Bird strike threats and mitigation measures for Urban Air Mobility operations

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Bird Strike Committee-USA, July 2022 (Salt Lake City)

WS Wildlife Services
Protecting People
Protecting Agriculture
Protecting Wildlife

USDA
United States Department of Agriculture
Animal and Plant Health Inspection Service

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Findings and recommendations expressed in this presentation do not necessarily represent the position of the U.S. Federal Aviation Administration

"Miracle on the Hudson" and "Miracle in the Cornfield"

A study in similarities and contrasts

Characteristics of event	Miracle on Hudson	Miracle in Cornfield
1. Aircraft	A-320 (2 engines)	A-321 (2 engines)
2. Birds struck	Multiple Canada geese	Multiple Gulls
3. Parts struck/damaged	Both engines	Both engines
4. Status of aircraft	Climb, 2900 ft AGL	Take-off run, 0 ft AGL
5. Status of birds	Migrating, 2900 ft	On runway
6. Methods available to mitigate risk	None	Garbage control/ harassment/ lethal control

- **Since the Miracle on the Hudson (2009), we have nothing in place to prevent this type of event from occurring again!.**

Descent into KDTO at 4500 feet, Apr 2022

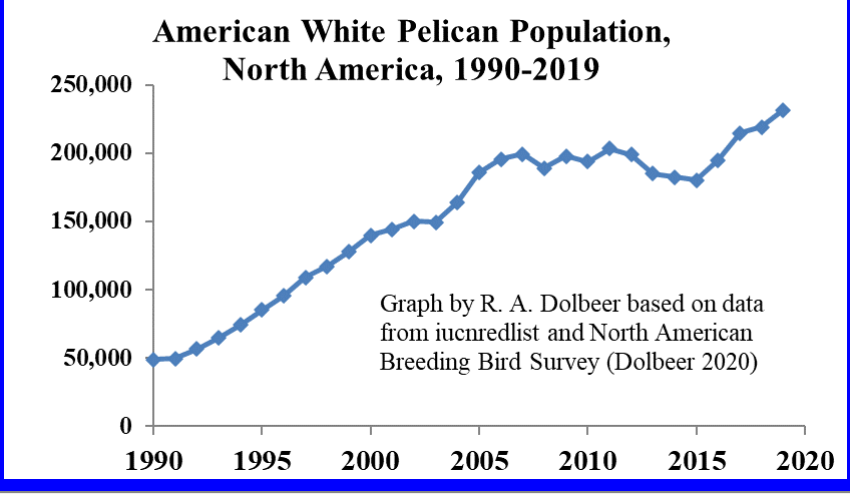
Climb out of SLC at 4000 feet, Mar 2021

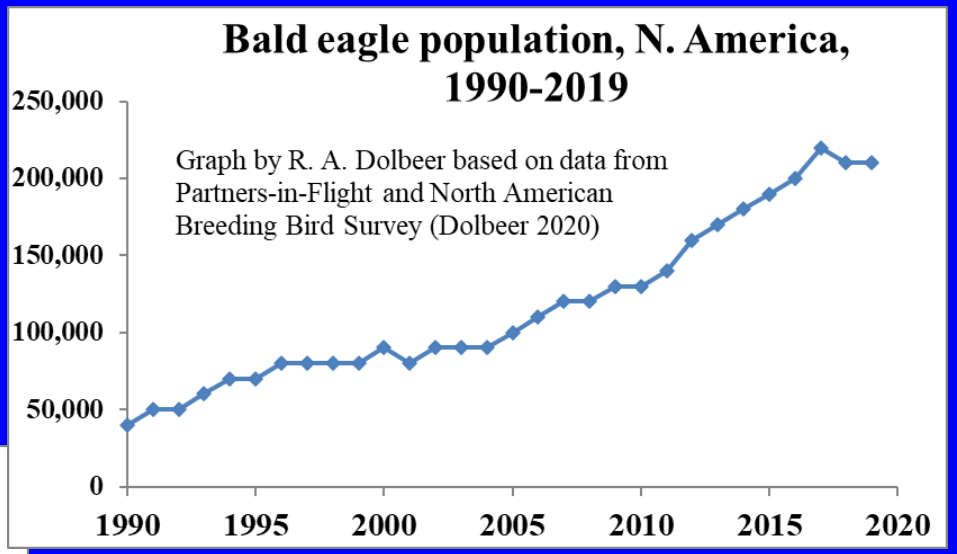
We are entering a new era of electric-powered aircraft

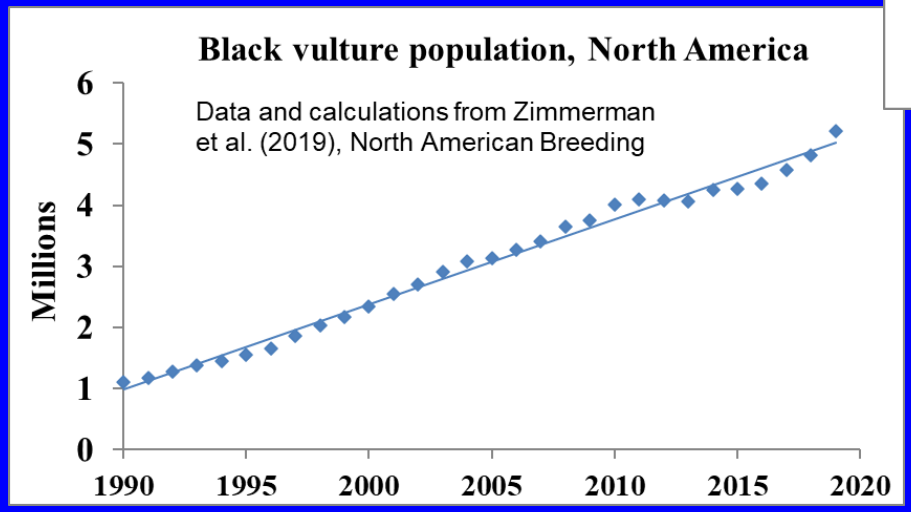
Large numbers of quiet aircraft sharing low-altitude zones with raptors, waterfowl, and other large birds.

As with “Miracle on the Hudson” type events, **we have no mitigation strategies in place!**

Almost all large bird species in North America have significant population increases since 1990*



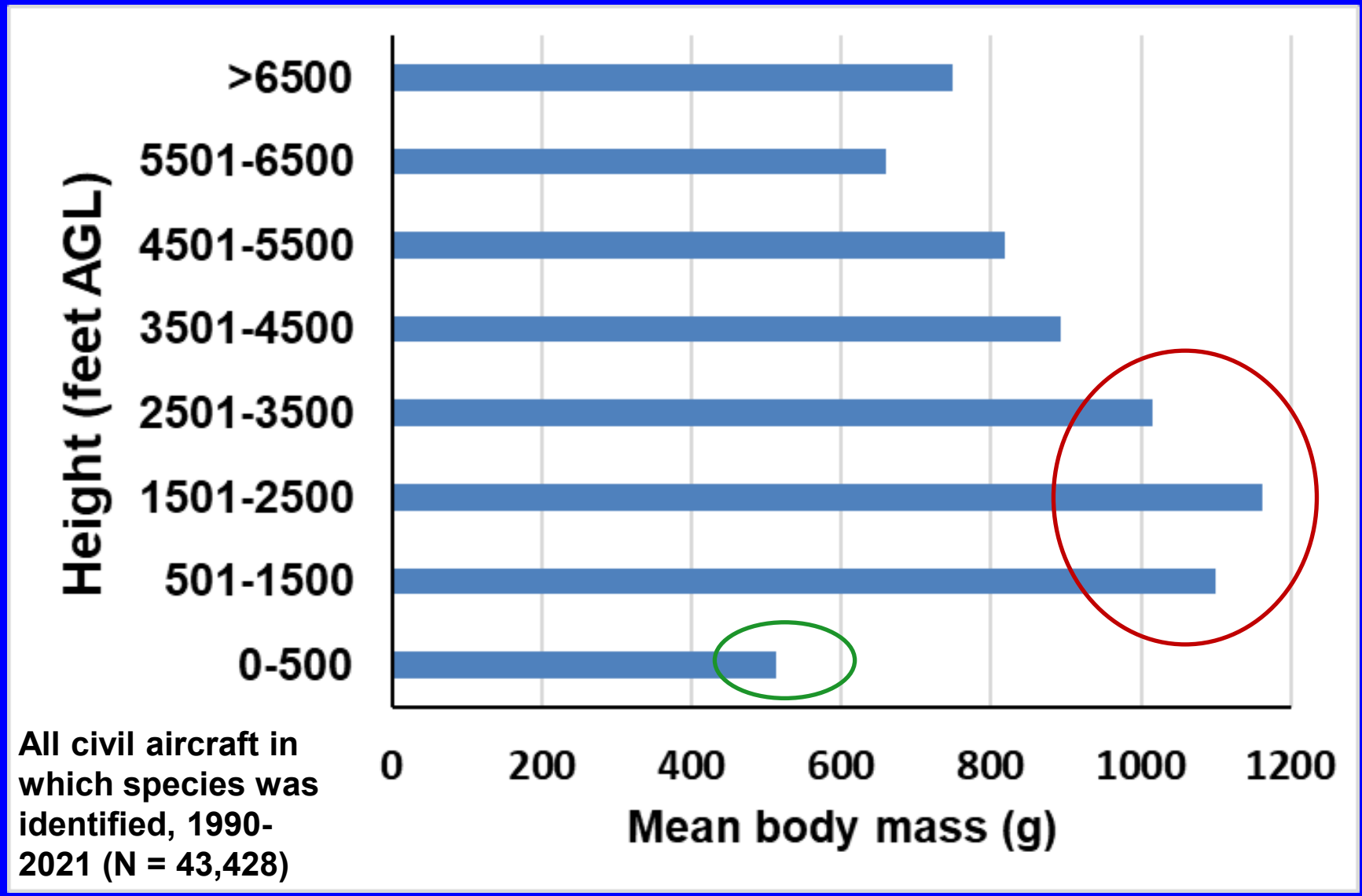




4- to 5-fold increases

*Dolbeer, R. A. 2020. Population increases of large bird species in North America pose challenges for aviation safety. Human Wildlife Interactions 14 (3):345–357.

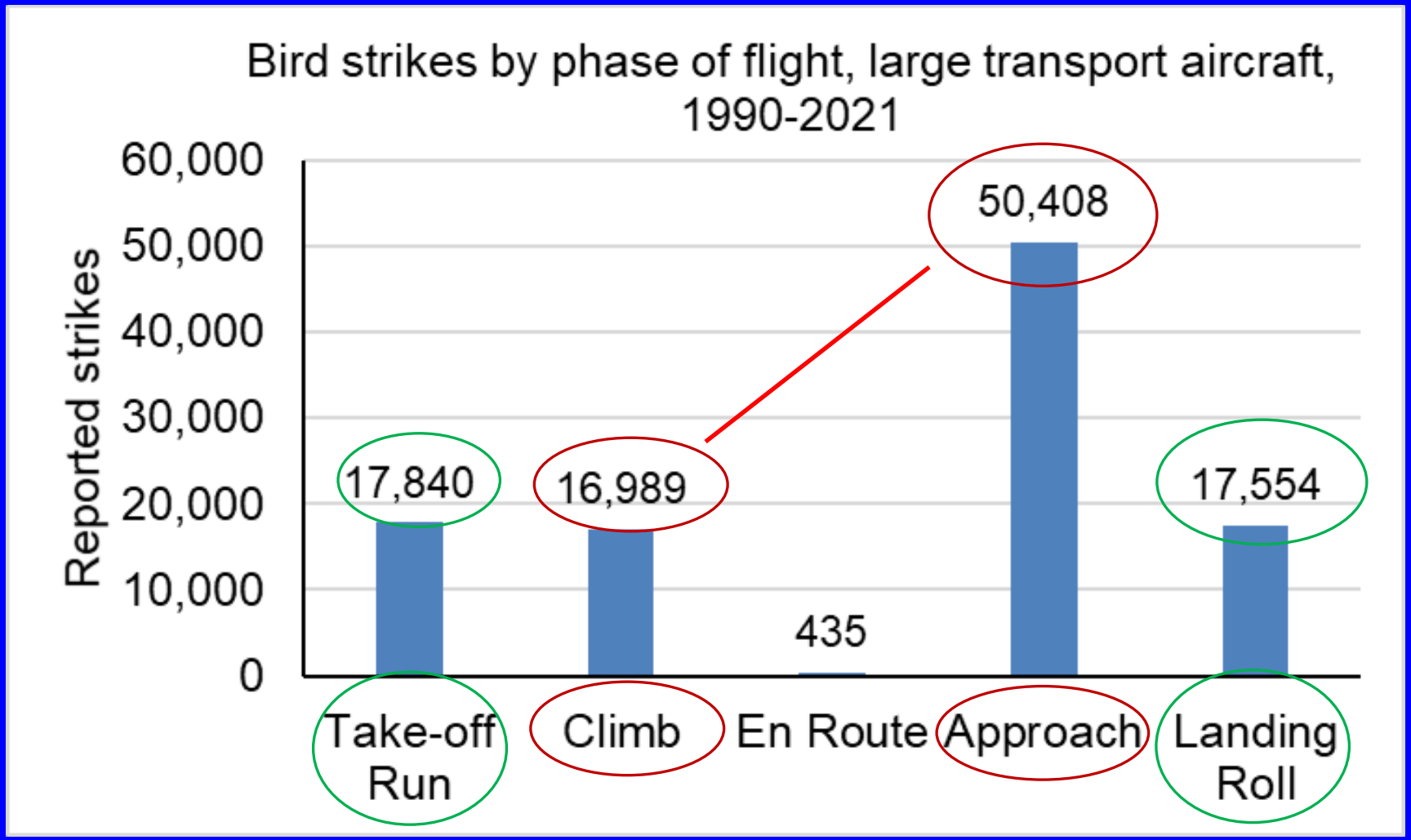
The mean body mass of birds struck at 501-3500 feet AGL is twice that of birds struck at ≤500 feet!



All civil aircraft in which species was identified, 1990-2021 (N = 43,428)

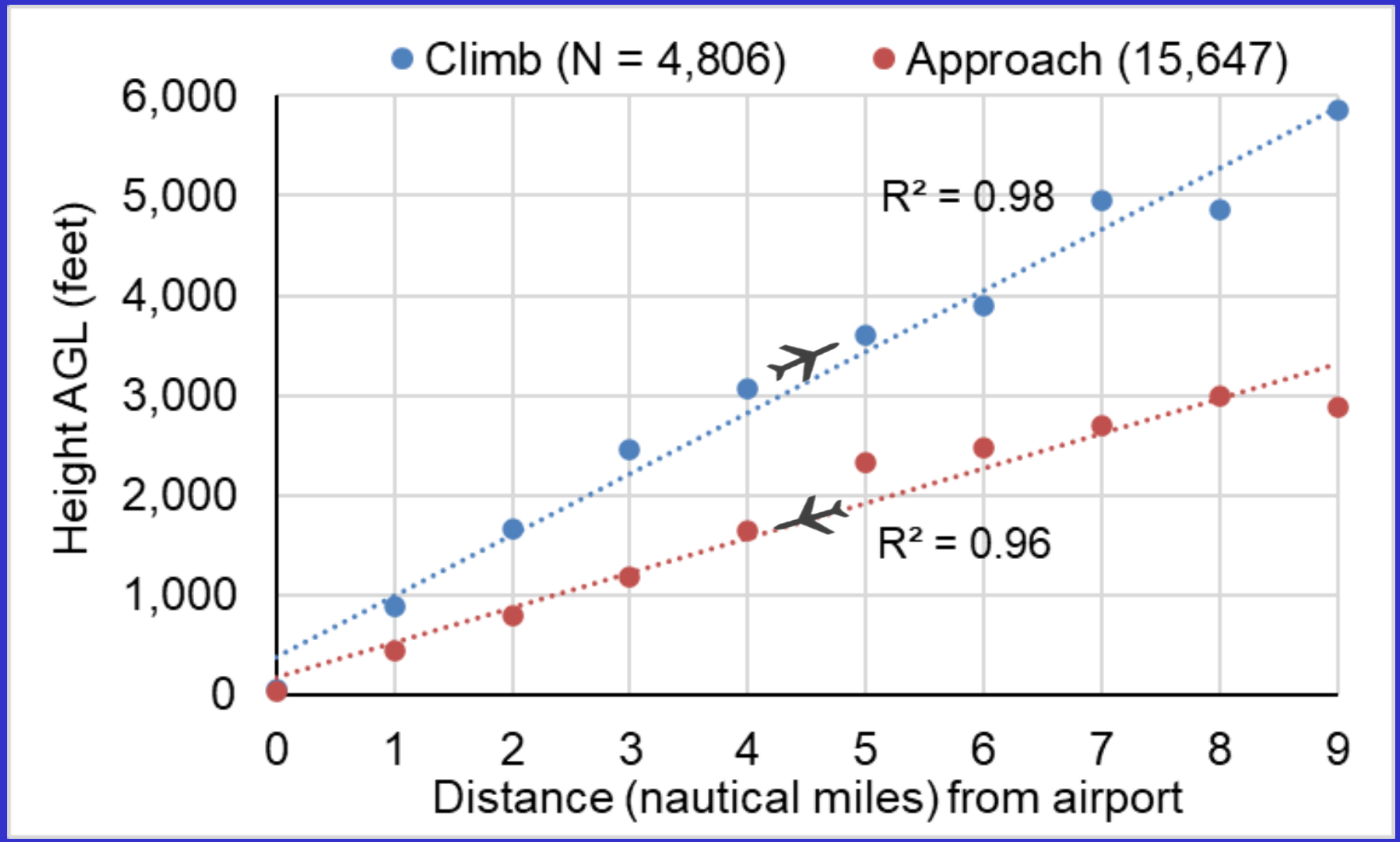
How can we mitigate the risk of bird strikes with Urban Air Taxis and Delivery Drones?

1. Adjust flight height above ground level (AGL)



- **Same number of strikes on T/O-off run and Landing roll!**
- **3x more strikes on Approach vs Climb. Why?**

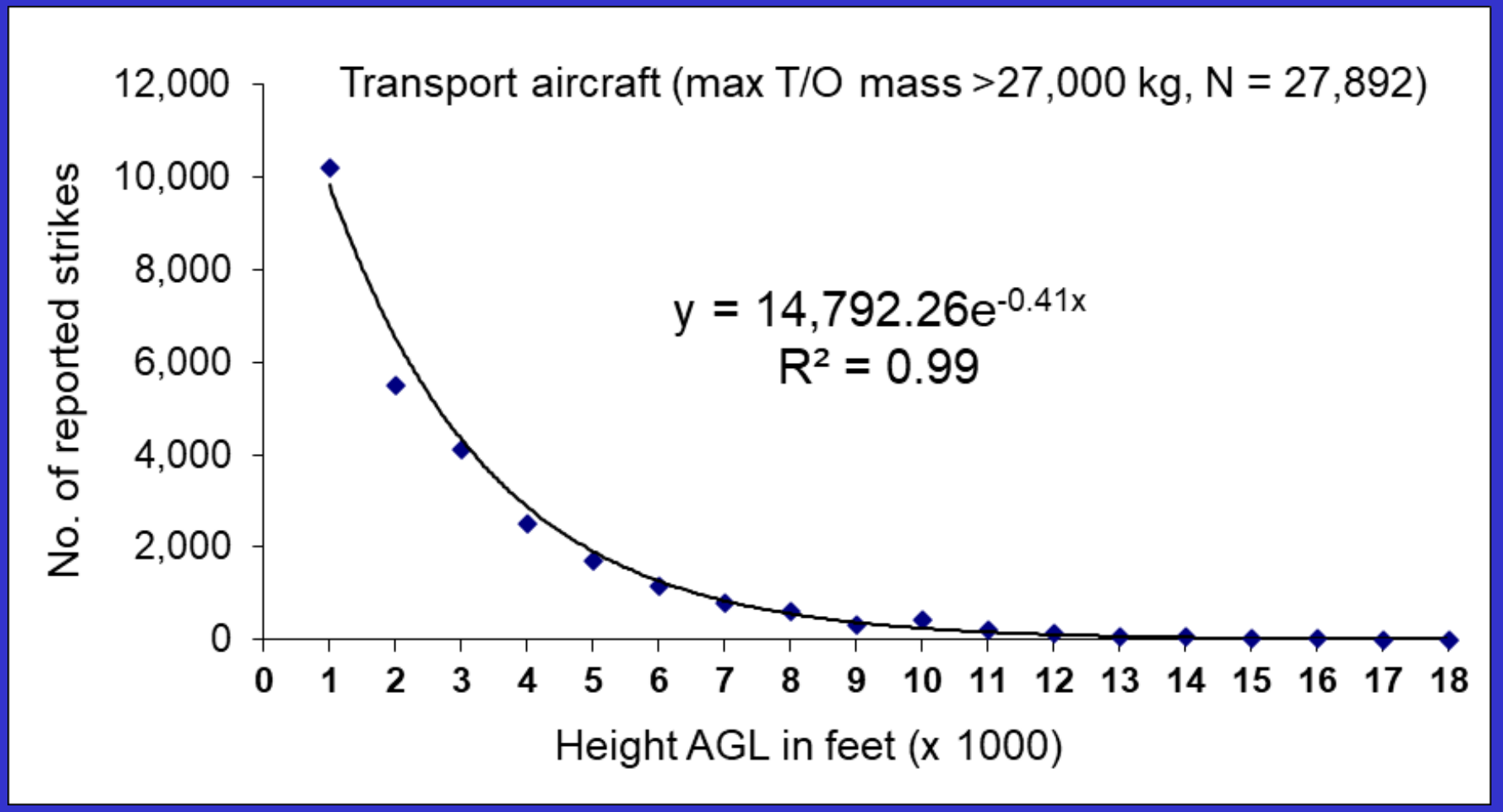
Distance vs Height profiles during Climb and Approach, Large transport aircraft (1990-2021).



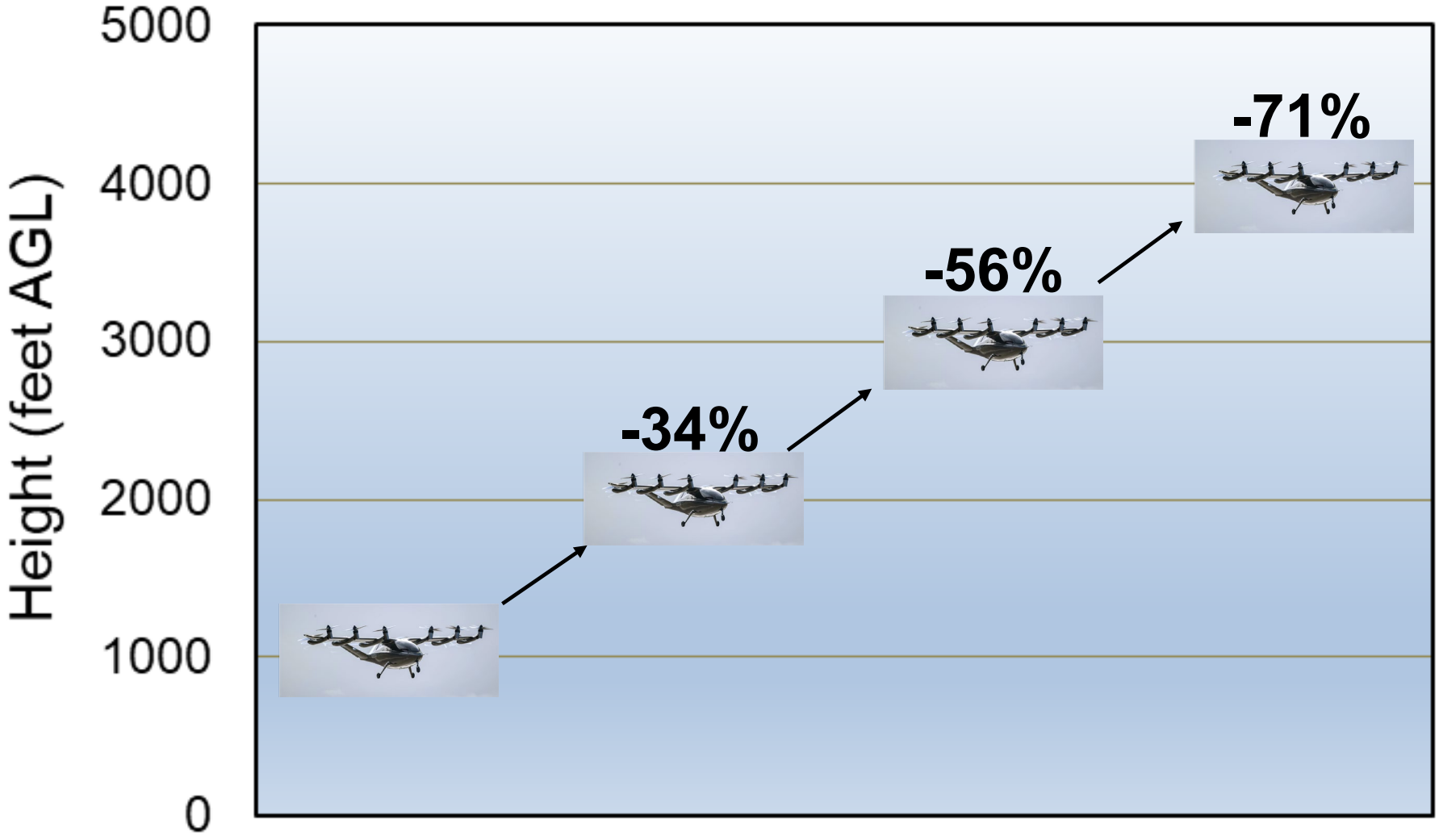
Cumulative time (seconds) elapsed by large transport aircraft during departure and arrival, based on height and speed reported for bird strikes in NWSD, 1990-2021

Height zone (feet AGL)	Cumulative time (seconds) spent below various heights		Difference (seconds)
	Departure	Arrival	
1-5000	135	329	194

Above 500 feet, for every 1,000–foot gain in height AGL, probability of a bird strike declines by 34%

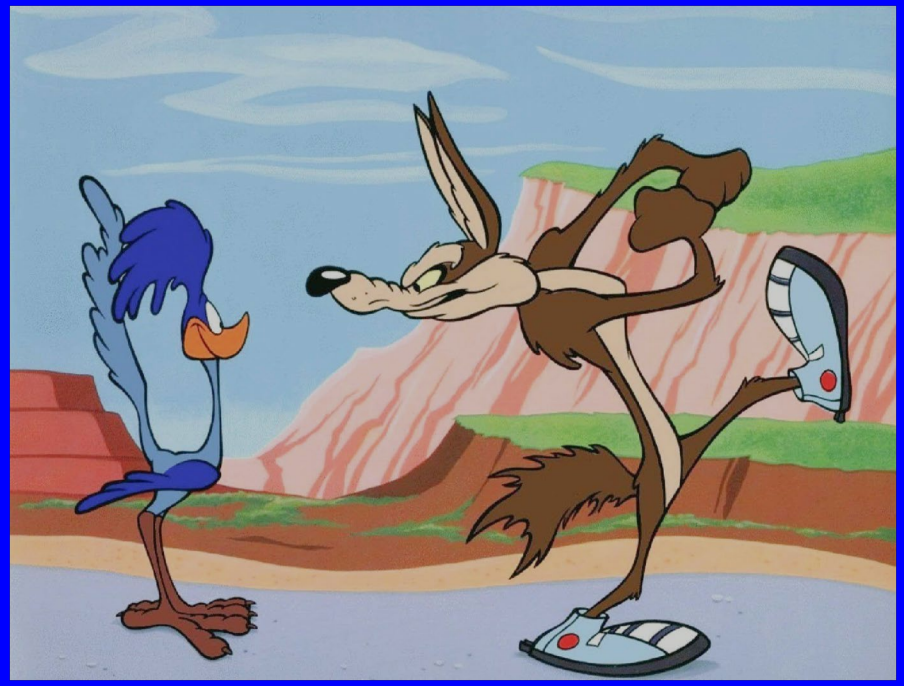


Dolbeer's rule: For every 1,000-foot increase in height, 34% reduction in probability of a strike




Helicopter Association International
Doc's ROTOR
SAFETY
Tip of the Week
Bird Strikes
You reduce your chance of a BIRD STRIKE by 32% for each additional 1000' of altitude.
Fly higher to fly safer!

2. Adjust speed of aircraft



Three studies on bird avoidance and vehicle speed

DeVault, T. L. et al. 2014. Effects of vehicle speed on flight initiation by turkey vultures: implications for bird–vehicle collisions. PLoS ONE 9(2):e87944

"antipredator behaviors in turkey vultures might not be well tuned to vehicles approaching at speeds >50 knots."

DeVault, T. L. et al. 2015. Speed kills: ineffective avian escape responses to oncoming vehicles. Proceedings of the Royal Society B.

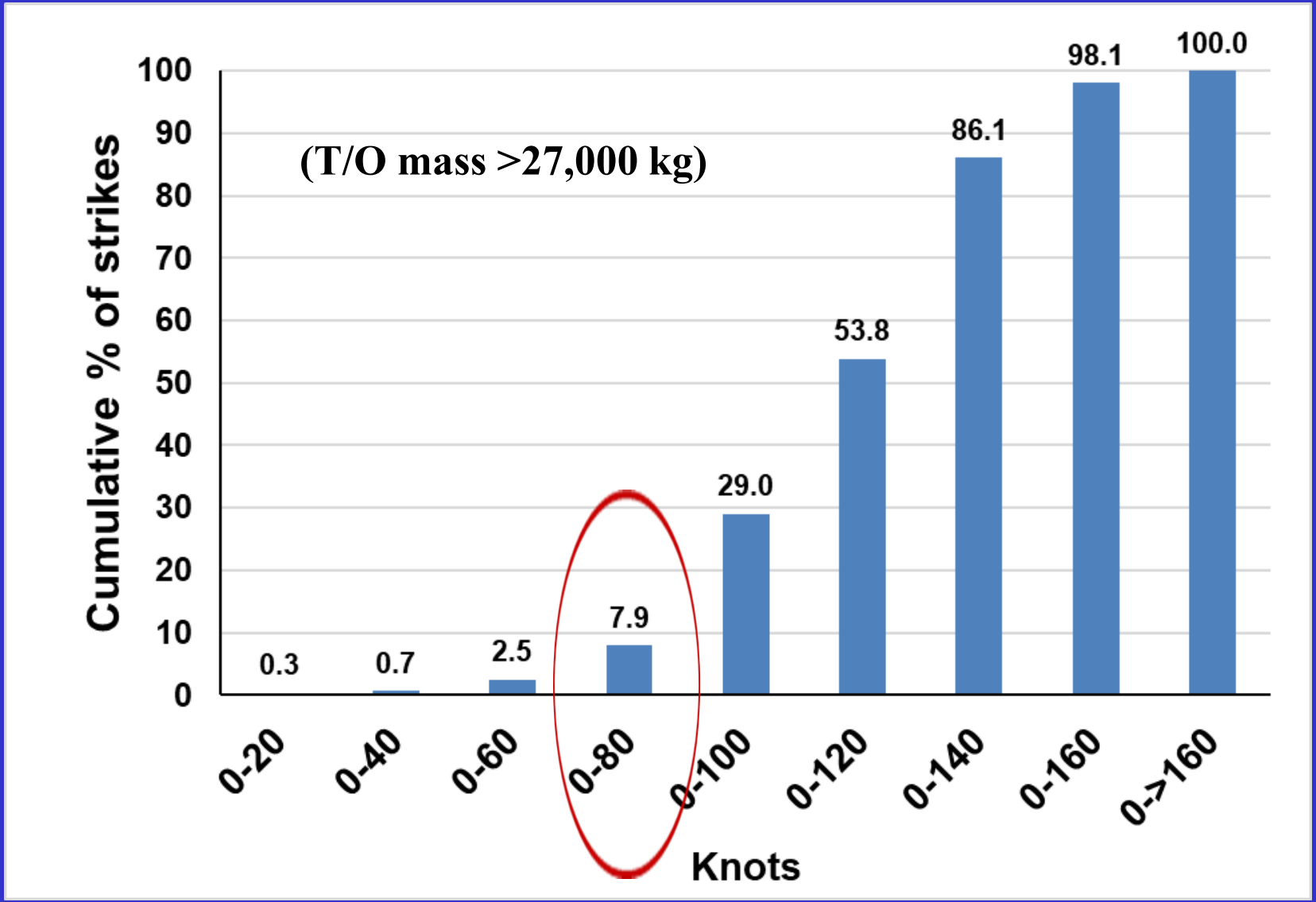
"cowbirds generally did not initiate flight with enough time to avoid collision when vehicle speed exceeded 65 knots"

Rotorcraft Bird Strike Working Group Recommendations to the Aviation Rulemaking Advisory Committee (ARAC). FAA. Rev. B, 2019 (page 41).

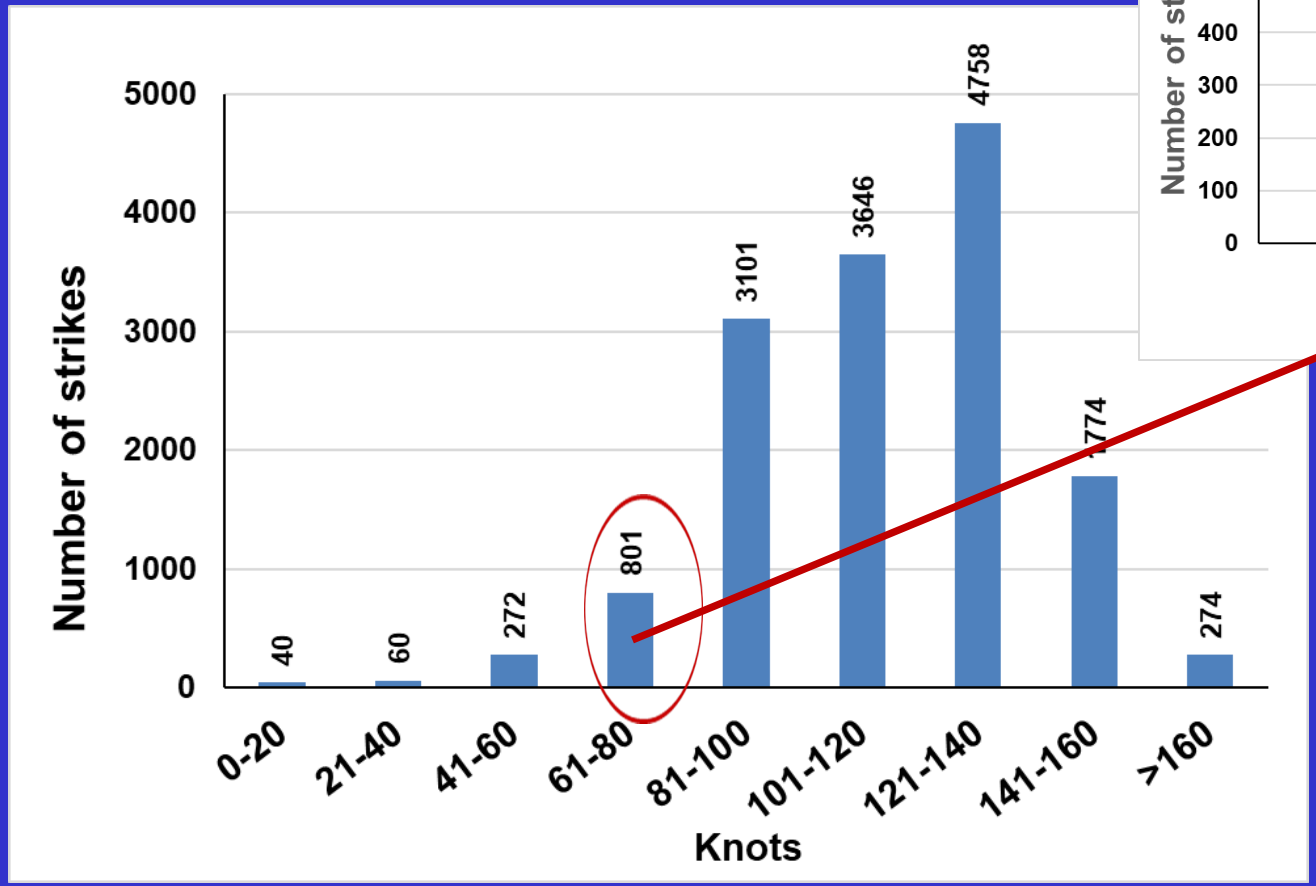
***77% of 1,664 reported bird strikes on Part 27 rotorcraft occurred above 80 knots (NWSD).**

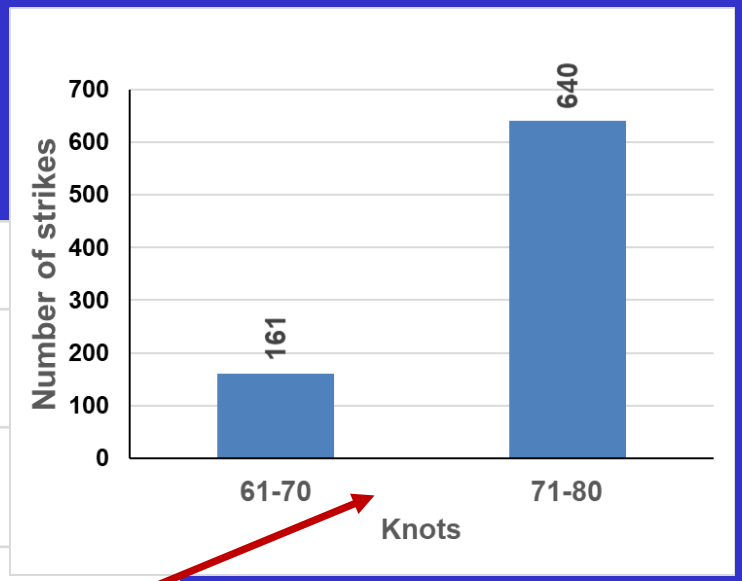
***Zero occurred below 55 knots.**

>92% of bird strikes occur at >80 knots for large civil aircraft during take-off run or landing roll, 1990-2021, USA (N = 14,726)



Birds do a decent job of avoiding transport aircraft on runway up to about 70 knots (N = 14,726)





Bird avoidance in relation to speed of aircraft

- **Birds do a decent job of avoiding aircraft below ~70 knots**
- **<u>Above 70 knots, aircraft speed makes little difference</u>**
- **Delivery Drones should maintain speeds below 70 knots**
- **Urban Air Taxis should reduce speeds to 70 knots when radar indicates high bird densities in the air**

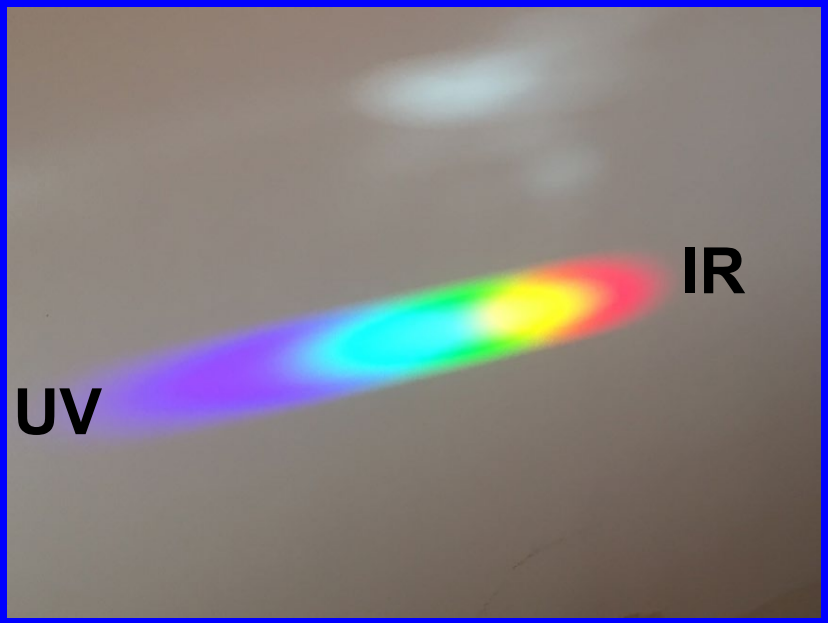
3. Aircraft lighting

a) Wavelength

b) Pulse rate

3. Aircraft lighting 3a. (Wavelength)

Many bird species “see” in near UV



Birds do not see well in red end of spectrum

Dolbeer, R. A., and W. J. Barnes. 2017. Positive bias in bird strikes to engines on left side of aircraft. Human-Wildlife Interactions 11 (1): 71-76.

Based on avian research*, the FAA changed obstruction lighting standards to reduce bird mortality, including the elimination of steady-burning red lights from several lighting configurations (Patterson 2012, Federal Aviation Administration 2015).

•Communication towers with red warning lights had more bird collisions than towers with lights of shorter wave lengths (Gehring et al. 2009, Sheppard 2011, Patterson 2012).

•More night migrants flew in circular flight patterns near a tower with a combination of blinking and non-blinking red lights than near a tower of similar height equipped only with white strobe lights (Gauthreaux and Belser (2006) .

•Tasmanian silvereyes oriented in the appropriate migratory direction under white and green light (571 nm) but were disoriented under red (633 nm) light (Munro et al. 1997) .

•Sandhill cranes, Nebraska

Ultraviolet illumination helps birds avoid power lines

"Over a 38-night period, sandhill crane collisions decreased 98% when the lights were on"

•Dwyer et al. 2019. Near-ultraviolet light reduced Sandhill Crane collisions with a power line by 98%. The Condor 121 (2).

3. Aircraft lighting (3b. Pulsating lights)

Blackwell et al. 2012. Exploiting avian vision with aircraft lighting to reduce bird strikes. Journal of Applied Ecology 49:758–766.

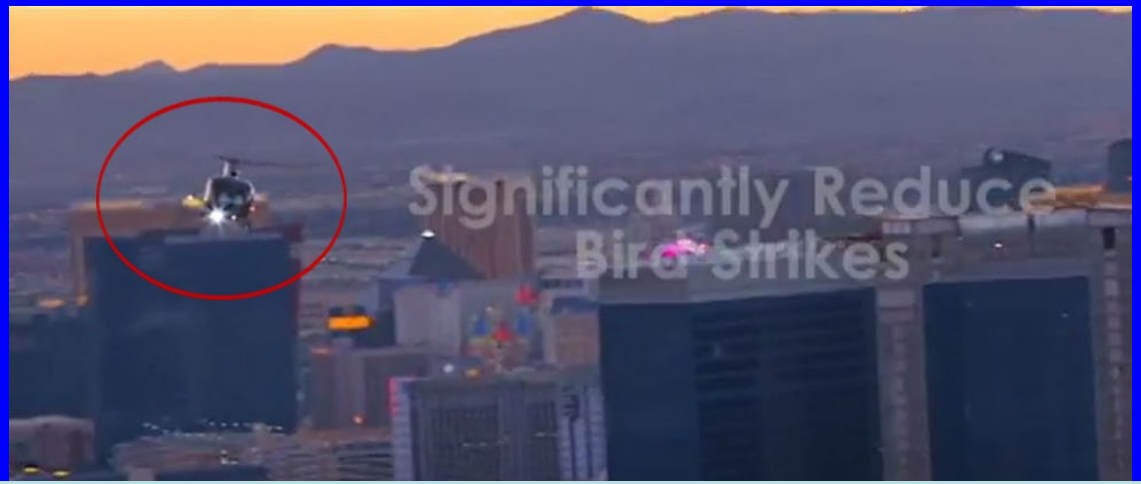
Radio-controlled (RC) aircraft with a 2-Hz alternating pulse of two lights was more salient to the visual system of Canada geese than with lights off or a RC-predator model aircraft

Three recent studies with commercial aircraft indicate Pulsating lights reduce bird strikes.

1. Mandernach, J. 2018. Pulsating exterior lights save lives: mitigating bird strikes. Rotor. Winter 2018: 22-24.

Maverick Aviation statistics	Before pulsing lights	After pulsing lights
Flight hours	142,848	284,170
Near-fatal bird strikes	6	0

2. Fedy, D. 2018. Metro study finds Pulselites helps reduce bird strikes. Vertical magazine. June-July: 32.



- Study looked at 43 helicopters in Metro Aviation's fleet, 2016-2017.
- For the 2-year period, strike rate was 3x lower on aircraft with pulsing lights.
- During Sep-Oct (migration months), strike rate was 5x lower on aircraft with pulsing lights.

3. Qantas Airlines. Pulselite System B737 Operational Evaluation. https://drive.google.com/file/d/0Bz896FpqkY4aUlgzenozanhNWjA/view

After a 32-month partial fleet installation of pulsing lights, Qantas reported a <u>30% and 66% decrease in bird strikes</u> on their B737-400's and B737-800's, respectively.

3. Aircraft lighting (Summary)

- **Equip UATs and DDS with pulsed lighting with UV component (minimize lighting at red end of spectrum).**
- **Advanced, lightweight LED lighting gives many options.**

Pulsating LED lights on ear tags to deter predation on livestock

Cow vid 1 - YouTube

4. Bird-detecting Radar

- Birds have been detected by radar since initial deployment in WWII.
- Radar systems to give real-time warnings for windshear have mitigated this threat at over 100 USA airports since the 1990s.
- Advances are being made in dedicated radars for detecting drones and birds in 3D.
- NextRad Weather Radar already provides remarkable data on bird movements, especially during migration periods.

FAA Airports Engineering Division issued an Advisory Circular on Bird-detecting Radar for Airports in 2010:

Airport Avian Radar Systems, 150/5220-25

1. **PURPOSE. Provides guidance on the use of avian radar systems to supplement an airport's Wildlife Hazard Management Plan (WHMP) and reduce potential avian threats to aircraft.**
2. **SCOPE. Describes how airports can select, procure, deploy, and manage an avian radar system.**

The FAA Technical Center has conducted exploratory/ conceptual research to use real-time radar data to mitigate bird strike risk

"Enhanced Bird Threat Information in the Air Traffic Control Tower: Wildlife Surveillance Concept (WiSC) Research Update"
Mark Hale, Federal Aviation Administration/CSSI. Inc.
Bird Strike Committee-USA meeting Dallas TX 2018

The objective is to deliver filtered airport avian radar threat data to controllers for communication to aircraft pilots up to an altitude of approximately 3,000' AGL.

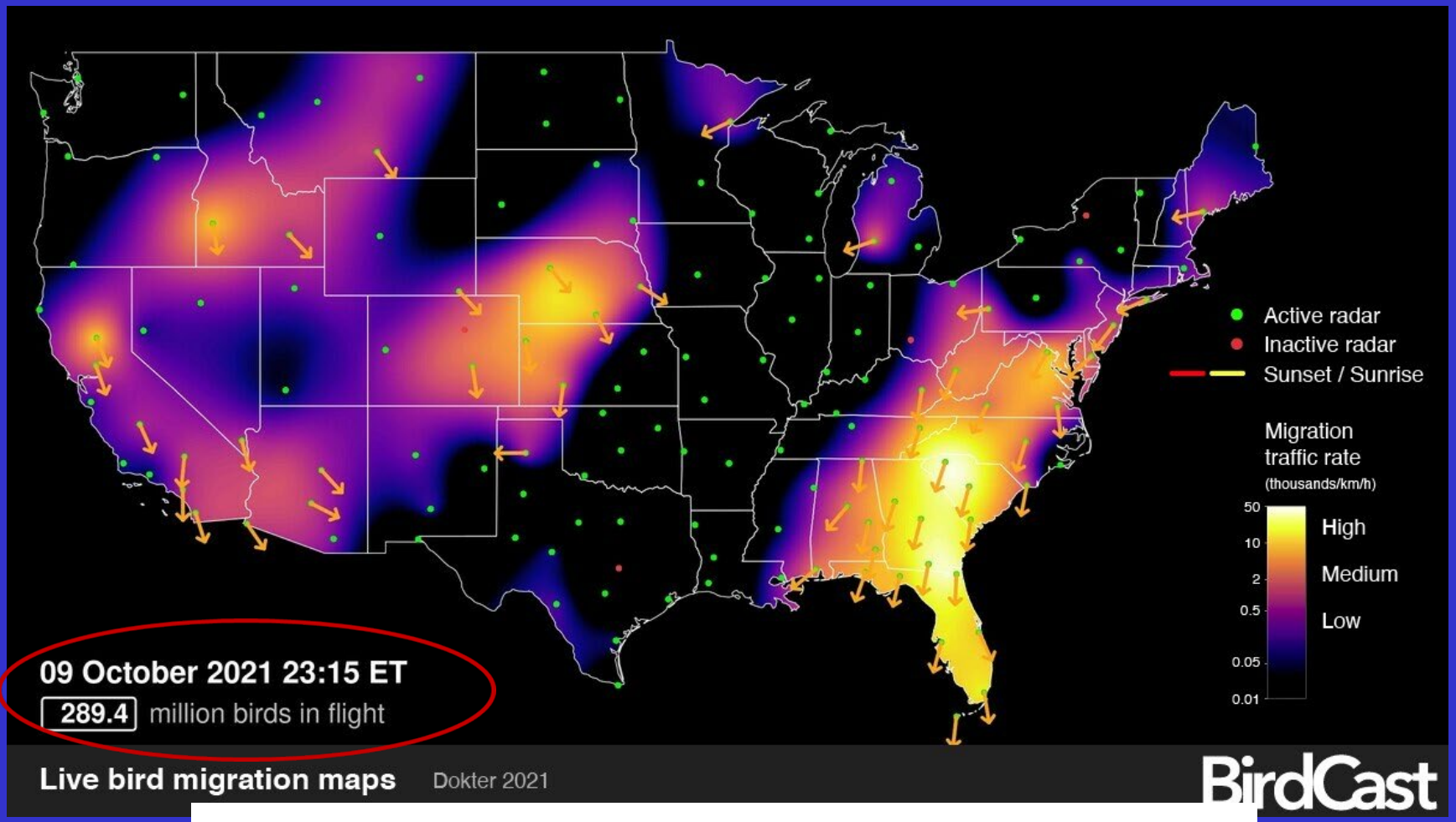
Two recent publications related to using real-time radar data to mitigate bird strike risk

- Nilsson et al. 2021**. Bird strikes at commercial airports explained by citizen science and weather radar data. Journal of Applied Ecology 58(10):2029-2039.**
- Metz et al. 2021. **The efficacy of operational bird strike prevention. Aerospace 2021, 8, 17. https://doi.org/10.3390/aerospace8010017.**

All three studies indicate the feasibility of using real-time radar (coupled with e-bird and other bird-monitoring tools) to provide real-time warnings for pilots

Live bird migration maps – BirdCast

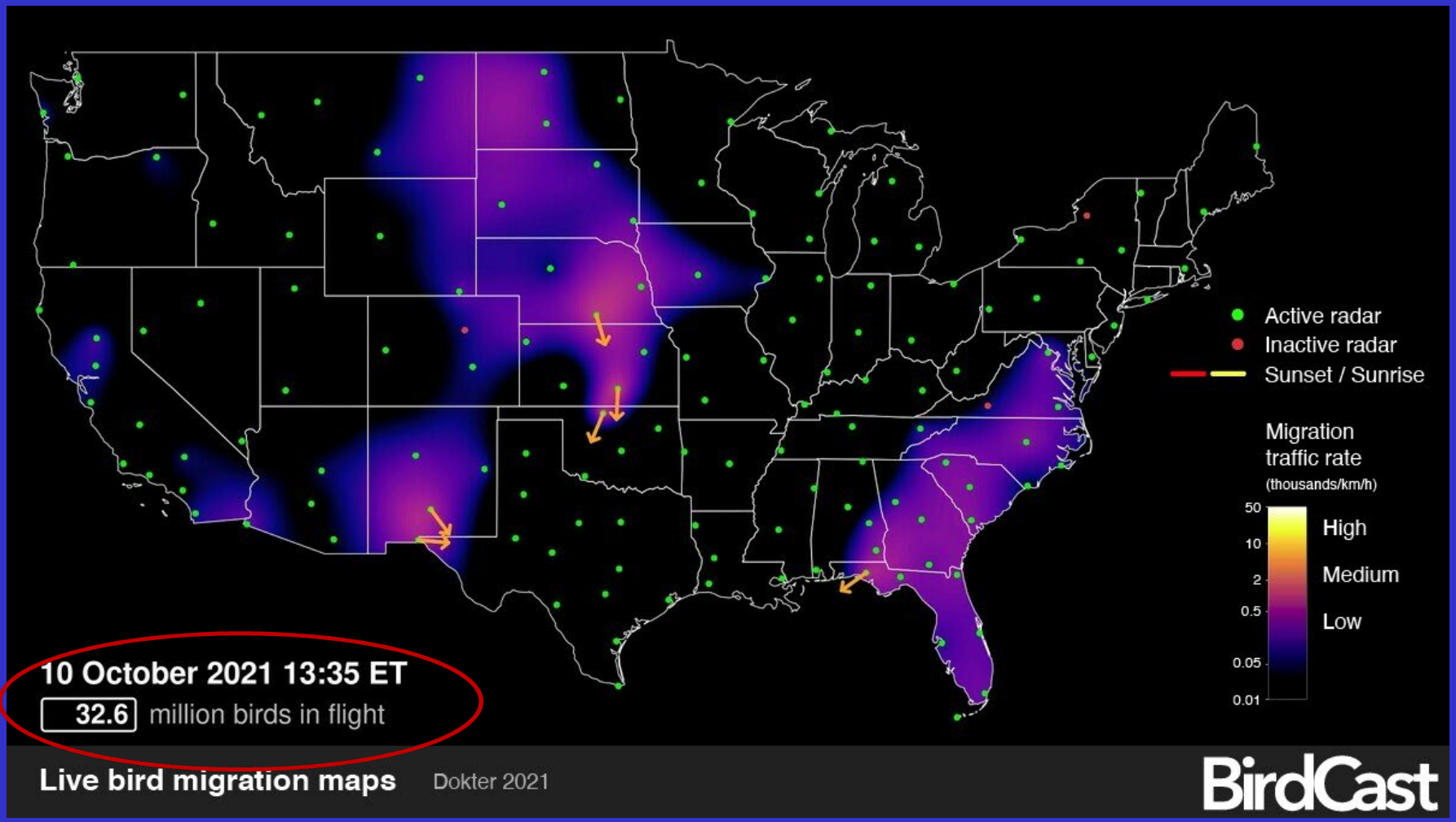
Midnight 9-10 Oct 2021 (289.4 million birds in flight)



- The US weather radar network (NEXRAD) consists of 143 radar stations

Live bird migration maps – BirdCast

12 hours later at mid-day, 10 Oct 2021 (32.6 million birds in flight)



A considerable amount of research has focused on:

- Spatial distribution of birds in air
- Avian vision and aircraft lighting systems
- Wildlife response to moving vehicles/aircraft
- Advancing bird-detecting radar
- Integrating bird-detecting radar into airport operations

Conclusions

- Large numbers of quiet electric-powered aircraft will share low-altitude zones with raptors, waterfowl, and other large birds.
- **This is not an airport problem!**
- This is an off-airport, airspace management problem; **we have no mitigation measures in place for bird strikes.**

Mitigation measures that can be implemented for UAT/DDS

- Fly at maximum allowed heights.
- DDS keep speed <70 knots; UAT <70 knots under high bird densities.
- Install pulsating lights with UV component.
- Bird-detecting radar for flight planning and real-time warnings to UATs and commercial transport aviation.


We cannot manage a problem that is undetected and unmeasured!
We have the tools:
Let's do it!
•Safer skies for all who fly!
•Thank you.