

Ultraviolet illumination as a means of reducing bat activity at wind turbines

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Presented 2 December 2016
Wind Wildlife Research Meeting XI
Broomfield, Colorado



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Close Attraction



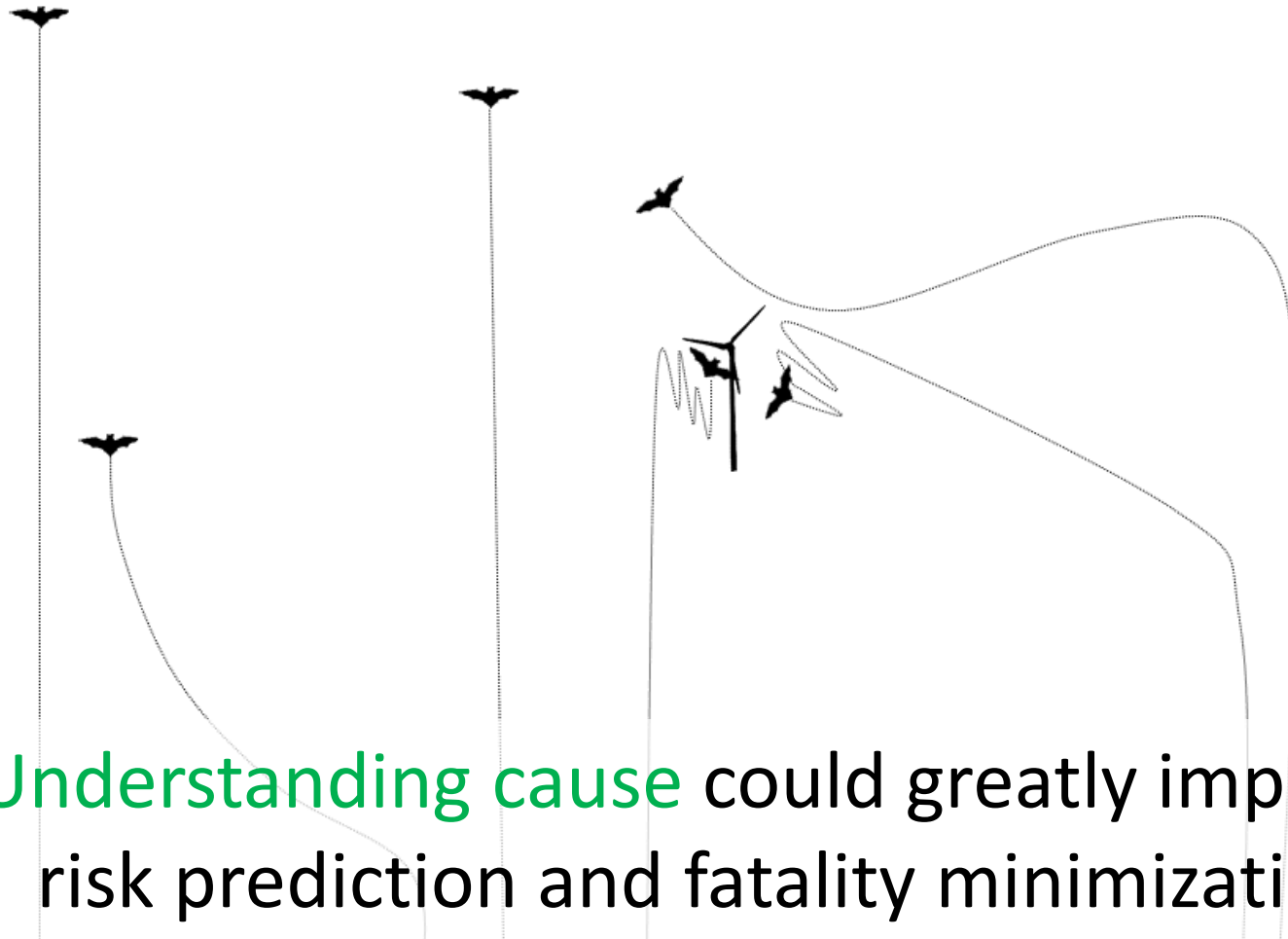
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Attraction when **close** (our current view)



Observations of tree bats attracted to turbines at close (<50 m) range are limited in scale by technology

Attraction when **close** (what lays beyond?)



Understanding cause could greatly improve risk prediction and fatality minimization



Current understanding and minimization = **Close** to turbine

Methods of Understanding

Fatality searches
Acoustic detectors
Video cameras

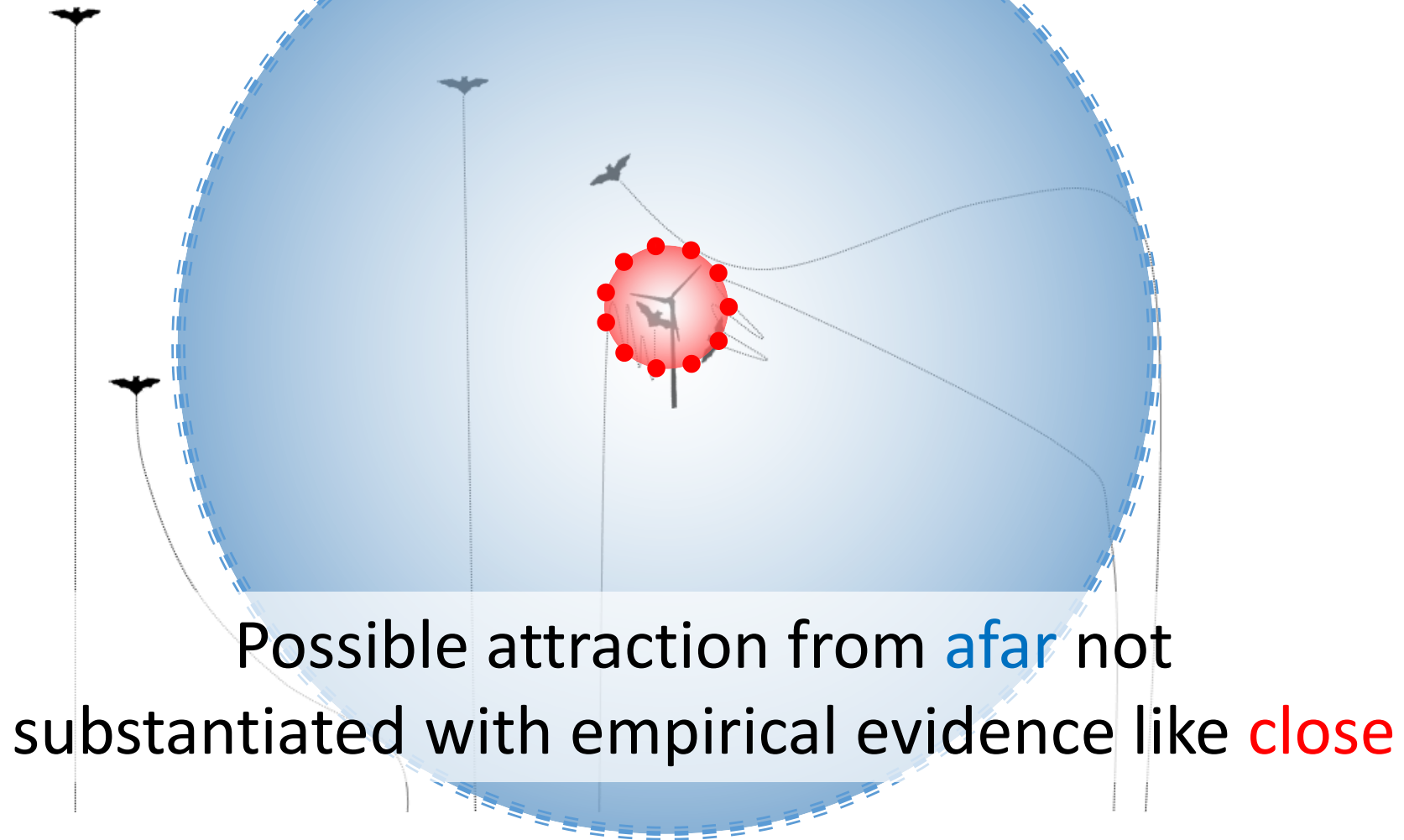
Minimization

Curtailment
Acoustic deterrents
Detect & deter
Texture modification

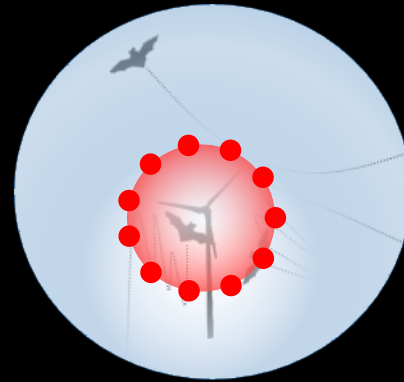
If fatality minimization research is moving forward
before understanding **cause** at observable scale,
why not go bigger?



Can we avoid possible attraction from afar?



Why act beyond our **close** view without clear evidence of attraction from **afar**?



Empirical
Evidence



*Logical
Argument*





Photo by Rosalie Winard (www.rosaliewinard.com)

“If you want to understand animals, you need to get away from verbal language...There is a world full of picture, sound, taste and touch memories. It’s detailed, sensory-based information.”

-Temple Grandin



Echolocation is a **close-proximity** sense

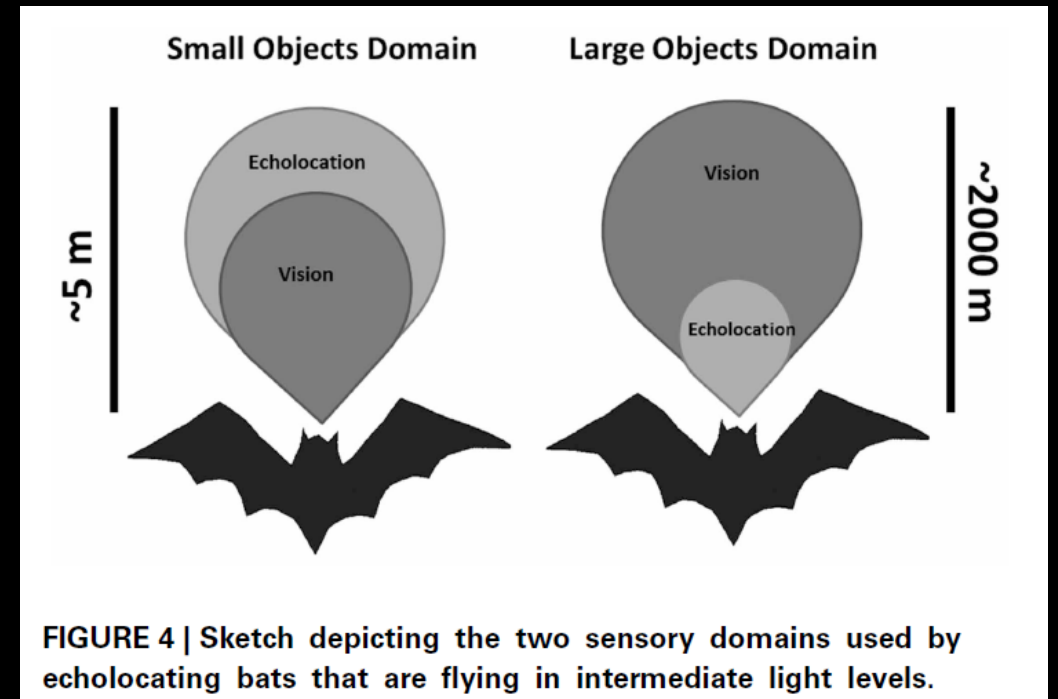
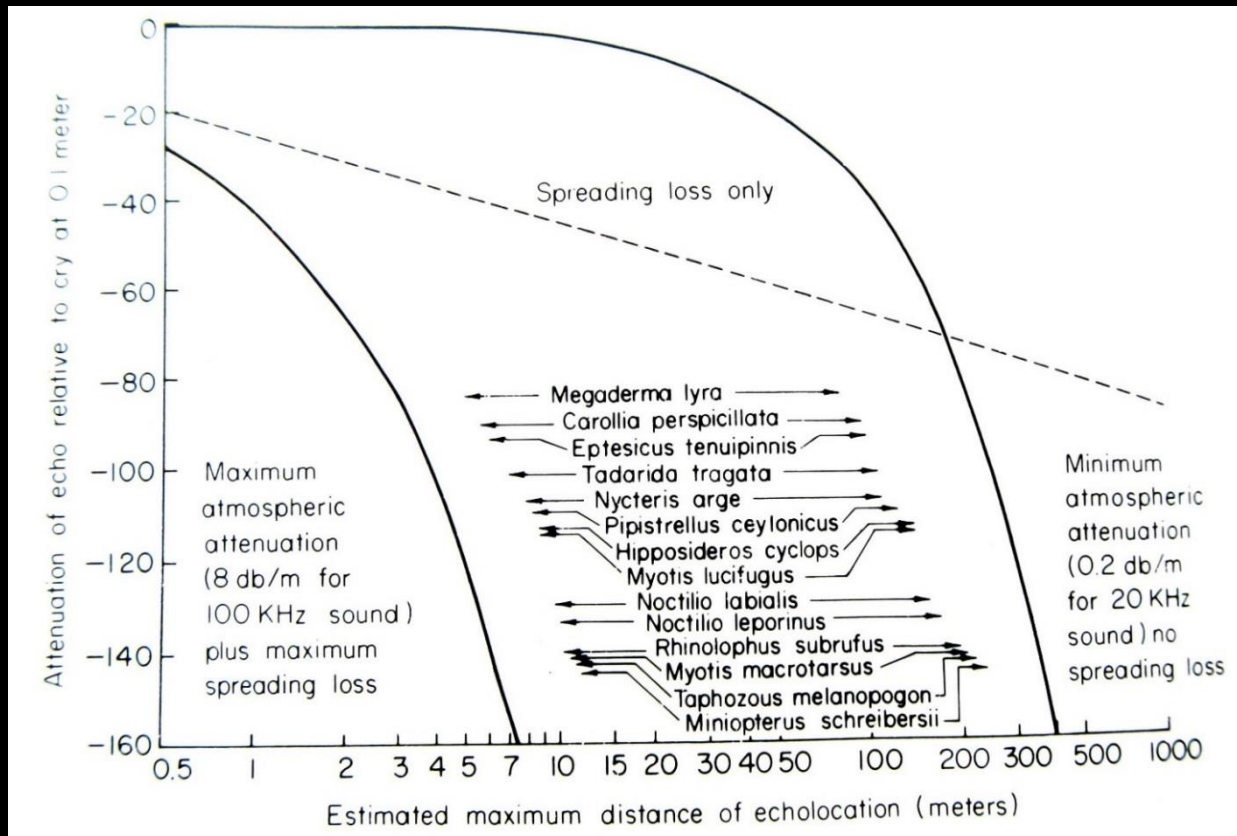


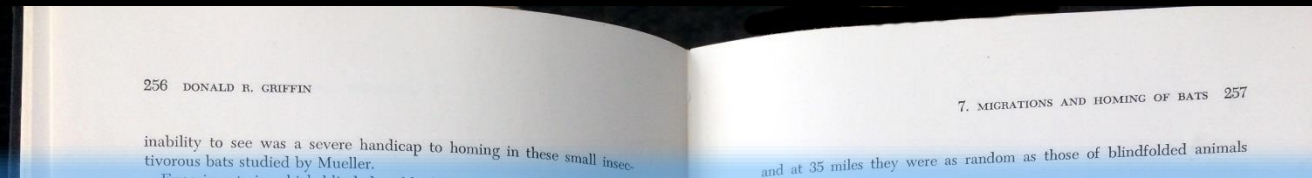
FIGURE 4 | Sketch depicting the two sensory domains used by echolocating bats that are flying in intermediate light levels.

Boonman et al. 2013. *Front. Physiol.* 4: 248

Suthers. 1970. *in* Biology of bats, Vol. 2

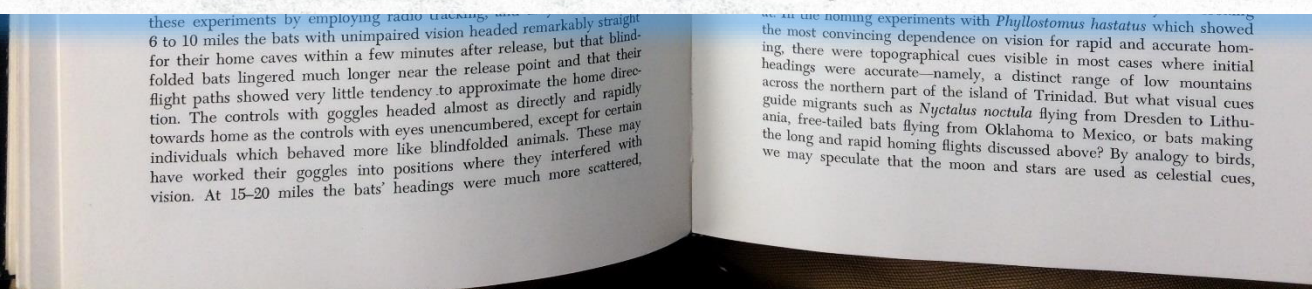


Dark-adapted vision is a long-distance sense



1968, pp. 160-167). If migrating bats are using their eyes for distant orientation, it would not be surprising if they were occasionally confused by deceptive optical cues along with migrating birds.

If we accept these indications that migrating and homing bats navigate by vision, we must then face the question of what they are looking at. In the homing experiments with *Phyllostomus hastatus* which showed



Griffin, D.R. 1970. in Biology of bats, Vol. 1

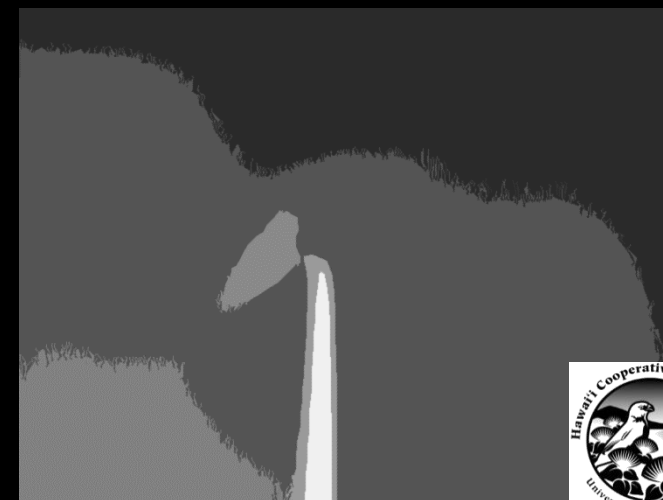
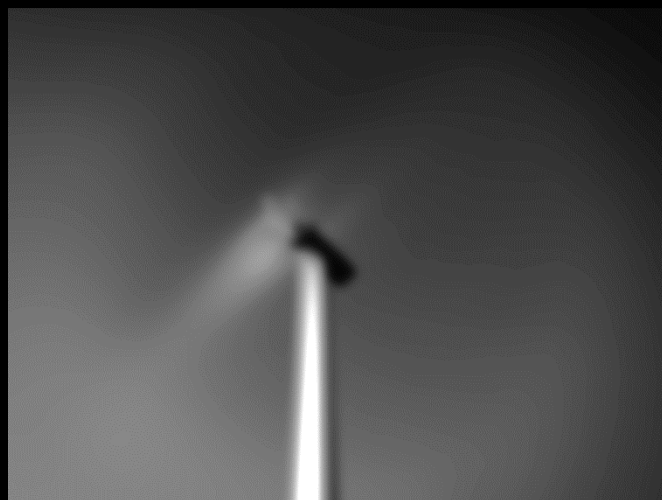
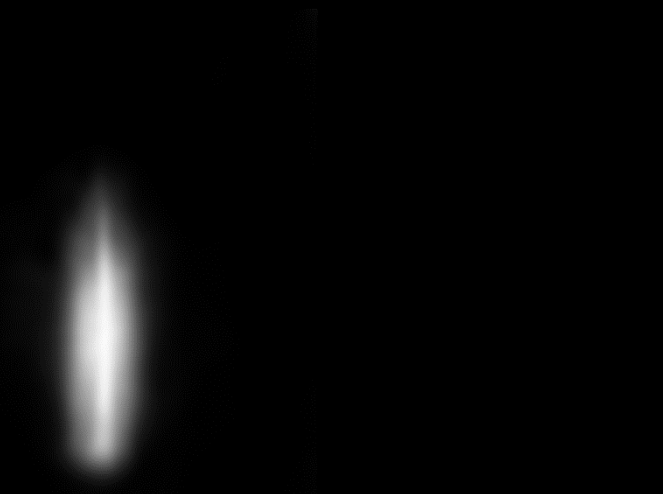
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Can tree bats see turbines through the trees they evolved among?

- Only sensory memories (no logic)
- Ingrained stimulus-response behaviors?
- Behaviors shaped by ancient forests

How might bats see turbines and trees?



The Goal: Change how bats see turbines from afar

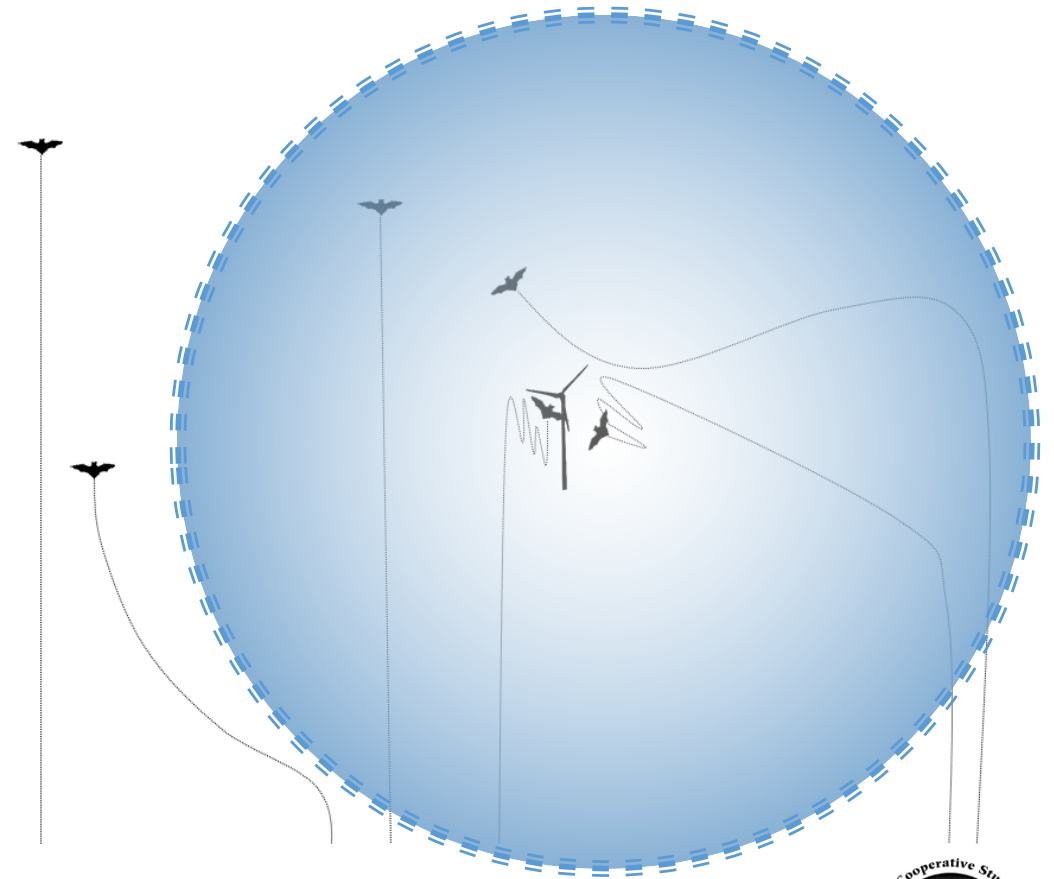
“Deceptive optical cues” from objects like those naturally associated with...

Shelter?

Food?

Water?

Others?



Why Very Dim Ultraviolet (UV) Light?

Easy to transmit through air
Outside spectral range of humans
Outside sensitivity range of birds
Unlikely to attract insects from afar

A potential bat-specific
communication channel

Ultraviolet

letters to nature

dontians, but the new data from Patagonia suggests that this ecological replacement was delayed with respect to the northern continents. This may help to explain why sphenodontians persisted longer in Gondwana than on other landmasses. □

Received 9 June; accepted 23 July 2003; doi:10.1038/nature01995

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Ultraviolet vision in a bat

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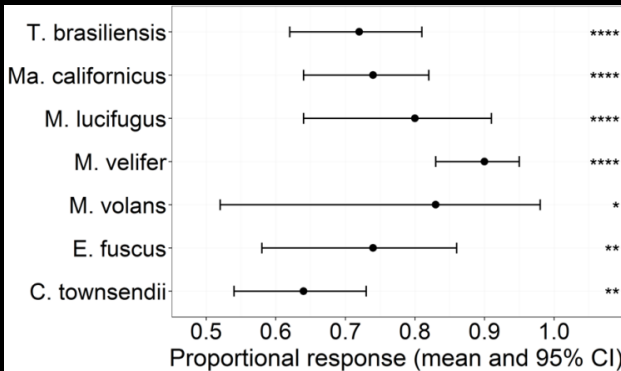
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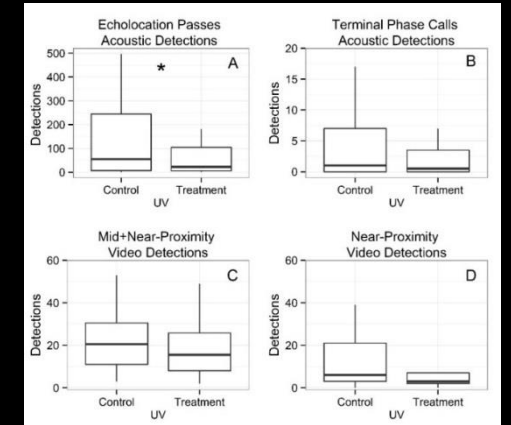
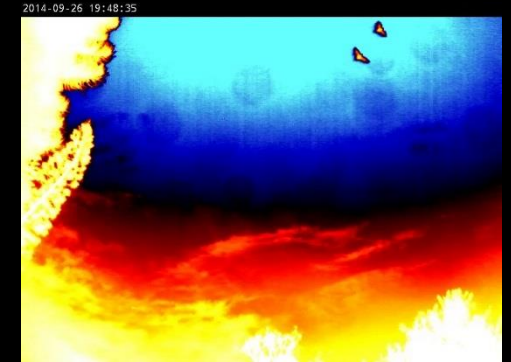


Testing Assumptions

- ✓ 2014: tested & confirmed 7 diverse bat species see dim UV
- ✓ 2014: decreased hoary bat activity by flickering UV on trees
- ✓ 2015: tested prototype UV light system on an operating turbine



Gorresen *et al.* 2015 **Ultraviolet vision may be widespread in bats.** *Acta Chiropterologica* 17:193-198.



Gorresen *et al.* 2015 **Dim ultraviolet light as a means of deterring activity by the Hawaiian hoary bat (*Lasiurus cinereus semotus*).** *Endangered Species Research* 28:249-257



A Selectively Perceptible Wind Turbine System

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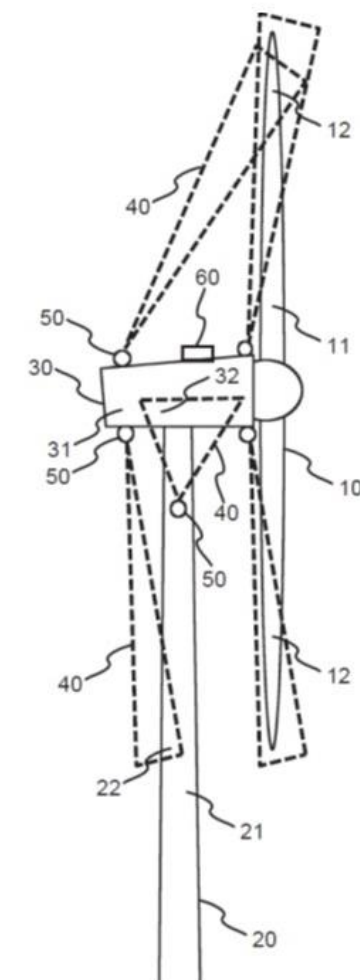
Bibliographic Data

Application Number:	14/964,386	Correspondence Address Customer Number:	57520
Filing or 371 (c) Date:	12-09-2015	Status:	Docketed New Case - Ready for Examination
Application Type:	Utility	Status Date:	07-06-2016
Examiner Name:		Location:	ELECTRONIC
Group Art Unit:		Location Date:	-
Confirmation Number:		Earliest Publication No:	US 2016-0169501 A1
Attorney Docket Number:		Earliest Publication Date:	06-16-2016
Class / Subclass:		Patent Number:	-
First Named Inventor:	Paul Michael Cryan , Fort Collins, CO (US) all Inventors	Issue Date of Patent:	-
First Named Applicant:	The US Department of the Interior , Reston, VA all Applicants	International Registration Number (Hague):	-
Entity Status:	Undiscounted	International Registration Publication Date:	-
AIA (First Inventor to File):	Yes		

Title of Invention: SELECTIVELY PERCEPTIBLE WIND TURBINE SYSTEM

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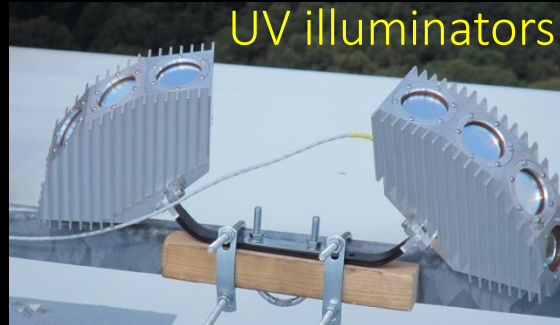


The Big Test

...with funds and industry research partner...

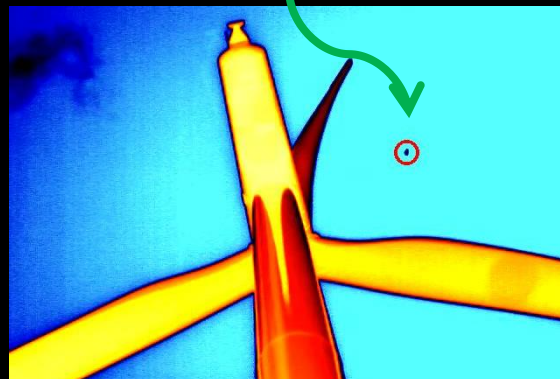
2017?: Experimentally UV-illuminate 10 turbines for 70 nights at a high-fatality wind facility

bat activity & fatality monitored by tower-mounted thermal cameras



UV illuminators

bat detection



UV illuminators on bottom and top of turbine nacelle



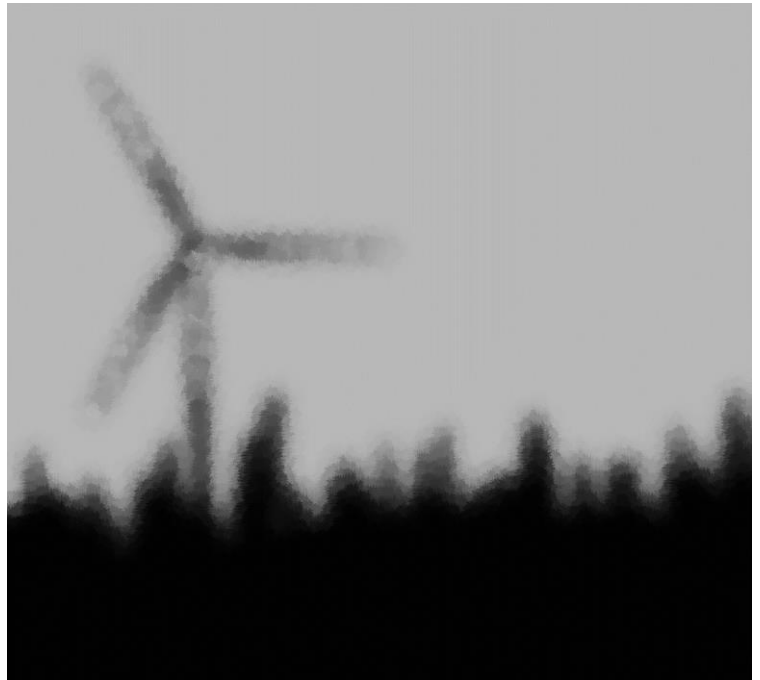
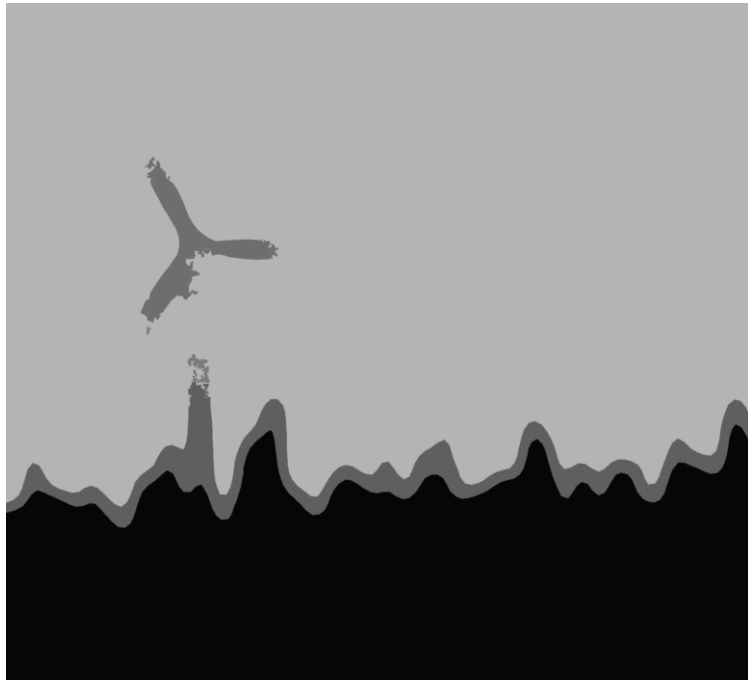
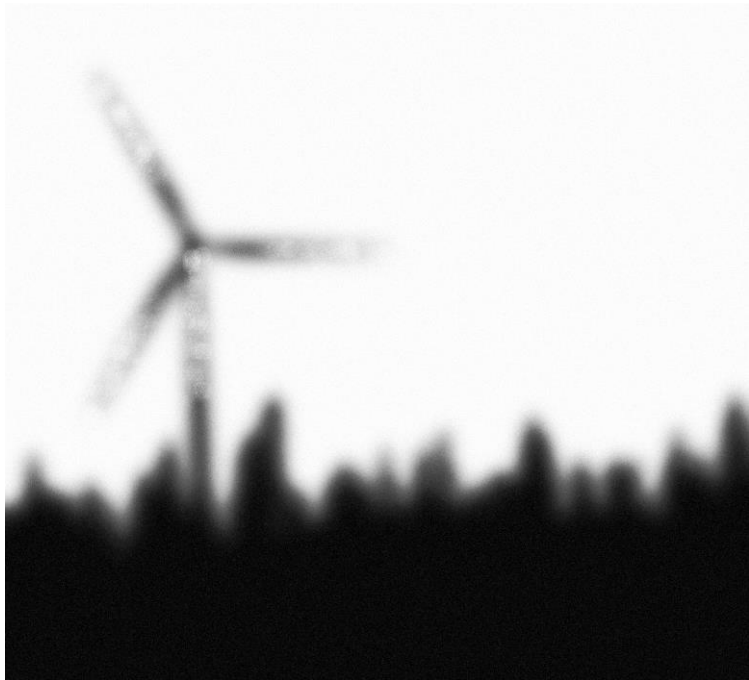
Does changing the visual appearance of the turbine reduce **close** activity and fatality?



If it does, then we may have reached beyond the scale of our current technology limitations to infer **cause**



If we do not know **cause**, we will need to be lucky to find the best minimization strategy.



Acknowledgments

- Funding
 - USGS Innovation Center for Earth Sciences
 - USGS Ecosystems Mission Area
 - USGS Pacific Island Ecosystems Research Center
 - USGS Fort Collins Science Center
- Logistical support
 - Island Princess Macadamia Estate
 - Iberdrola Renewables staff
 - National Renewable Energy Lab, National Wind Technology Center staff
 - C. Avena, K. Brinck, M. Bucci, K. Castle, S. Daugherty, T. Dewey, L. Ellison, Q. Gorresen, K. Henker, K. Hughes, B. LaBelle, R. LaBelle, J. Makiejus, J. McCoy, M. McCoy, D. Neubaum, K. Navo, P. Nyland, K. O'Brien, J. Pelham, I. Rodden, L. Rossi, M. Schirmacher, R. Schorr, J. Siemers, C. Trejo, T. Weller, L. Wheeler

