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Filling a Critical SMS Information Gap for Bird-Strike Risk Management Off-Airport and at Night

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Birds in the Vicinity of the Airport,

2011 Bird Strike North America Conference, Niagara Falls,
Edward Coleman, Air Force Safety Center said the following:

We believe the aircraft/bird separation index we introduce in this paper can address Ed's call.

- Tune in the ATIS and you will hear that there are birds in the vicinity of the airport.
- The problem with the current system is people taking the risks, the aircrew and owners, have the least amount of information available to make an accurate risk decision.
- Imagine tuning in the traffic report on your commute to work and hearing the announcer say “Vehicles in the vicinity of the city”. This is exactly the situation flight crews are placed in every day.
- AFI 91-202 defines a Bird Watch Condition (BWC) code {low, moderate, severe} that could serve as a template or point of departure to develop a standard BWC for all airports.
- A standard BWC has the added benefit of allowing companies, through their Safety Management System (SMS), to determine the risk they are willing to accept. Companies can dictate what actions flight crews should take under different BWCs.
- By combining bird radar information with pilot reports and tower observations, an accurate assessment of the bird strike risk can be made.

- Bird-strike risk day versus night
- Bird-strike risk off-airport versus on-airport
- How can avian radar help fill the critical information gap (especially at night and off-airport) needed by airport safety management systems (SMS) to prioritize & mitigate this risk?
- Introduction to the aircraft/bird separation index
- Discussion

Characterization of bird strikes – in time

While most bird strikes occur during daylight hours, nearly one-third of strikes, particularly those during migration, occur at night – where the birds cannot be seen on- or off-airport by visual methods.

Time of Occurrence of Wildlife Strikes Involving Civil Aircraft, USA, 1990-2015¹

Time of Day	Birds	Bats
Dawn to Dusk	70%	19%
Night	30%	81%

Above 500 feet, seven times more bird strikes per aircraft movement occur at night compared to day².



Damage to the vertical stabilizer of a B-737 that was struck by a Greater Yellowlegs at night on approach to a west coast airport in October 2015. Repairs costs exceeded \$100K and the aircraft was out of service for 72 hours.

¹Dolbeer, et al. 2016. Wildlife Strikes to Civil Aircraft in the United States, 1990-2015.

²Dolbeer, Richard A., "Height Distribution of Birds Recorded by Collisions with Civil Aircraft" (2006). USDA National Wildlife Research Center - Staff Publications. 500.

Characterization of bird strikes – in space

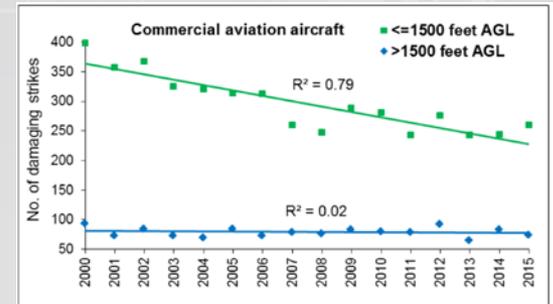
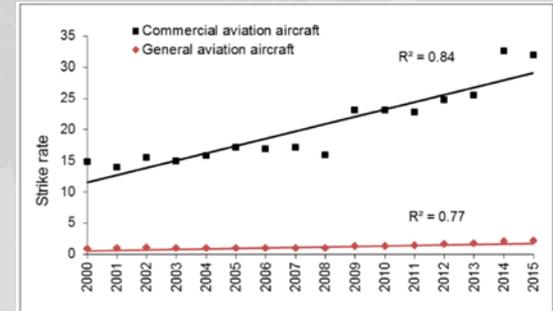
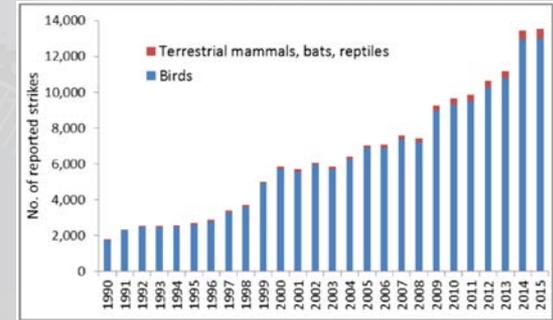


CRJ 100/200 aircraft struck at 5000' AGL by a soaring bald eagle in Minnesota in May 2015, causing \$100K of damage and forcing an overweight return landing.

For commercial aircraft in the USA, since 2000 the number of reported bird strikes ...

... and the strike rate have *increased* significantly ...

... while the damaging strike rate has *decreased* over that period ... **but not off-airport** (>1500' AGL), where wildlife management options are limited.



Source: Dolbeer, et al. 2016. Wildlife Strikes to Civil Aircraft in the United States, 1990-2015.

FAA's Four-Component SMS Functional Model

The Four SMS Components

Safety Policy

Establishes senior management's commitment to continually improve safety; defines the methods, processes, and organizational structure needed to meet safety goals

Safety Assurance

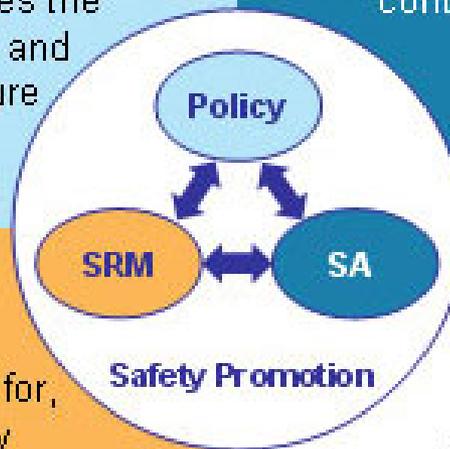
Evaluates the continued effectiveness of implemented risk control strategies; supports the identification of new hazards

Safety Risk Management

Determines the need for, and adequacy of, new or revised risk controls based on the assessment of acceptable risk

Safety Promotion

Includes training, communication, and other actions to create a positive safety culture within all levels of the workforce



Do we have adequate night-time and off-airport bird-strike risk controls?

<https://www.faa.gov/about/initiatives/sms/explained/components/>

How can airports assess off-airport and night-time bird-strike risk and advise stakeholders ?

RISK ASSESSMENT MATRIX

AVIATION DIVISION – FACILITY AND INFRASTRUCTURE OPERATIONS - RISK MATRIX

LIKELIHOOD		Description	IMPACT TO AVIATION DIVISION				
Measure	Description		Financial	Operational ¹	Emergency Prepare/Safety ²	Reputation/Community	Employees ³
When voting, the overall combined impact should be considered on the areas identified above.							
ALMOST CERTAIN Something already happening on a regular basis.	Almost Certain	Critical	Broad <u>and</u> sustained interruption to airport activities. Multiple people <u>and</u> key systems impacted. Full recovery and return to normal operations will be gradual and over a long time period.				
LIKELY Something already happening on a regular basis but is sporadic in nature.	Likely	Major	Broad <u>and/or</u> sustained interruption to or cessation of operations. Multiple people <u>and/or</u> key systems impacted. Full recovery and return to normal operations estimated to be long term.				
POSSIBLE Something not happening currently, but anticipated to happen.	Possible	Moderate	Impacts require sustained and/or complicated workarounds; some operation Recovery will take some time. Some people and key systems impacted.				
UNLIKELY Something not happening but it could in very infrequent cycles.	Unlikely	Minor	Workarounds are relatively easily to implement and maintain. Few operation Recovery will take relatively little time. Fewer people and key systems impacted.				
RARE Something not happening and not anticipated to happen.	Rare	Insignificant	No impact or consequence that cannot be easily absorbed into daily operation remain fully functional. Today's investment decisions have no future impact				



Risk Map

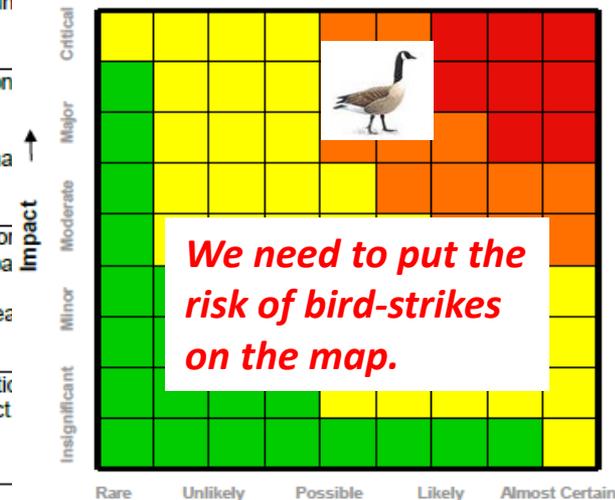


Table Notes:

- 1 Operational impacts are in three main areas: (1) Airline and concession tenants/Port's revenue (2) Slowing down the CIF traveling customers.
- 2 Safety to Port employees, our tenants, and the public or traveling customer
- 3 Impact on employee staffing and employee engagement

Jeff Hollingsworth, Port of Seattle, ERM Project, Audit Committee, 20 May 2014

Likelihood →

Avian radar data can fill gaps in visual observations and bird strike data

Safety Management Implications	Avian Radar Data	Visual Observations	Bird Strike Data
Provides <u>unattended</u> , real-time safety/risk alerting	Yes	No	No
Supports investigation of root cause for each bird strike	Yes	No	Limited
Supports safety risk assessment at night	Yes	No	Limited
Supports safety risk assessment in fog	Yes	No	Limited
Supports safety risk assessment off-airport	Yes	Expensive	Limited
Provides quantitative baseline spatial hazard data to prioritize habitat management	Yes	Expensive	No
Provides quantitative baseline temporal hazard data (abundance hourly, daily, monthly)	Yes	Yes	Yes
Provides Safety Risk Management leading indicators (KPIs e.g. hourly, daily, uptick/downtick) & weekly dashboard components (e.g. MTD, YTD) to monitor known hazards and measuring the effectiveness of mitigations	Yes	Yes	No
Provides Safety Assurance metrics such as year over year baseline trends (e.g. abundance, near-miss statistics, et cetera)	Yes	Yes	Yes
Promotes increased awareness of bird strike risks	Yes	Yes	Yes

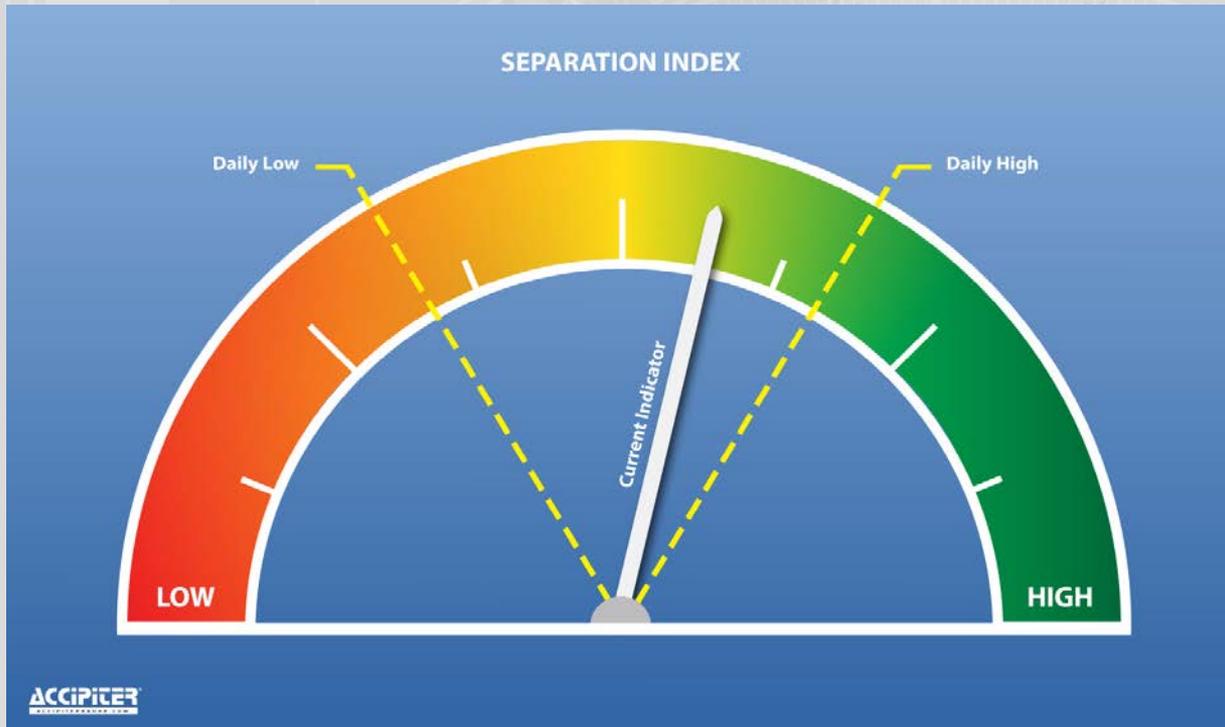
What are the differences between the three data sources?

Data Source Characteristics (typical)	Avian Radar Data	Visual Observations	Bird Strike Data
Proactive or reactive monitoring	Proactive	Proactive	Reactive
Monitoring – temporal duration	24/7/365	1 hr/day - daytime 5 days/week	n/a
Monitoring – spatial extent	0-10 km 0-360°	Several locations in aerodrome	Within flight corridors
Sampling Rate	1/2.5 seconds	1/minute	1/day to 1/month
Bird trajectories {lat,lon, alt, versus t}	Yes	Limited	No
Bird speed	Yes	No	No
Flocking behaviour	Yes	Yes	Yes
Data – night/off-airport/fog	Yes	No	Yes
Data – on ground/buildings	No	Yes	No
Size	Limited (RCS)	Yes	Yes
Species	No	Yes	Yes

What are some characteristics of a meaningful SMS key performance indicator (KPI) for bird-strikes at an airport?

1. Easy to understand and communicate
2. Provides useful awareness for all airport stakeholders
3. Leading indicator: i.e. provides predictive warning of high risk conditions
4. Quantitative indicator of risk
5. Customizable to the risk posture of each aerodrome, flight crew and airline.

Aircraft/bird separation index is a measure inversely proportional to bird-strike risk

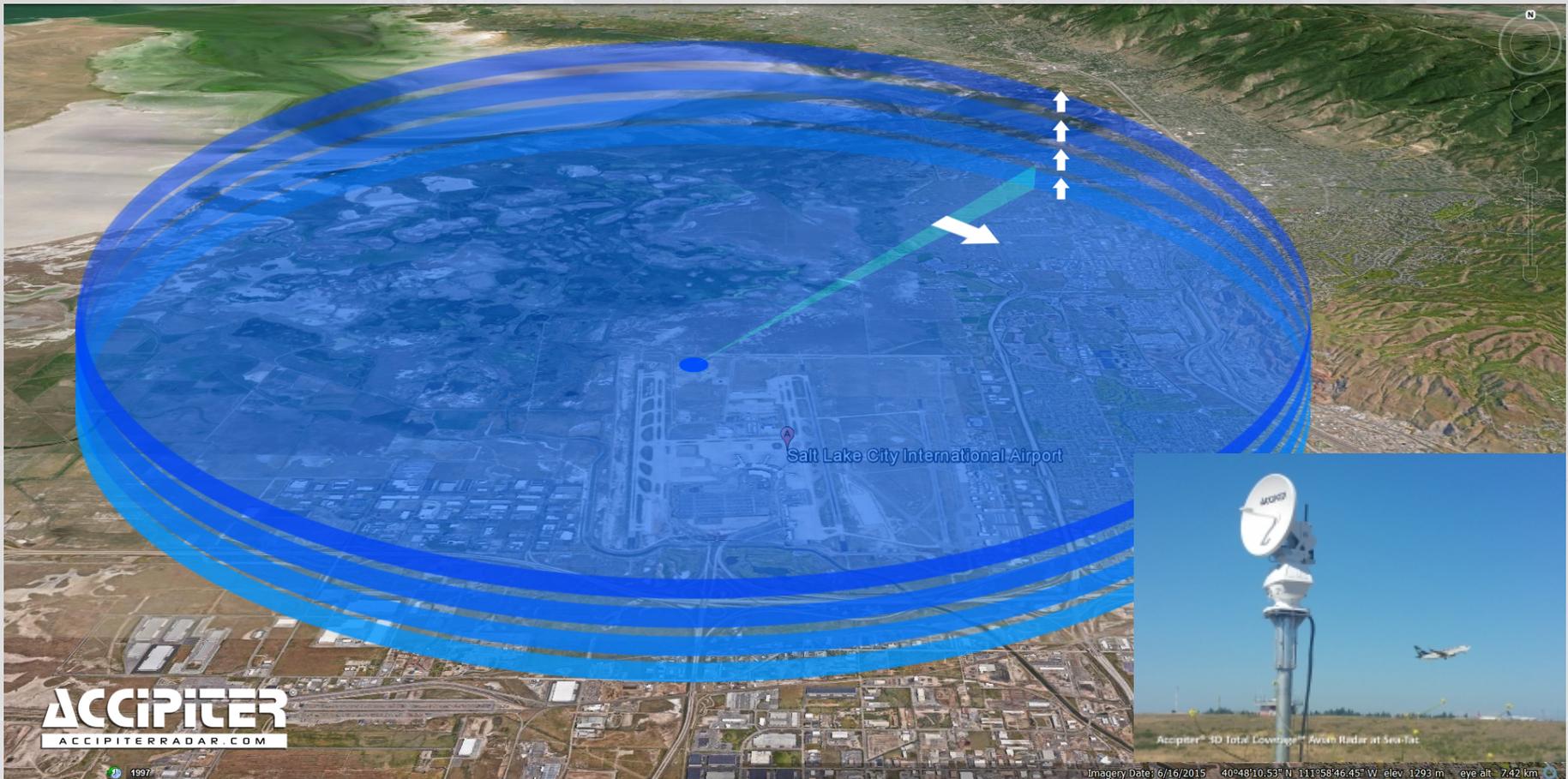


- The need for airspace and airside management to maintain minimum separation is broadly understood and accepted (Ref1):
 - Aircraft to aircraft
 - Aircraft to ground
 - Aircraft to vehicles
- Why not have each airport define a separation minimum for aircraft/bird separation index?
- Loss of separation means birds and aircraft are in conflict

- A near-miss (Ref2,5) involves a bird/flock occupying nearly the same airspace as an aircraft at the same time.
- Aircraft/bird separation index is different. It is a key performance indicator (KPI) based on the geometric/statistical separation between the airspace used by aircraft and the airspace used by birds over a period of time on the order of minutes. The KPI is updated on-the-fly. It can be used as a risk measure to keep birds and aircraft out of “conflict”.

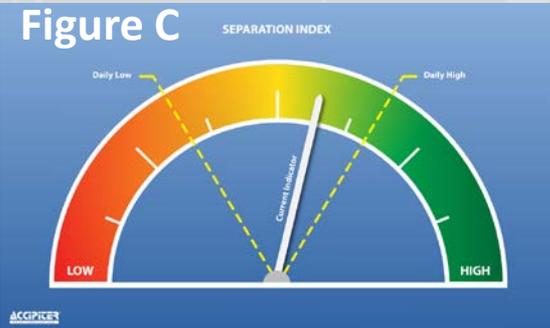
How does it work?

- Place radar in suitable volume scanning pattern.
- Track birds and aircraft in separate channels in 3D (Ref3)
- At regular intervals on the order of minutes, perform the separation index calculation, and update the display.
- Issue a conflict alert if index falls below airport's separation minimum.



Aircraft/bird separation index algorithm

Figure C



- Assemble the 3D trajectories for aircraft and birds for the current separation index update time period. (see Figure A)
- Calculate the aircraft/bird separation index for these data (see Figure B)
- Update the current indicator on the display (Figure C)

Figure A

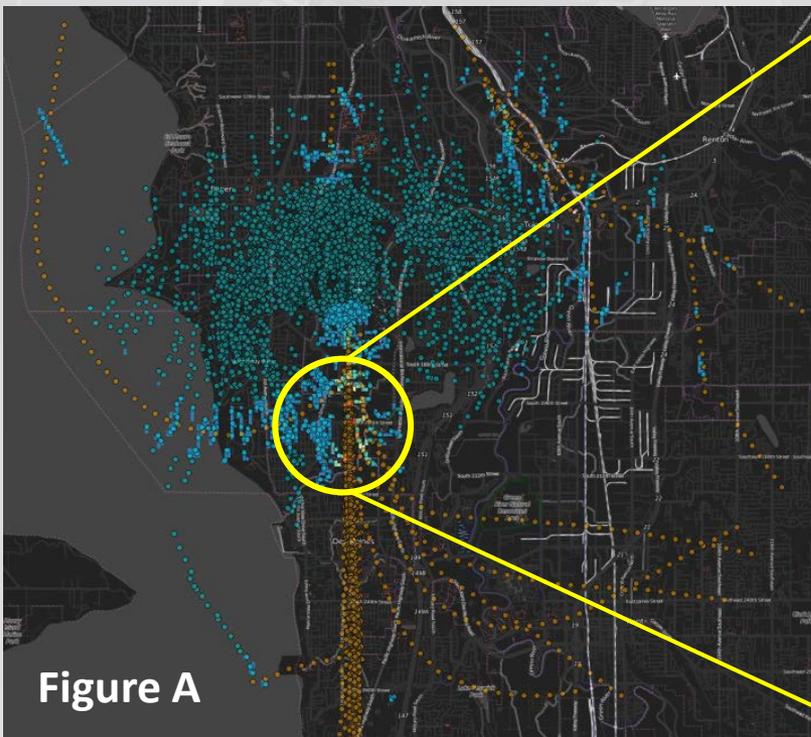
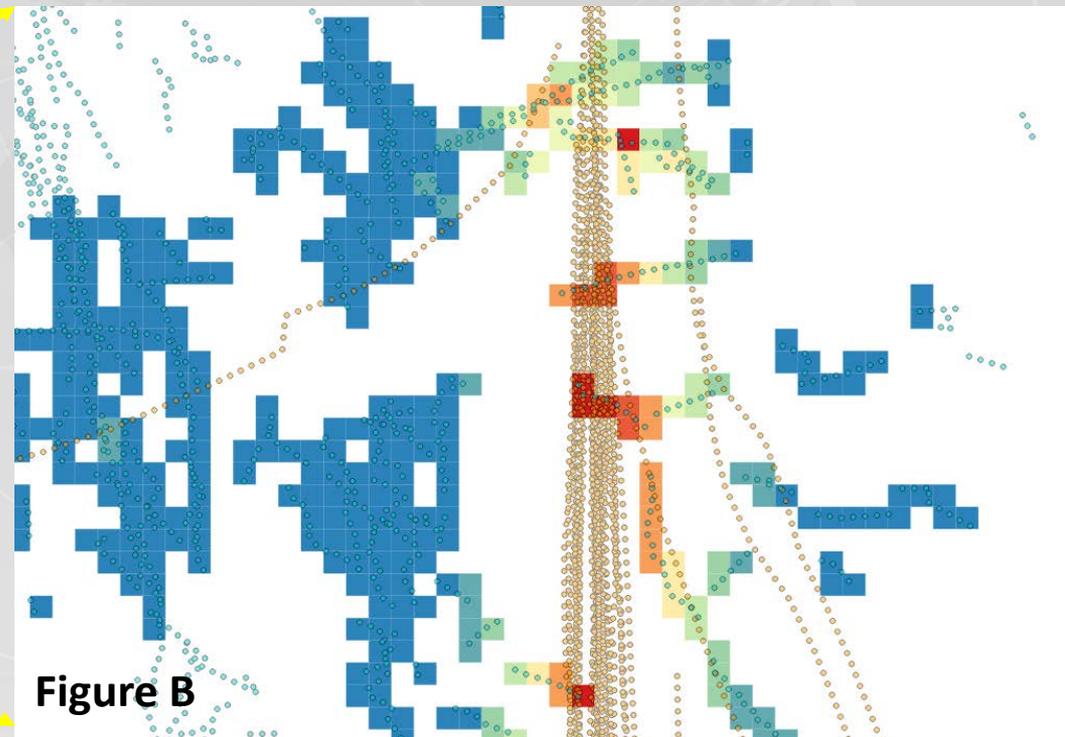
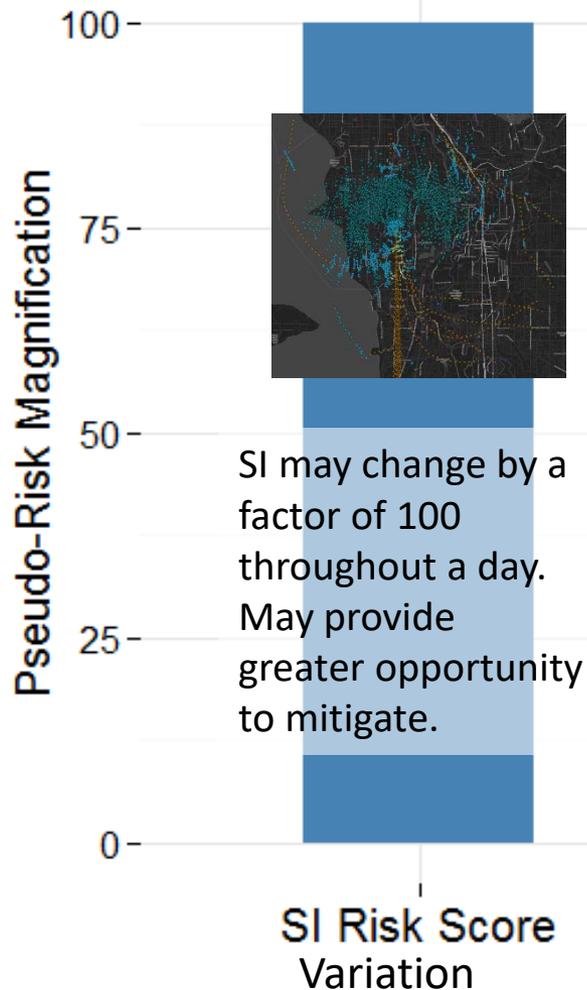


Figure B



We believe the Separation Index (SI) will provide significant *pseudo-risk* magnification making it a good leading indicator of bird-strike risk



On order of ~10 a day. By the time you detect a change in near-misses, you might have time to mitigate.



Notionally ~1 strike a day. By the time you have one, it's too late to mitigate the bird strike.

INCIDENT_DATE	STATE	AIRPORT_ID	AIRPORT
12/22/2015 12:00:00 AM	WA	KSEA	SEATTLE-TACOMA IN
12/15/2015 12:00:00 AM	WA	KSEA	SEATTLE-TACOMA IN
12/14/2015 12:00:00 AM	WA	KSEA	SEATTLE-TACOMA IN
12/10/2015 12:00:00 AM	WA	KSEA	SEATTLE-TACOMA IN
12/8/2015 12:00:00 AM	WA	KSEA	SEATTLE-TACOMA IN

- As civil airports adopt SMS, now is the time to start using avian radar to characterize night-time and off-airport bird-strike risk. There is no other viable way to provide a leading indicator of this risk so that it can (i) be put on the same risk map along with all other risks; and (ii) generate tactical alerts to mitigate risk.
- Instead of *birds in the vicinity of the airport*, we are on our way to having *aircraft/bird separation low, moderate and high* as a function of time; and we can drill-down the data further to characterize localized areas that are driving the separation index down.
- In 2012, we reported on how avian-radar-derived information could enhance awareness of pilots and air traffic controllers (Ref4). Separation Index could be used for NOTAMs, ATIS, & ATS communications.
- Each airport could set their own risk thresholds and future targets.
- Each airline and aircrew could apply the separation index to their particular decision making, accounting for aircraft type and other factors.
- Next steps are to use historical 3D aircraft and bird data collected at SeaTac to refine the aircraft/bird separation index, tune it, and then start testing it in actual operations.

1. [https://en.wikipedia.org/wiki/Separation_\(aeronautics\)](https://en.wikipedia.org/wiki/Separation_(aeronautics))
2. Thurber-Duggan, B. and C. Bowser, “Exploring the relationship between near-miss events and bird strike risk”, North American Bird Strike Conference, Montreal, Quebec, 15-17 September 2015
3. Beason, R., T.J. Nohara and P. Weber. 2013. Beware of the Boojum: caveats and strengths of avian radar. Human-Wildlife Interactions 7(1) 16-46.
4. Nohara, T.J., R. Sowden, R. Perkins, and R. Beason. 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, Stavanger, Norway, 25-29 June 2012.
5. Klope, M., R. Beason, T.J. Nohara and M. Begier. 2009. Role of near-miss bird strikes in assessing hazards. Human Wildlife Interactions 3(2) 208-215.