Assessing relative hazard, risk, and seasonal differences of wildlife - aircraft collisions

Caryn D. Ross, Mahalah Schank, Michael J. Begier, Bradley F. Blackwell, Travis L. DeVault

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RESEARCH ARTICLE

Assessing relative hazard, risk, and seasonal differences of Wildlife-aircraft collisions

Caryn D. Ross [1] | Mahalah Schank [2] | Michael J. Begier [3] | Bradley F. Blackwell [4] | Travis L. DeVault [5]

[1]University of Georgia, Savannah River Ecology Laboratory, Warnell School of Forestry and Natural Resources, Aiken, 29801, SC, USA

[2]USDA APHIS Wildlife Services, Airport Wildlife Hazards Program, Sandusky, OH, USA

[3]USDA APHIS Wildlife Services, Airport Wildlife Hazards Program, Washington, D.C., USA

[4]USDA APHIS Wildlife Services, National Wildlife Research Center, Ohio Field Station, Sandusky, OH, USA

[5]University of Georgia, Savannah River Ecology Laboratory, Aiken, SC, USA

Correspondence Caryn D. Ross, University of Georgia, Savannah River Ecology Laboratory, P.O. Drawer E, Aiken, SC, USA.
Email: caryn.ross@uga.edu

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Abstract

Wildlife collisions with aircraft have serious safety and economic implications. Strike risk models are used to assess the probability of an adverse event between wildlife and aircraft, providing information to guide wildlife management at airports. In the strike risk model actively used across the USA, species-specific strike risk is a product of severity and frequency. The severity component of risk, termed relative hazard score (RHS), is a composite variable that indexes the probability of aircraft damage, severe damage, and effect on flight when aircraft are struck by a species, whereas frequency is the number of strikes recorded per species. Our objectives were to update RHS values by incorporating recent strike data available for birds and mammals, update the active strike risk model, and investigate seasonal differences in bird strike risk across species. Using data from the Federal Aviation Administration (FAA)'s National Wildlife Strike Database (NWSD) for the years 2010–2023, we calculated RHS for 132 bird species and 16 mammal species. We found that large-bodied birds, such as the red-tailed hawk (*Buteo jamaicensis*; risk = 1,225,479), Canada goose (*Branta canadensis*; risk = 918,744), and turkey vulture (*Cathartes aura*; risk = 552,026) continue to pose the highest nationwide risk, with species-specific risk ranks fluctuating seasonally. Notably, our analysis highlights one facet of the dynamic nature of wildlife risk at airports, emphasizing the importance of adaptive management strategies that consider seasonal changes in strike risk. We also identify limitations in the current risk assessment model, suggesting future improvements through bias-corrected bird surveys and telemetry data to refine our understanding of species behavior and movement patterns in airport settings. Our findings provide insights for airport wildlife biologists to prioritize management actions, reduce wildlife-related risk, and improve aviation safety.

MANAGING WILDLIFE HAZARDS AT AIRPORTS

- Management strategies vary by species:
  - Fencing is effective for most hazardous mammals
  - Birds require alternative approaches

- Regional factors influence management:
  - local wildlife, resource limitations, habitat features, and operational constraints

- Effective prioritization is critical for proactive, long-term strike prevention

Risk = Severity x Frequency

MOST WIDELY USED RISK MODEL

$$Risk = RHS^2 \times Strikes^2$$

$$R^2 = 0.74$$

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Original Article

Estimating Interspecific Economic Risk of Bird Strikes With Aircraft

TRAVIS L. DEVAULT,[1] *U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services, National Wildlife Research Center, Ohio Field Station, 6100 Columbus Avenue, Sandusky, OH 44870, USA*

BRADLEY F. BLACKWELL, *U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services, National Wildlife Research Center, Ohio Field Station, 6100 Columbus Avenue, Sandusky, OH 44870, USA*

THOMAS W. SEAMANS, *U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services, National Wildlife Research Center, Ohio Field Station, 6100 Columbus Avenue, Sandusky, OH 44870, USA*

MICHAEL J. BEGIER, *U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services, Airports Wildlife Hazards Program, 1400 Independence Avenue SW, Washington, D.C. 20250, USA*

JASON D. KOUGHER, *U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services, Airports Wildlife Hazards Program, 6100 Columbus Avenue, Sandusky, OH 44870, USA*

JENNY E. WASHBURN, *U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services, Airports Wildlife Hazards Program, 6100 Columbus Avenue, Sandusky, OH 44870, USA*

PHYLLIS R. MILLER, *U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services, Airports Wildlife Hazards Program, 6100 Columbus Avenue, Sandusky, OH 44870, USA*

RICHARD A. DOLBEER, *U.S. Department of Agriculture, Animal and Plant Health Inspection Service, Wildlife Services, Airports Wildlife Hazards Program, 6100 Columbus Avenue, Sandusky, OH 44870, USA*

ABSTRACT The International Civil Aviation Organization promotes prioritization of wildlife management on airports, among other safety issues, by emphasizing the risk of wildlife–aircraft collisions (strikes). In its basic form, strike risk comprises a frequency component (i.e., how often strikes occur) and a severity component reflecting the cost of the incident. However, there is no widely accepted formula for estimating strike risk. Our goal was to develop a probabilistic risk metric that is adaptable for airports to use. Our specific objectives were to 1) update species-specific, relative hazard scores (i.e., the likelihood of aircraft damage or effect on flight when strikes occur) using recent U.S. Federal Aviation Administration (FAA) wildlife strike data (2010–2015); 2) develop 4 *a priori* risk models, reflecting species-specific strike data and updated relative hazard scores; 3) test these models against independent data (monetary costs associated with strikes); and 4) apply our best model to strike data from 4 large, FAA-certificated airports to illustrate its application at the local level. Our best-fitting risk model included an independent variable that was an interaction of quadratic transformed relative hazard score and number of wildlife strikes ($r^2 = 0.74$). Top species in terms of estimated risk nationally were red-tailed hawk (*Buteo jamaicensis*), Canada goose (*Branta canadensis*), turkey vulture (*Cathartes aura*), rock pigeon (*Columba livia*), and mourning dove (*Zenaida macroura*). We found substantial overlap among the top 5 riskiest species locally across 3 of 4 airports considered, illustrating the degree of site-specific differences that affect risk. Strike risk is dynamic; therefore, future work on risk estimation should allow for model adjustment to reflect ongoing wildlife management actions at airports that could influence future strike risk. Published 2018. This article is a U.S. Government work and is in the public domain in the USA.

KEY WORDS airport, aviation, bird strike, relative hazard score, strike risk.

Threats posed by wildlife to aviation safety have received growing recognition by the aviation community over the past 40 years (DeVault et al. 2013). Wildlife–aircraft collisions (strikes) primarily involve birds and result in costs to the civil aviation industry exceeding US$1.2 billion annually (Allan 2002). These events pose safety hazards to passengers and crew, as well as people and structures on the ground (Dolbeer et al. 2016). Wildlife management efforts on airports certificated for passenger traffic are now common in most developed countries. For example, the International Civil Aviation Organization (ICAO) recognizes the need to manage wildlife on member state airports (ICAO 2004). Guidance by ICAO and the U.S. Federal Aviation Administration (FAA) stresses minimization of food, water, and cover attractants to wildlife on and near airport property (ICAO 1991, 2002; FAA 2007*a*; Blackwell et al. 2009; Dolbeer 2013).

Although ICAO and FAA guidance serves to focus airport management on wildlife hazards, these suggestions are broad

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[1]*E-mail: travis.l.devault@aphis.usda.gov*

Why publish another paper?

More data available

There have been roughly 127,000 new records added to NWSD since 2018

Seasonal differences

Investigating seasonal changes in bird species risk

Methods

01 **Extracted wildlife records for 2010 - 2023 from the National Wildlife Strike Database**

Records used in dataset met specific criteria

02 **Calculated Relative Hazard Score (RHS) for 132 bird species and 16 mammal species**

Following Dolbeer et al. (2000) and DeVault et al. (2011, 2018)

03 **Assessed RHS in relation to body mass**

Providing an updated equation to estimate RHS for species not included

04 **Calculated national annual and seasonal risk**

Providing updated risk scores and new seasonal risk scores

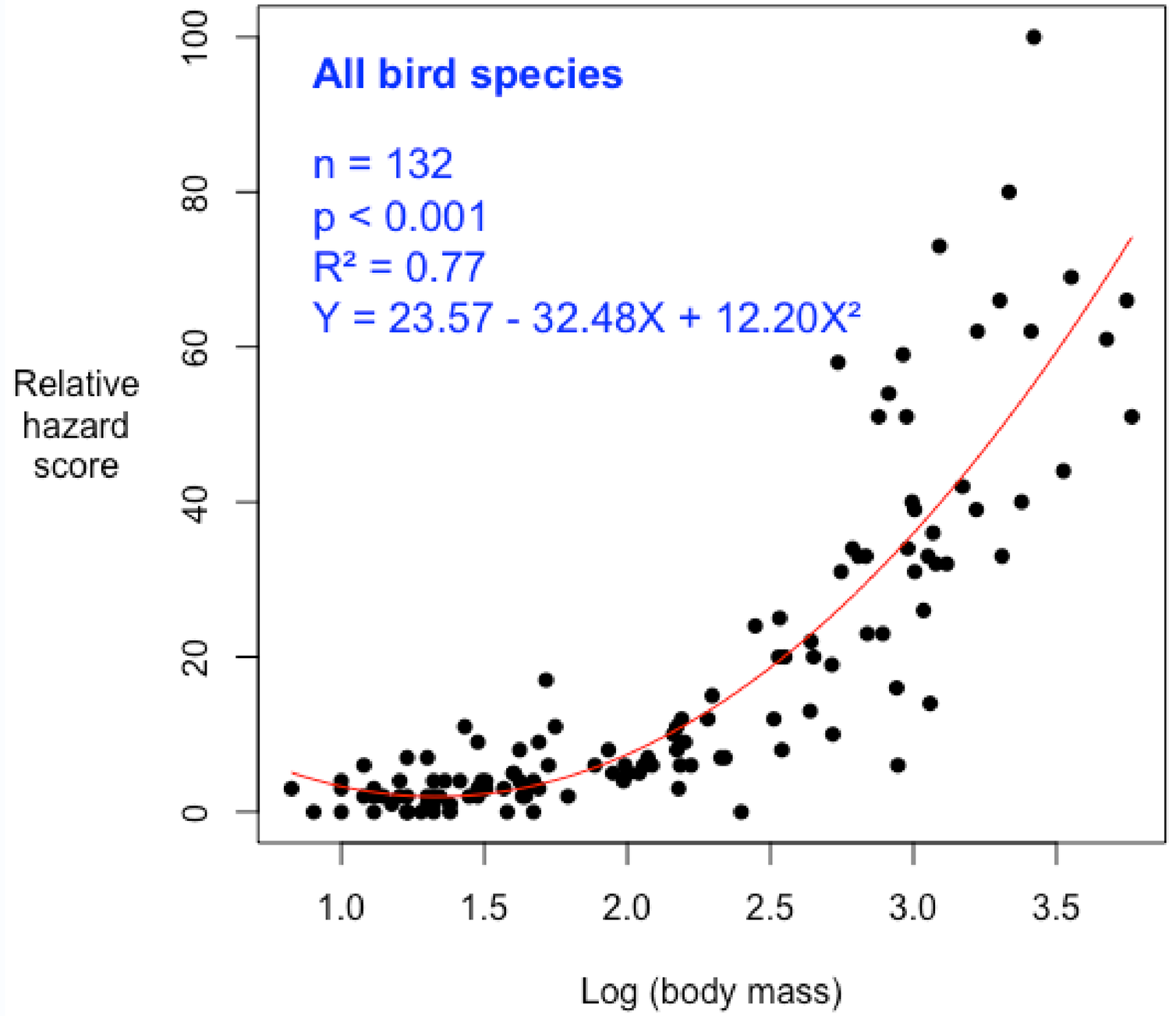
Mammal RHS

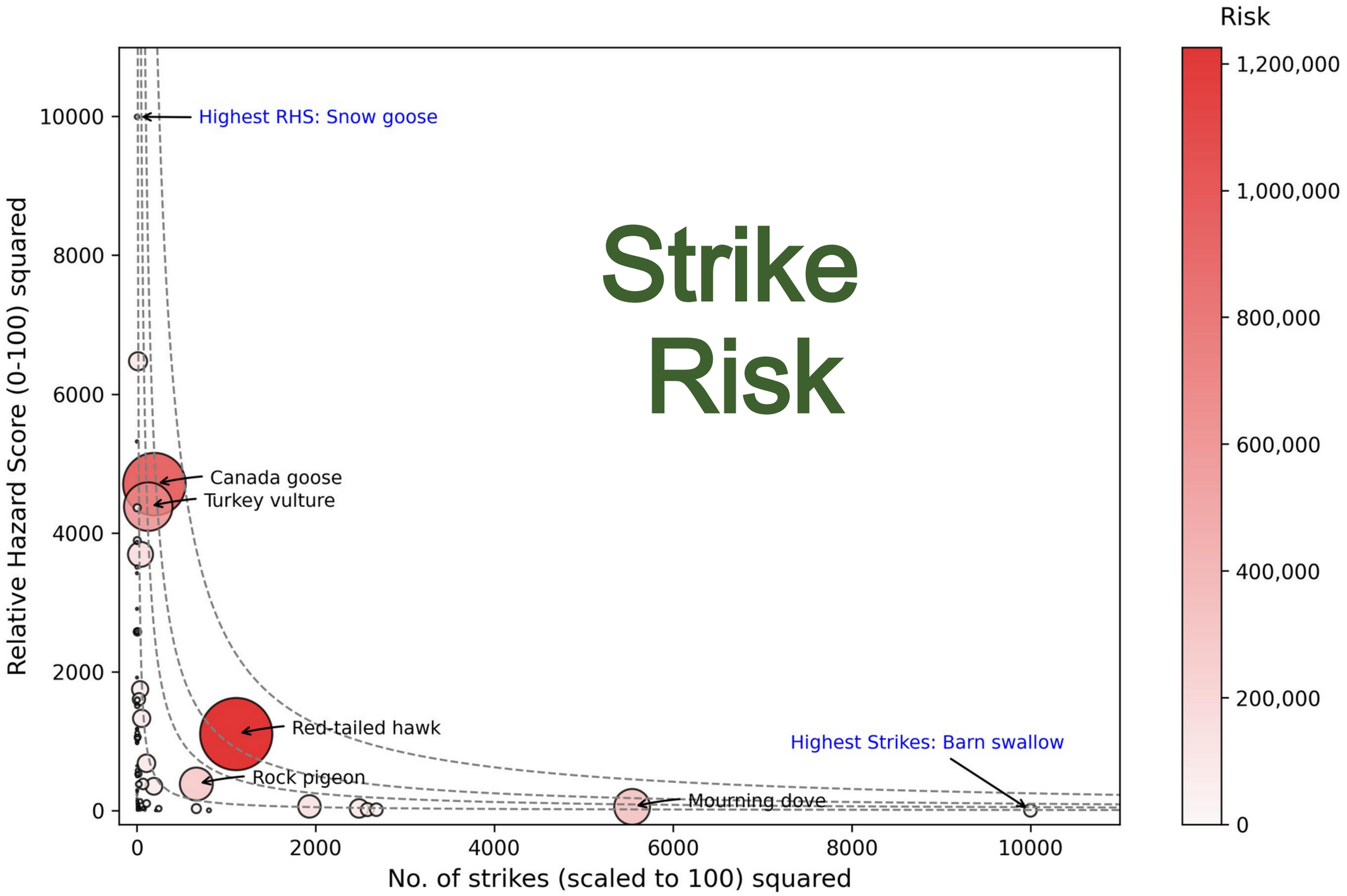
Species	Damaging strikes	Total strikes	RHS
White-tailed deer (*Odocoileus virginianus*)	338	419	100
Mule deer (*Odocoileus hemionus*)	14	21	81
Coyote (*Canis latrans*)	38	411	29
Red fox (*Vulpes vulpes*)	3	109	15
Woodchuck (*Marmota monax*)	1	51	12
Raccoon (*Procyon lotor*)	2	47	7
Big brown bat (*Eptesicus fuscus*)	0	40	3
Striped skunk (*Mephitis mephitis*)	2	88	3
Evening bat (*Nycticeius humeralis*)	1	25	2
White-tailed jackrabbit (*Lepus townsendii*)	0	35	3

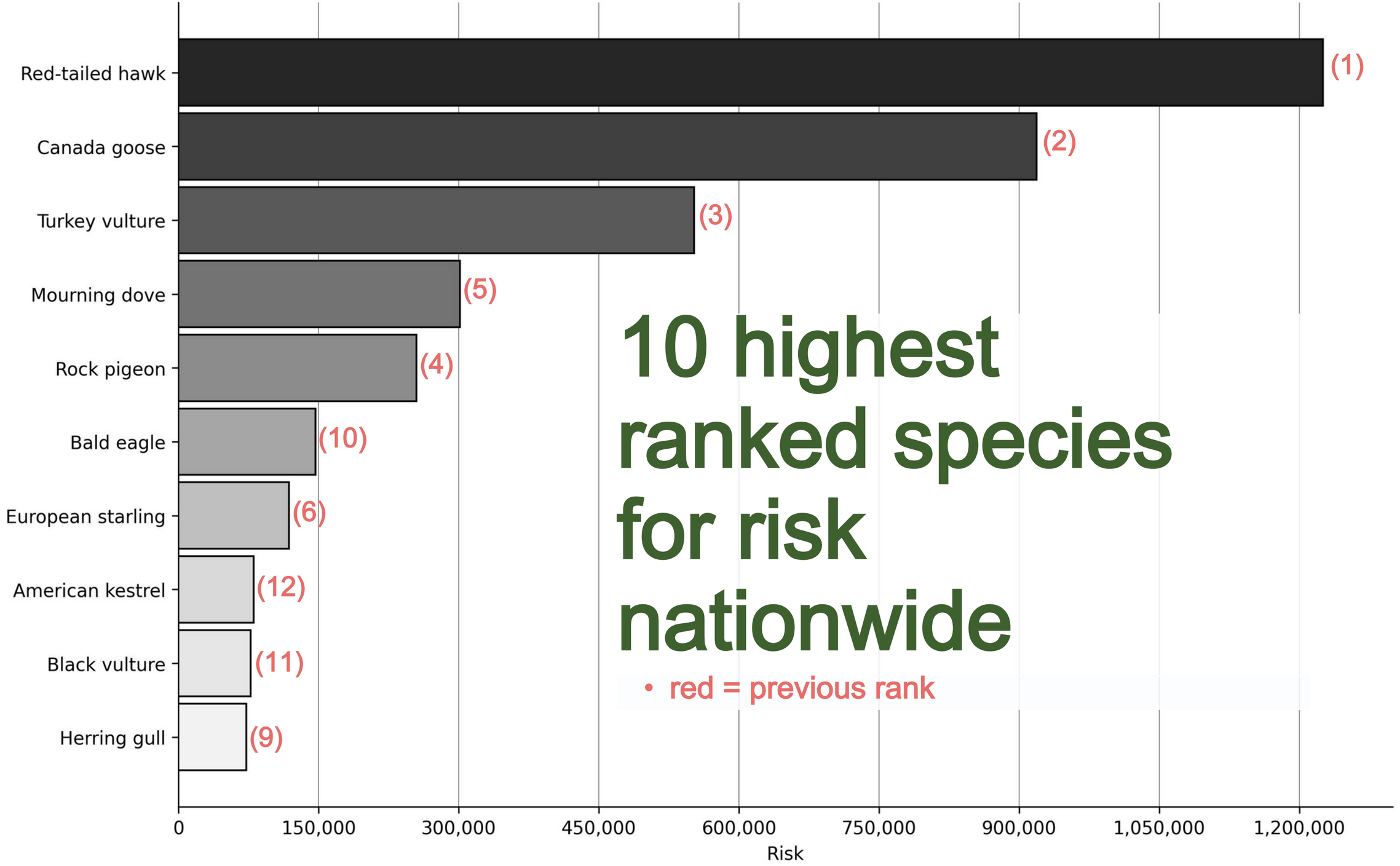
Bird RHS

Species	Damaging strikes	Total strikes	RHS
Snow goose (*Anser caerulescens*)	16	27	100
Black vulture (*Coragyps atratus*)	91	138	80
Anhinga (*Anhinga anhinga*)	9	20	73
Canada goose (*Branta canadensis*)	253	559	69
Turkey vulture (*Cathartes aura*)	207	449	66
Sandhill crane (*Grus canadensis*)	28	67	66
Double-crested cormorant (*Phalacrocorax auritus*)	25	69	62
Greater white-fronted goose (*Anser albifrons*)	15	28	62
Bald eagle (*Haliaeetus leucocephalus*)	95	252	61
Gadwall (*Mareca strepera*)	15	34	59

Bird RHS and body mass



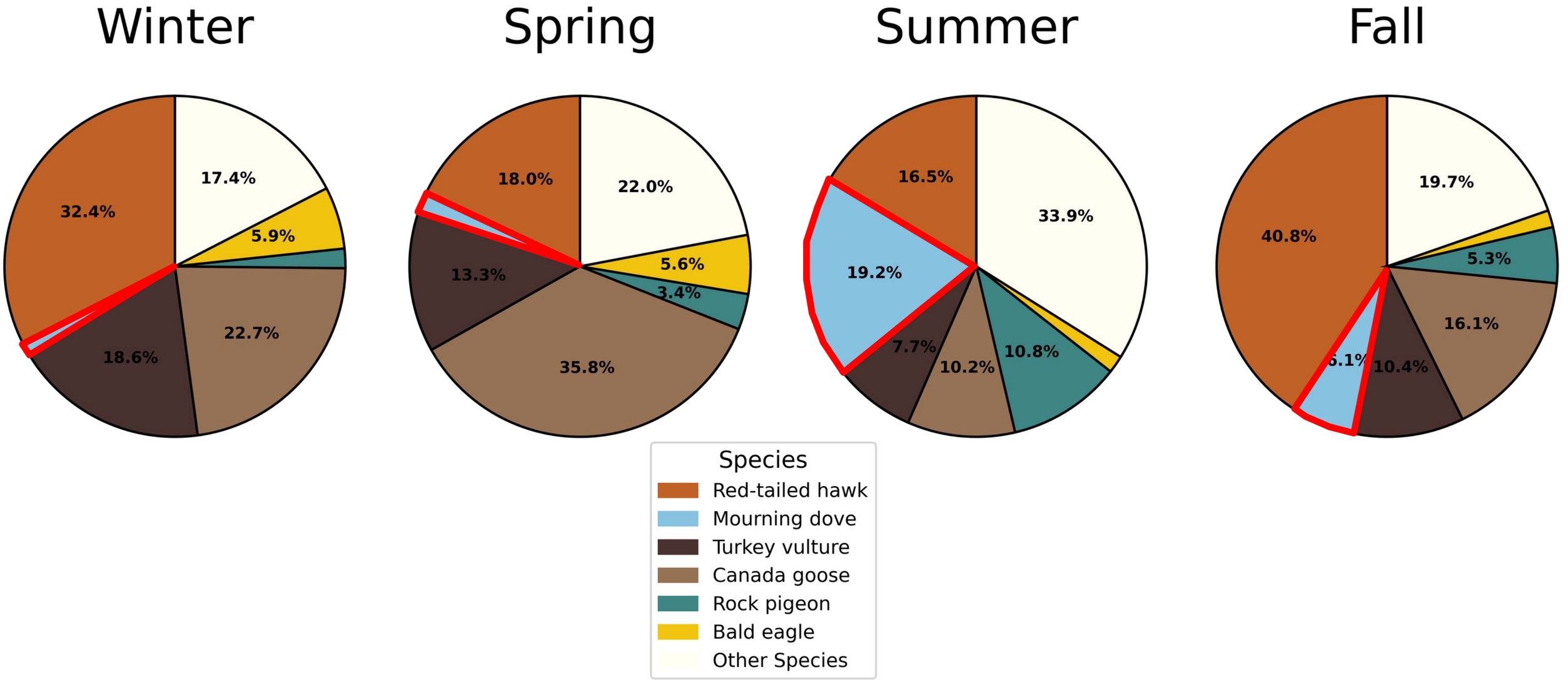

Strike Risk
Highest RHS: Snow goose
Canada goose
Turkey vulture
Red-tailed hawk
Rock pigeon
Mourning dove
Highest Strikes: Barn swallow
Relative Hazard Score (0-100) squared
No. of strikes (scaled to 100) squared
0
2000
4000
6000
8000
10000
Risk
1,200,000
1,000,000
800,000
600,000
400,000
200,000
0


Red-tailed hawk
Canada goose
Turkey vulture
Mourning dove
Rock pigeon
Bald eagle
European starling
American kestrel
Black vulture
Herring gull
(1)
(2)
(3)
(5)
(4)
(10)
(6)
(12)
(11)
(9)
0
150,000
300,000
450,000
600,000
750,000
900,000
1,050,000
1,200,000
Risk
10 highest ranked species for risk nationwide
• red = previous rank

Seasonal changes in risk

	Winter		*Spring*		*Summer*		*Fall*	
Risk Rank	**Species**	**Risk**	**Species**	**Risk**	**Species**	**Risk**	**Species**	**Risk**
1	Red-tailed hawk	4,110,780	Canada goose	9,495,249	Mourning dove	172,859	Red-tailed hawk	3,511,187
2	Canada goose	2,874,737	Red-tailed hawk	4,757,749	Red-tailed hawk	148,995	Canada goose	1,385,657
3	Turkey vulture	2,355,856	Turkey vulture	3,530,653	Rock pigeon	96,951	Turkey vulture	893,662
4	Bald eagle	746,755	Bald eagle	1,476,534	European starling	91,988	Mourning dove	522,812
5	Mallard	311,731	Ring-billed gull	1,222,070	Canada goose	91,963	Rock pigeon	455,281
6	Northern pintail	308,280	Mallard	910,159	Turkey vulture	69,501	Herring gull	329,292
7	Black vulture	297,816	Rock pigeon	898,272	American kestrel	40,318	American kestrel	186,357
8	Snowy owl	271,126	Osprey	648,589	Barn swallow	37,131	Bald eagle	138,367
9	Rock pigeon	234,493	Herring gull	512,514	Killdeer	25,326	Black vulture	127,694
10	Horned lark	138,960	Mourning dove	493,692	Osprey	19,344	Horned lark	93,147

Seasonal changes in proportion of risk



What do these results mean?

- It's important to periodically **re-evaluate** our assessment of **risk**
- **RHS is qualitatively similar** to previous calculations
    - **highest scores** are held by **large-bodied birds**
- nationwide annual risk rank remained the same for top 3
    - emphasizes the **ongoing attraction** these species have to **airport environments**
- risk rank of some species has changed notably
    - **bald eagle** has moved from 10 to 6
    - **American kestrel** and **black vulture** moving into top 10

Limitations of strike risk model

01 Model does not quantify true **species-specific strike likelihood**

02 Species present at an airport but **poorly represented in strike records** are **not reflected in model**

MANAGEMENT IMPLICATIONS

- This paper demonstrates using this risk metric at a national level for annual and seasonal risk
- Managers can use this model to better allocate resources across seasons

Incorporate this risk metric as a guide to your local strike data to better prioritize wildlife management to reduce strikes

United States Department of Agriculture

Animal and Plant Health Inspection Service
Wildlife Services

UNIVERSITY OF GEORGIA
Savannah River Ecology Laboratory

QUESTIONS?

Email:
caryn.ross@uga.edu