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An Analysis of Deer Strikes with Civil Aircraft, USA, 1982-2000

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Wright et al. (1988) stated that although deer strikes comprise only about 2% of total reported wildlife strikes, 86% of those strikes damaged the aircraft. Dolbeer et al. (2000) ranked deer as the most hazardous species to aircraft based on damage and effect-on-flight. On January 14, 2001, a Learjet collided with two white-tailed deer (*Odocoileus virginianus*) on an airport in Troy, Alabama. Both pilots were critically injured and would have perished in the fire that destroyed the aircraft if rescuers had not arrived quickly.

The above example of a damaging wildlife strike to an aircraft is not uncommon. Wildlife strikes to civil aircraft are a serious economic and safety problem in the United States (Cleary et al. 2000). However, reporting of bird or other wildlife strikes to aircraft (Federal Aviation Administration [FAA] Form 5200-7) remains voluntary. Further, prior to this, the strike data for non-avian species are incomplete prior to 1991. The forms for reporting strikes before 1991 only collected bird strike data. The author gathered deer and mammal strike data prior to 1991, from the National Transportation Safety Board and the Aviation Safety Reporting System databases.

The white-tailed deer populations in the United States have increase dramatically in recent years. In 1900, white-tailed deer had been hunted to near extinction with only about 100,000 remaining, but they now number over 26 million (Jacobson and Kroll 1994). From 1982 to 2000, 901 mammal strikes with civil aircraft were reported to the FAA (Table 1). The number of damaging strikes was 502 (71%) (Table 1). Deer strikes totaled 518 (there were also 3 moose, 7 elk and 6 pronghorn strikes). The number of damaging strikes caused by deer was 425 (86%) (Table 1).

During this same period, 47 states reported deer strikes (Table 2), with 404 (78%) of the reports coming from states east of the Mississippi River. More strikes occur in November (20%) than in any other month (Figure 1). The strike rate (number/hr) was 3, 7, and 11 times greater at dusk than during night, dawn, or day respectively (Table 3). About 57% of deer strikes occurred during the landing phase of flight (Figure 2), making landing at dusk in November the most likely time for deer strikes.

In addition, 75% of strikes had a negative effect on the flight (Figure 3). Only 20% of reports indicating damage provided estimates of repair costs. The mean cost for these reports was \$74,209 (range \$100-\$1,400,000). Reported human injuries resulting from deer strikes have been few (20 from 1982-March 2001) but the potential exists for a major disaster. For example, aircraft with a capacity of 101-380 passengers were involved in 12% of the reported strikes (Table 4).

Management Implications

Airports should adopt a zero tolerance for deer within the airport operations area (AOA). Deer removal by professional shooters, in conjunction with permanent exclusion with 3m high fencing is the preferred management action (Cleary & Dolbeer 1999). In addition, cattle guards can be installed at gates that must be opened frequently, to prevent deer entry onto the AOA (Seamans 1998).

In addition, it is suggested that the International Civil Aviation Organization include data on non-bird strikes and that nations begin reporting all wildlife strikes. We can't solve a problem we don't understand, and we can't understand a problem without adequate data.

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Acknowledgements

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TABLES AND FIGURES

Table 1. Number of Reported Mammal Strikes and Number Causing Damage to Civil Aircraft, USA, 1982-2000.

Species	No. strikes	No. strikes with damage	Damage not reported	% strikes with damage
Armadillo	11		11	
Bat	48	4	22	15
Canid	1		1	
Caribou	1	1	0	100
Cat	4	0	2	0
Cattle	13	13	0	100
Chipmunk	1		1	
Coati	1	0	0	0
Collared peccary	1	1	0	100
Coyote	92	11	25	16
Deer (all species)	518	425	26	86
Dog	17	6	1	38
Elk	7	7	0	100
Fox	36	4	17	21
Horse	8	8	0	100
Moose	3	3	0	100
Muskrat	5		5	
Opossum	19	0	14	0
Porcupine	2	0	1	0
Prairie dog	1		1	
Pronghorn	6	5	0	83
Rabbit/hare	33	2	24	22
Raccoon	14	1	8	17
River otter	1	1	0	100
Rodent	1	0	0	0
Sheep	1	1	0	100
Skunk	21	0	20	0
Swine	1	0	0	0
Unknown mammal	12	8	2	80
Woodchuck	22	1	11	9
Total	901	502	192	71

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Table 2. Reported Deer Strikes to Civil Aircraft by U.S. State, 1982-2000.

States East of Mississippi R.	No. strikes	States West of Mississippi R.	No. strikes
AL	4	AK	2
CT	13	AR	6
DC	7	AZ	4
DE	1	CA	13
FL	7	CO	4
GA	10	IA	4
IL	17	ID	3
IN	5	KS	1
KY	2	LA	1
MA	7	MN	9
MD	21	MO	18
ME	6	MT	1
MI	45	ND	1
MS	2	NE	6
NC	17	OK	6
NH	5	OR	3
NJ	34	SD	6
NY	41	TX	15
OH	16	UT	3
PA	41	WA	2
RI	2	WY	5
SC	6		
TN	9		
VA	23		
WI	24		
WV	39		
Total	404		113

Table 3. Time of Day and Number of Strikes per Hour for Reported Deer Strikes to Civil Aircraft, USA, 1982-1990.

Time of Day	Strikes		
	No.	%	No./hr
Dawn	10	2	12
Day	88	20	8
Dusk	64	14	85
Night	288	64	26
Total known	450	100	
Not reported	68		
Total	518		

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Table 4. Deer Strikes to Civil Aircraft Carrying Over 100 Passengers, USA, 1982-2000.

Aircraft type	No. strikes	No. passengers
A-320	1	179
B-707	1	223
B-727	7	134
B-727-200	3	189
B-737	12	132
B-737-300	1	151
B-737-400	4	190
B-737-500	1	134
B-737-700	1	146
B-757-200	3	239
B-767	1	292
DC-8	1	182
DC-9	12	117
DC-9-50	1	141
DC-10	4	383
FK-100	5	122
MD-80	4	172
Total	62	

Figure 1. Number of Reported Deer Strikes to Civil Aircraft by Month, USA, 1982-2000

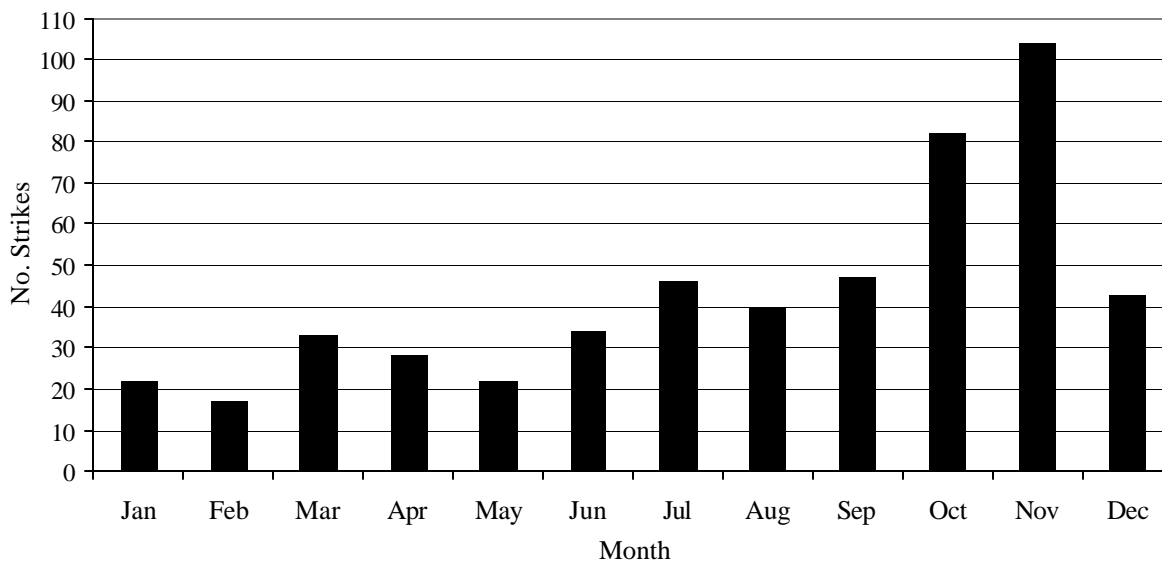


Figure 2. Number of Reported Deer Strikes to Civil Aircraft by Phase of Flight, USA, 1982-2000

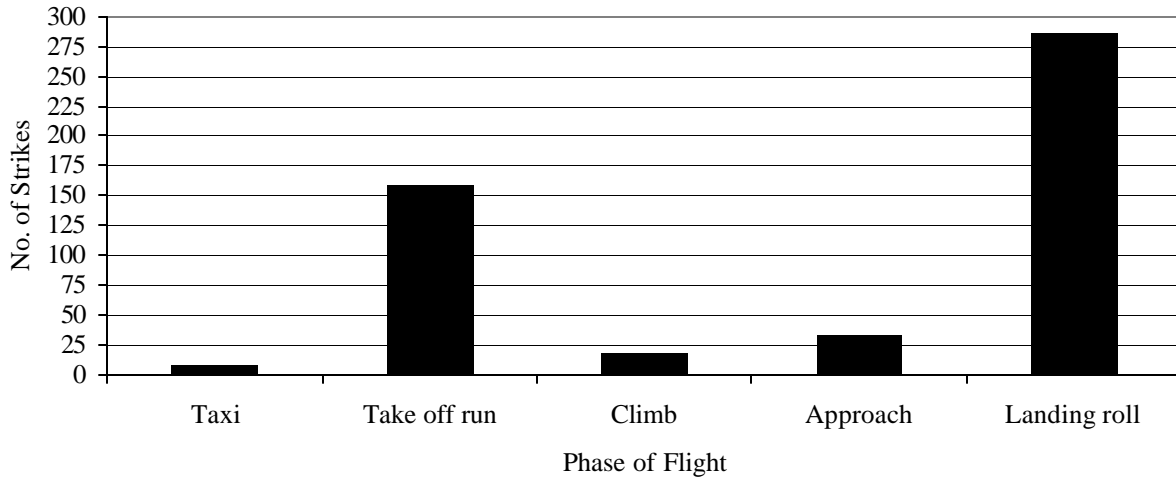
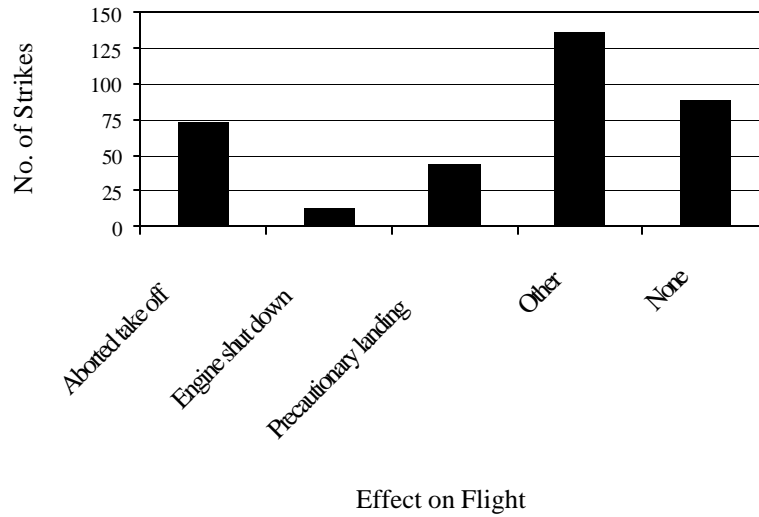


Figure 3. Effect on flight as a result of deer strikes to civil aircraft, USA, 1982-2000



Appendix

Some Significant Strikes to Civil Aircraft, USA, with Deer 1990-January 2001

The U.S. Department of Agriculture, through an interagency agreement with the Federal Aviation Administration, compiles a database of all reported wildlife strikes to U.S. civil aircraft and to foreign carriers experiencing strikes in the USA. We have compiled over 35,000 strike reports from 1,100 airports, 1990-2000 (about 6,000 strikes in 2000), but estimate that this represents only about 20% of the strikes that have occurred. The following examples from the database are presented to show the serious impacts that strikes by deer can have on aircraft. These examples, from throughout the USA, demonstrate the widespread and diverse nature of the problem. The examples are not intended to highlight or criticize individual airports because strikes have occurred on almost every airport in the USA. For more information on wildlife strikes or to report a strike, visit www.birdstrike.org or http://wildlife-mitigation.tc.faa.gov/public_html/index.html.

Date: 11 January 1990

Aircraft: Hawker Siddeley
Airport: John Tune (TN)
Phase of Flight: Takeoff
Effect on Flight: Not reported
Damage: Engine
Wildlife Species: White-tailed deer
Comments from Report: Several deer were struck during takeoff. One was completely ingested in the left engine. The impact tore the engine loose from the aircraft. The aircraft had to be replaced at a cost of \$1.4 million.

Date: 2 February 1992

Aircraft: Piper 28
Airport: Sandstone (MN)
Phase of Flight: Approach
Effect on Flight: Impacted trees and ground
Damage: Aircraft destroyed
Wildlife Species: Deer
Comments from Report: Just prior to touchdown, a deer ran toward and collided with the aircraft. The pilot added power and aborted the landing. Loss of engine power was experienced during the climb and the aircraft crashed into trees then the ground ¼ mile south of airport. Pilot was seriously injured and the aircraft was destroyed. The NTSB found that the deer had damaged the gascolator and fuel starvation resulted.

Date: 04 September 1992

Aircraft: Aero Commander S2R
Airport: Jay Kay Ranch Arpt. (TX)
Phase of Flight: Landing
Effect on Flight: Swerved to avoid
Damage: Substantial
Wildlife Species: Deer
Comments from Report: Pilot lifted off the ground to avoid a deer crossing the runway and settled into some trees. The aircraft was rebuilt.

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Appendix (cont.)

Date: 13 December 1996
Aircraft: BE-1900
Airport: Arnold Palmer Regional (PA)
Phase of Flight: Landing roll
Effect on Flight: Skidded to stop on runway
Damage: Landing gear
Wildlife Species: White-tailed deer
Comments from Report: Struck deer on landing causing left main gear to collapse. Prop blades broke, underside of fuselage, wing tip and aileron flap were damaged. Aircraft was evacuated. No injuries.

Date: 23 July 1997
Aircraft: Beechcraft 58
Airport: Mid-America Industrial (OK)
Phase of Flight: Landing roll
Effect on Flight: Other
Damage: Radome, engines #1 and #2, prop & landing gear
Wildlife Species: Deer
Comments from Report: During the landing roll a small herd of deer ran across the runway, directly in front of the plane. One deer struck the nose wheel, then bounced against the nose links causing it to collapse. Both props struck the ground. Time out of service was 3 months and cost of repairs was \$80,000.

Date: 13 December 1997
Aircraft: B-737
Airport: Wilkes-Barre/Scranton Intl. (PA)
Phase of Flight: Landing roll
Effect on Flight: None
Damage: Engine, nose cowl
Wildlife Species: White-tailed deer
Comments from Report: Captain radioed tower that he believed he hit something. Aircraft was examined at the terminal and found damage to nose cowl and engine cowl and one fan blade. Out of service 48 hours awaiting new parts.

Date: 17 December 1997
Aircraft: Bellanca Super Viking
Airport: Jefferson County (OH)
Phase of Flight: Takeoff
Effect on Flight: Aircraft lost power
Damage: Aircraft destroyed
Wildlife Species: White-tailed deer
Comments from Report: Aircraft hit a deer on takeoff and lost power, crashing into a heavily wooded area. Aircraft was destroyed. Pilot was life-flighted out, passenger had minor injuries.

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Appendix (cont.)

Date: 27 January 1998
Aircraft: Cessna 340
Airport: Wagoner Airstrip (OK)
Phase of Flight: Landing roll
Effect on Flight: Other
Damage: Aircraft destroyed
Wildlife Species: Deer
Comments from Report: Aircraft struck 2 deer on landing, the gear collapsed and the fuel tank was punctured resulting in a fire which destroyed the aircraft.

Date: 29 January 1998
Aircraft: Cessna 500
Airport: Horseshoe Bay Airpark (TX)
Phase of Flight: Landing roll
Effect on Flight: Unknown
Damage: Fuel tank
Wildlife Species: Deer
Comments from Report: Aircraft struck a deer on landing. The fuel tank was punctured, spilling 200 gallons of fuel.

Date: 06 April 1998
Aircraft: Cessna 172
Airport: Mallards Landing (GA)
Phase of Flight: Takeoff
Effect on Flight: Aborted takeoff
Damage: Aircraft destroyed
Wildlife Species: White-tailed deer
Comments from Report: Deer crossed in front of aircraft during takeoff with nose gear up. Aircraft swerved to avoid a deer, ran off the runway, flipped over and was destroyed. Pilot was injured.

Date: 31 May 1998
Aircraft: Piper Cherokee
Airport: Sikeston Memorial Municipal (MO)
Phase of Flight: Landing roll
Effect on Flight: Lost control of aircraft
Damage: Not reported - substantial
Wildlife Species: Deer
Comments from Report: Pilot tried to avoid striking a deer on landing, lost control and struck a tree. Aircraft had substantial damage and pilot was injured.

Date: 22 July 1998
Aircraft: Beechcraft-58
Airport: Antrim County (MI)
Phase of Flight: Landing roll
Effect on Flight: Not reported
Damage: Engines, props, landing gear and flaps
Wildlife Species: White-tailed deer
Comments from Report: Two deer came out on runway. Each prop hit a deer cutting them in half. One was thrown into the left gear and left flap. The other deer went under the right wing striking the right flap. Time out of service was 1 month, and cost was \$33,000.

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Appendix (cont.)

Date: 17 November 1998
Aircraft: B-737
Airport: Western Nebraska Regional (NE)
Phase of Flight: Takeoff
Effect on Flight: Precautionary landing
Damage: Engine
Wildlife Species: Deer
Comments from Report: Aircraft struck a buck deer on the runway and proceeded with takeoff, then returned to land. There was major damage to the engine. The flight was canceled; passengers and crew were rerouted the next day. Total cost was \$430,000 for repairs, lost revenue, meals and hotel rooms, and other transportation for passengers.

Date: 15 October 1999
Aircraft: C-182
Airport: Air Haven (NY)
Phase of Flight: Landing Roll
Effect on Flight: Other
Damage: Wing, landing gear, propeller, fuselage
Wildlife Species: White-tailed deer
Comments from Report: Pilot veered to avoid deer on runway and went into an embankment. Left wing snapped in half. Propeller and left landing gear were destroyed and the fuselage was damaged. Time out of service was 90 days and cost to repair was \$90,000.

Date: 07 November 1999
Aircraft: American AA-1B
Airport: Lake Viking (MO)
Phase of Flight: Landing flare
Effect on Flight: Other
Damage: Not reported
Wildlife Species: Deer
Comments from Report: Aircraft struck a deer during the landing flare at night. Aircraft veered off the runway and stopped nose down 50 ft off the runway. Damage reported as substantial.

Date: 15 November 1999
Aircraft: BE-65
Airport: Alpine-Casparis Muni (TX)
Phase of Flight: Takeoff
Effect on Flight: Emergency landing
Damage: Wing, landing gear
Wildlife Species: Deer
Comments from Report: Pilot attempted to rotate the aircraft in order to avoid the deer, but the landing gear hit the deer. Ground personnel could not tell if there was any damage during a flyby. The tower could not see the right main landing gear. The pilot elected to land gear up however, the right main landing gear had not retracted. There was substantial damage to the right wing spar, landing gear and wheel assembly.

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Appendix (cont.)

Date: 17 November 1999
Aircraft: Learjet 60
Airport: Truckee-Tahoe (CA)
Phase of Flight: Takeoff
Effect on Flight: Other
Damage: Not reported
Wildlife Species: Deer
Comments from Report: Aircraft struck a deer on takeoff. Fire ensued and was extinguished. There was substantial damage.

Date: 03 December 1999
Aircraft: BE-58
Airport: Festus Memorial (MO)
Phase of Flight: Takeoff (rotation)
Effect on Flight: None
Damage: Landing gear, wing, engine and propeller
Wildlife Species: Deer
Comments from Report: During rotation, a deer collided with the landing gear. Indicators showed no problem. Upon landing, the left main gear collapsed damaging the left wing, engine and prop.

Date: 24 February 2000
Aircraft: BA 125
Airport: Floyd Jones Memorial (MO)
Phase of Flight: Landing
Effect on Flight: None
Damage: Engine, wing, airbrakes
Wildlife Species: Deer
Comments from Report: Deer strike damaged the left wing flap which struck and damaged the engine cowling. Time out of service was 30 days. Cost to repair was \$200,000.

Date: 25 April 2000
Aircraft: Saab 340
Airport: Houghton Memorial (MI)
Phase of Flight: Takeoff
Effect on Flight: Aborted takeoff
Damage: Engine and prop
Wildlife Species: White-tailed deer
Comments from Report: Aircraft collided with two deer during takeoff just before V1. The left engine was substantially damaged. None of the 31 passengers was injured.

Date: 14 January 2001
Aircraft: Learjet 60
Airport: Troy Municipal (AL)
Phase of Flight: Landing
Effect on Flight: Aircraft was destroyed
Damage: Aircraft destroyed
Wildlife Species: White-tailed deer
Comments from Report: The Learjet collided with two deer and ran off the end of the runway into a ditch because the thrust reversers would not operate. The aircraft burst into flames. Rescuers kept the fire from reaching the pilots for about 40 minutes until they could be removed. The pilot and first officer had serious injuries and were flown to a hospital. Cost to replace aircraft \$9.5 million. Other costs \$25,000.