How important is the cost calculation to enhance wildlife strike risk management?

AeroFauna

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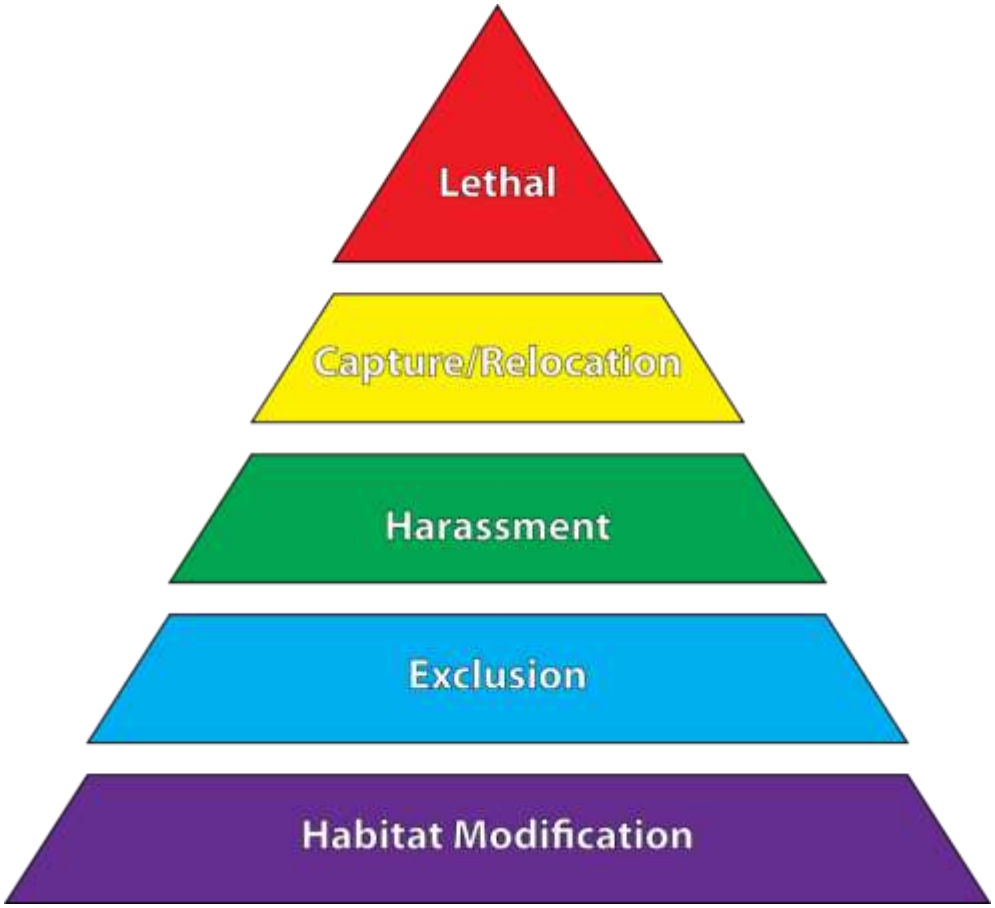


- **All of these management actions cost $.**
- **How much are wildlife strikes costing the industry?**
- **Are management efforts bringing a return on investment?**

Prioritization of management actions to mitigate the risk of wildlife strikes

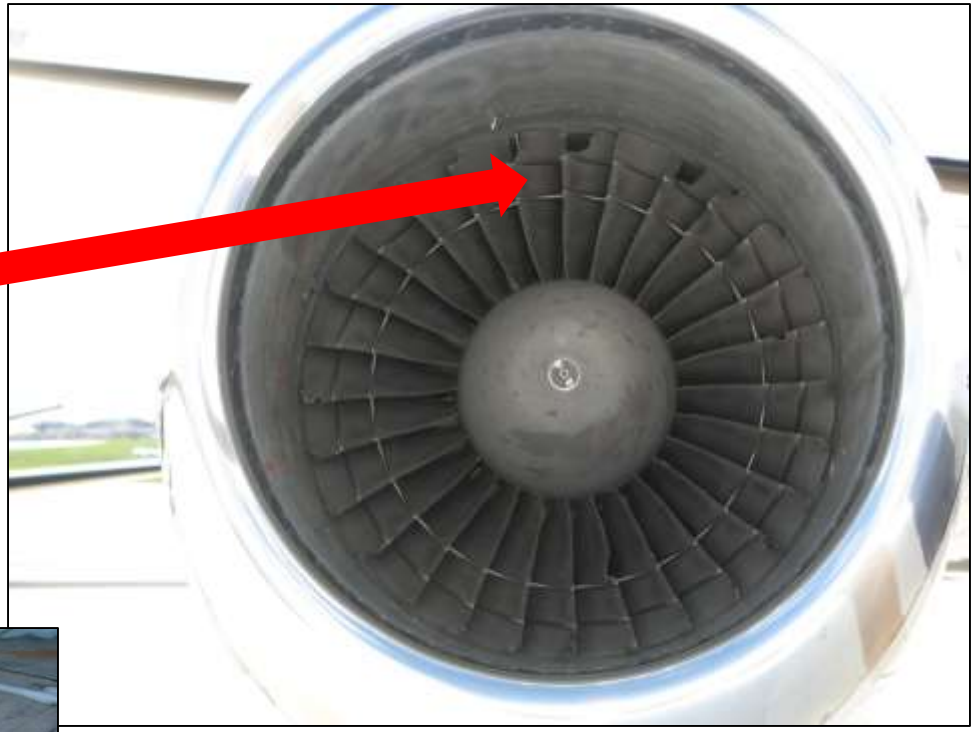
Most important: What is the Return On Investment ?

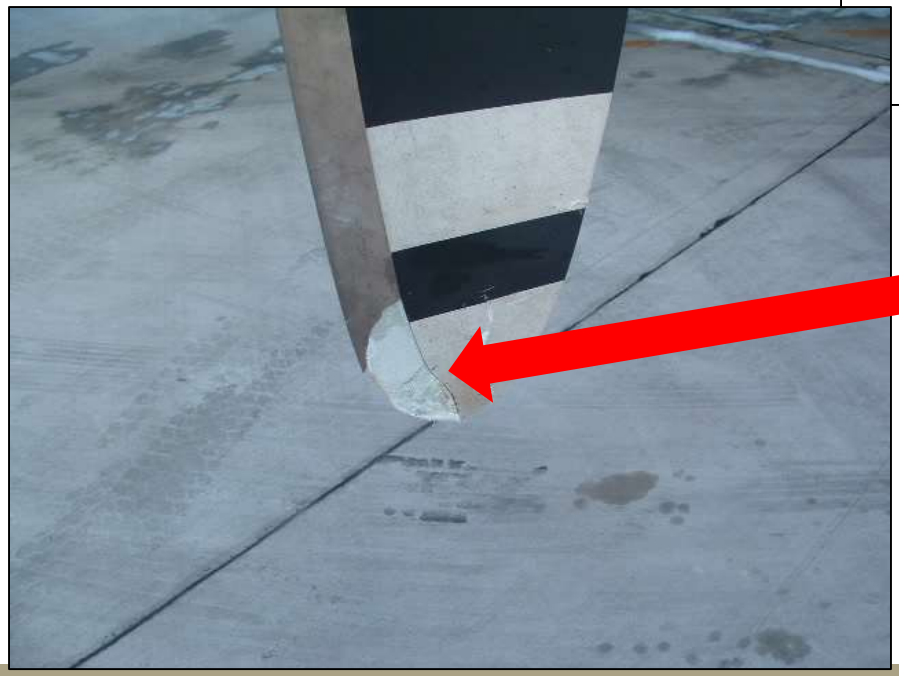
We need to know:

a) the costs to aviation industry overall (macro-economic costs),

b) the costs to individual airports, aircraft types, aircraft components, air transport companies. (micro-economic costs).

How do we obtain these cost estimates ???



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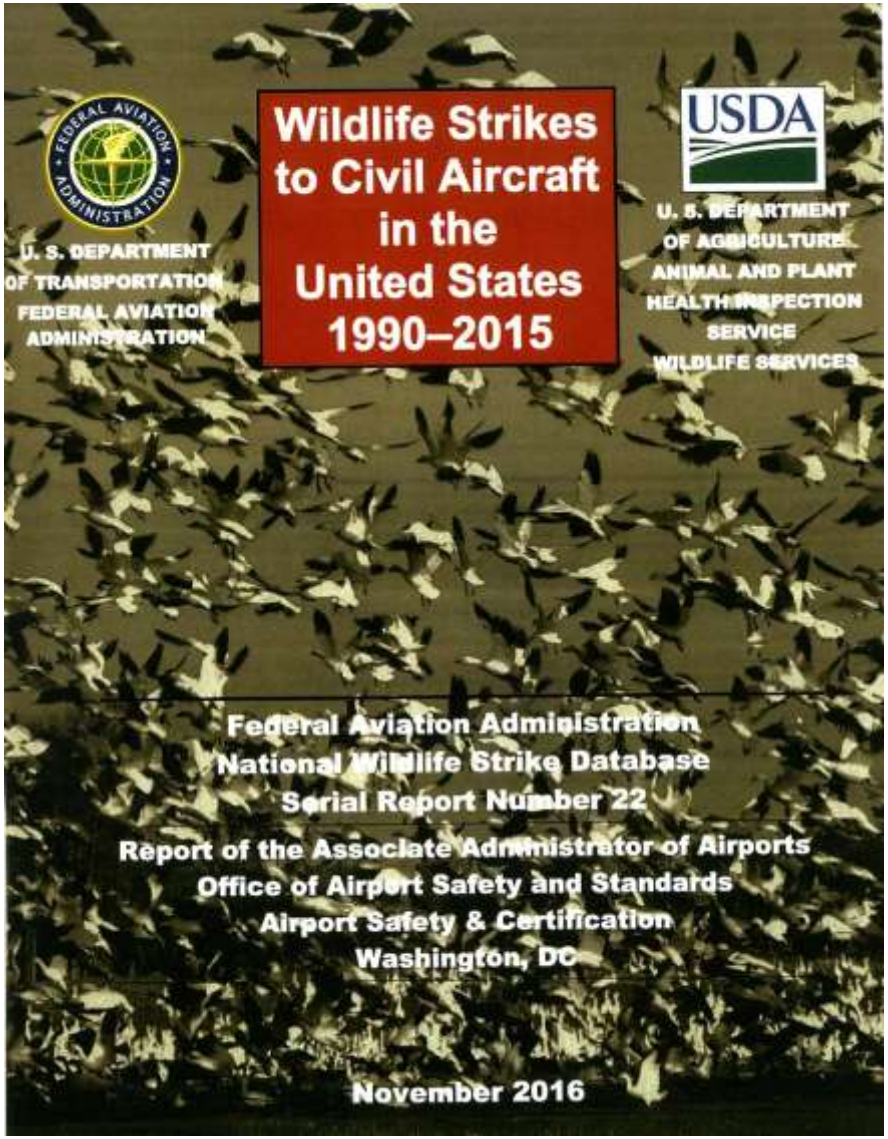
So what did these events cost?

Macro-economic calculation of costs from wildlife strikes in USA based on reported costs and downtime in National Wildlife Strike Database

Tables 23 and 24 in report

https://www.faa.gov/airports/airport_safety/wildlife/media/Wildlife-Strike-Report-1990-2015.pdf



Data on economic losses from bird strikes to civil aircraft in USA, example for year 2015 from NWSD (step 1 of 2)

Total strike reports in 2015 = 13,795
Number indicating adverse effect = 1,451 (10.5%)

Type of economic loss	No. of reports providing data	Total cost or down time reported	Mean costs and down time per report providing data
Repair costs ($)	210	$29,310,540	$139,574
Other costs ($)	292	$5,366,376	$18,378
Total costs ($)			$157,952
Down time (hrs)	706	33,817 hours	47.9 hours

Data on economic losses from bird strikes to civil aircraft in USA, example for year 2015 from NWSD (step 2 of 2)

Total strike reports in 2015 = 13,795
Number indicating adverse effect = 1,451 (10.5%)

Type of economic loss	Total reports indicating adverse effect	Mean cost and down time per report providing data	Minimum projected total costs and down time
Repair cost	1,451	$139,574	$202,000,000
Other costs	1,451	$18,378	$27,000,000
Total costs			$229,000,000
Down time (hrs)	1,451	47.9 hours	69,500 hours

Data on economic losses from bird strikes to civil aircraft in USA, 2011-2015 (from NWSD)

			Minimum projected losses		
Year	No. of adverse incidents	Down-time (hours)	Repair costs (x $1 million)	Other costs (x $1 million)	Total costs (x $1 million)
2011	1,145	81,036	267	17	284
2012	1,330	100,611	145	11	156
2013	1,444	109,457	90	18	108
2014	1,456	92,078	189	15	204
2015	1,451	69,497	203	27	229

Calculation of cost savings by reducing Adverse Effect (AE) strike rate at an airport (JFK using 2015 data)

	AE strike rate (per 100K movements)	No. of aircraft movements/ year	No. AE strikes/ year	Mean cost (US$) for AE strike	Total annual cost of strikes
JFK airport (actual)	1.75	420,000	7.4	$158,000	$1,161,300
JFK airport (goal)	0.90	420,000	3.8	$158,000	$597,240
Net savings	-0.85	0	-3.6	0	-$564,060

Micro-economic approach:

Modeling the cost of bird strikes to US civil aircraft using a two-part regression model

Transportation Research Part D: Transport and Environment
Volume 38, July 2015, Pages 49-58

Aaron Anderson, David S. Carpenter, Michael J. Begier, Bradley F. Blackwell, Travis L. DeVault & Stephanie A. Shwiff

Purpose: construct a model to interpolate expected repair costs where none have been reported

A better understanding of determinants of strike costs can guide future efforts to minimize these costs

Variability in strike reporting & missing data make it difficult to draw accurate conclusions

Why don't we use the average of reported costs to fill in the values for the strikes that don't report a cost?

- Every missing value would be assigned the same value regardless of season or airport or aircraft

- Costs likely due to the bird species, aircraft types involved, phase of flight and other factors

Modeling Strategy

Models included the following sets of categorical variables:

- Number of birds
- Size of birds
- Phase of flight
- Aircraft mass
- Engine type
- Engine ingestion
- Component(s) struck

Modeling Strategy – Probit

Probit model -Predicts the probability of a non-zero repair cost

Probit model allows for non-constant variance, which is a key feature of this data:

- **An engine strike can cause no damage or destroy the aircraft; a strike to an aircraft light displays much less variation**

Modeling Strategy – Log-linear

The log-linear model is concerned with the magnitude of the cost of a strike given that the cost is >0

Estimates from this model are based only on strikes that reported >0 repair costs

Modeling Strategy

Predicted cost of a strike is = Probability that damage occurs × magnitude of damage

$$\mathbf{E}\left[Cost_i \middle| x_i, z_i\right] = \mathbf{Prob}\left(Cost_i > 0 \middle| x_i, z_i\right) * \mathbf{E}\left[Cost_i \middle| Cost_i > 0, x_i\right]$$

$$= \Phi\left(\frac{x_i'\hat{\beta}}{exp(z_i'\hat{\gamma})}\right) * exp(x_i'\hat{\alpha})$$

In the last line above, the first term comes from probit model and the second comes from the log-linear model

When inserting estimated parameters of a strike, the equation returns the expected cost of a strike

Results are generally intuitive

- Strikes on the ground tend to cause less damage
- Expected costs increase as bird size increases
- Expected costs increase as the # of birds struck increase
- Engine ingestion is a primary driver of expected cost

Expected costs decline as aircraft size increases, perhaps because larger aircraft are less susceptible to catastrophic damage

Turbofan aircraft sustain more damage than other aircraft

Next steps…

Use the micro-economic model to fill in the blanks in the data

- **Improved total cost estimate of bird strikes**

When missing values in the data are acquired:

Calculate monthly total costs by airport or region over time

Construct a model that effectively explains variation in monthly strike costs

19 people killed in plane crash at Kathmandu Airport, Nepal, September 2012 (Dornier 228-200)

Thank you…
Questions ?

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