

# Real-time acoustic smart curtailment increases energy optimization and may be improved by integrating with AI.

## Intelligent Curtailment: Can AI improve the balance between bat conservation and wind energy production?

Roger Rodriguez | rogerr@echosensellc.com

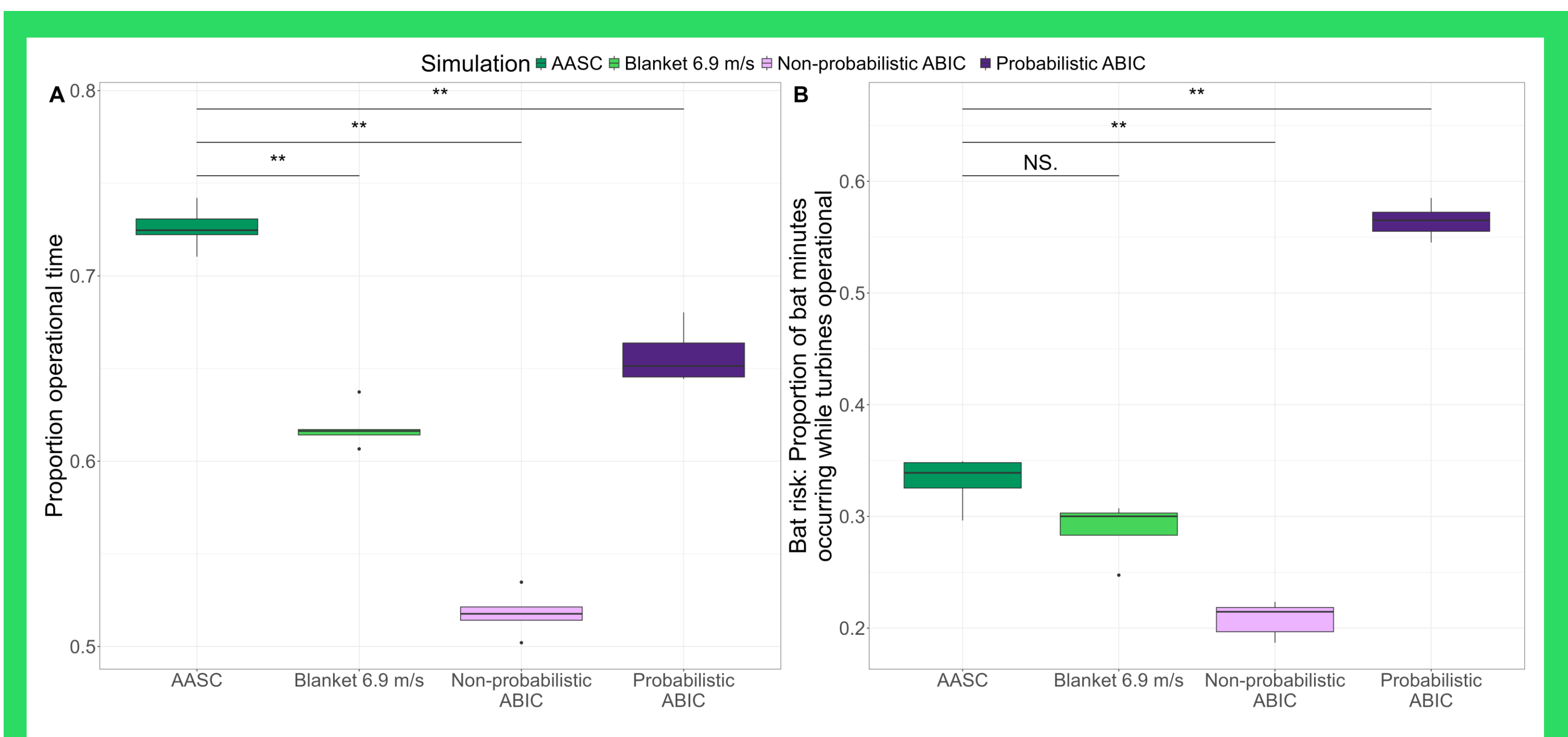


Figure 1: Proxies for energy production and bat activity exposed to operational turbines across four simulations representing different curtailment regimes. Bat risk was estimated using detections at each individual turbine.

**BLANKET CURTAILMENT**  
Curtailing when wind speed drops below 6.9 m/s.

**ACOUSTIC-ACTIVATED (AASC)**  
Curtailment initiated based on bat call detections across the site using the **EchoSense®** technology.

**NON-PROBABILISTIC ABIC**  
Periods of curtailment are determined from proportional estimates of bat activity within wind speed and temperature thresholds.

**PROBABILISTIC ABIC**  
Periods of curtailment are determined from bat occurrence probabilities ( $p \geq 0.5$ ) predicted from modeling of bat and weather data.

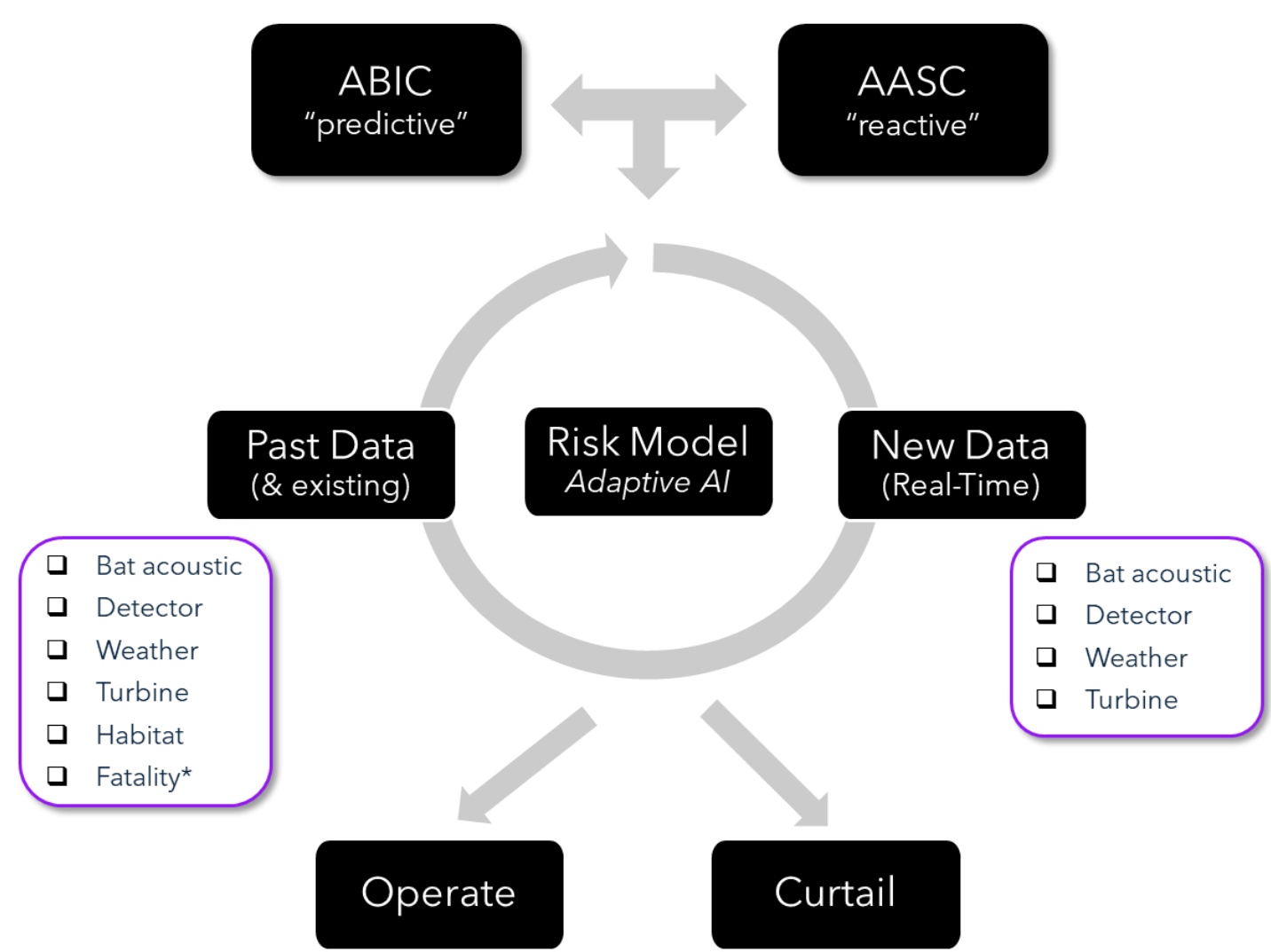


Figure 2: Conceptual model of intelligent curtailment. AI is integrated into AASC for real-time risk prediction and response.  
  
\*Fatality data maybe incorporated on a semi-real time basis.

### Intro

Smart curtailment strategies that use bat presence data are improved over blanket curtailment, but how do they compare?

**Algorithm-based informed curtailment (ABIC)** – predictive method to optimize curtailment

**Acoustic-activated smart curtailment (AASC)** – reactive (real-time) method to optimize curtailment

### Methods

1. Developed ABIC including Machine Learning method
2. Compared ABIC vs. AASC via operational time and bat risk

### Results

- AASC had more operational time than ABIC<sub>prob</sub> (>20%) and ABIC<sub>non-prob</sub> (>5%)
- AASC had a significantly lower bat risk level than ABIC<sub>prob</sub> (~30%), but not to ABIC<sub>non-prob</sub>

### Discussion

- Real-time data results in increased operation
- Intelligent Curtailment
  - The future of curtailment
  - Combine AASC & ABIC
  - Adaptive AI

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