Wind energy and insects: reviewing the state of knowledge and identifying potential interactions

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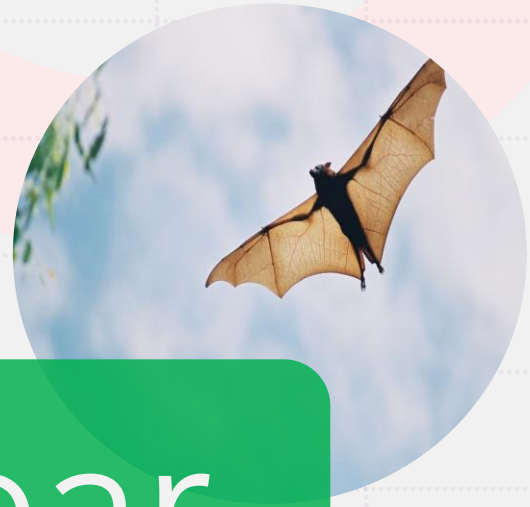
Ecosystem Services: direct and indirect contributions of ecosystems or their parts to human well-being

Pollination

Nutrient Cycling



Forage

$57 billion/year

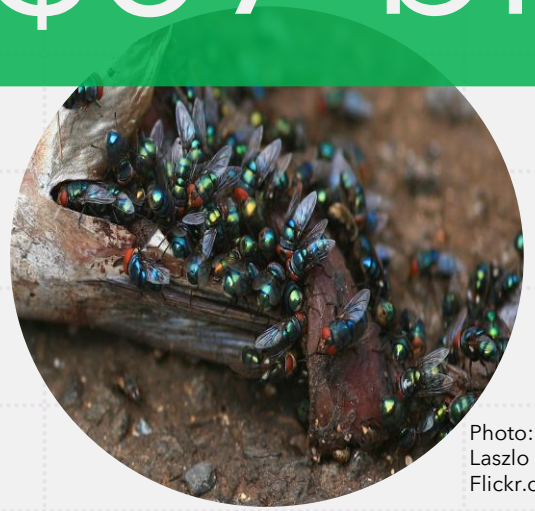


Photo:
Laszlo Ilyes
Flickr.com

Decomposition

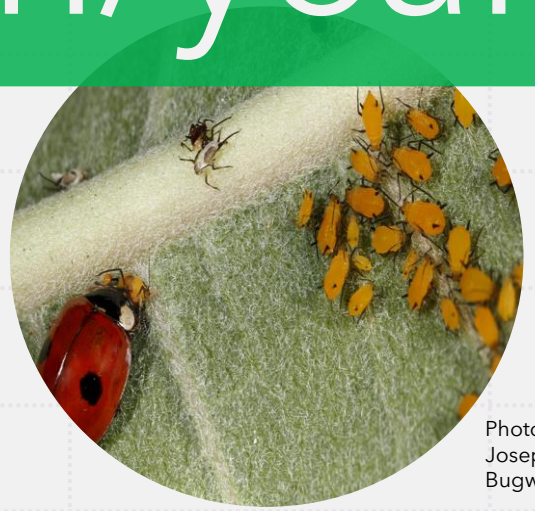


Photo:
Joseph Berger
Bugwood.org

Pest Control

More than 75 percent decline over 27 years in total flying insect biomass in protected areas

Caspar A. Hallmann, Martin Sorg, Eelke Jongejans, Henk Siepel, Nick Hofland, Heinz Schwan, Werner Stenmans, Andreas Müller, Hubert Sumser, Thomas Hörren, Dave Goulson, Hans de Kroon

Published: October 18, 2017 • https://doi.org/10.1371/journal.pone.0185809

Scientists' warning on climate change and insects

Jeffrey A. Harvey, Kévin Tougeron, Rieta Gols, Robin Heinen, Mariana Abarca, Paul K. Abram, Yves Basset, Matty Berg, Carol Boggs, Jacques Brodeur, Pedro Cardoso ... See all authors

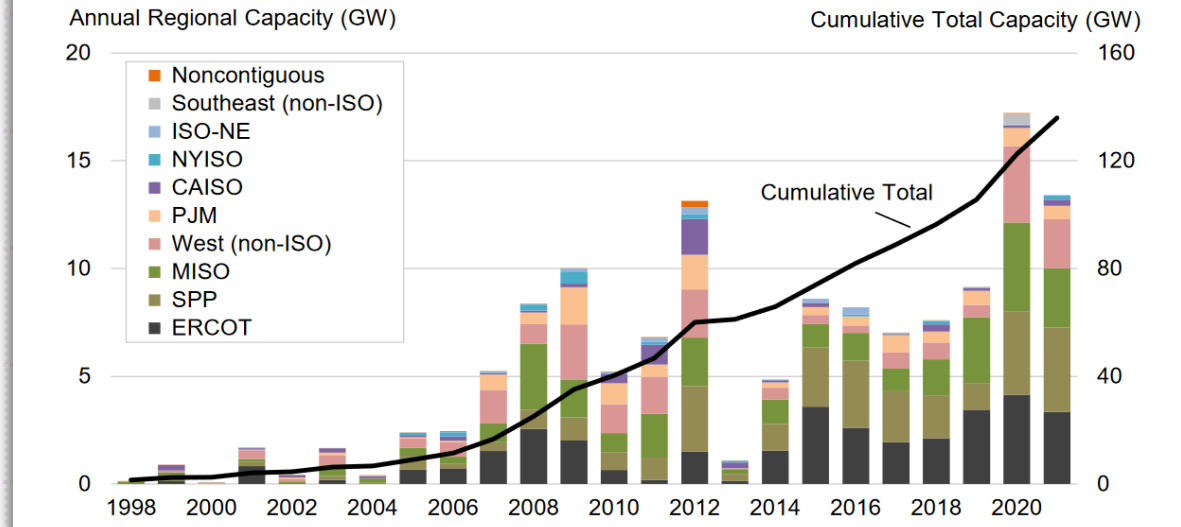
First published: 07 November 2022 | https://doi.org/10.1002/ecm.1553 | Citations: 3

Global pollinator declines: trends, impacts and drivers

Simon G Potts [1], Jacobus C Biesmeijer, Claire Kremen, Peter Neumann, Oliver Schweiger, William E Kunin

Affiliations + expand

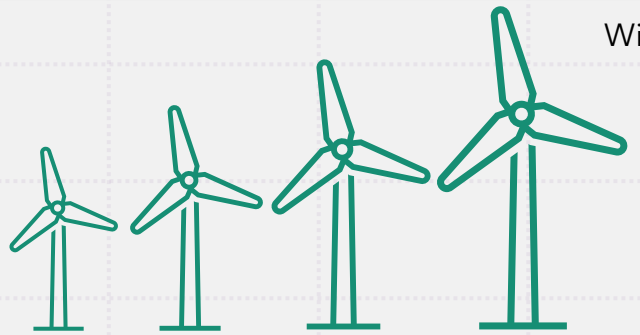
PMID: 20188434 DOI: 10.1016/j.tree.2010.01.007

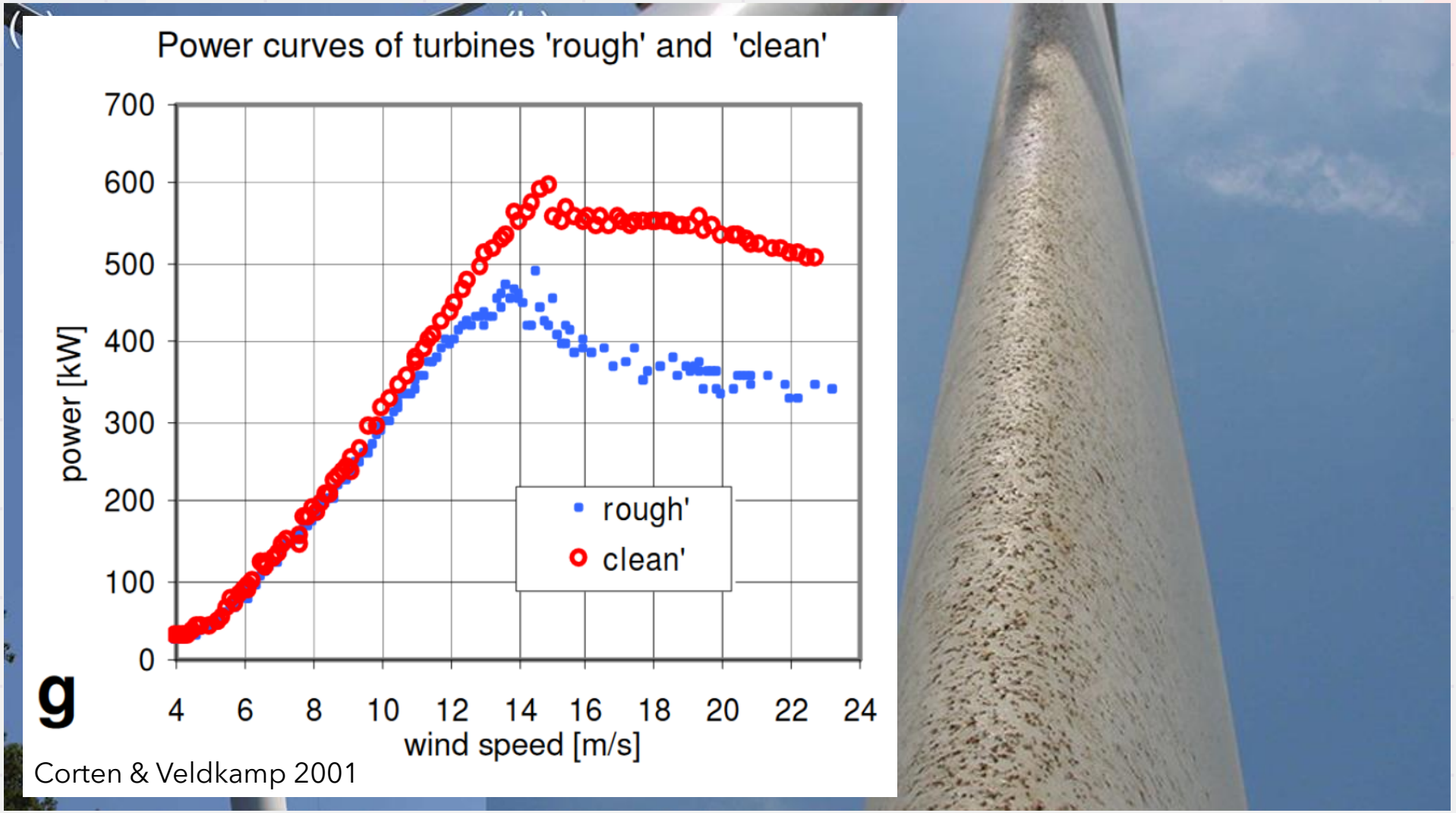


Source: ACP

Figure 2. Annual and cumulative growth in U.S. wind power capacity

Wiser et al. 2022

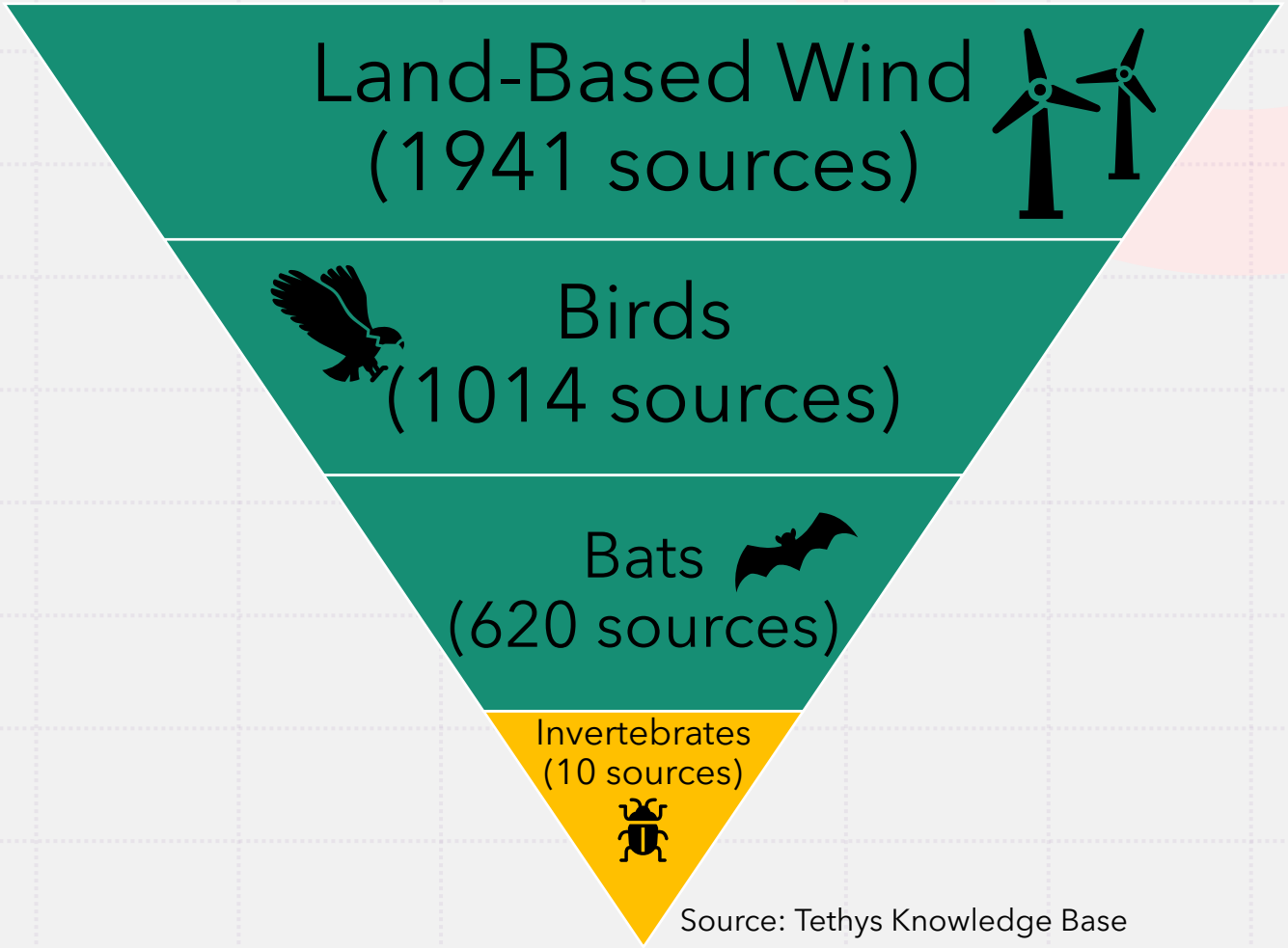




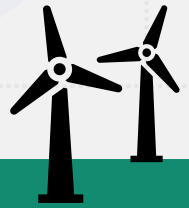
Corten & Veldkamp 2001

Voight 2021, Jose Luis Ruiz, Bladecleaning S.A.

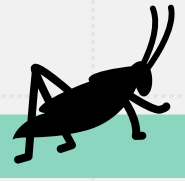
(as of yesterday)



Source: Tethys Knowledge Base



How do turbines influence habitats?

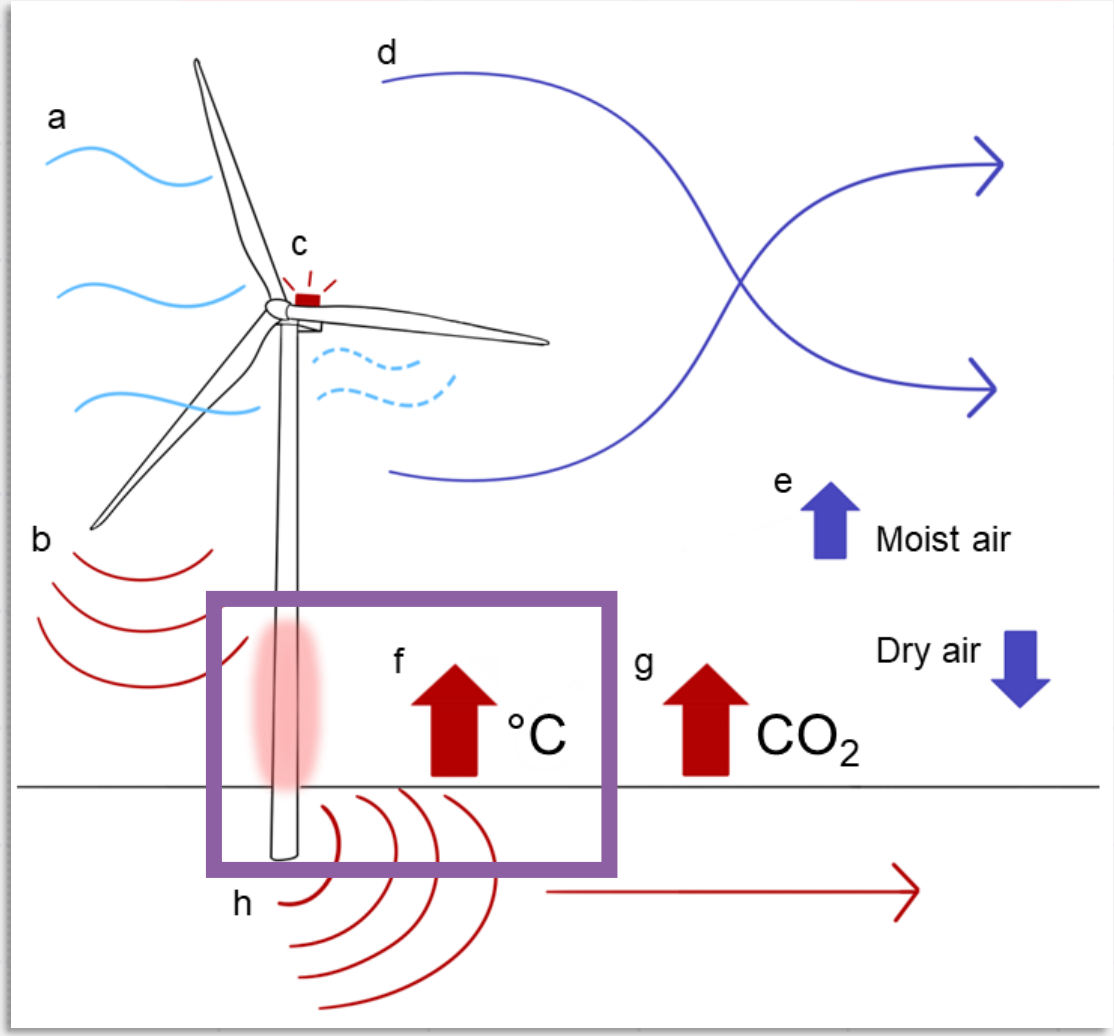


How do those effects influence insects?

What can we do to understand these impacts and mitigate them?

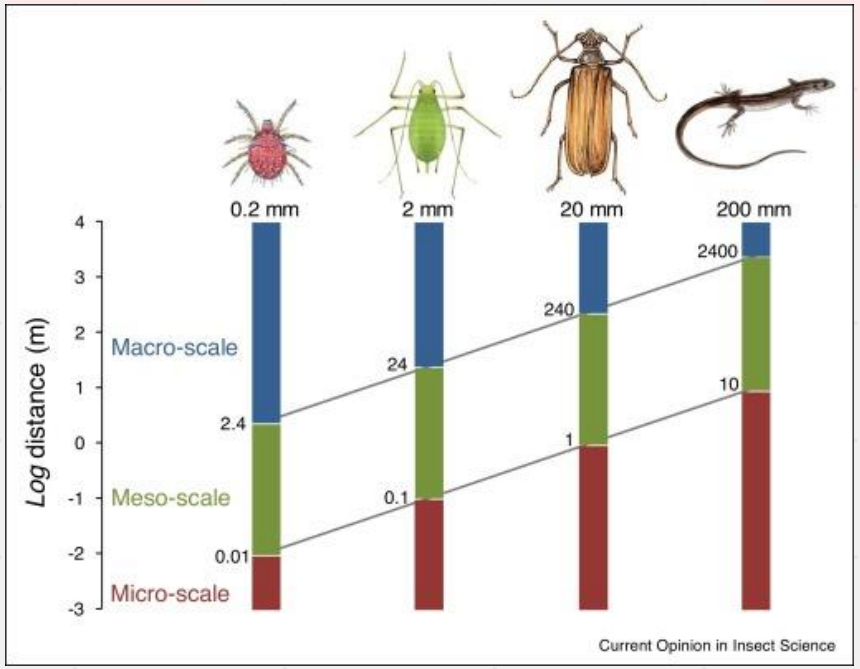
Temperature

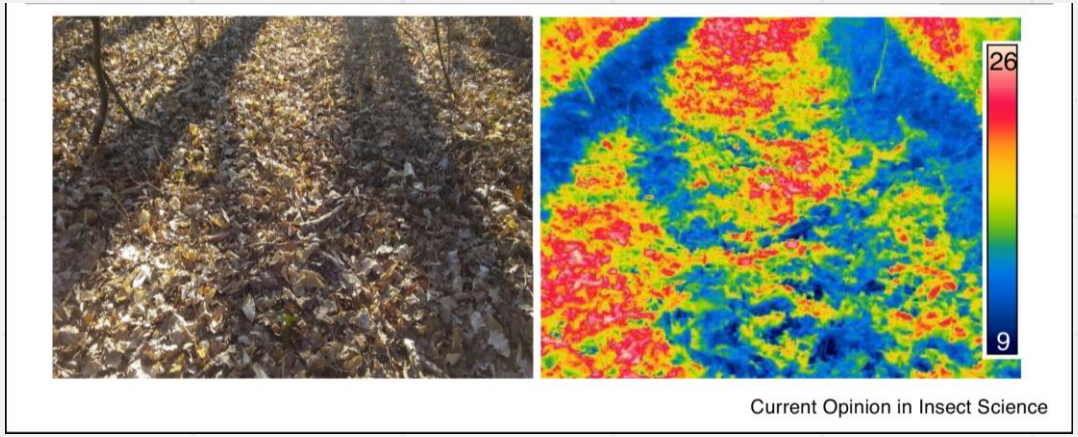
- Warming effect at night
- Cooling during day
- Strength of temperature effects may depend on:
  - Topography
  - Natural turbulence
  - Environment type
  - Size of facility
- Surface of turbines ≥2°C warmer than ambient temperature



Temperature

- Flies bask on turbine towers despite predation risk
- Ladybeetles use turbine towers to overwinter
- Warmer temperatures at night -> more insects
- Variations in surface temperature could attract temperature generalists

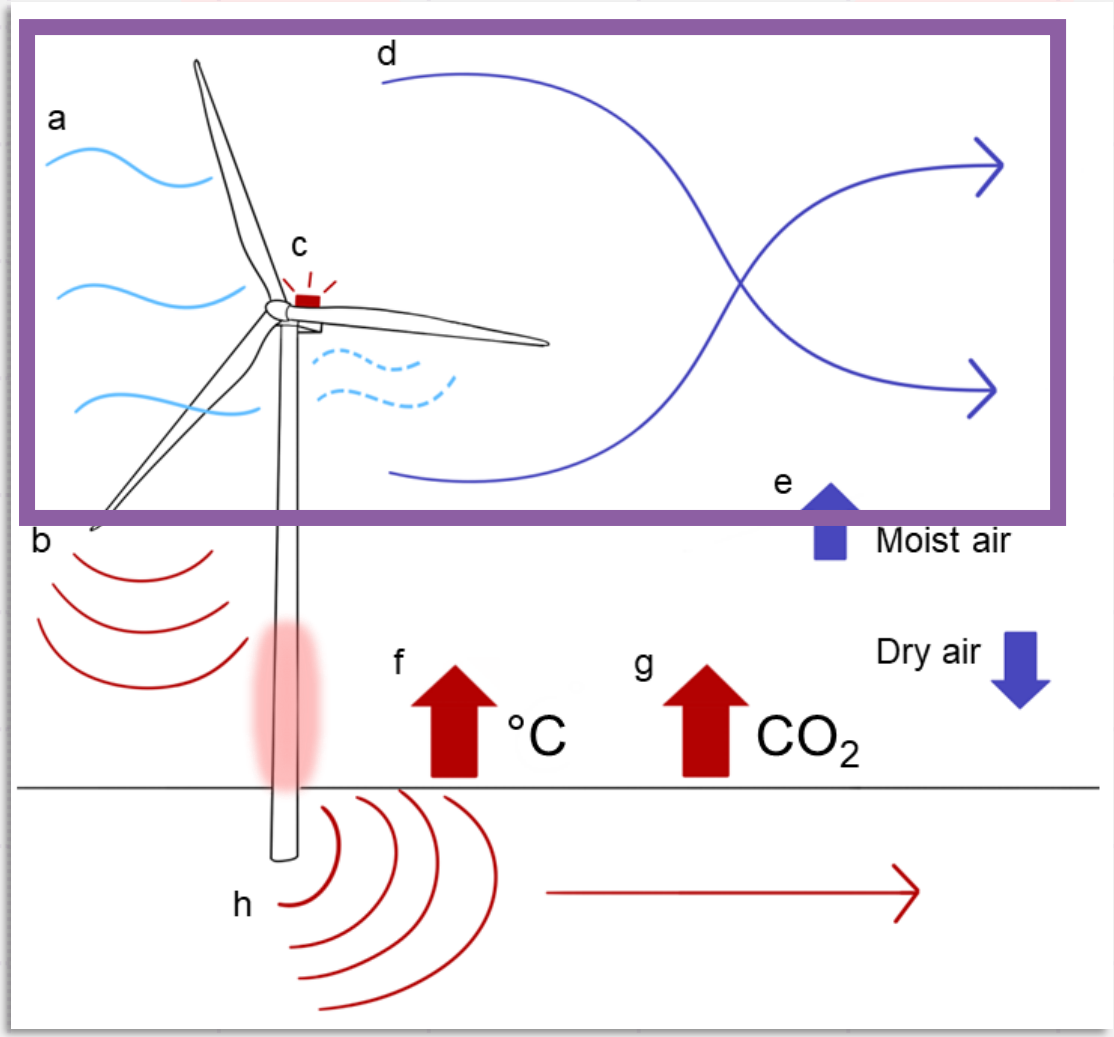




Pincebourde and Woods 2020

Wind

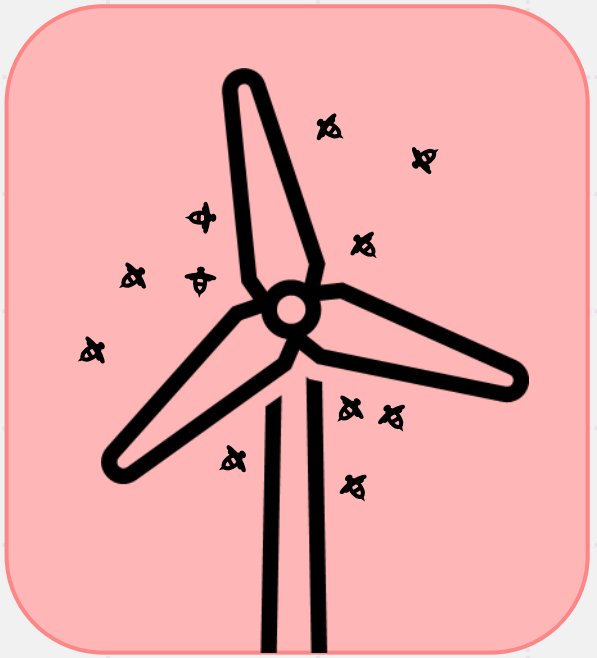
- Increased turbulence in wake – can persist downwind
- Reduced windspeed at hub height
- Turbines increasingly installed at sites with lower average wind speeds in US



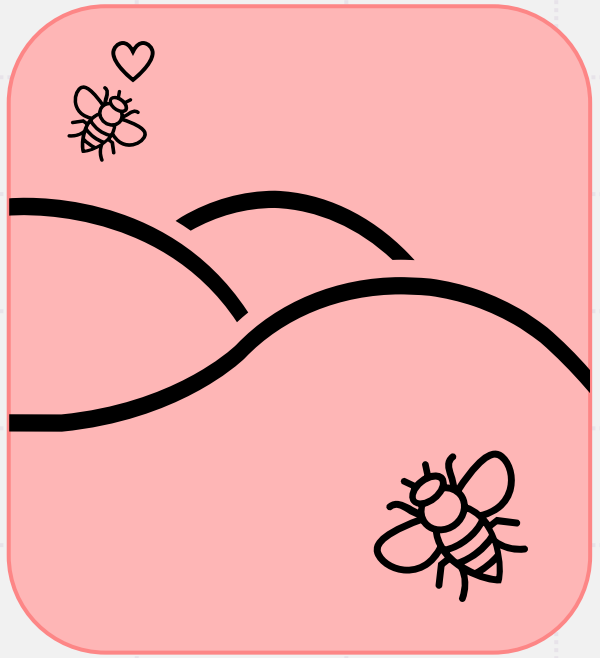
Flight

Migration

Swarming



Mating



Light

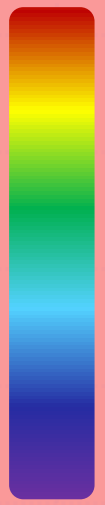

Aircraft Detection Lighting System (ADLS)
Terma North America

Vision

Light

Positive Phototaxis

- Wavelength
- Intensity
- Exposure
- Attraction to red LED lighting
- Ambient levels of artificial light
- Differences in eye structure



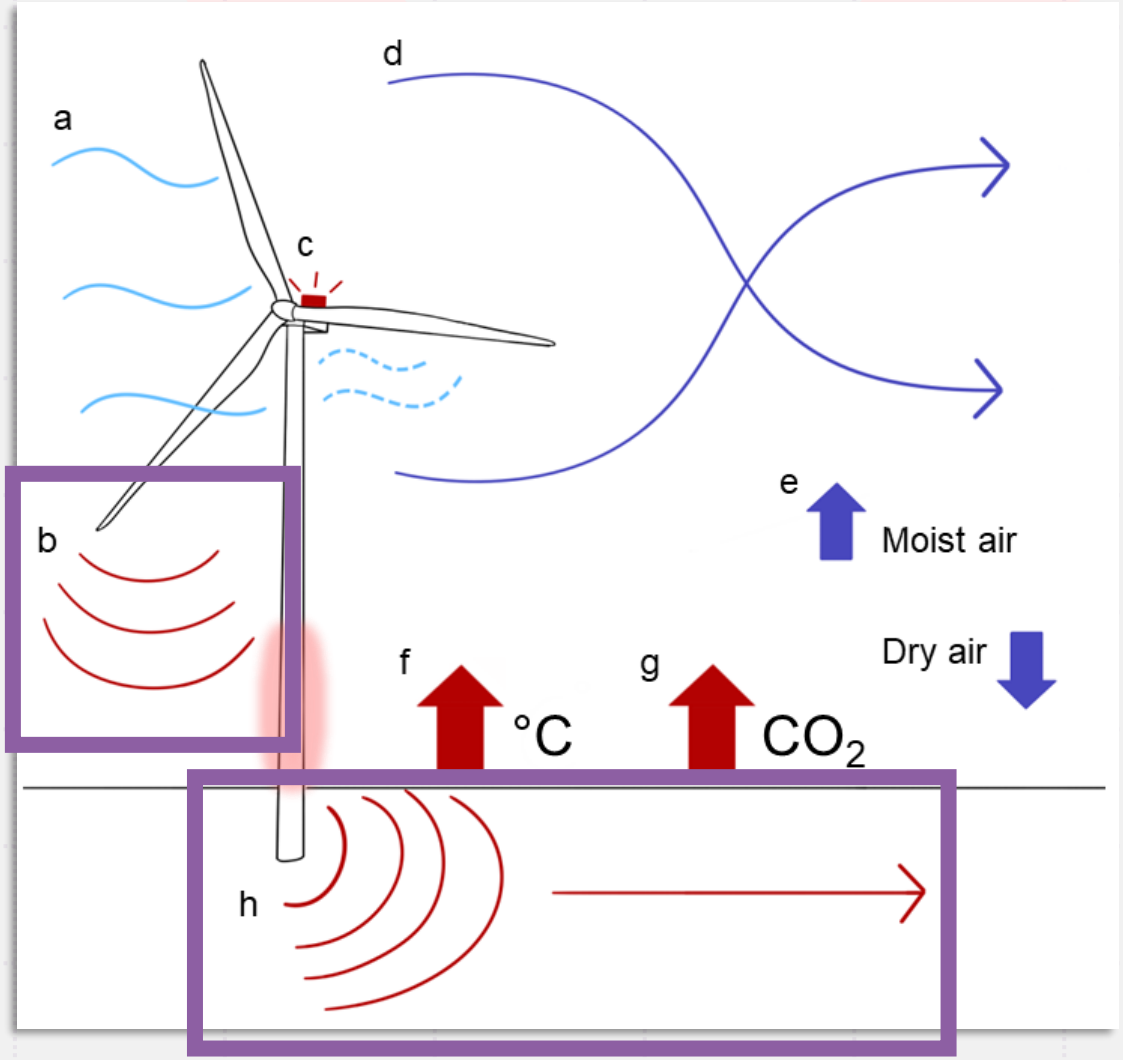
Color

- Wavelength
- Reflectivity
- Contrast
- White and light grey attractive to insects
- Shape + size + color = marker

Madison Crawford

Sound

- High frequency (≤ 8 kHz)
- Low frequency (< 200 Hz)
- Infrasound (< 20 Hz)



Sound

Masking

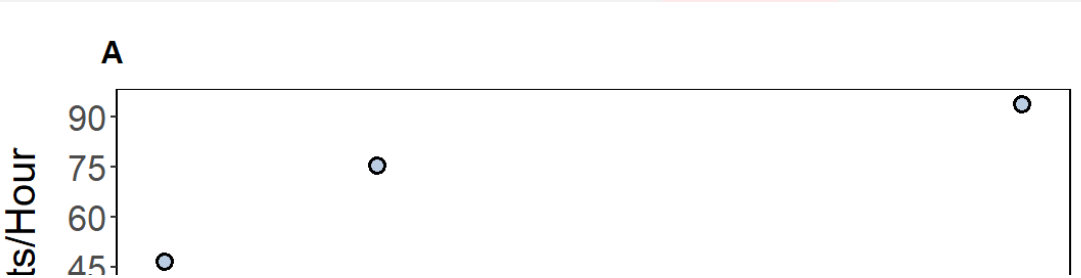
- Increased calling → Increased energy cost
- Decreased calling → Lower effectiveness → Hindered mate location
- Changes in frequencies → Lower effectiveness → Hindered mate location
- Interference with predation and host location

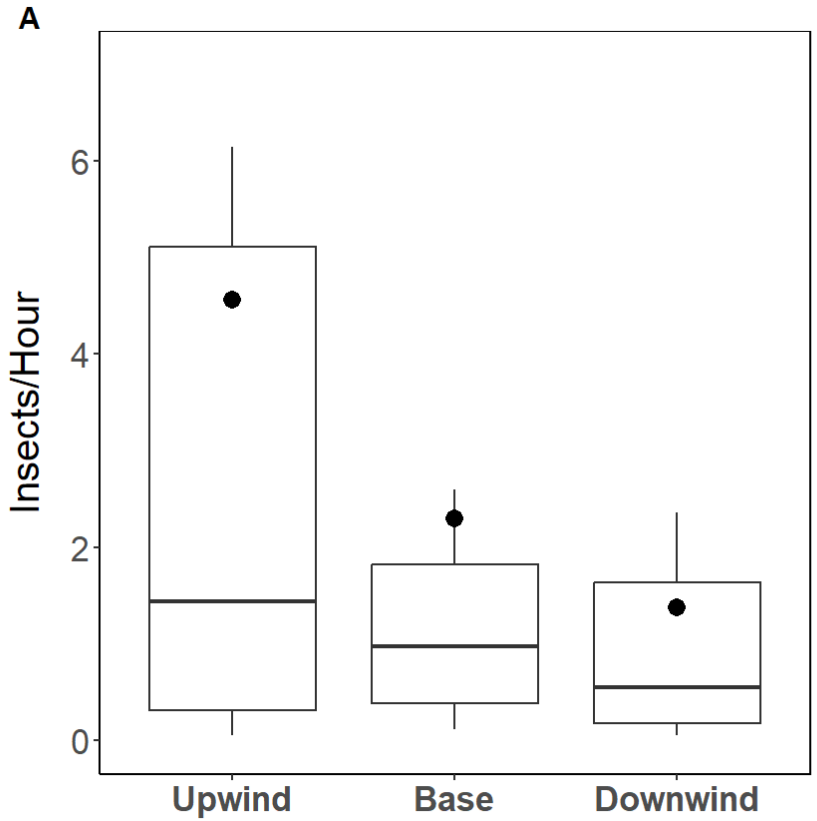
Disturbance

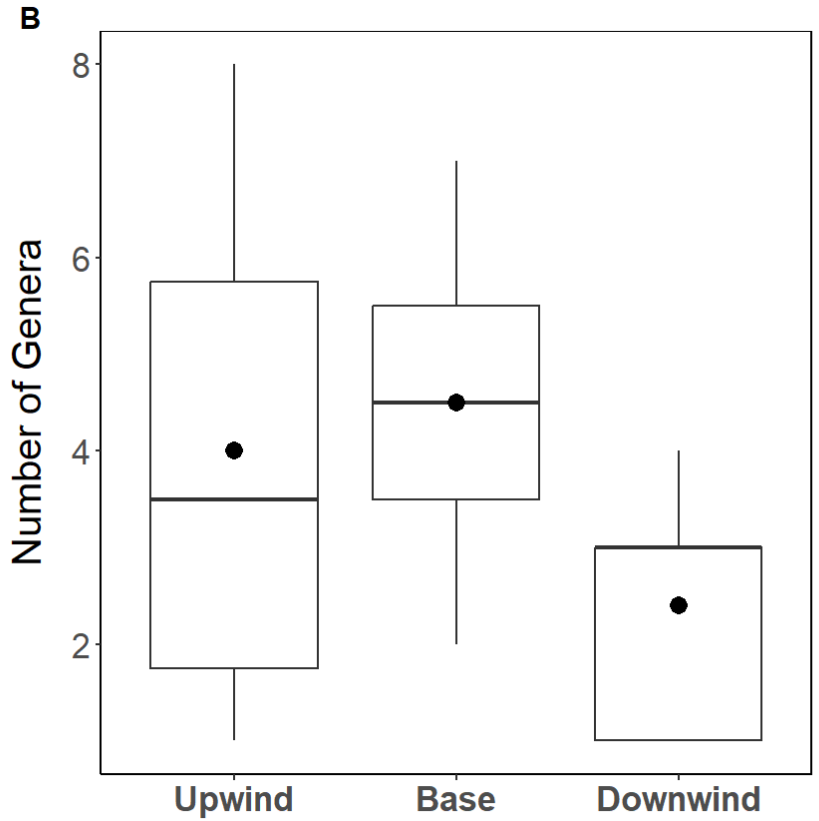
- Increased stress → Reduced abundance
- Delayed development → Reduced fitness
- Fewer offspring → Reduced fitness

Heather Broccard Bell

Case Study


A
90
75
60
45
ts/Hour

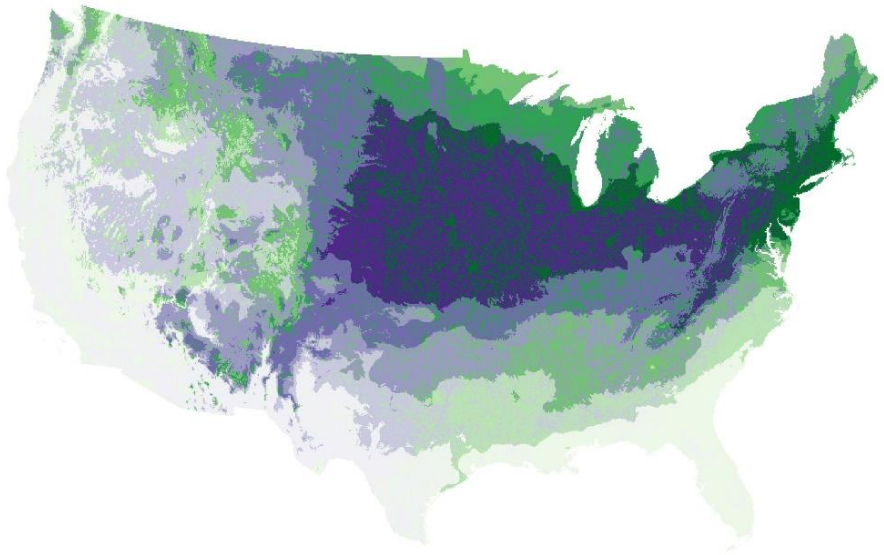

A
Insects/Hour
6
4
2
0
Upwind
Base
Downwind


B
Number of Genera
8
6
4
2
Upwind
Base
Downwind

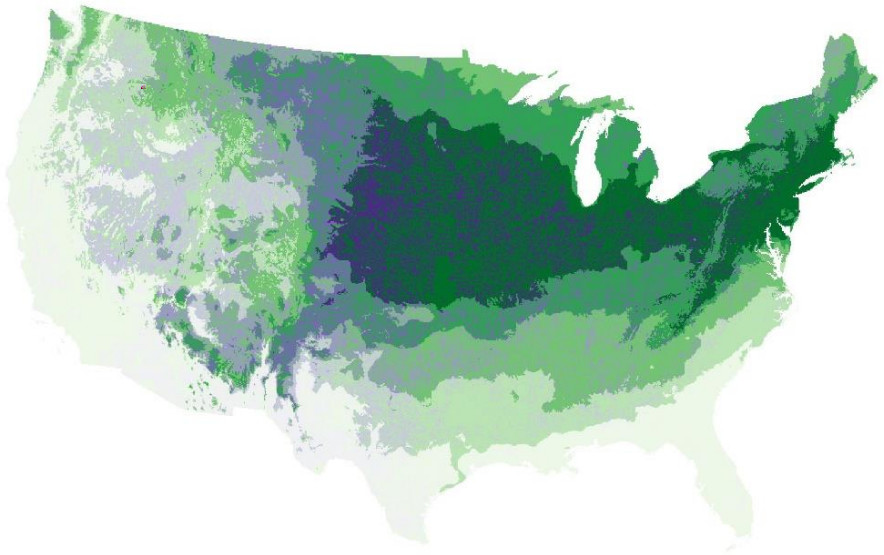
Risk Assessment

Regal Fritillary (*Speyeria idalia*)
Petitioned for listing under ESA

Open Access Scenario



Reference Access Scenario



Development potential

Yes No

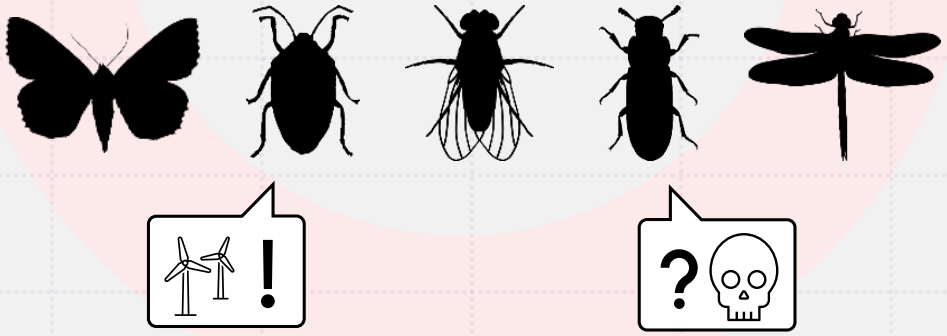
Habitat potential

Conclusions

- Color and microclimate effects may attract insects to turbines
- Insects with specific behaviors may be most at risk
  - Lepidoptera, Coleoptera, Diptera, Hemiptera
- Likely large variations in species and numbers of insects affected based on location
- Standardized monitoring before and after development to inform future siting
- Sound/vibrations could affect insect development and communication at wind energy facilities

Lusha Tronstad

Knowledge Gaps



- Which taxa are killed by wind turbines?
  - How much does this differ by facility or region?
  - Are these losses influencing population dynamics or biodiversity?

- Are insects nesting within or otherwise using wind energy facilities?
  - How do turbines impact insect development?
  - How are turbines affecting plants?
    - Seed set manuscript in progress at Tronstad Lab

- How do turbines influence fine-scale microhabitats?

- Could mitigation strategies used for bats and birds also mitigate insect fatalities?

- Can turbines provide refuge for some insects?

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Thank you!

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WYNDD
Wyoming Natural Diversity Database

Special thanks to: Amy-Marie Story, Katrina Cook, Joy Handley, Audrey Lindsteadt, Bella Sadler, Sam Poratti, Madi Crawford, Delina Dority, Tim Collier, Jonathan Naughton, Zach Wallace, Travis Williams, Paige Copenhaver-Parry

This project was funded by the United States Fish and Wildlife Service
The case study was funded by the Bureau of Land Management

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Photo: Lusha Tronstad