
Patricia Hofmeester/123rf.com

Wildlife Surveillance Concept (WiSC) Benefits in the Airport Environment

By A. Koros, FAA, and M. Hale, CSSI, Inc.

It was a typical April afternoon at John F. Kennedy International Airport (JFK) with temperatures hovering near 60 degrees and winds picking up throughout the day from the south-southwest (SSW) nearly 11 knots. The Boeing 757-200 taxied from the terminal and was released for departure on runway 13 Right. It climbed gracefully from the tarmac. Passing through 800 feet, passengers strained to look out the window for a glimpse of the breathtaking city skyline. A flock of large ebony birds flashed by. In their path were nearly 20 double-crested cormorants with wingspans approaching four feet and weighing nearly five pounds each. The fuselage echoed with several loud bangs and the right engine produced a streak of bright orange and yellow flames. The Captain calmly shut down the engine and contacted JFK tower. [1]

DAL1063: "And, Delta 1063 has had an engine failure on the right engine. Declaring an emergency due to a bird strike."

JFK Tower: "Sir, Delta 1063? Heading straight ahead, contact Departure 135.9, we'll get you straight back in."

DAL1063: "Okay, heading straight ahead, Delta 1063...
"All right... Departure, Delta 1063, we have declared an emergency. Engine failure on the right engine, request visual return back to 13R."

Working methodically and professionally through the procedures ingrained through years of training and aviation experience, the captain quickly ascertained that Runway 22 was a safer alternative and proceeded.

DAL1063: "If we could have the trucks standing by and everything for an inspection for 22 Right. And we would – again – like the visual 22 right, right side please."

NY Departure "22 Right it is then. And just let me know when you are ready to turn inbound and I will clear you for the visual approach."

DAL1063: "Ok. We are gonna square it out to the right here and we'll head back in. And just to let you know our stats for Delta 1063. We have 179 souls on board, eight hours and five minutes remaining." [1]

Within 10 minutes, the aircraft was back safely on the ground. This incident, like 2009's "Miracle on the Hudson," ended well in that there was no loss of human life. Intense ongoing wildlife mitigation and harassment efforts by airport personnel reduce the threat; however,

Figure 1. Bird strikes by the numbers.

nearly 37 bird strikes are reported to the FAA's Wildlife Strike Database daily.[2] What else can be done?

Researchers from the FAA's William J. Hughes Technical Center in Atlantic City, N.J., are investigating a concept that applies new technology to help address the very real challenge of mitigating bird strikes. This research is called the Wildlife Surveillance Concept (WiSC) and it was highlighted in the Spring 2017 *Journal*.[4] In the current issue, we outline the fundamental challenges in acquiring timely and actionable bird strike threat information, and how delivering avian radar surveillance information to the airport traffic control tower (ATCT) may help address this gap while enabling a safer airport operating environment.

Background

Bird strikes are nothing new to the aviation community, with the first documented bird strike well over a century ago. However, the number of reported bird strikes has increased substantially over the years. Figure 1 presents the incidence of reported bird strikes captured in the FAA's National Wildlife Strike Database.[2]

Several factors are responsible for the increase in reported bird strikes. A portion is certainly due to improvements in the reporting process itself, however, there are other significant contributing factors. These include an increase in the overall number of air traffic operations (increasing the potential for bird strikes), quieter aircraft engines, new air traffic procedures, and highly successful environmental conservation efforts, which have contributed to an increase in some populations of bird species that are among the most problematic to air traffic operations. This problem is compounded near airports,

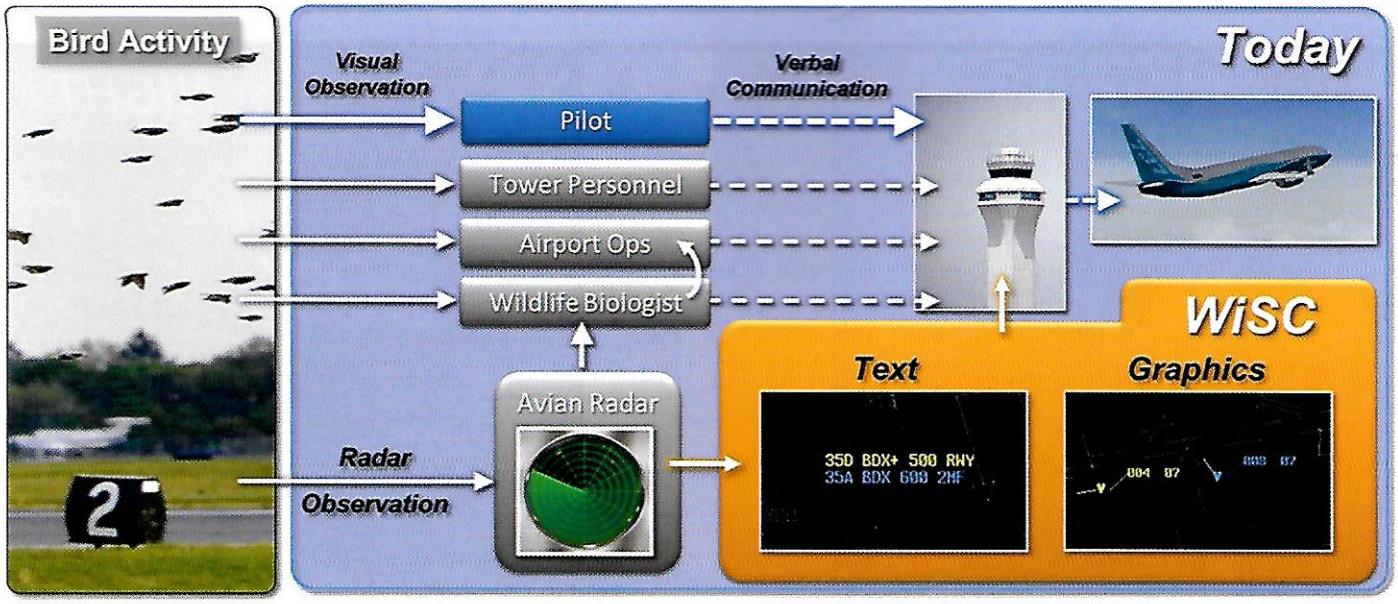


Figure 2. Bird strike threat information flow.

which are naturally rich in wildlife attractants (marshy bodies of water, fields for foraging, landfills, etc.) and when they serve a large city, represent a high density of aircraft operations.

In the current airport environment, detecting bird strike threats to aircraft relies on human observation. However, birds are relatively small, fast-moving, unpredictable targets, making it difficult to ascertain distance, direction of movement, and the true threat that they represent to operations. Most often, the observer is a pilot, perhaps traveling at 120 knots, who catches a brief glimpse of the fleeting threat as it flashes by. Workload permitting, the pilot will report any relevant information to an air traffic controller to be broadcast to other pilots. In some instances, if the threat is close to the tower, the controller may observe the activity. However, due to the characteristics of these threats and the vast size of many airports, specific information is often limited and the threat can be extremely difficult to localize. While substantial bird activity can occur at night, very little information is available. This is also the case during instrument meteorological conditions (IMC).

In 2007, the FAA, in collaboration with academic and industry partners, began formally investigating the performance and suitability of commercial off the shelf (COTS) radar systems to detect and track birds on and around the airport environment. The results from this research led to the development of Advisory Circular 150/5220-25, Airport Avian Radar Systems.[5] This publication identifies the performance requirements for avian radar systems at airports and provides guidance on the acquisition process. The FAA also installed avian radar at selected test sites and validated that the COTS radar systems were suitable for detecting and tracking bird targets on and around the airport in near real time.[6]

The FAA's Airport Technology Research and Development Branch Initiated and sponsored a research effort to investigate the filtering and integration of bird radar information into the ATC environment for use by ATC personnel. The objective of WiSC is to decrease the probability of high-consequence bird strikes by improving threat detection, capturing accurate threat position and heading information, and improving information dissemination from air traffic controllers to pilots. Figure 2 shows how bird strike threats are detected and disseminated in today's operational environment and how avian radar information may be introduced into the tower environment.

Challenges and Proposed Solutions

The research has identified three main limitations in current-day bird strike threat management operations:[7]

- Limited threat detection.
- Incomplete and decaying bird strike threat information.
- Non-optimal procedures for disseminating bird strike threat information.

Is there a bird strike threat?

Currently, bird strike threats are detected at airports almost exclusively by human observers – whether it is a pilot, airport operations personnel, or an air traffic controller. Besides the fundamental limitations of human perception, especially at a distance, each of these observers has a variety of competing duties and is not focused solely on locating these intermittent bird threats. Pilots most commonly detect and share bird strike threats, but they may be traveling at significant speed and have a brief opportunity to capture information on counts, species, heading, speed, altitude, and other factors of interest. In addition, the phases of flight where strikes are mostly like to occur – approach and departure – are also the phases when a pilot's workload is highest. So, even if a pilot does observe a threat, their workload may not permit reporting it at that time. Another limitation is that there may be significant bird activity at night, especially during migratory periods, but pilots and controllers remain unaware of the threat unless a bird-aircraft collision is reported.[2]

Avian radar provides 24-hour dedicated surveillance with improved information, particularly during IMC. Identifying bird strike threats will no longer be reliant on human observation. The challenge for effectively leveraging this technology in the ATCT environment is filtering the threats to share just those of potential consequence for airport operations. This is the focus of the next phase of research.

Where is the threat?

Airport personnel, controllers, and pilots often have difficulty perceiving the location, direction of flight, and operational impact of small, distant, and moving targets like birds. Figure 4 illustrates position uncertainty that may occur when a controller attempts to localize birds out of the tower cab window. In addition, even if the information is accurate and complete, it decays quickly. Change in the

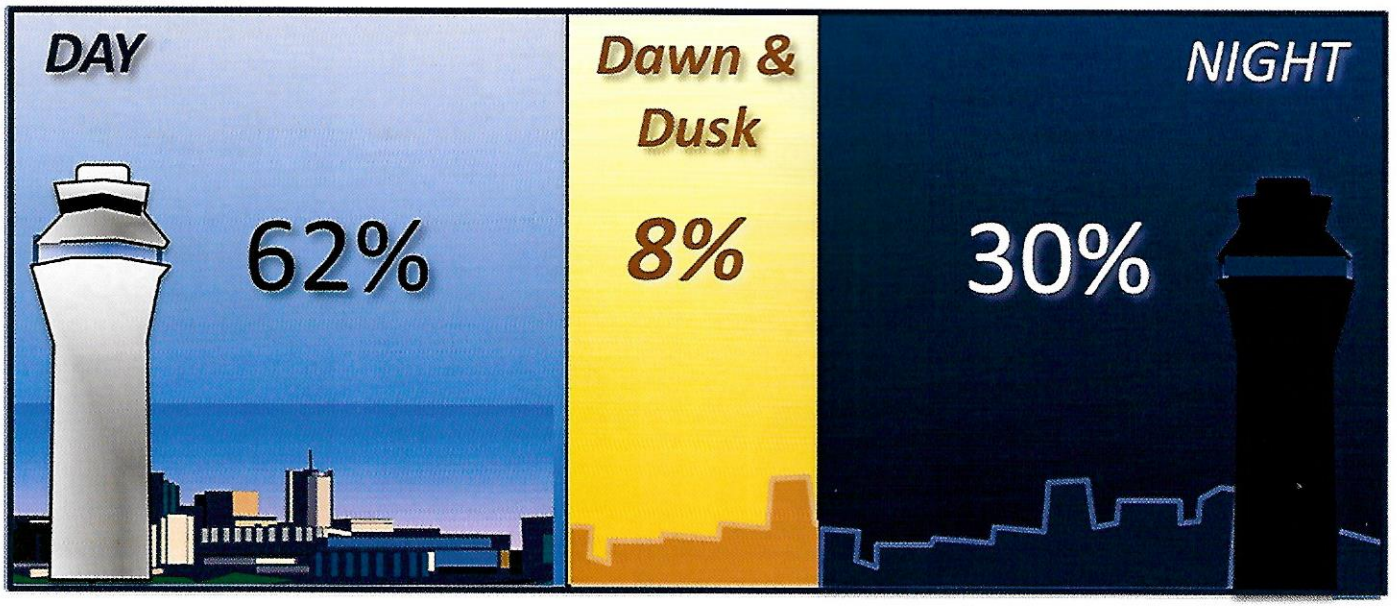


Figure 3. Percentage of total bird strikes as a function of time of day

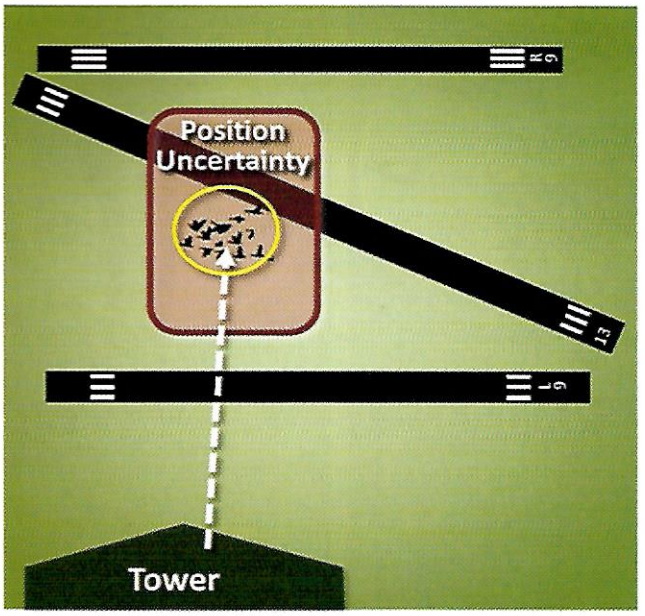
status of a threat can vary dramatically with respect to position, altitude, and direction of flight. This may mean that within as little as one minute the information may be obsolete. To combat this, workload permitting, controllers will query pilots or airport operations personnel, and visually search in the vicinity of the reported threat to corroborate and update bird strike threat information.

The avian radar system in use by airport operations personnel at Seattle-Tacoma International Airport (SEA) has an update rate of approximately three seconds. The benefit of processing this, or similar avian radar data, and filtering it for use by air traffic controllers in the tower, is twofold. First, it can relieve controllers of the additional workload and verbal communications required to query pilots or ground personnel for updated information. Second, the data is more complete than a typical human observation, providing location, heading, speed, relative size, and depending on the sensor, other relevant information such as altitude.

How do pilots learn of the threat?

In today's environment, pilots may become aware of a threat when another pilot broadcasts this information to a controller, or when the local or ground controller provides the last known location report. The FAA's Air Traffic Control Manual directs controllers to gather bird activity including position, species or size (if known), course of flight, and altitude, and to broadcast this for 15 minutes or until the threat is no longer a factor.[8] These procedures are the best that can be accomplished in today's environment but result in additional workload for controllers. Controllers must expend cognitive resources to track the bird threat and monitor the 15-minute reporting period. Also, if workload permits, they may query pilots for updated information over the radio frequency, which can be operationally significant, especially at a busy tower. Furthermore, as noted earlier, this information may be

Birds observed by controller out of the ATCT cab window.



Position uncertainty due to the challenge of localizing birds in relation to operational runways.

Figure 4. Uncertainty in identifying the location of a bird threat out of the ATCT cab window.

incomplete or of limited practical value as illustrated in Figure 5.

Integrating enhanced bird threat information into the tower environment should help mitigate these cognitive and communications demands. Regularly updated, complete location and heading information, without the need for constantly querying pilots for new reports, will alleviate much of the burden if implemented correctly. In addition, with this digitized data, there may be an opportunity to share this information directly to pilots for their situational awareness without adding to a controller's duties.

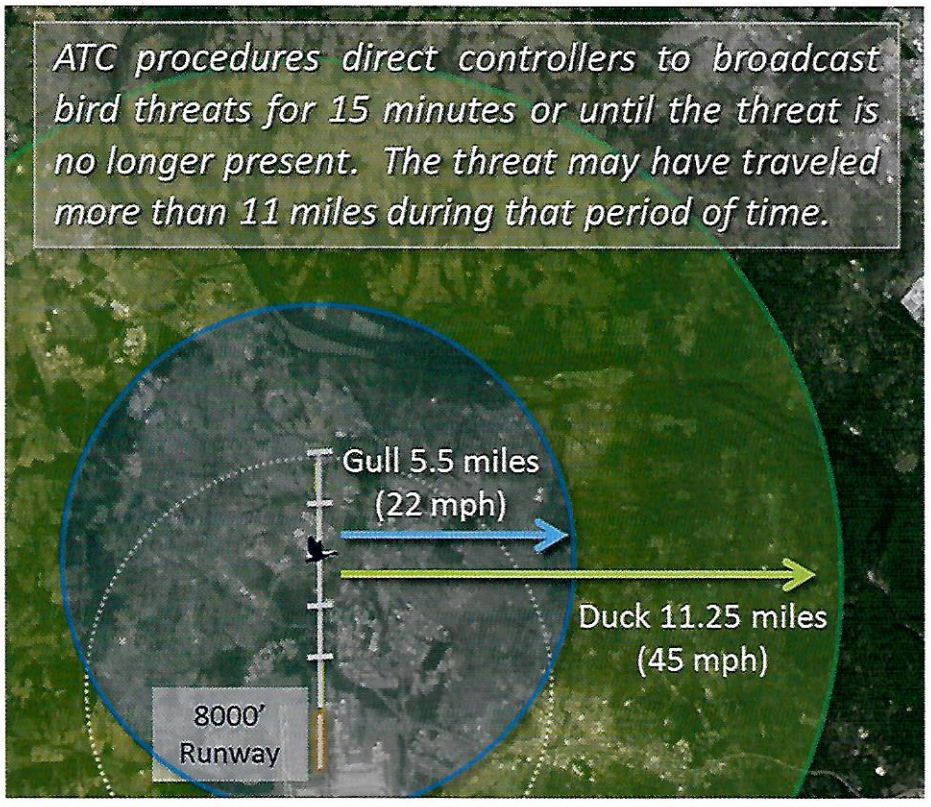


Figure 5. Maximum distance traveled by two common bird species in 15 minutes.

What other benefits do avian radars provide?

Wildlife management and airport operations personnel can gain significant benefits when avian radar is deployed in the airport environment. Figure 6 illustrates the multiple stakeholders that can benefit from using avian radar.

Avian radar has been operationalized at SEA and already provides substantial benefit to wildlife management and airport operations personnel. They use radar-derived historical data for wildlife trend analysis in support of wildlife hazard management planning strategies, including habitat modification. This data enables the wildlife biologist to determine wildlife trends and identify specific areas of concern, as well as wildlife attractants (ponds, food sources, etc.) on and around the airport. This information is required for the mandated Wildlife Hazard Management Plan (WHMP). SEA has even leveraged historical avian radar data to validate the success of stormwater mitigation efforts using vegetation control and netted ponds.

SEA also leverages near real-time avian radar data for tactical mitigation and dispersal measures. The avian radar system at SEA monitors the airport environment and alerts airport operations personnel when bird activity meets a threshold persistence level (e.g., activity > 15 percent of any 15-minute period). SEA's Airport Communications Center

Figure 6. Avian radar benefits pool.

(ACC) then dispatches airport operations personnel to mitigate the threat using appropriate dispersal techniques. Figure 7 depicts the display used in the ACC at SEA with several alerted areas including one severe alert in red.

As for potential air carrier benefits, the FAA identified a $337 million annual safety shortfall attributed to the inability to identify and mitigate bird strikes[9] in the current operational environment.[8] Other FAA estimates indicate that bird strikes may cause losses as high as $957 million annually.[3] Although further research is needed to determine how much of this shortfall WiSC will capture, the potential to mitigate the most costly and severe bird strikes is compelling.

Where do we go from here?

Future research will focus on filtering the large number of threats that avian radar identifies, determining high-consequence and high-probability threats, and presenting this information effectively to controllers. Factors of interest to pilots and controllers include quantifying the threat in terms of biological mass (e.g. size and number of birds) as well as proximity to arrival or departure corridors or other ongoing operations.

References

[1] *Delta 1063 bird strike recording. From www.youtube.com/watch?v=7rTVxktP8xEC. Accessed 9/10/18.*

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[4] *Hale, M. (2017). "Incorporating Avian Radar Information in the Airport Traffic Control Tower," The Journal of Air Traffic Control. Spring 2017.*

[5] *Advisory Circular 150/5220-25: Airport Avian Radar Systems. Federal Aviation Administration, Washington, D.C. 2010.*

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[9] *FAA (2015), Quantified Shortfall Analysis Report for the Wildfire Surveillance Concept, Final Report. FAA, Washington, D.C.*

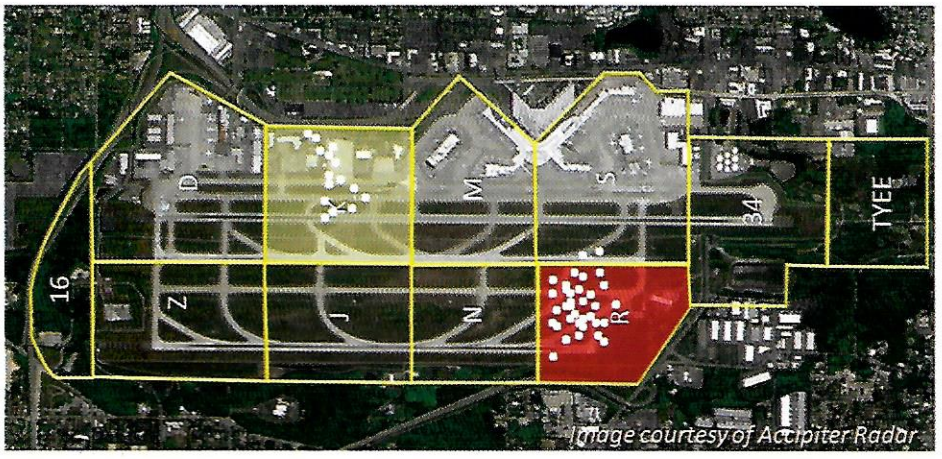

Figure 7. Avian radar threat viewer used at SEA ACC.