BIRDSTRIKE – PERCHED OUT ON A LIMB.

Jeff McKee, Kylie Patrick, and Phil Shaw
Avisure, West Burleigh, Queensland. *jmckee@avisure.com.au*

Abstract

ATSB reports that bird strike was the leading single cause of RPT operational occurrence (1998-2007) in Australia and major airlines estimate resulting losses in excess of $2M per year. Paradoxically bird strike management in Australia currently sits isolated on a safety limb, its efficacy restricted by unilateral and unintegrated management approach – by default strike risk assessment and management responsibility is, for all practical purposes, relegated to aerodrome operators with most other industry sectors blissfully uninvolved. When reduced to its basic elements bird strike mitigation is analogous to preventing mid-air collision and weather related accidents. However while separation and weather mitigation practices are embedded at every level of the industry bird strike awareness and mitigation practices are not. Here we present a plan to reduce bird strike in Australia using long standing legislative and operational procedures and recent innovative technology.

Background

Bird strike (including bats and other wildlife) is the commonest cause of in-flight collision. Each year in Australia between 1200 and 1400 bird strikes are reported. The current RPT strike rate is between 6-7 strikes/10000 movements (ATSB 2008) and from 1998 – 2007 bird strike represented the leading single cause (16%) of all operational occurrences (ATSB 2009). The costs associated with bird strike in Australia are poorly documented but are estimated at around $10M-15M/ year for the major domestic RPT carriers combined.

There are real and confounding reasons why strike rates appear to be increasing in Australia. ATSB (2008) suggest increased reporting diligence is the primary reason. While bird surveillance and strike reporting rates have increased since reporting became mandatory in 2000 other factors are also likely to contribute to a real increase in strike frequency.

Over the last 30 years there have been worldwide redistributions of bird species into urban areas with a concomitant increase in aircraft conflict rates (Buurma 1996; Sauer *et al* 2006; Dolbeer and Eschenfelder 2003). In Australia similar redistributions have been noted in high strike risk taxa such as the Australian White Ibis (*Threskiornis molucca)* and flying foxes (*Pteropus spp).* Since 1972, Australian White Ibis populations have dramatically increased around urban centres along the eastern seaboard in response to protracted inland drought (Shirreffs *et al* 1997). Australian White Ibis strike and survey rates increased simultaneously in regional and metropolitan airports from Cairns to Melbourne (pers obs). From 2000 onwards the rate of increase in flying fox strikes was eight times the rate of increase for all strikes (derived from ATSB strike database) suggesting that changed reporting rates do not alone account for the increase strike rate (also see Patrick *et al* 2008; Parsons *et al* 2009). The hypothesis that flying fox numbers are increasing in urban areas is supported by parallel ecological observations including the recent emergence of diseases in humans and livestock that are carried by these animals (McKee *et al* 2000; McKenzie & Field 2004).

A second factor likely to contribute to a real increasing strike trend is changing aircraft type. Newer aircraft that have larger frontal areas, fewer quieter engines and higher V_{ref} are likely to see increased strike rates independent of bird numbers (Dolbeer 2007; Shaw & McKee 2008). ATSB (2008) report that RPT aircraft are 16 times more likely to have a reported strike than GA aircraft. While this is a coarse estimate likely to be confounded by differences in reporting rates between the two operational categories, a more detailed analysis at regional levels supports the idea that there is a significant discrepancy in strike susceptibility between aircraft types. At selected regional centres we found that strikes rates were 10-15 times higher in high capacity RPT jets than in low capacity RPT turboprop aircraft (*pers. obs.*). Here differences in reporting rates are unlikely to be significant.

Notwithstanding changes in bird distribution, reporting rates and aircraft type the most significant factor contributing to strike rates in Australia is that current strike management systems and approaches are limited and relatively ineffective. Strike management responsibility has been, for all practical purposes, relegated to aerodrome operators with most other industry sectors only peripherally or sporadically involved. Given the acknowledged frequency and cost of bird strike this compartmentalisation of responsibility is somewhat paradoxical and is not representative of the way other air safety risks are managed.

Here we compare and contrast the safety systems and approaches used for weather and mid air collision mitigation against those used for bird strike mitigation. We present case studies that highlight a general industry inability to assess bird strike risk, to make sound operational judgements and to implement effective management.

Case Reports

Case 1. Reference Anonymous (2009)

The Italian ANSV released its report on the significant B767 incident at Rome in July, 2007. Shortly after lift off the aircraft ingested at least 30 Yellow-legged Gulls into both engines. Both engines began significant vibrations and one engine over-temped. The crew dumped fuel and returned for a safe landing. The report noted that the crew noticed the birds during their taxi out, discussed the birds but did not report the birds nor did they ask for a bird scarer to disperse the birds prior to takeoff. Instead they took off, damaged their aircraft and placed their passengers at risk. The ANSV found that *"...the underestimation by the flight crew of the risks connected with the presence of birds, observed during the taxi, was a contributing factor..."* The ANSV did not recommend training or procedures for the crew.

Case 2. Reference Eschenfelder P (2010)

In February 2010 a B757 from the same company as in *Case 1* departed Tampa, Florida in the US. On taxi for departure ATC advised the crew of birds on the departure end of the RWY and the previous departing A321 advised that they needed to manoeuver around the birds after liftoff. Despite this advice the crew elected to depart regardless and on liftoff hit a buzzard which caused fuselage damage.

Case 3. Reference Anonymous (2009)

In Australia in 2006 a B767 struck a flock of 30-50 unspecified birds on departure from Melbourne. The multiple strike caused the left engine to vibrate and the vibration indicator to read significantly above the safe level. The crew reduced power to lower the vibration level and continued on their flight to Sydney. Later inspection revealed bird strikes all over the aircraft, including ingestions into both engines and fan blade damage in both engines. The ATSB faulted the crew and the airline as *"...the decision to continue the flight to Sydney was made without a full appreciation of the aircraft damage and the potential risks to the safe conduct of the flight...."*

The crew had no training regarding bird strikes, nor was any required. The operator had no bird strike policy other than to report strikes, nor was any required. Subsequently the report found that

"...As a result of this incident the aircraft operator issued a Flight Standing Order on 6 October 2006 that provided a policy for flight crew in the event of a bird strike on any of their twin engine aircraft fleet." The policy states: Any time a bird strike to an engine (or engines) is known to have occurred and there is obvious sign of engine damage, then a landing at the nearest suitable airport should be accomplished.

Case 4. Reference Dale (2009)

Until fairly recently the only notification procedures for wildlife hazard in most Australian airports was either a NOTAM or permanent entry in the ERSA stating "Wildlife hazard exists". The ineffectual value of this sort of notification was highlighted by a court judgement in Croatia which held an aerodrome operator liable for a strike to a departing B737 in 1998. The aerodrome operator pleaded that they had a permanent NOTAM to warn air carriers of "birds in the vicinity of the runway". The court ruled that the NOTAM only acknowledged that a problem existed and did not equate to meaningful mitigation.

Overview of cases

Both *Cases 1 and 3* underscore a lack of aircrew and corporate awareness of how to operationally assess and mitigate a bird risk hazard. In Australia aircrew are not formally trained in bird recognition or bird behaviour and hence have no frame of reference to quickly assess and offset the risk to their operation. These two cases also highlight the reluctance of regulators to enact the obvious – that is, to ensure that aircrew are trained appropriately.

Case 2 underscores corporate inability to learn from prior mistakes. In Tampa, despite the Rome incident 3 years prior and despite sound advice from ATC and another crew, the protagonists elected to press on regardless. In Australia ATC and aerodrome reporting officers in CTAF often broadcast imminent wildlife hazards. Rarely do aircraft hold, delay departure or execute a missed approach in response to these warnings. Avoiding “press-on-itis” is a constantly reiterated Airmanship theme when training crew to avoid bad weather, fuel depletion, volcanic ash and last light. How come bird hazards missed out?

Case 4 is indicative of a crude and tokenistic approach taken to mitigation. Clearly “Wildlife hazard exists” is not operationally meaningful information and is akin to summarising weather hazard at an aerodrome by saying “Thunderstorms occur at this aerodrome”. If the latter was the only meteorological information available to pilots there would be a lot more weather related accidents. Here the aerodrome operators attempt to offset liability backfired on them. But this case also highlights the plight of aerodrome operators in that they alone tend to shoulder the burden of responsibility for strike mitigation. Bird movements are part of an open system. Even if an aerodrome operator could remove all birds from his field he cannot control transiting bird movements or changes in movement frequencies associated with climatic, land use and environmental factors outside his boundary. Relying almost solely on aerodromes to manage this problem and then testing their liability makes about as much sense as suing them for wind shear accidents that occur inside their boundary fence.

The current bird strike safety model

When reduced to its basic elements bird strike is essentially an operational air safety problem with a biological background. It is:

1. A separation issue, analogous to aircraft collision hazard.
2. An environmental issue, analogous to weather hazard.

However while aircraft separation and weather mitigation practices are highly redundant and embedded at every level of the industry bird strike awareness and mitigation practices are not.

With the exception of some aerodrome reporting officers very few people in the industry have any understanding of bird movements or any clear appreciation of how to asses strike risk to a particular operation. Hence the burden of mitigating strike mostly resides with this aerodrome operations staff sometimes with the help of external biologists. At primary airports traffic controllers will often advise immediate bird risks when they are noticed. However this courtesy is normally done as time and traffic permits. Despite their best efforts constant bird hazard surveillance with detailed risk information is currently beyond the training, scope and resource of ATC. With current resource levels ATC cannot be expected to carry out bird-aircraft separation at the expense of core separation duties.

The probability of a bird strike is dependent on the probability of a bird track intersecting an aircraft track. Yet rarely is track data assessed and analysed in a way that would derive any immediate or predictive operational value. The consequences of a bird strike are dependent on a range of species specific characteristics such as weight, age and behaviour. Yet few in the industry have knowledge of these attributes and those that do are often remote from the operational net.

Like aircraft movements and weather, bird movements are complex and dynamic; bird hazard risks are constantly in flux. Yet most mitigation procedures are based on either sporadic dispersal or longer term habitat management. Neither of these measures are particularly good at resolving an immediate risk to an aircraft and neither adequately address threats beyond the aerodrome boundary.

Weather and separation notification procedures are based on consistent data collection and collation, a standardised redundant series of forecasting and reporting methods and these notifications are linked by multiple communications nets. The operational requirements associated with increased weather or traffic hazards are clearly defined and backed by concise legislature. No hazard forecasting and only limited ad hoc reporting procedures exist for wildlife hazards. No operational requirements are specified. In isolated circumstance some operators now carry extra fuel under some circumstances.

Beyond mandatory reporting bird strikes are rarely investigated. Serious accidents resulting from bird strike may be investigated using the standard apparatus but rarely if ever do these investigations dissect or attempt to resolve the biological components of the event (for example see
NTSB Aircraft Accident Report 10-03.)

Table 1 below summarises a comparison of some of the systems and elements used to mitigate aircraft collision, weather risk and bird strike risk. Elements enacted on an ad hoc, courtesy or opportunistic basis are in brackets

Table 1 Comparison of some of the safety elements that mitigate weather, separation and bird hazards.

SAFETY BARRIER	CURRENT		
	Weather Hazard	**A/c Collision hazard**	**Wildlife Collision Hazard**
Hazard awareness training - aircrew	MET NAV APO	FRP AL APO IREX VFR	
Hazard awareness training - air traffic controllers	MET NAV APO	FRP AL APO IREX VFR	
Hazard awareness training - aerodrome safety officers	Suitably trained	APN MAN FRP GND	Suitably trained (sometimes)
Ethics training	AIRMANSHIP	AIRMANSHIP	
Currency and testing procedures	YES	YES	
Hazard forecasting system	TAF ARFOR TTF VOLMET	ATC PROC	
Hazard reporting system	ATIS METAR SPECI VOLMET AERIS	ATIS ATC PROC	(ATC PROC)
Regional real time hazard detection and avoidance systems	Doppler Wx AIREP	SSR	(ATC PROC)
On board real time hazard detection and avoidance systems	Wx RADAR	TCAS	
Significant Risk Event Notification	SIGMET AIRMET BCHA VOLMET	NOTAM	(NOTAM ERSA)
Operational procedures for forecast or actual hazards	AIP IREX	AIP IREX	
Occurrence investigation procedures	ASI	ASI	Mandatory Reporting
Occurrence forensic procedures	ASI	ASI	(some)
Accurate, current and meaningful data collection and analysis	YES	YES	ATSB Strike Database
Legislative framework	CAR CASR AIP CAO VFG DAP	CAR CASR AIP CAO VFG DAP	CASR 139 MOS AD
Management program - aircrew	CO SOP	CO SOP	
Management program - aircraft operator	CO SOP	CO SOP	(Some operators)
Management program - aerodrome operator	AD MAN	AD MAN	(Some AD)

Discussion and recommendations

We propose that the main reason for the frequency of bird strike in Australia is an isolated and limited strike management system run primarily by one industry sector, the aerodrome operators. While it is true that most bird strikes occur on or in the vicinity of aerodromes the same argument could apply to incidents or accidents involving wind shear, failure of separation, controlled flight into terrain, and a host of others that predominantly occur at low level. The latter occurrences are comparatively infrequent: the knowledge base and safety systems associated with these risks are highly redundant and embedded at every level in the industry from *ab initio* training to standard operating procedures.

Ideally bird strike prevention should be addressed using the same multilateral and embedded systems we use to mitigate mid-air collisions and weather related accidents.

1. Responsibility for maintaining separation between birds and aircraft should be devolved across the industry to include informed air crew, air traffic control, surrounding land users/land authorities and air operations support services – in addition to aerodrome operators.
    a. While responsibility is restricted, mitigation will remain costly, piecemeal, unintegrated and ineffective. Bird strike will continue as a significant industry cost and safety risk.
2. General industry awareness and knowledge of wildlife hazard is almost non-existent – if meteorological awareness levels were the same we would have a significant increase in weather related incidents.
    a. Bird identification, behaviour and strike risk management courses should be introduced for all LAME, PPL, CPL, ATPL, ATC training syllabuses.
    b. Animal welfare and conservation ethics should be incorporated into this syllabus. Is bird strike just “road kill” in the air? *“………… bird strike, while frequent and a common cause of minor damage, delay and cancellation, rarely results in fatal accident or hull loss…………………on the other hand bird strike is almost always fatal to the animal involved; a significant fact <u>never</u> addressed in industry statistics and one that highlights the cavalier, almost dismissive disregard the industry has towards the complex ecosystem in which it operates…………”*
    c. The application of bird identification and behaviour knowledge should be routinely tested as with other standard currency requirements.

2. With isolated exceptions there is no standardised wildlife hazard notification system that gives operationally meaningful data.

    a. Introduce both terminal and en route wildlife hazard notification and reporting systems that are site specific and detailed, (aka the TAF METAR ARFOR systems in use for weather).

    b. Notification systems should be real time, extend beyond the aerodrome boundary and should be flight path related.

    c. We need defined operational requirements that match the wildlife hazards levels identified in the reporting systems.

        i. e.g. - If wildlife hazard level alpha exists or is forecast within 20mins of your ETA then you are required to carry 30mins HLDG fuel OR plan ALTN and you are required to confirm a reduction in hazard level before commencing a published approach or turning final. Confirmation from ATC on APP/TWR FREQ or Aerodrome Safety Officer on CTAF or via a responsible person delegated for this purpose.

3. Many aerodrome strike management programs address bird biological considerations but do not adequately integrate air operational procedures.

    a. Strike management biologists need to be cross trained in aerodrome operating procedures and need a thorough understanding of aircraft recognition, performance characteristics as well as IFR and VFR DAPS. It's all about preventing bird tracks intersecting with aircraft tracks – not a nebulous and unmonitored attempt to reduce bird numbers in an 'area' defined by the aerodrome boundary.

    b. DAPS design, particularly new RNAV procedures, should consider available knowledge on bird spatial and temporal movement patterns

    c. Strike risk analysis should be site and time specific and it needs to be adaptive. It needs to address aircraft type/operations that are strike susceptible as well as birds/demographics that have an increased strike risk.

4. All of the above are predicated on frequent, standardised and accurate surveys that detail bird behaviour, strike patterns and aircraft movements at an aerodrome.

    a. Regulators and operators should ensure that appropriate data collection and database management procedures are mandated & standardised (at least nationally) so that accurate analysis is possible.

b. Primary strike data may not be a very useful risk indicator, particularly at aerodromes with small movement rates. Management should be monitored against pyramid indicators such as bird infringement rates into critical movement areas. For example; risk of aircraft mid-air collision is not measured against number of mid-air collisions; it is assessed using trends in number of FS (Failure of Separation) and VCA (Violations of Controlled Airspace) incidents.

5. Available strike management technology should be introduced and integrated with ATC flight planning and airport security procedures. These include:

    a. En-route Avian Hazard Advisory System based on Doppler Weather Radar (NEXRAD AHAS)

    b. Aerodrome bird radar and strike mitigation systems (DeTect)

6. Many strikes even those involving significant damage or delay are not investigated. They are often poorly documented with little attention to accuracy. Information necessary for future strike prevention and for developing forecasting and notification systems is lost.

    a. Significant strike investigations (Shaw *et al* 2009) should be routinely carried out with the emphasis on bird identification and analysing why the bird(s) and the aircraft were occupying the same time and place.

        i. Investigators should be trained and validated through ASASI/ISASI.

        ii. Legislation to mandate SSI using threshold criteria may be warranted.

    b. Regional ecological events can significantly change strike risk. E.g. eruptive flowering events can shift flying fox movements into conflict with aircraft movements.

        i. We need a standard mechanism for detecting assessing & reporting Significant Strike Risk Events (SSRE) so that air operations can be modified accordingly

In conclusion, preventing bird strike should be easy; the necessary systems and approaches are already in use and are effectively applied to most other operational safety issues. Emerging radar technology is available to support these systems. The challenge is to motivate and involve all industry sectors and to find cost effective ways of applying those systems to wildlife management.

Acknowledgments: The authors sincerely appreciate discussions and support from many in the industry in particular John Allan, Graeme Gordon, and Paul Eschenfelder.

References

ATSB 2008. An analysis of Australian birdstrike occurrences 2002-2006, *Australian Transport Safety Bureau safety investigation report AR-2008-027*

ATSB 2009. Australian aviation safety in review: 1998 – 2007 *Australian Transport Safety Bureau transport safety report AR-2008-079*

Anonymous 2009. Careless or reckless? Aviation Wildlife Mitigation 2009 3(1):2

Buurma L. 1996. Superabundance of birds: trends, wetlands and aviation. *Pp 43-50 in Proc. of the 23rd Bird Strike Committee Europe Meeting. London,England*

Dale L. 2009. Personal and corporate liability in the aftermath of bird strikes: a costly consideration *Human Wildlife Conflicts* 3(2):216–225

Dolbeer R. 2007. Bird damage to turbofan and turbojet engines in relation to phase of flight - why speed matters. 2007 *Bird and Aviation 27(2): 1-9*

Dolbeer R and Eschenfelder P. 2003. Amplified bird-strike risks related to population increases of large birds in North America. *Pp 49-67 in Proc. of the 26th International Bird Strike Committee meeting, Warsaw, Poland*

Eschenfelder P. 2010. pers. comm..

McKee J, Hall L, Field H and Shaw P. 2000. Recognition of emergent disease risk in wildlife populations. Proc. Ann Conf. Int. Soc. for Ecosystem Health, Brisbane, July 2000

McKee J, Shirreffs L and Shaw P. 1997. An overview of the biological, economic and air safety aspects of bird strike to commercial air operations. *Combined FAC, BASI, NPWS & SCC Meeting Nov 1997. Sydney Airport, Bird Hazard Management.*

Mackenzie J and Field H. 2004. Emerging encephalitogenic viruses: lyssaviruses and henipaviruses transmitted by frugivorous bats. *Arch Virol Suppl. 2004;(18):97-111.*

Parsons J, Blair D, Luly J and Robson S. 2009. Bat Strikes in the Australian Aviation Industry *2009 J Wildlife management 73(4):526–529*

Patrick K, McKee J and Shaw P. 2008. A practical approach to managing the flying-fox hazard at a tropical Australian airport: an example of successful proactive risk management *Proc International Birdstrike Committee Meeting Brasilia, Brazil Nov. 2008*

Sauer, J. Hines J and Fallon J 2006. The North American Breeding Bird Survey, Results and Analysis 1966 - 2005. *Version 6.2.2006, U.S. Geo-logical Survey, Patuxent, Wildlife Research Center, Laurel, Maryland USA*

Shaw P, McKee J and Patrick K. 2009. Significant Strike Investigations. *Proc Joint Conf. Australia & NZ Association of Air Safety Investigators. Rotorua NZ 2009*

Shaw P. and McKee J. 2008. Risk Assessment: quantifying aircraft and bird susceptibility to strike. *Proc International Birdstrike Committee Meeting Brasilia, Brazil Nov. 2008*

Shirreffs L, McKee J, Shaw P, Ludgate H, MacQueen A, Charlie D, Armstrong T, Campbell J and Fletcher A. 1997. Integrated management of the public health, air safety, and environmental hazards associated with an over abundant native species: The Australian White Ibis, *Threskiornis molucca*. *Proc. Aust. Wildlife Management Soc. Meeting, Armidale, Nov.1997*