Wildlife Strike Risks in Urban Air Mobility: Insights from Helicopter Operations

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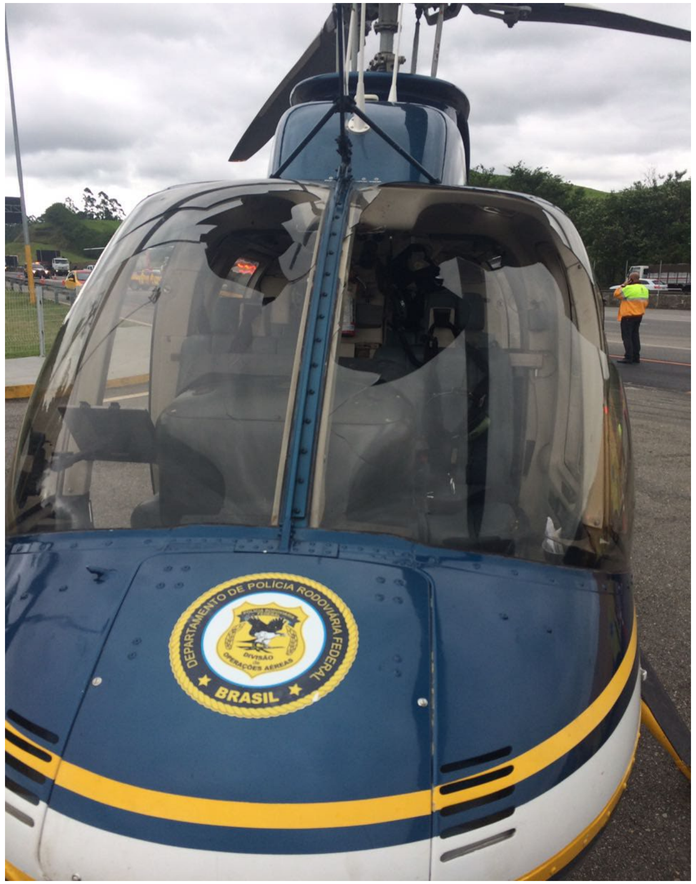
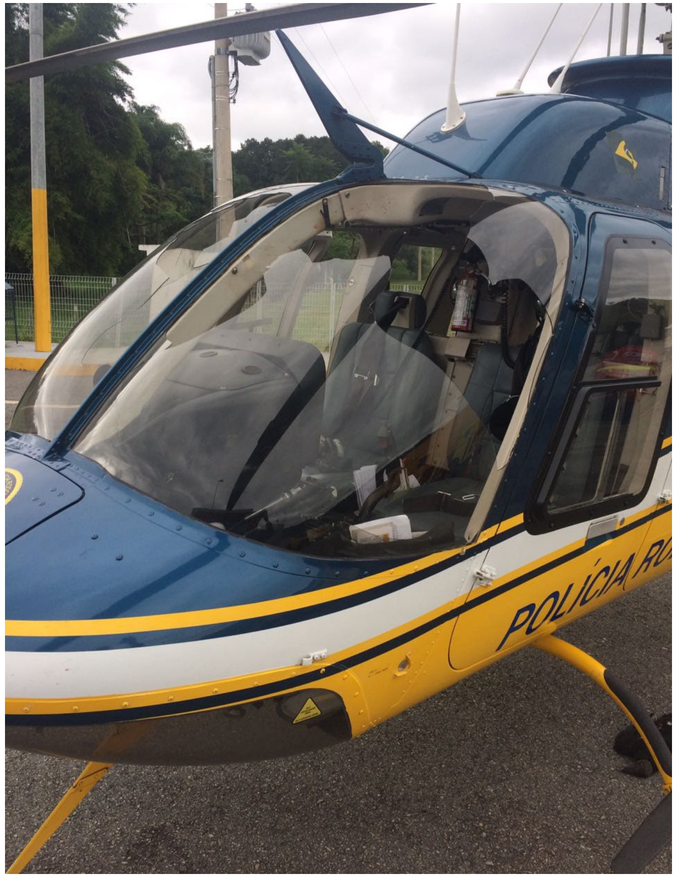
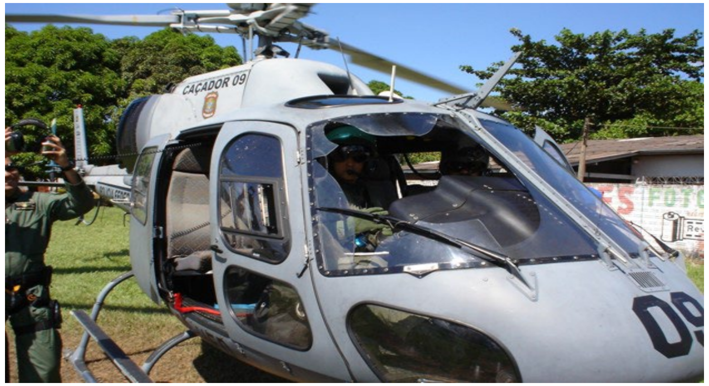
Background and Significance

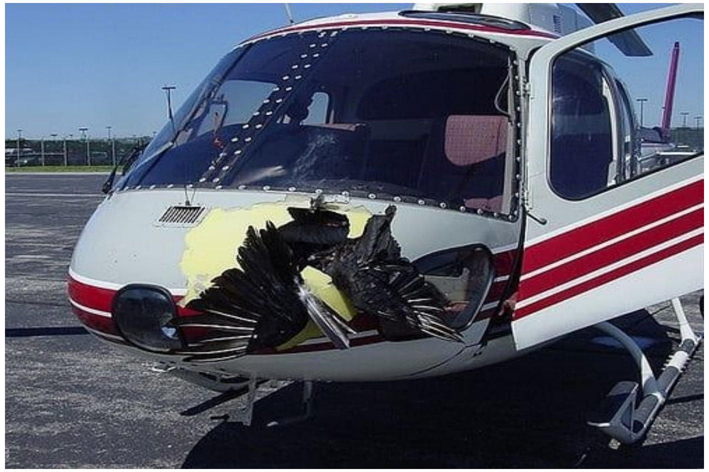
- Since 1988, wildlife strikes have caused over 464 fatalities and the destruction of 305 aircraft worldwide.
- In response to the risks these strikes pose to aviation, industry stakeholders have intensified their safety measures to prevent future incidents.
- This research **seeks to fill the gap in published reports on wildlife strikes involving urban air mobility**
    1. Evaluate the potential dangers of wildlife strikes to UAMs.
    2. The findings will inform safety management practices, route planning, and schedule adjustments for UAM operations.

Background and Significance



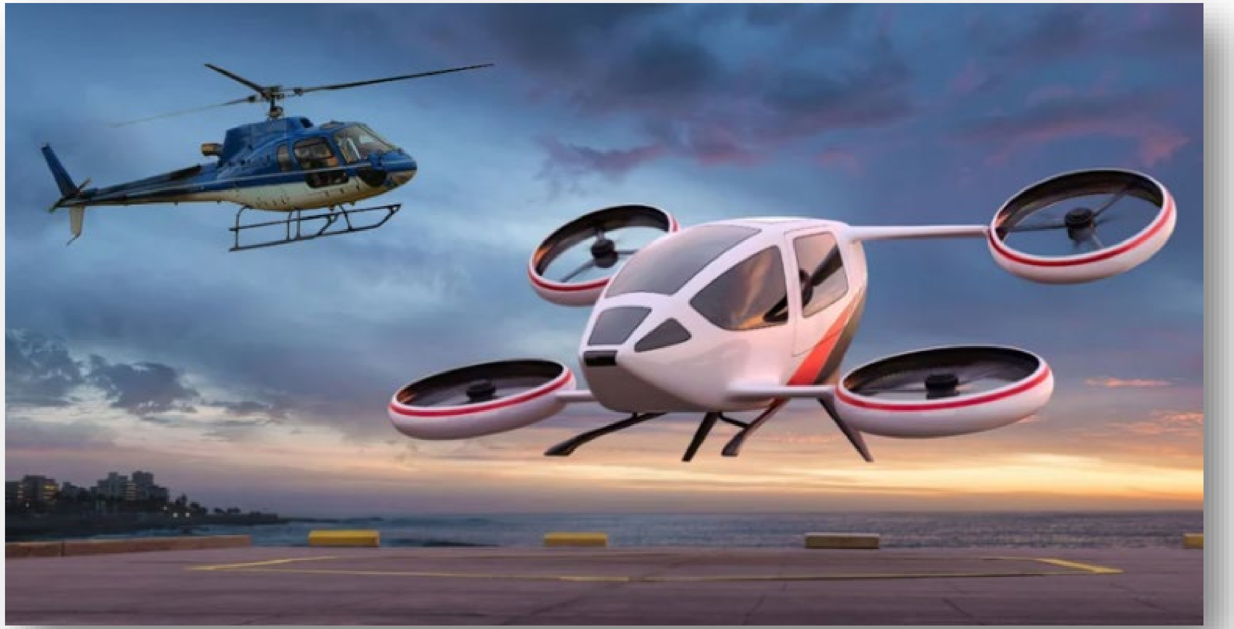






UAM and Helicopters

- **Urban Air Mobility** (UAM) employs small, electric vertical take-off and landing (eVTOL). aircraft to transport passengers or cargo in urban areas.
- Studies show that UAM operations are comparable to helicopter operations in urban environments.
- Both UAM vehicles and helicopters are rotorcraft, using rotor blades for lift and capable of VTOL.
- UAM vehicles operate at **lower altitudes** and **speeds** in congested airspace, with flight profiles similar to helicopters, including cruising speeds of 55 to 120 knots.



Wildlife Strike Risks in the Aviation Industry

- Approximately **90%** of wildlife strikes involve birds, with most incidents involving medium to large species.
- Wildlife strikes can pose safety hazards, cause damage to aircraft, and result in flight disruptions.
- As urban areas expand and encroach upon airport perimeters, the frequency of wildlife strikes is increasing, thereby elevating associated risks.
- Climate change is impacting migration routes, making timings more difficult to predict and leading to unexpected encounters with birds.

Purpose of the Study

To identify trends in wildlife strikes involving helicopters to inform future Urban Air Mobility (UAM) operators of **potential strike risks** during normal operations.

To identify significant **predictors of damaging wildlife** strikes for UAM vehicles.

To determine whether a **predictive model** for damaging wildlife strikes can be developed using various factors.

To **enhance** safety and **mitigate** the risks of wildlife strikes for future UAM operations.

Helicopter Wildlife Strike Data

- Between 2013 and 2022, the voluntary reporting system recorded a total of **2,816** wildlife strikes involving helicopters.
- The actual number of strikes may differ, as not all incidents are reported.
- Common trends from FAA reports:
  - The morning dove is the most frequently encountered bird species, but only **1.8%** of these encounters result in damage.
  - Canadian Goose is only the 14th most frequently encountered bird species, **46.4%** of these encounters lead to damage.

Methodology

- Quantitative research approach.
- Statistical method - **binary logistic regression**.
- **Dependent variable** – damaging strikes.
- **Independent variables** – 6 predictors.
- Excel was used for descriptive statistics.
- SPSS was used for the prediction model testing.

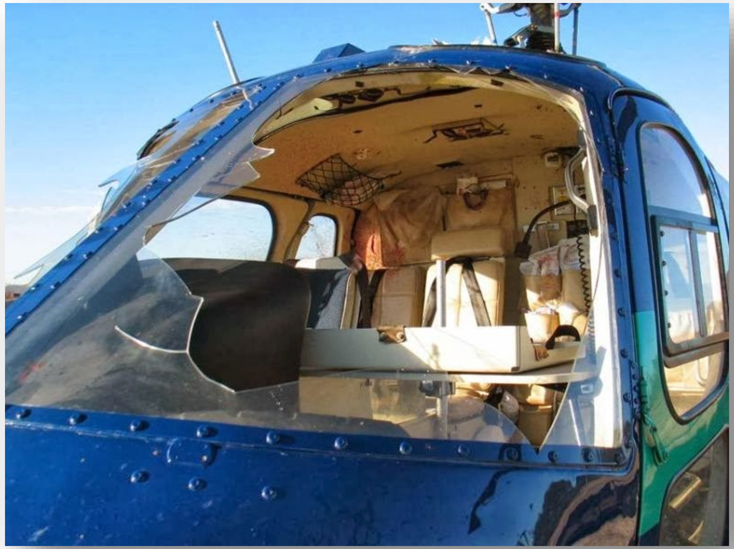
Hypothesis and Limitations

- **Hypothesis for logistic regression:** There is no significant relationship between the 6 independent variables and the binary outcome.
- **The main limitation** - this research used only the Wildlife Strike Database, a voluntary reporting system that may include subjective data.
- **A significant number of missing cases** prevented the inclusion of a larger sample size for the creation of prediction model.

Statistical Data

General Trends and Findings:

- Total number of cases (strikes) analyzed was **2816.**
- 405 (14.38%) of these were damaging strikes.



PHASE OF FLIGHT

EN-ROUTE – **80.25%**

SPEED GROUP

101 TO 150KTS – **50.62%**

TIME OF DAY

NIGHT – **46.42%**

BIRD SIZE

MEDIUM – **38.27%**

ALTITUDE GROUP

501 TO 1000FT – **28.40%**

SKY CONDITION

NO CLOUD – **27.65%**

Statistical Data

SPSS Output:

- For binary logistic regression only 1676 cases were used.
- **The Omnibus Tests of Model Coefficients** was significant with $p < 0.001$ and $\chi 2 = 285.322$, meaning further evaluation of model was needed.
- To test the fit of data, three tests were performed.
- **Cox & Snell** r^2 = 0.157, while **Nagelkerke** r^2 = 0.268. Both tests should be more than 0.2 for model to be perfect. However, if one is larger and the other is smaller,+ model is considered to be acceptable.
- Lastly, **Hosmer & Lemeshow** test indicates $p = 0.627$. This means that data fits the prediction model (closer to 1, means stronger fit).

Statistical Data

		False	True	Percentage correct
Indicated damage	FALSE	1378	31	97.8
	TRUE	227	40	16.9
Overall percentage				84.7

- **High percentage** of prediction for FALSE cases
- **Low percentage** of prediction for TRUE cases.
- Overall quality of prediction is acceptable, however mainly because of FALSE (non-damaging) cases.

Discussion of Results

Key findings:

- In the model, time of day, phase of flight, and speed groups are identified as significant predictors.
- More than **50%** of damaging strikes occur within the 101-150 knot speed range.
- The highest probability of encountering a damaging strike (over **80%**) occurs during the en route phase of flight.
- Among bird sizes, medium-sized birds have the highest proportion of damaging strikes at **38.27%**. This finding aligns with the FAA (2023) report, which indicates that most damaging strikes were caused by medium-sized waterfowl, such as geese and ducks.

Conclusion

- **Developing** a prediction model for damaging strikes is feasible, but it requires additional data, varied variables, and more case studies to be effective.
- Advanced air mobility operators should plan routes considering bird migration patterns to **reduce** the risk of strikes.
- **Minimize** or avoid nighttime operations to lower risk.
- **Avoid** altitudes between 501 and 1000 feet to reduce the chance of bird strikes.
- **Reduce** speed to below 100 knots when approaching the destination.
- Additional research is needed to identify further predictors of damaging bird strikes.

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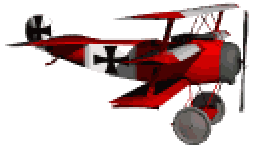

Source: NASA

Select References

- DeFusco, R. P., & Unangst, E. T. (2013). *Airport wildlife population management*. National Academies of Sciences, Engineering, and Medicine. The National Academies Press. https://doi.org/10.17226/22599
- Federal Aviation Administration. (2023). *Bird strikes to civil aircraft in the United States 1990 – 2022*. https://www.faa.gov/sites/faa.gov/files/Bird-Strike-Report-1990-2022.pdf
- Freyfogle, E. T., & Goble, D. D. (2009). *Wildlife law: A primer*. Island Press.
- Rajendran, S., & Pagel, E. (2020). Recommendations for emerging air taxi network operations based on online review analysis of helicopter services. *Heliyon*, *6*(12), e05581–e05581. https://doi.org/10.1016/j.heliyon.2020.e05581