Mitigating risk from collision fatalities: avoidance

Avoid

Use risk analysis and other research findings to inform siting

Siting

Macro-siting: locating individual projects within a landscape,
Micro-siting: locating individual turbines and associated infrastructure within a project boundary

Barriers to implementation

- Lack robust understanding of risk factors associated with siting, especially for bats.
- Turbines may attract bats, greatly hindering risk assessment.

Mitigating risk from collision fatalities: minimization

Minimize

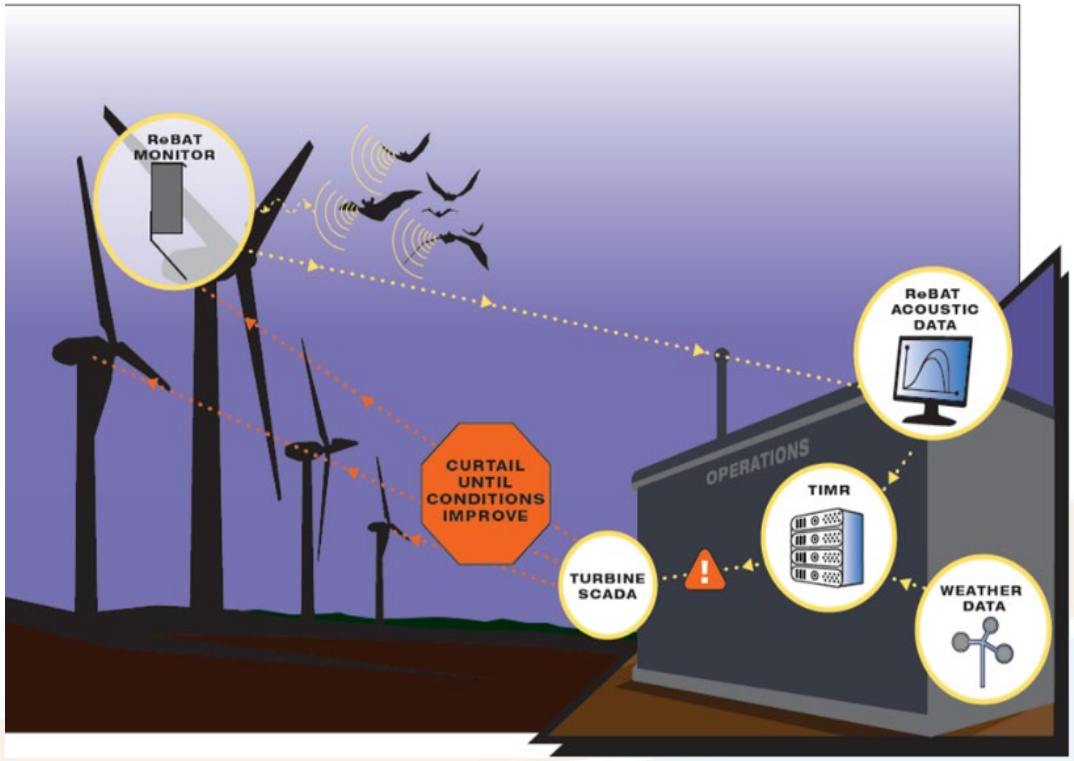
Develop and evaluate techniques and technologies to reduce impacts

Turbine shutdown

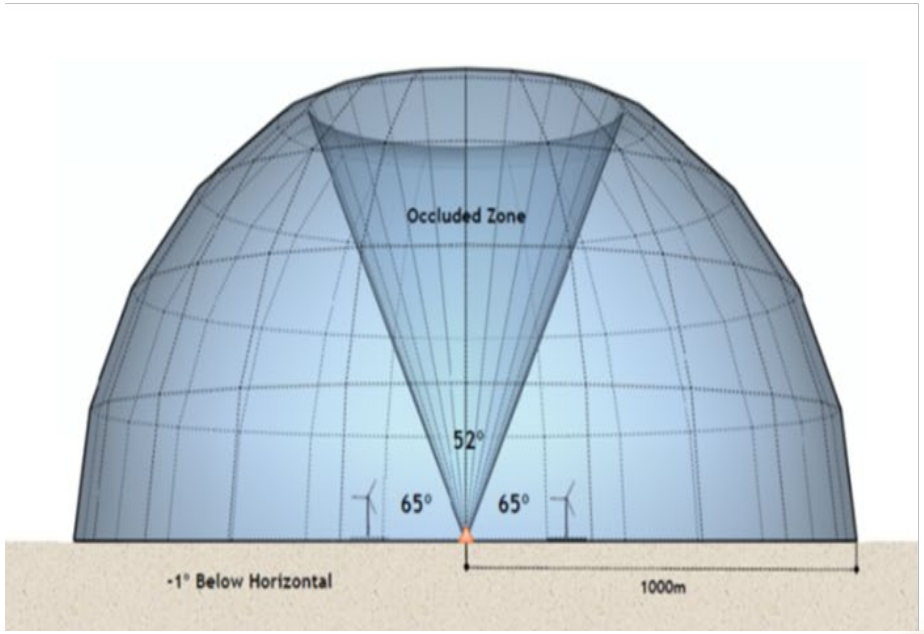
Blanket curtailment: seasonal or during particular conditions (e.g., low wind speed)

"Smart" curtailment: only when risk is elevated

Smart curtailment examples: TIMR



Smart curtailment examples: IdentiFlight



Mitigating risk from collision fatalities: minimization

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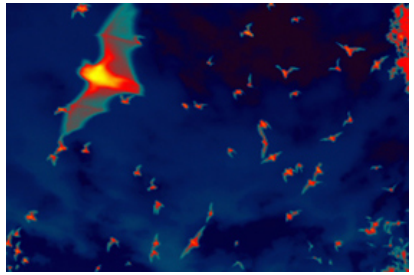
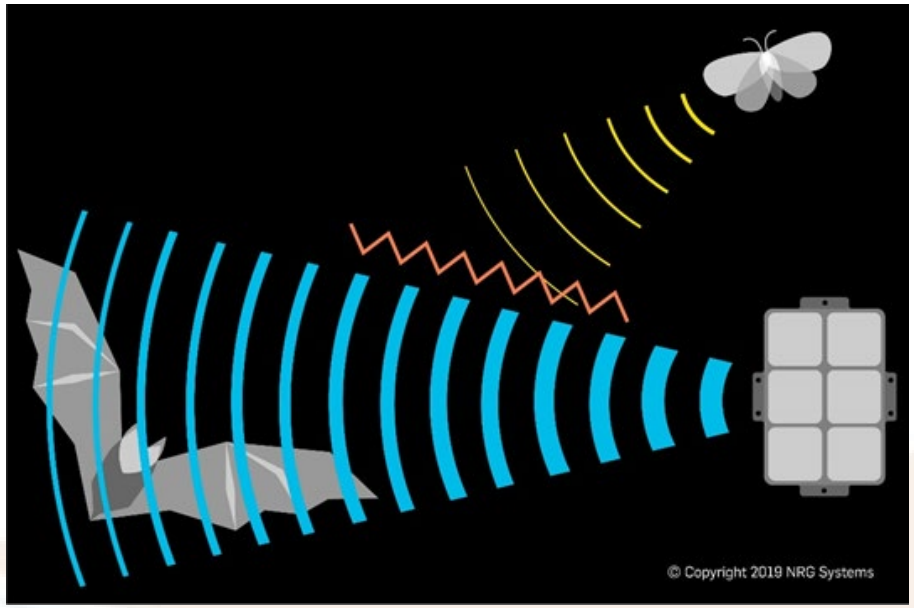
Deterrence

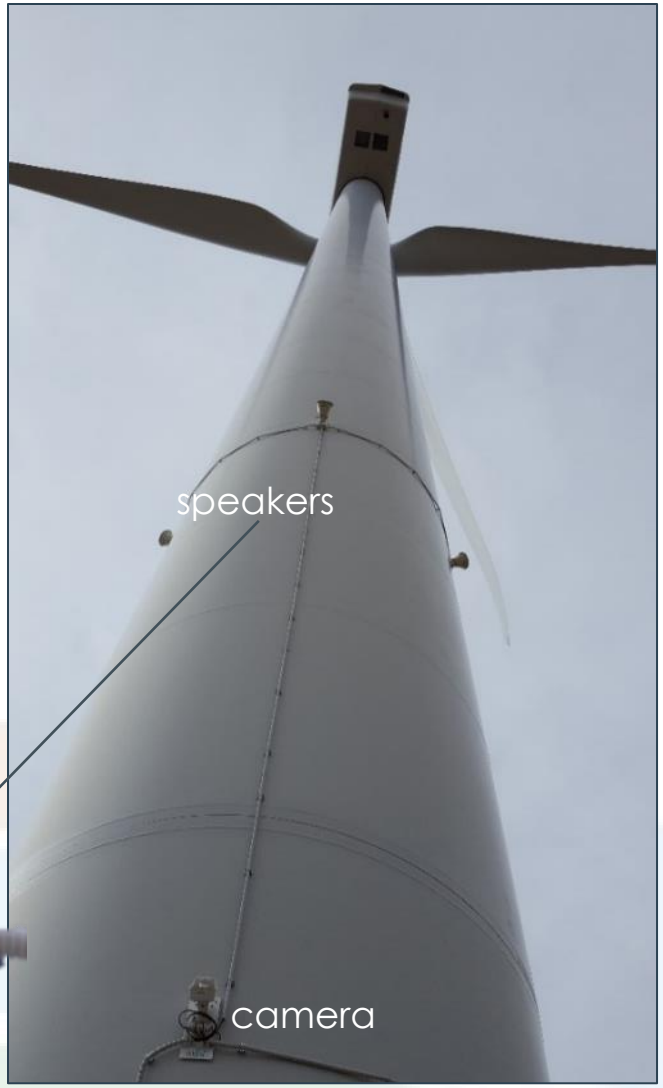
Deterrents

Ultrasonic





Audible



Mitigating risk from collision fatalities: minimization

Minimize

Develop and evaluate techniques and technologies to reduce impacts

Turbine shutdown

Blanket curtailment: seasonal or during particular conditions (e.g., low wind speed)
"Smart" curtailment: only when risk is elevated

Deterrence

Increase detectability of blades

Blade painting
Surface roughening

Mitigating risk from collision fatalities: compensation

Compensate

Develop quantifiable and verifiable options for offsetting impacts

Eagles

- Power-pole retrofits
- Lead abatement?
- Roadkill removal?
- Habitat improvement?

Bats

- Habitat banks
- In-lieu fees

Overview on impacts & mitigation: an outline of our approach

Two kinds of adverse impact

Fatalities from collisions

Habitat-based impacts

We'll summarize what is known about:

1. Risk
2. Mitigation
3. **Information gaps**

Collision fatalities: key information needs

Objective	Outcome
Improve understanding of risk factors for bats and migratory birds	Improved siting and avoidance of high-risk areas
Evaluate and refine minimization technologies and strategies	Reduced bat and eagle fatalities
Develop estimates of population size for migratory tree bats	Establish empirical basis for setting fatality reduction targets

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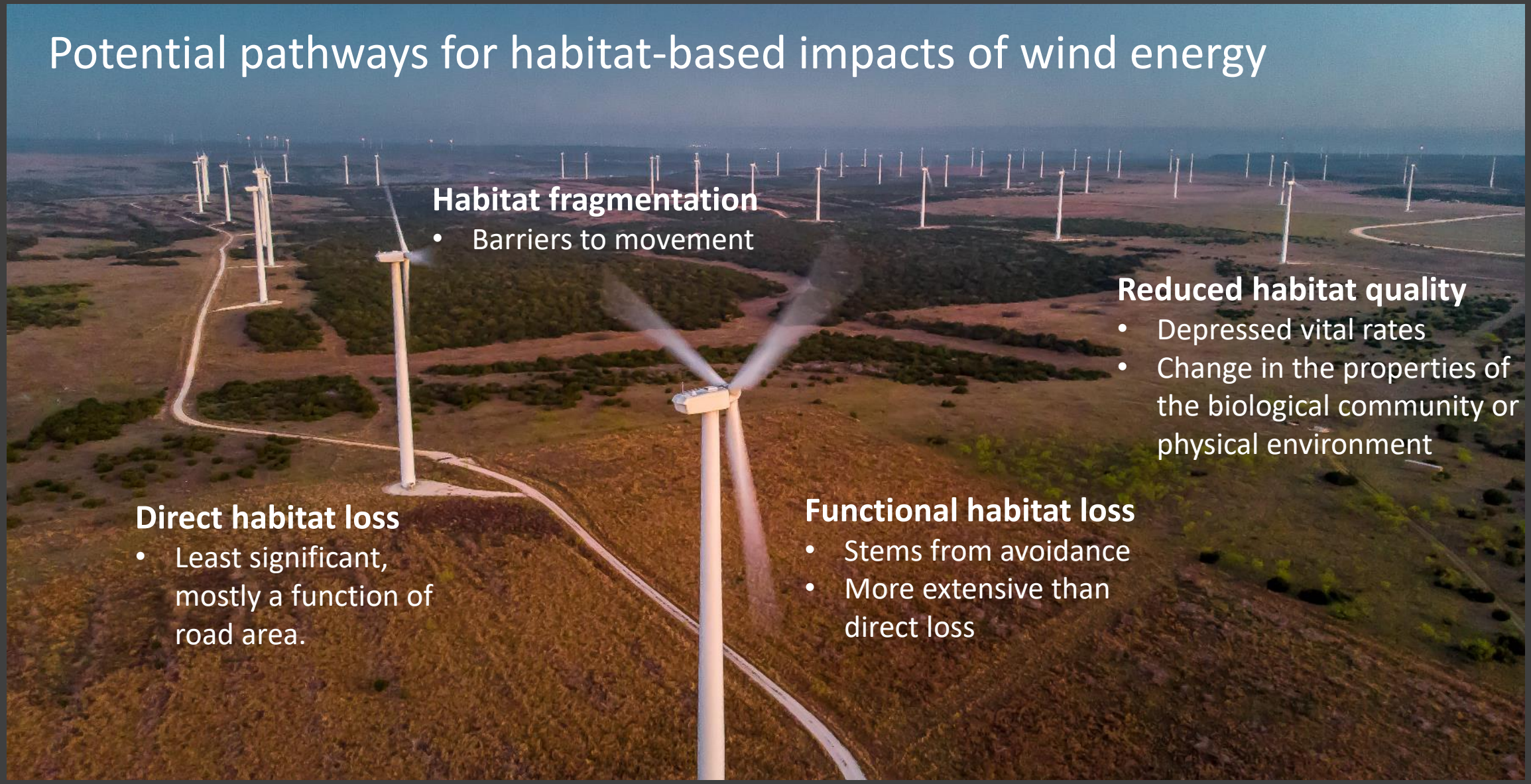
Potential pathways for habitat-based impacts of wind energy



Habitat fragmentation
- Barriers to movement

Reduced habitat quality
- Depressed vital rates
- Change in the properties of the biological community or physical environment

Direct habitat loss
- Least significant, mostly a function of road area.

Functional habitat loss
- Stems from avoidance
- More extensive than direct loss

Taxa of concern for habitat-based impacts

Direct habitat loss

Functional habitat loss

Habitat fragmentation

Reduced habitat quality

Functional habitat loss

Reduced habitat quality

Functional habitat loss

Reduced habitat quality

Functional habitat loss

Habitat fragmentation

Reduced habitat quality

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Mitigating risk from habitat-based impacts

Avoid

Use risk analysis and other research findings to inform siting

Minimize

Develop and evaluate techniques and technologies to reduce impacts

Compensate

Develop quantifiable and verifiable options for offsetting impacts

Mitigating risk from habitat-based impacts

Avoid

Use risk analysis and other research findings to inform siting

Minimize

Develop and evaluate techniques and technologies to reduce impacts

Buffers or setbacks around critical habitat features (e.g., leks)
Best Management Practices (e.g., bury overhead lines, limit timing of disturbance)

Compensate

Develop quantifiable and verifiable options for offsetting impacts

Mitigating risk from habitat-based impacts

Avoid
Use risk analysis and other research findings to inform siting

Minimize
Develop and evaluate techniques and technologies to reduce impacts

Compensate
Develop quantifiable and verifiable options for offsetting impacts

In-lieu fees
Habitat banks
Habitat management

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We'll summarize what is known about:

1. Risk
2. Mitigation
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Habitat-based impacts: key information needs

Objective	Outcome
Identify taxa at greatest risk from habitat-based impacts	Future research on risk and mitigation targeted at species with greatest need
Understand causes of variation in habitat-based response to wind energy	Improved basis for implementing effective conservation measures
Develop verifiable, quantifiable approaches to offset impacts to habitat	Expanded mitigation options that reduce impacts and facilitate development in low-risk areas
Integrate conservation of wildlife habitat into electric-system build-out models	Enhanced ability to identify low-risk sites under realistic future scenarios of energy generation and transmission.

Resources

- General overview of wind/wildlife science:
  - **Allison et al. 2019. Impacts to wildlife of wind energy siting and operation in the United States.**
    - https://www.esa.org/wp-content/uploads/2019/09/Issues-in-Ecology_Fall-2019.pdf
- Curtailment:
  - **Hayes et al. 2019. A smart curtailment approach for reducing bat fatalities and curtailment time at wind energy facilities.**
    - https://doi.org/10.1002/eap.1881
  - **McClure et al. 2021. Eagle fatalities are reduced by automated curtailment of wind turbines.**
    - https://doi.org/10.1111/1365-2664.13831

For annual updates on the peer-reviewed literature addressing wind and wildlife, see https://awwi.org/resources/summary-of-wind-power-interactions-with-wildlife/