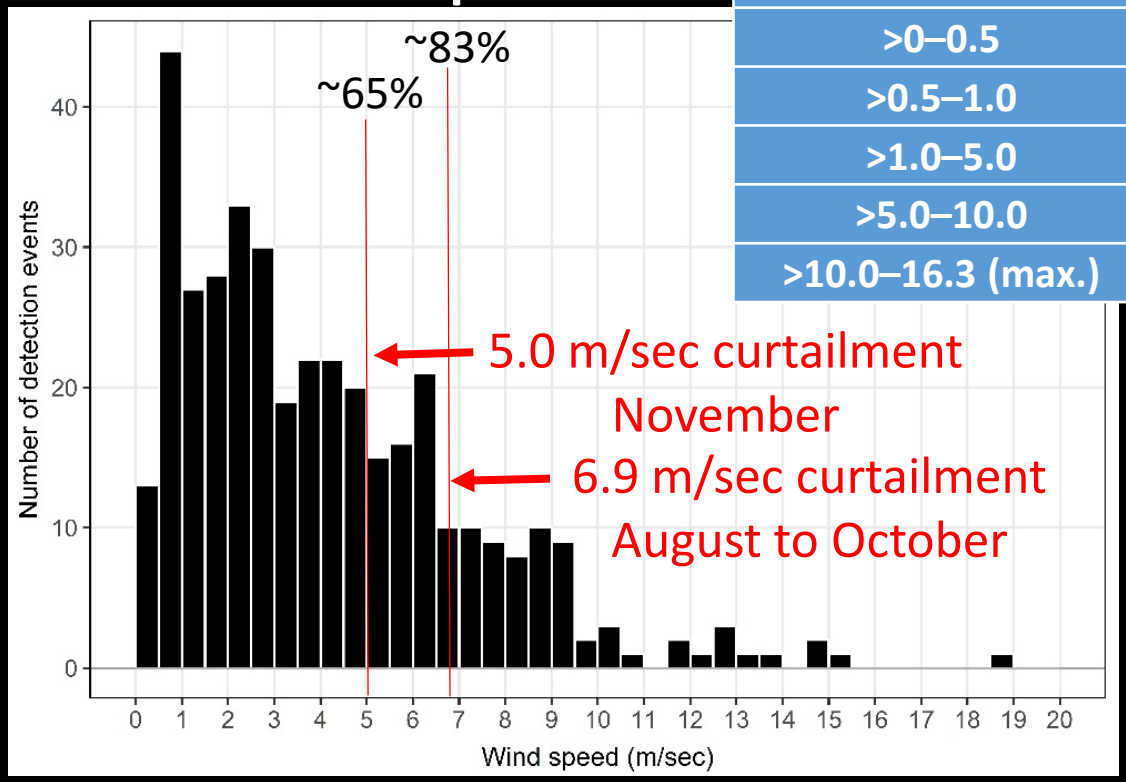
Detection interval





- brief and infrequent detections
- 0.05% total monitoring (2.5 hours of 5,066 hours)

Bat detections and wind speed



Bat detections and turbine RPM

RPM	Number of events	Proportion
0	315	82.0%
>0–0.5	35	9.1%
>0.5–1.0	4	1.0%
>1.0–5.0	3	0.8%
>5.0–10.0	9	2.3%
>10.0–16.3 (max.)	18	4.7%

at 0.5 RPM blade velocity is 2.6 m/sec

- most detections occurs below curtailment thresholds
- most detections occur at or close to 0 RPM

Acoustic detection at turbines

reliability of acoustic monitoring to determine bat presence

- previous study: bats seen were heard 1/3rd of time
- echolocation detection
  - call strength and peak frequency, "silent" flight
  - bat-mic angle, mic-sensitivity, ambient noise

- concurrent visual (video) and acoustic samples
  - 294 visual detections
  - 10 minute window: 12%
  - 2 hour window: 22%
    - 65% bats flying within 15 m of nacelle

Acknowledgments

- Grace Tredinnick (HCSU - UH Hilo)
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  - M. VanZandt, G. Akau, B. Campbell, N. Santos, R. Pederson, and J. Galvan
- Natural Power Consultants
  - C. Sutter

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Ultraviolet light deterrents

Marcos Gorresen — Hawai'i Cooperative Studies Unit – UH Hilo
Paul Cryan — US Geological Survey – Fort Collins Science Center

Current understanding and minimization

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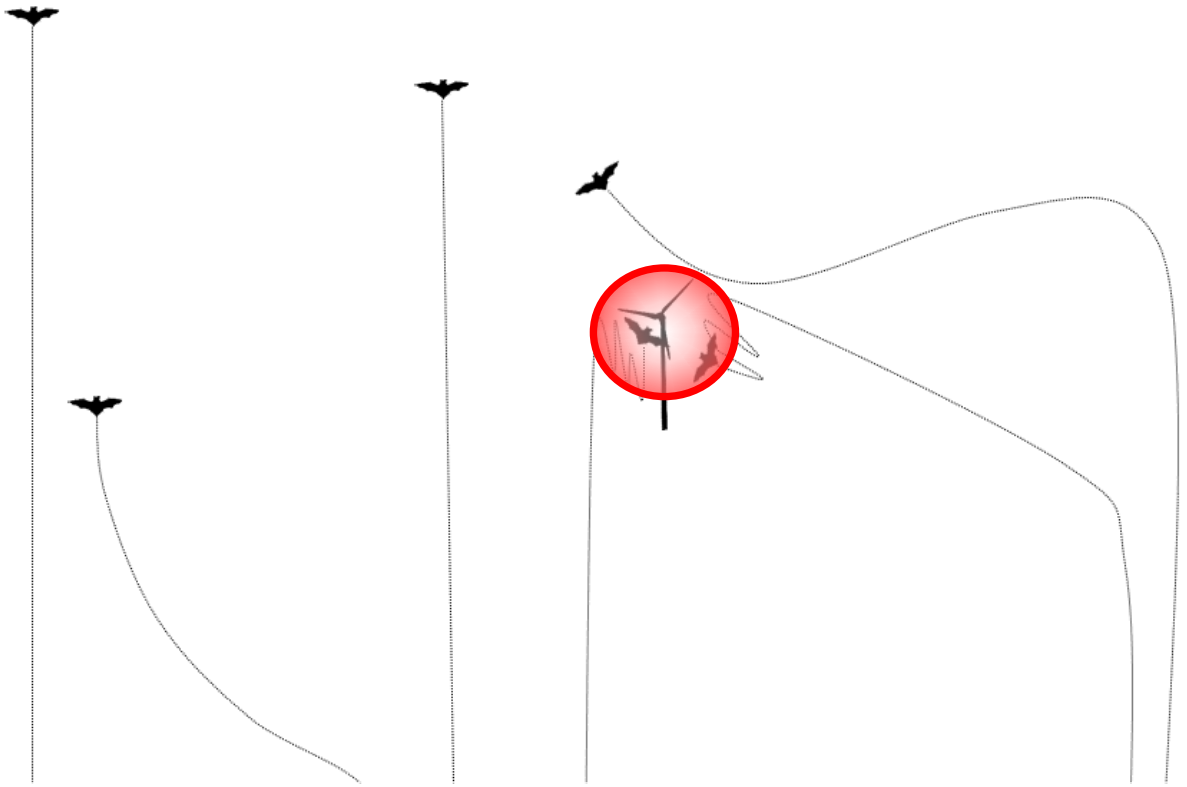
close to turbine

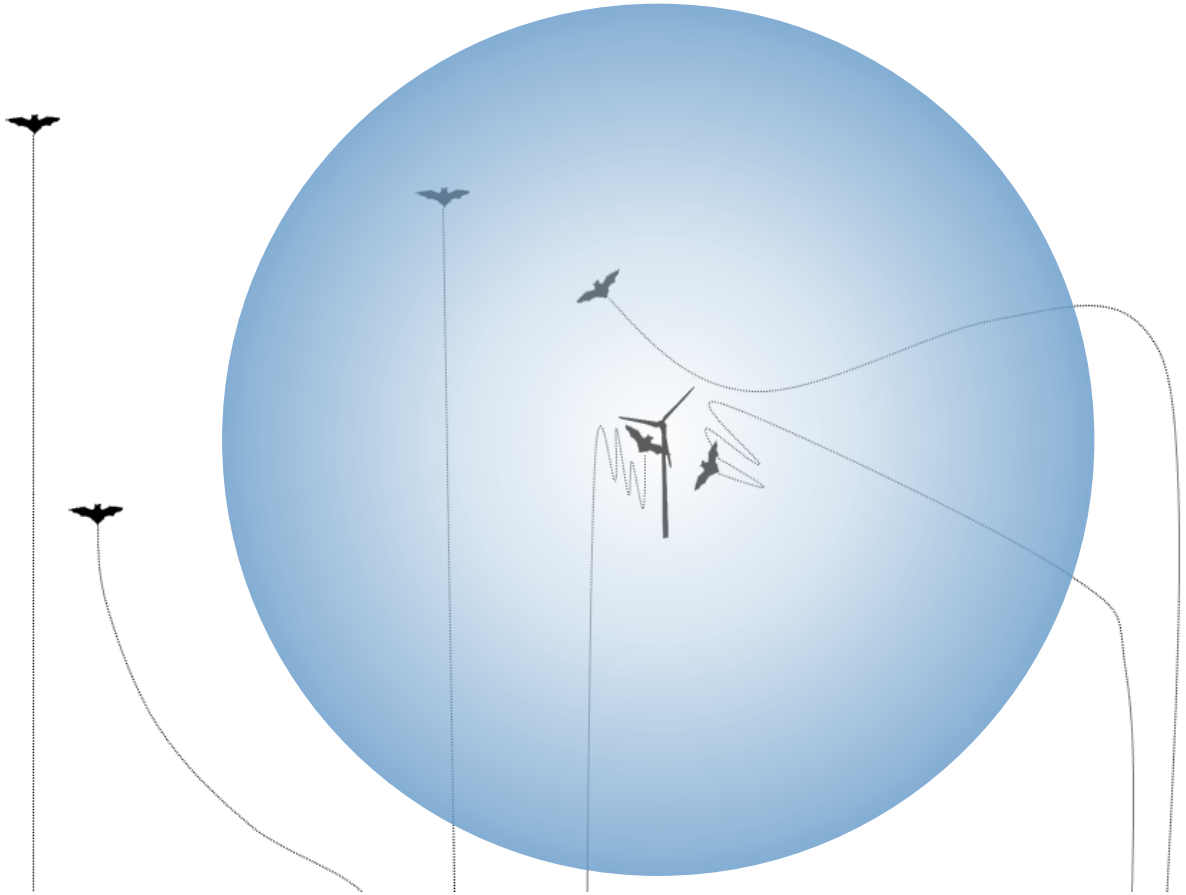
Methods Fatality searches Acoustic detectors Video cameras

Minimization Curtailment Acoustic deterrents Texture modification



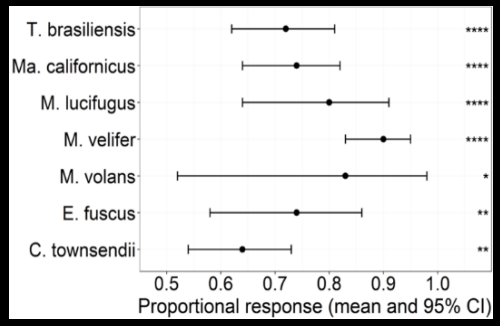
If fatality minimization is moving forward before understanding cause at observable scale, ***why not go bigger*?**

Can we avoid possible attraction from afar?



How might bats see trees and turbines?

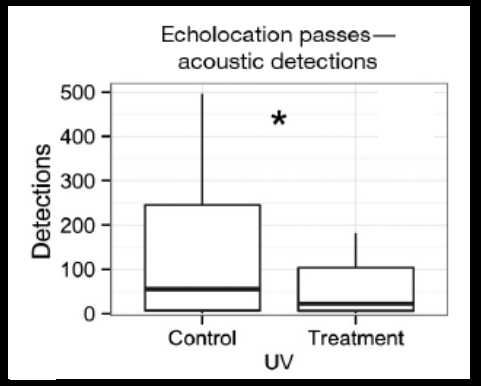
Ultraviolet vision and bats

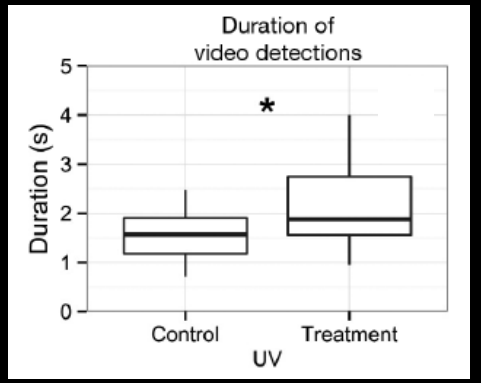


Gorresen *et al*. 2015
Ultraviolet vision may be widespread in bats.
Acta Chiropterologica

- ✓2014: tested & confirmed 7 bat species (3 families) see dim UV
- ✓2014: decreased hoary bat activity by flickering UV on trees
- ✓2019: tested prototype UV light systems on operating wind turbines

2020: bat response to UV at wind turbines

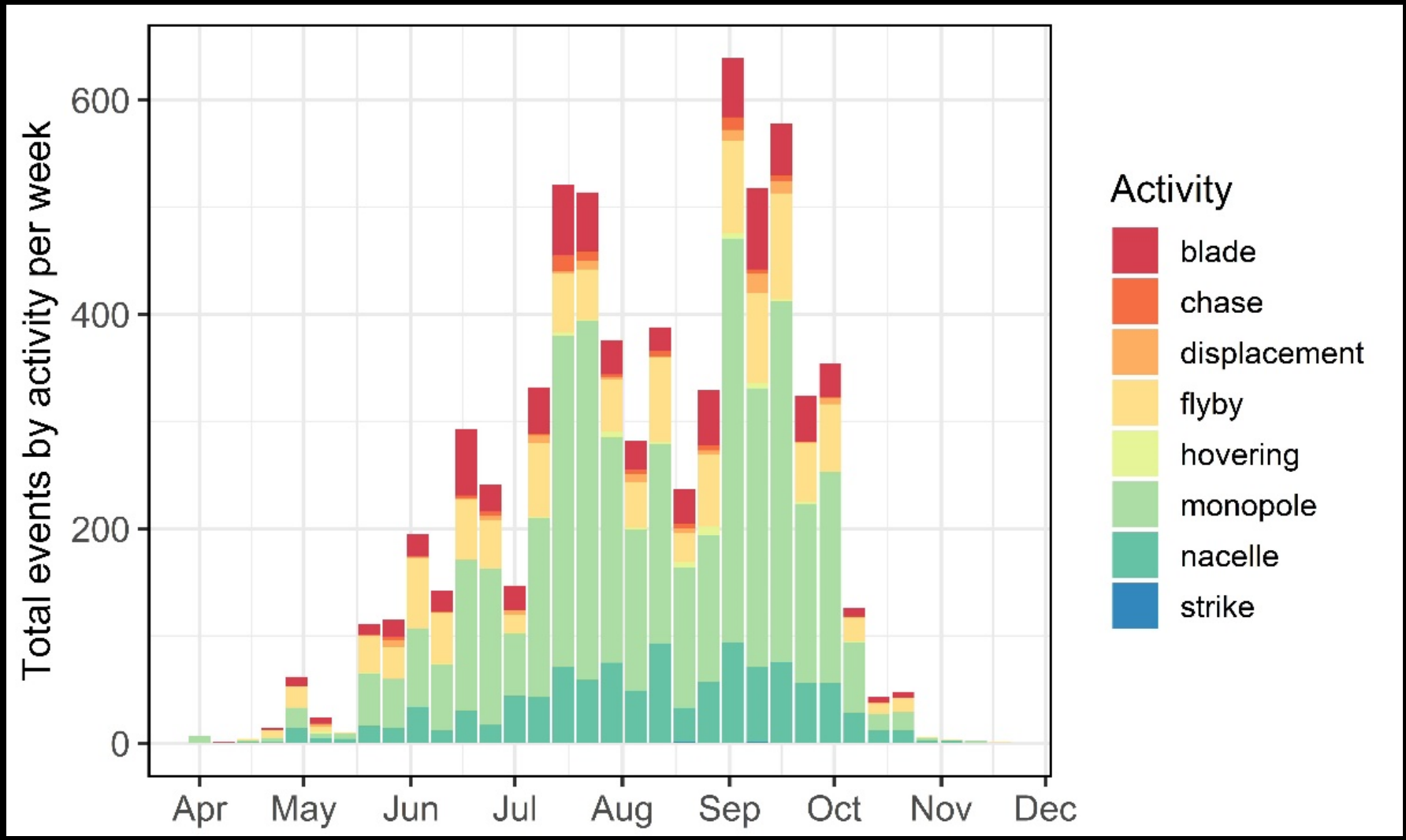




Gorresen et al. 2015
Dim ultraviolet light as a means of deterring activity by the Hawaiian hoary bat (*Lasiurus cinereus semotus*).
Endangered Species Research

UV turbine tests
National Wind Technology Center

Bat behavior at turbines



S. Z. Goldenberg, P. M. Cryan, P. M. Gorresen, and L. J. Fingersh. In review.
Behavioral patterns of bats at a wind turbine confirm seasonality of fatality risk

Acknowledgments

- National Renewable Energy Laboratory
  - National Wind Technology Center (NWTC)
    - Bethany Straw, Lee Jay Fingersh
- Siemens Gamesa Renewable Energy
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- Bat Conservation International
    - Michael Schirmacher
- American Wind Wildlife Institute

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