(1) Who done it? Ingestions, species and phase of flight

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Extensive analysis has shown that 'take-off' and 'climb-out' are the phases of flight when the greatest risk of engine damage occurs due to ingestion (Frings, 1984 DOT /FAA/CT-84/13; Hovey et al. 1991 DOT /FAA/CT-90/28). Subsequent research by Dr. Richard Dolbeer provided an explanation for why this is the case. The use of DNA to identify the culprit species – pioneered by Dr Carla Dove – enabled a more accurate estimate of the probability of engine damage to be correlated with the mass of the bird or birds which had been ingested. However, the recovery of material which permits correct species identification (through a carcass or DNA) may be less likely at 'take-off' and 'climb-out' when the risk of , for example, fan blade damage is greatest. This study reviews ingestion events at Dublin Airport, Ireland over a 25 year interval extending from 1990 to 2014. It compares the recovery of identifiable bird remains during the 'landing' and 'take-of' phases both before and after the availability of DNA based diagnostic techniques. The results show that there is a lower rate of recovery of diagnostic material when an ingestion occurs at 'take-off'. The findings are discussed in the context of developing protocols to improve the recovery of bird remains from aircraft that have departed from the airfield.

Kelly, T.C., E. Dillane, G. Keogh, N. Coughlan, B. Keogh and M.J.A. O'Callaghan. 2015. Who done it? Ingestions, species and phase of flight. Proceedings of the North American Birdstrike Conference 15. 50 pages.

Who done it? Ingestions, species and phase of flight

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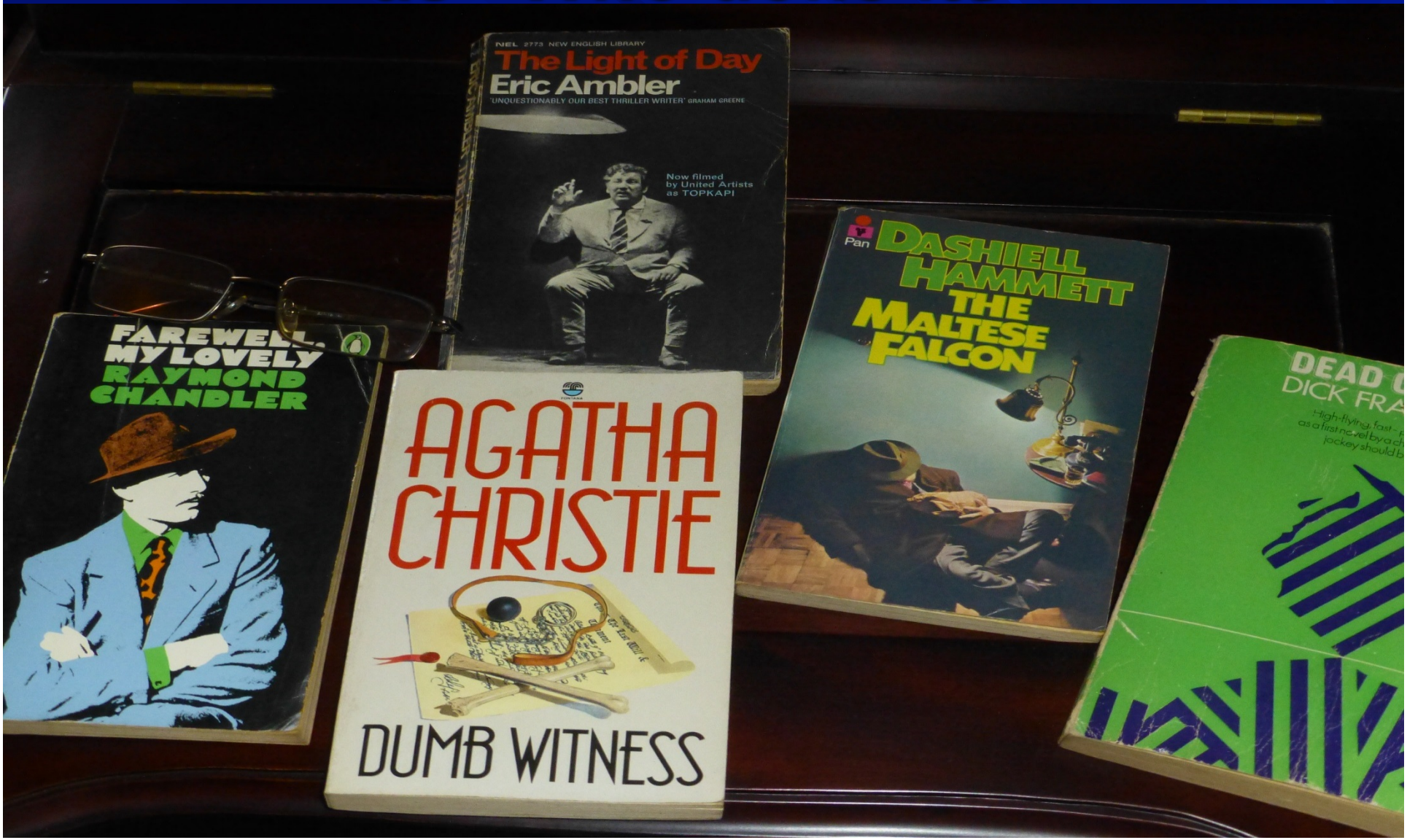
WHO DONE IT?


The Light of Day
Eric Ambler
FAREWELL MY LOVELY
RAYMOND CHANDLER
AGATHA CHRISTIE
DUMB WITNESS
DASHIELL HAMMETT
THE MALTESE FALCON
DEAD CERT
DICK FRANCIS

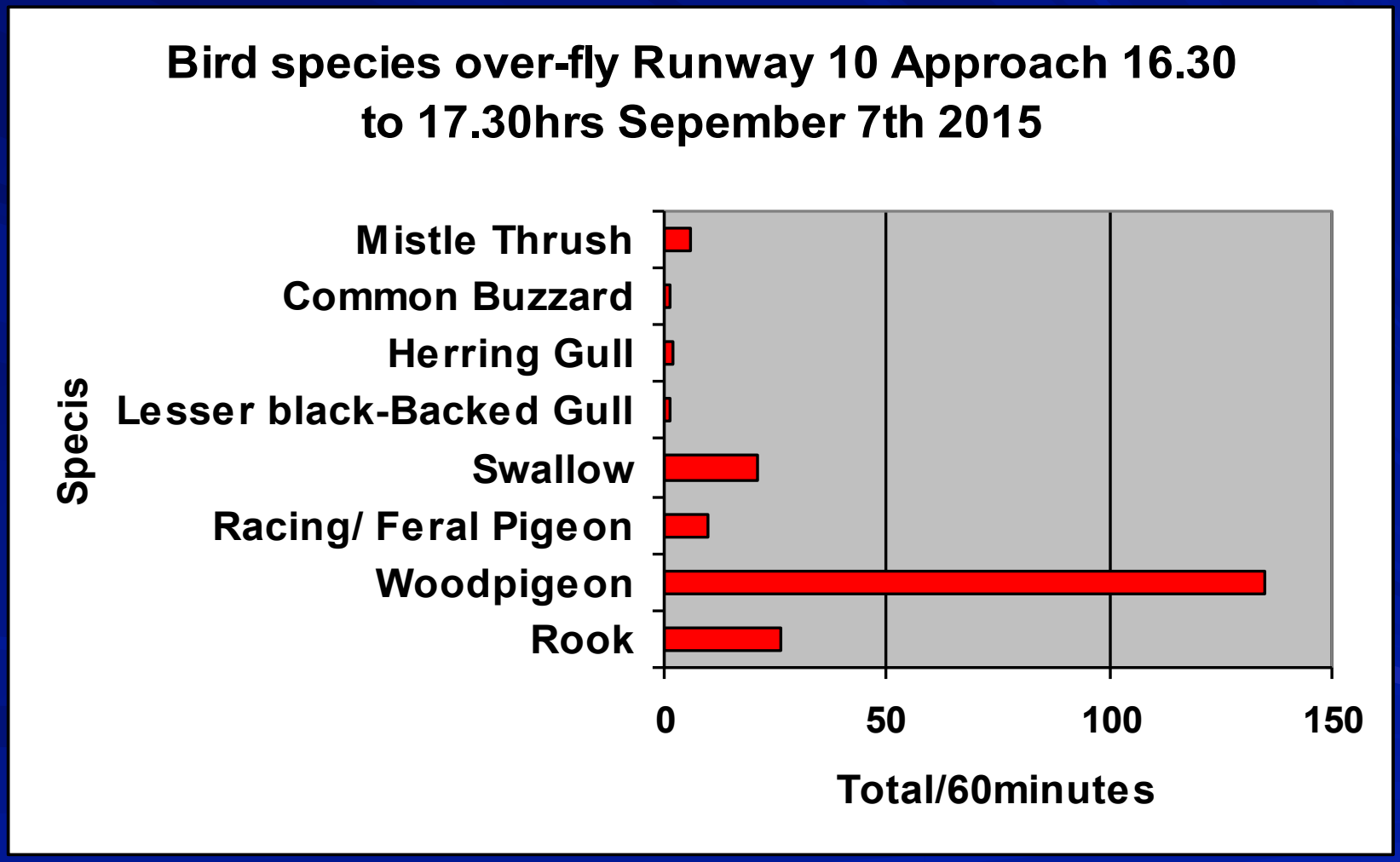
Crime *Mystery* Novels - Known as "Who done its"



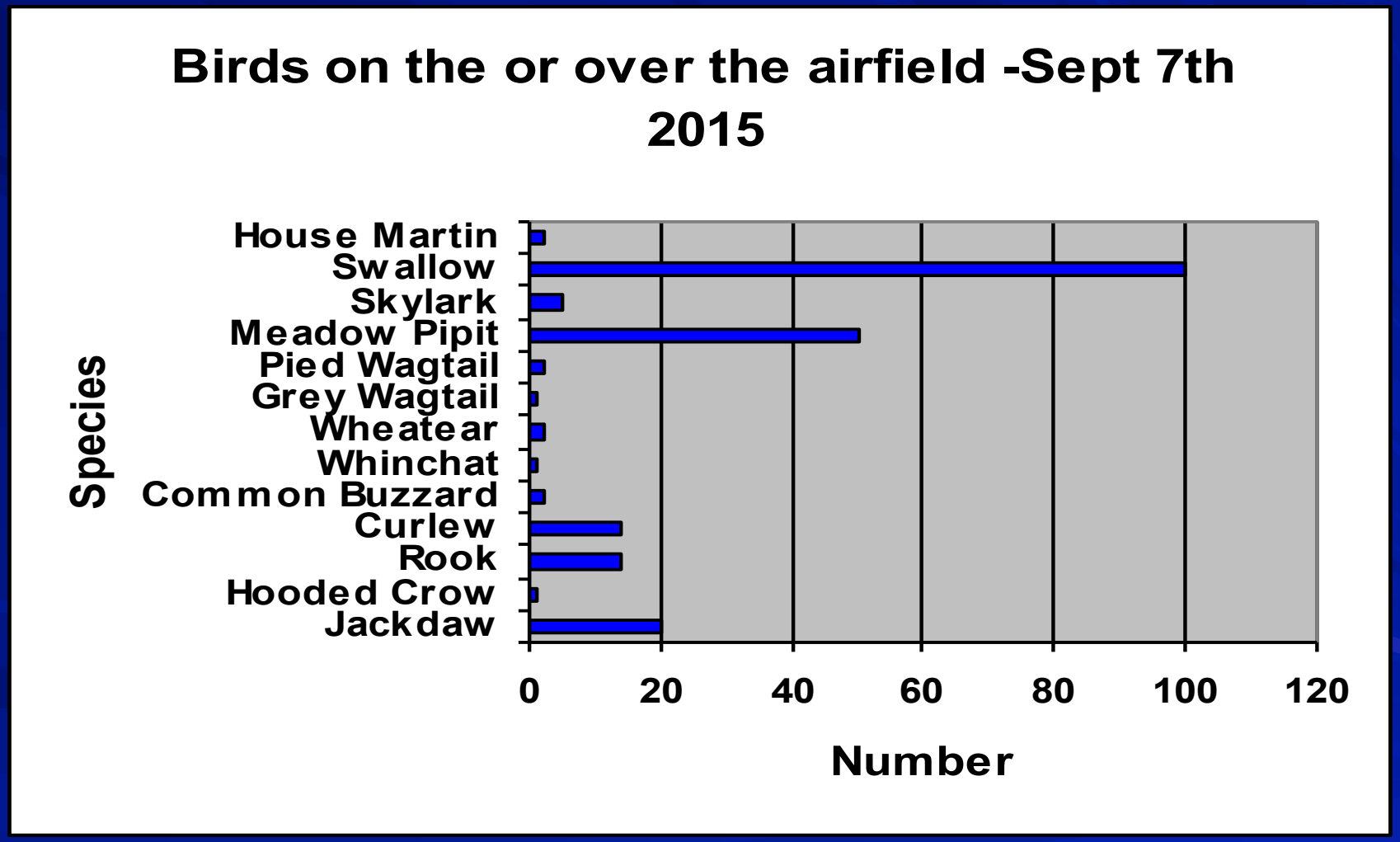
INTRODUCTION -1

- This talk is about the identity of the bird species that that enters a jet engine i.e. is 'ingested'
- And how the answer to this question a) may explain why the engine has been damaged and b) direct the attention of wildlife managers and controllers to those species that are the cause of ***actual*** hazards
- Identifying the species "Who done it" is an improvement from a zero or 'fuzzy' picture of events - to a 'Sharp' focus on what exactly has happened

OVER-FLY SEPTEMBER 7th 2015 – AT DUBLIN



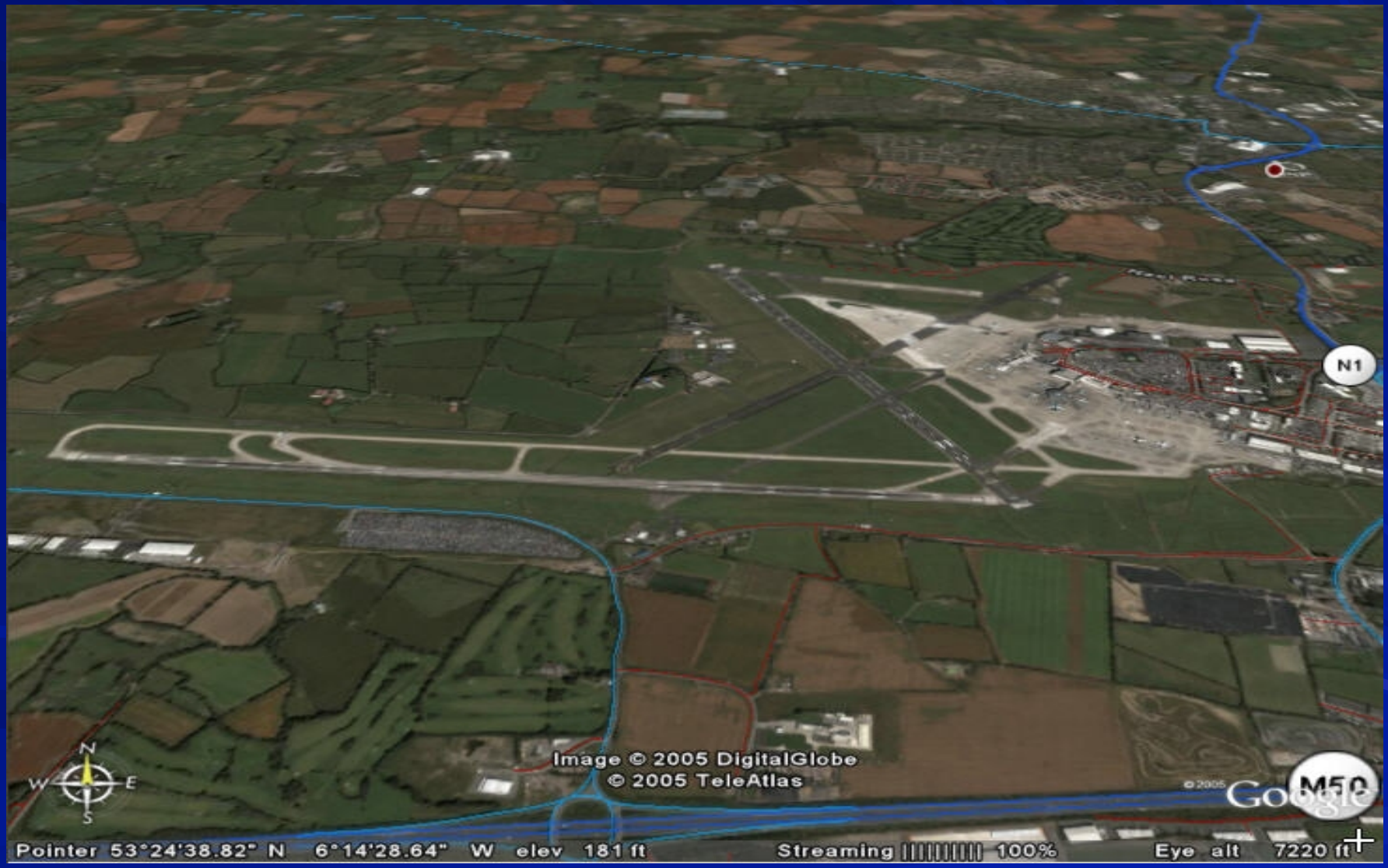
BIRDS ON OR ‘OVER’ THE AIRFIELD AT DUBLIN



INTRODUCTION - 2

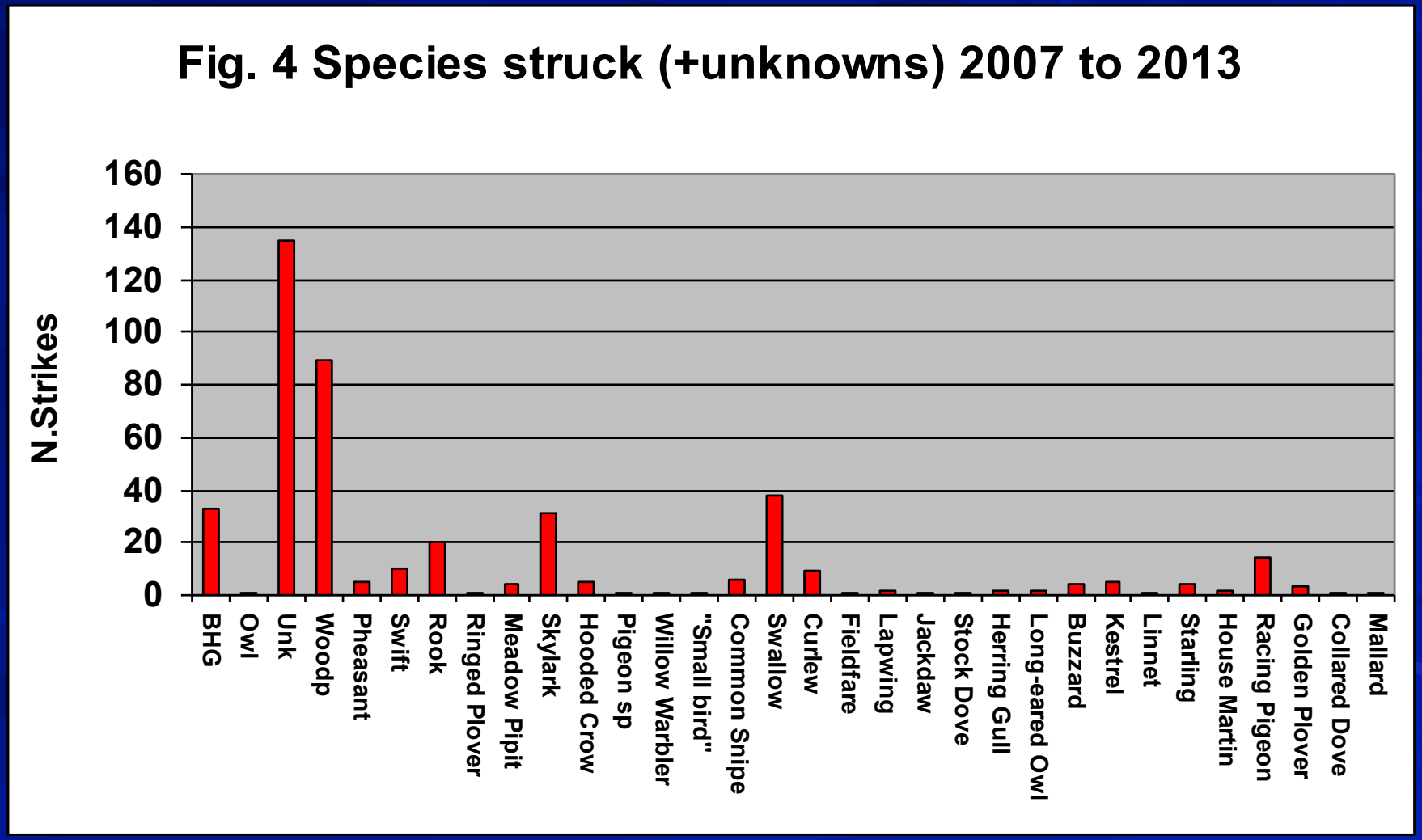
- Most of the bird strikes at Dublin are caused by collisions with birds over-flying the runways
- So over-flying surveys will – or should – show what species are most *likely* to be hit
- But a carcass and/or additional evidence e.g. DNA is unambiguous *actual* data
- Nevertheless in about 30% of cases there is no identification

DUBLIN AIRPORT



Different Species – Which has been struck?

DATA 2007 TO 2013



THE ‘UNIDENTIFIED’

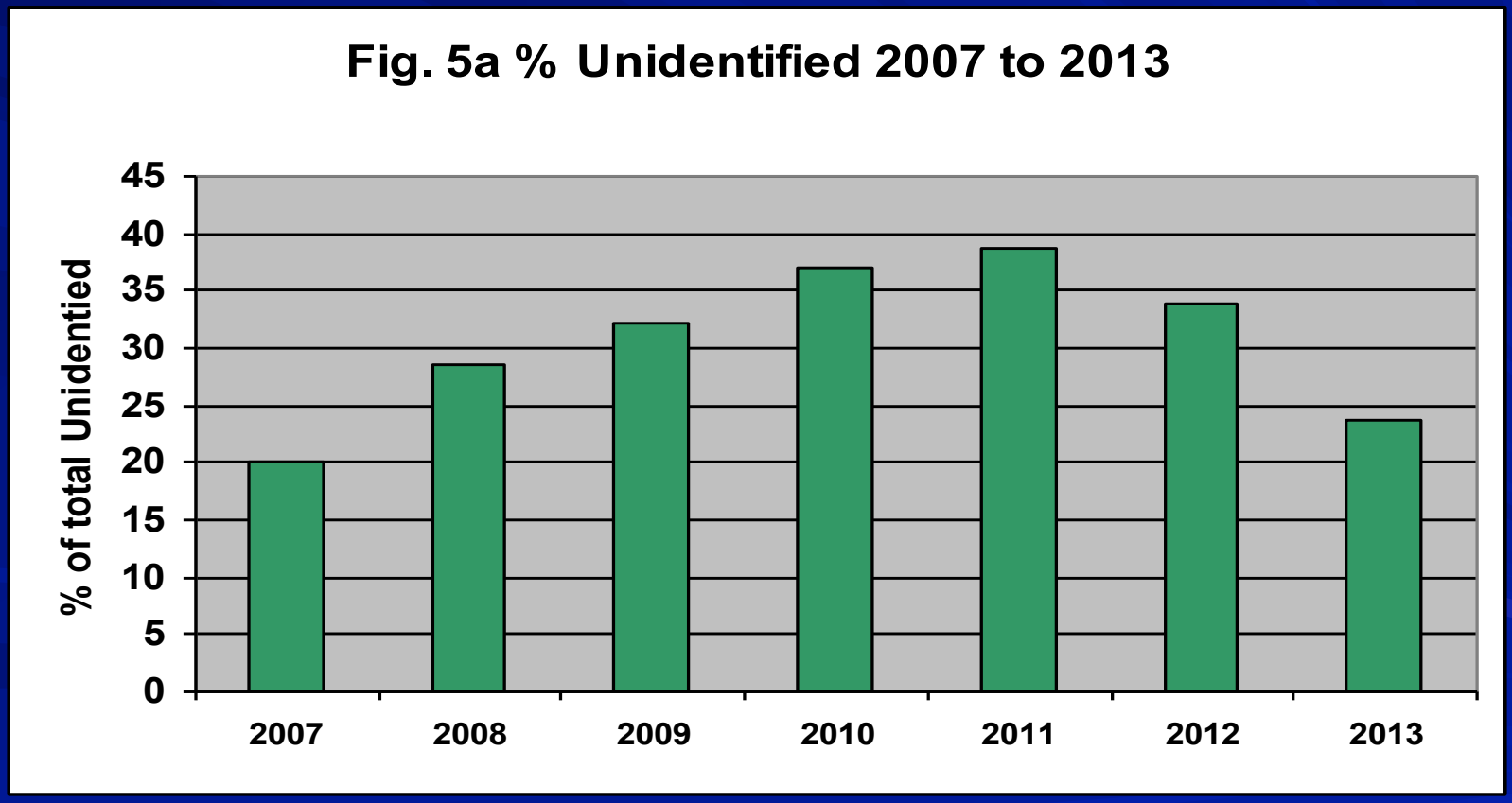
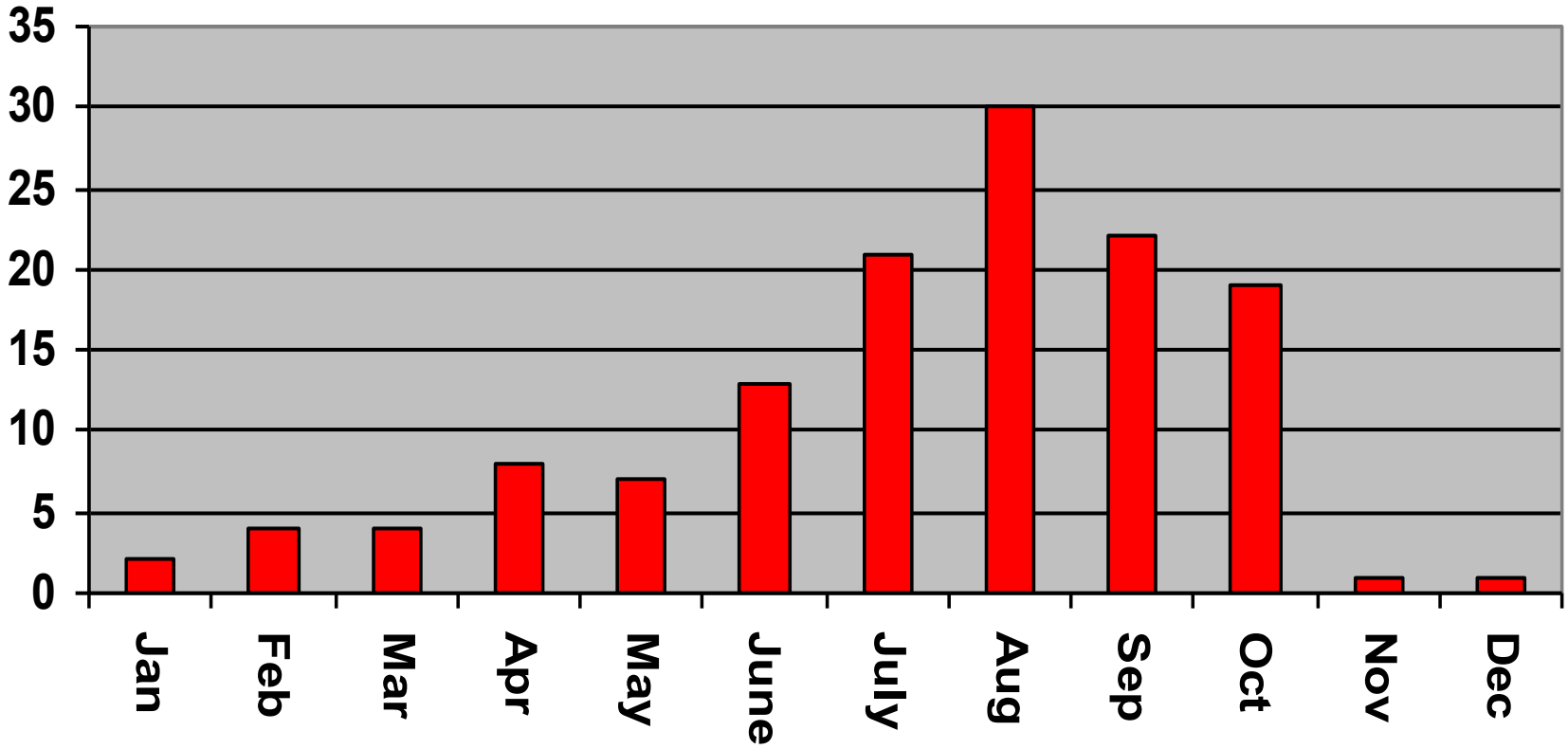
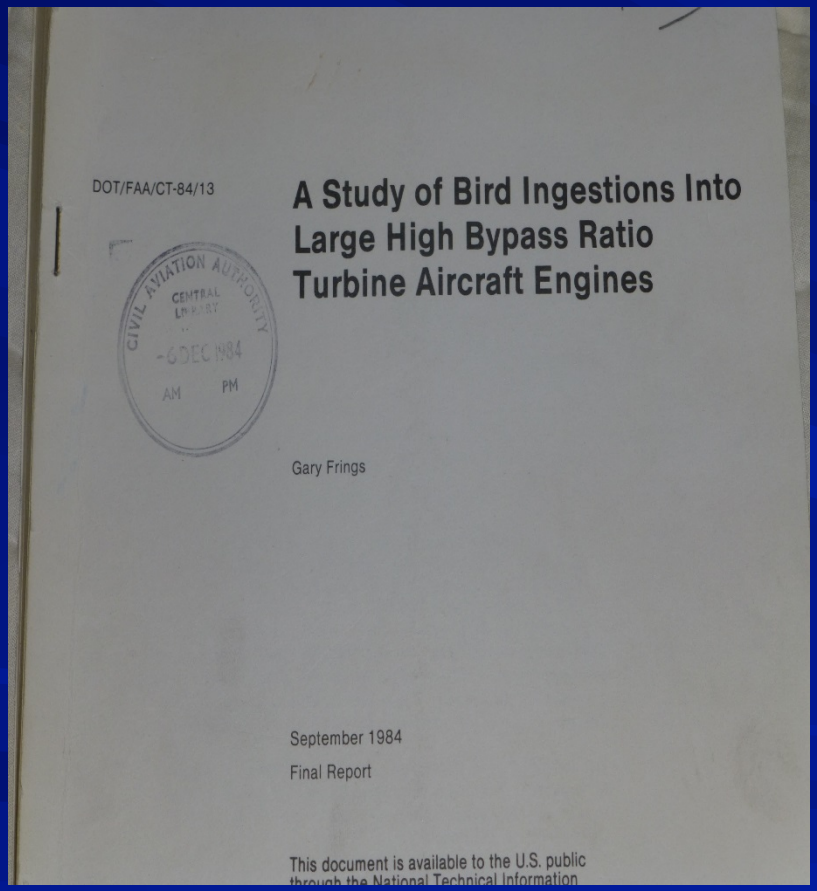


Fig. 5b Culprit species UNIDENTIFIED 2007 to 2013



ENGINE INGESTION MOST SERIOUS

DAMAGE FROM INGESTIONS



DOT/FAA/CT-84/13

A Study of Bird Ingestions Into Large High Bypass Ratio Turbine Aircraft Engines

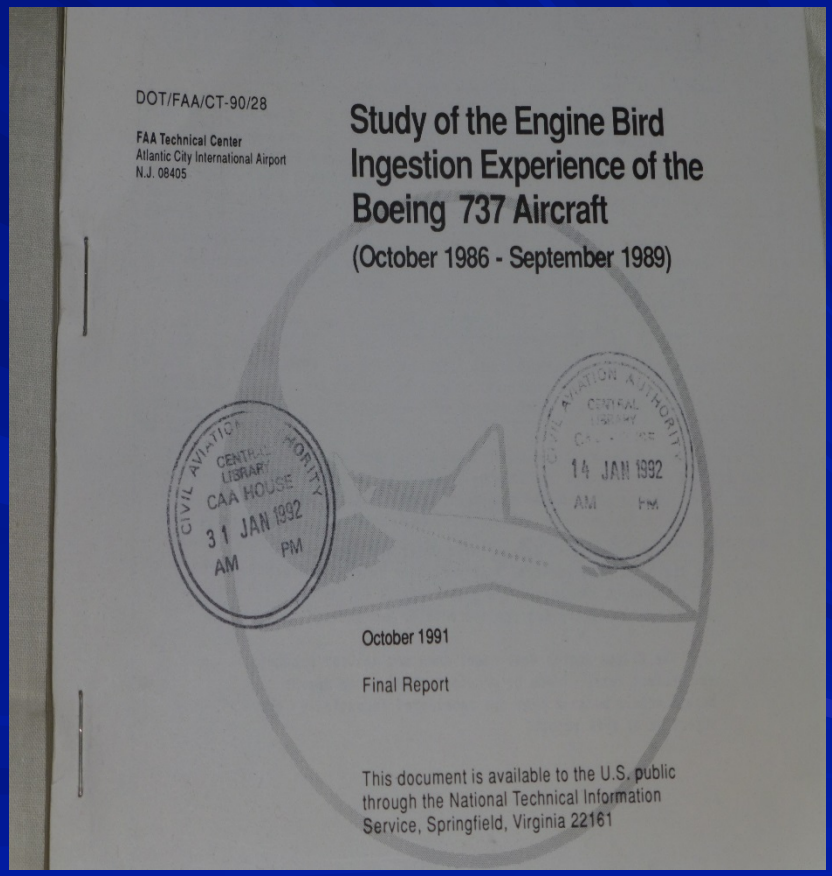
Gary Frings

September 1984

Final Report

This document is available to the U.S. public through the National Technical Information

Frings 1984



DOT/FAA/CT-90/28

FAA Technical Center
Atlantic City International Airport
N.J. 08405

Study of the Engine Bird Ingestion Experience of the Boeing 737 Aircraft
(October 1986 - September 1989)

October 1991

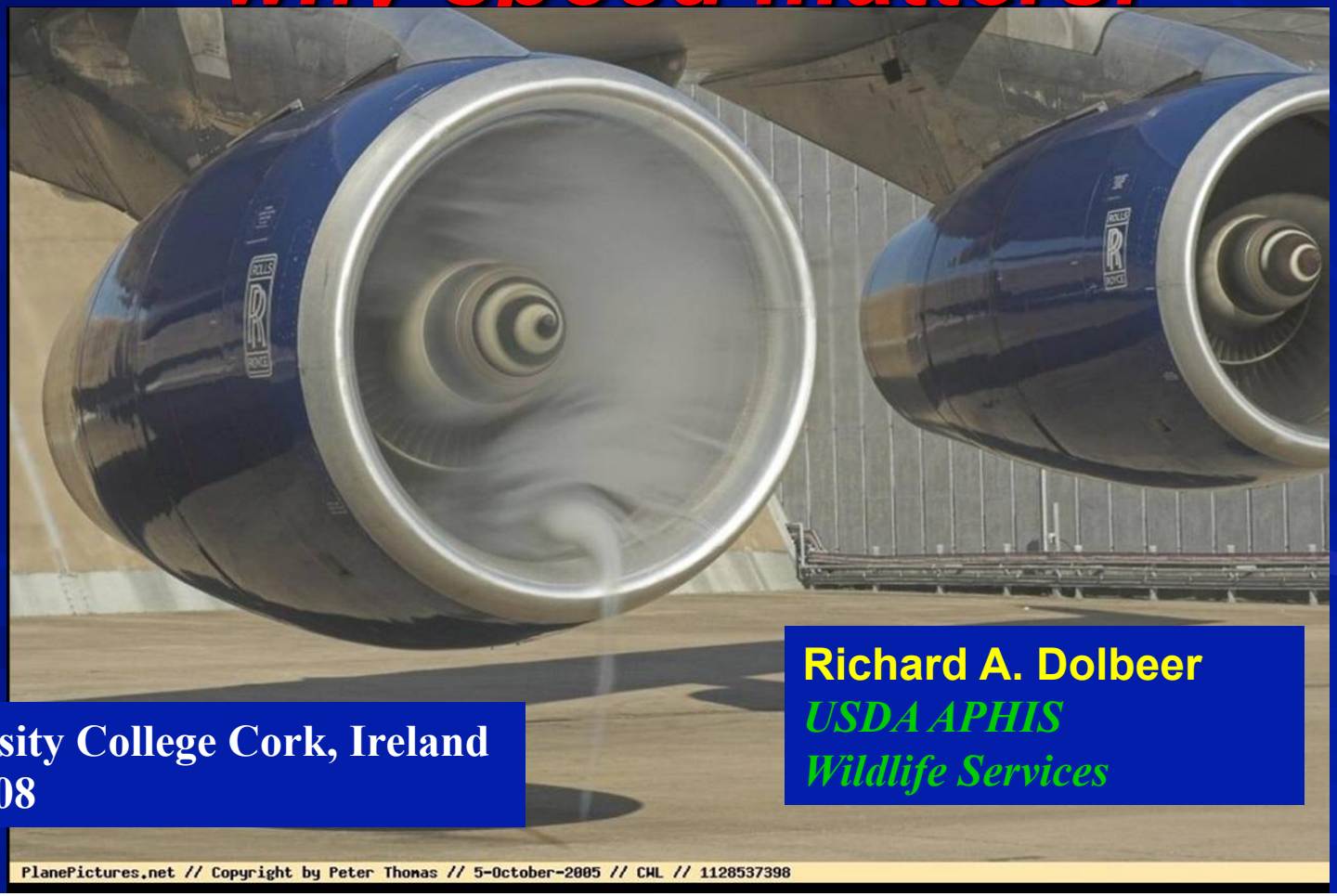
Final Report

This document is available to the U.S. public through the National Technical Information Service, Springfield, Virginia 22161

Hovey, Skinns and Wilson (1991)

Bird damage to turbofan engines in relation to phase of flight-

why speed matters!



Richard A. Dolbeer
USDA APHIS
Wildlife Services

University College Cork, Ireland
Sep 2008

RESEARCH - INGESTIONS

- Ingestions mostly at take-off and landing
- Damage most likely at Take-off and climb
- Dr Richard Dolbeer subsequently explained why these phases are so prone to fan blade damage in a paper called “Why speed matters”?
- Many examples subsequently proved him right including Flight 1549 and the Air Maroc incident at Schipol June 6th 2010

MOST CRITICAL PHASE

Royal Air Maroc- Fan Blade damage

AIMS -1

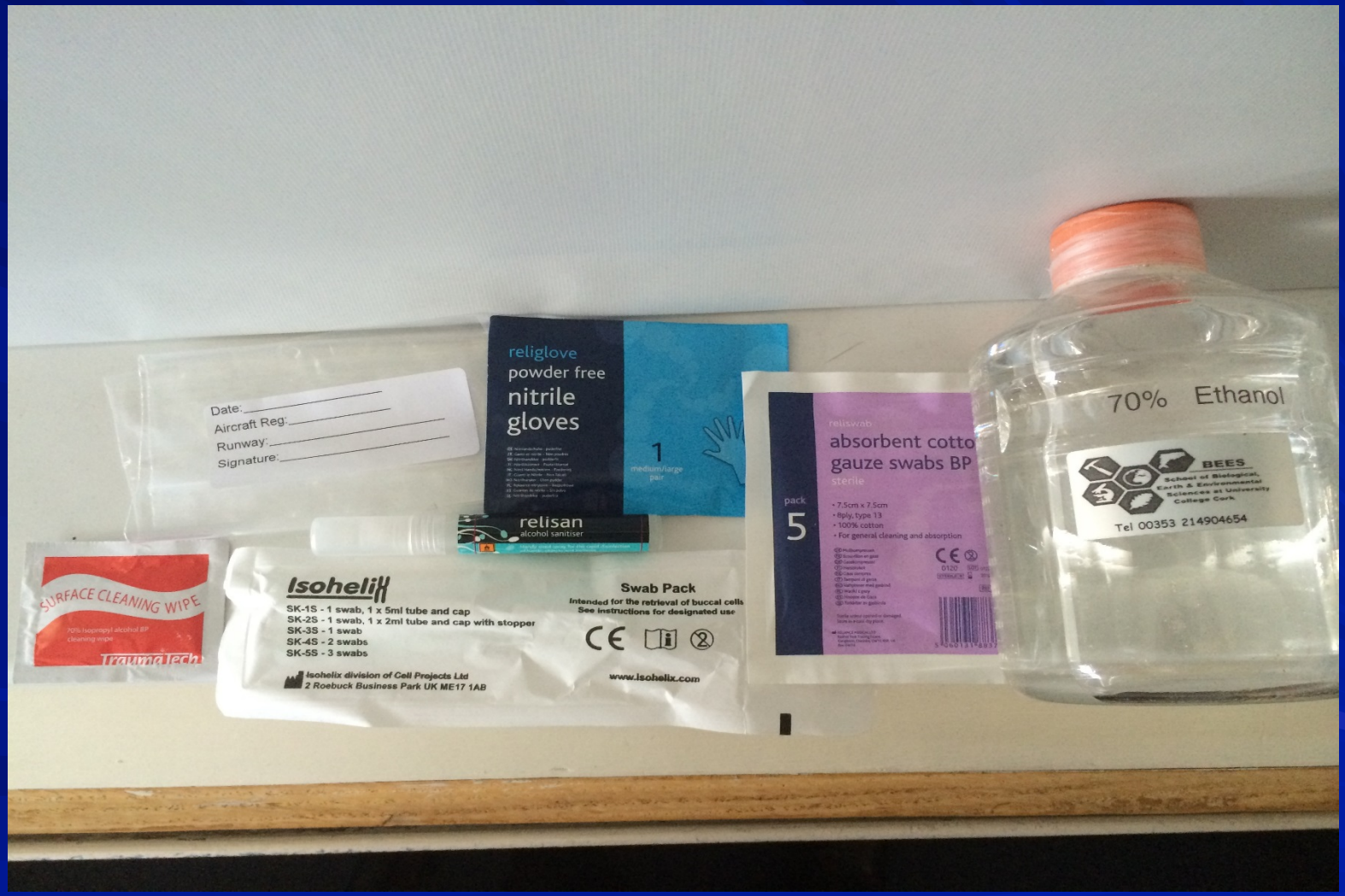
- Aims of this presentation are:
- A) To provide a preliminary summary of ingestion data at Dublin Airport, Ireland, for the 25 year interval 1990 to 2014
- B) To compare the incidence of damage in relation to the different Phases of Flight
- And C) to compare the frequency of species identifications in relation to landing and Take-off

AIMS -2

- D) to outline the increasing and decisive role of DNA-based identification in improving the “focus” i.e. the “Who done it” aspect
- And to discuss the difficulty of recovering forensic material from departing aircraft i.e. at the phase when ingestion damage is most likely to occur

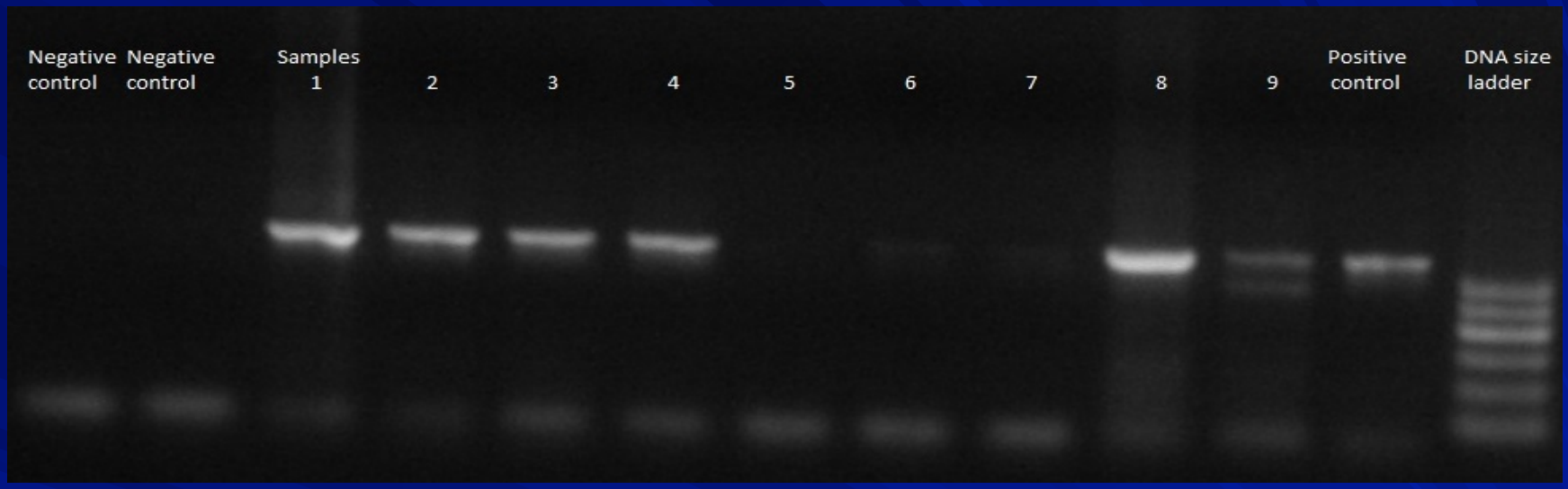
Blood Smear

DNA collecting kit



DNA-2


Isohelix
SK-1S - 1 swab, 1 x 5ml tube and cap
SK-2S - 1 swab, 1 x 2ml tube and cap with stopper
SK-3S - 1 swab
SK-4S - 2 swabs
SK-5S - 3 swabs
Isohelix division of Cell Projects Ltd
2 Roebuck Business Park UK ME17 1AB
Swab Pack
Intended for the retrieval of buccal cells
See instructions for designated use
www.isohelix.com



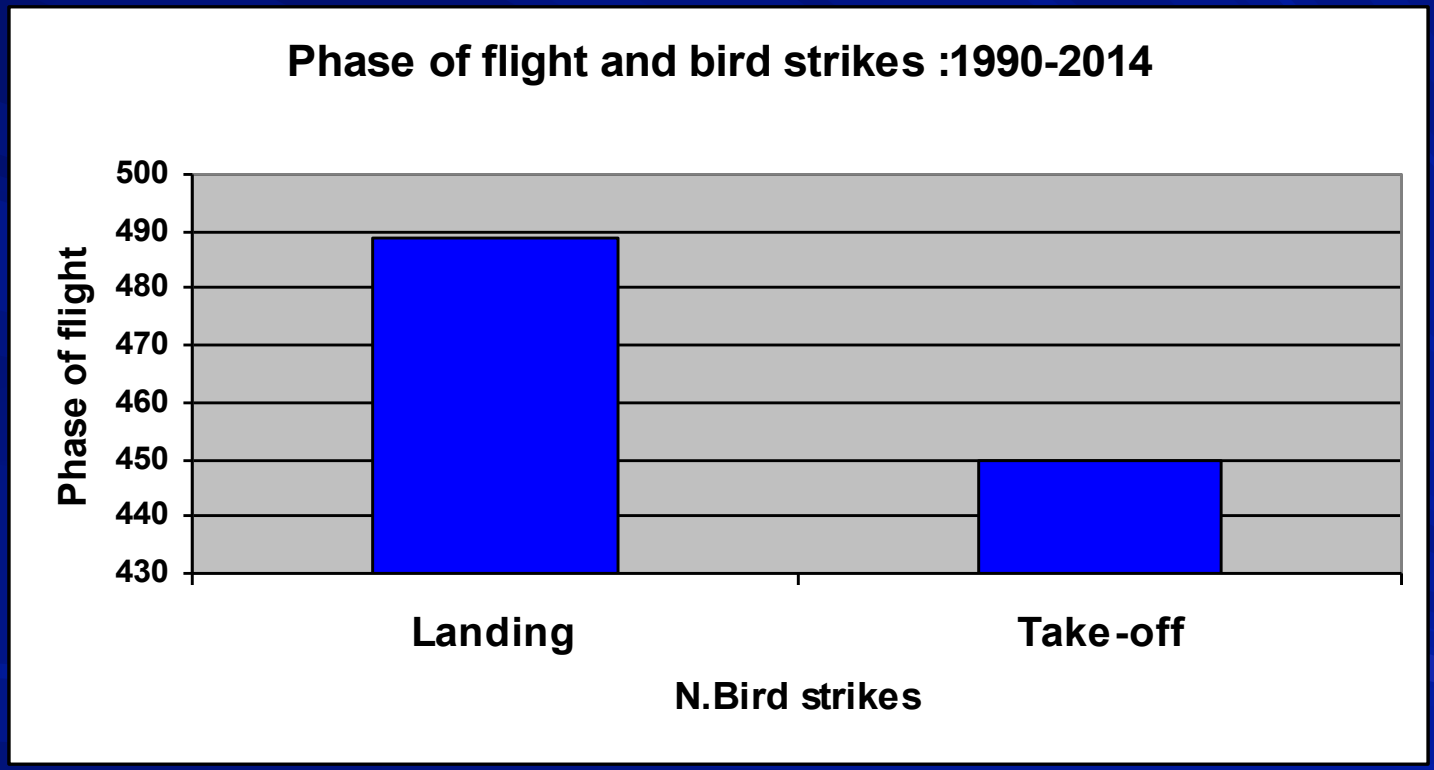
An example of CO1 region PCR products generated from samples alongside negative and positive controls, and DNA size ladder

- DNA extracted using DNeasy Blood and Tissue kit (Qiagen)
- A ~650bp region of the CO1 region of the mitochondrial DNA (mtDNA) genome is amplified and sequenced following the method of Dove *et al* 2007, using appropriate positive and negative controls
- Sequences are identified to species using the Basic Local Assignment Search Tool (BLAST) of the nucleotide databases, facilitated by the US government National Centre for Biotechnology Information (NCBI)
- Positive identifications are made only when the query sequence matches a voucher specimen sequence

RESULTS

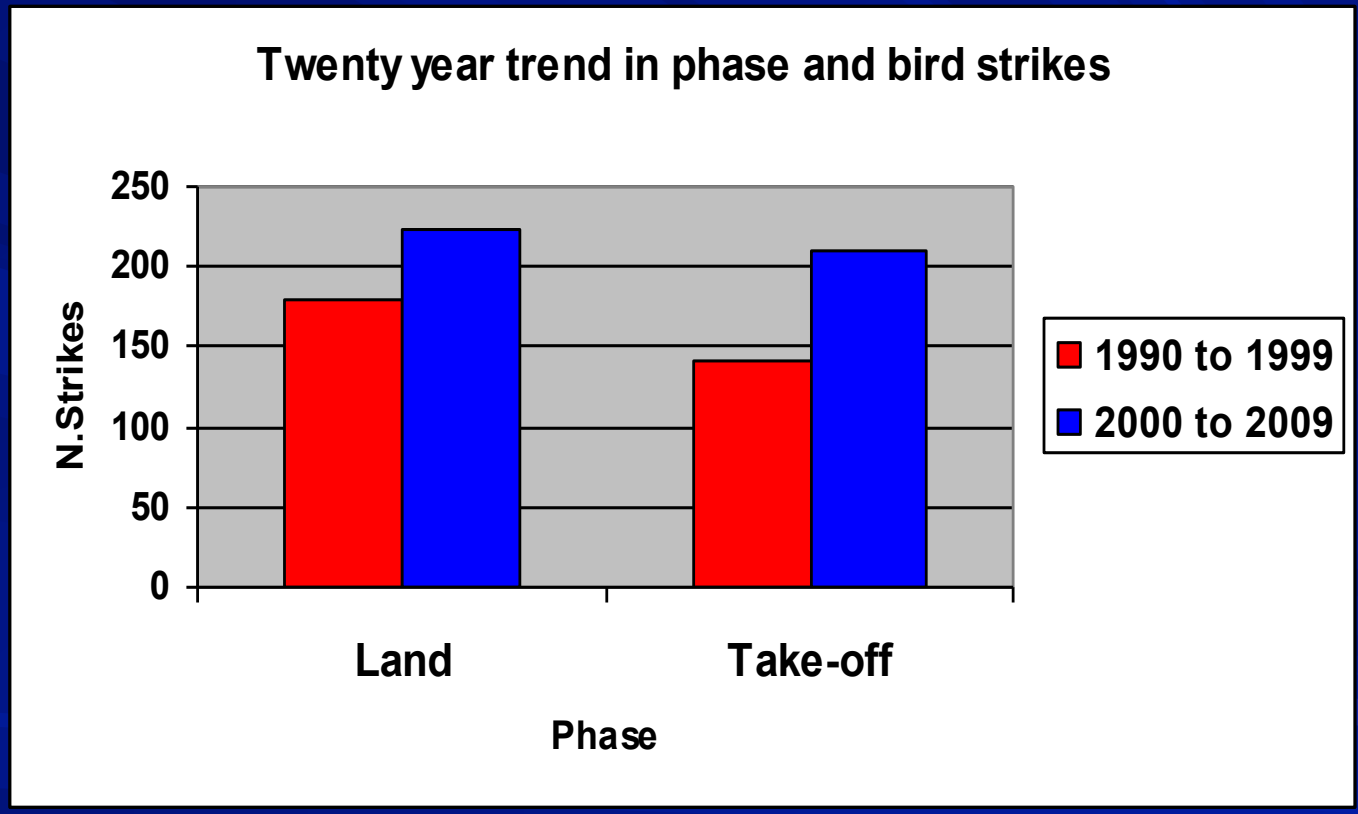
- 1059 confirmed bird strikes (see Kelly *et al*.1996) over the 25 year interval
- Average 47.28 ± 3.15 SE per year
- Average 2.62 strikes per 10,000 aircraft movements per year
- 111 (10.48%) could not be assigned with certainty to either phase; thus these consisted **exclusively of a carcass** - without an accompanying bird strike report. Pathology diagnostic.

PHASE OF FLIGHT + BIRDSTRIKES -1990 to 2014 interval



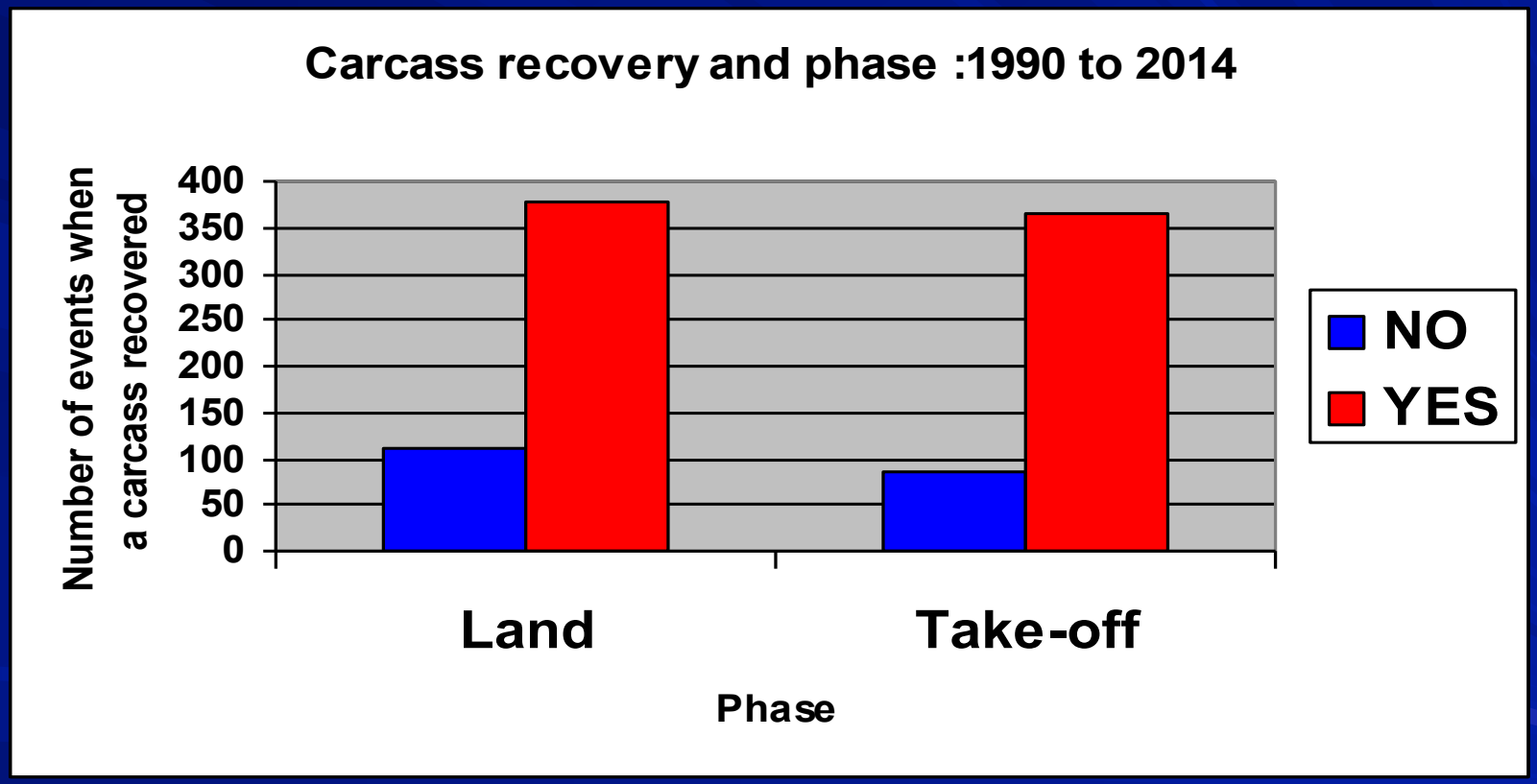
χ^2 = 1.62; df=1; NS

Trend over two 10 year intervals: 1990 to 1999 and 2000 to 2009



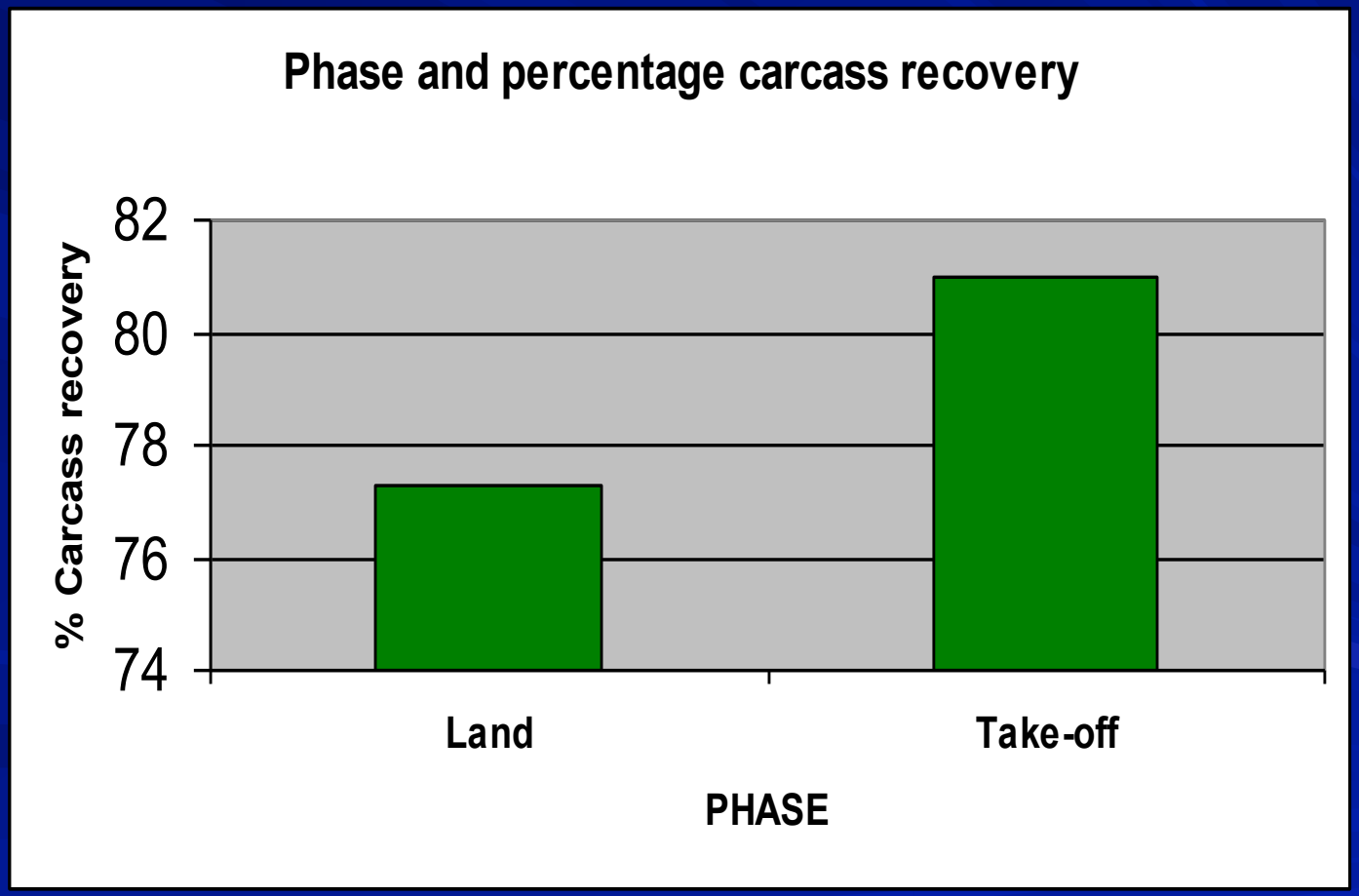
1990 to 1999 $\chi 2$ = 4.738; df=1; *P*<0.029
2000 to 2009 $\chi 2$= 0.390;df=1;NS

CARCASS RECOVERY AND PHASE



$\chi 2 = 3.449; df=1; P=<0.063$ (NS)

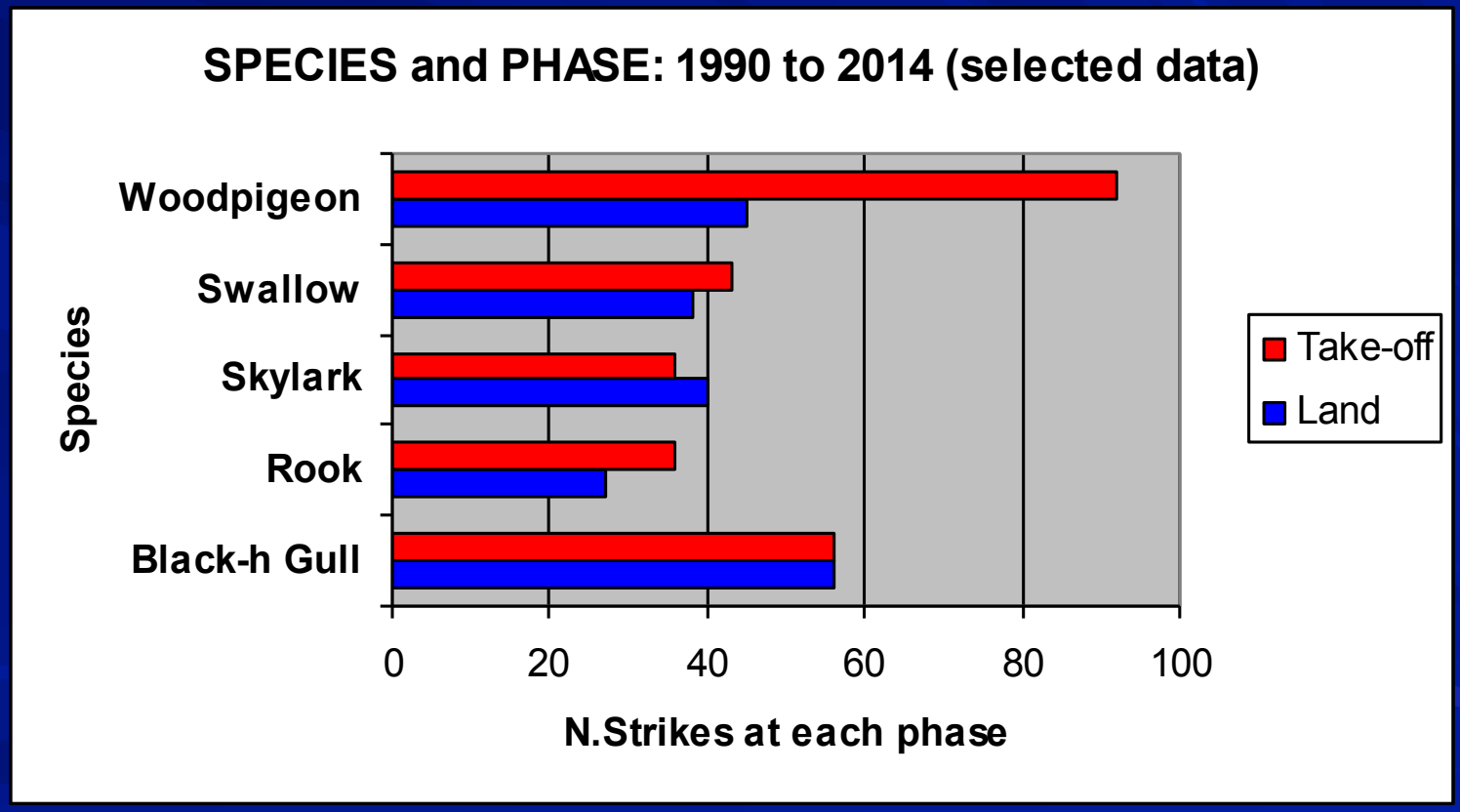
PERCENT RECOVERY OF CARCASSES AND PHASE



PHASE AND BIRD STRIKES

- More bird strikes occurred during landing than take-off though the difference is not statistically significant
- But - there was a significant difference during the 1st 10 years -1990 to 1999
- This was not seen in the 2nd decade when no difference was detected
- Carcasses were recovered in a higher percentage of bird strikes at Take –off than at landing- though not significantly

SPECIES AND PHASE OF FLIGHT

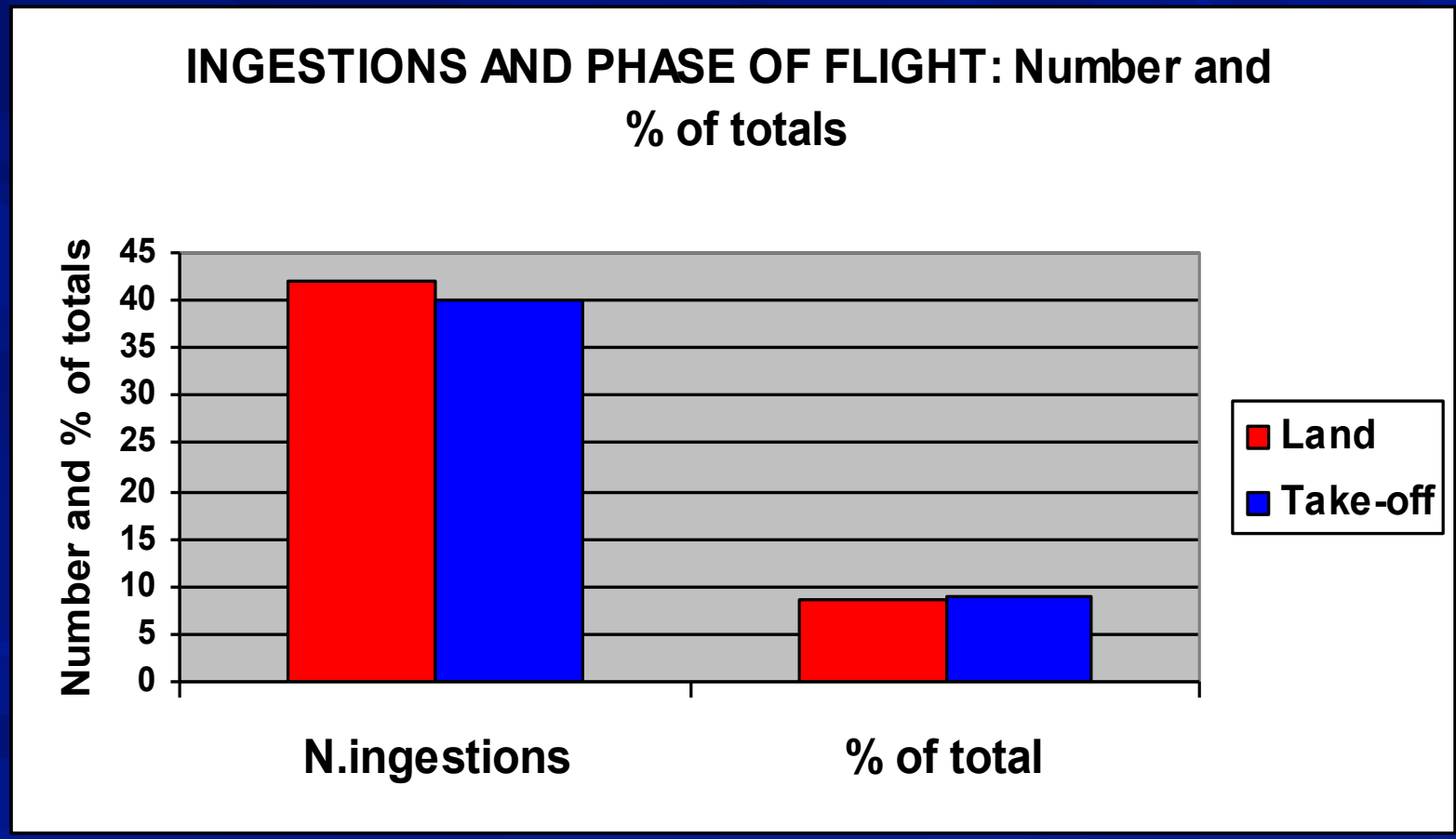


No significant difference between phases for each species – except Woodpigeon $\chi 2$ = 16.124;df=1P=<0.001

INGESTIONS, PHASE, ENGINE DAMAGE, AND RECOVERY OF IDENTIFIABLE REMAINS

- We looked at the issue of ingestions and phase of flight and asked the following questions: what is the incidence of ingestions in relation to phase?
- What is the incidence of damage in relation to ingestions and phase?
- And how frequently is the culprit species identified – in relation to ingestions at landing and take-off
- When damage occurs - management want to know ASAP *"who done it"*!!

INGESTIONS AND PHASE

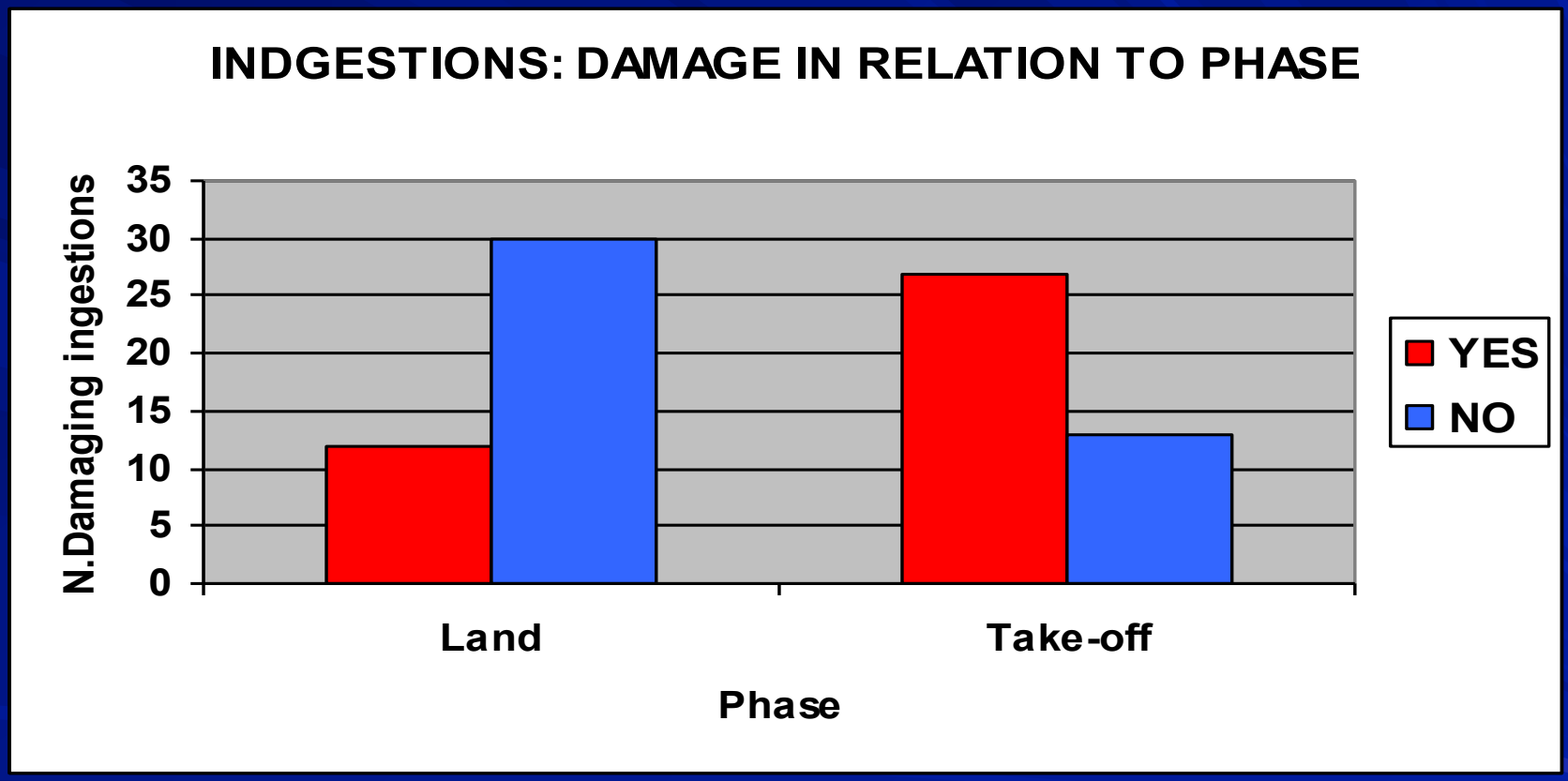


Marginally more ingestions at landing but a slightly higher % at Take-off

INGESTIONS and PHASE

- There was a total of 82 ingestions recorded over the 25 year interval
- 7.7% of the total
- 3.28 per year
- 42 occurred during ‘landing’ and 40 during ‘Take-off’
- A slightly higher percentage of ingestions occurred at ‘Take-off’ (8.9%) than at landing (8.6%).

INGESTIONS, DAMAGE AND PHASE



Significantly less damaging strikes at Landing

$\chi 2 = 7.714; df=1 P=<0.005$

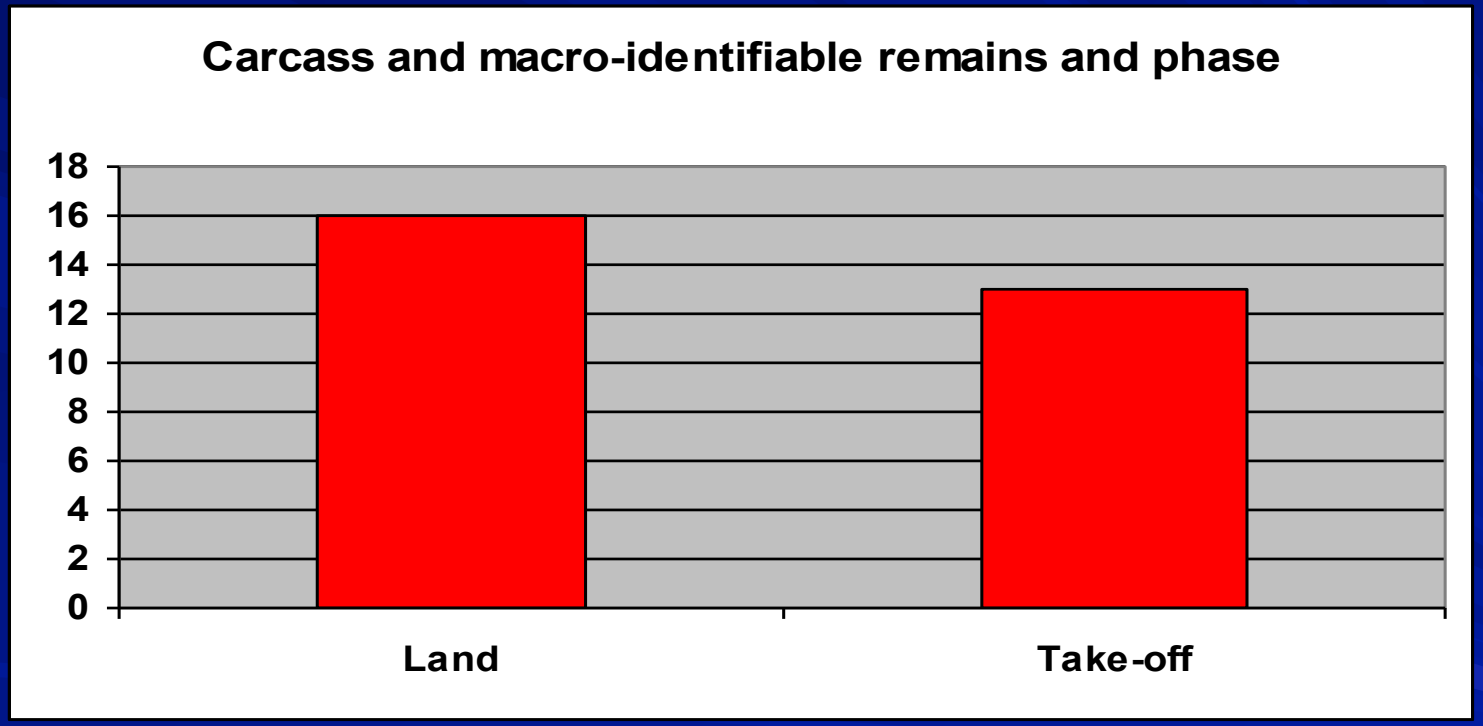
Significantly more damaging strikes at 'Take-off'

$\chi 2 = 4.9; df=1 P=<0.027$

INGESTIONS, DAMAGING EVENTS AND PHASE

- In all 39 (47.56%) ingestions caused engine damage
- Refers to all damage and ranking of severity not analysed here
- Damage occurred in 12 (28.57%) ingestions at landing – significantly lower than expected
- Damage occurred in 27 (67.5%) ingestions at ‘Take-off’ significantly higher than expected
- Damage is more than twice as likely at ‘Take-off’-ingestions than at ‘Landing’
- But “Who Done It”?

CARCASS OR OTHER MACRO-IDENTIFIABLE REMAINS ON THE RUNWAY –AT INGESTION -AND PHASE



No significant difference from expected at 'LANDING'
BUT significantly fewer at 'Take-off' P<0.03

DNA – DAMAGE –INGESTION - PHASE

- DNA first employed 2006 at Dublin Airport (CSL)
- Early use of water lead to low % success
- Use of alcohol as recommended by Dove *et al*. (2008) and pers.comm. to BK increased success to 90+ %
- But mostly applied to damaging strikes so there is a bias here and of course a cost
- But ***highly informative*** where damage has occurred

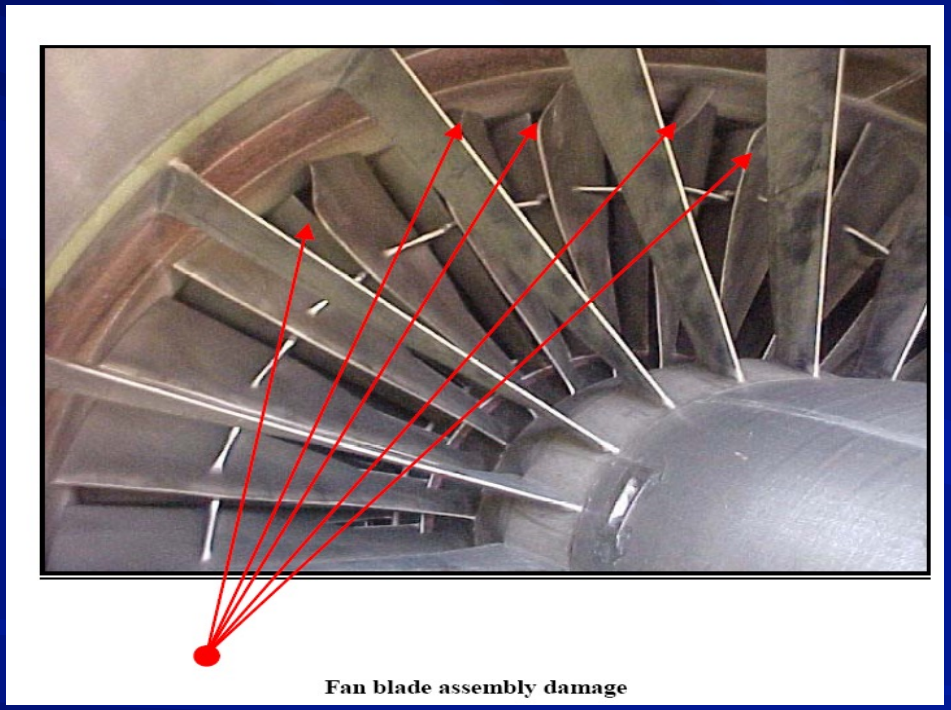
DNA-2

- In 10 cases of ingestions since 2006 - at Take-off - where damage occurred – the culprit species was identified
- Most involved the Woodpigeon (N=7) – with the DNA extracted following the return of the aircraft
- Similar results with Curlew (N=2) and Lapwing (N=1)
- **NOTABLY in none of the above was there any sign of a carcass, or even feathers, on the runway - Emerging trend?**

DNA-3

- However, in at least two other cases – where fan blades had to be replaced at the ‘out station’ – no DNA was recovered
- So the “Who done it”? question remained unanswered
- Academic? We don’t think so
- Need to develop protocols for recovery of DNA from the ‘out station’

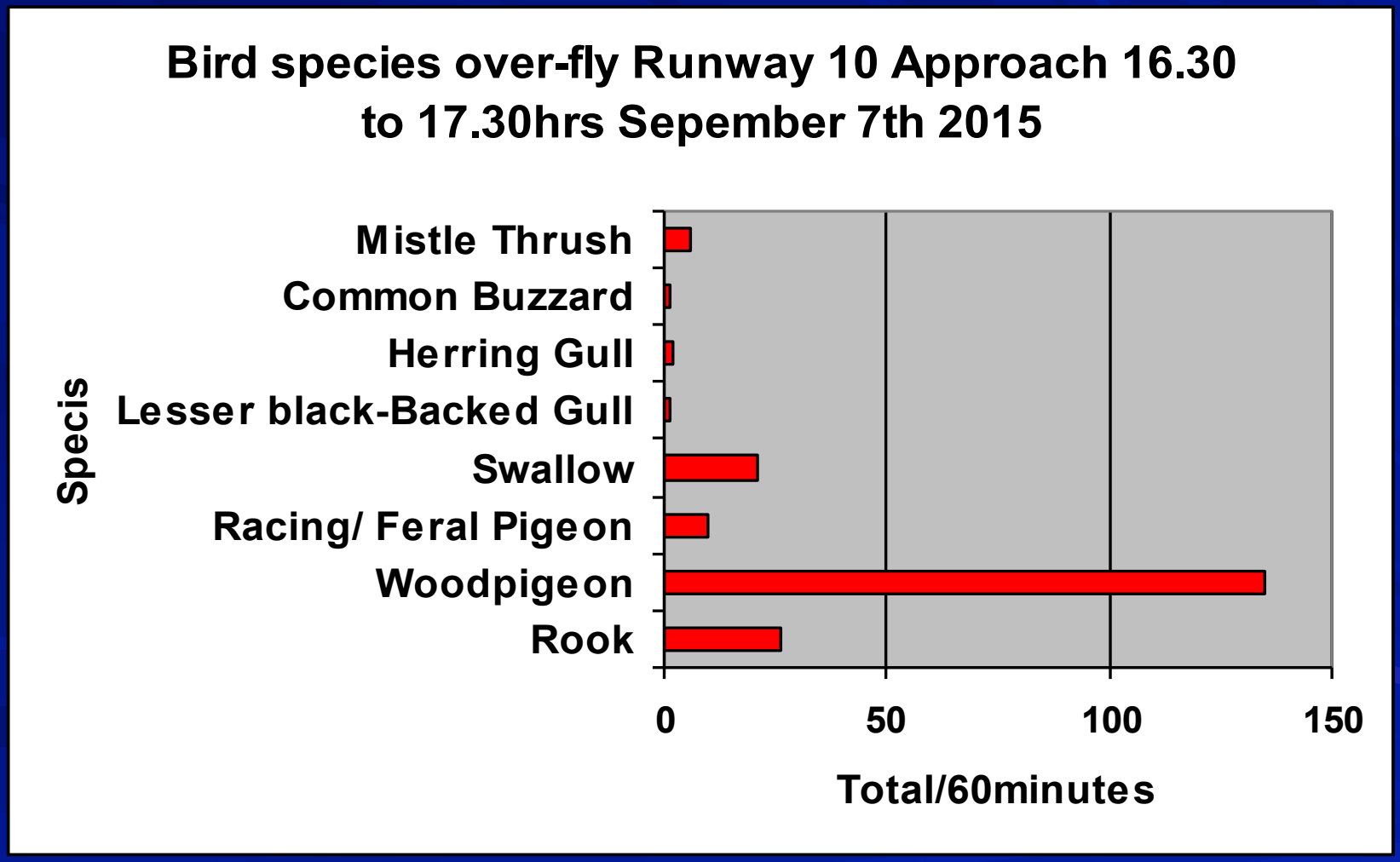
TYPICAL DAMAGE RESULTING FROM INGESTION



Fan blade assembly damage

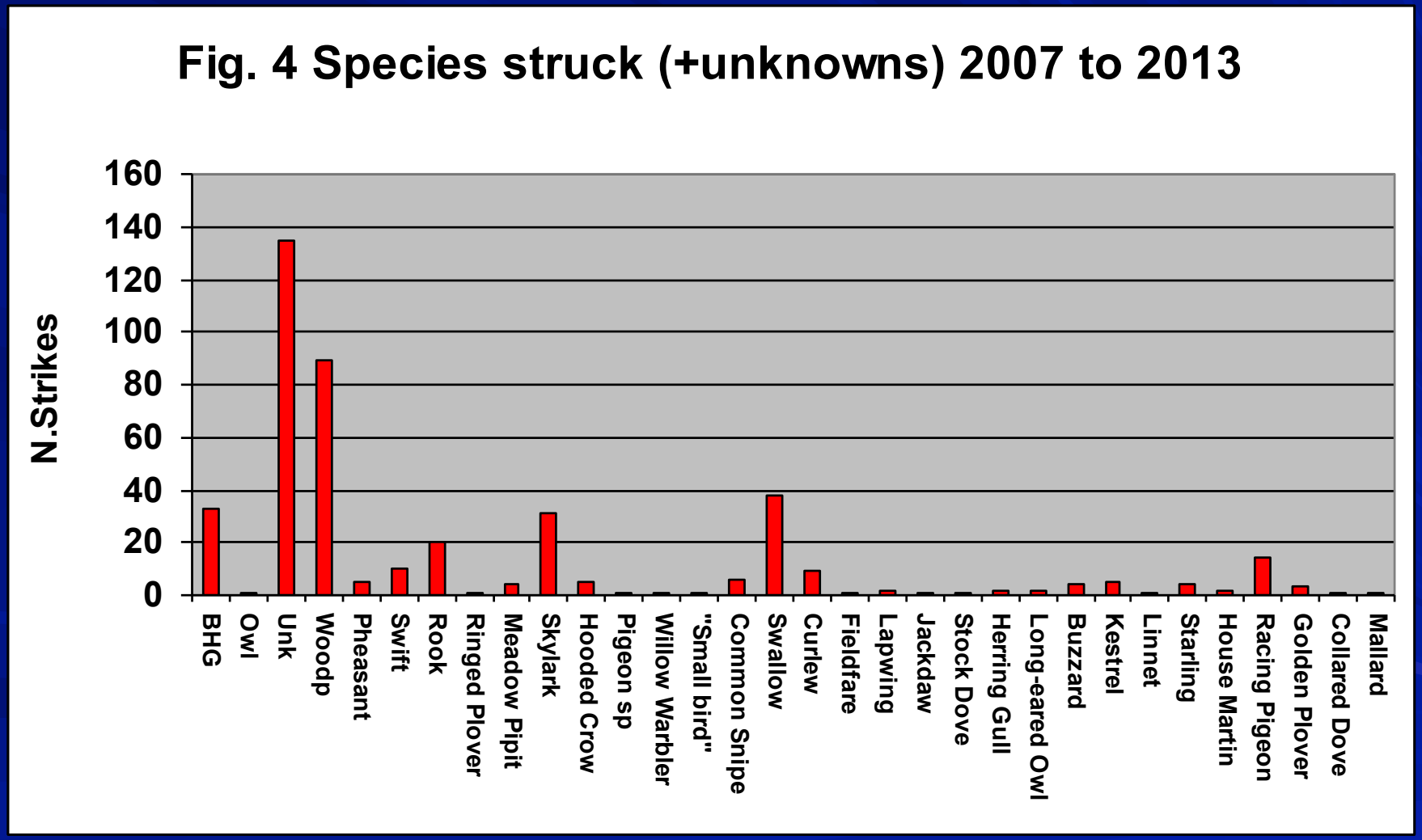
WOODPIGEON –JULY 5th 2014 ; AC made emergency return-DNA ID

OVER-FLY SEPTEMBER 7th 2015 – AT DUBLIN



WOODPIGEON

DATA 2007 TO 2013



Engine ingestion of Racing Pigeon

Photo Courtesy of Mr Brendan Keogh AFO

DAMAGE TO AIRCRAFT

ENGINE INGESTION + DAMAGE TO WING OF A320 ON AUGUST 15TH 2010 DURING TAKE-OFF (DNA ID)

CONCLUSIONS

- DNA powerful method of identifying “Who done it”
- But DNA not always recoverable and /or collected
- Take-off a particular problem
- Planning new system and protocols
- KPI to reduce % “unidentified” but “easier said than done”
- Bird Patrollers less time to inspect manoeuvring areas; reduced separation times; ac turn around much quicker and blood and tissue often “washed off”
- These are the changes that separate the 1990’s from the present
- Yet DNA can be collected in less 5 minutes
- Challenge is to work co-operatively with the system

WHO DONE IT?

THANKS

- To all relevant personnel at Dublin Airport for their hard work and careful recording of data – without which this presentation would not have been possible
- Drs Dove and Dolbeer -and their colleagues and co-workers– Who have pointed us in the right direction
- Colleagues at UC Cork for their assistance and continuing interest