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Bird-strike Solutions Spurred By Imagination, Innovation

Although only three fatal air transport accidents have been linked to bird strikes, many less-serious accidents continue to be caused by aircraft-bird encounters, and the possibility of bird strike–caused disaster can never be ruled out. Techniques to counter the threat include strike-resistant engines, lights, noise, airport ecology management and, at one airport, pigs.

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Maurice Martin

Researchers and airport operators are developing new and innovative methods to reduce bird strikes in the airport environment. While some solutions involve the testing and implementation of sophisticated, high-tech gear, decidedly low-tech and natural methods are also showing promise.

Bird strikes are potentially dangerous and occur everywhere in the world. An International Civil Aviation Organization (ICAO) reporting system data base reveals that between 1986 and 1990, 877 strikes were reported in Africa; 4,131 in Asia and the Pacific; 204 in the Caribbean and South America; 217 in the Middle East; 9,980 in Europe; and 6,922 in the North Atlantic and North America.[1]

During 1991 and 1992 (January to mid-November) 842 and 327 bird strikes, respectively, were reported to the Airports Group of Transport Canada.[2] ICAO received an average 5,480 bird strike reports annually from member nations from 1984 through 1989, although only about 60 percent of members reported. About 11 percent of the bird strikes had an effect on flight. Of those, 45 percent caused a precautionary landing, 35 percent required aborting a takeoff, and 11 percent caused engine shutdown.[3]

Bird strikes affect aircraft of all levels of technological sophistication. The first plane brought down by a bird strike was a Wright Brothers–designed biplane flown by aviation pioneer Calbraith Perry Rodgers. A gull became jammed into the aircraft's controls, causing the accident. Rodgers, best known for completing the first transcontinental flight in 1911, died in the crash near Long Beach, California, U.S.

From Rodgers' biplane to the high-tech B-1B bomber represents 70 years of aviation advances. Nevertheless, during a flight near La Junta, Colorado, U.S., on Sept. 28, 1987, a bird strike on a B-1B had the same fatal effect. Three of the six-man crew died after the aircraft hit a 15-pound bird, possibly an American white pelican or Sandhill crane. The bird strike ruptured the plane's hydraulic control system, starting a fire and causing loss of control.

"We had 2,059 reported strikes in 1991 [in the United States], but that's just the tip of the iceberg," said Eugene LeBoeuf, a bird-strike scientist for the U.S. Air Force's Bird Aircraft Strike Hazard (BASH) Team, who has researched animal hazards to air travel. His records also show 1,736 strikes in 1990 and 1,598 in 1989, numbers that seem to indicate an increase. "But that could be because for the last few years pilots have been encouraged to report bird strikes more," LeBoeuf said. "It could also be because more flights are taken. Or maybe there really are more bird strikes — it's hard to say."

LeBoeuf was a wildlife biologist for the U.S. Federal Aviation Administration (FAA) before joining the BASH team.

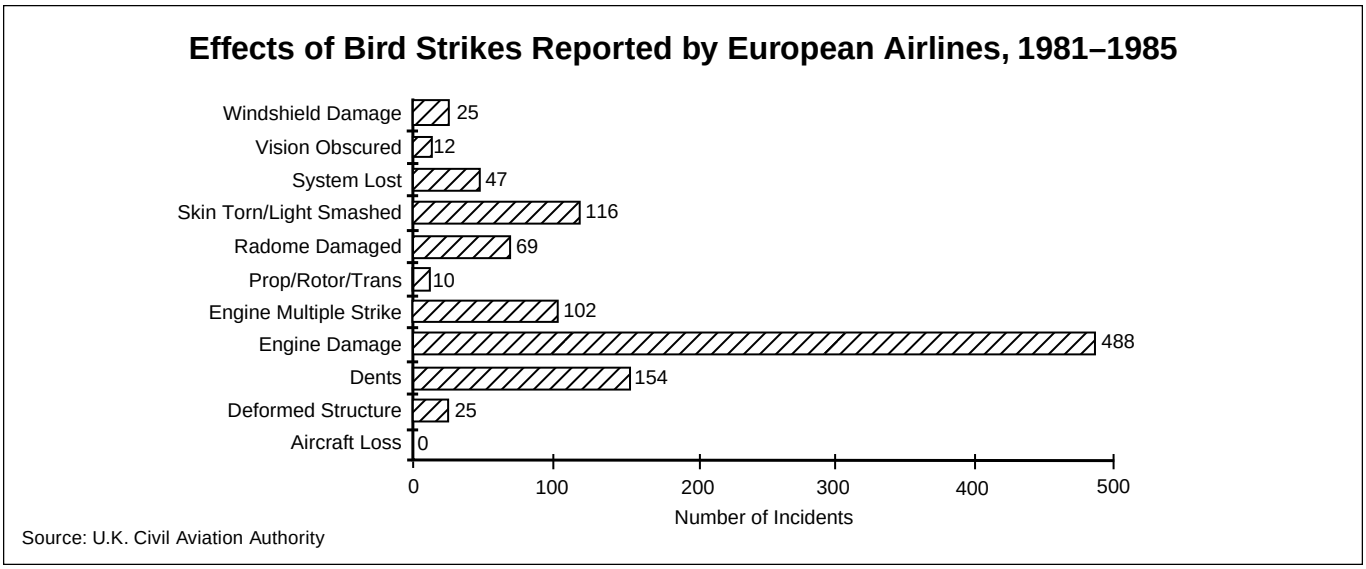


Figure 1

A large bird can penetrate a windshield or damage other aircraft surfaces that are critical to safe flight. Moreover, ingestion of birds into engines can lead to engine failures. A modern jet engine is designed to withstand some damage from bird ingestion, but flocking birds are especially threating because ingestion of multiple birds can result in an engine failure. Depending on the weight of the bird and where it hits the aircraft — large airliner or small general aviation aircraft — damage can range from negligible to catastrophic (Figure 1). Since 1960, worldwide there have been 18 bird-strike accidents that resulted in a crash or fatality involving aircraft weighing 12,500 pounds (5,700 kilograms) or more.[4] Worldwide, ICAO reports 169 lives known to be lost to bird strikes between 1912 and 1992.[1] The FAA attributes 104 civil aviation fatalities in the United States between 1912 and 1986 to bird strikes.

In 1988, in Bahar Dar, Ethiopia, a Boeing 737 flew into a flock of about 1,000 speckled pigeons, and 10 to 15 birds were ingested into each of the two JT8D engines. The engines failed before the crew could complete an emergency landing, and the ensuing crash killed 35 people.

In October 1960, a Lockheed Electra ingested a flock of starlings into three engines and crashed into the harbor at Boston, Massachusetts, U.S. Sixty-two of its passengers and crew died.[5] Also during the 1960s, a British Vickers Viscount transport collided with an eight-pound swan, which destroyed the aircraft's vertical tail. The subsequent crash led to improved structural designs that would withstand birdstrikes.

"One thing you don't want is for a whole bird to go through the prop and hit the windshield. That could incapacitate the pilot," said Hank Russ, a seaplane pilot whose four-place single-engine Cessna 185 collided with a duck while taking off from Lake Hood Seaplane Base near Anchorage, Alaska, U.S. Lake Hood attracts nesting ducks, geese and gulls every summer, creating a hazard for planes during takeoff and landing.

Russ considers himself fortunate to have survived an encounter that has proved fatal for others. In April 1981, for example, a loon penetrated the windshield of a Gates Learjet 23 at 4,000 feet (1,219 meters), killing the copilot and injuring the pilot.[1]

For pilots, the most important evasive action that they can take is on the ground. They should delay takeoffs until flocking birds are cleared from the runway. In the United States, pilots and operators are encouraged to report all bird strikes to the FAA, because problems — and solutions — cannot be addressed without accurate data. Bird strike data may not be accurate because of underreporting in the United States and other countries.

A Boeing researcher reported that "of all turbine-powered commercial aircraft fatal hull-loss accidents, three (0.9 percent) have been caused by bird strikes. The percentage appears small, but it is a significantly larger percentage of engine-related accidents … ."[6] A study of bird strikes reported by European airlines found that engine strikes comprised 16.8 percent of all strikes, and 1.3 percent of the total affected more than one engine (Figure 2, page 3). Data for 1981 to 1985 included 59 cases where birds struck all of an airplane's engines.[4]

Often dangerous for humans and always deadly for birds, strikes can be costly even when no human casualties result. Bird strikes in Canada between 1985 and 1987 resulted in damages totaling Canadian $6.6 million. But reported losses are often underestimates, because the reported losses do not include lost flying hours, fuel or disruption of passenger and freight transportation.[2]

Many airports around the world have the same problem as Anchorage's Lake Hood Seaplane Base — in one way or another, they provide an environment attractive to birds, increasing the likelihood that airplanes taking off and landing there will experience a bird strike. Some biologists and air safety experts believe that the most important factor in reducing

the overall number of bird strikes is the understanding and manipulation of environmental factors in and around airports. In this sense, bird strikes challenge humans to be better managers of land, water and animal populations.

Most aircraft bird strikes occur at or near an airport during takeoff or landing, and this is where bird control must be focused.[5] Although the hard, flat tarmac of a busy runway may seem noisy and unappealing to humans, it can be a very attractive environment for birds.

Tarmacs and runways are often feeding grounds where birds find worms during a rain storm. Worms can suffocate in earth that is saturated with water. When it rains, they crawl up onto pavement and can be found on streets, sidewalks and runways. Because airports tend to be very flat and drain slowly, worms stay out of the ground long enough to attract birds. Moreover, crows have been known to kill rats by dropping them on tarmacs.

Birds also find food in the grass between runways, the ornamental shrubs found at some airports and crops planted in surrounding fields. Some birds, such as gulls, like open areas, and many will quickly adapt to the incessant din of jets at a busy airport. Fences surrounding airports can create, in effect, small wildlife preserves that afford birds some protection from predators.

John F. Kennedy International Airport (JFK), New York, U.S., almost *is* a legal wildlife preserve. It is located adjacent to the Jamaica Bay Wildlife Refuge, whose marshes contain a colony of laughing gulls (*Larus atricilla*). Between 1988 and 1990, this species played a role in 52 percent of the bird strikes at JFK (involving an average of 302 airplanes a year).[7]

Moreover, airport designers sometimes accidentally build in extra bird-strike hazards. This happened at the Lake Hood Seaplane Base. To separate the takeoff canal from the slow-taxi canal, a strip of land 2,000 feet by 125 feet (610 meters by 38 meters) was put in between the two waterways. With no predators, it quickly became a nesting spot of gulls, geese and ducks. "Gull Island," as it was dubbed, had become an inadvertent bird-strike hazard.

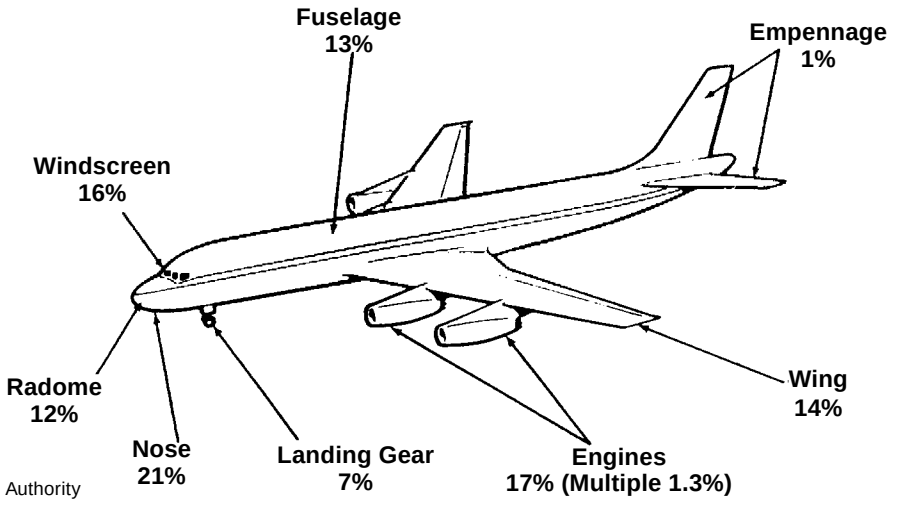
Civil planners can create a bird-strike problem too, such as when a town decides to put a landfill at the end of a runway. This may seem like a good idea because the land around airports is so noisy. "Developers won't touch it," said LeBoeuf, "but the land has good access because of the airport roads. The problem is, if you build a dump, the birds will come." This occurred in 1973, when a Gates Learjet at the DeKalb-Peachtree Airport in Atlanta, Georgia, U.S., struck cowbirds during takeoff and crashed, killing all seven persons on board.

Structures built near airport approach paths can also make an area more attractive to birds. "It's hard to believe a shopping center would, but it can," said Paul O'Neil, formerly a wildlife biologist with the U.S. Department of Agriculture (USDA) and now with the U.S. Fish and Wildlife Service. "Shopping centers may have less-than-careful systems of disposing of waste, like open dumpsters. Also, people feed birds in parking lots and food pavilion areas."

In his studies of bird strikes, O'Neil observed that human development of real estate favors some species over others. "If you have [a stand of wild] scrub oak or loblolly pine, you might have a warbler habitat. We don't have many air strikes with warblers." Nevertheless, once cleared for human use, the area is more likely to attract gulls. Being slow, clumsy fliers, "gulls [appear in] more than 50 percent of all strikes," he said.

LeBoeuf agrees that, "of all the birds, [flocking] gulls probably come into play most." Statistics from the ICAO data base indicate that in strikes between 1984 and 1989, where the

Location on Aircraft of Bird Strikes Reported by European Airlines, 1981–1985



Source: U.K. Civil Aviation Authority

Figure 2

species of bird was determined, flocking gulls and terns (in a combined category) were involved in the largest number of cases, followed by "perching birds," hawks/eagles, lapwings/plovers, pigeons/doves and "other."[3]

"The fact that we have a growing human population means there's a growing need for things like airports and landfills," said O'Neil. "As we get closer together, there are a lot more friction points" between humans and animals.

Designers Seek Ways to Minimize Bird-strike Damage

Aircraft and engine designers have invested millions in research and development to design aircraft to better withstand bird strikes. To determine how airplane components withstand to the impact of a bird's body at high speeds, for example, researchers have mounted airplane components onto rocket sleds, accelerated them to air speed and directed them to run into dead chickens suspended from scaffolds. They have also used impact-simulator guns to hurl dead birds into propellers, windshields and jet engines.

The engines for the Boeing 777, the world's largest twin-jet aircraft that is being introduced into airline service during 1995, are required to be able to ingest four 2.5-pound (1.14-kilogram) birds while in operation and still produce at least 75 percent of their full thrust rating.[6]

The products of this type of research have made large passenger aircraft much safer from the effects of bird strikes, but older aircraft and engines, which did not have the benefit of modern technology in their designs, will remain in service for many years.

But bird-proofing aircraft does not address the harm done to the birds, another reason why environmentalists and governments are increasingly looking for humane as well as practical responses to bird strike hazards at airports.

A study sponsored by Transport Canada evaluated the use of strobe lights on aircraft to increase birds' awareness of aircraft, giving them more time to take evasive action. In Phase I of a planned two-phase experiment, laughing gulls were subjected to strobe lights of varying wavelengths and frequencies to determine their responses. Measurements of the gulls' heart rates indicated that they did respond physiologically to the strobes. But Phase II of the study, which was to have tested whether aircraft-mounted strobe lights could help the birds' avoidance maneuvers, was cancelled because in-flight testing was deemed neither technically nor financially feasible.[2]

Airports Remain Focus of Actions

One way to reduce bird strikes is to make airports unappealing environments for birds. Among technologies that are being tried or considered are application of methyl anthranilate to pools of water on runways, ultrasonics, falconry, sanitary landfill management and airfield habitat management.

An FAA-sponsored wildlife management program is in place at Atlantic City International Airport, New Jersey, U.S. Its elements include:

- Wildlife harassment training;
- An airport bird study;
- Detailed biological studies;
- Bird-strike data compilation;
- Bird harassment program;
- Minimization of water attractions for birds;
- Long-grass management;
- Insect control;
- Opposition to solid-waste facilities near the airport; and,
- Long-term research on habitat management.[8]

There are also modern equivalents of the traditional farmer's standby, the scarecrow. In the 1960s and 1970s, engineers experimented with laser beams, hoping that an airplane-mounted laser could burn or scatter birds in the path of the plane.[9] This did not prove effective and would have posed a hazard to humans wandering into the laser beam's path.

Wayne Gibson, who is only one of the many unsung heroes of local bird control, is familiar with bird-scaring techniques as chief of runway maintenance at the Anchorage International Airport. He works to reduce bird-strike hazards not only for the Lake Hood Seaplane Base but for the 225,000 airplanes that fly in and out of the airport's land-based runways each year.

Gibson explained two different bird-scaring systems tried on Gull Island to clear the seaplane base of birds: shellcrackers, a kind of shotgun shell with an explosive charge in the projectile, which were fired above the birds to scare without injury; and screamers, a kind of noisemaker shot from a specially designed pistol. "These methods work for three or four days, then the birds get used to them," said Gibson. Sometimes, simply a human presence will get birds to leave, but he said that on Gull Island, "it just made the gulls mad." Also, the birds ignored a scarecrow fashioned from a hard hat and an orange airport jumpsuit.

On the 15,000-acre land-based portion of the Anchorage International Airport, Gibson has another bird-scaring device nestled in the grass next to a runway: a propane cannon. This squat device has a bladder that fills with propane, which is set off at intervals in mini-explosions, producing a bird-scaring boom. Propane cannons are somewhat effective, he said,

although they must be moved regularly so that the birds do not get used to them.

Like Gibson, LeBoeuf has found that birds will acclimate to most forms of harassment. If the environment around an airport remains attractive, birds will return. Even if one batch of birds is killed, others will just take their places. "We always try to get airport staff to look at the airport grounds first," said LeBoeuf. "What's attracting the birds? Is it a puddle of water? Is it grass length? Poor housekeeping? Garbage dumps left untidy? We try to reduce those attractions first, and go for the harassment second."

Once LeBoeuf knows what is attracting the birds, the solution may seem obvious. If it is water, better drainage might help. If tall grass lures the birds in, mow more often. LeBoeuf sometimes suggests playing recordings of bird distress calls to get the birds to leave.

But it is not always so straightforward. Environmental factors that drive out birds in one area can have the opposite effect in another. Air safety experts in England have found that keeping airport grass long keeps birds away. That is because "lapwings are the biggest problem there," said LeBoeuf. "There's much less biodiversity in England than here in the United States. If you had, say, a pheasant problem in Nebraska, you wouldn't work with long grass." Solutions must consider the many different geographical and ecological regions and their corresponding animal populations.

"It could go so far as shooting birds, depending on the situation," said LeBoeuf, although that option is always a last resort. But in extreme situations, shooting may have to be undertaken. At JFK, despite an active bird management program including habitat alteration, insect and garbage control and a full-time patrol that attempted to frighten birds off, problems persisted. Although the actions taken did discourage gulls from lingering at the airport, they were ineffectual in stopping them from flying *over* JFK while migrating or heading from their sanctuary on nearby U.S. National Park Service land to their feeding grounds.

In the summers of 1991 through 1993, U.S. Department of Agriculture wildlife biologists, working under special federal and state permits, used shotguns to kill some 35,000 gulls at the airport. The program was pronounced a success, with gull strikes reduced by about 70 percent in 1991 and 89 percent in 1992 and 1993 over 1988–1990 levels. (Populations of laughing gulls at the adjacent colony in Jamaica Bay were not endangered.)[7]

Whatever their nature, programs are not always carried out in time to prevent an accident. The DeKalb accident is a tragic illustration. The dump at the end of the runway that attracted the cowbirds had already been cited by the FAA as a hazard and was scheduled to be closed in six months. The U.S. National Transportation Safety Board (NTSB) investigated the crash and in its report chided the FAA for failing to do more to close the dump. Nevertheless, the FAA cannot direct what a community does. It can only advise what is good for air safety.

That suggests one of the institutional obstacles to preventing bird strikes. If prevention means changing land usage, who has the authority to demand changes? In the United States, because it is an air safety issue, the FAA is involved. But it is also an animal issue, and so the U.S. Department of Agriculture, operating through the Fish and Wildlife Service, is also involved. And clearing out birds may mean altering the local environment, so the Environmental Protection Agency will introduce its own concerns. Add civic and state governments, land owners, airlines and branches of the military that build and maintain airports, and this issue can quickly become mired in bureaucracy.

With so many viewpoints represented, it is difficult to please everyone. But recognition of the problem at Anchorage International Airport has prompted the formation of a Wildlife Advisory Committee consisting of representatives from the airport staff, the Audubon Society and local waterfowl associations. LeBoeuf said that this kind of cooperation among people approaching the problem from many directions can be an important step toward addressing bird strikes.

An international organization called the Bird Strike Committee Europe brings together airport personnel, biologists, engineers, meteorologists, ornithologists, pilots and safety staff from many nations. Among their projects are exchanging information on airport safety and identifying bird remains to find out which birds are most likely to become involved in strikes. A Bird Strike Committee USA (BSCUSA) and a Bird Strike Committee Canada also have been formed to target their respective geographic regions.

Canadian efforts since 1980 have resulted in a dramatic reduction of bird strikes, which have been credited to airport managers and bird patrols. There has been significant improvement since 1986 in India, where field scientists have reduced the presence of large birds, including vultures, near airports.[5] The successful efforts in Canada and India demostrate that bird hazards can be reduced when the efforts are made to reduce them.

Other efforts to address bird-strike hazards include the U.S. Air Force's BASH Team. BASH analyzes data from the Air Force's strikes, which numbered 2,227 in 1992 and resulted in damage that exceeded US$23 million. BASH shares its findings with other organizations at meetings of Bird Strike Committee USA.

The FAA has created a computer data base on bird strikes in the United States and is also, in cooperation with the U.S. Department of Agriculture, conducting research in habitat management in and around airports, birds' use of waste disposal facilities near airports, and the development and evaluation of wildlife repellent techniques.[8]

One of the most creative approaches has helped reduce bird strikes at the Lake Hood Seaplane Base. Faced with the

problem of how to get rid of the birds on Gull Island, Wayne Gibson and his coworkers have turned to a low-tech solution: three hogs named Moe, Larry and Curly.

In 1993 and 1994, the airport staff turned the hogs loose on Gull Island throughout the birds' breeding season, May to August. The hogs roamed free on the island, shuffling around in the grass and eating the eggs laid by the birds. Because it is artificial, Gull Island had no predators before the hogs arrived.

Gibson has had to install a feeder to supplement the pigs' egg diet and a mud wallow to make them comfortable on warm days. He says that he will have to bring the pigs back every summer for at least five years to convince the birds to stay away. But the pig system is nonpolluting, nonlethal and humane. And it seems to be effective. Though statistics have not been compiled yet, the number of bird strikes seems to be down.

Hank Russ, whose flying service used to have two or three bird strikes per year, said that the program has been a success so far. "We didn't have any strikes last year. Those pigs are the first thing that's ever worked."♦

References

1. Thorpe, J. "Bird Strike Data from World Regions." Paper presented at the International Civil Aviation Organization (ICAO) Workshop on Bird Hazards, Santiago, Chile, March 29–April 2, 1993.

2. Transport Canada/Department of National Defense. *Minutes of the 21st Meeting of Bird Strike Committee Canada, November 29–30, 1994, Ottawa, Canada,* Appendix 3.

3. Huang, S.C. "Trends of Worldwide Bird Strikes, Calendar Years 1984–1989." *Flight Safety Digest* Volume 10 (November 1991): 11–13.

4. U.K. Civil Aviation Authority. "Analysis of Bird Strikes Reported by European Airlines 1981–1985." CAA Paper 92004. January 1992.

5. Alge, T.L. "Engine Ingestion Hazards: Birds, Ice Slabs and FOD." In *Proceedings of the Flight Safety Foundation 45th International Air Safety Seminar and International Federation of Airworthiness 22nd International Conference.* Arlington, Virginia, U.S.: Flight Safety Foundation, 1992.

6. Lewis, C.M. Jr. "Engine Bird Ingestion." *Airliner* (Boeing Customer Services Division) (January–March 1995): 17–19.

7. Dolberer, R.A. "Bird Strikes." *Airliner* (Boeing Customer Services Division) (January–March 1995): 20–23.

8. Schmidt, R. "Bird Strike Committee USA Is Born." *The Probe,* published by the National Animal Damage Control Association. Issue 125 (September 1992): 1–5.

9. Blokpoel, H. *Bird Hazards to Aircraft: Problems and Prevention of Bird/Aircraft Collisions.* Clarke, Irwin & Co.; Ministry of Supplies and Services Canada, 1976.

About the Author

Maurice Martin is a freelance writer based in Arlington, Virginia, U.S. His articles on wildlife and environmental issues have appeared in ZooGoer *magazine,* Destinations *magazine, and* Glass *magazine. His father, a pilot, inspired his interest in aviation.*

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