# Quantification of avian hazards to military aircraft


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# The issue: bird strikes with military aircraft

- Human safety
- Annual costs $35 million for United States Air Force (USAF)[1]
- Not as well studied

[1] (Zakrajsek and Bissonette 2005)

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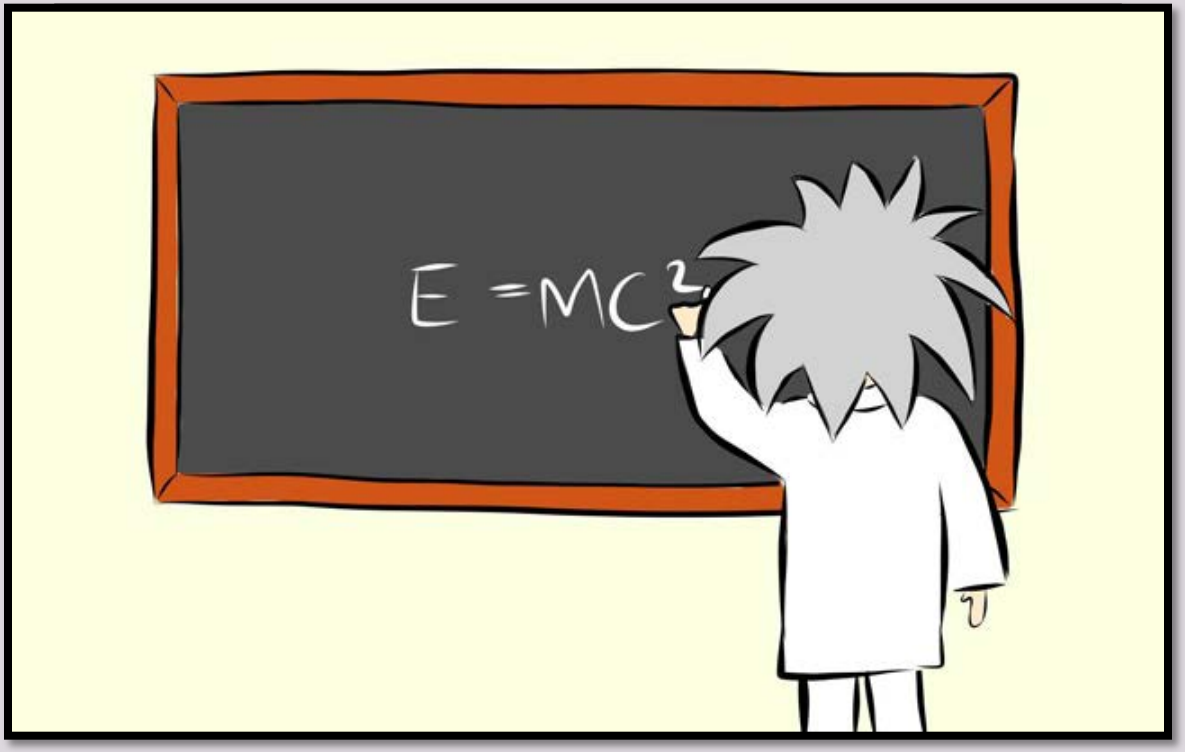
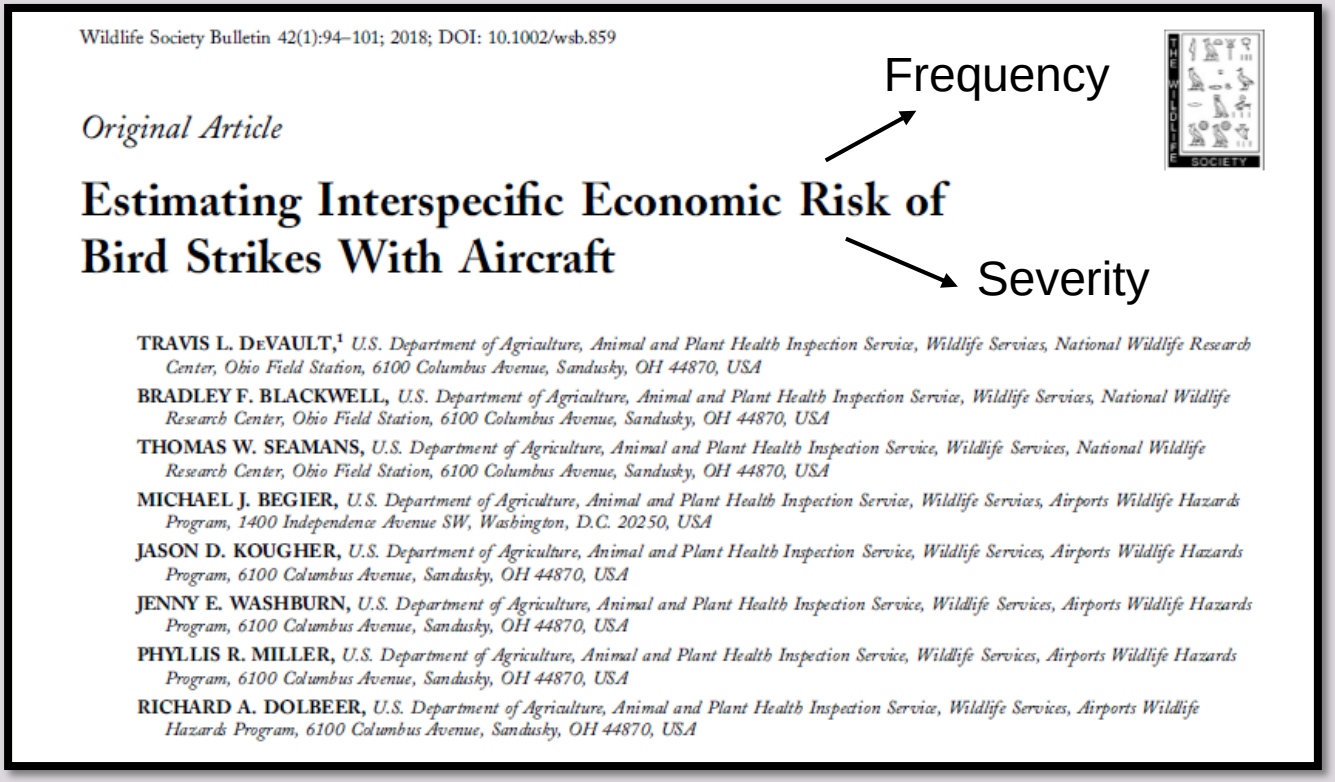
# Why expect different patterns than civil aviation?

- Variety of airframes (cargo, fighters, etc.)
- Long flight durations at low altitudes (Dolbeer et al. 2006)
- Greater speeds



# Prioritize avian management for military airfields

- Over 700 wildlife species struck by military aircraft
- Focus time and resources on a subset of these species



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Frequency

*Original Article*

## Estimating Interspecific Economic Risk of Bird Strikes With Aircraft

Severity

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# Ranking Severity

- Zakrajsek and Bissonette 2005
- Hazard Index

$$HI_S = (C_S \times W_C) + (B_S \times W_B) + (A_S \times W_A),$$

- Weights were constant regardless of species and based on a monetary index
- Which species cause the most damage?

# Relative Hazard Scores (RHS)

- Which species are the most hazardous if struck?

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*Original Article*

## Interspecific Variation in Wildlife Hazards to Aircraft: Implications for Airport Wildlife Management

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**ABSTRACT** Understanding the relative hazards of wildlife to aircraft is important for developing effective management programs. We used Federal Aviation Administration National Wildlife Strike Database records from 1990 to 2009 in the United States to rank the relative hazard of wildlife to aircraft. We summarized data for 77 species or species groups with ≥20 records where collisions occurred ≤500 ft (152 m) above ground level. We also assessed the effects of avian body mass, body density, and group size on relative hazard scores. The 3 most hazardous species or species groups were mule deer (*Odocoileus hemionus*), white-tailed deer (*O. virginianus*), and domestic dogs. "Other geese" (snow goose [*Chen caerulescens*], brant [*Branta bernicla*], and greater white-fronted goose [*Anser albifrons*]) was the most hazardous bird group. Ten of the 15 most hazardous bird species or species groups are strongly associated with water. Avian body mass was strongly associated with percentage of all strikes that caused damage, but not for species exceeding median body mass (1,125 g) of birds in damaging strikes. In contrast, percentage of damaging strikes increased when multiple birds were involved, but only for those species with body mass ≥1,125 g. Managers should prioritize efforts that will reduce habitat suitability for those species most hazardous to aircraft. We recommend use of exclusion (e.g., fences) for managing large mammals and habitat modifications (e.g., reductions in standing water) accompanied by hazing for reducing bird use of airports. We also recommend that evaluations of jet turbine engine performance following bird ingestions consider using multiple birds with body mass >1,000 g. 

# Hypotheses


- Airframe and avian body mass would influence RHS (DeVault et al. 2011)
- Region (Pfeiffer et al. 2018)
- Reporting military branch
  - Mandatory reporting USAF > 20 years
  - Mandatory reporting United States Navy (USN) since 2017

# Data Filtering

- USN 1990-2017; USAF 1994-2017
- ONLY avian species (groups) struck > 20 times in the US
- Not filtered based on altitude, airframes grouped

| Damage Class | Associated monetary Cost |
|---|---|
| **A** | > $2,000,000 |
| **B** | $500,000 – $2,000,000 |
| **C** | $50,000 – $500,000 |
| **D** | $20,000 – $50,000 |
| **E** | < $50,000 |
| **H (damaging)** | > $55 |
| **H (non-damaging)** | ≤ $55 |

Minor Damage

Substantial Damage

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# RHS Calculations – American Kestrel

- 1,237 strikes
  - 15 strikes with substantial damage
  - 90 with minor damage
  - 1,147 no damage

Max is 116% (Snow goose)

| Species | % damage | Damage rank | % sub. damage | Sub. damage rank | Sum of ranks | Sum of % | RHS | Composite rank |
|---|---|---|---|---|---|---|---|---|
| American Kestrel | 7% | 68 | 1% | 51 | 119 | 8% | 7 | 58 |

Out of 108 species (groups)

8/116 = 6.89

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# Statistical Analysis

- Compare RHS among military and civil airframes
- Examine the relationship between body mass and RHS
- Use AIC model ranking to determine the best combination of predictors

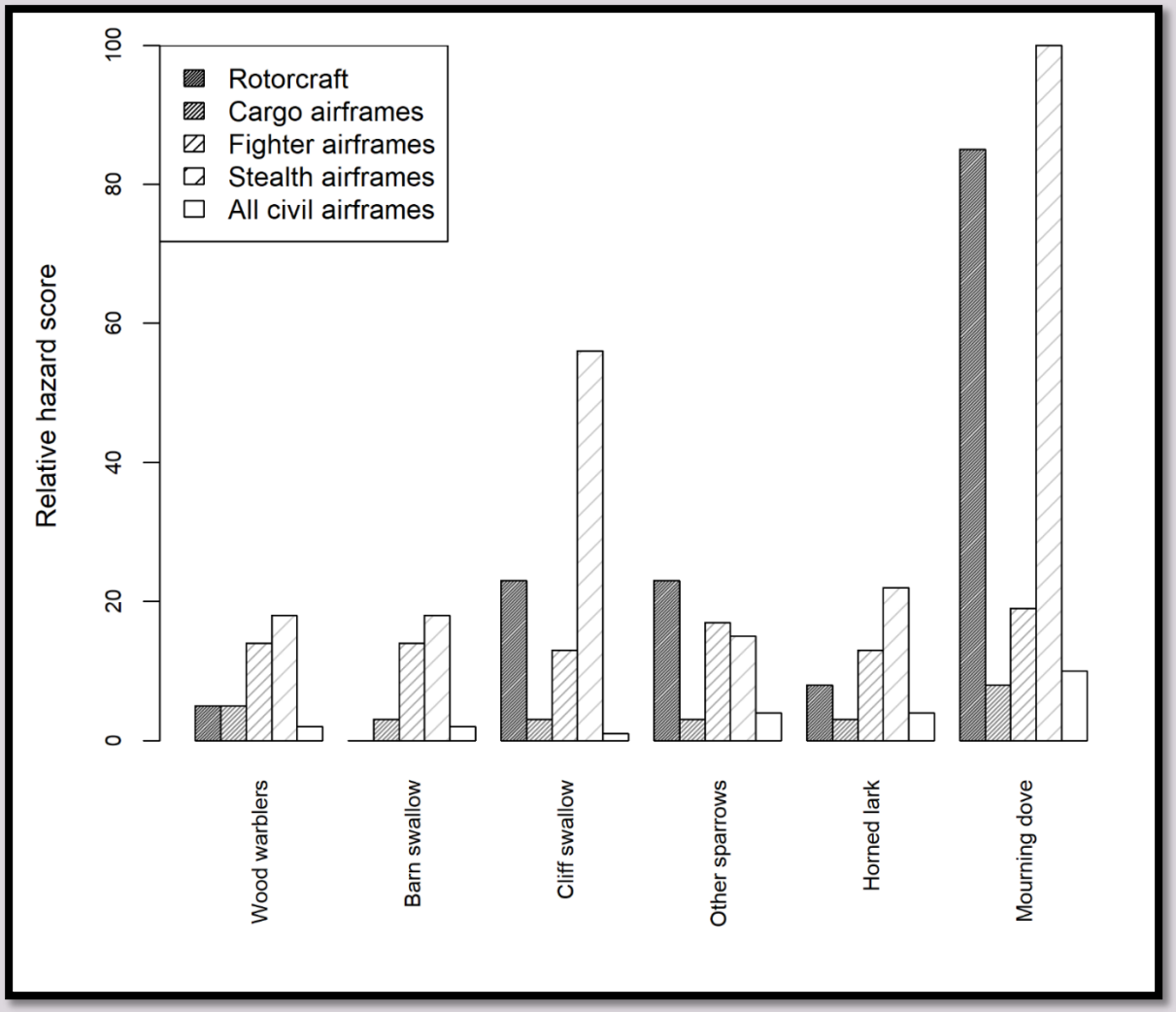
# Results

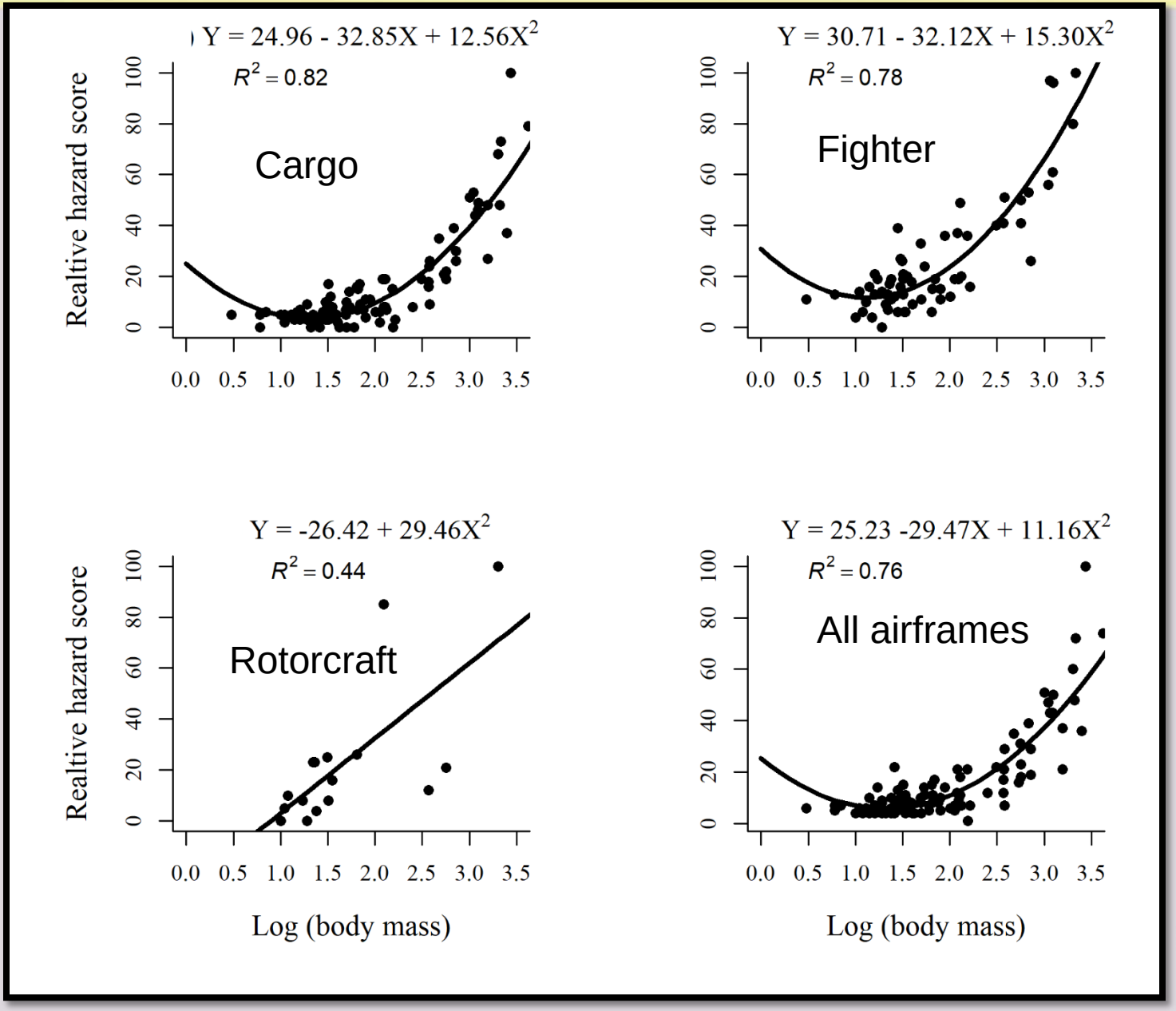
- % of strikes removed because species was unknown
  - USN – 62% removed
  - USAF – 20% removed

- Final number of strikes used
  - USN – 4,136 (11%)
  - USAF – 34,990 (89%)

| Damage Class | Number of Strikes |
|---|---|
| A/B/C (substantial) | 1,001 |
| D/E/H (minor damage) | 3,239 |

| Species | % with damage | % with substantial damage | Relative hazard score | Composite rank |
|---|---|---|---|---|
| **Snow goose** | 74 | 42 | 100 | 1 |
| **Common loon** | 70 | 30 | 86 | 2 |
| **Black vulture** | 58 | 25 | 72 | 3 |
| **Canada goose** | 56 | 29 | 74 | 3 |
| **Turkey vulture** | 48 | 21 | 60 | 5 |
| **Northern pintail** | 44 | 16 | 51 | 6 |
| **Mallard** | 45 | 13 | 50 | 7 |
| **Swainson's hawk** | 41 | 14 | 47 | 8 |
| **Double-crested cormorant** | 44 | 13 | 48 | 9 |
| **Herring gull** | 32 | 18 | 43 | 10 |
| **Red-tailed hawk** | 37 | 14 | 43 | 10 |


Relative hazard score
0
20
40
60
80
100
Rotorcraft
Cargo airframes
Fighter airframes
Stealth airframes
All civil airframes
Wood warblers
Barn swallow
Cliff swallow
Other sparrows
Horned lark
Mourning dove

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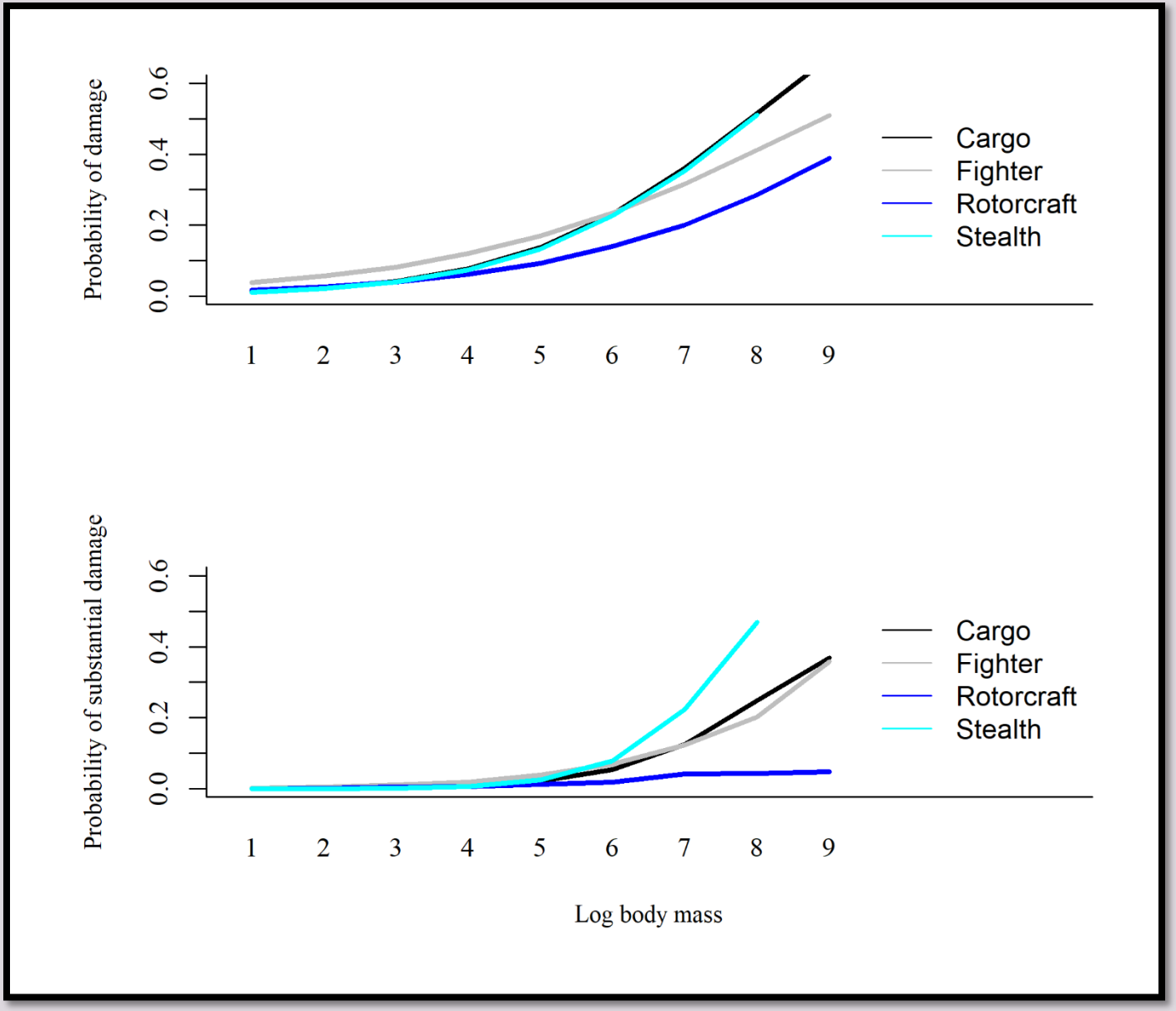
# Results

- Binary logistic regression for damage or not and substantial damage or not
  - Best models included:
    - Flyway
    - Airframe
    - Body mass
    - Military branch
    - Airframe × body mass
  - Airframe, body mass, and Airframe × body mass significant



# Results

- Migration flyway significant for probability of substantial damage (Pacific)

- Military branch significant for probability of substantial damage (USAF)

# Discussion

- First RHS for military aviation calculated
- Need to incorporate frequency data
- Need monetary independent data to evaluate

# Discussion


- Airframe and avian body mass influenced RHS
- Region was significant at predicting substantial damage
- Reporting military branch was significant at predicting substantial damage

# Conclusion

- Military avian RHS were different than civil
- RHS differed per airframe and with avian body mass
- RHS prioritize wildlife management absent a risk estimate
- Only as accurate as the data provided

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- Office support: Betsy Poggiali



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# Questions?

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