

# Approaches to developing smart curtailment algorithms for bats and birds: big data and machine learning perspectives from BatCast and BirdCast

4 October, AWWI

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# BatCast Project Objectives

We sought to develop of a proof-of-concept approach:

... using gradient boosted linear regression trees ... to explore using regional-scale weather data  
... to predict broader-scale movements of bats ... to further the goal of reducing fatalities.

Models: bat mortality from fatality data and activity from audio recordings with  
31 predictor variables (i.e. atmospheric conditions, landcover, temporal and geographic data).

Intent: predict when, where, and under what conditions bats would occur in hazardous  
proximities to wind turbines based on BirdCast model (Van Doren and Horton 2018).

Focus: Great Lakes - high data density, existing bat distribution, weather, mortality acoustic data

# BirdCast

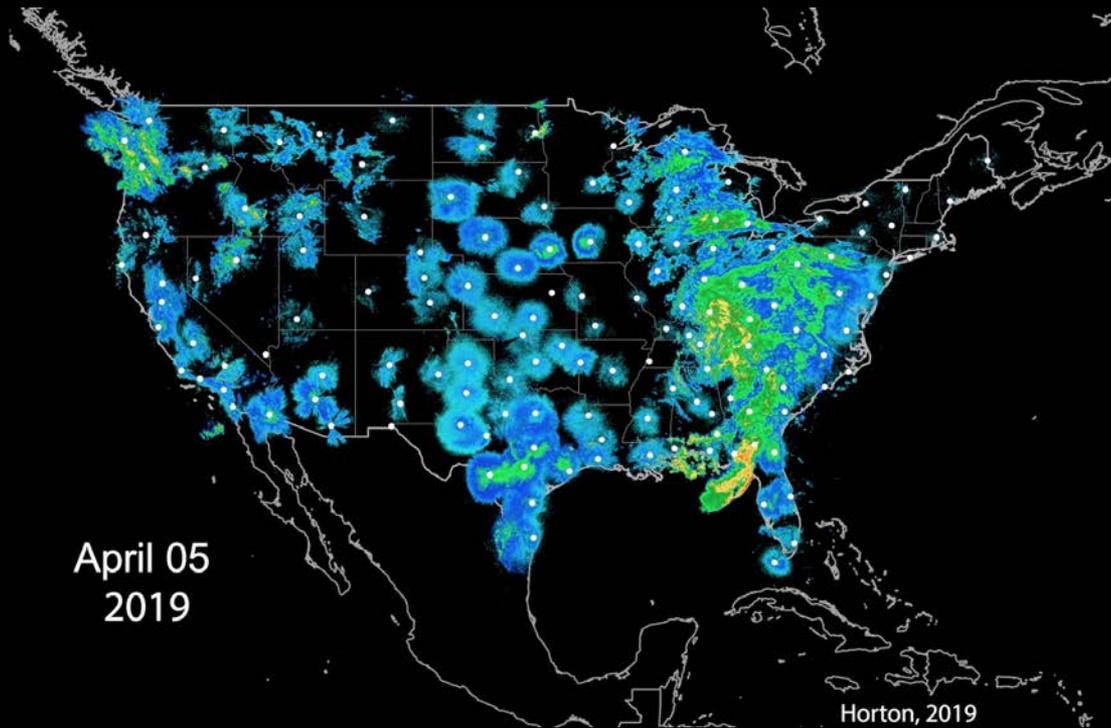
## Bird migration forecasts in real-time

When, where, and how far will birds migrate? Our migration forecasts will answer these questions for the first time.

[Learn here](#)



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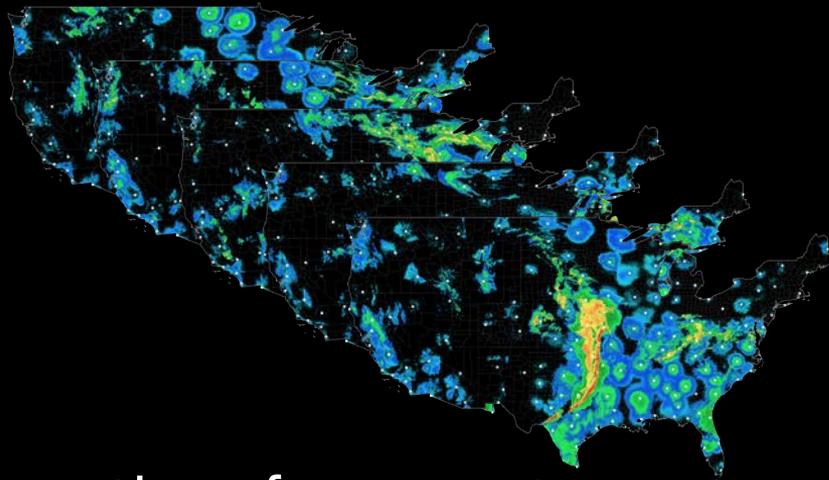


Weather surveillance radar data contain meteorological and biological information.

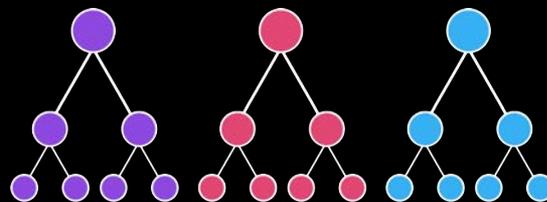
This animation depicts progressions of rain, irregular patterns, that characterize boundaries between air masses and biological phenomena, more uniform patterns, dominated by birds. Note the pulsed nature of biology, largely tied to mesoscale weather.

Machine learning, cloud computing, and big data analytics allowed us to develop a workflow to extract bird information from these complex radar data. And these data with which we characterize migration are the basis for forecast models.

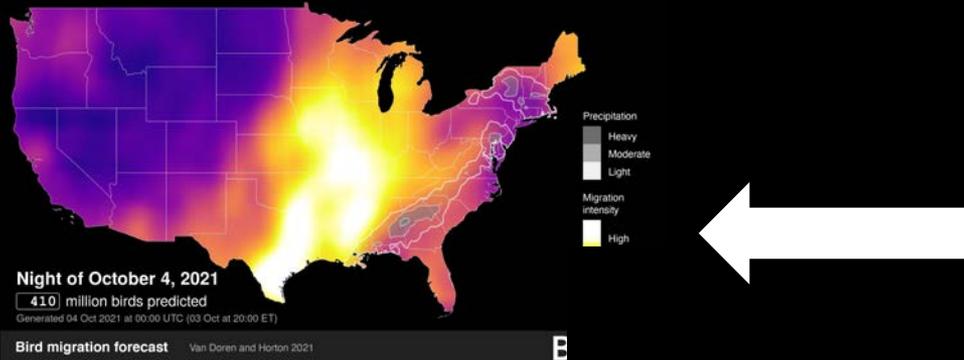
# Radar training data



# Learn associations



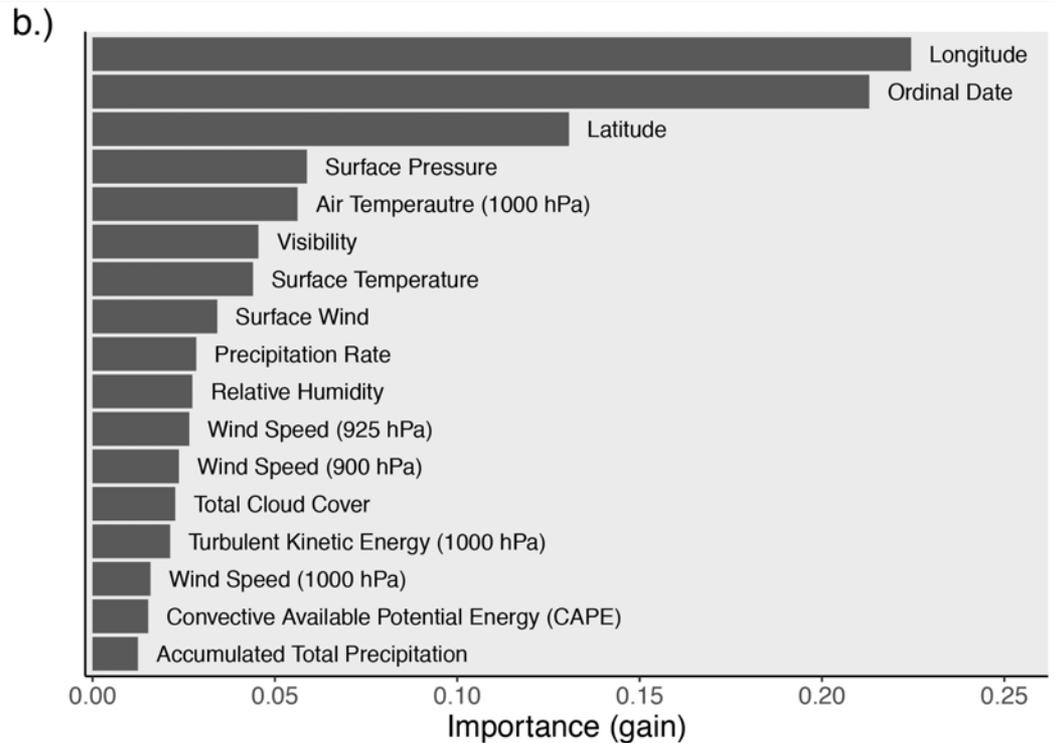
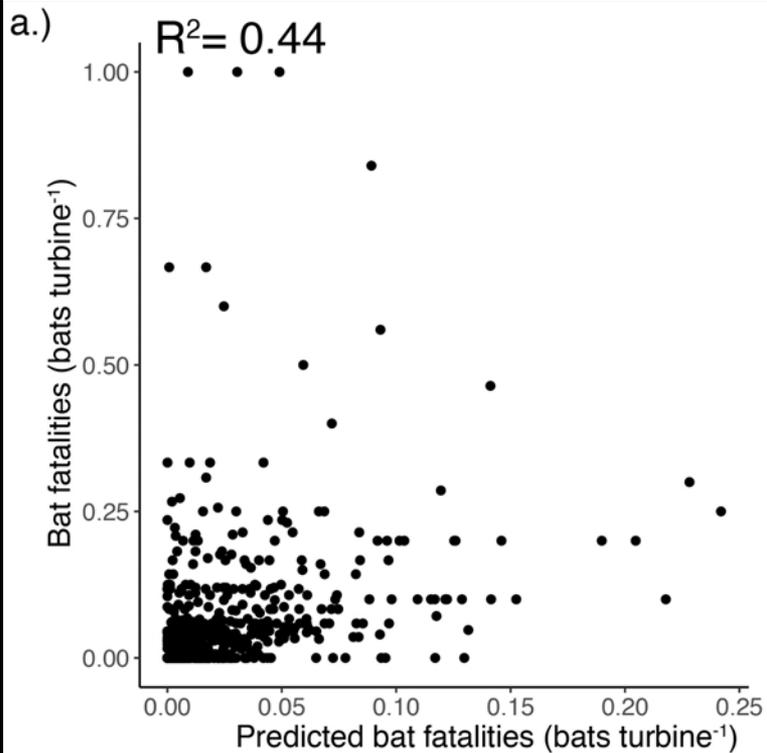
# Migration forecast



# Weather forecast/data

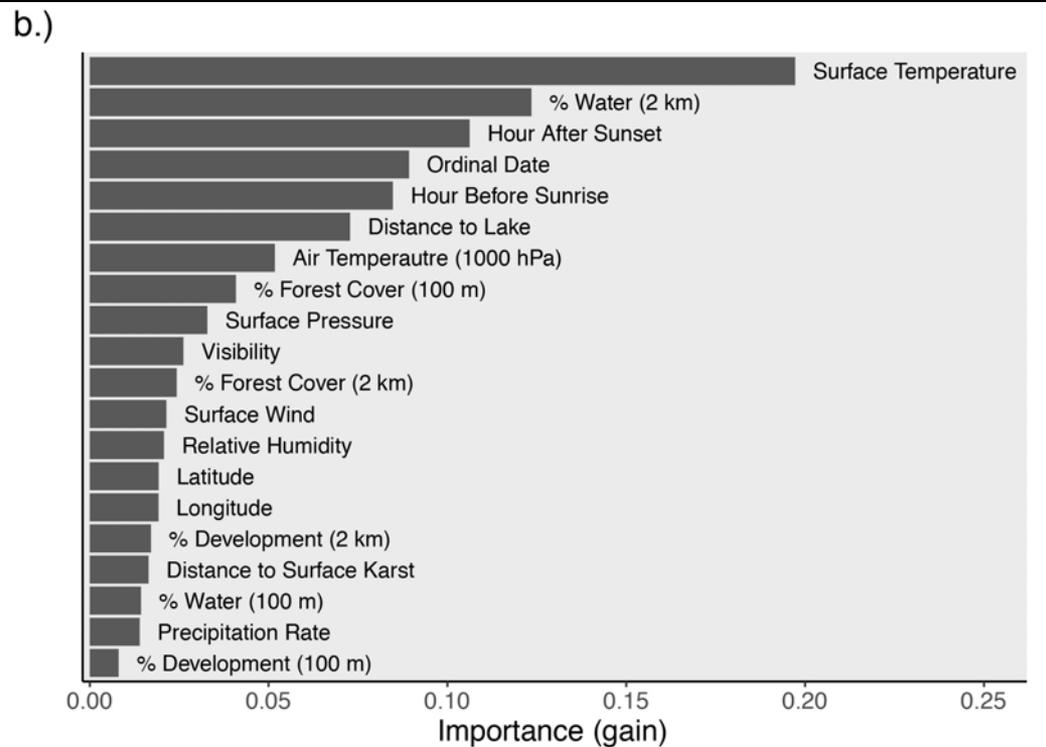
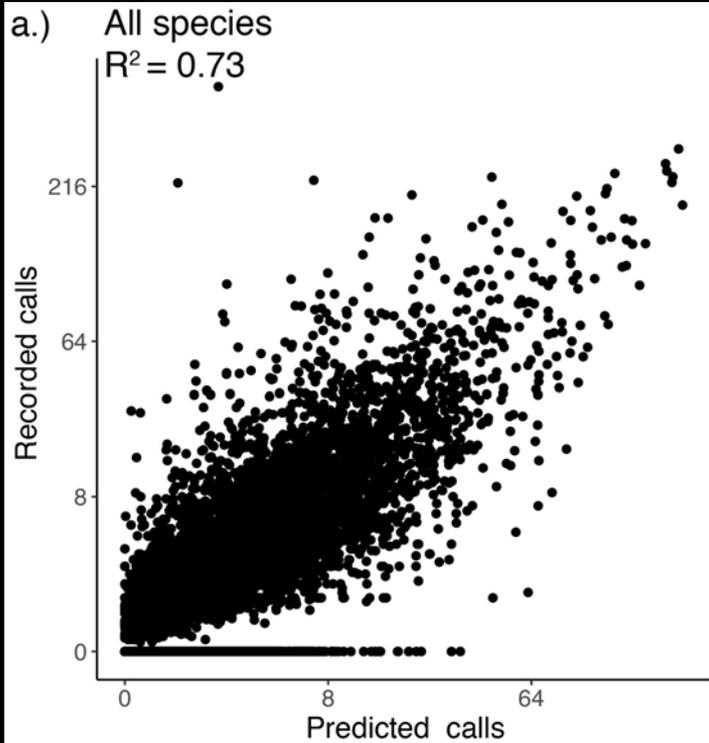
# Brief Methodology

- Gradient Boosted Regression Trees (e.g.)
  - Air pollution and weather (Cheng et al. 2021);
  - Bird Migration (Van Doren and Horton 2018);
  - Ecological modeling (De'Ath 2007)
- Gradient boosting involves:
  - Optimizing (a loss function).
  - Predicting (with a weak learner).
  - Additive models - learners to minimize loss.
  - General plan - reduce error and grow explanatory power (e.g. next best model?) in stages to predict an outcome
- Original model: fatality data
  - Insufficient sample sizes ( $N$ )
  - Low temporal resolution
  - Fresh carcass data is a fundamental constraint
- Adapted models: fatality **and** activity data
  - Fatality data – 6114 fresh carcasses
  - Activity data - acoustic monitoring of bat echolocation activity (407,452 calls)
    - Opportunistic addition and much prior analysis
- AWWIC, EPA Level III, AWWI Bat Technical Report
- BatAMP, Heist et al., late spring/late summer
- NARR (weather) data, Mesinger et al. 2006



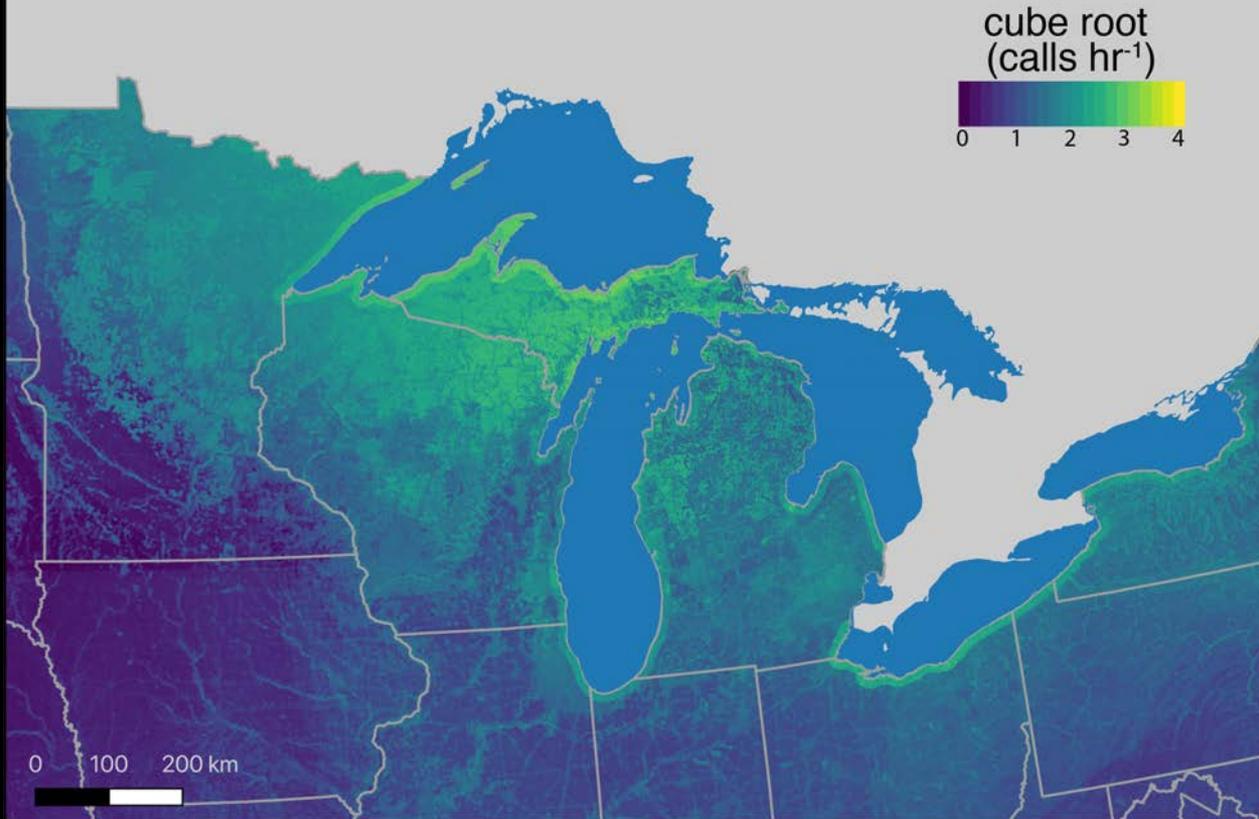
a.) Scatterplot of predicted versus reported bat carcasses.

b.) Predictor variable importance ranked in descending order.



a.) Scatterplot of bat vocalizations predicted by acoustic all-species model versus recorded vocalizations. Note, much work prior to BatCast.  
 b.) Predictor variable importance ranked in descending order.

## All bat species



Acoustic all-species model predictions for 7/19 with an average regional atmosphere – a static depiction of an “average” night – e.g. 90 °F, sunset+2 hours, 20km visibility, 85% relative humidity, no wind or precipitation.

# Brief Summary Discussion

Models performed well.

Acoustic activity outperformed mortality: 1) higher temporal resolution; 2) landcover predictors; 3) larger  $N$

Our efforts support regional in contrast to proximate scale models (advanced warning of risk).

Large datasets may be necessary for machine learning: more acoustic data than fatality data.

- Fatality - expensive, labor-intensive, spatially constrained, low temporal resolution.
- Model may improve if each fatality event has time stamp (e.g. specific weather variables tied to event).

This study focused on the Great Lakes region. Future value in expanding the geographic scope of analysis.

Applications at operational facilities will benefit from additional research guided by this proof-of-concept.

# Lights Out Alerts: [alert.birdcast.info/lightsout](http://alert.birdcast.info/lightsout)

Lights Out Alerts BETA BirdCast

Dallas, TX [Change location](#)

**Tonight's migration forecast** ⓘ  
Night of Monday, October 4

**High** >26,000 birds/km/night

**Lights Out Alert**  
Turn off your lights tonight to save migrating birds.

A Lights Out Alert has been issued for this region. Large numbers of birds are forecast to migrate over this area overnight. Bright lights attract and disorient nocturnally migrating birds, potentially causing fatal collisions with buildings or exposure to additional day time hazards. Help protect birds as they pass through your region by turning off all non-essential lighting from 11:00PM tonight until 6:00AM tomorrow morning. [Learn more](#)

[Subscribe to alerts](#)

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**3-night migration forecast** ⓘ

<b>Mon, Oct 4</b> <b>High</b> >26,000 birds/km/night	<b>Tue, Oct 5</b> <b>High</b> >26,000 birds/km/night	<b>Wed, Oct 6</b> <b>High</b> >26,000 birds/km/night
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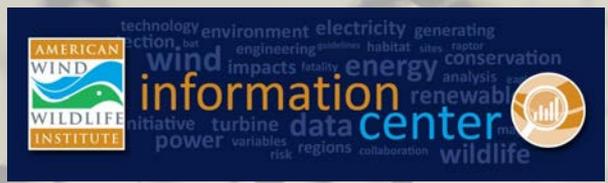
BirdCast model  
(Van Doren and Horton 2018)

Three, location specific migration predictions  
(low, medium, high)

High intensity prediction produces an "alert"

Example application of alert and early warning technologies





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Special thanks to Juan, Ryan, Taber, all of you in the audience and MANY others