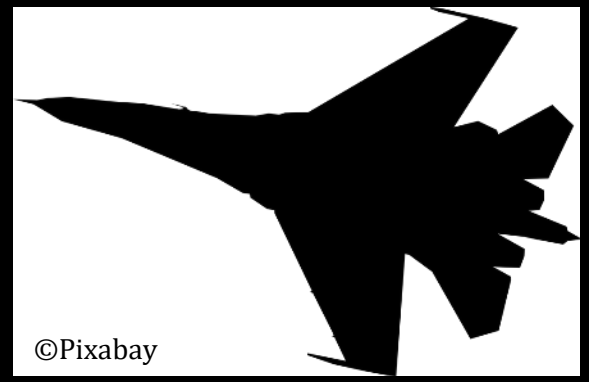
Why should we, and can we, develop a **bird strike risk model** for military aircraft?

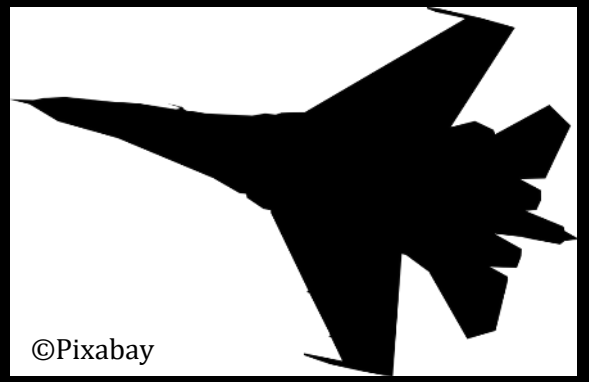


Raymond B. Iglay[1], Amanda L. Bowe[1], Morgan B. Pfeiffer[2], Bradley F. Blackwell[2], Travis L. DeVault[3], Michael J. Begier[2]

1 MISSISSIPPI STATE UNIVERSITY DEPARTMENT OF WILDLIFE, FISHERIES AND AQUACULTURE

2 USDA

3 GEORGIA Savannah River Ecology Lab



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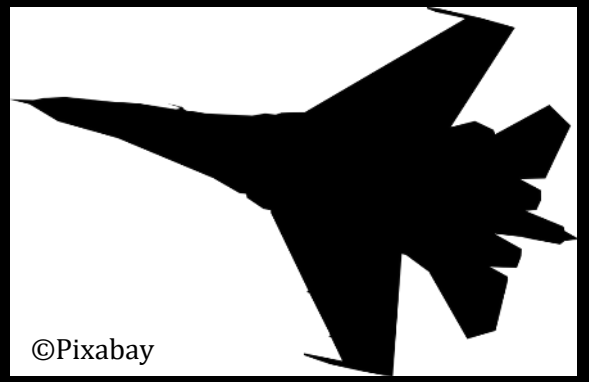

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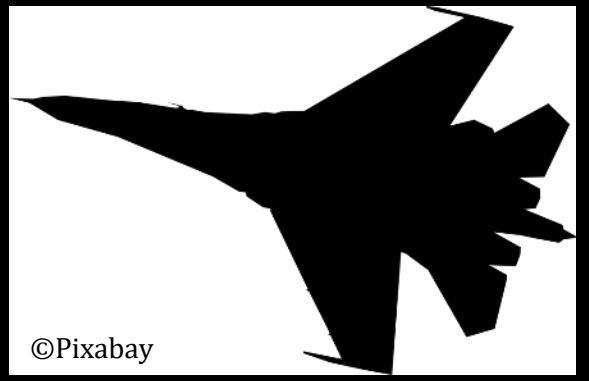
What combination of factors relates to, or *causes*, this event to occur?



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Severity

Frequency

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Strike Risk Model

Civil

OR

Military

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Strike Risk Model

Severity

r

Airframe/Mission Type

Fighter, Stealth, Cargo, Rotorcraft

Airspeed

Bird Body Size and Density

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Relative Hazard Scores

Military

Pfeiffer, M.B., B.F. Blackwell, and T.L. DeVault. 2018. Quantification of avian hazards to military aircraft and implications for wildlife management. PLoS ONE 13(11):e0206599

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Strike Risk Model

Frequency

p

The Probability of a Strike Occurring

What time are birds using airspace?

When are planes using airspace?

Less common in research

Where are the birds in the airspace?

When do flights occur?

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Strike Risk Model

Frequency

p

Airframe/Mission Type

Fighter, Stealth, Heavy/Cargo, Rotorcraft

Other Airport Characteristics

- Daily/annual Aircraft Movements
- Mitigation Activities
- Migratory Flyway

Airport Land Use

- % cropland
- % open water
- Landscape heterogeneity

Bird Presence

- Airbase bird surveys
- Wildlife Hazard Assessments
- Breeding Bird Survey

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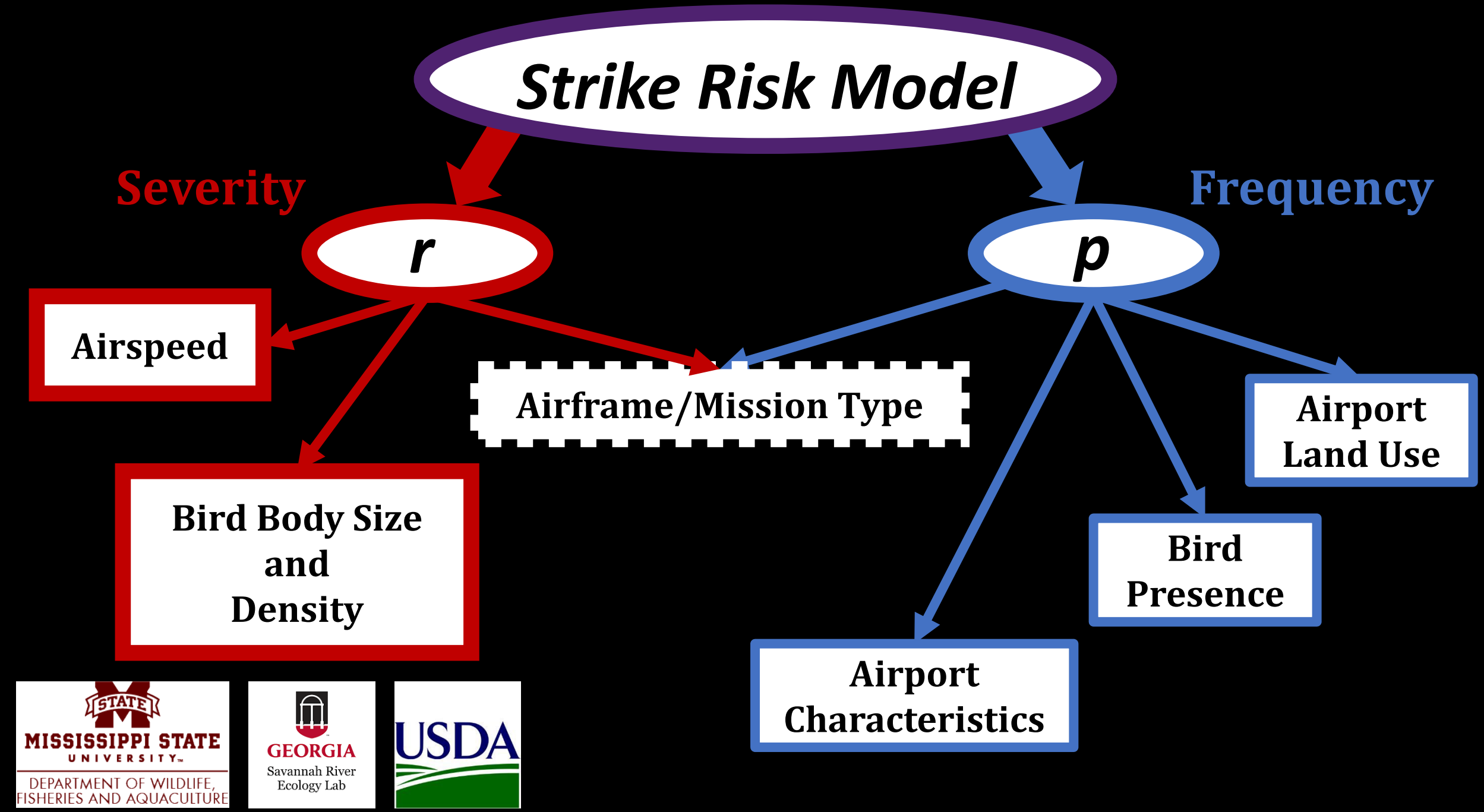
Strike Risk Model
Severity
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Airport Characteristics
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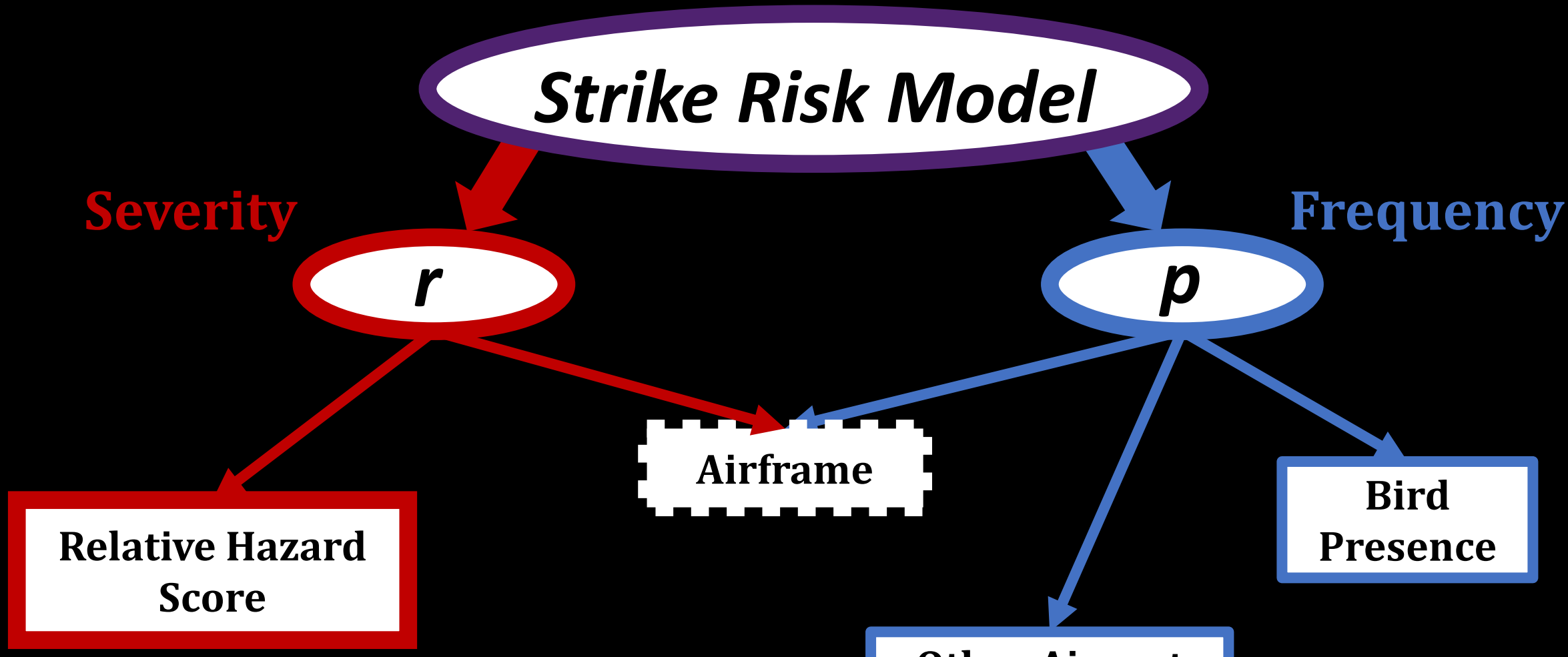

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Our attempt at a military strike risk model

Strike Events
WESS (RMI)

U.S. Navy Data

Aircraft Movements
NAVFLIR

Factors of Interest

Airframe
Season
Time of Day
Flyway

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Strike Frequency Predictions

Airframes

Cargo, Fighter, Rotorcraft, Other

"Fighters greater strike frequency than Cargo"

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Strike Frequency Predictions

Airframes

Cargo, Fighter, Rotorcraft, Other

"Fighters greater strike frequency than Cargo"

Time of Day

"Greater strike frequencies during dawn (0600-0900) and late afternoon/early evening (1500-2100)"

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Strike Frequency Predictions

Airframes

Cargo, Fighter, Rotorcraft, Other

"Fighters greater strike frequency than Cargo"

Time of Day

"Greater strike frequencies during dawn (0600-0900) and late afternoon/early evening (1500-2100)"

Flyway

Atlantic, MS, Central, Pacific

"Central and MS greater strike frequency than coastal flyways"

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Strike Frequency Predictions

Airframes

Cargo, Fighter, Rotorcraft, Other

"Fighters greater strike frequency than Cargo"

Time of Day

"Greater strike frequencies during dawn (0600-0900) and late afternoon/early evening (1500-2100)"

Flyway

Atlantic, MS, Central, Pacific

"Central and MS greater strike frequency than coastal flyways"

Season

Fall	Winter	Spring	Summer
Sept-Oct	Nov-Mar	Apr-May	June-Aug

"Migration periods > winter
Spring migration > fall migration"

Data Filtering

~4.5 M flight records, >12,000 strike records, 2010-2018

Only flights departing from continental U.S.

Restricted strike records to flight years

Unidentified aircraft removed (no BUNO)

Only bird strikes included

Records missing data removed (e.g., no airframe, no flyway)

Removed duplicates after merging data sets

"Near miss" events removed

~2.5 M flight records, ~1,800 bird strike records, 2013-2018

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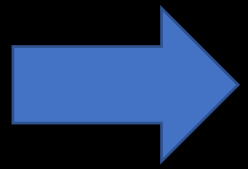
Analysis

Season (month)

Flyway

Airframe

Time of Day



Logistic Regression
k-nearest Neighbor Classification
Random Forest Model

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Models Failed to Converge

Data Caveats

Big data but data limited

Data Caveats

Strikes are rare, but how about risk?

Baseline Strike Rate

7.3 strikes per 10,000 flights

0.073%

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Data Caveats

Similar characteristics between strike and safe flights

~1,800 strikes

~2.5 M safe flights

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Data Caveats

What does airfield mean when strike location is missing?

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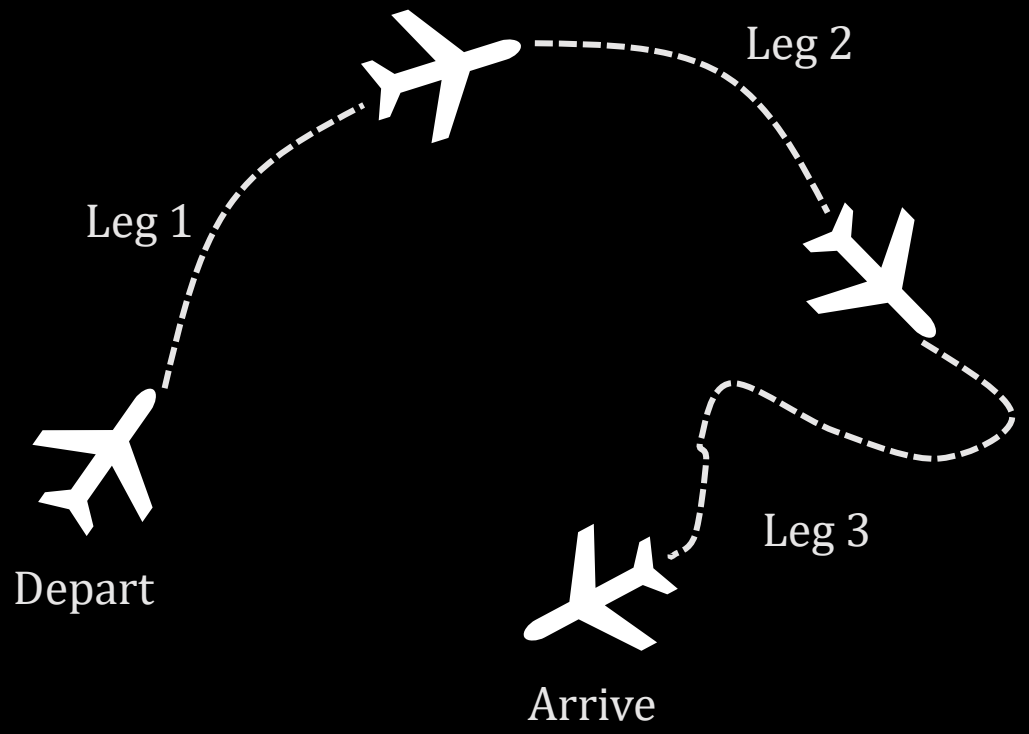
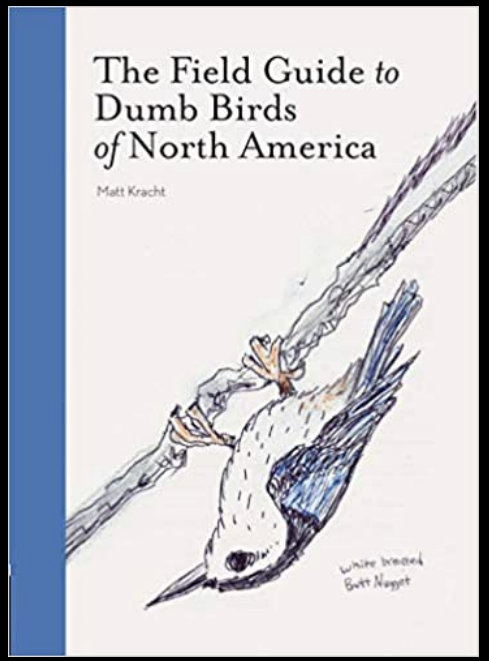
Data Caveats

Unknown Flight Legs and Carcasses Found





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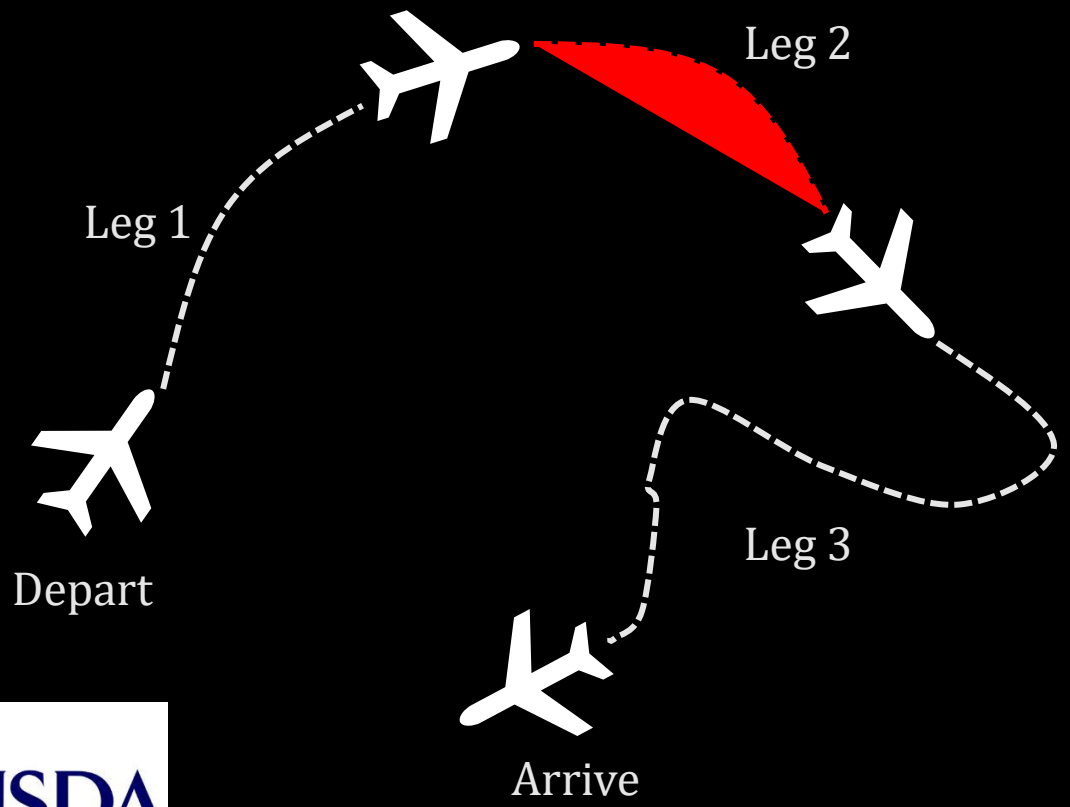
Data Caveats

Unknown Flight Legs ➔ Known Flight Leg



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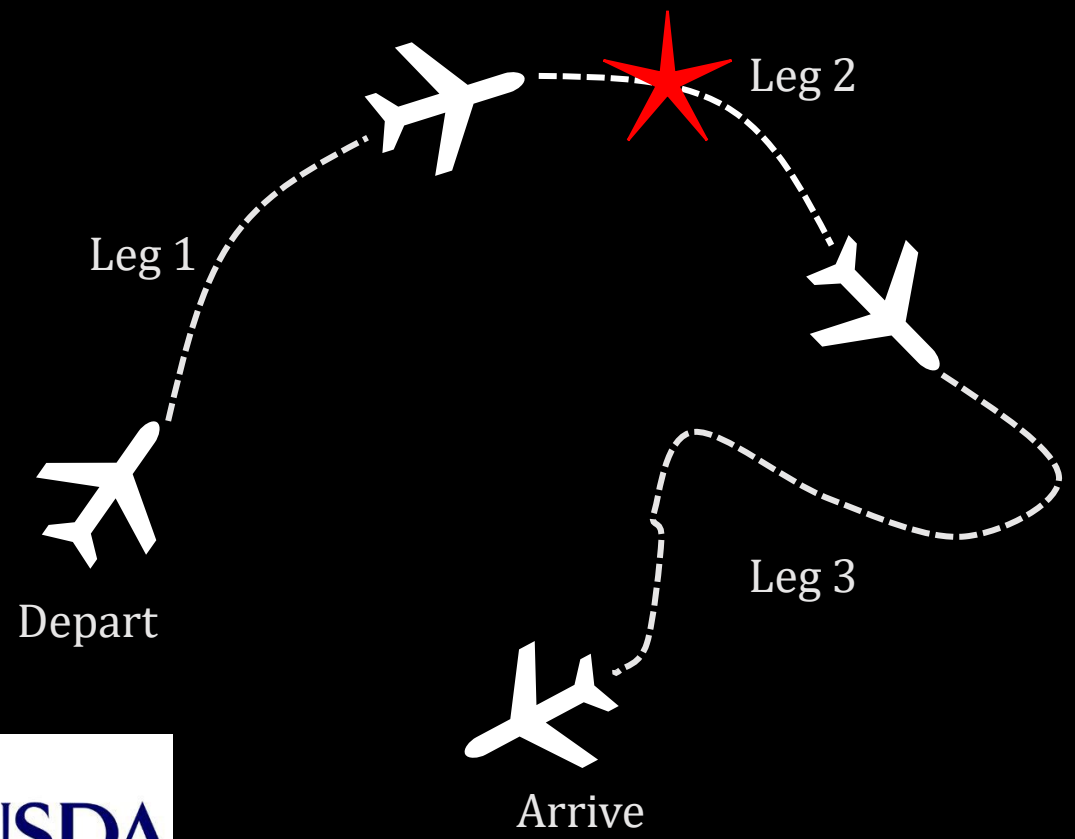
Data Caveats

Unknown Flight Legs ➔ Known Strike Location



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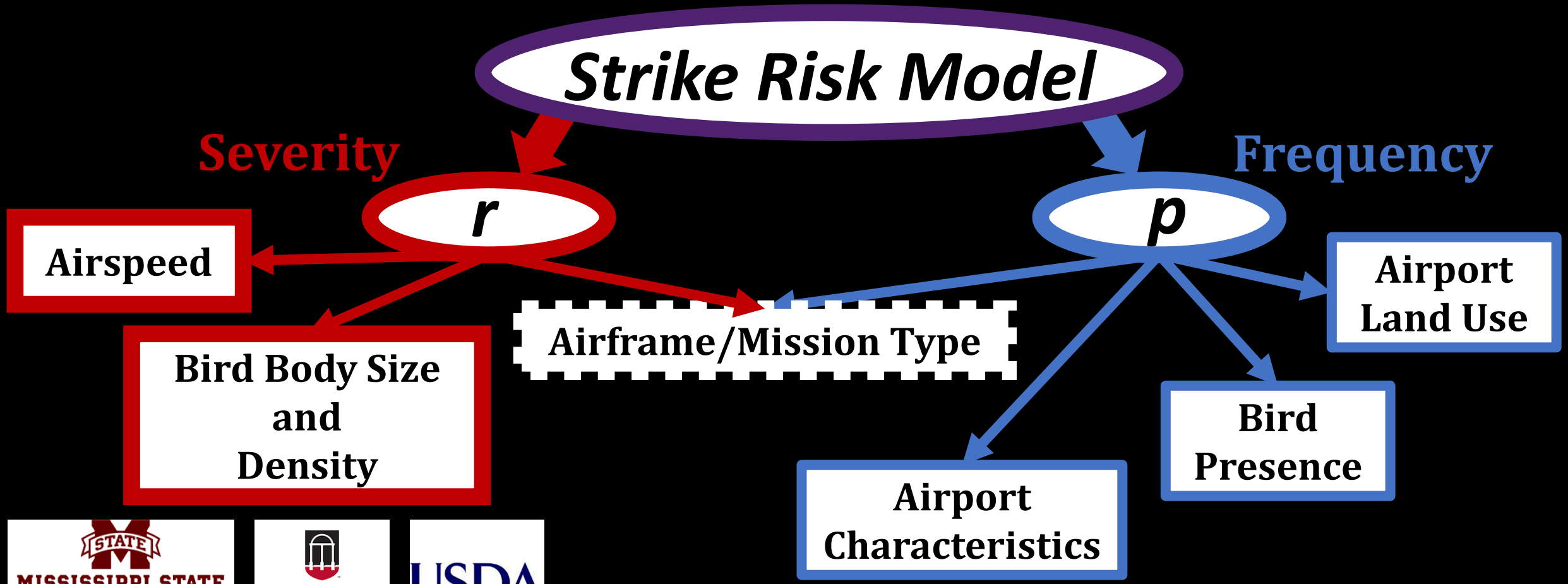
Data Caveats

This really is a complex challenge!



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Looking Ahead

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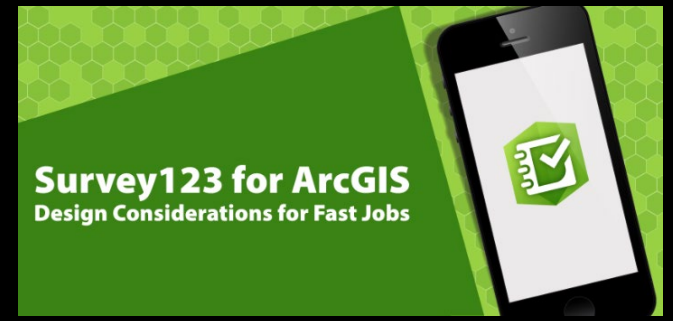
Are we collecting the right data?

Wildlife Strike Database



Risk Workbooks

DeVault et al. 2018

Filling in the data gaps

<u>Common Missing Data</u>

Altitude

Airspeed

Time of Strike

Strike Location

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Understanding Bird Strikes from the *Ground up*

Investigating the complexity of strike and non-strike events

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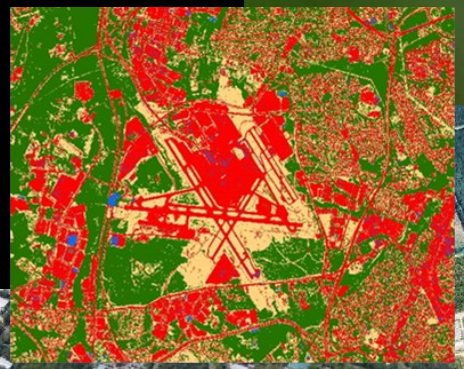
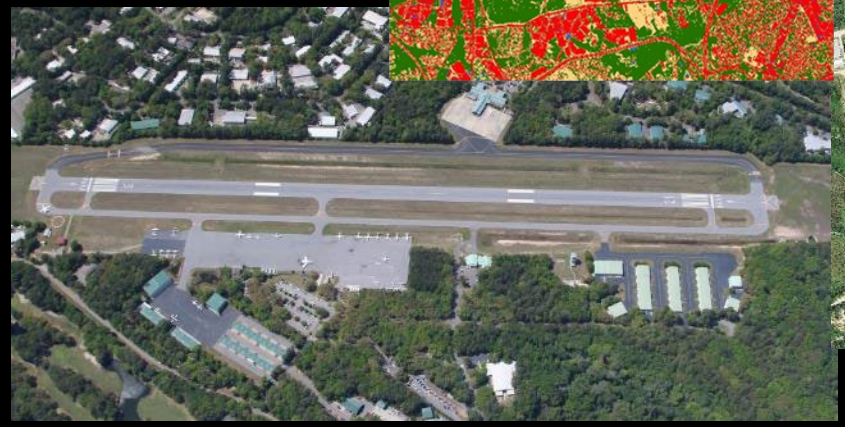
Z

Boise State's R2 Compute Cluste

X,Y





Hilton Head Island Airport

Augusta
Regional Airport

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New Technologies for Better Data

What does the future hold?

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New Technologies for Better Data

What does the future hold?

Press a button,
log a bird strike!

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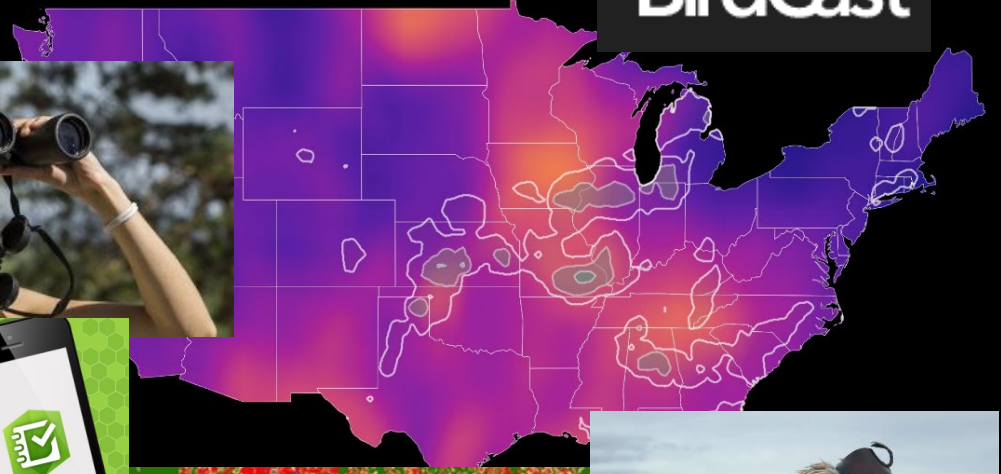
Teamwork = Safer Skies



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Questions

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