BIRD HAZARD IN BRAZIL
2006-2010

Cyanopsitta spixii / Spix's Macaw / Arara Azul

BIRD HAZARD IN BRAZIL
2006-2010

OBJECTIVE

- *Identify the evolution of bird hazard in Brazil between 2006 and 2010*

AGENDA

- *Introduction*
- *Literature review*
  - ✓ *Probability*
  - ✓ *Pareto's analysis*
- *Sample space*
- *Height of strikes above ground level (AGL)*
- *Phase of flight*
- *Bird species involved*
- *Aircraft components damaged*
- *Discussion and conclusions*

BIRD HAZARD IN BRAZIL 2006-2010

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Sample space

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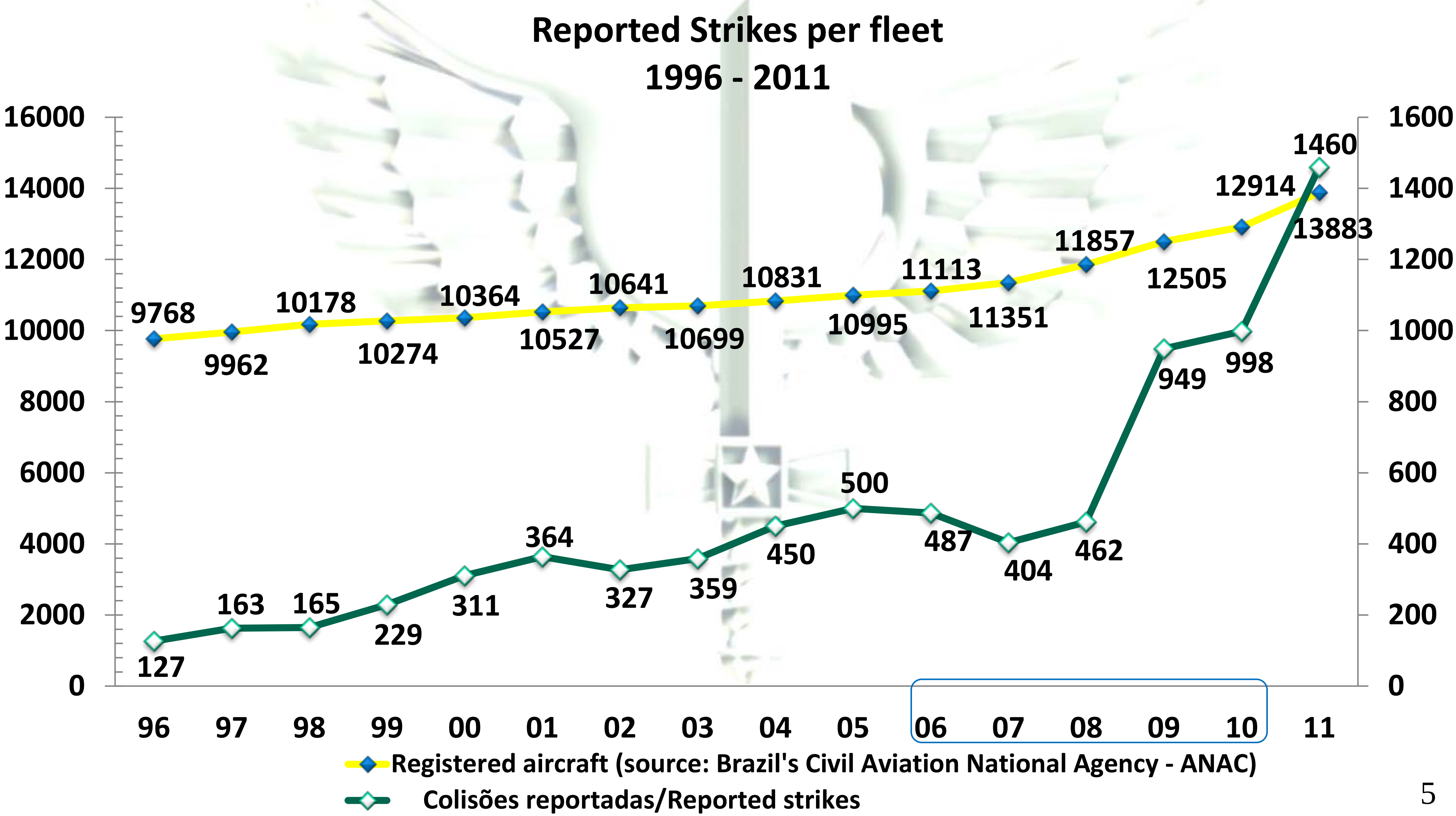

BIRD HAZARD IN BRAZIL
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- ***Probability***

To Fernandes (1999) the fundamental aspect in probability is the notion of random experiment. Random experiment is a process that, at a given attempt, results in one of various possible values.

Bussab and Morettin (2004) affirm that the distribution of frequency is an important tool for the evaluation of a random phenomenon. The frequencies are estimates of the probability of an event to occur.

✓ ***Probability***

Ericson (2005) says that the probability* of a component not failing is given by the Equation 1:

$$P1 = 1 - e^{-\lambda T} \qquad (1)$$

Where:

- λ is the failure rate;
- T is the time length of exposure.
- *e* is a constant.

* Reliability - "The probability that an item will perform a required function without failure under stated conditions for a stated period of time."

- ✓ ***Probability***

Ericson (2005) also states that, if $\lambda T < 0.001$, then the probability of a component failure is given by the equation 2:

$$P2 = \lambda . T \qquad (2)$$

✓ *Probability*

Thus the Equation (3) expresses the bird strike probability (***Pc***) proposed in this paper:

$$P_c = \frac{C_p.T}{M_p} \qquad (3)$$

λ - will be the number of collisions in the period (***Cp***) divided by the number of aircraft movements in the same period (***Mp***)

T will be the time length of exposure or the number of movements that a specific aircraft will carry out in the airport under evaluation.

- ✓ ***Pareto's analysis***

Pareto`s analysis is a heuristic that distributes the causes of a problem and calculates the relative and accumulated percentages from each component of the issue under study. In this way the researcher proposed the reason 20-80 that can be applied in different contexts (DOUCHY. 1992).

*(Vilfredo Pareto, 1897; Joseph Juran, 1950)

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- Period: between **2006** and **2010**;
- Strikes: **3,300**;

  Strikes with land animals and bats: **61;**
- Bird strikes: **3,239**

  Strikes in **104** controlled airports: **2,874**;

  Strikes in **51** non-controlled airfields: **81;**

  Airport not identified : **284** events;
- Aircraft movements recorded: **13,898,165;**

  Landings: **6,145,706;**

  Takeoffs : **7,224,976;**

  Touch-and-go landings: **527,483**.

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BIRD HAZARD IN BRAZIL
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Altitude (AGL) - ft	Quantity	Participation (%)	Accumulated (%)
0-100	604	50.54	50.54
101-500	236	19.75	70.29
501-1500	183	15.31	85.60
1501-3000	82	6.86	92.46
3001-10000	83	6.95	99.41
10001-36000	7	0.59	100
>36000	0.0	0.0	100
Total	1,195		

✓ In the universe of 3,239 events, only 1,195 had the altitude identified.

BIRD HAZARD IN BRAZIL
2006-2010

Agricultural aviation

Military aviation

Altitude (AGL) - ft	Quantity	Participation (%)	Accumulated (%)
0-100	604	50.54	50.54
101-500	236	19.75	70.29

BIRD HAZARD IN BRAZIL
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BIRD HAZARD IN BRAZIL 2006-2010

Introduction | Literature review | Sample space | Height | **Phase of flight** | Bird species | Aircraft damaged | Conclusion

Phase of flight	Strikes	Movements	Probability
Landing	1,234	6,409,448	19.3×10^{-5}
Takeoff	834	7,488,718	11.1×10^{-5}
⇨ Traffic Patterns	49	527,483	9.3×10^{-5}
Final approach	503	6,409,448	7.8×10^{-5}
Climb	107	7,488,718	1.4×10^{-5}
Descent	78	6,145,706	1.3×10^{-5}
Taxi	53	13,898,166	0.4×10^{-5}
Cruise	51	13,370,682	0.4×10^{-5}
Low Altitude	102	unknown	
Total	3,011	13,898,165	

In 228 occurrences the phase of flight was not identified

BIRD HAZARD IN BRAZIL 2006-2010

Introduction | Literature review | Sample space | Height | **Phase of flight** | Bird species | Aircraft damaged | Conclusion

1,234 strikes ; probability = 19.3 x 10^{-5}

834 strikes ; probability = 11.1 x 10^{-5}

503 strikes ; probability = 7.8 x 10^{-5}

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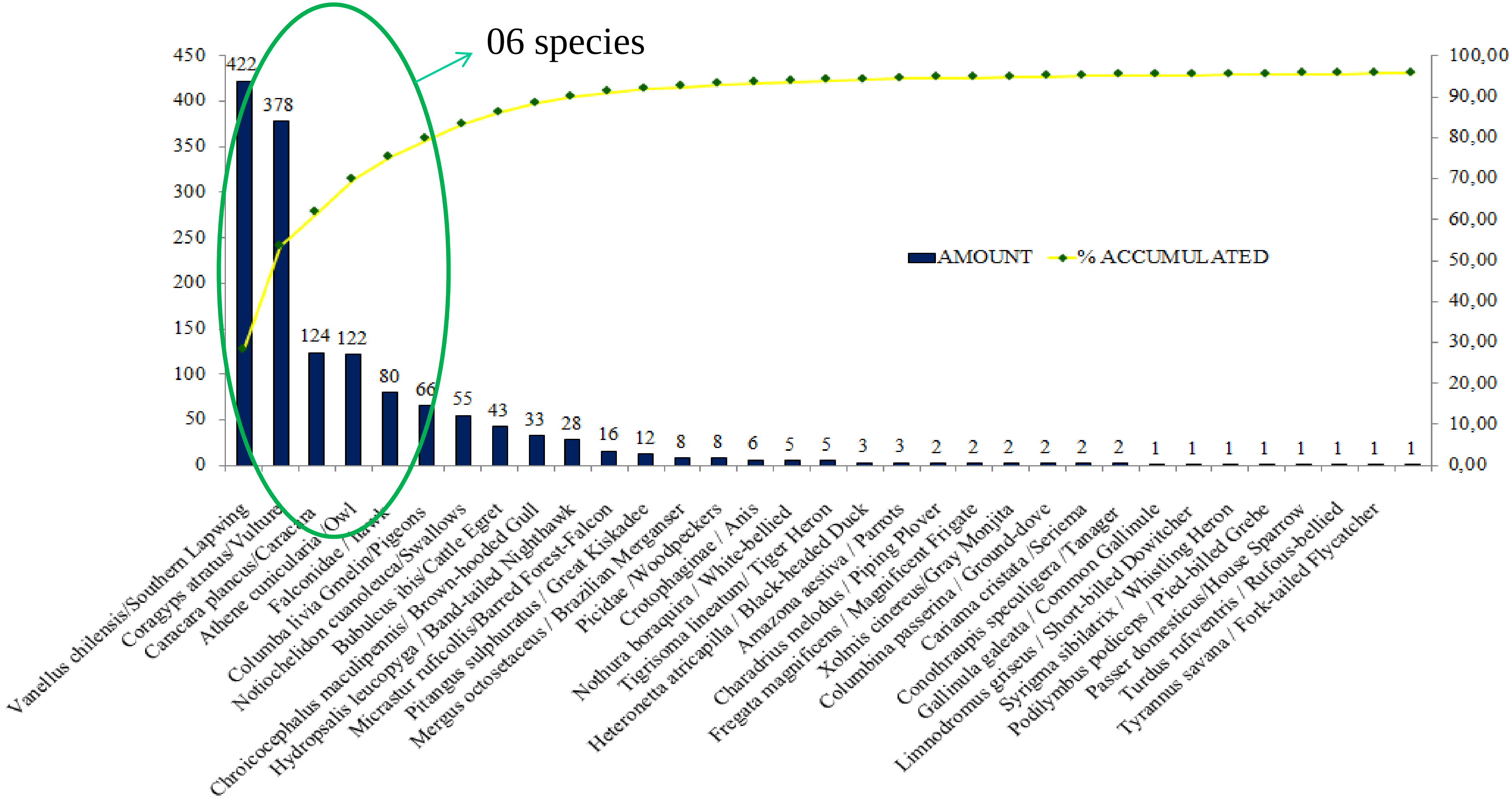
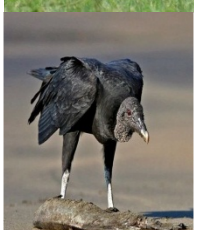


Total : 33 species

BIRD HAZARD IN BRAZIL 2006-2010

Six types of birds contributed to a little under 80% of the occurrences in the period assessed. They represent approximately 20% of the birds involved in incidents.

79,57%


BIRD	CONTRIBUTION (%)	BODY MASS (≅)
Lap wings	28.17	300g / 0.66 lb
Vultures	25.23	1.5kg / 3.31 lb
Caracaras	8.28	1.0 Kg / 2.2 lb
Owls	8.14	100g / 0.22 lb
Sparrow-hawks	5.34	500g / 1.1 lb
Pigeons	4.41	300g / 0.66 lb



Important to aircraft certification

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Part hit	Number of strikes	Percentage
Engine	744	22.54
Wing/Rotor	387	11.73
Fuselage	355	10.76
Windshield	309	9.36
Radome	255	7.73
Landing gear	219	6.64
Nose	114	3.45
Propeller	56	1.70
Tail	43	1.3
Other	818	24.79
Sum total	3.300	100

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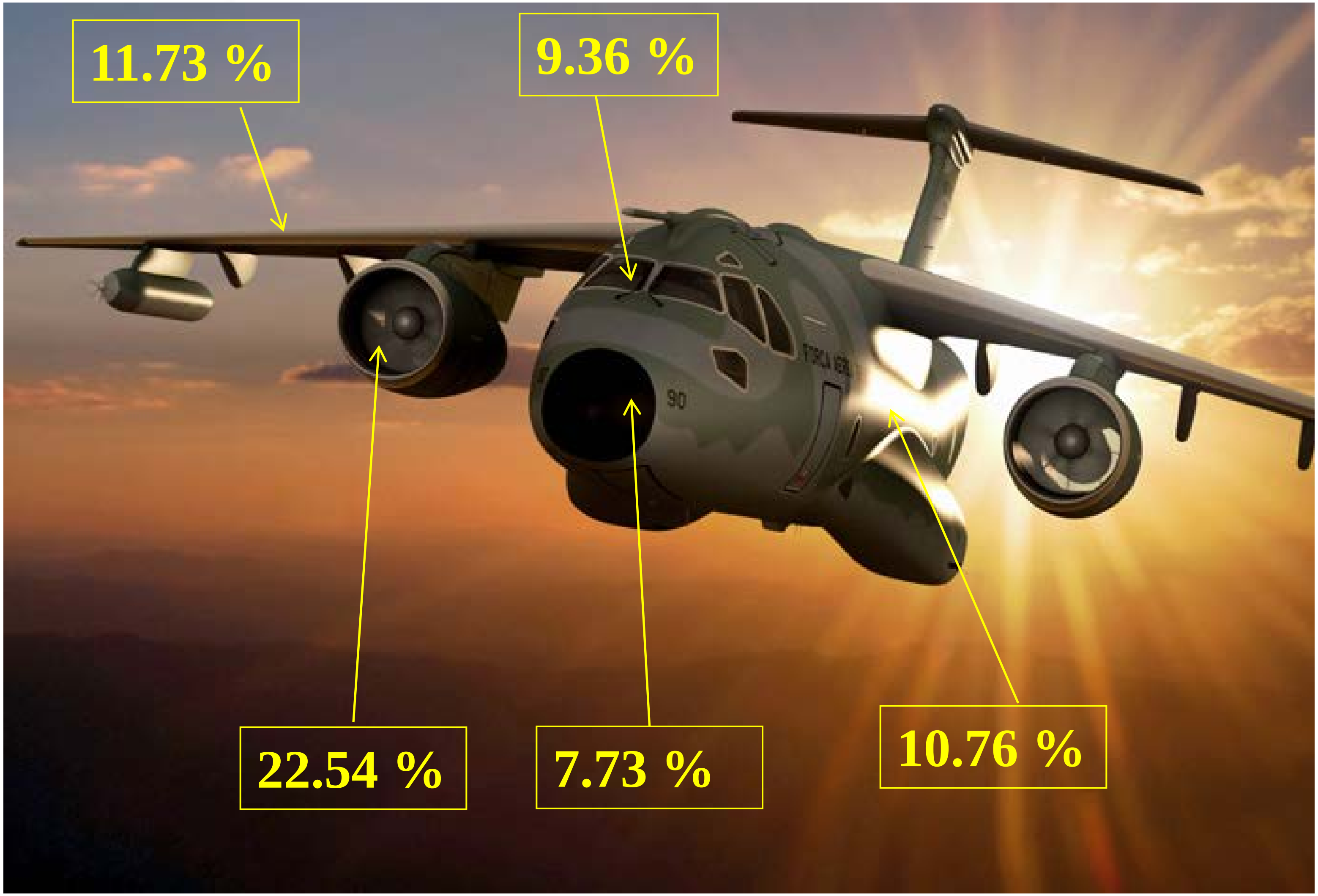

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- ✓ By applying the equation 3, it may be noted that between 2006 and 2010 there were 2.33 strikes per 10,000 landings, takeoff's and touch-and-go landings;
- ✓ According to Allan et al., 2003 and Morais, 2012, the overall risk is moderate;
- ✓ It was observed that 92.46% of the strikes happened from the surface up to 3000ft (AGL). This implies two possible actions of prevention:
  - The aircraft should remain the least time possible in this air space;
  - Local Civil Authority and Airport Administration should intensify the mitigating measures inside and outside the fence.
- ✓ The bird with the greatest mass recorded in this study weighs 1.5kg /3.31lb (on average). This weight is within what is required by the FAR 33, 29, 27 , 25, and 23 for the certification of engines, aircraft and helicopters.

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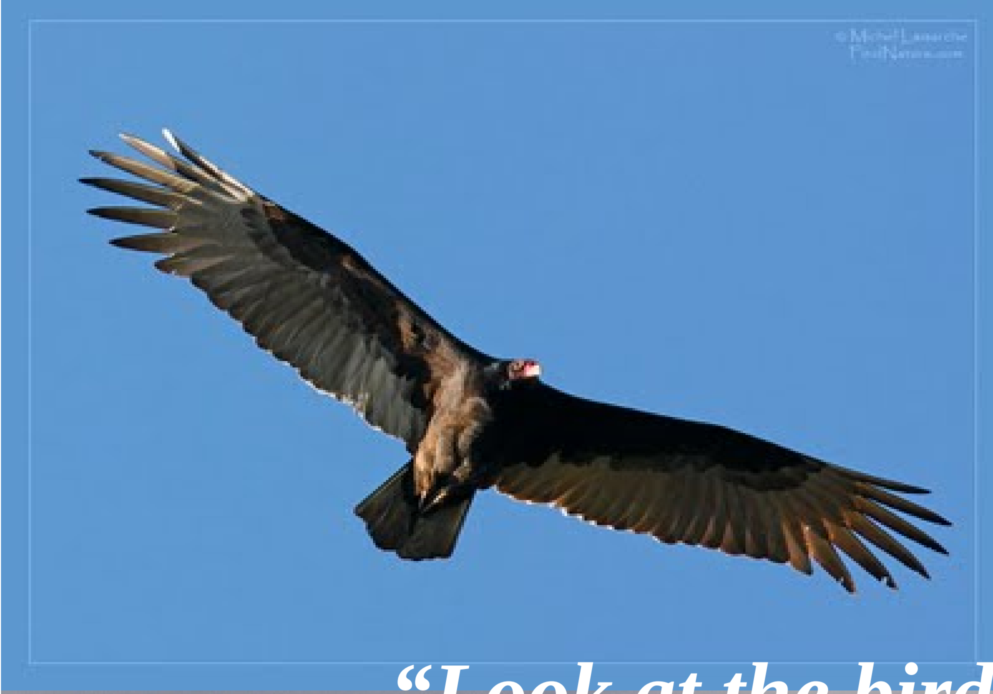

"Look at the birds of the sky..."

Mathew 6:26

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