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Comparison of wildlife strike data among airports to improve aviation safety

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Abstract: The current system for managing wildlife hazards at airports in the USA is regulatory driven under the U.S. Code of Federal Regulations. The compliance process begins with an assessment of wildlife hazards followed by the development of a Wildlife Hazard Management Plan (WHMP). However, formal assessment of risk to evaluate the efficacy of the WHMP and to guide future improvement is lacking. In the context of a Safety Management System, we propose that the U.S. Wildlife Strike Database can be a key element for providing objective benchmarks and for prioritizing wildlife risks (hazard level *x* probability of occurrence). Comparisons of the number of reported strikes/100,000 aircraft movements among airports are not a valid metric because hazard levels of wildlife species vary among airports. Instead, we propose the use of the "adverse effect" strike rate (strikes that cause damage or a negative effect on flight/100,000 movements). Adverse effect strikes are potential precursors to catastrophic events and constitute a valid metric for measuring risk. From 2007-2011, the 100 busiest certificated airports had a median adverse-effect strike rate of 0.90 for strikes at ≤1,500 feet above ground level (AGL, generally within the airport environment and covered by the airport's WHMP) and 0.17 for strikes at >1,500 feet AGL (aircraft on initial climb or final approach but generally outside the purview of the airport's WHMP). This median rate of 0.90 for strikes at ≤1,500 feet provides a benchmark to gauge an airport's level of risk for "adverse effect" wildlife strikes related to the airport's WHMP. This does not imply that an airport with an adverse-effect rate below 0.90 should not seek improvements in its WHMP. All airports must reevaluate their WHMP annually, with a focus on those species and habitats posing the greatest risk (based on species most likely to cause adverse effects). Likewise, the median rate of 0.17 for strikes at >1,500 feet provides a benchmark to gauge an airport's level of risk for "adverse effect" wildlife strikes in the departure and approach zones that cannot be managed related to the airport's traditional WHMP. Mitigation of these off-airport risks may require the integration of bird-detecting radar, alterations in departure and arrival flight paths and other strategies into the airport's WHMP. The goal is to reduce the adverse-effect strike rates above and below 1,500 feet to zero.

***Key words*:** aircraft, airport, aviation safety, bird strike, database, hazard, risk, safety management system, wildlife.

1.0 Introduction

Highly successful programs funded by governmental and private organizations during the past 40 years (e.g., pesticide regulation, expansion of wildlife refuge systems, wetlands restoration), coupled with land-use changes, have resulted in dramatic increases in populations of many larger bird species in North America and elsewhere (Buurma 1996, Dolbeer and Eschenfelder 2003, Dolbeer et al. 2012). Many of these birds have adapted to urban environments and find that airports, with large areas of grass and pavement, are attractive habitats for feeding and resting.

Other wildlife such as deer (*Odocoileus* spp.) and coyotes (*Canis latrans*) are also attracted to airport environments for similar reasons. In addition, modern turbofan-powered aircraft, with quieter engines, are less obvious to birds compared to noisier piston-powered aircraft and older turbine-powered aircraft (Burger 1983, Kelly et al. 2001).

For these reasons, birds and other wildlife in the vicinity of airports are an increasing problem for the aviation industry. Allan (2002) estimated that bird strikes annually cost commercial air carriers over $1.2 billion worldwide. At least 221 people died and 231 aircraft were destroyed worldwide as a result of bird and other wildlife strikes with civil and military aircraft from 1988-2012 (Richardson and West 2000; Thorpe 2003, 2005; 2010, Dolbeer et al. 2012, Dolbeer, unpublished data).

In 1990, the 190 member States of the International Civil Aviation Organization (ICAO) adopted, in Annex 14 to the Convention on Civil International Aviation, 3 recommended practices regarding bird hazards to aviation. These recommended practices were that aviation authorities: 1) assess the extent of the hazard posed by birds on and in the vicinity of airports certificated for passenger traffic, 2) take necessary action to decrease the number of birds, and 3) eliminate or prevent the establishment of any site in the vicinity of the airport which would be an attraction to birds and thereby present a danger to aviation. Because of the increasing threat to aviation worldwide caused by birds, member states voted to make these recommended practices into mandatory ICAO standards, effective November 2003 (ICAO 2004).

In concert with ICAO standards, the approximately 550 airports in the USA certificated by the Federal Aviation Administration (FAA) for passenger traffic that experience wildlife hazards are required (14 Code of Federal Regulations [CFR] Part 139.337) to conduct a Wildlife Hazard Assessment (WHA). Based on the findings of the WHA, most airports are required to develop and implement a Wildlife Hazard Management Plan (WHMP). Wildlife Hazard Management Plans, as required in Part 139.337 regulations, call for the removal of habitat and food attractive to wildlife; the use of techniques to exclude, disperse, or remove wildlife that pose a risk to aircraft; and the training of airport personnel in wildlife management techniques. The FAA and U.S. Department of Agriculture have published a 348-page manual, "Wildlife Hazard Management at Airports" (Cleary and Dolbeer 2005), that provides detailed guidance and background material for airport personnel implementing WHMPs.

Thus, the current system for managing wildlife hazards at airports in the USA is regulatory-driven under 14 CFR Part 139. If an airport has conducted a WHA and developed a WHMP that is acceptable to the FAA, the airport is in compliance. However, there are no formalized procedures defined to: 1) provide benchmarks to the effectiveness of the WHMP and 2) prioritize risk (hazard level or severity *times* the probability of occurrence) by wildlife species and location of strikes (e.g., on the airport or off-airport in approach/departure airspace) so that management efforts can be focused on the most critical species and circumstances. Such procedures are needed in the development of Airport Safety Management Systems (SMS), which will be required under amendments to Annex 14, Volume I Aerodrome Design and Operations (ICAO 2005). The FAA has committed to implementing the use of SMS at U.S. airports in a way that complements existing safety regulations in 14 CFR Part 139 (Federal Aviation Administration 2007).

Three questions frequently posed by airport operators are: 1) "How effective is my airport's WHMP?", 2) "How does the strike rate at my airport compare to other airports?", and 3) "What about off-airport strikes for aircraft in initial climb from or on final approach to my airport? Should these strikes be 'counted' in an evaluation of my WHMP!". Essentially, the airport operator is asking: "How well are we managing the risk posed by wildlife strikes at my airport, and what can we do about those strikes away from the airport that we do not cover in our WHMP?" Under SMS, it is important to identify safety performance indicators and targets (FAA 2007).

The National Wildlife Strike Database for Civil Aviation in the USA became operational in 1995 with the initiation of data entry of all strikes reported to the FAA beginning in 1990 (Dolbeer et al. 2012). With the impending requirement for airports in the USA and elsewhere to manage safety risks through a formal SMS approach, we propose that the database can be a key element to provide objective benchmarks and goals regarding the effectiveness of WHMPs and to help prioritize actions to reduce risks posed by wildlife. This process will also facilitate the development and integration of mitigation efforts for off-airport strikes into an airport's WHMP. This paper expands upon a prototype analysis of the database that is already in place to assist airports and FAA airport certification inspectors in evaluating WHMPs (Dolbeer et al. 2007).

2.0 Methods

We used strike records from the 5 most recent years (2007-2011) because, for this analysis, we are not interested in historical trends in strikes at airports going back to 1990. We selected the 100 busiest Part 139-certificated airports in the USA from 2007-2011 based on civil aircraft movements (Federal Aviation Administration 2012*a*, *b*). The mean number of movements per year at these 100 airports ranged from 111,467 to 966,361 (median of 184,660, Table 1). We used strike statistics from these 100 airports to develop our proposed benchmarks because these airports are more likely than smaller airports to have sufficient resources devoted to WHMPs and better reporting rates of strikes (Dolbeer 2009).

For each airport, we separated strikes that occurred at ≤1,500 feet[1] (within the airport environment and typically covered under an airport's WHMP) from those that occurred on approach or departure at >1,500 feet. Aircraft on approach at a standard 3-degree glide slope are about 8 km from the runway at 1,500 feet. Commercial aircraft on departure are usually closer to the airport when they climb through 1,500 feet. The FAA provides guidance for airports and communities regarding the minimization of wildlife hazard attractants within 8 km of airport operating surfaces (Advisory Circular 150/5200-33B); WHMPs, as per federal regulations (14CFR Part 139.337), focus on the wildlife that are causing strikes in this environment at ≤1,500 feet. Although strikes outside the airport environment on approach and departure at >1,500 feet are important for risk analysis and mitigation, they typically fall outside the realm of WHMPs at present (Eschenfelder and DeFusco 2010). The forced landing of US Airways Flight 1549 in the Hudson River in 2009 after ingesting migrating Canada geese (*Branta canadensis*) in both engines at 2,700 feet and 8 km from the departure runway at LaGuardia Airport, New York is an example of such an "off airport" strike not covered by traditional WHMPs in the USA (Marra et al. 2009).

We believe that using total strikes at ≤1,500 and >1,500 feet as a means of developing benchmarks and comparisons among airports is inappropriate. First, airports often vary in the hazard level of species struck. For example, an airport with numerous strikes involving Canada

[1]All measures of height refer to height above ground level.

geese (>50% of strikes cause an adverse effect [damage or a negative effect on flight]) has a much higher safety risk than another airport where similar numbers of strikes are reported that involve small passerine birds such as sparrows and swallows (<1% of strikes cause an adverse effect, see Table 17, Dolbeer et al 2012 for hazard levels of various wildlife species in the USA). Second, although airports may vary in the completeness of reporting all strikes events (e.g., reporting of carcasses found on runways), most strikes at Part 139 airports in USA that cause an adverse effect are entered into the database either through standard reporting by the airport, air carrier, or flight crew, or through FAA regional incident reports (Dolbeer 2009). Finally, from a SMS perspective, the goal of a WHMP is not necessarily to prevent all strikes, but to focus on preventing strikes that pose a risk to flight safety.

For these reasons, we propose the use of adverse effect strikes as the appropriate metric for establishing benchmarks, because these events are potential precursors to catastrophic events and constitute a valid metric for measuring risk. Thus, we calculated the mean number of adverse effect strikes at ≤1,500 and >1,500 feet per 100,000 aircraft movements/year for each of these 100 airports for the most recent 5-year period (2007-2011).

3.0 Results

3.1 Adverse effect strike rates for the 100 airports (≤1,500 feet)

The 100 airports had 24,408 wildlife strikes reported at ≤1,500 feet in 2007-2011 of which 1,429 (5.9%) had an adverse effect (Table 1). With one exception, the 5-year adverse effect strike rates for these 100 airports were distributed normally, ranging from 0.0 to 3.75 (Figure 1, Table 1). One airport had an unusually high rate of 8.06 (over 2 times the next highest rate). The median rate for the 100 airports for the 5-year period was 0.90 adverse effect strikes /100,000 aircraft movements. With the outlier airport excluded or included, there was no correlation (R^2 = 0.0003 to 0.0016) between the number of aircraft movements and the adverse effect strike rate for the airports (i.e., the adverse effect strike rate was independent of the activity level of aircraft at an airport, Figure 2).

3.2 Adverse effect strike rates for the 100 airports (>1,500 feet)

The 100 airports had 3,431 wildlife strikes reported at >1,500 feet of which 409 (11.9%) had an adverse effect (Table 1). With one exception, the 5-year adverse effect strike rates for these 100 airports were distributed normally, ranging from 0.0 to 1.38 (Figure 1, Table 1). One airport had an unusually high rate of 3.96 (almost 3 times the next highest rate). The median rate for the 100 airports for the 5-year period was 0.17 adverse effect strikes /100,000 aircraft movements. There was little correlation between the number of aircraft movements and the adverse effect strike rate (R^2 = 0.0424 and 0.0055 with outlier airport excluded and included, respectively Figure 3).

Although strikes at >1,500 feet were about twice as likely to cause an adverse effect as strikes at ≤1,500 feet (11.9% vs. 5.9%), the overall adverse effect strike rate at >1,500 feet was only 1/5 the rate at ≤1,500 feet. This was because 88% of the strikes occurred at ≤1,500 feet (Table 1).

There was some degree of correlation (R^2 = 0.2218 and 0.5531 with outlier airport excluded and included, respectively) between the adverse effect strike rate at ≤1,500 and >1,500 feet for the airports (i.e., airports that had a higher rate at ≤1,500 feet tended to have a higher rate at >1,500 feet and vice-verse, Figure 4). Yet, as shown in the scatter of data points in Figure 4, there were many airports in which this trend did not hold. This indicates that the partitioning of effort to mitigate the risk of on-airport and off-airport strikes will vary among airports. For example, airports in the lower right quadrant of graph (above median value for adverse effect strike rate at ≤1,500 feet and below median value for adverse effect strike rate at >1,500 feet) need to more fully address on-airport mitigation efforts. Alternatively, airports in the upper left quadrant of graph (below median value for adverse effect strike rate at ≤1,500 feet and above median value for adverse effect strike rate at >1,500 feet) need to more fully address off-airport mitigation efforts related to approach and departure zones at >1,500 feet.

4.0 Discussion

4.1 Use of adverse effect strike rates as benchmarks

We propose that benchmarks of 0.90 and 0.17 adverse effect strike at ≤1,500 and >1,500 feet/100,000 aircraft movements per year (the median rates for the 100 busiest Part 139 airports) be established for annually evaluating an airport's WHMP. Ideally, all airports should strive for 0 adverse effect strikes at ≤1,500 feet and >1,500 feet every year. However, given the abundance, diversity, mobility and adaptability of wildlife species that are a threat to aviation, achieving an adverse effect strike rate of 0 every year may not be practical for most airports. These benchmarks provide realistic risk-reduction goals for airports with rates above the national medians. Any airport exceeding these median damaging strike rates of 0.90 and 0.17 in a given year should reevaluate its WHMP, with a focus on those species (see below) and situations (strikes at ≤1,500 or >1,500 feet) posing the greatest risk, to reduce the rates below these benchmark levels. Likewise, airports whose rates are already at or below the national medians should continually strive to lower their rates even further. Finally, we propose that these national benchmarks be recalculated yearly, to adjust for changing numbers of adverse effect strikes and aircraft movements, for the most recent 5-year period. Ideally, as wildlife risk management becomes more focused and effective at the nation's airports under SMS, the benchmark rates (0.90 and 0.17 for 2007-2011) will decline.

We believe there is a major advantage in the calculation of an adverse effect strike rate at each airport for strikes at >1,500 feet that is separate from the adverse effect strike rate at ≤1,500 feet. The calculation and comparison of this adverse effect rate with a national benchmark provides a starting point to develop and integrate mitigation efforts for off-airport strikes in approach and departure airspace (>1,500 feet) that are not presently addressed in most WHMPs. As noted above, the partitioning of effort to mitigate the risk of on-airport and off-airport strikes will vary among airports.

4.2. Objections to establishing benchmarks and comparing adverse effect strike rates among airports

A common objection to comparing strike rates among airports is that airports inherently vary in the numbers and species of birds and other wildlife present throughout the year and in the number of aircraft movements. As noted above, we base our calculations and comparisons on only those strikes that cause an adverse effect. Thus, airports that, for example, have an abundance of small passerine birds (low hazard level) and are diligent in reporting all strikes, will not see their adverse effect strike rate influenced by these circumstances. Adverse effect strike rates are based on the number of aircraft movements, so aircraft movements are factored into the calculations. In addition, because there was no correlation between the adverse effect strike rate and the number of aircraft movements for the 100 airports analyzed, there is no inherent bias in comparing rates at larger and smaller airports.

Even with these adjustments, it is true that some airports (e.g., coastal airports on major migratory bird flyways) inherently have larger numbers of high-hazard wildlife such as waterfowl compared to airports in other locations. But this does not mean that it is inappropriate or unfair to compare adverse effect strike rates among airports and against national benchmark values. We argue that this variation in wildlife environments and inherent risk among airports makes it important to compare adverse effect strikes rates. This allows an objective measure of the risk at each airport and, for those airports with high adverse effect strike rates, a basis for securing resources and modifying WHMPs to lower the rates. This approach (comparing incident rates among airports) is being used to address other airport safety concerns such as runway incursions (Federal Aviation Authority 2008). Why should we not do the same for wildlife risk? If we refuse to measure and compare risk to aviation safety caused by wildlife at airports, how can we wisely manage to mitigate the risk?

Finally, there is concern that establishing benchmarks will be counterproductive because airports that find themselves at or below the benchmarks will be complacent and not attempt to reduce adverse strikes further. Likewise, if there is a perception that exceeding the benchmark might result in punitive action by the aviation authority, airports may be reluctant to report adverse effect strikes (Kievits 2008). As noted above, the benchmarks are intended to provide a baseline whereby airports can gauge their level of risk and set objective goals to lower risk, regardless if they are above or below the benchmark. The benchmarks are not intended to be used a threshold whereby airports are punished if the threshold is exceeded. Rather, they are a means to help airports objectively assess their risk and secure resources to reduce the risk in a “just culture” environment (Reason 1998). As noted above, if we refuse to measure and compare risk to aviation safety caused by wildlife at airports as we already do for other safety issues, how can we wisely mitigate the risk?

4.3 Prioritizing risk by wildlife species

As noted above, all wildlife species are not equally hazardous to aviation. In implementing WHMPs to reduce risk, airport operators and aviation regulatory agencies need guidance on the relative hazard posed by various species so that management actions can be prioritized by the most hazardous species occurring at the airport and in approach and departure airspace. Dolbeer et al. (2000) provided a preliminary ranking of hazard level for 21 wildlife species or species groups in the USA. As more strike data have accumulated worldwide in the past decade, refinements have been made in documenting and ranking the hazard levels of numerous wildlife species (e.g., DeVault et al. 2011, Dolbeer et al. 2012, Australian Transport Safety Bureau 2012). Allan et al (2003) and Dolbeer and Wright (2009) discuss how these hazard levels of individual species or species groups can be used to prioritize management actions.

5.0 Conclusions

During the past 15 years, the Wildlife Strike Database for Civil Aviation in the USA has provided a broad scientific foundation for the various efforts underway nationally to reduce the problem of bird and other wildlife strikes with aircraft (e.g., Dolbeer 2011). With the impending requirement for airports in the USA to manage safety risks through a formal SMS approach, we propose that the database also can play a key role in improving WHMPs for individual airports. First, the calculation of an adverse effect strike rate for strikes at >1,500 feet separate from strikes at ≤1,500 feet will assist airports in defining the nature of their off-airport wildlife risks and integrating mitigation measures for these risks into the traditional WHMP. Second, by calculating separate adverse effect strike rates within the airport environment at ≤1,500 feet and for approach and departure airspace at >1,500 feet, each airport can determine their performance in mitigating risk in each of these environments and set objective goals to reduce risk compared to national benchmarks (median values). Finally, the accumulated statistics on the hazard levels of individual wildlife species can be used to prioritize each airport's management actions based on the species and numbers that are encountered on the airport and in approach/departure airspace.

6.0 Acknowledgments.

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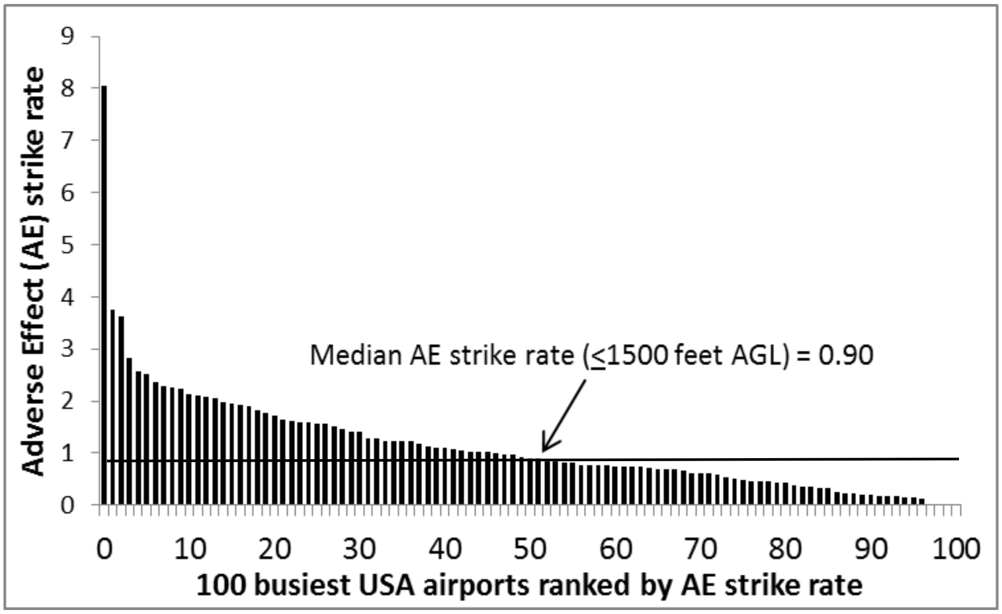
Table 1. The total number of wildlife strikes and strikes with an adverse effect[a] at ≤1,500 feet and >1,500 feet above ground level (AGL) and the adverse effect strike rate in 2007-2011 for the 100 busiest airports certificated for passenger traffic in USA (based on number of aircraft movements).

Height (feet AGL) where strike occurred	Number of strikes:		Adverse effect strikes/100,000 movements[b] (100 busiest airports in USA, 2007-2011)			
	Total	With adverse effect	Mean (standard deviation)	Median	Minimum	Maximum
≤1,500	24,408	1,429	1.150 (1.032)	0.904	0.000	8.056
>1,500	3,431	409	0.304 (0.468)	0.174	0.000	3.957
Total	27,839	1,838	1.453 (1.415)	1.189	0.000	12.013

[a] Strike resulted in damage to aircraft or a negative effect on flight (e.g., aborted take-off, precautionary or emergency landing, engine shutdown, Dolbeer et al. 2012).

[b] The number of movements (a civil aircraft departing or landing) per year ranged from 111,467 to 966,361 (median of 184,660) for the 100 busiest USA airports, 2007-2011.



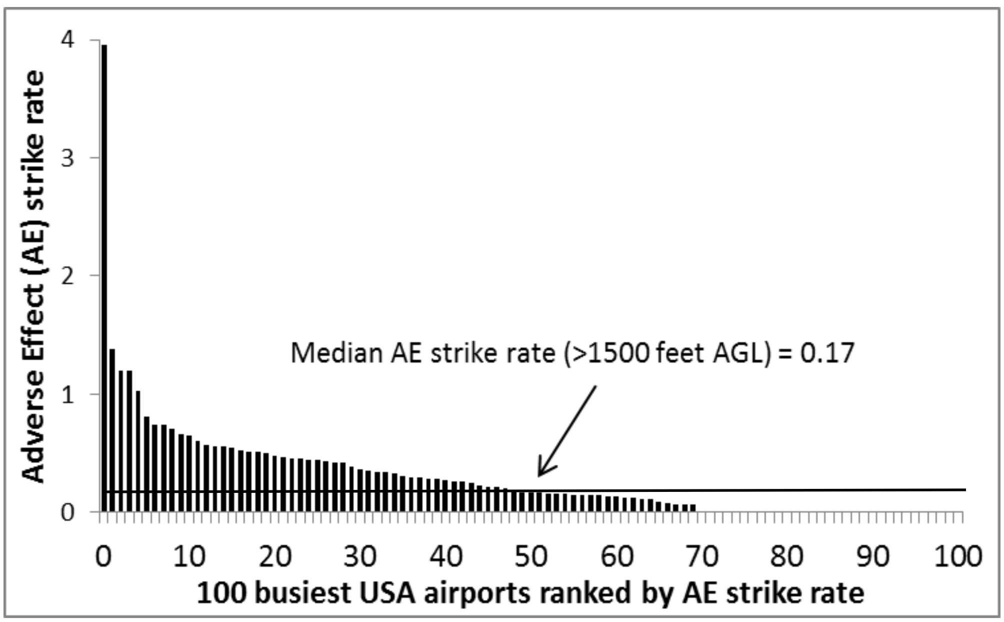


Figure 1. The number of adverse effect (AE) wildlife strikes at ≤1,500 feet (top graph) and >1,500 feet (bottom graph) above ground level (AGL) per 100,000 aircraft movements in 2007-2011 for each of the 100 busiest airports certificated for passenger traffic in USA (based on number of aircraft movements). The median adverse effect strike rate for the 100 airports was 0.90 at ≤1,500 feet AGL and 0.17 at >1,500 feet AGL.

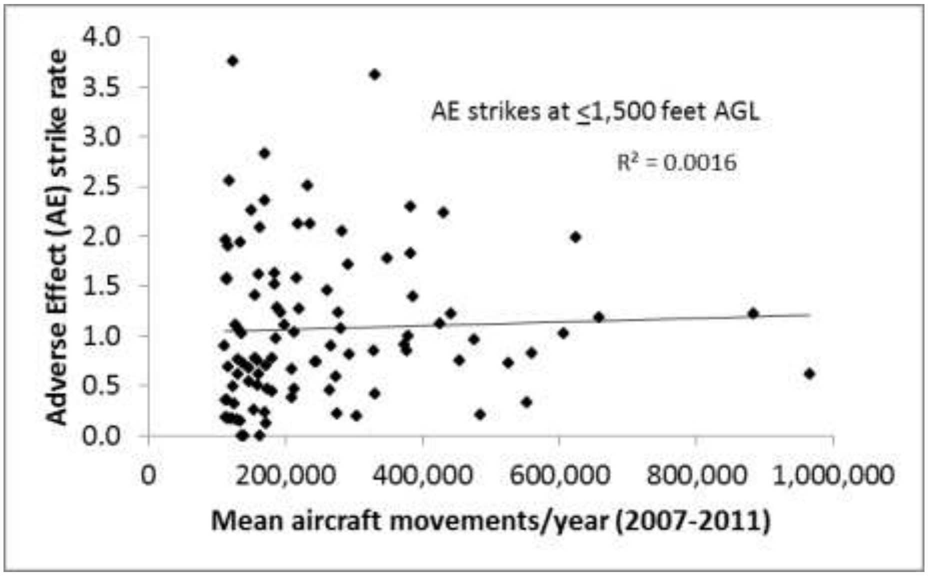


Figure 2. The number of adverse effect (AE) wildlife strikes at ≤1,500 feet above ground level (AGL) per 100,000 aircraft movements in 2007-2011 in relation to the number of aircraft movements for 99 of the 100 busiest airports certificated for passenger traffic in USA, 2007-2011 (one outlier airport with AE strike rate of 8.06 for ≤1,500 feet [see Figure 1] was excluded from this graph). There was no correlation (R^2 = 0.0016) between movements and the AE strike rate, indicting the rate of adverse effect strikes at ≤1,500 feet was independent of the number of movements at an airport. If the outlier airport is included, the correlation (R^2 = 0.0003) is even lower.

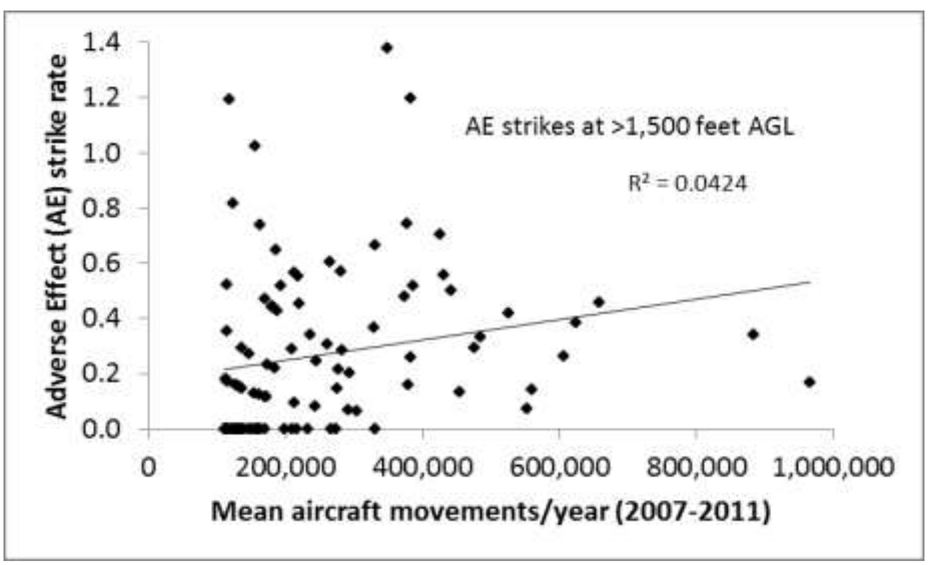


Figure 3. The number of adverse effect (AE) wildlife strikes at >1,500 feet above ground level (AGL) per 100,000 aircraft movements in 2007-2011 in relation to the number of aircraft movements for 99 of the 100 busiest airports certificated for passenger traffic in USA, 2007-2011 (one outlier airport with AE strike rate of 3.96 for >1,500 feet [see Figure 1] was excluded). There was little correlation (R^2 = 0.0424) between movements and the AE strike rate, indicting the rate of adverse effect strikes at >1,500 feet was independent of the number of movements at an airport. If the outlier airport is included, the correlation (R^2 = 0.0055) is even lower.

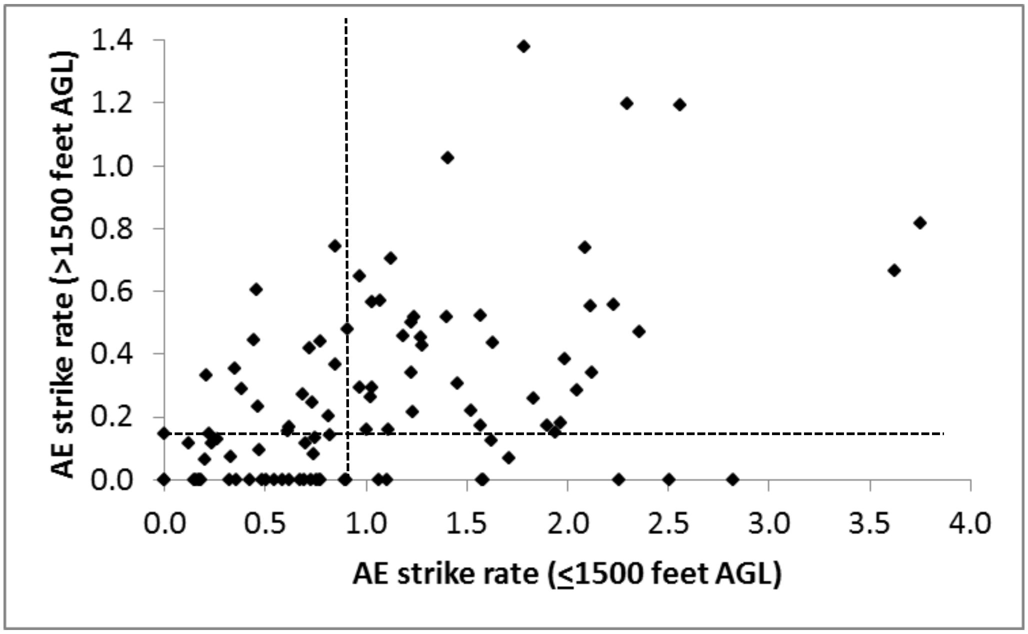
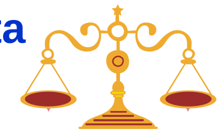


Figure 4. The number of adverse effect (AE) wildlife strikes at ≤1,500 feet (x-axis) in relation to the number of adverse effect strikes at >1,500 feet (y-axis) above ground level (AGL) for 99 of the 100 busiest airports certificated for passenger traffic in USA, 2007-2011 (one outlier airport with AE strike rates of 8.06 and 3.96 for < and >1,500 feet [see Figure 1] was excluded from this graph). The horizontal and vertical dashed lines represent the median AE strike rates at >1,500 and ≤1,500 feet AGL, respectively for these airports (see Figure 1). The correlation (R^2) between AE strike rates at ≤1,500 and >1,500 feet AGL was 0.2218 with the outlier airport excluded and 0.5531 with the outlier included.

Comparison of wildlife strike data among airports to improve aviation safety



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30th International Bird Strike Committee Conference, Stavanger, Norway

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Wildlife Services
Protecting People
Protecting Agriculture
Protecting Wildlife

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

Acknowledgements

U.S. Federal Aviation Administration

U.S. Department of Agriculture, Wildlife Services

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

Question: How do we evaluate programs to mitigate risk of wildlife strikes at USA airports?

Answer: Current system is regulatory-driven under 14 CFR Part 139:

- If airport has Wildlife Hazard Management Plan (WHMP) acceptable to the FAA, the airport is in compliance.
- WHMP is reviewed annually for completion of targeted projects (e.g., drainage improvement).

- However, there are no objective procedures to evaluate effectiveness of the WHMP and to guide improvements.

The current system is the antithesis of Safety Management System (SMS) approach!

Airport managers naturally want to know:

- How does our program compare to other airports?
- How good is our WHMP—are we getting good value (risk mitigation) for money invested?

At present, the U.S. FAA has no objective process in place to provide answers!!

What process does the civil or military aviation authority use in your country??

Is there a solution to this dilemma?

We propose that Wildlife Strike Databases can play a key role to:

- provide <u>objective benchmarks</u> of airport's performance in mitigating risk compared to other airports.
  - Strikes in airport environment (≤1500 feet)
  - Strikes on approach/climb at >1500 feet

If we do not have <u>objective, comparative data</u>, we must base decisions upon subjective opinion!

No one is held accountable!

Knowledge = Power

Power (Improved WHMP)

↑ Application of knowledge

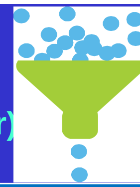
Objective (quantitative) knowledge

↑ Data analysis

Database provides scientific foundation

Filtering the records in database for analysis:

Years = 2007-2011
Airports = 100 busiest airports
(median of 185,000 movements/year)



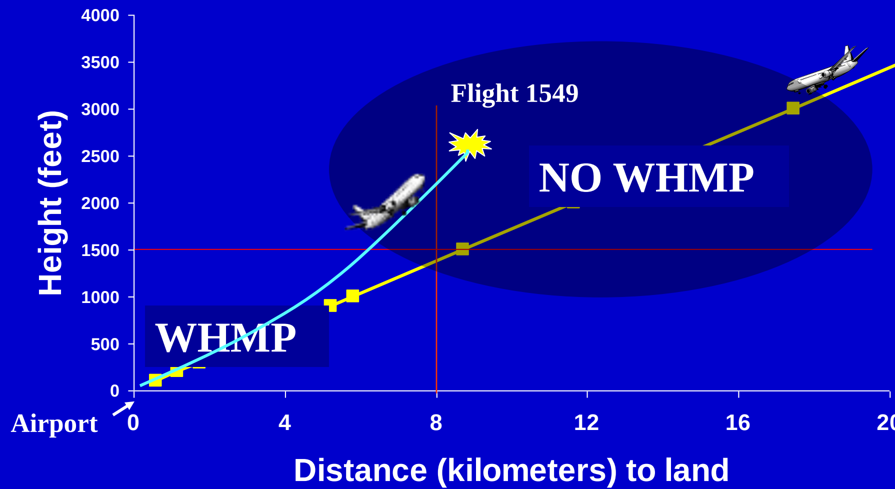
Height (AGL) where strike occurred	Number of strikes:	
	Total	With adverse effect*
<=1,500 feet	24,408	1,429 (5.9%)
>1,500 feet	3,431	409 (11.9%)
Total	27,839	1,838

*Strikes that cause damage or negative effect on flight (aborted take-off, precautionary/emergency landing, engine shutdown)

Why should there be a separate benchmark for strikes on approach/ departure at >1500 feet AGL?

Answer:

- These strikes are usually >8 km from AOA.
- These strikes are important for risk analysis and mitigation… But these strikes typically are not addressed in an airport's WHMP.
- By creating a separate benchmark, it permits an airport to assess the risk for these "off airport" strikes.
- Provides objective basis to incorporate mitigation strategies for these "off airport" strikes into the WHMP.



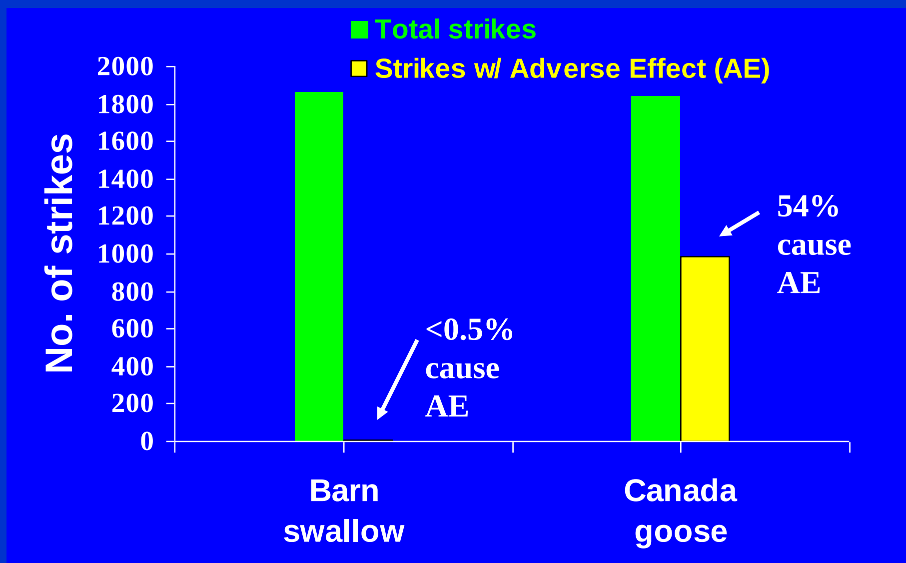
What is an objective benchmark of an airport's performance in mitigating risk?

Should benchmark be the <u>overall strike rate</u> (all reported strikes/100K movements)?

Answer: <u>No!</u> Comparison of the reported <u>strike rate</u> at an airport in relation to rates at other airports is not a valid metric because airports may vary in:

- **hazard level of species struck (e.g., swallow vs. goose).**
- **completeness of reporting all strikes (e.g., carcasses found on runway).**

Example: Hazard level of Barn Swallows versus Geese, Civil Aircraft, USA, 1990-2011



Should benchmark be the Adverse Effect strike rate?[1, 2]

Answer: Yes. Comparison of AE strike rate at airport in relation to rates at other airports is valid metric:

- **AE strike rate incorporates hazard level of species struck (e.g., swallow vs. dove vs. goose).**
- **There is much less bias among airports in reporting AE strikes compared to all strikes.**
- **Bottom line of airport's WHMP is to reduce AE strikes.**

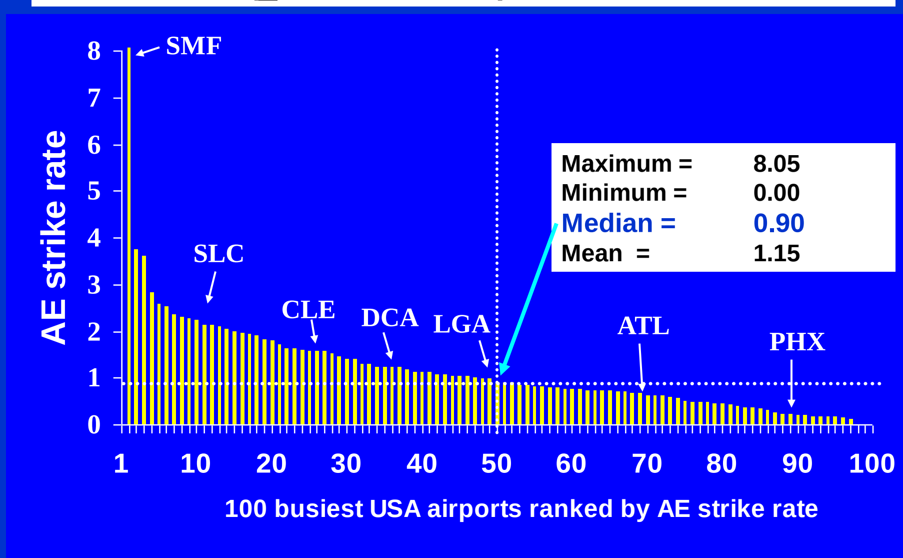
(1) Strikes at ≤1500 ft AGL that cause damage or negative effect on flight/100K movements

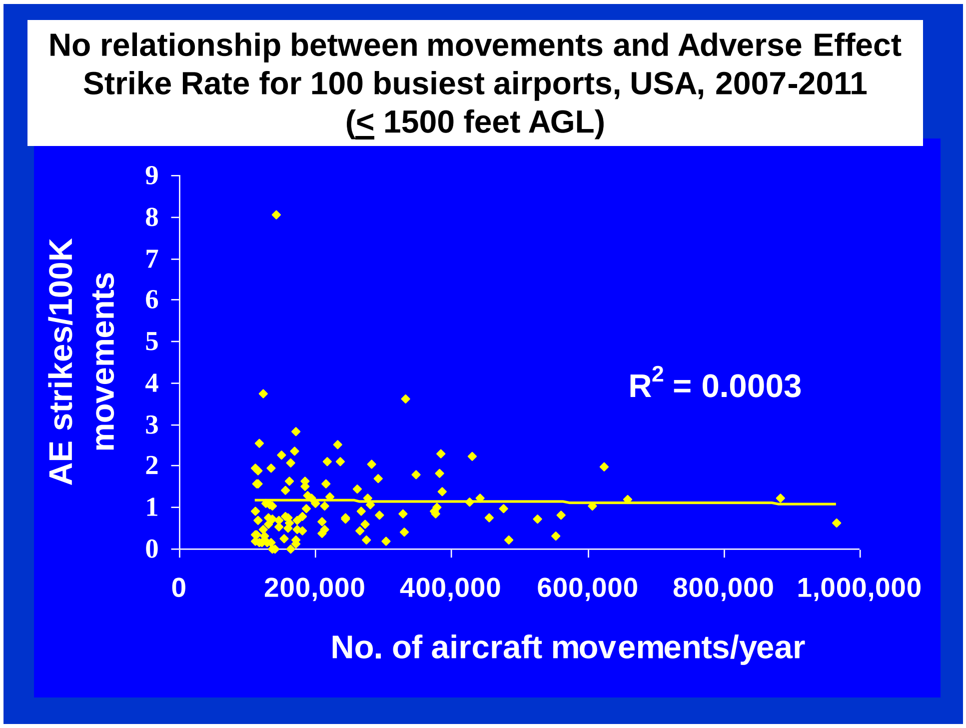
(2) Strikes at >1500 ft AGL on final approach/initial climb that cause damage or negative effect on flight/100K movements

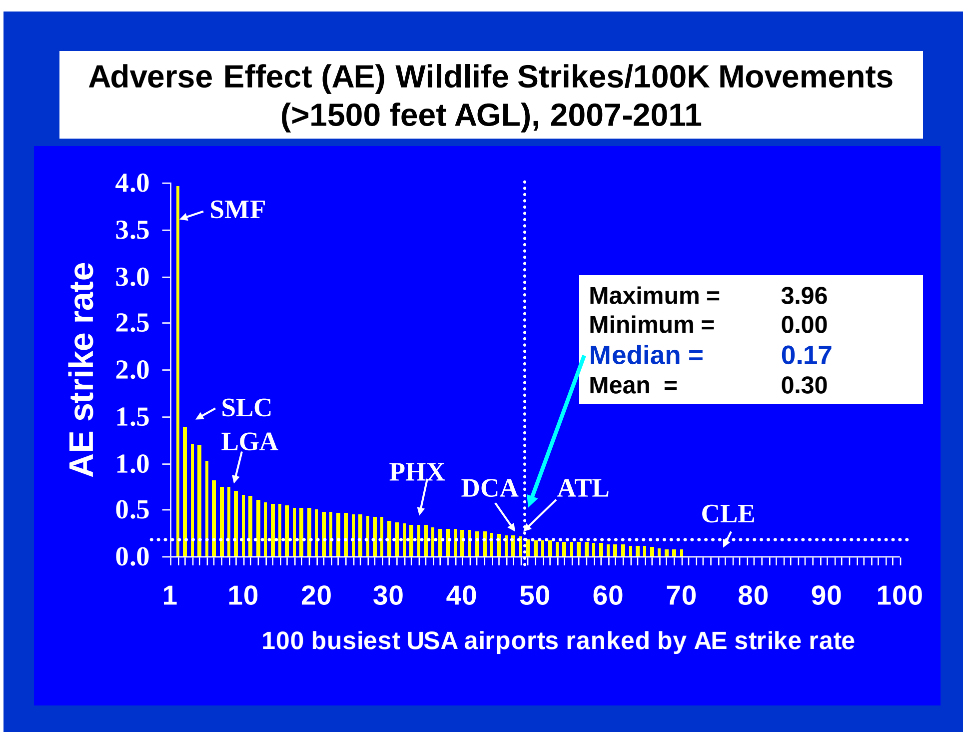
Okay, if we can agree that the AE strike rate is a valid metric, then what are these rates for U.S. Airports?

Snow goose strike
Minneapolis-St. Paul (MSP)
Nov 2010

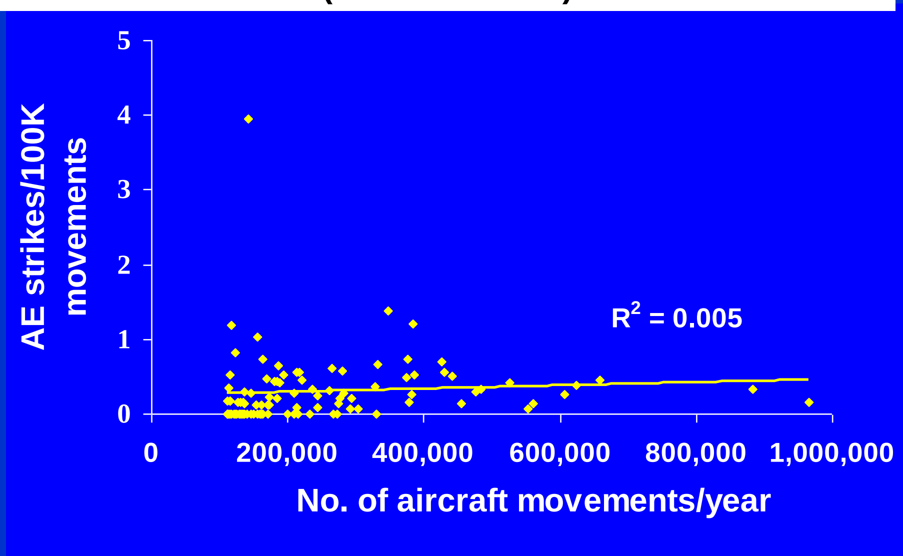
Adverse Effect (AE) Wildlife Strikes/100K Movements (≤ 1500 feet AGL), 2007-2011



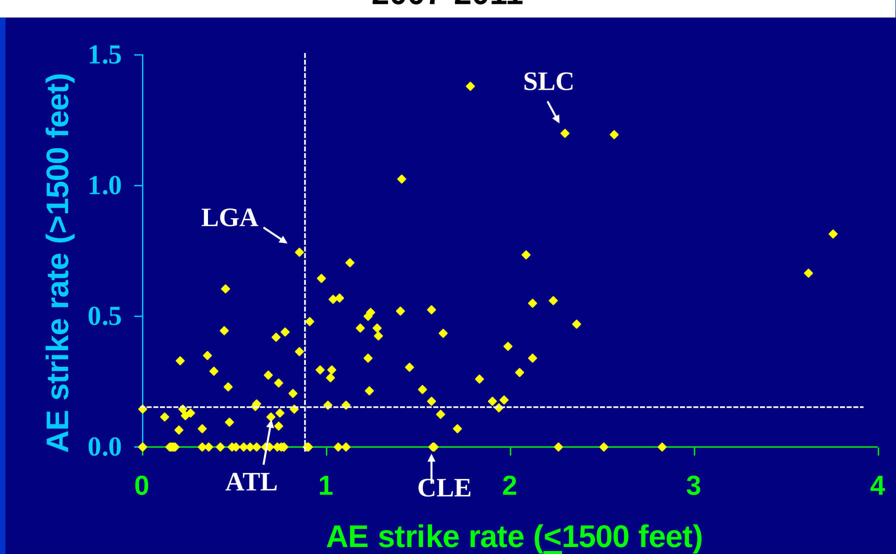

No relationship between movements and Adverse Effect Strike Rate for 100 busiest airports, USA, 2007-2011
(≤ 1500 feet AGL)
AE strikes/100K movements
9
8
7
6
5
4
3
2
1
0
R2 = 0.0003
0
200,000
400,000
600,000
800,000
1,000,000
No. of aircraft movements/year


Adverse Effect (AE) Wildlife Strikes/100K Movements
(>1500 feet AGL), 2007-2011
AE strike rate
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
SMF
SLC
LGA
PHX
DCA
ATL
CLE
Maximum = 3.96
Minimum = 0.00
Median = 0.17
Mean = 0.30
1
10
20
30
40
50
60
70
80
90
100
100 busiest USA airports ranked by AE strike rate

No relationship between movements and Adverse Effect Strike Rate for 100 busiest airports, USA, 2007-2011 (>1500 feet AGL)



Relationship between Adverse Effect Strike Rates at ≤1500 and >1500 feet AGL for 100 busiest airports, USA, 2007-2011



Does this mean that if my airport is below the median AE strike rates (0.90; 0.17), I don't need to improve anything to mitigate risk?

Answer: No. Every airport should strive for an AE strike rate of 0 at both <1500 and >1500 feet.

Your airport may have a lower risk than many other airports because of:

a) Inherent geographic or site-specific location.

b) Superior WHMP and personnel.

Knowing your airport's AE strike rate provides a "benchmark" or goal to measure future progress or setbacks.

If my airport is above the median AE strike rates (0.90; 0.17), should I be criticized/penalized?

Answer: Not necessarily. Your airport may have a higher risk because of:

a) Inherent "birdy" geographic or site-specific location.

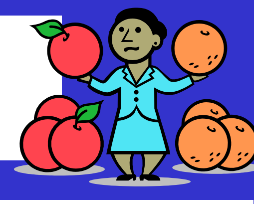
b) An inferior WHMP.

c) Good WHMP but poorly trained or motivated staff.

However, a high AE strike rate is a red flag; the WHMP needs to be evaluated to lower the rate.

The AE strike rates simply show where your airport stands in relation to other airports and provide "benchmarks" or goals to measure future progress.

Is it really fair to compare airports when one airport has more wildlife inherently present than another airport?



Answer: **Yes.** The FAA compares airports for other safety-related issues (e.g., runway incursions) and then:

a) Identifies high-risk airports and pin-points problems.

b) Prioritizes ($) mitigation efforts to reduce risk.

Why should we not do this for wildlife risks?

If we refuse to measure and compare risk, how can we wisely manage to mitigate the risk?

Conclusions: Data Rule!

•The USA National Wildlife Strike Database has always provided overview of problem from a national perspective.

•The database has matured. It now enables objective evaluation and guidance at individual airports.

1. We propose an annual report for each Part 139 airport that calculates the AE strike rates for past 5- and 1-year periods at $\leq$ and >1500 feet AGL in relation to national median values (benchmarks).
2. These AE strike rates should form the basis for integrating mitigation efforts for strikes at >1500 feet AGL into each airport’s WHMP.

USDA/Sandusky, OH