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BY PAUL ESCHENFELDER AND RUSS DEFUSCO

Bird Strike Mitigation *beyond the airport*

Pilots must be prepared for bird strike avoidance and damage control.

Damage to left-engine fan blades of a Boeing 767-432-ER following the ingestion of gulls after takeoff at Rome Fiumicino Airport, July 2007.

Agenzia Nazionale per la Sicurezza del Volo (ANSV)

Between November 2007 and January 2009, U.S. civil aviation experienced four major accidents caused by bird strikes. The accidents demonstrated the range of aircraft categories and types affected by this threat, and served as a reminder that the entire aviation community is challenged. A Piper Seneca, a transport helicopter, a Cessna Citation business jet and an Airbus A320 were all destroyed, and 17 people died.[1–4]

Three months prior to the US Airways A320 bird strike accident, a similar accident occurred at Rome Ciampino Airport. A Ryanair Boeing 737-800 encountered a large flock of starlings during its approach. The flight crew attempted a go-around, but birds were ingested into both engines, and both lost thrust. The crew landed the aircraft on the runway, but the left main landing gear collapsed. Although no one was killed, there were 10 injuries and the airplane was damaged beyond repair.

Before the Ryanair accident, an A320 operated by Balkan Holidays encountered a flock of gulls while departing the seaside resort of Bourgas, Bulgaria. Both engines were damaged by bird ingestion and lost thrust. The crew had pre-briefed an immediate return plan and successfully executed their plan. The airplane was landed safely, but a total of 32 fan blades on both engines had to be changed.

Turboprops are likewise at risk, but for different reasons. Propellers with composite material tend to shatter when struck. A de Havilland DHC-8, on landing at Toronto City Airport, struck geese just at touchdown. Both propellers lost large chunks of the blades and vibrated so severely that the crew had to shut down the engines on the runway. The airport management had been tolerating the geese on the field until this incident.

While general aviation airplanes typically do not have the same engine ingestion concern as transport category jets, their overall design and certification make them much less able to resist damage from bird strikes. Mid-size to large birds can penetrate the windshields and can cause pilot incapacitation or disorientation, resulting in loss of control. The drag caused by the loss of the windshield has also resulted in accidents because enough thrust is not always available to overcome the huge drag increase. Likewise, collision-caused deformation of wing or tail surfaces can increase stall speed considerably and affect handling qualities, especially at slower speeds.

Other aspects of the problem have received concentrated attention and reduced hazards on airports. While not always properly implemented, well-developed and documented standards exist for airport habitat management, means for deterring wildlife from entering airfields, active dispersal of birds and other wildlife, and even lethal methods when population control must be employed.

Such efforts must continue and be constantly monitored, but these strategies will not solve the problems of off-airport hazards, communication failures, inadequate pilot training and procedures, or lack of operational guidelines by aircraft owners and regulators that led to the primary causes of the accidents cited.

What is missing is a comprehensive, integrated plan that involves all parties: airports, aircraft operators, air traffic controllers, aircraft and engine manufacturers, regulators and others.

What would an effective bird strike mitigation policy look like? In the US Airways accident, the New York area airports were well known for the large bird populations affecting

them. La Guardia Airport has had a problem with resident Canada geese for some time. John F. Kennedy International Airport is located across the fence line from a U.S. government wildlife refuge with a very large gull colony, protected by federal law.

The U.S. Air Force Bird Avoidance Model (BAM) had shown the risk of high bird concentrations in the New York area during the A320 accident period.[5] The presence of large numbers of birds in the area should have been cause for action by aircraft operators, but was not.

No aviation hazard today is successfully mitigated without effective policy guidance for the flight crews and adherence to that policy.

In the Ryanair 737 accident, the crew response was incorrect in our view. In many low-altitude scenarios, the commonly used response is to increase thrust and climb to avoid the hazard. But the problem with this technique in connection with bird encounters is that it increases the kinetic energy of impact, which equals one-half of the mass times velocity squared. In this case, velocity is determined by engine rotation. By selecting maximum allowed thrust, the crew placed the engine at risk of a high-energy collision, almost guaranteeing damage.

A better technique based on current guidelines for confronting large flocks of birds close to the airport is to fly *through* the flock at low engine rotation speed, allowing the engine to bypass the bird remains around the engine core without cascading damage to the compressor blades.[6,7]

But the crew had no training on the current technique. Nor is training required by any regulator. Nor is any training available.

In another serious event in 2007 in Rome, a Delta Air Lines 767-400 was taxiing for departure. The crew observed a large number of gulls on the runway and in their departure path. The crew discussed the situation but did not report the gulls, ask for bird dispersal prior to takeoff or delay takeoff waiting for the birds to move. Instead, they took off into the birds and ingested gulls into both engines, the impact causing serious vibrations and significant loss of thrust in both engines. The aircraft was returned safely, but both engines were damaged beyond repair.

Fast forward to February 2010 and another Delta flight conducting a departure from Tampa, Florida, U.S. Warned that large birds were in their departure path by the airport traffic controller and by the crew of the Airbus that preceded them, the Delta crew took off, and bird strikes damaged their aircraft. Delta Air Lines reportedly had no policy for its crews to mitigate this hazard.

Hazard avoidance is superior to application of emergency procedures. Avoidance can take a number of forms, many of them simple and cost-free. If birds are in the takeoff path, the pilot should notify the airport operator and delay departure until the birds move or are scared away. Another alternative is to depart via another runway that is free of hazard. Likewise, for landing, flight crews should use a different runway if birds are reported on the landing runway. Or go around and wait for the birds to leave.

Bird Dispersal Goes Digital

Airport bird dispersal is becoming, if not an exact science, at least an organized and highly sophisticated one.

One example of a high-tech tool is the Ultima, a tablet touch-screen personal computer offered by Scarecrow Bio-Acoustic Systems of Uckfield, East Sussex, England. Combined with an airfield vehicle–mounted processor and loudspeakers, the system emits recorded distress calls of as many as 20 species to drive birds away, while logging all actions and GPS locations in real time. The system creates a database featuring date, time, location, system operator, species, flock size and dispersal direction, all of which can be used for data analysis and to store records for program documentation and auditing.

The Ultima includes a report-generation function that allows sorting by combined factors such as dates, species, location and operator name. Printouts are available in spreadsheet or graphical formats.

Ultima has been installed at airports in Pittsburgh; London Luton; Belfast, Northern Ireland; Cancun, Mexico; and Christchurch, New Zealand. The company reports that it has sold more than 70 units since the product's introduction in 2008.

— Rick Darby

Another important area where study and action are needed is the lack of adequate aircraft design specifications. This problem is complex, because many interrelated systems are involved: aircraft design and operation, engine design and operation, airport mitigation, bird population control, airport habitat, training, warning systems, policy, etc. It is complicated, because there is no one answer but, as with all aviation hazards, an interdisciplinary approach is required.

The majority of bird strikes occur below 3,000 ft. If departing from an airport in a high-bird-threat environment, jets should use International Civil Aviation Organization Noise Abatement Procedure 1.[8] This rapid climb to above 3,000 ft above ground level would, in all likelihood, have prevented the US Airways accident. General aviation aircraft should depart at best angle-of-climb speed. Those techniques enable the aircraft to clear the hazard zone below 3,000 ft faster and climb at a lower speed, which can lessen the severity of impact. When landing in an area of high bird activity, the aircraft should remain at 3,000 ft or above if possible until necessary to descend for landing.

If birds are encountered en route, on climb or descent, the flight crew should pull up — consistent with good piloting technique — to pass *over* the birds. If birds see the aircraft, they will treat it as an obstacle, but may misjudge the closing speed because the threat is usually beyond their experience. Birds may turn or dive as avoidance maneuvers, but they rarely climb. So pulling up is the best and fastest avoidance maneuver.

If the aircraft is capable of high-speed flight at low altitude … don't do it. The kinetic energy formula applies to airframes and windows. While modern heated windows should resist a gull or duck, larger birds may penetrate them or shower the pilots with glass as the inner pane of the window spalls or shatters. Likewise, the small bird that bounces off like a tennis ball when struck at slower speed suddenly becomes a bowling ball when struck at high speed. Below 10,000 ft, limit aircraft speed to 250 kt indicated airspeed or less.

Aviation operations successfully mitigate a variety of hazards every day. The industry has built strong defenses against them. We can do the same with the birds.

An Air Berlin Boeing 737-700 windshield after encountering a flock of white-fronted geese at about 2,150 ft and 226 kt indicated airspeed.

Capt. Paul Eschenfelder is the lead instructor for Embry-Riddle Aeronautical University's Airport Wildlife Training Seminar, the only such course approved by the FAA for full compliance with FAA training guidelines.

Dr. Russ DeFusco is a former associate professor of biology at the U.S. Air Force Academy and formerly chief of the USAF Bird Aircraft Strike Hazard Team.

Notes

1. In October 2007, a Piper Seneca collided with a flock of Canada geese during night-time operations. The strike significantly damaged the aircraft and was followed by a loss of control and crash that killed both crewmembers.
2. A Cessna Citation was climbing through 3,000 ft after departing from Wiley Post Airport, Oklahoma City, Oklahoma, U.S., in March 2008. It struck a flock of migrating white pelicans, causing right-engine failure and wing damage. Loss of control followed, with the ensuing crash killing all five occupants.
3. A Sikorsky S-76 helicopter, flying at low altitude in January 2009, encountered a large bird that penetrated the front canopy. Either the crew or the controls were disabled by the collision, and the helicopter crashed, killing eight of the nine occupants.
4. In January 2009, a US Airways Airbus A320 ingested Canada geese in both engines, necessitating a ditching on the Hudson River. No occupants were killed, three sustained serious injuries and the aircraft was destroyed.
5. The BAM is an interactive risk calculation tool, accessible on the Internet at <www.usahas.com/bam>.

6. Airbus. *Flight Operations Briefing Notes: Operating Environment, Birdstrike Threat Awareness.* October 2004.
7. U.K. Civil Aviation Authority. "Operational Considerations in the Event of Multiple Bird Strikes to Multi-Engine Aeroplanes." Aeronautical Information Circular AIC 28/2004. April 29, 2004.
8. ICAO. *Review of Noise Abatement Procedure Research & Development and Implementation Results: Discussion of Survey Results.* Preliminary edition, 2007, p. 11.