3D Avian Radar Systems That Automatically Alert Pilots, ATC and Airlines to Loss of Separation with Birds

Tim J. Nohara, B.Eng, P.Eng, M. Eng, Ph.D, Accipiter Radar
tnohara@accipiterradar.com

Sara A. Handrigan, B.Sc, Accipiter Radar
shandrigan@acciptierradar.com

Abstract

US Airways 1549 (Miracle on the Hudson) on January 15, 2009, illustrated a damaging off-airport bird strike in the departure corridor of New York City's LaGuardia Airport. By a miracle, no souls were lost. At the 2012 International Bird Strike Committee meeting in Norway, we presented concerns regarding off-airport bird strike risk, underscoring the need to share off-airport bird strike risk information with pilots, ATC, airlines, and airport operators. Since that time, avian radar use at airports has been largely focused supporting on-airport bird strike risk mitigation.

At the 2024 Aviation Wildlife Management Conference in Minneapolis in August 2024, Dr. Richard Dolbeer presented evidence that bird strike risk mitigation efforts above 500' AGL remain inadequate, that off-airport damaging strikes occur at twice the rate of on-airport strikes, and that the growing abundance of large birds is escalating the risk of a devastating bird strike. Sadly, on December 29, 2024, Jeju Air Flight 2216 crashed after flying through a flock of Baikal teal on arrival to Muan International Airport, killing 179 of 181 people on board. This tragedy underscores the urgent need for ATC, pilots and airlines, in addition to airports, to be key stakeholders in a renewed effort to mitigate the risk of bird strikes in the arrival and departure corridors of airports. Simply reporting "birds in the vicinity of the airport" is not useful; and today, we can and must do better to localize bird congestion in the relevant airspace for pilots, airlines and ATC.

The technology to automatically detect off-airport loss of separation between birds and aircraft exists today, in the form of smart, ground-based, 3D avian radars which generate real-time, 3D trajectories (latitude, longitude, altitude, versus time) of birds and aircraft in critical airspace and automatically measure loss of (safe) separation using closest point of approach (CPA) methods. Loss of separation can be used both tactically and through analysis as a leading indicator of bird strikes, providing necessary decision support to stakeholders including pilots, ATC, airlines and airport operations to help mitigate the risk of off-airport bird strikes. This decision support can include real-time alerts directly to individual pilots, current bird congestion activity information to all pilots (as well as flight planners) (e.g. through the Automatic Terminal Information Service (ATIS)), and longer-term bird congestion patterns to flight planners and other stakeholders (e.g. using NOTAMs). We will use real data to help illustrate these new concepts.

Introduction

Nohara et al (2012) introduced the issue of better mitigation for off-airport bird strike mitigation at the International Bird Strike Committee Conference in 2012.

"If information for bird strike threats occurring … off-airport were available; and if this information was appropriately communicated to … pilots, ATC, airlines, and airport operators, just as we provide other environmental hazard information such as wind-shear and volcanic eruptions, couldn't we improve aviation safety further? Shouldn't we?"

Since then, little has been done to mitigate off airport bird strike risk. Dolbeer et al. is once again highlighting this issue within the international bird strike mitigation community. Here on some of the most critical extracts that speak to this gap.

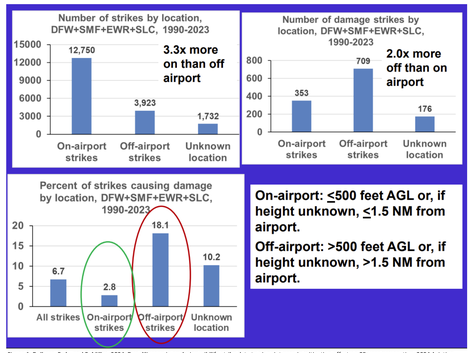


Figure 1. Dolbeer, R. A., and P. Miller. 2024. Due diligence in analyzing wildlife strike data to pinpoint gaps in mitigation efforts: a 35-year perspective. 2024 Aviation Wildlife Management Conference, Minneapolis, USA.

- No bird strike mitigation efforts are in place for off-airport departure/arrival airspace above 500' AGL, and off-airport damaging strikes are now 2X (twice) those on-airport
- Off-airport strikes with increasing large bird populations will not continue to have "miraculous" endings
- The mean body mass of birds struck at >500 feet AGL is twice that of birds struck at ≤ 500 feet
- Mean speed of transport aircraft is 1.4x greater for bird strikes at >500 feet AGL than at <500 feet
- Mean kinetic energy on impact is 4x greater at >500 feet
- Damaging strike rate during approach and climb at >500 feet AGL is increasing significantly
- Mitigation measures are not being implemented.
  - Bird Detecting/Avoidance Radar (BDAR) is a possible solution.

Dolbeer' s concluding message shared with everyone is that:

"we are failing in due diligence if we do not address this issue."

NOTAMs, ATIS, and ATS Advisories issued to pilots need to be better than "birds in the vicinity" to address this issue. Avian radar can be used to identify and provide detail on specific bird behaviors as they occur in real-time (Figure 2). Each of which represents a unique risk to aircraft.

Figure 2. Examples of migration, resident, and commuting behaviors as recorded by an Accipiter® avian radar at Chicago O'Hare, SeaTac and JFK US airports

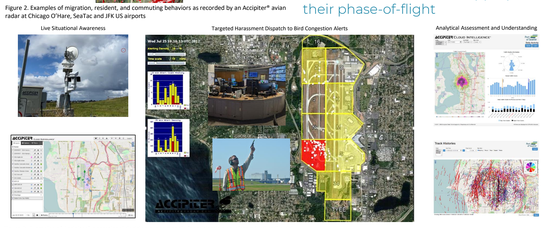


Figure 3. Examples of Accipiter® operational decision support tools for mitigating on-airport bird-strike risk

Decision support tools for mitigation of on-airport bird-strike risk (Figure 3) are operational to provide 3D identification of bird behaviors 24/7, during the day, at night, or fog.

New tools need to be developed to provide off-airport decision support. These tools should be designed to provide information to pilots, airlines, and ATC and need to be appropriate to their phase-of-flight

Only the flight crew, tower, and ATC can mitigate off-airport bird strikes and within the Airport Operational Environment (Figure 4) are considered the top of the safety pyramid. This requires them to be provided the right information at the right time. At civil airports, flight crew, tower, and ATC are often ignored when it comes to bird strike mitigation.

Figure 4. FAA Center of Excellence for Airport Technology Safety Pyramid

Off-airport damaging strikes like Jeju Air Flight 2216 will continue to occur at increasing frequency if stakeholders related to bird strike mitigation don't agree on appropriate ways to process bird strike data from avian radars to provide useful information. For off-airport bird strike mitigation, the focus should be on the critical arrival and departure corridors.

Accipiter already processes the data in many ways which are excellent starting points (Figure 5).

Bird-strike risk is greater when there are more birds crossing the arrival and departure corridors. The time where this occurs can vary depending on geographic location of the airport, time of day, season, and for airports near an ocean coast the phase of the tide.

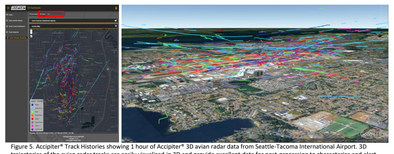


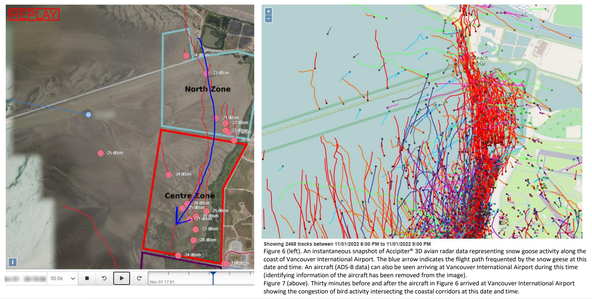
Figure 5. Accipiter® Track Histories showing 1 hour of Accipiter® 3D avian radar data from Seattle-Tacoma International Airport. 3D trajectories of the avian radar tracks are easily visualized in 3D and provide excellent data for post-processing to characterize and alert to congestion in critical flight corridors.

Many airports have off-airport approach and departure corridors that extend over the ocean because these locations offer clear airspace free of other obstructions. At the same time, over the ocean arrival and departure corridors present an increased risk to aviation safety because many species use the coast as a migratory pathway, or for feeding. Many of the species attracted to ocean coastlines are also those which present a greater risk for damaging strikes due to their large size or flocking behavior (e.g., waterfowl, and gulls).

This means that deploying off-airport decision support tools at airports with arrival and departure corridors over the coast may stand to provide a greater immediate benefit than airports with their arrival and departure corridors exclusively over land.

Analysis

Avian radar data can be used to measure congestion in the coastal corridors.



Showing 2468 tracks between 11/01/2022 8:00 PM to 11/01/2022 9:00 PM

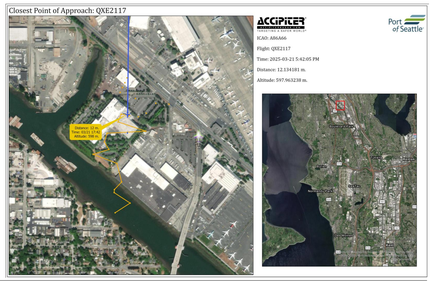
Figure 6 (left). An instantaneous snapshot of Accipiter® 3D avian radar data representing snow goose activity along the coast of Vancouver International Airport. The blue arrow indicates the flight path frequented by the snow geese at this date and time. An aircraft (ADS-B data) can also be seen arriving at Vancouver International Airport during this time (identifying information of the aircraft has been removed from the image).
Figure 7 (above). Thirty minutes before and after the aircraft in Figure 6 arrived at Vancouver International Airport showing the congestion of bird activity intersecting the coastal corridors at this date and time.

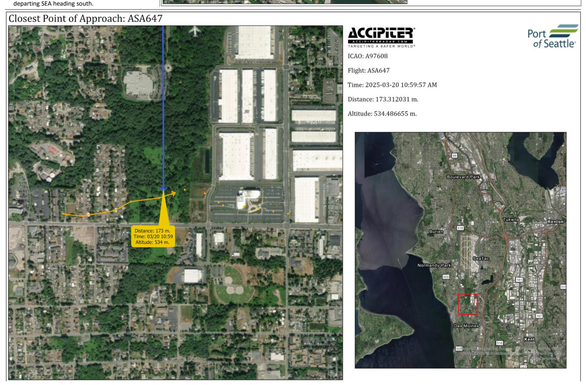
We have developed a Closest Point of Approach (CPA) methodology for automatically identifying situations like Figure 8 where an aircraft (from ADS-B) and bird (from avian radar) are very near each other. This allows for situations of congestion between to be automatically detected and reported to stakeholders. Figures 9 and 10 are two examples of automated CPA reports for off-airport aircraft each coming very close to a bird track.

Figure 8 (above). Example of a manually identified situation where birds (tracked by Accipiter® 3D avian radar) are very near aircraft (ADS-B).

Figure 9 (right). Example Closest Point of Approach Report from Seattle-Tacoma International Airport (SEA) where the aircraft is approaching SEA from the north.

Figure 10 (below). Example Closest Point of Approach Report from Seattle-Tacoma International Airport (SEA) where the aircraft is departing SEA heading south.





CPA counts can be used to understand how off-airport bird strike risk can be mitigated. Figure 11, presents an analysis of trends in CPAs at Toronto Pearson International Airport (YYZ).

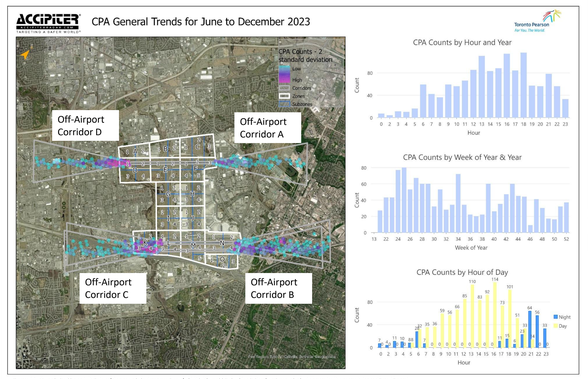


Figure 11. Trends in Closest Points of Approach between aircraft (ADS-B) and birds (Accipiter® avian radar) at Toronto Pearson Internation Airport

All four off-airport arrival and departure corridors at YYZ show evidence of loss of separation using CPA, which is no surprise. This can support real-time alerts to pilots (e.g. ATS communications or "app"). We have evidence of sufficient CPA data to support (sub-) hourly trends with flight corridor differentiation (e.g., for ATIS messages,); i.e. not just "birds in the vicinity". We also have evidence of sufficient CPA data to support NOTAMs with seasonal, time of day and flight corridor information. Figure 12, presents a daily summary of the CPA identified for a date in the summer. There was also a bird strike reported on this date. Based on the CPA evidence, one possible mitigation that could have been applied on this date would have been landing on Runway 23 instead of 24L.

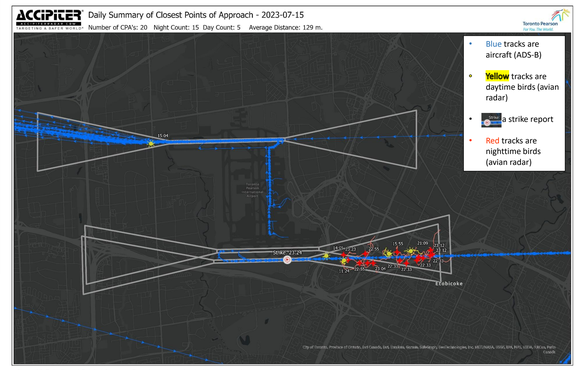


Figure 12. Daily Closest Point of Approach Report showing both nighttime and daytime loss of separation between aircraft (ADS-B) and birds (Accipiter® avian radar) where a bird strike was also reported

Recommendations and Conclusions

Visualizations of bird congestion in critical corridors derived from avian radar along with a description of what to expect, can be presented directly to pilots, ATC and airlines during flight planning.

One leading example is Vancouver International Airport (YVR) who summarizes information about significant seasonal off-airport snow goose hazards and presents them to Pilots via a Pilot Brief Sheet (D. Bradbeer – personal communication).

The Pilot Brief Sheet summarizes into a single statement and image information about:

- When the risk is present (at night vs. during the day)
- Where it is present (along the coast over certain geographic locations)
- How long the risk is expected to persist (on any given date, and for how many days)
- Which species are involved (snow geese)
- Which phase of flight and runways are at greatest risk (e.g., arrival vs. departure)
- A visualization to help stakeholders understand the risk
- Altitude band (e.g., below 400 feet)
- A distance away from threshold of the runway

Information presented in this way is much more useful for pilots to understand and mitigate this risk than telling them "birds in the vicinity". This allows pilots to anticipate a possible bird strike and be mentally prepared to respond if and as necessary. CPA analysis could be easily added into these Pilot Briefing Sheets.

We believe it is time to address the off-airport damaging strike problem and that the technology (avian radar and processing methods) is available to facilitate this.

Using Accipiter® avian radar data from YVR, SEA and YYZ, we have demonstrated the potential to automatically derive loss of separation information between aircraft and birds and measure congestion in critical, off-airport flight corridors.

We have introduced a Closest Point of Approach (CPA) methodology that provides significant information gain over bird strike reports allowing for leading indicators and alerts to be developed, implemented, tested and refined with input from pilots, airlines, ATC, airport operations, and regulators.

The time to act is now. If you are a pilot, airline, air traffic service provider, airport or regulator and you want to help make air travel safer from the risk of damaging bird strikes, join us in developing the needed strategic and tactical information products and communication processes suitable for off-airport bird-threat awareness and decision making.

If you are interested in learning more or participating in this exciting new development, please contact us.

References

Nohara, T.J., Sowden, R., Perkins, R. and B. Beason. 2012. Aviation stakeholder management of bird strike risks – enhancing communication processes to pilots and air traffic controllers for information derived from avian radar. International Bird Strike Committee Conference, IBSC 2012, 25-29 June 2012, Stavanger, Norway.

Dolbeer et al. 2024. Wildlife strikes to civil aircraft in the United States, 1990-2023. FAA. Serial Report No. 30, Washington, DC.

Dolbeer, R. A., and P. Miller. 2024. Due diligence in analyzing wildlife strike data to pinpoint gaps in mitigation efforts: a 35-year perspective. 2024 Aviation Wildlife Management Conference, Minneapolis, USA.

Dolbeer, R. A., and M. J. Begier. 2024. Bird strikes during approach and climb: a potential application for radar-based management strategies. Human Wildlife Interactions 18 (): In review.

Acknowledgements

We would like to acknowledge the following people and organizations for their support and partnership on this work.

John Sterrit – Accipiter Radar
David Bradbeer – Vancouver International Airport
Lisa Cooke & Falcon Environmental – Toronto Pearson International Airport
Steve Osmek – Seattle-Tacoma International Airport