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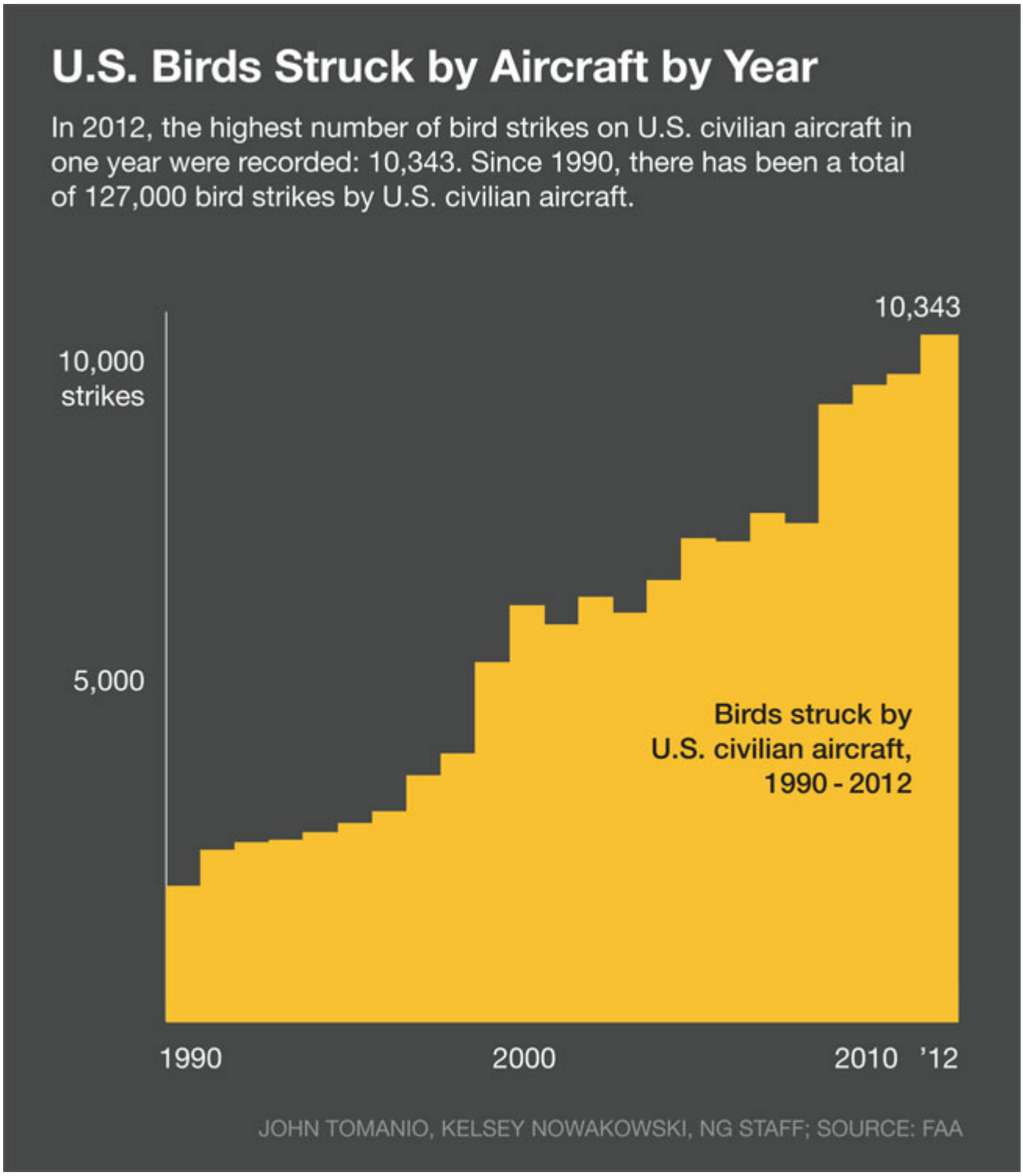
Nearly five years after Capt. Chesley B. "Sully" Sullenberger miraculously landed his crippled US Airways A320 jet on the Hudson River after flying into a flock of Canada geese, he says that the risk of airplanes striking birds is as great today as it was that cold January day in 2009.

"What happened to us," Sullenberger says, "could happen again tomorrow."
The data bear this out.
The Federal Aviation Administration (FAA) says more than 9,000 birds are reported struck annually by planes in the U.S., a figure that is rising every year. But because pilots don't have to report inconsequential bird strikes, the actual number is likely twice that.
The FAA has identified 482 bird species that were hit in the U.S. from 1990 through 2012. Airplanes run into loons, starlings, grebes, pelicans, cormorants, herons, storks, egrets, swans, ducks, vultures, hawks, eagles, cranes, sandpipers, gulls, pigeons, cuckoos, owls, turkeys, blackbirds, crows, chickadees, woodpeckers, hummingbirds, mockingbirds, parrots, bats—as well as various kinds of geese. (Animals, such as deer, struck on the ground during takeoffs and landings also make up a meaningful portion of kills.)
The unfortunate reality is that airplanes collide with birds at an astonishing rate because almost everywhere wildlife and airports exist in close proximity to each other.
How many of the collisions force pilots to land prematurely? The FAA says the rate over the past 23 years has been one a day.
The FAA notes that bird strikes cost the airline industry more than $700 million every year.

Zero Tolerance for Geese
In the U.S., the FAA is responsible for flight safety. It collects information on bird strikes, conducts research, establishes air safety directives, helps fund wildlife hazard assessments around airports, and helps develop wildlife management plans. But direct on-the-ground actions intended to mitigate bird strikes are put in place by local, state, and regional agencies.
After Capt. Sullenberger's near catastrophic collision on Flight 1549, New York's mayor Michael Bloomberg told the *Wall Street Journal*, "Look, the Department of Agriculture has to deal with the fact that all these geese are a danger to people flying. People are not going to stop flying and we have to make a decision. It's geese or human beings. And I can tell you where I come out on that."
So efforts to drastically reduce the resident population of Canada geese around New York City were stepped up.
A mayoral steering committee made up of eight government agencies gave the go-ahead to the USDA to cull geese. And the Port Authority of New York and New Jersey, which owns the three major metropolitan airports (John F. Kennedy International, LaGuardia, and Newark International), adopted a "zero tolerance policy" for geese.
Now early each summer teams of USDA goose catchers, paid by local governments, scour municipal properties in a 450-square-mile area encompassing the airports. At that time of year the geese are molting and can't fly. Once located, they and their offspring are easy to snag. They're then taken to slaughterhouses and quickly dispatched.
The USDA sweeps occur from Inwood Park in north Manhattan to Jamaica Bay Wildlife Preserve in south Brooklyn, adjacent to Kennedy Airport. Culling isn't supposed to occur more than seven miles from the closest airport, but USDA catchers have also removed hundreds of geese from Prospect Park in central Brooklyn, outside that designated limit.

In New York City alone between 2009 and 2010, 2,911 geese were killed. In 2011 and 2012, another 1,616, and this year, 554.
In addition to authorizing the trapping or shooting of geese, local governments have adopted longer-term strategies that focus on discouraging grazing and nesting: letting grass grow taller, planting unpalatable grasses, reducing standing rainwater, discouraging humans from feeding them, oiling eggs (to prevent hatching), and using harassment techniques such as firing propane cannons and setting off pyrotechnics.



Super Goose—the Back Story

While migratory birds are known to fly remarkable distances, why did a species whose name indicates distant roots set up residence in the U.S.?

Answer: Half a century ago Canada geese got some unexpected help, thanks to a revenue-raising plan by state wildlife agencies.

"The agencies," William Langewiesche wrote in his June 2009 *Vanity Fair* article on Flight 1549, "captured breeding pairs of an endangered but supersize subspecies known as the giant Canada goose, and by clipping their wings forced them to settle permanently into authorized nesting grounds along the Eastern Seaboard and elsewhere in the United States. The offspring of these clipped-wing geese imprinted to the new locations, and, having lost the collective memory of migration, became full-time resident populations."

The result: a lot of geese for hunters to shoot, and more money in state coffers from the issuing of hunting licenses, and a new avian population that found itself quite capable of reproducing and thriving.

Does Culling Geese Work?

According to USDA spokesperson Carol Bannerman, there are approximately 5.7 million migratory and resident geese in the U.S., and their numbers have been increasing by 10 percent a year.

Seen in the context of total bird strikes, airplane collisions with Canada geese made up less than one-half of one percent of the 10,726 reported avian hits in 2012. But geese are a worry because they're large and fly in flocks.

The annual killing of some 25,000 Canada geese nationwide—which the USDA claims is essential for aviation safety—is the most aggressive piece of the government's overall policy to reduce local geese populations in targeted areas where they graze and nest.

The USDA says that 80 percent of Canada geese struck by planes are resident, not migratory, birds—hence the argument for killing local geese.

There are an estimated 20,000 to 25,000 resident geese in the New York metropolitan area. Given the rich habitat surrounding New York's airports, which will always attract wildlife, can continuous culling be a meaningful part of the answer? City, state, and federal officials say yes, because the visible number of large birds cited near takeoff and landing paths poses a clear risk.

In the wake of the culls in New York, Bannerman says, the number of geese observed "in only a partial survey of about half the city properties the USDA covers" declined from 2,826 in June 2010 to 953 in June 2013.

"Over time, populations can increase," Bannerman notes, "but repopulation is not going to happen overnight, next week, and maybe not within 12 months."

What the Numbers Say

It seems that the stepped-up USDA killings haven't materially reduced the number of Canada geese strikes.

A new study led by Richard Dolbeer and Michael Begier, the former and the current national coordinators of the USDA Wildlife Services Airport Wildlife Hazards Program, respectively, found that the number of commercial airplane collisions with Canada geese peaked nationwide at 87 in 1998, with nearly 20 percent causing engine damage.

In 2009, the year of the US Airways Flight 1549 accident, and just before enhanced government wildlife management policies were adopted, the hit rate was 56, with 6 affecting engines. In 2012, the number had declined only slightly, to 50, also with 6 affecting engines.

Would the number of geese strikes have been larger without the culling?

That's difficult to say for sure.

What we do know is that greater, and persistent, reliance on non-lethal techniques would likely have reduced collisions to similar, if not lower, levels. Why? Because focusing on dispersal and avoidance deals with the problem head-on.

The Politics of Culling

Killing birds may provide political cover, showing an elected official's constituents that his or her administration is confronting the problem. It also presents a simple narrative that helps leaders discuss the problem in a way that seems to obviate discussion of alternative solutions.

But it's a response uninformed by environmental realities.

In a recent policy statement, the New York City Bar Association wrote, "There is growing agreement among aviation experts and biologists that killing geese and other birds has no long-term impact in reducing the risk of bird strikes and may exacerbate existing threats by creating vacant desirable habitat thereby inviting other birds."

By 2006 an aggressive USDA program to reduce the presence of laughing gulls around Kennedy Airport, where they were considered the primary threat to airline safety, had virtually eliminated their collisions with planes.

One debatable consequence—unforeseen and unintended—was that the local Canada geese population subsequently flourished in the broad ecological gap created by removal of the gulls.

The USDA maintains that Canada geese were already a problem at Kennedy in the early 2000s. But the current government emphasis on killing thousands of geese implies that they now pose a greater threat.

In their report, Dolbeer and Begier assert the importance of the USDA's wildlife management (including culling) for airline safety. But they also admit "that management actions at and in the immediate vicinity of airports do little to mitigate the risk of off-airport strikes during departure and approach."

Jim Hall, former chair of the National Transportation Safety Board, and Ron Merritt, biologist and former chief of the U.S. Air Force's Bird Aircraft Strike Hazard team (and now president of the U.S.-based avian radar manufacturer DeTect), consider lethal intervention as justifiable only as an isolated response of last resort.

They believe officials must address underlying environmental realities, such as by adopting more mindful land-use management that deters avian residency and grazing near airports and by taking steps to scare off birds near runways, thereby altering habitual behavior and making takeoffs and landings safer.

The geese Capt. Sullenberger's plane hit at 3,000 feet were migratory, not resident. (This was established during the National Transportation Safety Board study of the accident, which included DNA analysis of bird remains.)

Authorities agree that the risk migratory birds pose to flight is impossible to control. Despite this concession, the official response to Flight 1549 was an aggressive cull.

Sully's Rule

As long as avian attractants exist near airports, Sullenberger points out, killing birds doesn't address the underlying flight-risk problem.

In an interview this past June, Sullenberger said that even before his plane went down, "it was clear that in spite of how complex and large the problem of aircraft-bird collisions is, there is one thing we do know for sure. The most effective thing to prevent these collisions is not to allow anything anywhere near an airport that's likely to be a bird attractant."

Sullenberger said, for example, that he was very concerned by New York City's recent decision to build a major waste transfer station within 2,000 feet of LaGuardia—the airport from which he started his ill-fated flight.

The dubious value of bird culling to make skies safer for human flight is borne out in New York City by the proximity of the Jamaica Bay Wildlife Preserve to one of the world's largest airports: JFK International. And because so many airports are situated on the edge of water, this ubiquitous danger begs the use of avian radar to help pilots steer clear of birds.

To sanction construction, Sullenberger says, "officials changed the [safety] categorization of an adjacent runway. This means the runway will never again be able to be used to its fullest capacity where aircraft could land with the most precise guidance during periods of

very low visibility. So this development has negative operational consequences as well as safety implications."
Such contradictory government policy leads Sullenberger to question the integrity of actions officials claim are necessary to make flying safe. "It just follows."
What happened to him, as he says, can happen again.

It Did Happen Again

In June 2010, just 17 months after US Airways Flight 1549 went down, a Royal Air Maroc Boeing 737-400 with 162 people on board struck a flock of geese after departing Amsterdam's Schiphol Airport.
The plane was badly damaged, and the pilot struggled with the controls. Only by the slimmest of margins was he able to land the jet back at Schiphol.
The subsequent investigation revealed the carnage. The remains of 24 geese were found in the left main landing gear, the nose landing gear, and the electronic compartment. Seven more dead geese were found on the runway.
Study of the plane itself revealed:

Dents in the underside of the fuselage near the nose
Denting in the leading edge of the vertical fin
Dents and cracks at the leading edge of the left engine's inlet and dents inside the engine
Three fan blades fractured at about mid-span and damage to all the rest of the fan blades
Damage to the left engine's low- and high-pressure compressors, the combustion chamber, high-pressure turbine guide vanes, high-pressure turbine blades, low-pressure turbine outlet guide vanes, and the first to fourth low-pressure turbine stages
Soot and oil found on the left side of the left engine
Oil found on the fuselage
Jammed right main gear brakes

Highlighting the global nature of the risk, the European Space Agency has reported that worldwide airplane-bird collisions cost airlines more than $1.2 billion a year.

Lessons From Tel Aviv

For a better understanding of the link between birds and air safety, and how pilots can avoid hitting birds, Sullenberger defers to Yossi Leshem, a senior researcher in Tel Aviv University's zoology department. Leshem's research has helped the Israeli Air Force dramatically reduce bird strikes through non-lethal means.
From 1960 through 1984, the country's air force lost nine aircraft outright and experienced 55 additional collisions, each resulting in at least a million dollars' worth of damage to planes. The authorities considered these accidents the unfortunate cost of high-speed, low-altitude training in narrow flight corridors where birds are present.
A great many of them: Israel sits squarely under the spring and fall migratory paths of some 500 million birds, and Leshem argued that a better understanding of these sky-darkening migratory movements would help reduce bird strikes.
Leshem used radar, motorized gliders, and drones to identify and understand flock movement by species, time, altitude, and habitual routes taken. "No one had ever undertaken this basic analysis before, and the knowledge that we gained from just this study alone helped immediately to mitigate bird strikes," he says.
Historical data about birds' flight patterns was then merged with active bird tracking—day and night—by radar.
"This began allowing us to follow individual birds as small as ten grams from as far away as 20 kilometers," Leshem says, "and birds as large as pelicans and geese up to 90 kilometers away."

Leshem says that when these data are overlaid with weather radar, infrared and ultraviolet-based tracking systems, and historically based algorithms, it is possible to predict where birds are heading.

Between 1985—the year after Leshem completed his study and Israel adopted his measures—and today, the air force lost two jets and suffered 20 bird-strike-related collisions that caused more than a million dollars' worth of damage each.

Leshem says that if a real-time integrated avian radar strategy had been in place at LaGuardia before US Airways Flight 1549 took off, radar technicians would likely have recognized the approaching migratory birds from at least a dozen miles away. Their readings would have been overlaid on the screens of flight controllers, who would then have noted the potential for collision even before Sullenberger started his roll.

"Delaying takeoff by just several minutes or sending him off in a different direction," Leshem says, "would have meant Flight 1549 would not have hit these geese."

This is the lesson that can be taken away by officials everywhere who must confront the persistent risk of bird strikes.

The Radar Solution

Additional research appears to be verifying the capabilities of avian radar.

Seattle-Tacoma International Airport installed an Accipiter Radarsystem in 2007. Since then, says Steve Osmek, the airport's wildlife biologist, the radar has been helping track birds and assessing avian movement at night.

"When we see—via radar—birds flying over the airfield, posing an immediate risk," Osmek explains, "we can direct airport operations to take action to scurry them away."

The airport's radar isn't being used to warn about potential midair bird strikes, which would require a seamless integration between radar technicians and the control tower. Osmek hopes eventually there will be a protocol for that.

Siete Hamminga, head of the Dutch radar manufacturer Robin Radar, claims his product "can distinguish among flocks of small, medium, and large birds." His system is currently being tested at Amsterdam's Schiphol Airport, Europe's fourth busiest, to help prevent pilots from colliding with geese at low altitudes.

Robin Radar is also in use elsewhere, including air force bases in Holland and Belgium and Hatay Airport in Turkey.

Hamminga says his company is enhancing its radar's capabilities by "including more variables like airspeed, flight path, wing-beat frequency, and pattern that together serve to create a species fingerprint that can trigger alerts when radar picks them up from as far away as ten kilometers."

In 2011 an avian radar study managed under the auspices of the U.S. Department of Defense tapped the knowledge of leading U.S. airline, U.S. Air Force, and university experts. Called the Integration and Validation of Avian Radars (IVAR), it found that the eBirdRad mobile radar unit manufactured by Accipiter Radar "could readily track more than 100 targets simultaneously, and could record in real time a host of parameters for each tracked target … [at a] range of at least 6 nautical miles, and up to an altitude of [approximately] 3000 feet."

According to IVAR, the system "detected 50 times more birds than human observers using conventional visual methods." Also, "data generated can be displayed on maps or graphs to show bird activity patterns in time and space."

With data transmittable over vast regions, this system could trigger automatic alerts when, for instance, a large flock is entering sensitive airspace.

The cost of an eBirdRad unit is about $450,000. A large international airport, such as Kennedy, would need four or five of them.

Preserving the Status Quo

A year after the IVAR report was released, the FAA—one of whose officials participated in the study—contradicted the findings.

In a joint 2012 bird-strike study with the USDA, the FAA stated, "Though it is well established that radar can detect wild birds, there is little published information concerning the accuracy and detection capabilities related to range, altitude, target size, and effects of weather for avian radar systems."

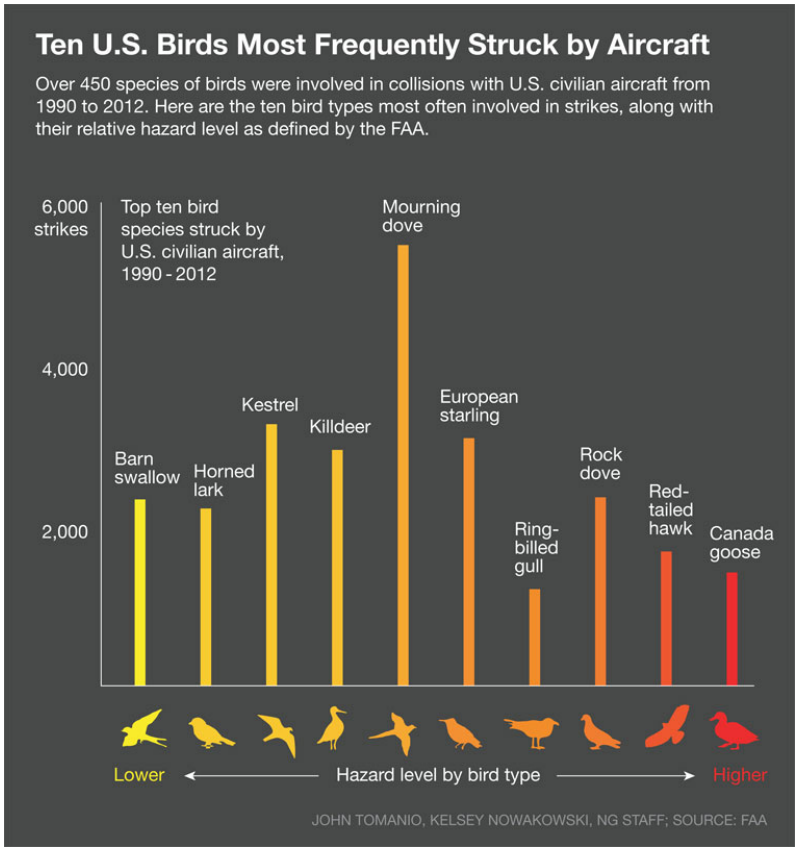
Gary Andrews, general manager of DeTect—which manufactures the Merlin Bird Radar, the only bird-detection radar system currently used for real-time bird avoidance by the U.S. Air Force, the U.S. Navy, and NASA—says his company's equipment sorts birds by size and flock status.

He believes the USDA won't recommend use of radar because the agency sees it as a threat to its own business. "The USDA is paid by local agencies for the work it does to mitigate bird populations," Andrews says. "And because the FAA recommends use of the USDA for wildlife management, local agencies that do the hiring typically follow this recommendation to help sustain good relations with federal authorities."

Andrews says that although USDA personnel are doing effective wildlife management at airports, the agency is "too focused on research and not enough on practical application to more effectively identify and quantify risk in real time, and then to implement effective responses."

Edwin Herricks, professor emeritus at the University of Illinois, has helped coordinate the FAA's testing of avian radar across the U.S. In his view, existing systems still pick up too much "noise" to be able to reliably distinguish dangerous birds and accurately assess risks.

"This means radar operators may be prone to produce false-positive results when there are no birds present," he says. It could "also render negative results when birds are present but not detected."



Know Your Species?

The USDA's Michael Begier, a co-author of the IVAR study, says identifying bird species is essential for risk assessment and real-time decision making.

He faults avian radar for not being able to distinguish one species from another and doesn't want to see avian detection systems in place until such recognition is possible.

"This is typical bureaucracy," scoffs Yoshi Leshem. "You don't need to identify the species by radar." But, he says, you do need "to identify an approaching flock, and this we see perfectly with radars used by the Israeli Air Force, and in air bases in Netherlands, Germany, and Belgium."

He says that the Swiss Ornithological Institute, in Sempach, has developed Doppler radar that can identify species. And Robin Radar's Hamminga says that the wide range of corporal and flight characteristics of birds his system picks up can collectively form a virtual species fingerprint.

Herricks agrees that avian radar systems can work well for targeting a single species. He cites La Mercy Airport, in Durban, South Africa, where DeTect's radar is used to monitor swallow roosting, shown to be a significant threat to airplanes, especially around sunrise and in the afternoon.

And he says avian radar can also be very helpful in assessing wildlife activity to determine where birds are massing and in tracking their local flight patterns, especially at night.

DeTect's Ron Merritt finds such comments ironic. He has come across many experts who favor using avian radar at night when they know they can't see, "but during daylight hours, when they're virtually as blind as they are at night, they're more reluctant to use the tool."

Driving the point home, Merritt posits: "Ask any seasoned air traffic controller how many times he or she actually saw a flock of birds, then provided any kind of advisory to an air crew. Most will tell you, 'Never.'"

Other Possible Solutions

When a bird strike occurs, the media typically report that the bird flew into the plane. The gruesome reality is that airplanes plow into birds that are either oblivious to the oncoming risk or apprehend the hazard too late.

Begier says birds do typically try to avoid planes when they see them. But turbine-powered jet engines have gotten quieter over the years, which, he surmises, may be exacerbating the problem.

He urges that "methods to enhance aircraft detection by birds be pursued more vigorously."

Ryan King, the FAA's national wildlife biologist, points to anecdotal evidence offered by Australia's Qantas Airlines and by Alaska Airlines suggesting that pulsing landing lights may help deter birds from veering into flight paths.

Use of more frequent visible light pulses from an aircraft, King says, could make birds flying ahead of planes more aware of an approaching threat.

Authorities are also studying the possibility that finely tuned weather radar emissions from an aircraft's nose cone could warn birds of impending danger. According to King, anecdotal evidence also suggests that birds may respond to such microwaves. But he's less hopeful about this strategy because birds may sense the emissions only when they're close to the source—too late to avoid disaster.

Soon after Flight 1549 went down, James Genova of the U.S. Naval Research Laboratory, in Washington, D.C., suggested that a more powerful signal could do the trick. He claimed research had shown that heat from microwave radiation—the medium of weather radar—makes the inner ear expand, causing a clicking sound. If the wave is sufficiently disturbing, it may be enough to redirect birds away from planes. (According to DeTect's Merritt, this notion has long since been disproved.)

You All Be Careful Now

Without systems in place that visually track flocks, how are pilots warned about potential bird strikes?

When there have been sightings of birds by ground crews, air traffic controllers, or pilots, airports and the FAA may put out a general warning.

"But that's like saying, 'Be careful out there!'" Capt. Sullenberger exclaims. "It's not useful. It's not effective. So any improvement on bird detection and bird warning would be welcomed."

Despite the FAA's having started radar testing in 2001, and having issued an advisory in 2010 that recommends guidance and specifications for deploying and managing an avian radar system, not one U.S. airport now uses an integrated system tied to air traffic control.

Why the Foot-Dragging?

When the Port Authority was asked about the potential use of integrated avian radar at New York City's three main airports, the agency didn't respond.

A number of industry observers suspect that adoption of integrated radar networks has been retarded by worries about the time it takes to learn how to efficiently use the systems. And then there is the inevitable need to fine-tune them for greater accuracy.

(Introduction of wind-shear gauges was greeted with the same skepticism. Initially, false readings led many pilots to deactivate them, but the devices have since been improved and are now an essential cockpit tool.)

Spokespersons at the USDA and the New York City Department of Environmental Protections have expressed concerns about the operational and economic impacts of potential flight delays triggered by overly cautious interpretation of data about the presence of birds.

If unnecessary flight delays do occur, might someone be liable for related economic losses? Hard to say at this point, but it's unlikely, given the benign underlying intent of avian radar systems.

One expected source of input into the discussion of liability—the insurance industry—has been conspicuously silent about risks and expenses associated with bird strikes.

The large global insurer Allianz, which underwrites policies for both major airlines and airports, admits that the problem of bird strikes is significant. But Joseph Strickland, the firm's Global Head of Aviation, Americas, says bird accidents "represent only a small percent of total losses paid."

Further, he says, there's no standard process to assess avian risk when underwriting such policies.

Implementation delays may also have to do with the additional labor costs associated with round-the-clock management of avian radar systems. The airline industry is averse to most initiatives that could raise costs, but a small fee levied on passengers could help offset labor costs and finance operations.

Sullenberger surmises that the main reason such technology isn't in place has to do with the fractured layers of government, which means that policies set at the federal level are often very hard to put in place at the local level.

He also points to a lack of leadership by Washington on the bird-strike issue, as well as complacency bred by a strong industry safety record that produces what he calls "a drift toward expedience."

These constraints may explain why none of the recommendations issued by the National Transportation Safety Board after Flight 1549 landed on the Hudson have been fully implemented.

As Capt. Sullenberger sees it, the risk of a catastrophic event is plain as day. "There's always this constant tension between doing what's easiest, what's quickest, what's least

costly, versus taking the time, making the effort, to doing it right. But I think many are hoping we can continue to be lucky."

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