



Activity-based Informed Curtailment

Using Acoustics to Design and Evaluate Smart Curtailment Programs

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Turbine-related Bat Fatality

- Cumulative fatality at wind projects could threaten certain species like the hoary bat
- Bats only collide with moving turbines
- Curtailing turbine operation avoids risk (*and sacrifices energy production*)
- Most existing curtailment strategies use no site-specific data on bat activity patterns



Blanket Curtailment

- Parameters like cut-in speed, season, temperature threshold set without benefit of site-specific information
 - Regulatory or industry precedent
- Limited number of parameters/triggers

Smart Curtailment

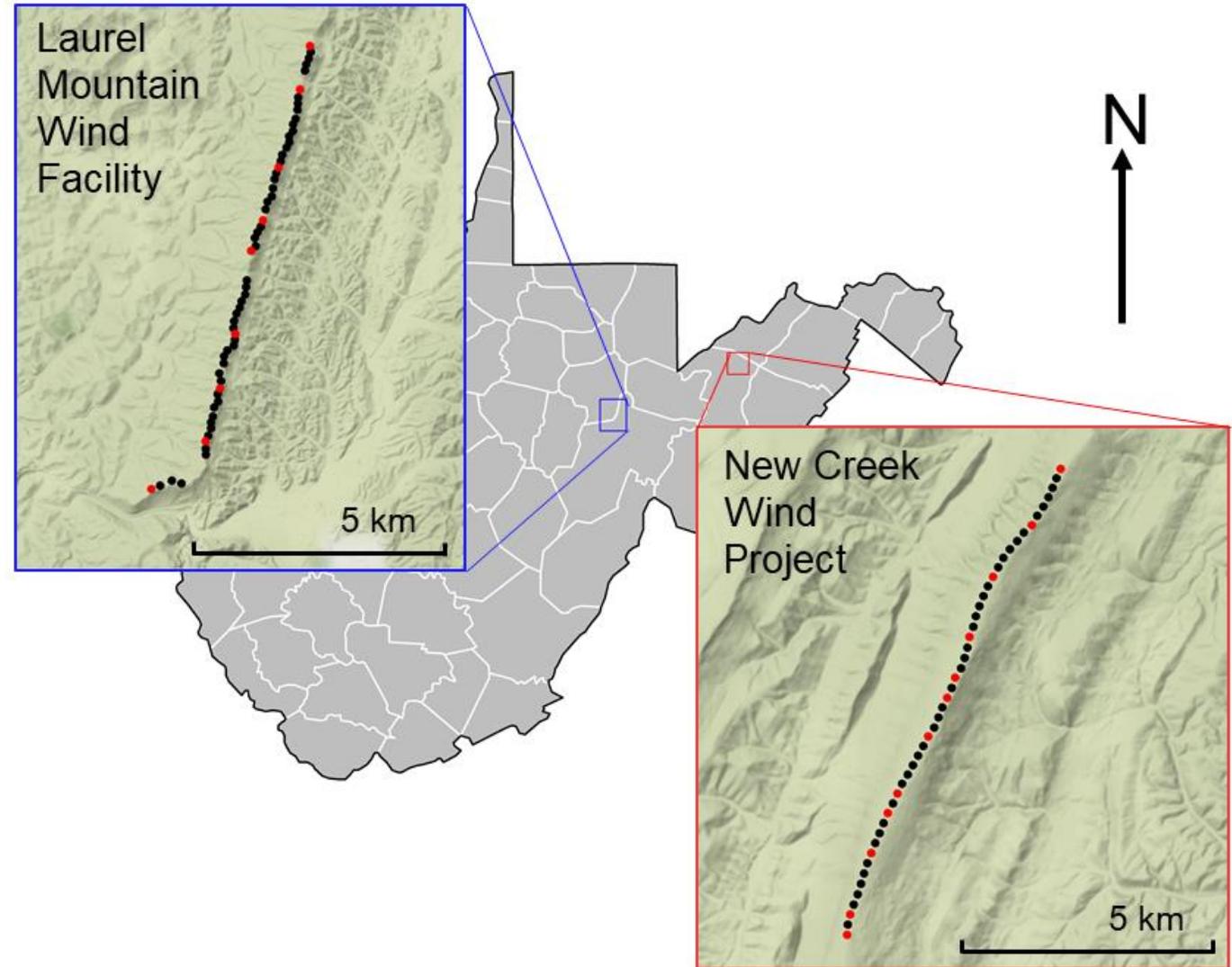
- Parameters informed by site-specific data on bat activity
- Curtailment focused on periods of high risk
- Include multiple parameters/triggers



Activity-based Informed Curtailment

- Site-specific bat acoustic data from nacelle height
- Curtailment focused on conditions with most activity
- Exposed bat passes as a quantitative metric of risk
- Flexible design

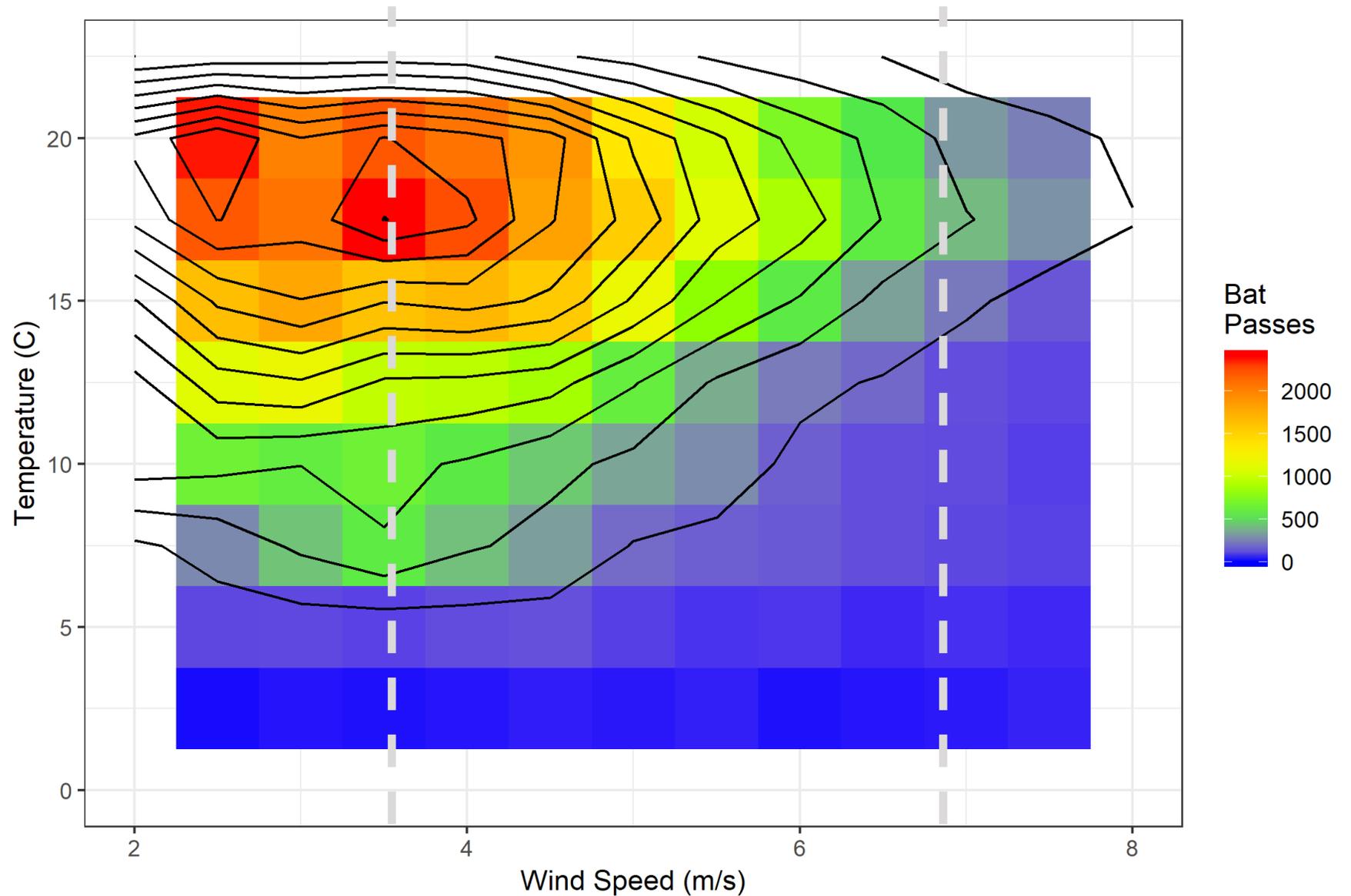
Nacelle-height Acoustics



Bat Activity Exposure

Bat activity is concentrated during calm, warm conditions...

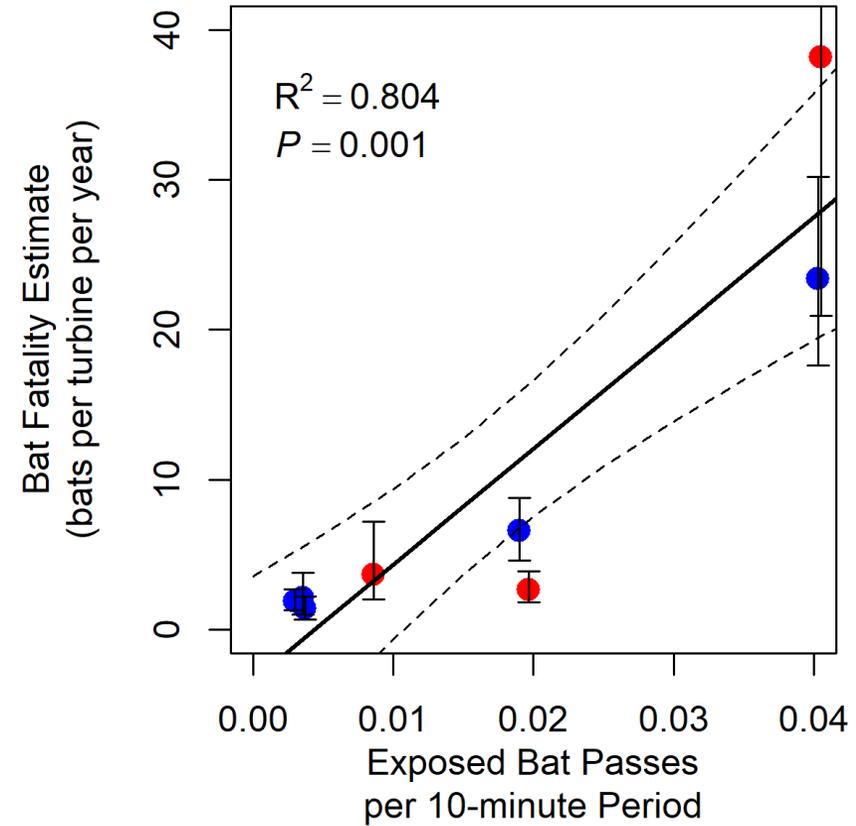
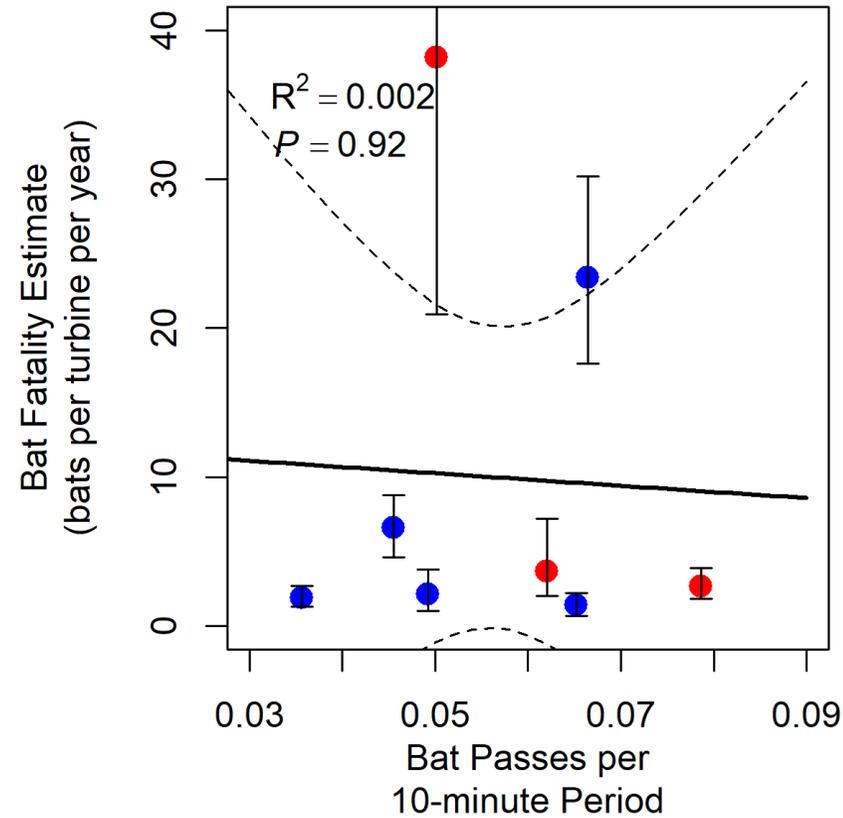
Only some activity is exposed to turbine operation.



Managing Risk with Acoustics

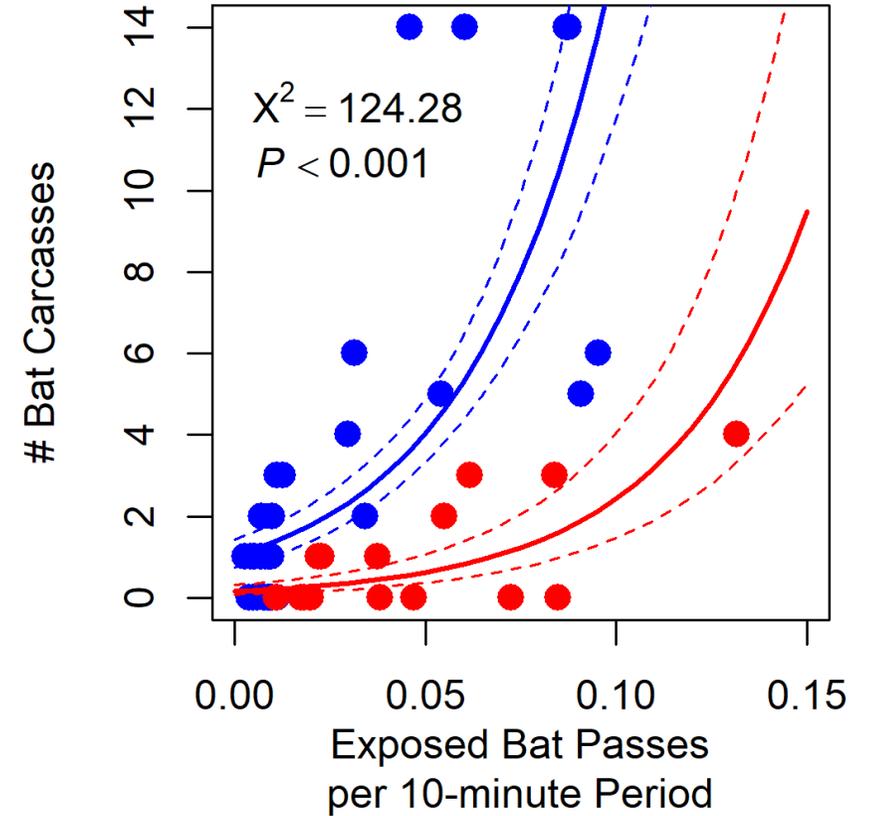
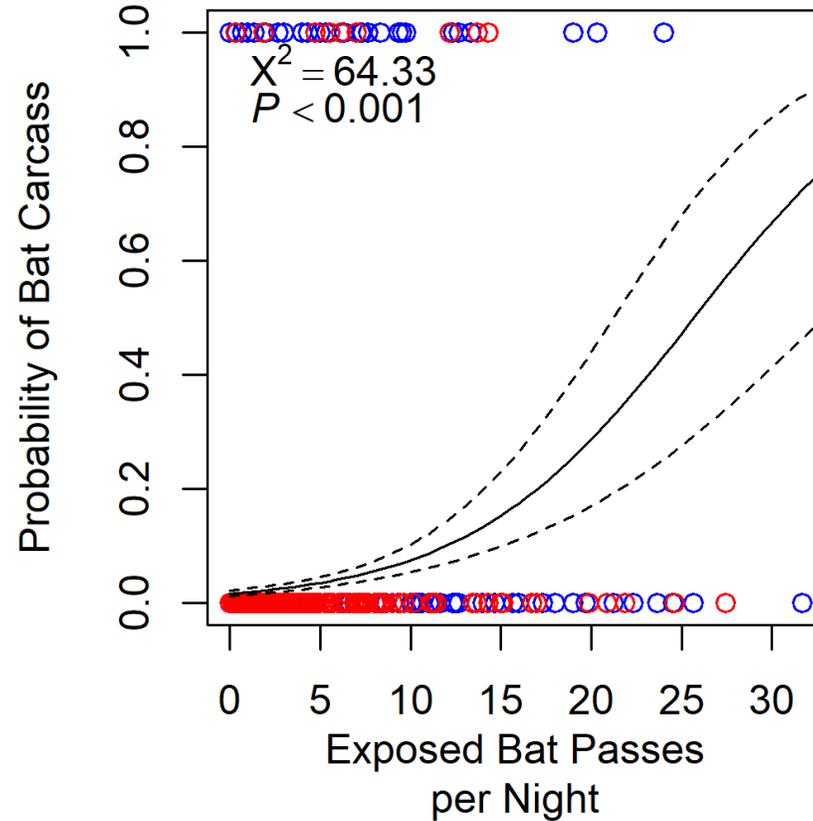
Rate of overall bat activity measured pre-construction has not helped predict fatality rates...

Only the subset of exposed activity indicates fatality risk.



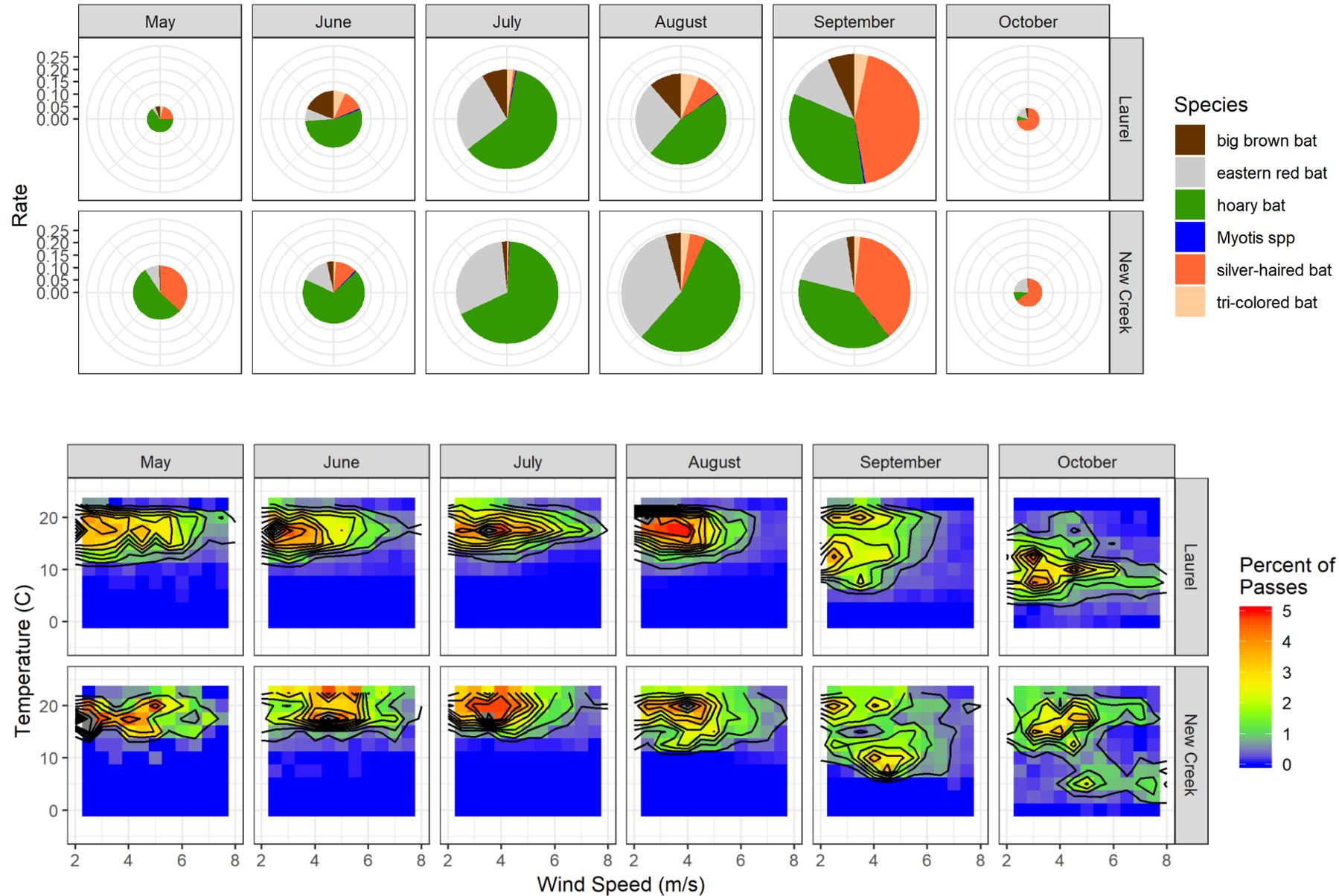
Managing Risk with Acoustics

Exposed activity explained significant variation in probability of finding carcasses and total number of carcasses.



Predicting Exposure

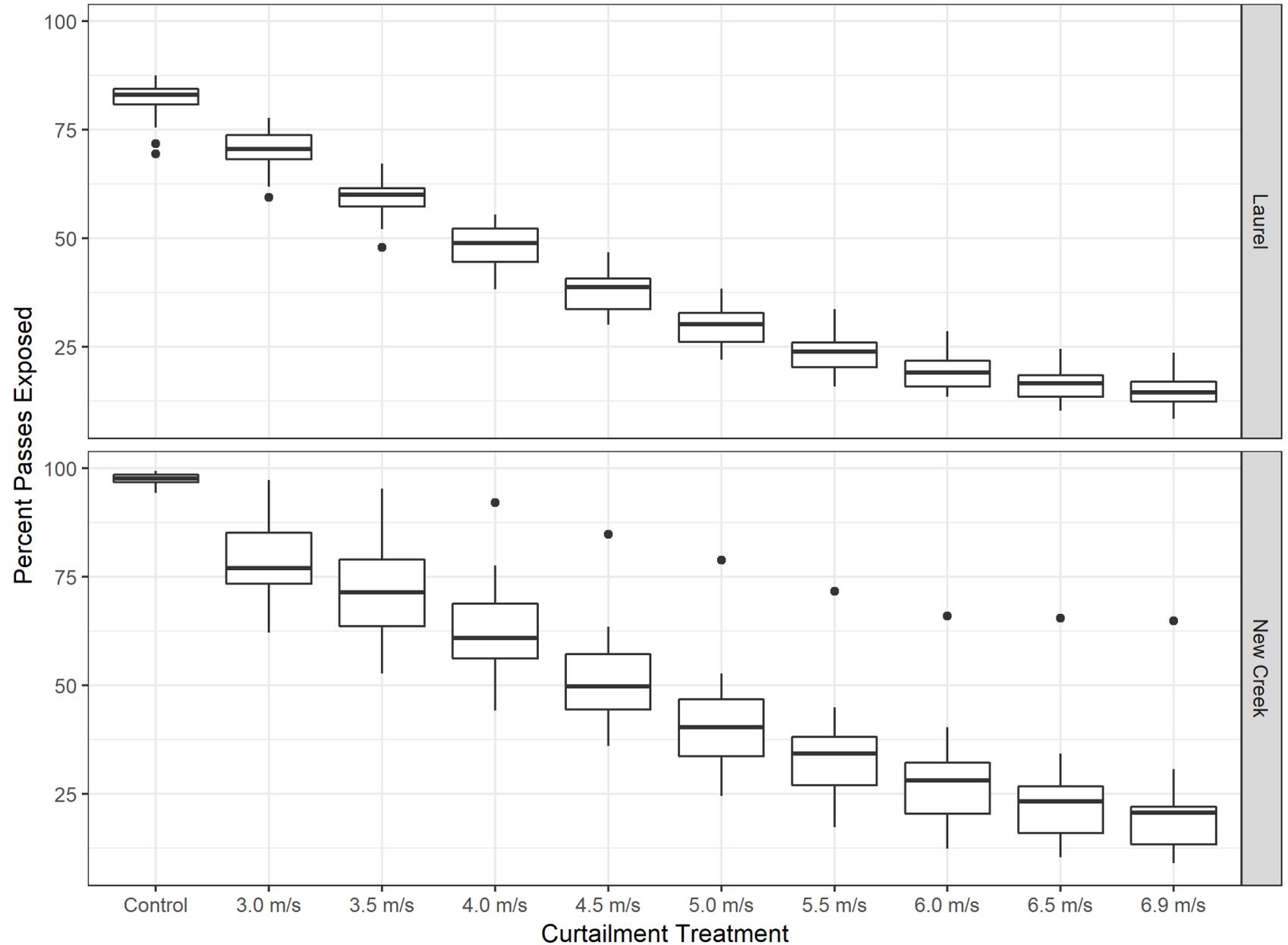
Seasonal patterns and effect of temperature and wind speed on bat activity are consistent and therefore predictable.



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Simulating Curtailment

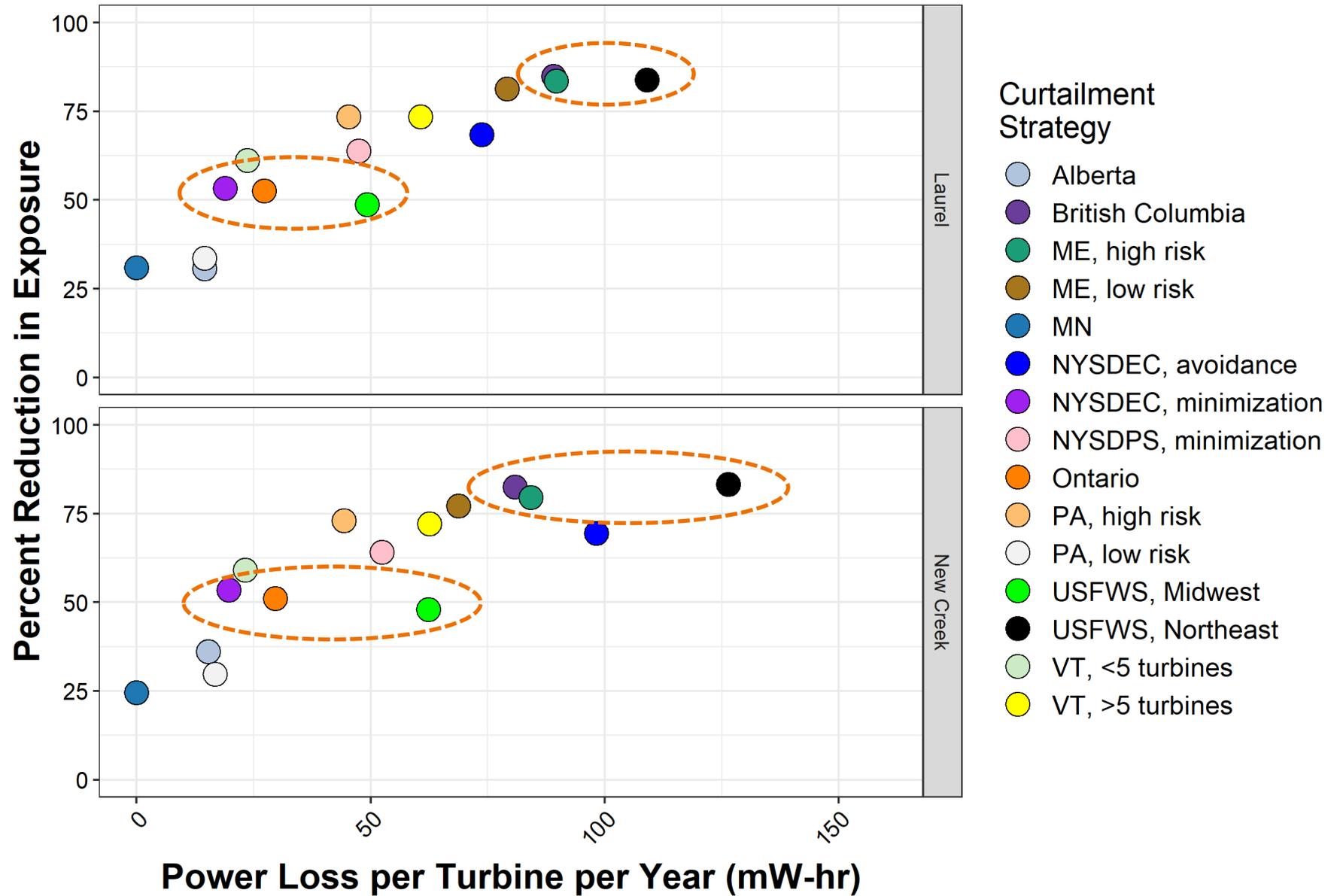
Exposed bat activity is a quantitative, temporally precise metric that can readily distinguish curtailment alternatives.



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Simulating Curtailment

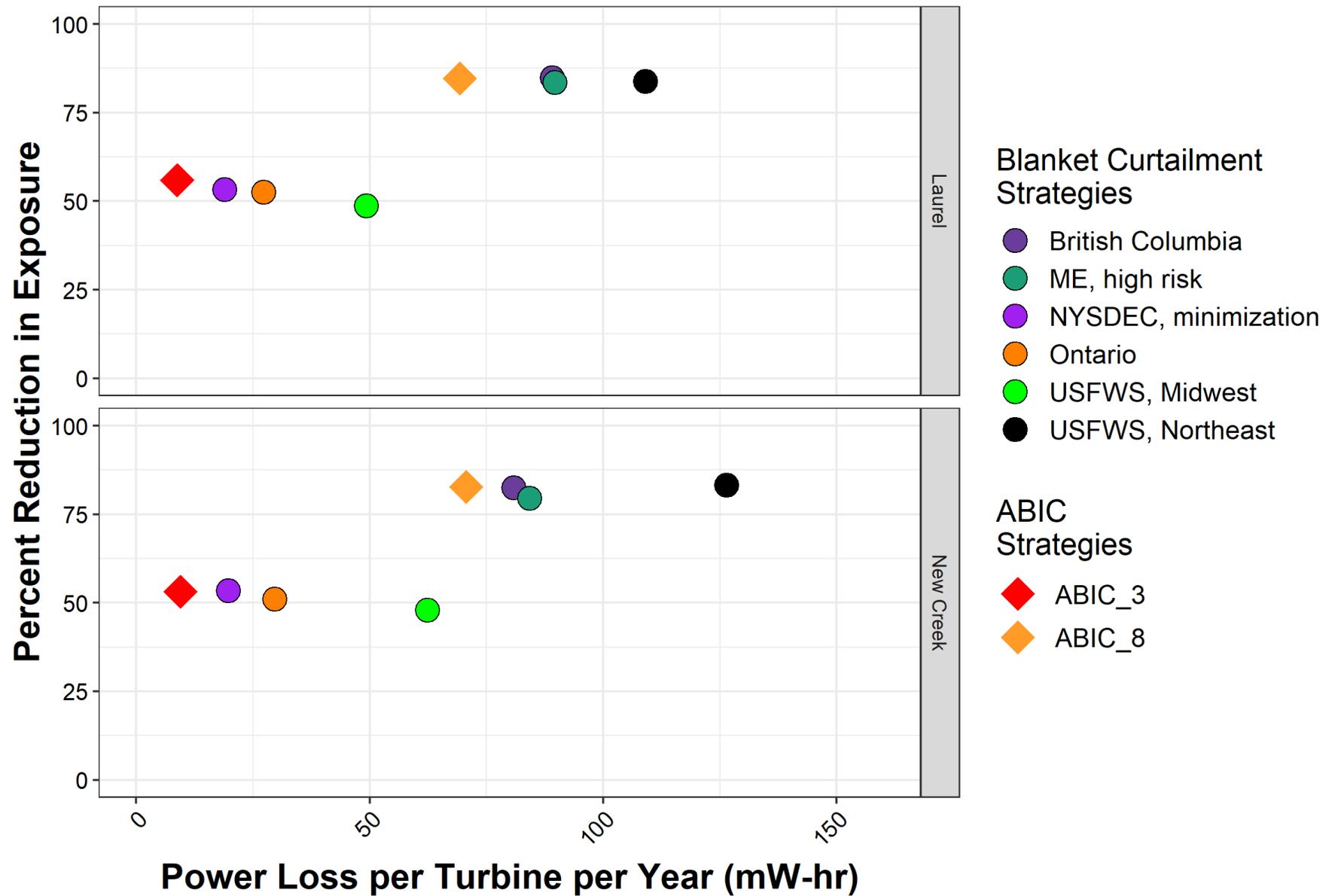
We can simulate effectiveness and cost of any blanket curtailment strategy.



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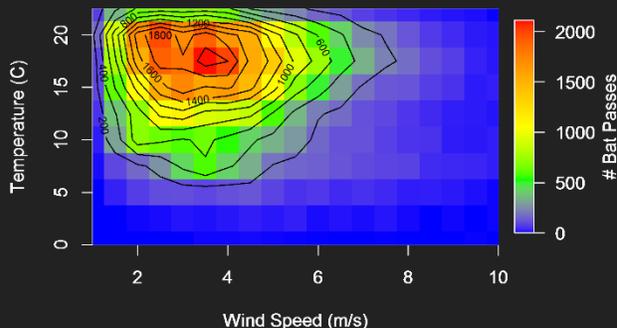
Optimizing Curtailment

We can simulate effectiveness and cost of any blanket curtailment strategy.



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Stantec Study

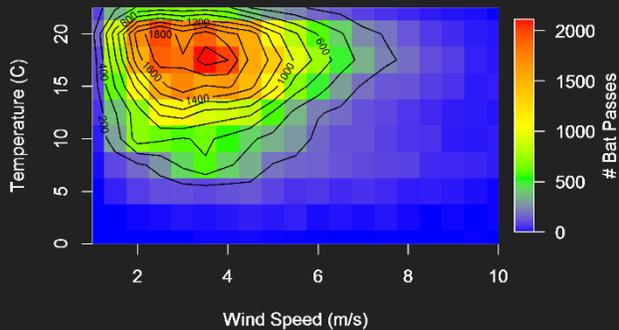


Training Year (2020) & Validation Year (2021)

- Record acoustic & weather data at nacelle height of 15 turbines each at up to 3 sites
- Empirical fatality estimates for each curtailment treatment
- Compare exposed activity and fatality at 3 scales (treatment, turbine, search)
- Determine reduction in exposed activity from blanket curtailment
- Design smart curtailment alternative (ABIC) targeting equal or greater reduction

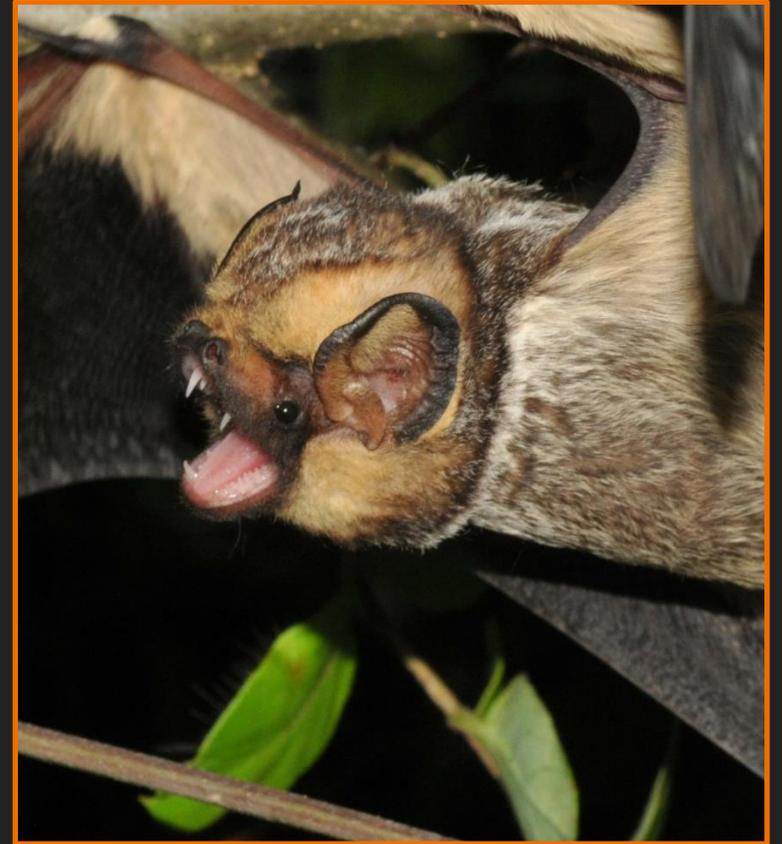
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Stantec Study



Goals

- Demonstrate utility of exposed bat activity as a quantitative metric of risk
 - Species-specific
 - Easily collected
 - Suitable for adaptive management
- Lower cost (energy loss) of conditions-based curtailment strategies
- Shift curtailment to a target-based versus parameter-based risk reduction strategy



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