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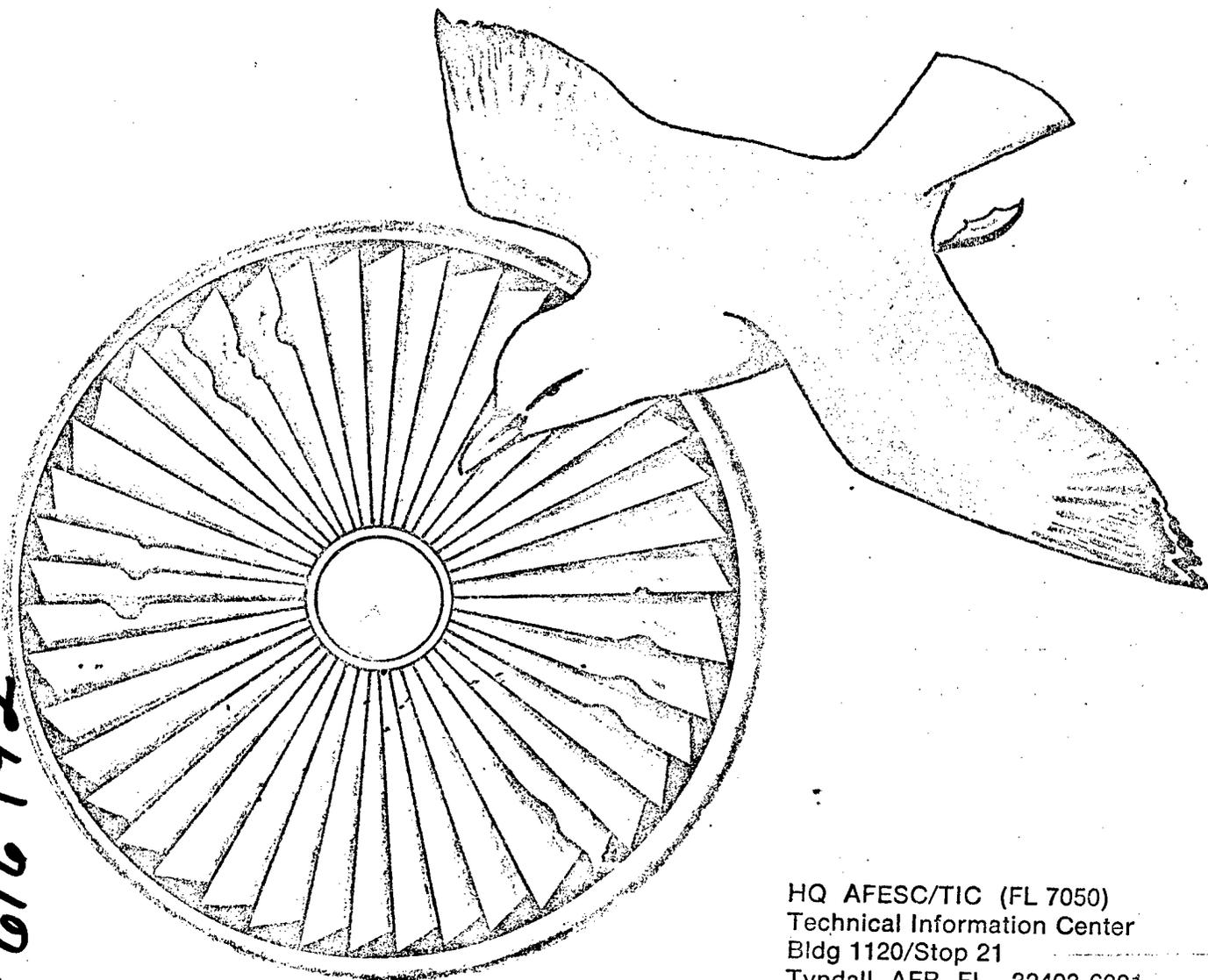
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11th MEETING

BIRD STRIKE COMMITTEE EUROPE



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13. ABSTRACT (Maximum 200 words) The Bird Strike Committee Europe consists of civil and military participants from Europe with a common interest in the bird strike problem. Attendance is open to participants from other parts of the world. Annual Meeting Proceedings include Chairman's Report, Working Group Reports and Papers Presented:  TABLE OF CONTENTS: Report on Overseas National DC-10 Accident at Kennedy Airport Bird Strikes to Engines Height Distribution of Bird Movements in Southern Sweden Measured by Radar Presentation of Bird Intensity on an 8 Point Scale Display Unit Soaring of Birds by use of Lights and Lasers Growth Prohibiting Substances and Effects on Grassland Allocation of Finance to Strengthen Aircraft Structure Attempts to Get Rid of Wood Pigeons from Orly Airport Bird Strikes during 1974 to European Registered Civil Aircraft Bird Strikes at projected Munich 2 Airport Trials of Bird Repellant Substances at Ben Gurion Airport Radar Study of Waders Migrating Birds and Their Danger to Aeroplanes The Problems of Planting Trees and Shrubs Near Airfields			
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**11th BIRD STRIKE COMMITTEE EUROPE**

**(BSCE 11)**

**Held in LONDON, U.K.**

**24 - 28th May 1976**

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SUMMARY

The Eleventh Annual Meeting of Bird Strike Committee Europe was held in London between the 24th and 28th May. The Committee is a joint Civil-Military committee, and is currently led by the Chairman Monsieur V E Ferry of France and Vice-Chairman Mr L O Turesson of Sweden, both of whom are elected by the BSCE members. This year's meeting in London was organised by the Ministry of Defence Procurement Executive, and was attended by members and observers from Belgium, Canada, Denmark, France, West Germany, Israel, Italy, Netherlands, Norway, Poland, Spain, Switzerland, Sweden, Turkey, United Kingdom, USA, USSR, and an ICAO observer.

The meeting commenced with two days of specialist Working Group meetings, followed by a two day Plenary Meeting. On the final day a visit was made to Heathrow Airport to see the work on bird control, and to the RAF Museum at Hendon.

The Committee's work includes the use of radar to track bird migrations and movements in order that warning to pilots can be issued, research and trial of measures to discourage or move birds from aerodromes, collection and analysis of bird strike data, compilation of maps of European bird movements, collection of information on structural testing of civil airframes, and the establishment of communications systems for pilot warnings.

A considerable number of Papers were presented at the meeting including:

Report on Overseas National DC 10 Accident at Kennedy Airport

Bird Strikes to Engines

Height Distribution of Bird Movements in Southern Sweden measured by Radar

Presentation of Bird Intensity on an 8 Point Scale Display Unit

Scaring of Birds by Use of Lights and Lasers

Growth Prohibiting Substances and Effects on Grassland

Allocation of Finance to Strengthen Aircraft Structure

Attempts to Get Rid of Wood Pigeons from Orly Airport

Bird Strikes during 1974 to European Registered Civil Aircraft

Bird Problems at Projected Munich 2 Airport

Trials of Bird Repellant Substances at Ben Gurion Airport

A Radar Study of Waders

Migrating Birds and their Danger to Aeroplanes

The Problems of Planting Trees and Shrubs near Airfields

The venue of the 1977 Meeting has not yet been arranged, because a world wide meeting was under consideration for that year.

**C O N T E N T S**

- Section 1      Recommendations.
- Section 2      List of Participants.
- Section 3      Opening Speech.
- Section 4      Introduction by Chairman.
- Section 5      Reports by Chairmen of Working Groups of the BSCE.
- Section 6      Papers Presented
- Section 7      Terms of Reference.
- Section 8      Concluding Speech.
- Section 9      Report on 11th Meeting.

**SECTION 1 - Recommendations**

11TH MEETING  
BIRD STRIKE COMMITTEE EUROPE

CORRIGENDUM

Section 1 - Recommendations

BSCE - 11-1

Bottom of Page 2, after ".. used;" add the following table:

" very small	below 110 g ( $\frac{1}{4}$ lb)
small	between 111 g and 681 ( $1\frac{1}{2}$ lb)
medium	681 g to 1.81 Kg (4 lb)
large	1.82 to 3.63 Kg (8 lb)
very large	over 3.64 Kg "



THE BIRD STRIKE COMMITTEE EUROPE RECOMMENDATIONSA Based on the work of Bird Movement Working Group

- 1 Bird concentration and bird movement maps should be published in the AIP of each State (See Stockholm recommendation A-1 and Appendix 1 of ICAO Annex 15 to Chicago Convention).
- 2 The Working Group is to undertake the task of studying bird strike risk maps. States are invited to send indications about their bird numbers according to weight (see C7) for their particular risk areas or submit maps of their bird strike risk based on actual strike experience and ecological comparisons by 1 October 1976.
- 3 The Chairman of Working Group is requested to send a jet navigation map to all participants together with an indication of the information required on bird concentrations and bird movements.
- 4 The Working Group is to ask Belgium and Germany to transfer the information requested by the above recommendation on to a large scale bird concentration and movement map for Europe.

B Based on the work of Communications Working Group

- 1 That a special effort has to be made from the communication point of view in order to convince people of the urgency of the information carried by BIRDTAM or Bird Warning forecast.
- 2 That a complete set of already agreed practices (format of the message, code used, prefixes) be published again in the 11th Meeting Report. (See Section 5)
- 3 This code of practice should be proposed to International Organisations as standard practice, with the final aim of becoming a part of Documentation already published (ref Airport Services Manual - part 3).
- 4 That the Working Group should include work on Flight Procedures.

C Based on the work of Aerodrome Working Group

- 1 The Working Group is to prepare a summary document to be used by airport manager. The information provided by Working Paper No 24 is to be transferred into a check list by the Working Group.
- 2 Each State shall provide details about
  - a) successful bird dispersal devices
  - b) devices judged to be unsuccessful
 in order that the Chairman of the Working Group can distribute a consolidated report for the next meeting.

- 3 Each State shall provide local and national regulations applying to Garbage Dumps and to controllable bird movements (eg racing pigeons) (See Stockholm recommendation No C.2)
- 4 In order to avoid duplication, members are requested to provide information they may have through their national organisations about the activity of the International Organisation on matters relating to the Group activity.
- 5 Chairman of the Aerodrome Working Group will collect observations made by States on ICAO Document 9139-AN898 Part 3 "Bird Control and Reduction", and send the agreed amendments by an ad hoc group of those received before 1 January 1977.

**D Based on work of Analysis Working Group**

- 1 The Committee recommends that all countries should be asked to review their reporting system on non-damaging as well as damaging strikes.
- 2 The Committee recommends that all countries should establish a system for the proper identification of bird remains, noting that identification is possible from remains as small as one feather, or from a colour photograph of a carcass.
- 3 That the Chairman ask ICAO to request each State that:
  - a) on receipt of a bird strike report involving an aircraft of that State but occurring at an airport in another State, to send a copy of such report to the State in which the strike occurred and,
  - b) that the state in which the strike occurred should in turn forward it to the aerodrome concerned.
- 4 That all Countries should institute the measures of para 3(a) and 3(b) by sending the report to the appropriate name on the list to be supplied by the Working Group Chairman.
- 5 That the Chairman of the Working Group should send the appropriate members of the Working Group modified sets of Analysis Forms, in order to make the changes agreed at the Working Group Meeting.
- 6 That the Chairman of the Working Group shall circulate proposals for a Computer based data storage and analysis system.
- 7 That it is recommended that for Design Requirement and Test purposes the specific bird weight should be quoted, and words should not be used:
 

ie	110 g	( $\frac{1}{4}$ lb)
	675 g	(1 $\frac{1}{2}$ lb)
	908 g	(2 lb)
	1.81Kg	(4 lb)
	3.63Kg	(8 lb)

However for statistical and descriptive purposes etc the following should be used:

2  
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ICAO is to be approached by the Chairman of the Committee to adopt this proposal.

- 8 That the Association of European Airlines be approached with the information contained in Bird Strikes to European Registered Civil Aircraft.
- 9 That information on Serious Civil accidents due to bird strikes be sent to the WG Chairman in order that Quarterly Bulletins may be circulated.

E Based on work of Radar Working Group

- 1 The Radar Working Group reminds all BSCE members that future radars currently being developed may incorporate digital or computer-aided data processing, which will exclude unwanted targets - such as birds.
- 2 In the case of radars with electronically-scanned aerials, data processing may be used at the input of the radar, and in other cases data processing may be performed at the radar which may be sited a long distance from the airfield.
- 3 The Committee then recommends that these types of radar be fitted with raw radar data display or output monitoring possibility which could be used for bird observations.

F Based on work of Structural Testing of Airframes Working Group

- 1 That, in support of para 1, 2(i) and (iv) of the terms of reference, Members should supply to the Chairman of the Working Group.
  - a) results of any bird impact structural testing together with geometric details, which have been completed by their organisations,
  - b) details of any future testing programmes by their organisations.
- 2 That, in support of para 1.2(ii) and (iii) of the terms of reference, members should supply the Working Group Chairman with details of any methods of analysing the bird impact resistance of structures correlated as far as possible with testing experience, which have been done by their organisations.
- 3 In order that the Chairman can commence the work of drafting the initial manual material in time for the next meeting, reports should be sent as early as possible but, preferably not later than the end of October 1976.

G Recommendations from Plenary Meeting

During the session, the following have been proposed and accepted as Bird Strike Committee Europe recommendations:

- 1 The Chairman of Working Group Analysis is to continue the publication of Civil Incidents Quarterly information bulletin. Each State is asked to provide relevant Civil information.
- 2 The Chairman of the Committee is invited to ask Bird Strike National Committees to ensure that proper information is forwarded for the

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completion of the document on dispersing devices.

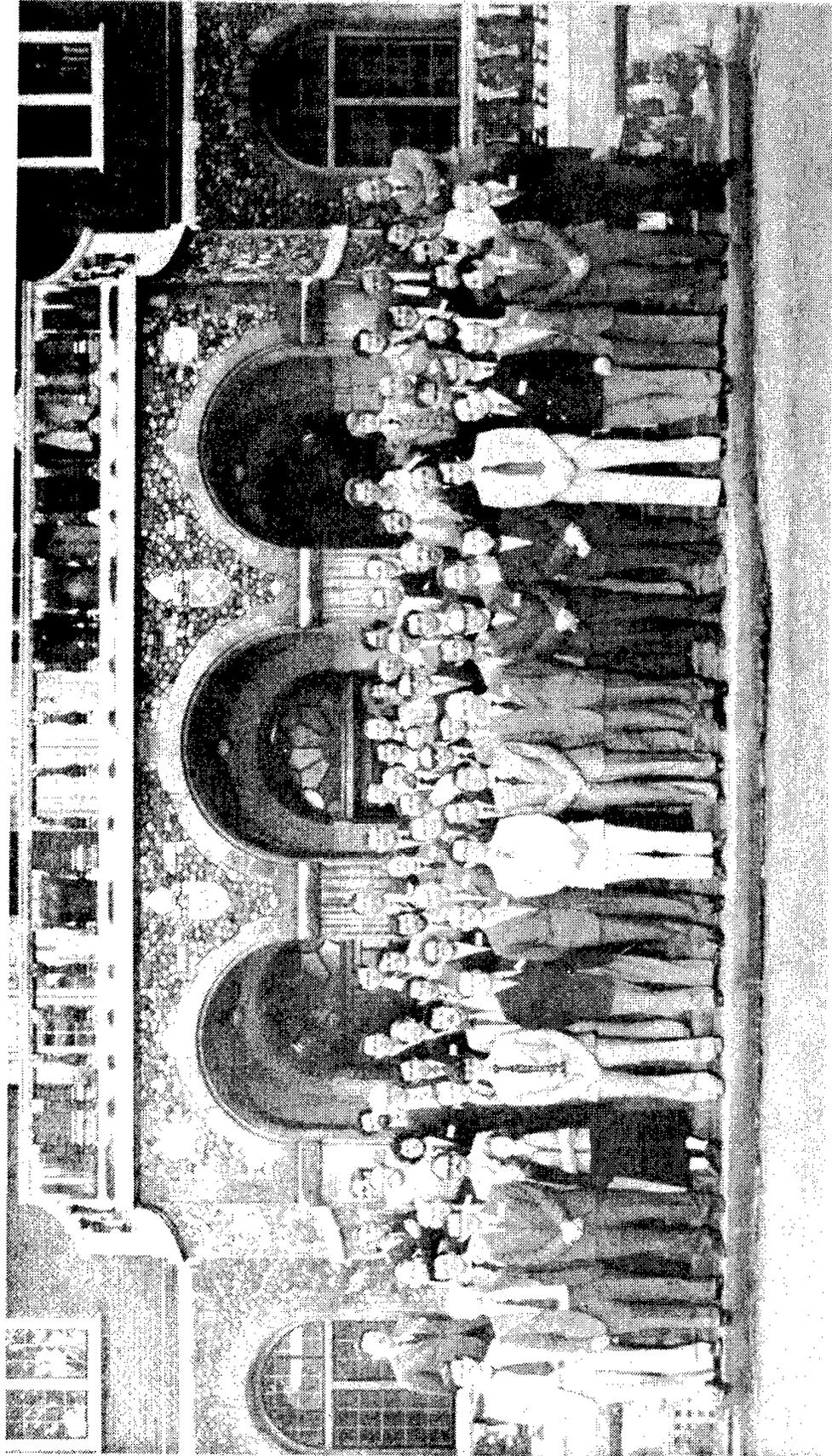
3 The Chairman of the Committee is required:

3.1 to review recommendations issued at previous meetings and publish a comprehensive list of those still in force,

3.2 to call ICAO attention to the standardisation in process inside BSCE of the description of weight ranges of birds.

3.3 to approach Airports Associations about the information shown by Bird Strike analysis tabulated by airports.

**SECTION 2 - List of Participants**



Group of those attending the Meeting, standing in front of Church House.

(The lady, Miss Alison Stark, is one of the French/English, English/French Interpreters).



Working Groups						Unable to attend/ Report Requested
Radar	Communications	Structural Testing	Aerodromes	Analysis	Bird Movement	
						FINLAND
						o Mr K Salonen
						FRANCE
	+	+	+	+		Mr V E Ferry
		+		+		Mr A Attig
				+		Mr Marc Laty
						o Mr Marqueze-Pouey
						Mr Briot
						Mr Mugnier
		+		+		o Cdt Prigent
		+				Capt H Cesbron Lavau
						Mr Rochas
		+	+	+		o Mr Clamagirand
						Mr M Sonnette
						o Mr Vondermuhll
						o Mr B Devoge
						WEST GERMANY
+	+	+	+	+	+	Dr J Hild
+	+	+	+	+	+	Dr Werner J Keil
	+		+	+		Mr Ulrich Kempkens
	+		+	+		Mr Walter Schabram
						o Dr D Volk
						Mr Becker
		+		+		Mr Klaus Linke
						Mr C Fussmann
						Mr Rudolf Germander
						o Mr Johannes Maron
						Mr Peill
						ICAO
	+		+	+		o Mr J F Montgomerie
						Mr Kenneth K Wilde
						o Mr C Eigl



Working Groups						Unable to attend/ Report requested
Radar	Communications	Structural Testing	Aerodrome	Analysis	Bird Movement	
			+		+	
+					+	
+	+		+	+	+	
+	+	+	+	+	+	
+						
			+		+	

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13  
14







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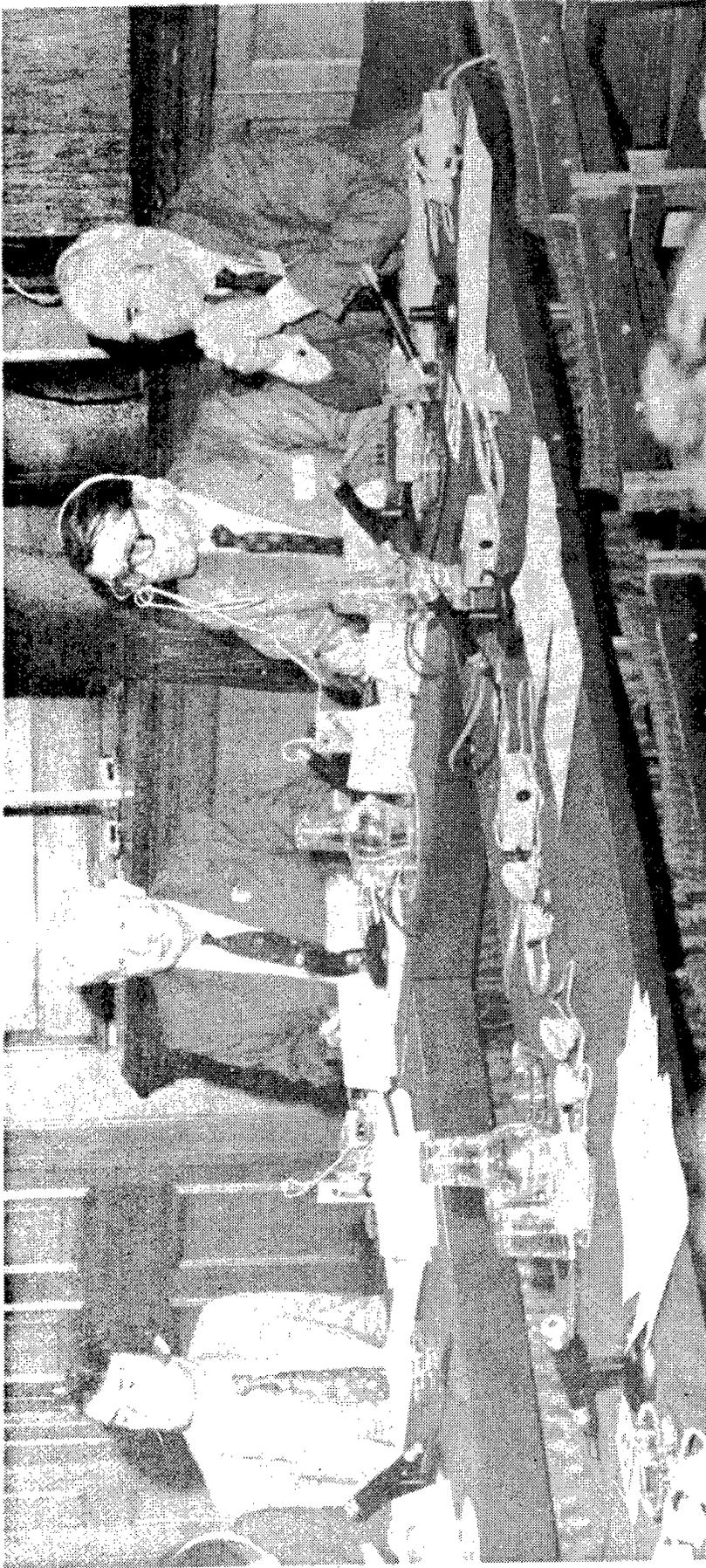
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**SECTION 3 - Opening Speech**





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Mr V E Ferry,  
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Mr N Sharp,  
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opening the Meeting.

OPENING SPEECH OF WELCOME BY IER N SHARP, A DIRECTOR OF THE BRITISH  
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Monsieur Ferry, Gentlemen

My name is Norman Sharp, and I am responsible in our Ministry of Defence, Procurement Executive, for directing programmes of work on what may be broadly described as electrical and mechanical equipment of systems for military and civil aircraft. I say broadly because included is work on various hazards to aircraft, including the hazard from birds. With this responsibility, I am Chairman of the United Kingdom **Bird Impact Research and Development Committee** and it is with this interest that I welcome you all to London for the 11th Meeting of the **Bird Strike Committee Europe**. I do this with great pleasure extending a particular welcome to those of you who are visiting our country from overseas.

In the UK, we continue to tackle the problems which birds present through various organisations and approaches, and undoubtedly of great importance is the UK **BIRD Committee**. Represented on this, we have several official bodies, namely, the Ministry of Defence (Procurement Executive), with its Directorate of Aircraft Mechanical and Electrical Engineering Equipment, its Directorate of Engine Development, and its Research Establishments engaged with programmes on bird impact and on radar etc: the Ministry of Defence (Air), with its Directorate of Flight Safety: the Ministry of Defence (Navv) with its Flight Safety Centre: the Civil Aviation Authority with the Chief **Fire Service Officer**, the **National Air Traffic Services** and the **Airworthiness Division**: the Ministry of Agriculture, Fisheries & Food with its Pest Infestation Control Laboratory at Worplesdon in Surrey: and, of course, the **International Air Transport Association** comprising British Airways and the independent operators.

This Committee takes an extremely active interest in virtually all the problems, that is in the many various measures to combat the hazard including detection and control methods, investigations of bird population and behaviour, habitat management and dispersal, as well as in the engineering aspects of the hazard as affecting the integrity of aircraft structures and propulsion engines. While the Committee has no funds at its direct disposal, it encourages and promotes research through its essential bodies and has an active interest in policy making, as, for example, affecting aerodromes and aerodrome environs. Several members of the Committee are active in this 11th Meeting of BSCE.

While awareness of the high annual cost of repair to both the British Military Forces and to the British Civil Aircraft operators is enough to ensure that serious attention continues to be given to the bird problem, the occurrence last year of what, I suppose, one might coldly describe as an isolated accident involving a small jet taking off from an airfield in Surrey, gave us a sharp reminder of the ever present threat from bird impact to life and property. In fact this accident resulted in 6 innocent persons in a passing car being killed, and it was indeed harrowing.

The message is that we must press forwards with the objective of a steady increase in our knowledge and control of the problem and a related decrease in the risk from a hazard which is bound to persist. In this process the 11th Meeting of BSCE is without doubt of considerable value and I am sure that we will all benefit from the opportunity for communication which it affords and the fostering of further collaboration in dealing with a truly international problem. If anything, the basic nature of the bird problem is such that it is intensifying. With the advent of the jet, there was a steep increase in risk due to the higher speed of

these aircraft as compared with their piston engined predecessors and we may now expect limited types of jet aircraft to operate for all time at the relatively low altitudes in which birds have evolved through the countless years. Fortunately, because of the limitation of their normally aspirated motors and other air density affects, we have little worry that birds will decide to change their normal operating habits to create a new traffic problem at the more popular aircraft altitudes.

It is evident that the programme for the meeting comprises a range of remarkably interesting and pertinent topics. To avoid the possibility of stealing the thunder of any of our contributors to this Meeting, I shall say no more than these few words except, in welcoming you, to wish you all success, not only at the Meeting, but also in the future, and I trust that you have a pleasant and enjoyable sojourn here in London.

Now I hand over to Monsieur Ferry.

**SECTION 4 - Introduction by Chairman**

THIS HALL OF CHURCH HOUSE  
 WAS AS OCCASION REQUIRED DURING THE  
 YEARS 1940 1941 & 1944  
 THE CHAMBER OF THE HOUSE OF COMMONS  
 WITHIN ITS WALLS  
 THE PRIME MINISTER WINSTON CHURCHILL  
 IN THE DARKEST DAYS OF THE WAR  
 SPOKE TO THE COMMONS AND TO THE NATION  
 THE WORDS HERE RECORDED

"Today, in inaugurating a new Session of Parliament, we proclaim the depth and sincerity of our resolve to keep vital and active, even in the midst of our struggle for life, even under the fire of the enemy, those parliamentary institutions which have served us so well, which have proved themselves the most flexible instruments for securing ordered unceasing change and progress: which, while they throw open the portals of the future, carry forward also the traditions and glories of the past and which, at this solemn moment in the world history, are at once the proudest assertion of British freedom and the expression of an unconquerable national will."  
 21st November 1940

Plaque in the historic Hoare Memorial Hall in Church House, Dean's Yard, Westminster, in which the main meeting was held.

Introduction by the Chairman, Mr V E Ferry

It is a great honour for the Chairman of the BSCE to open this session in this Hall where so many historic decisions were taken during the difficult period of the blitz. Let us hope that the solemnity of these walls and the wisdom of the then members of parliament will inspire our work.

The last meeting of the BSCE was held in Stockholm, 9 to 12 June 1975.

Although the report of the meeting was very large, it was distributed in good time with a small addition a few months later. Because we had entered the second decade, the Stockholm meeting was exceptional for its quality and hospitality and will be difficult to excel, so let us officially express our thanks to the Swedish organisation.

On the whole the year's activity, on the post bag side, has been very busy, almost 200 letters received and 100 letters sent, some of which were circulars in order to save the poor Chairman's time. Letters have brought confirmation that questions unsolved at the last meeting were being studied, and some solutions have been brought to the Chairman's attention.

One recently formed working group has been firmly established and proposals for a new one have been received. That question has been put on the Agenda of this session for further consideration. In connection with the formation of the Structural Testing Group we were fortunate enough to enter into close contact with ICAO and become involved in the last Airworthiness Committee Meeting.

As instructed by the Committee we have tried to improve our contact with ICAO and IATA and have achieved a certain amount of success. We hope that, through the years, we can envisage a close collaboration in the future.

In Europe the European Civil Aviation Conference (ECAC) is entering into the bird business, so to speak, and we hope that we will be officially invited to attend their meeting. We will learn that answer during the next meeting of the Director Generals of Civil Aviation to be convened in June in Strasbourg. Some help is needed from your representatives and that will appear in the Agenda.

We are glad to have with us today representatives of Italy and Turkey. Also a large USSR delegation is amongst us. We hope that the new participants will be very active and bring us the benefit of their experience.

Czechoslovakia, who announced her participation for the 1976 meeting is not present, but every country is experiencing problems due to the crisis, and we expect to have them with us for 1977.

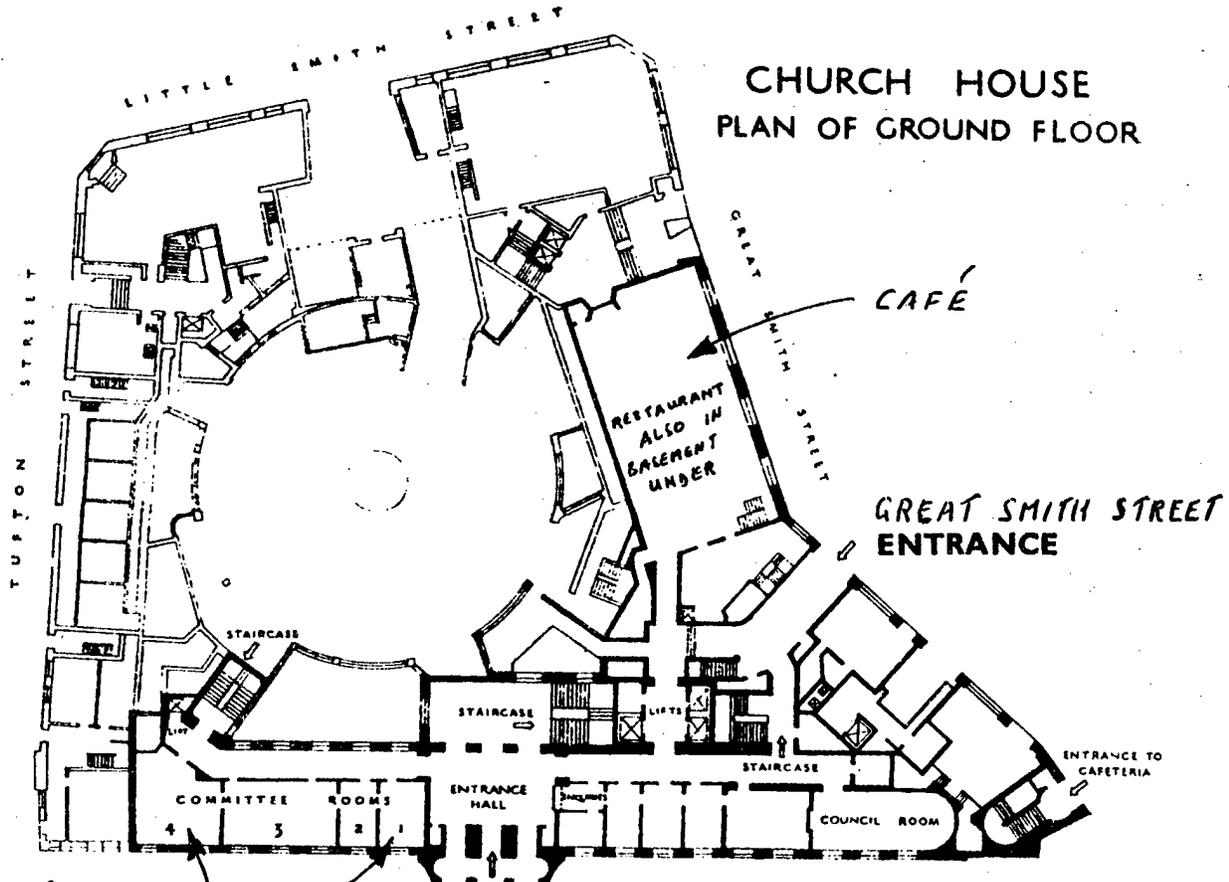
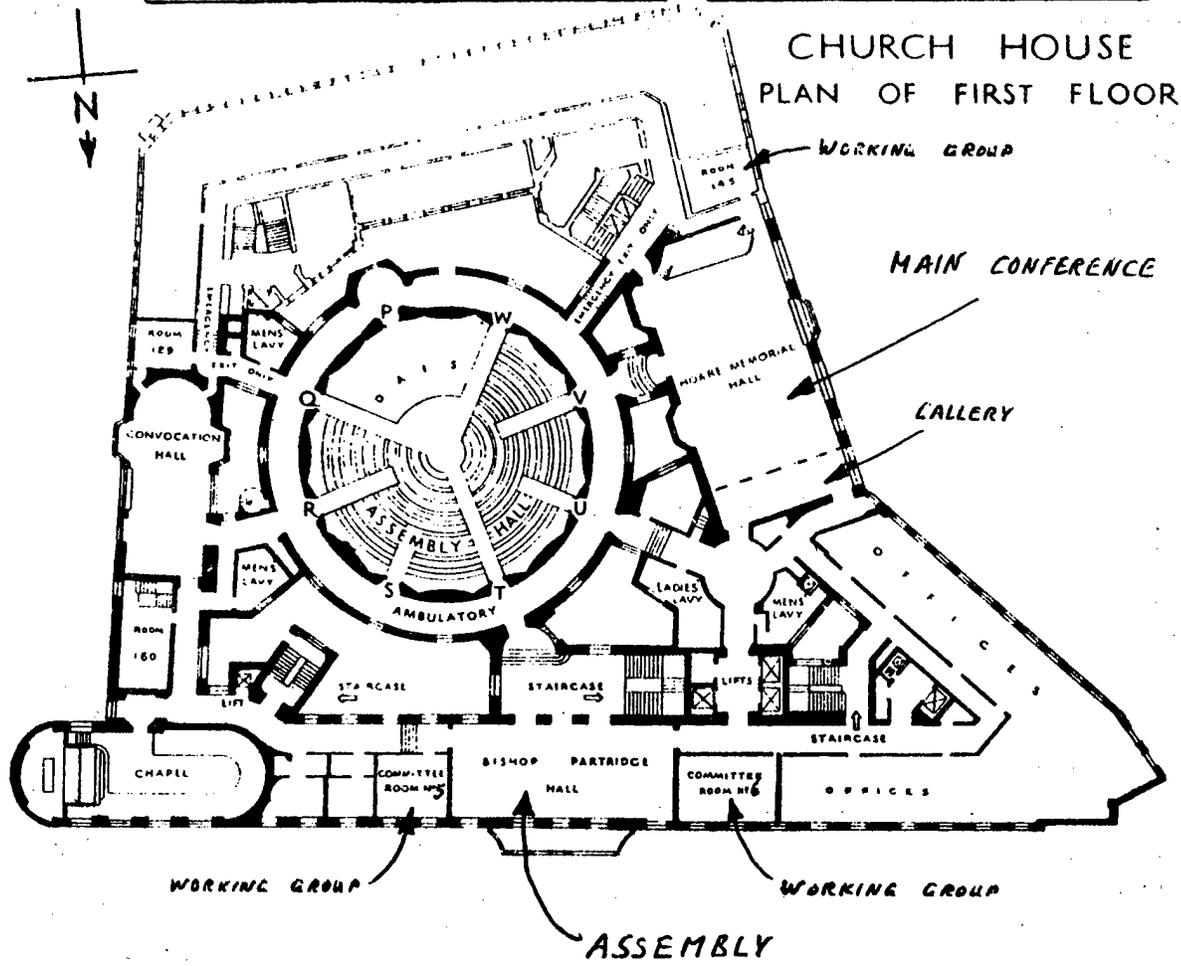
Professor Jacoby, travelling in France, is unable to join us and has asked me to convey to you his wishes for the success of our meeting. A letter from Colonel Schneider also expresses the same good wishes. With such backing as this we will certainly meet with success.

As you will remember some changes have to be introduced in the structure of the Committee. We have to elect a vice chairman and explore the possibility of having a permanent structure. The Chances are good for this last question, but let us wait and see.

This year was darkened by a fatal accident at Dunsfold in England and by the occurrence of the DC10 crash at Kennedy Airport last November, both caused by bird strikes. These accidents highlight the relevance of our work and we hope they will serve to impress upon our authorities the importance of finding solutions to bird hazards to aircraft.

The Newspapers were full of information, two days ago, about the new trans-lantic system that cuts travelling time by half, so if I want to stay in line, I had better cut short my introduction. My last words must be to thank the British Organisation for the arrangements they have made here, and for their efficient and good organisation which are guarantees of success for our Meeting.

# THE BIRD STRIKE COMMITTEE EUROPE



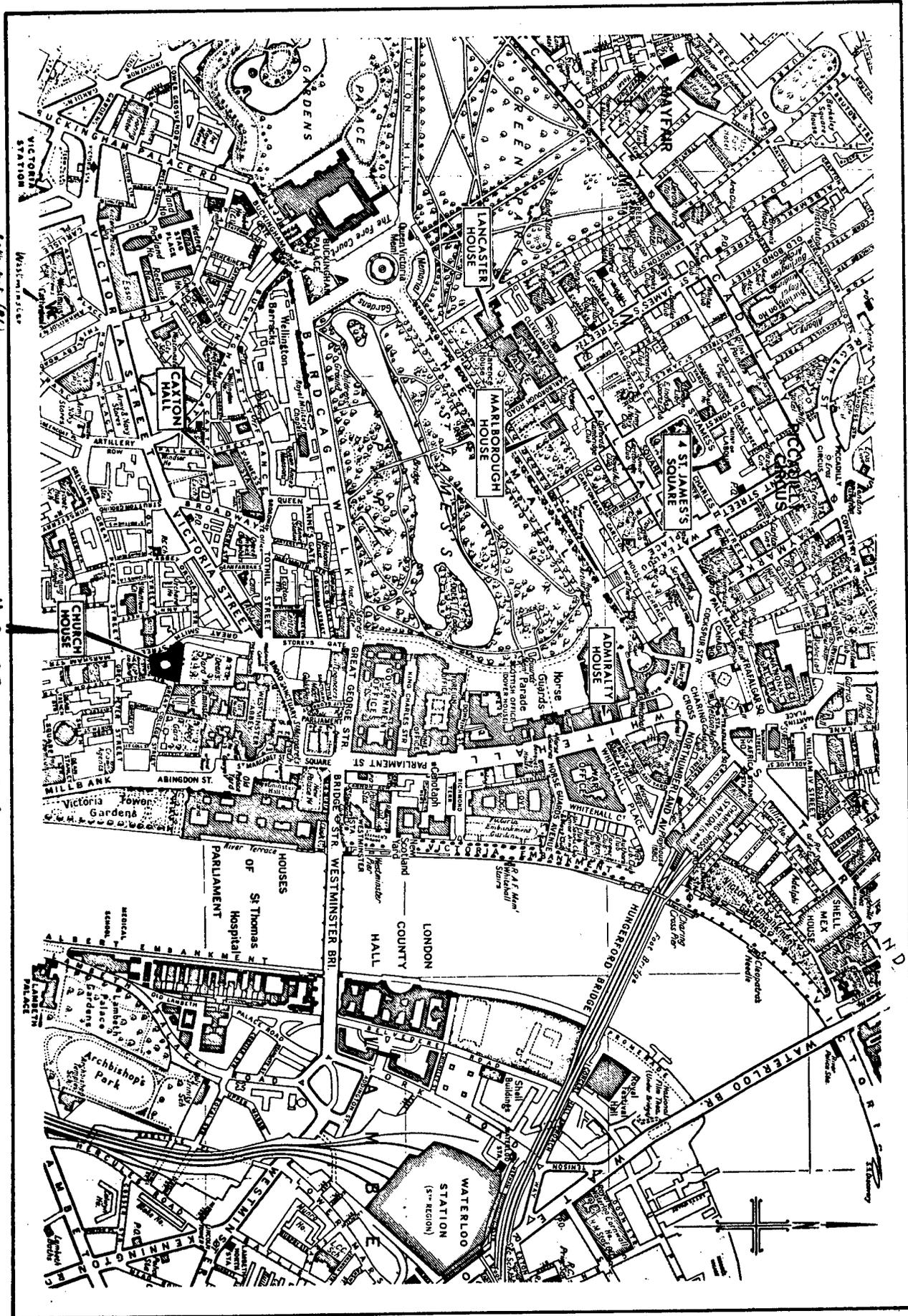
TYPISTS  
DUPLICATOR  
TELEPHONES

DEAN'S YARD  
ENTRANCE

45



WESTMINSTER LONDON



2/6  
Lambeth (N.E.)  
Westminster

17th BSCE - MAY 1976

0 .5 1 km

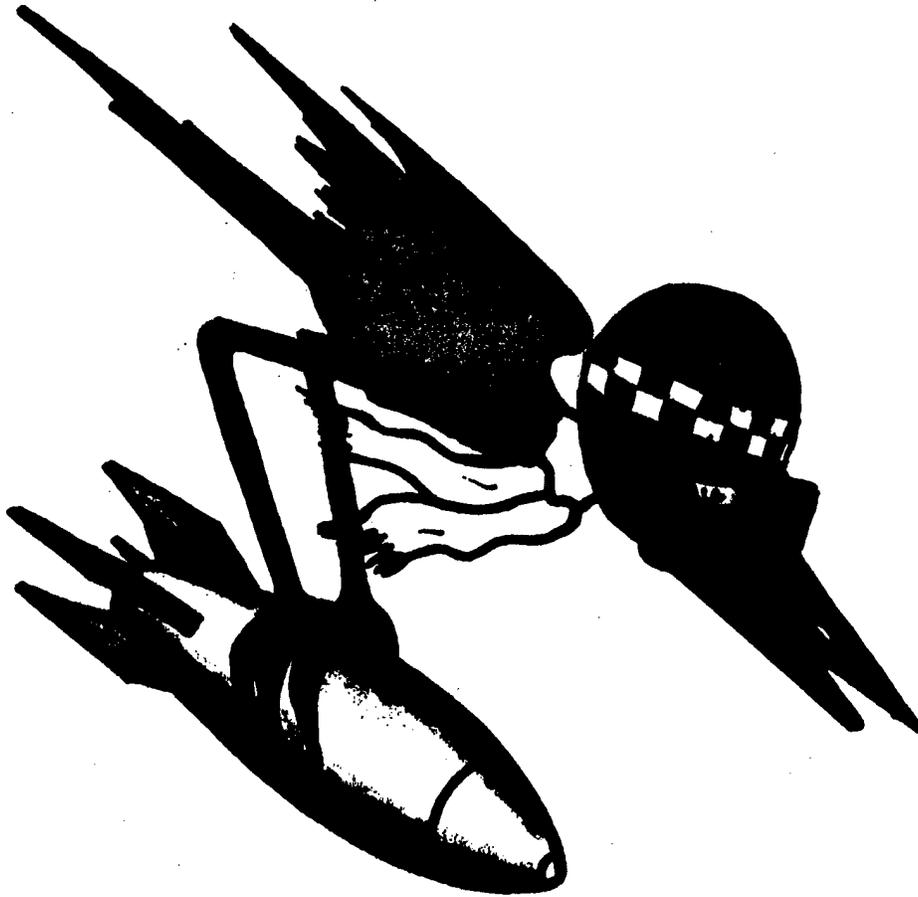
BIRD MOVEMENT



1. Title: BIRD MOVEMENT
2. Terms of Reference: Study of bird concentrations and movements and preparation of special maps for the information of aircrews and aviation services.
3. Progress report:
  - a. The bird concentration and bird movement maps, published in 1973/74 have and are being revised in the light of the latest information.
  - b. Most countries published concentration and movement maps in the Civil and/or Mil AIP.
  - c. Belgium has drawn up a first draft of a bird strike risk map in accordance with the recommendations of the 9th Meeting. Netherlands, Denmark and Germany are preparing similar maps.
4. Future Programme:
  - a. Periodic revision of maps should be continued.
  - b. Where required further maps of airfields and their surroundings will be produced.
  - c. Bird strike rates in existing low level flying areas will be used as a basis for predicting strike rates in other areas and maps will be produced.
5. Recommendations:
  - a. Bird concentration and bird movement maps should be published in the AIP of each country.
  - b. Chairman of W.G. is requested to send a jet navigation map to all participants together with an indication of the information required on bird concentrations and bird movements. Participants should provide their latest data on these maps and return it to the Chairman by 1st October 1976.
  - c. Belgium and Germany are requested to transfer this information on to a large scale bird concentration and movement map for Europe.
  - d. Countries which are interested in bird strike risk maps are invited to send indications about their bird numbers according to weight for their particular risk areas or to submit maps of the bird strike risk based on actual strike experience and ecological comparisons. (Deadline 1st October 1976).

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Dr J. HILD  
Chairman

COMMUNICATIONS



Tora!  
Tora!  
Tora!

## ACTIVITIES OF THE WORKING GROUP

1. Title: COMMUNICATIONS

## 2. Recommendations from the 10th Meeting - Stockholm - June 1974.

As the group was officially suspended for a time, no recommendation was proposed to the Committee. However the group accepted to carry out the following tasks required by the Committee:

2.1. check NOTAM circulation dealing with bird movement during the autumn migration period as well as the mode of transmission of these messages and their use of the addresses,

2.2. check and complete if necessary the NOTAM addresses when dealing with bird activities,

2.3. send to each Chairman of the National Bird Strike Committees the complete list of NOTAM address for action.

3. Progress report

3.1. the survey of Birdtam was made and revealed no more information than the previous one. It was noted that some countries had introduced automatic detection of bird activity and that messages were also sent in a completely automatic mode. It was also pointed out that migration forecast messages were helpful so they needed to be continued,

3.2. a complete list of addresses used by Belgium is provided as an example:

EBMBZP, EBBEZP, EBLGZP, EBSTZP, EPFNZP, EPFSZP, EBBLZP, EBSZZP,  
EBGLZP, EBSZZP, EBWAYN, EBBRYN, EBBRSN, EDDYZQ, EBZZNA, EBCIZP,  
EBOSZP, EDAAYO, EDEEYO, EDDZYN, EGGNYN, EGVCYO, EHM CYO, EKMCYO,  
ENFBYN, LFZZNH, LFYXYRSM, LIIAYN, LIJJYA, LIZZNA, EHZZNH,  
LXGBYN, LFZZNH, EDNVYO, ELANYO, EBWMYM, LEZZNE, LTBSYN, EFWAYG,  
WWZZNK.

Representatives from Countries agreed to provide their list and propose amendments to the comprehensive summary that would be made available in the near future.

3.3. no action was taken in order to improve the phraseology; the experimental period was consequently extended by one year,

3.4. some discussions took place on a draft proposal about the establishment of a new working group whose terms of reference would include the development of flight procedures. It was agreed that if needed the Communications W.G. could participate, as a group, in the work dealing with associated phraseology.

4. Chairman's report:

4.1. From the discussions it appears that a special effort has to be made from the communication point of view in order to convince people of the urgent need for the information carried by Birdtam or Bird Warning forecast.

4.2. It has been suggested that a complete set of already agreed practice (format of the message, code used, prefixes) be published again in the 11th Meeting report.

4.3. This code of practice should be proposed to the International Organisation as standard practice, with the final aim of becoming a part of Documentation already published (ref Airport Services Manual - part 3).

V E FERRY  
Chairman

AERODROME



AERODROME BIRD STRIKE WORKING GROUP,  
CHAIRMAN'S REPORT

1 Recommendations of 10th Meeting, Stockholm, 12 June 1975.

1.1 It is recommended that a list should be prepared of the technical specifications of all currently used bird dispersal devices for distribution by the Chairman of the Working Group.

1.2 It is recommended that countries provide local and national regulations applying to garbage dumps and to controllable bird movements (eg racing pigeons).

1.3 New recommendation

It is recommended that each country be requested to include on their bird strike reporting form the following new questions:

"Were lights being used

Landing	Yes	No
Strobe anti-collision	Yes	No

2 Progress report:

2.1 Recommendations No 1

Only Denmark, Switzerland and Germany send material to the chairman. The given survey contains the used methods in these countries. But it is known that eg Belgium, Britain, France and the Netherlands use with much success a variety of technical specifications for bird dispersal devices. The chairman hopes that the other nations will give their devices to the chairman of the working group in the near future.

2.2 Recommendation No 2

On the basis of this recommendation the chairman received answers from Denmark and Switzerland. It seems that only one country - Germany - has local or national regulations applying to garbage dumps. The same must be supposed about controllable bird movements, as with racing pigeons.

In Germany we have had regulations since February 1974. All participants of the 9th meeting of BSCE received an English translation. The regulations were also printed in the congress minutes of the Frankfurt meeting.



The German regulations say that garbage dumps have to be closed inside the fence of the aerodrome. The same had to be done outside the aerodrome over special distances.

This regulation of the Federal Ministry of Transport has been used with great success on civil aerodromes in the past two years.

### 2.3 Recommendation No 3

The third recommendation has been in use for two years by the Deutsche Lufthansa. But it was not possible in the short time to assess the effect of the measure. The Luftfahrtbundesamt issued a special note to general aviation in Germany to use landing lights during the approach-phase of the flight. From other countries no reports about the recommendation were received.

### 2.4 Check list for the airport manager

It was not possible to hold a special meeting to discuss the proposal made for the check list. Squadron Leader Lake who was responsible for it was transferred to another place. But Squadron Leader Austin gave a special report about the list under Working Paper No 24.

### 2.5 Meetings of the working group

The intention to hold the future meetings of the WG separately from the main meeting of BSCE must be given up (financial and time reasons).

Finally it should be noted that the co-operation of the WG members must be improved.

## 3 Future work

3.1 Preparation of a document to be used as a check list by the airport manager

3.2 Exchange of all information about bird dispersal devices and completion of the survey of the list for distribution to the member States. Information about successful devices should also be provided.

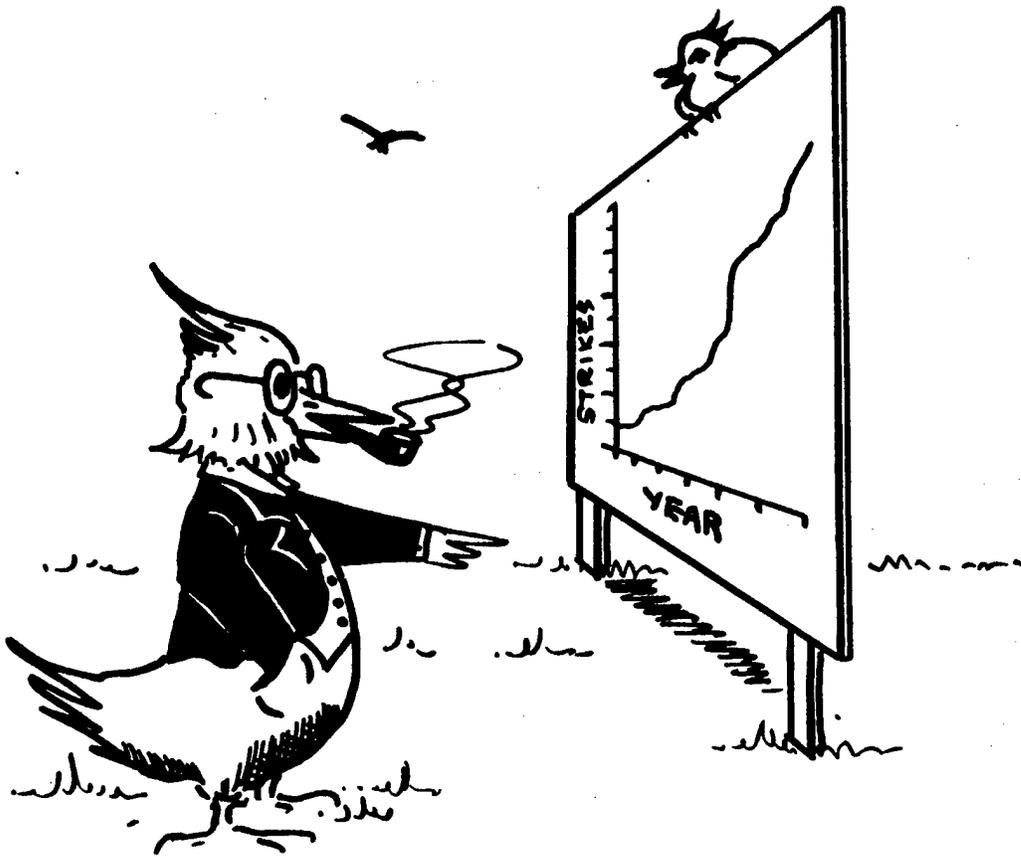
3.3 Collecting of national regulations applying to garbage dumps, gravel pits eg as far as available

3.4 In order to avoid duplication, members are requested to provide information they may have through their national organisations about the activity of the International Organisation on matters related to the group activity.

Frankfurt/M.  
20 May 1976

Dr Werner Keil  
Chairman  
Aerodrome Bird Strike  
Working Group

ANALYSIS



24th May 1976

## BIRD STRIKE COMMITTEE EUROPE

## Activities of Working Group Established by BSCE

## Working Group - ANALYSIS

1. Recommendations of 10th Meeting, Stockholm, June 1975

## 1.1 The following recommendations from the Analysis Working Group were endorsed by the Plenary Meeting

1. That those European countries which did not provide analyses using the BSCE layout should again be requested to provide the information.

Note: The countries concerned are Germany, Italy and Norway.

2. That the Authorities responsible for civil airports with above average strikes should be informed, and asked to investigate and take appropriate action.
3. That the available evidence which indicates differing abilities of various parts of civil aircraft including intakes and engines to withstand bird strikes, should be further investigated.
4. That every effort should be made to obtain the cost of engineering repairs caused by bird strikes on Civil aircraft.
5. That all European air forces should be approached at the appropriate level by the BSCE Chairman in order that security will allow the use of both movement and strike rate information. Each delegation should give this appropriate name and address to the BSCE Chairman.
6. That information should be provided to the United States NTSB as the BSCE contribution to their current survey on bird ingestions by large fan engines.
7. That the Aerodromes W.G. resolution on the reporting of the use of lights is fully endorsed.

1.2 The following work programme was agreed for the Analysis Working Group

- i) insist that all BSCE-states have to use the BSCE-forms for the yearly report of the distribution of bird strikes recorded by each state (civil and military reports).
- ii) produce a BSCE bird weight classification to avoid inconsistencies in the national reports.
- iii) continue the special analysis on strikes to engines with an investigation oriented to the ability of intakes and engines to withstand bird strikes.
- iv) study the effectiveness of the use of aircraft landing lights for driving birds away from aircraft path.

## 2. Progress Report

- 2.1 Notes of the Analysis WG Meeting in Stockholm were sent to those who attended the meeting, in addition to the Chairmen of the other Working Groups.
- 2.2 The attachment shows those countries which have sent their Analyses. The Civil Analyses have been added together to produce "Bird Strikes during 1974 to European Registered Civil Aircraft" BSCE/11-WP 2, which is being presented at this meeting. Owing to inconsistencies in individual reports, and the very high workload on the UK RAF representative, it has not been possible to present a consolidated report on Bird Strikes to European Military aircraft at the meeting. However a summary of the important points will be given, and the report will be included in the Meeting Report.
- 2.3 Little progress has been made in obtaining costs due to bird strikes, all countries were circulated but very few countries were able to supply information. The evidence suggests that the cost to European Airlines is at least 4 million US dollars per annum.
- 2.4 The NTSB were sent a copy of the 1973 European Civil Aircraft Paper, which included an Appendix on Strikes to Engines.

- 2.5 Some countries have now included a question on the Use of  
of Lights on their National Bird Strike Report Form.
- 2.6 It has not been possible for the BSCE Bird Weight Classification  
document to be produced, owing to pressure of work on the  
appropriate representative. However work is currently in progress.
- 2.7 The special study of Bird Strikes to Engines is presented as  
BSCE/11-WP 3 at this meeting. This Paper was presented to the  
ICAO Airworthiness Committee Meeting in Montreal during March 1976.
- 2.8 The adoption of the ICAO definition of a Confirmed Bird Strike  
should be noted:

"A bird encounter is considered a 'confirmed' bird strike if  
it leaves, on the aircraft concerned, a trace of bird impact,  
or ingestion into the engine, and this either

- a) in the form of damage to the aircraft; or
- b) where no damage occurs, a blood smear or bird  
tissue or feathers visible somewhere on the aircraft."

Note: The above terminology is extracted from  
ICAO State letter AN 3/32 - 71/150 of  
28 October 1971.

- 2.9 The Chairman compiled a Civil Incidents Quarterly Information  
Bulletin which contained definitions of 'Serious', together with  
brief details of 1975 incidents/accidents. No 1 dated 27 January  
1976 was sent to the Chairmen of Bird Committees and the person  
responsible for Civil analysis in each country.

J Thorpe  
Chairman, Analysis WG

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-3-

R11

May 1976

1974 BIRD STRIKE DATA RECEIVED FROM BSCE MEMBERS

MILITARY

Canadian Forces Europe  
Belgium  
Denmark  
France  
Netherlands  
Norway  
Spain  
Sweden  
UK

CIVIL

Denmark  
Finland  
France  
Germany\*  
Netherlands  
Norway  
Sweden\*  
Switzerland  
UK

\*BSCE Analysis Forms NOT used.

R A D A R



CHAIRMAN'S REPORT AND PROGRESS

## Tasks assigned to the RADAR WORKING GROUP

Following the resolution of the main meeting at Stockholm, Dr F Hunt (NRC, Canada) has written a paper relating radar bird observation and bird strike probability. The paper is entitled: "The probability of bird-aircraft collisions based on radar data". The paper has been reviewed by three referees, and also it was discussed by members of the Working Group. Dr Bruderer agreed to include some of the main points brought up in the Group discussion in his own report to Dr Hunt. Dr Hunt will make alterations to the paper and issue it later this year after he has considered criticisms from the referees.

Chairman's report and progress

The Belgian Air Force has now put into operation their computer-aided bird density evaluation method, whereby bird intensity (scale 0 to 8) obtained by radar is automatically printed out on an electronic display device. Cdt Theo Jacobs described the Belgian project and gave copies of a leaflet "Belga Radar" (SEROS Semmerzake Radar Operating System) to the delegates.

The Danish Air Force who pioneered electronic-counting of bird echoes has now designed and fabricated their own electronic system for measuring bird densities. This system is called "Faust". One equipment has been installed and two further equipments will be fitted shortly. More details of this project are given in Peter Clausen's note accompanying this report.

Germany, besides maintaining their photographic analysis scheme on 15 radars, are currently evaluating an electronic counting system.

In Norway the current use of radar as applied to the Bird Strike Problem is concentrated in part of Oslo and Trondheim FIR districts. Polaroid pictures are being taken of the PPI and the 8 point scale is being used for evaluation and bird warnings. Warnings are sent to civil and military airfields and when possible to a/c in flight in the two FIRs.

Sweden has revived the interest in predicting bird intensity from weather factors using multivariate analysis methods. Swedish scientists have also been looking at the height distribution of bird movements by radar and this work was reported during the main meeting.

In Switzerland Dr Bruderer has been continuing his bird migration studies with a tracking radar. This time with the radar at 1950 metres above sea level on a pass in the Bernese Alps. A brief note on this work will be issued with this report.

The Royal Netherlands Air Force have restarted their radar work.

Dr Fred Hunt (Canada) was unable to be present, but he has sent a progress report which is attached to this report.

As a result of collaboration within BSCE, Thomas Alerstam (Sweden) and Luit Buurma (Netherlands) have worked with Bruno Bruderer in Switzerland for a short time and also Lars-Olof Turesson (Sweden) and Luit Buurma (Netherlands) have visited the Royal Signals and Radar Establishment (UK) for discussions on the bird identification analysis methods used in Britain.



Actions pending

Dr Hild asked what steps could be taken to calibrate different types of radar on different sites in order they could be used for comparison purposes. Could correction factors be devised? After a short discussion the matter was closed until the next meeting.

E W Houghton  
Chairman

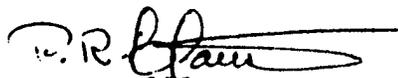
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19th May 1976

PRESENT STATUS OF THE DANISH ELECTRONIC COUNTING SYSTEM

now named : " F A U S T " .

1. The old electronic counting system, using a commercial electronic counter HP 5325B, has, as mentioned at the last meeting, been in operation 8 - 10 times a day since June 1973.
2. After approximately 3 years in operation the old electronic counting system, in our opinion, had proved its ability to judge bird density. Designing the "FAUST" system we decided that it should be contained in one box, without the use of an external electronic counter, but with an internal display directly giving the results for each antenna revolution.
3. The basic principle of the bird density measurement in "FAUST" is purely time integration.  
 Actually the system measures in how much of the possible receiving time, inside the azimuth and range gate, signals greater than the thresholds are received ( radar video minus SLB video ).  
 This measurement is expressed in percent and after calibration of the "FAUST" system to the specific radar, this percentage will give the bird density from 1 to 8.  
 For each antenna revolution the internal counters are read by the ALU (Arithmetic Logic Unit) and presented on the displays together with the calculated percentage.  
 "FAUST" has 3 fixed/preset counting areas and one manually controlled area, which can be placed anywhere inside the radarcoverage by means of switches on the front panel.
4. "FAUST" has lately been installed and connected in parallel to the old electronic counting system on one site in Denmark, but will in the near future be installed on two other sites.
5. I am very sorry that I am not able to present official detailed drawings and descriptions at this meeting, but as mentioned before, "FAUST" has just left the workshop of the Air Material Command and the paper work has not yet been completed.

  
 ooooooooooQooooooooo

P R Clausen

## 1. Bird migration studies with a tracking radar in the Alps

In autumn 1975 as already in autumn 1974 we carried out a two month program of migration studies in the Alps. The tracking radar "superfledermaus" as well as some 100 m of mist nets were placed at 1950 m above sea level on a pass in the Bernese Alps.

During a night we usually tracked about 150 birds, 3 pilot balloons for wind measurements and we recorded the vertical distribution and frequency of echoes passing above the station each hour.

In the early morning we released the night migrants captured during the night at about 100 m above ground. The horizontally flying individuals (about 30% of all) were tracked, their echo signatures and wing-beat movements being recorded simultaneously on magnetic tape and on film respectively.

Evaluation of the data is not very far; so I can give only some indications instead of definite results:

Height of migration: As in the low lands birds prefer those levels with the best tailwinds. On an average migration is closer to the surface at an alpine pass than in the low lands. Maximum heights were 3500 m above station, that is about 5500 m above sea level.

Intensity and direction of migration: A first glance on the number of echoes crossing the beam per unit time (without any calculations or corrections) shows that the frequency of echoes in the Alps is about 40% lower than in the low lands, indicating that the Alps are a real obstacle for parts of the migrants. This confirms the observation that bird migration between the Jura and the Alps is deflected to a certain degree by these chains of mountains. Once over the Alps the bird's flight paths are influenced to a very small degree by topography as long as they have railwinds. In headwinds they tend to follow the valleys and passes, but always prefer direction SW.

As an effect of the collaboration within BSCE we had Thomas Alerstam from Sweden and Luit Buurma from the Netherlands at our station, where they worked with us during one week and could get - I hope - valuable information for their own work.

## 2. Visual and Radar observations on roosting gulls (Larus ridibundus) near Zurich airport

Counts of the inflight of gulls above the town of Zurich towards the lake have been carried out in the early fourties. These counts were repeated and accomplished by observations with the surveillance radar at Zurich airport during winter 1975/76.

From October to March there are always a large number of gulls wintering in the area of Zurich. Roosting flights in the order of 20,000 individuals following the valleys and the open landscape without woods reach the lake of Zurich each evening especially from sector N. Numbers have not increased during the last 20 years; this perhaps because of a new roosting place on an artificial lake about 30 km to the NW. The distances flown by the roosting birds each evening may reach 25 km. The roosting flights concentrate in the time between sunset and darkness. But even after complete darkness some inflights and especially changes of the roosting sites may occur.

## RADAR DETECTION OF BIRDS

Canada, 1975

F. R. Hunt

The Sector Automatic Detection Equipment (SADE) was developed in order to count flocks of large water fowl in selected sectors of a surveillance radar's coverage. It was first tested at Winnipeg Airport during the spring snow goose migration of 1974. It performed satisfactorily but several modifications were made in order to improve its performance. One modification allows the direct display of the number of flocks in a sector to the controller, i.e., he does not have to read the flock number from a chart. A second modification provided a small display for the controller which could be remoted from the main unit. Since the experimental model had only a single sector, its azimuth dial was calibrated in terms of the runway in use. The sector's azimuth extends  $\pm 50^\circ$  on either side of the runways center line and in range from 5 to 20 nautical miles. Thus the sector corresponded for the most part to the area in which aircraft fly below 5000 feet on landing at airports.

The equipment was installed at Ottawa Airport for the spring and autumn migrations of 1975. The spring tests involved operation by personnel from the National Research Council. The autumn tests were carried out by ATC personnel with NRC responsible only for installation and maintenance. Both trials were satisfactory and a Field Note is in preparation. Recommendations for the installation of operational models have been forwarded to the Ministry of Transport.

As part of the spring trials, scan-by-scan photography was made of the PPI. These were analyzed by a contractor in order to provide information on flock densities and possible flight patterns of water fowl flocks (chiefly Canada geese) in the vicinity of Ottawa.

A report on the operation of an automatic detection equipment attached to vertically-looking radar has been issued (F. R. Hunt, Automatic Radar Equipment to Determine Bird Strike Probability, Part I, night-time passerine migration, NRC Associate Committee on Bird Hazards to Aircraft, Field Note No. 69, April 1976, Ottawa, Canada). The height measurements made with the vertically-looking radar of the night-time migration of 1975 are still being analyzed.

STRUCTURAL TESTING  
of AIRFRAMES



24th May 1976

BIRD STRIKE COMMITTEE EUROPE

Activities of Working Groups Established by BSCE

Working Group - INFORMATION ON STRUCTURAL TESTING OF AIRFRAMES

1. Recommendation of 10th Meeting - Stockholm, June 1975

1.1 It was proposed that a new Working Group be formed called the "Information on Structural Testing of Airframes Working Group".

1.2 The terms of reference were proposed as follows:

(i) To exchange information on the results obtained from:

(a) Bird impact research testing of materials, structural specimens, windscreens etc.

(b) Tests to meet compliance with Civil Airworthiness requirements.

(ii) To discuss and evaluate the information in order to provide design guidance material for satisfactory methods of producing bird impact resistant structures, windscreens etc.

(iii) To exchange information on analytical work.

(iv) To establish liaison on future research programmes in order to avoid duplication.

1.3 It was proposed that there should be a meeting of the new Working Group in London in approximately 6 months time. During the next 6 months Mr Thorpe will invite the appropriate specialists in BSCE member countries to attend this meeting where a chairman will be appointed.

2. Progress Report

2.1 Notes of the Stockholm Working Group Meeting were circulated to those who attended the WG, as well as to Chairmen of the other Working Groups.

- 2.2 The Rapporteur wrote during July 1975 to the Chairmen, or representative, of each member country, requesting the name(s) of the specialist(s) in each country. It took a very considerable time for all replies to be received and the list of representatives to be completed, and it was therefore not possible to arrange the Autumn 1975 meeting as had been originally planned.
- 2.3 The appropriate specialists have been invited to the 11th BSCE Meeting in London, and a most useful meeting resulted.
- 2.4 In the absence of anyone from a European country other than the UK, who was prepared to undertake the chairmanship, P F Richards, of the UK Civil Aviation Authority agreed to act as Chairman. It was noted that this will unfortunately mean that 3 Working Groups now have UK Chairmen.

J THORPE  
Rapporteur

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BIRD STRIKE COMMITTEE EUROPE

LONDON, 24th-28th May 1976

Ref: BSCE/11 WP/2

BIRD STRIKES DURING 1974 TO EUROPEAN  
REGISTERED CIVIL AIRCRAFT

J Thorpe - UK

SUMMARY

The strikes, reported during 1974 throughout the World by nine European operators, to aircraft greater than 5700 kg (12,500 lb) have been analysed. The results are discussed, some problem areas highlighted and recommendations proposed.

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As this Paper is the work of an individual member of staff, any opinions and conclusions contained in this Paper are not necessarily the final views of the Civil Aviation Authority.



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## 1 INTRODUCTION

- 1.1 In the past reports containing data on bird strikes have been produced by different organisations, such as airlines, aviation authorities and ornithologists. The information has been presented in various forms, using different guidelines. These reports have seldom contained data on aircraft movements, such that the most useful form of comparison, strike rate, can be determined.
- 1.2 In order that a common basis for the analysis of bird strike data could be agreed, a Working Group of the Bird Strike Committee Europe was formed in 1972, led by the representative from the United Kingdom Civil Aviation Authority Airworthiness Division at Redhill. After consultation with other member countries sets of Analysis Tables with Explanatory Notes were circulated to all members of the BSCE, together with a request that each country produce an Analysis of their Bird Strikes. At the 1973 BSCE Meeting in Paris it was agreed that each country would provide a separate Analysis of their Civil, and of their Military bird strikes, commencing with 1972. At the 1974 BSCE Meeting in Frankfurt the Analysis Reports for the year 1972 were presented. The Civil Report was subsequently produced as CAA Airworthiness Division Technical Note No. 110. At the 1975 BSCE Meeting in Stockholm the Analysis Reports for the year 1973 were presented.
- 1.3 This report contains the Third Annual assessment of the data which has been provided by BSCE members, and covers strikes to civil aircraft recorded during 1974. The strikes to military aircraft are reported separately.
- 1.4 Appendix 1 contains the tables of data related to this report.
- 1.5 Appendix 2 lists reportable accidents caused by birds, world-wide during 1974 and 1975.
- 1.6 A separate report has been produced of bird strikes to engines during 1973 and 1974 (see BSCE/11-WP/3).

## 2 SCOPE

For the following reasons, the detailed analysis only includes civil aircraft of over 5700 kg (12,500 lb) maximum weight (i.e. light aircraft are excluded):

- (a) the airworthiness requirements relating to bird strikes are different for the smaller class of aeroplanes,
- (b) much more is known about the reporting standard, and movement data of operators of transport types, and the movement data is more readily available than that from air taxi or private owner aircraft,
- (c) the 5700 kg and less classification is, in general, a much slower aircraft with a different mode of operation, requiring less airspace, and a noticeably different strike rate would be expected.

### 3 COUNTRIES (see Table 1)

A total of nine European countries (2 more than last year), have provided information on 1146 bird strike incidents. The data from Germany was not available using the comprehensive BSCE layout and could only be used in some of the Tables. The overall strike rate is 4.1 per 10,000 movements (two movements per flight). This compares with a rate of 3.5 for 1973 and 3.1 for 1972 for the countries which reported in those years. As in previous years the Netherlands and Germany reported the highest strike rate. Since the rates are for strikes reported world-wide, it should be noted that it is probable that two factors affect the rate reported by a particular country

- Reporting standard
- National bird strike problem

Furthermore since some countries were unable to provide their movement data, estimates using ICAO sources have been used.

### 4 AIRCRAFT TYPES (see Table 2)

#### 4.1 General

It may be that aircraft types which appear to be similar to humans, are not similar to birds, and that there are other factors, such as noise patterns, size, and use of lights, which affect the rate. The continued long term collection of statistics will provide fuller information.

#### 4.2 Jet Aeroplanes

As in the previous report there appears to be little correlation, possibly for the reason suggested above, between aircraft of similar types the DC8 rate again being much higher than the Boeing 707. The 707 and DC8 are in wide use and operate on many identical routes, so a similar rate could be expected, although the rate for a type used by an operator who makes a high percentage of his movements at one particular airfield which has a bad bird problem, could affect the results. As a group, the wide-bodied aeroplanes, the Boeing 747, Douglas DC10, Lockheed Tristar and Dassault Mercure all show above average, although not the highest, rates, with the exception of the A300 B Airbus which had only made a small total of movements.

#### 4.3 Turboprop Aeroplanes

The extent to which turboprop aeroplanes are used has declined considerably, however the BAC Viscount, and H.P. Herald have a significant strike rate. The average rate for all turboprops is slightly lower than that for jets.

#### 4.4 Piston Aeroplanes

The Convair 440 is the only one which is in wide use which has been reported on, and has a rate similar to the rate for jets.

#### 4.5 Helicopters

Only four strikes were reported to helicopters, and these were not able to be related to hours or flights to provide a comparative rate.

#### 5 AERODROMES (see Table 3 and 3A)

5.1 The aerodrome data is of particular importance as it shows where bird control measures may need to be taken. Again, several countries were able to provide data on Nationally registered Transport Aircraft movements at each aerodrome. The number of strikes would be expected to be high at, for example, Paris-Orly, which is a particularly busy airport.

5.2 In Table 3 the rate for Copenhagen relates to the strikes to, and movements by, aircraft registered in Denmark. It can be seen that of the airports where movement data is available some of the smaller Scandinavian airports have a high strike rate, and that of the major airports Basle, Belfast, Ronaldsway-Isle of Man and Glasgow appear to have a rate that is well above average.

5.3 The strikes reported by several different countries at one airport, and thus for which no movement data is available, are shown in Table 3A. The number of strikes will be very dependent on the movements made by European operators, and the number of strikes can only be used as a guide.

#### 6 BIRDS (see Table 4)

It can be seen that of the 444 reports where there was identification of the bird species, 54% were gulls, (1973 - 53%, 1972 - 58%). The most commonly reported sort of gull was the Black-headed Gull (*Larus ridibundus*). The next largest total were Lapwings (*Vanellus Vanellus*) and Swallows (*Hirundo rustica*), with 7.9%. Only 2 strikes were known to involve birds of over 1.8 kg (4 lb) in weight.

#### 7 MONTH OF THE YEAR (see Table 5)

As data on aircraft movements in each month is only available from two countries, it has been assumed that these are typical of the whole of Europe, in order to calculate a comparative strike rate. The months with the worst strike rates are October and September.

#### 8 TIME OF DAY (see Table 5A)

The data provided for this year shows that only 71% of strikes occurred during the day, when most of the aircraft movements take place, and when the majority of birds are active. However 18.5% (1973 - 12%, 1972 - 20%) of the strikes were at night when the number of aircraft movements are comparatively low. The short periods of "dawn" and "dusk" also account for a significant percentage of strikes. Unfortunately, in very few of the incidents at night were the birds identified, and further investigation of night time strikes should be made, with particular emphasis on identification of remains, feathers, etc.

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9 AIR SPEED

Since only 6.7% (1973 - 3.7%) of strikes occurred at speeds up to 80 knots, it could be concluded that at low speed the birds generally are successful in avoiding the aircraft. Between 80 and 100 knots a further 16.7% (1973 - 13.6%) of strikes occurred, which tends to support the above conclusion. Only a small proportion (2.8%) of strikes occurred at high speed, mainly because the aircraft are above the altitude at which birds are common. These percentages may well be affected by the amount of time that the aircraft spends in each speed band.

10 ALTITUDE (see Table 6A)

Overall 75% of the strikes were recorded as being between 0 and 200 ft., with 9.5% between 201 and 800 ft. However 8.9% occurred at altitudes above 2500 ft., where, unfortunately the bird species is seldom identified. The percentages are virtually identical to those of the 1972 and 1973 Reports.

11 FLIGHT STAGE (see Table 7)

The take-off accounted for a slightly higher percentage of strikes than the landing (36.3% as against 36%), but 16% were recorded during the final approach. It should be noted that during the Climb, Cruise and Descent 9.2% of the strikes were recorded, the phases when speeds are high. The percentages are again very close to those of the 1972 and 1973 Reports.

12 PART OF AIRCRAFT STRUCK (see Table 8)

The nose section, including the radome received 34.2% of strikes (1973 - 32%), of which the radome received 6.0% (1973 - 9.3%). Engines received 18.2% (1973 - 18.4%), and windscreens 13.7% (1973 - 16%). In 1974 there were only 4 incidents which affected more than one engine, compared with 10 in 1973 (1973 - 1.6% of incidents).

13 EFFECT OF STRIKE (see Table 9)

13.1 One of the most notable aspects is that a total of 37 engines were changed (30 in 1973), 13 of the cases were on twin-engined aeroplanes. There were also 29 cases of damage necessitating repairs to fans/rotor/propellers. Paper BSCE/11-WO/3 gives more detailed analysis of selected engine strikes.

13.2 A total of 10 windscreens were changed (1973-2), out of the 160 strikes on windscreens. There were 12 cases of radome change (14 in 1973) out of the 70 cases where the radome was struck.

14 EFFECT versus AIRSPEED versus WEIGHT OF BIRD (see Table 9A)

The number of cases where damage is caused and the airspeed and bird weight are known, are comparatively few. However from the limited information so far available it appears that the greatest risk of damage lies in the 101-150 knot range, from birds of weight up to 1.8 kg (4 lb). Continued collection of data will provide a better sample.

15 COST (see Table 10)

Only four countries were able to provide information on cost, 25 incidents costing a total of 803,000 US dollars. If the cost from these four countries (218 strikes) is related to the 1146 strikes covered in this report, the total cost for this one year is in excess of 4 million US Dollars.

16 AIRCRAFT OPERATORS (see Table 11)

This table provides a guide to the airlines which either suffers the worst strike rate, or has the best reporting standard. It is probable that it is considerably affected by the airport(s) at which the airline has its main base.

17 CONCLUSIONS

- 17.1 The overall rate for the nine European countries which have provided information is 4.1 per 10,000 movements. This is slightly worse than 1973 (3.52). The Netherlands again has the highest rate, or possibly the best standard of reporting with a rate of 9.2
- 17.2 There does not appear, on the available data, to be any correlation between the strike rate and the aeroplane type. The strike rate for the group comprising wide bodied aeroplanes, on the evidence of this year, does appear to be above average.
- 17.3 Of the major airports where movement data was available Basle, Belfast, Ronaldsway and Glasgow have markedly above average strike rates.
- 17.4 Gulls were struck more frequently than other species, being involved in 54% of the incidents. Only two incidents involved birds of greater than 1.8 kg (4 lb).
- 17.5 The month with the highest strike rate, and number of strikes was October.
- 17.6 Although the majority of strikes occurred during daylight, 18.5% (similar to previous years) occurred at night, when the number of aircraft movements is very low.
- 17.7 As 93% of strikes occurred above 80 knots, it appears that up to that speed there is a very good chance that birds can successfully avoid aircraft.
- 17.8 A total of 84.5% of the strikes were recorded below 800 ft., however, 8.9% were above 2,500 ft. where speeds tend to be much higher.
- 17.9 The final approach and landing, as in the previous reports, accounted for the same percentage of strikes as the take-off.
- 17.10 The nose section and radome were struck in 34% of the incidents, whilst engines accounted for 18.4%.
- 17.11 The major effect on the aeroplane is that one in six radome strikes necessitated a radome change (1 in 4 in 1973). There were a total of 37 engine changes and 29 cases of fan repairs.

17.12 Based on the information provided by four countries, the estimated total cost of bird strikes to European airlines was approximately \$ 4 million for 1974.

17.13 The percentages in certain aspects of the investigation have been consistently the same for each of the three annual reports. The aspects concerned are Month of the Year, Time of Day, Airspeed, Altitude, and Flight Stage.

## 18 PROPOSED ACTIONS

18.1 That those European countries which did not provide analysis using the BSCE tabulations should again be requested to provide the information. The countries concerned are Austria, Belgium (expected for 1975), Germany, Italy, Portugal and Spain.

18.2 That the Authorities responsible for airports with above average strike rates should be made aware and requested to investigate and take appropriate action.

18.3 That investigation of those aspects for which the answers are now known, i.e. Month, Time of Day, Airspeed, Altitude and Flight Stage, should be deleted from the BSCE analysis in order to concentrate attention on those areas where further information is needed.

18.4 That Analysis of:-  
Aircraft Type  
Aerodrome  
Bird Species  
Part Struck  
Effect of Strike  
Effect versus Airspeed versus Weight of Bird  
Cost  
should be continued.

18.5 That the use of Landing and High Intensity Anti-Collision Lights be investigated.

18.6 That greater emphasis should be placed on the need for identification of bird remains recovered from aircraft.

BIRD STRIKE ANALYSIS

EUROPEAN OPERATORS 1974

CIVIL AIRCRAFT OVER 5700 KG. (12,500 LB.) MAXIMUM WEIGHT

- Notes:
- 0.1 The following are NOT included in this Analysis:
    - (a) aircraft of maximum weight 5700 kg. (12,500 lb.) and under,
    - (b) all military type and operated aircraft
  - 0.2 All Tables are for strikes reported World-Wide, except for Table 5 and 5A which are for Europe only.
  - 0.3 The TOTAL columns of many of the Tables are different, as some countries have not been able to provide full information for every Table.



TABLE 1 - COUNTRY

Country	Number of Incidents	Number of Movements	Rate per 10,000 Movements
Denmark	46	175,950	2.6
Finland	7	129,800 <sup>†</sup>	0.5
France*	62	354,270	1.75
Germany**	325	489,025 <sup>†</sup>	6.60
Netherlands <sup>+</sup>	187	203,370	9.20
Norway	39	206,710	1.8
Sweden	58	223,800 <sup>†</sup>	2.6
Switzerland <sup>++</sup>	52	182,940	2.8
United Kingdom	370	911,150	4.1
TOTAL	1146	2,877,000	4.1

- Notes:-
- 1.1 There are two movements per flight
  - \*1.2 Data from France does NOT include piston-engined aircraft
  - \*\*1.3 Data from Germany used only in Tables 1, 2, 5 and 8
  - <sup>+</sup>1.4 From KLM airline only
  - <sup>†</sup>1.5 Approximate movement data from ICAO sources
  - <sup>++</sup>1.6 Data from Switzerland only includes jet aeroplanes
  - 1.7 Movements Total does not correspond exactly to Table 2 Total, since in Table 1 some unspecified aircraft with stated movements but nil strikes have been included.

TABLE 2 - AIRCRAFT TYPE

Type	Aircraft	Number of Countries Reporting	No. of Strikes	No. of Movements	Strikes per 10,000 Movements
<b>JET</b>					
4 engined	Douglas DC8	6	95	100,724	9.48
	Boeing 747	7	37	73,840	5.0
	Boeing 707/720	5	88	184,290	4.8
	BAC VC 10	1	12	41,196	2.9
	Convair 990 Coronado	1	6	19,636	3.1
	HS Comet 4	1	3	19,450	1.5
3 engined	Boeing 727	4	134	275,570	4.9
	Douglas DC 10	5	32	46,948	6.8
	HS Trident	1	80	170,610	4.7
	L 1011 Tristar	2	4	3,696	10.8*
2 engined	A300 B Airbus	1	0	4,400	0
	Boeing 737	5	162	237,084	6.8
	Douglas DC9	6	152	453,170	3.3
	BAC 1-11	2	62	240,500	2.6
	Sud 210 Caravelle	6	40	241,520	1.7
	HS 125	1	3	11,660	2.6
	Jet Falcon	2	4	13,880	2.9
	Lear Jet	2	2	2,970	6.7*
	Dassault Mercure	1	2	2,180	9.2*
	Fokker F28 Fellowship	4	12	52,754	2.3
	Corvette	2	2	-	-
<b>TURBOPROP</b>					
4 engined	BAC Viscount	2	76	161,524	4.7
	BAC Vanguard/Merchantman	1	10	30,360	3.3
	BAC Britannia	1	1	5,000	2.0*
	HS Argosy	1	1	2,220	4.5*
	Canadair CL 44	1	0	7,720	0*
2 engined	Herald	1	22	56,090	3.9
	Fokker F27	4	15	88,972	1.7
	HS 748	2	3	32,710	0.9
	Short Skyvan	1	1	5,630	1.8*
	DH Twin Otter	1	1	76,290	0.1
	Nord 262	2	4	22,674	1.8
<b>PISTON</b>					
	ATL Carvair	1	2	15,550	1.3
	Convair 440	4	50	127,765	3.9
	Douglas DC3	1	1	12,790	0.8
	DH Heron	1	0	2,270	0*
<b>UNKNOWN</b>					
		1	25	-	-
<b>HELICOPTERS</b>					
	S 61N	-	2	-	-
	Bell 212	-	1	-	-
	Bell 47	-	1	-	-

TABLE 2A - SUMMARY OF AIRCRAFT TYPES

Jet	932	2,196,078	4.2
Turboprop	134	489,190	2.7
Piston	53	158,375	3.3
Helicopter	4	-	-
Unknown	23	-	-
TOTAL - Including those with NIL Strikes	1146	2,844,000	4.1

Notes:- 2.1 There are two movements per flight.

\*2.2 Rates for types with less than 10,000 movements are included in the Table, but are subject to some error.

2.3 Rates for aircraft types where ICAO data has been used are only approximate (ICAO data on Charter Operators is not comprehensive).

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TABLE 3 - AIRFIELD - EUROPEAN DATA 1974

AIRFIELD	INCIDENTS TO NATIONAL REGISTERED AIRCRAFT	MOVEMENTS OF NATIONAL REGISTERED AIRCRAFT	STRIKES PER 10,000 MOVEMENTS
<u>DOMESTIC</u> - Strikes reported by the airlines of the individual country, related to the movements by those airlines.			
<u>Denmark</u>			
Copenhagen, Kastrup	11	71,635	1.5
Arlberg	2	2,430	8.2*
Esbjerg	3	2,781	10.8*
Rønne	2	1,464	13.7*
Sønderborg	2	3,500	5.7*
Tirstrup	2	2,233	9.0*
<u>France</u>			
Paris, Orly	7	211,000	0.3
Paris, Le Bourget	2	100,000	0.2
Nice	5	45,000	1.1
Lyon-Bron	5	103,000	0.5
Marseilles	3	65,000	0.5
Saint Yan	2	94,000	0.2
Bordeaux	2	67,000	0.3
<u>Norway</u>			
Oslo, Fornebu	3	76,310	0.4
Kristiansand	2	21,435	0.9
Lista	2	1,624	12.3*
Bergen	6	31,668	1.9
Trondheim	3	39,181	0.8
Tromsø	2	15,333	1.3
<u>Switzerland</u>			
Zurich	5	51,888	1.0
Basle	9	9,775	9.2
Geneva	5	31,949	1.6
<u>U.K.</u>			
Belfast	37	22,700	16.3
Blackpool	9	6,100	14.7 *
Ronaldsway, Isle of Man	15	13,100	11.4
Glasgow	30	37,400	8.0
Birmingham	13	19,450	6.7
East Midlands	8	13,800	5.8
Luton	11	20,850	5.3
Liverpool	8	14,400	5.5
Teeside	4	7,700	5.2*
Prestwick	14	27,450	5.1 *
Bristol Lulsgate	3	6,050	4.9 *
Newcastle	6	12,200	4.9
London Stansted	9	18,600	4.8
Glamorgan/Rhoose	4	9,150	4.4 *

See next page for footnote to this Table.

TABLE 3A

U.K. (cont.)			
Edinburgh	9	23,050	3.9
Southend	3	11,750	2.5
London Heathrow	35	140,800	2.4
Aberdeen	4	20,500	1.9
London Gatwick	11	62,850	1.7
Manchester	6	35,200	1.7
Wick	2	-	-
Kirkwall	2	-	-
Exeter	2	-	-
<b>FOREIGN</b> - Alphabetical list of airfields where more than one strike has been reported by European countries, and where the movements are not known.			
Anchorage (US)	2	Kuopio (Finland)	3
Amsterdam (Netherl.)	74	London-Heathrow (UK)	11
Alicante (Spain)	2	Le Touquet (France)	3
Angelholm (Sweden)	3	Lisbon (Portugal)	3
Aalborg (Denmark)	3	Malaga (Spain)	4
Banjul (Gambia)	4	Monastir (Tunisia)	2
Beirut (Lebanon)	3	Munich (Germany)	3
Barcelona (Spain)	2	Manila (Phillipines)	2
Brussels (Belgium)	6	Milan-Linate (Italy)	2
Berlin-Temp (Germany)	3	New York-JFK (US)	7
Copenhagen (Denmark)	16	Nairobi (Kenya)	2
Colombo (Sri Lanka)	2	Nice (France)	2
Calcutta (India)	3	Norrkoping (Sweden)	3
Curacao (Antilles)	2	Ostend (Belgium)	2
Dusseldorf (Germany)	5	Palma (Spain)	4
Dakar (Senegal)	6	Paris-Le Bourget (France)	5
Dublin (Eire)	3	Port of Spain (Trinidad)	2
Delhi (India)	3	Paris-Orly (France)	3
Esbjerg (Denmark)	2	Rome-Leonardo (Italy)	3
Entebbe (Uganda)	2	Rotterdam (Netherl.)	4
Frankfurt (Germany)	2	Rome-Fuman (Italy)	3
Freetown (Sierra Leone)	2	Stockholm-Bromma (Sweden)	4
Gottenburg (Sweden)	2	Stockholm-Arl (Sweden)	3
Glasgow (UK)	3	Sundsvall (Sweden)	3
Groningen (Netherl.)	3	Tel Aviv (Israel)	2
Guernsey (UK)	3	Tunis (Tunisia)	2
Halmstad (Sweden)	2	Umea (Sweden)	2
Hamburg (Germany)	4	Venice (Italy)	3
Helsinki (Finland)	5	Visby (Sweden)	3
Istanbul (Turkey)	6	Zurich (Switzerland)	5
Jonkoping (Sweden)	2	Zagreb (Yugoslavia)	2
Jersey (UK)	5		
Other airfields with single strikes	114		
En-route	23		
Unknown	63		
<b>TOTAL</b>	<b>816</b>		

Notes: \*3.1 Rates for airfields with less than 10,000 movements are included in the Table, but are subject to some error.

3.2 Some airfields appear twice, first - where the strikes are related to movements, and second - where the reports are by several different countries and cannot be related to movements.

3.3 Does not include German data.

ENGLISH NAME	SCIENTIFIC NAME	APPROX. WEIGHT	CATEGORY	NUMBER OF STRIKES	% BASED ON 444
'Gull'	Larus sp.	300g-) 1.8Kg)	B	199	-
Black-headed Gull	Larus ridibundus	300g	B	22	-
Herring Gull	Larus argentatus	1.1Kg	B	12	-
Common Gull	Larus canus	450g	B	6	-
<b>TOTAL GULLS</b>	-	-	-	<b>239</b>	<b>53.8</b>
Lapwing	Vanellus vanellus	250g	B	56	12.6
Swallow	Hirundo rustica	15g	A	35	7.9
Pigeon	Columba sp.	450g	B	26	5.8
"Sparrow"	Small - Passeriformes	18-40g	A	16	3.6
Birds of Prey	Falconiformes	upto 800g	B	8	1.8
Rook/Crow	Corvus spp.	400- 550g	B	8	1.8
Kestrel	Falco tinnunculus	200	B	6	1.5
Swift	Apus apus	30g	A	4	0.9
Oystercatcher	Haematopus ostralegus	550g	B	3	0.7
Heron	Ardea sp.	up to 1.8 kg	B	3	0.7
Large unknown birds	-	-	C	3	-
Tern	Sterna sp.	40-240g	B	3	0.7
Starling	Sturnus vulgaris	85g	A	2	-
Sparrowhawk	Accipter nisus	200g	B	2	-
Hawk	-	assumed	B	2	-
Pheasant	Phasianus colchicus	1.2Kg	B	2	-
Barn Owl	Tyto alba	200g	B	2	-
Black Kite	Milvus migrans	1Kg	B	2	-
Buzzard	Buteo sp.	800g	B	2	-
Sandpiper	Fam. Scolopacidae	20-300g	B	1	-
Curlew	Numenius arquata	800g	B	1	-
Vulture	-	assumed	C	1	-
Owl	O. Strigiformes	170-) 380g)	B	1	-
Kite	Milvus sp.	1 Kg	B	1	-
Golden Plover	Pluvialis apricaria	200g	B	2	0.7
Ringed Plover	Charadrius hiaticula	50-60g	A	1	-
Thrush	Turdus sp.	60-120g	A	1	-
Redstart	Phoenicurus ph.	12g	A	1	-
Skylark	Alauda arvensis	40g	A	1	-
Snow Bunting	Plectrophenax nivalis	35g	A	1	-
Wheatear	Oenanthe oenanthe	24g	A	1	-
Sand Martin	Riparia riparia	15g	A	1	-
Redpol	Acanthis flammea	14g	A	1	-
Stork	Ciconiiformes	up to 3 kg	C	1	-
Jackdaw	Corvus monedula	230g	B	1	-
Tawny Owl	Strix aluco	400g	B	1	-
Wigeon	Anas penelope	900g	B	1	-
Egret	Ciconiiformes	-	B	1	-
White Crow	Corvus albus	500g	B	1	-
Unknown	-	-	-	373	-
<b>TOTAL</b>	-	-	-	<b>818</b>	-

Notes: 4.1 Bird weights and Latin names are based on Canadian Field Note No. 51 by G. Kaiser, unless there is positive evidence to the contrary, the AVERAGE weight is assumed.

4.2 The Bird Categories based on current Civil Airworthiness requirements are:

- CAT A - below 110g ( $\frac{1}{4}$  lb.)
- CAT B - 110 to 1.81 Kg. ( $\frac{1}{4}$  lb. to 4 lb.) i.e. includes all "gulls"
- CAT C - Over 1.81 Kg. to 3.63 Kg. (4 lb. to 8 lb.)
- CAT D - Over 3.63 Kg. (8 lb.)

4.3 Those birds not positively identified are tabled as Unknown.

4.4 Percentages are based on incidents where birds are identified.

TABLE 5 MONTH OF YEAR

MONTH	WEIGHT* UNKNOWN	CAT A and CAT B	CAT C and CAT D	TOTAL	NUMBER OF MOVEMENTS (UK & Switz.)	COMPARATIVE RATE
January	19	18	-	37	48,200	.37
February	11	15	-	26	44,900	.28
March	50	17	-	67	52,100	.61
April	32	12	-	44	58,800	.36
May	27	15	-	42	62,600	.32
June	37	33	-	70	68,300	.48
July	45	34	-	79	71,300	.52
August	38	52	1	91	71,000	.61
September	58	56	-	114	67,800	.80
October	87	37	-	124	58,900	1.00
November	30	33	1	64	48,400	.63
December	29	14	-	43	49,100	.41
Month Unknown	6	11	-	17	-	-
<b>TOTAL</b>	<b>469</b>	<b>347</b>	<b>2</b>	<b>818</b>	<b>-</b>	<b>-</b>

TABLE 5A TIME OF DAY

TIME	WEIGHT UNKNOWN	CAT A and CAT B	CAT C and CAT D	TOTAL	% BASED ON 367
Dawn	1	19	1	21	5.7
Day	51	209	1	261	71.1
Dusk	1	16	-	17	4.6
Night	36	32	-	68	18.5
Unknown	6	7	-	13	-
<b>TOTAL</b>	<b>95</b>	<b>283</b>	<b>2</b>	<b>380</b>	<b>-</b>

- Notes:-
- 5.1 Restricted to strikes reported in Europe.
  - 5.2 Table 5 includes data from Germany.
  - 5.3 Table 5A does not include data from Germany, Sweden and Netherlands.
  - 5.4 In the absence of Movement data from all countries, the Movement data from Switzerland and UK has been used to produce a comparative rate.
  - 5.5 Percentages are based on known totals.

TABLE 6 AIRSPEED

AIRSPEED (kts IAS)	WEIGHT UNKNOWN	CAT A	CAT B	CAT C & D	TOTAL	% BASED ON 432
0 - 80	4	2	23	-	29	6.7
81 - 100	9	6	56	1	72	16.7
101 - 150	63	37	143	2	245	56.7
151 - 200	25	10	15	1	51	11.8
201 - 250	17	1	5	-	23	5.3
Over 250	10	-	1	1	12	2.8
Airspeed Unknown	72	9	118	2	201	-
TOTAL	200	65	361	7	633	-

TABLE 6A ALTITUDE

ALTITUDE (ft)	WEIGHT UNKNOWN	CAT A	CAT B	CAT C & D	TOTAL	% BASED ON 560
0 - 200	93	45	278	3	419	74.8
201 - 800	23	11	19	-	53	9.5
801 - 2500	20	2	16	-	38	6.8
Over 2500	35	4	9	2	50	8.9
Altitude Unknown	29	3	39	2	73	-
TOTAL	200	65	361	7	633	-

## Notes:-

- 6.1 When the Altitude is not specifically stated, but the Flight Stage is quoted as take-off or landing the 0 to 200 ft division is assumed.
- 6.2 Birds found dead on the runway are included in the 0 to 200 ft division.
- 6.3 The percentages are based on the known totals.
- 6.4 These Tables do not include data from Netherlands and Germany.

TABLE 7 FLIGHT STAGE

STAGE	WEIGHT UNKNOWN	CAT A	CAT B	CAT C & D	TOTAL	% BASED ON 664
Taxying	1	0	3	0	4	0.6
Take-off	49	21	131	2	241	36.3
Initial climb	6	0	4	0	10	1.5
Climb	18	3	6	1	30	4.5
Cruise	11	2	5	0	19	2.9
Holding	0	1	0	0	1	0.1
Descent	10	0	1	1	12	1.8
Final Approach	42	6	38	0	103	15.5
Landing	31	25	196	0	239	36.0
Touch & Go/ Overshoot	1	1	3	0	5	0.7
Unknown	27	5	37	2	153	-
<b>TOTAL</b>	<b>196</b>	<b>64</b>	<b>424</b>	<b>6</b>	<b>817</b>	<b>-</b>

Notes:-

- 7.1 It is not possible to provide a precise definition of these stages as the altitudes vary with aircraft type, and particular operation.
- 7.2 Birds found dead on the runway are divided equally between take-off and landing.
- 7.3 The percentages are based on the total where the stage is known.
- 7.4 Does not include data from Germany.



TABLE 8 PART OF AIRCRAFT STRUCK

PART	WEIGHT* UNKNOWN	CAT. A	CAT B	CAT C & D	TOTAL	% BASED ON 1168
Fuselage	73	9	40	-	122	10.4
Nose (excluding radome and wind- screen)	229	19	82	-	330	28.2
Radome	41	13	14	2	70	6.0
Windscreen	103	17	40	-	160	13.7
Engine number unknown	93	-	-	-	93	)
1 engine struck	40	1	72	3	116	)
2 out of 3 struck	0	-	2	-	2	) 18.4
2 or more of 4 struck	2	-	-	-	2	)
all engines struck	-	-	2	-	2	)
Wing	136	2	60	-	198	16.9
Landing Gear	25	1	36	1	63	5.4
Empennage	11	-	3	-	14	1.2
Part unknown	73	10	87	-	170	-
TOTAL	826	72	438	6	1342	-

Notes:-

- 8.1 The totals in Table 8 are higher than the others, as one bird can strike several parts.
- 8.2 The percentages are based on incidents where the part struck is known.
- 8.3 Where both landing gear, or both wings are struck, two incidents are recorded.
- \*8.4 The data from Germany and Netherlands for which the weights are not known, are included.

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TABLE 9 EFFECT OF STRIKE

EFFECT	WEIGHT UNKNOWN	CAT A	CAT B	CAT C	CAT D	TOTAL	% BASED ON 755
Loss of life/aircraft	0	0	0	0	0	0	0
Flight Crew Injured	0	0	0	0	0	0	0
Engines prematurely Changed on:-							
2 engined aircraft	3	-	9	1	-	13	1.7
others	17	-	7	-	-	24	3.2
Windscreen cracked or broken	5	-	5	-	-	10	1.3
Radome changed	9	-	3	-	-	12	1.6
Deformed structure	9	-	5	2	-	16	2.1
Skin torn, light broken	8	1	4	-	-	13	1.7
Skin dented	10	1	20	-	-	31	4.1
Propeller/Rotor damaged/Fan	21	-	8	-	-	29	3.8
Aircraft system lost	2	-	4	-	-	6	0.8
Nil damage	301	61	237	2	-	601	79.6
Unknown	27	24	69	-	-	120	-
<b>TOTAL</b>	<b>412</b>	<b>87</b>	<b>371</b>	<b>5</b>	<b>-</b>	<b>875</b>	<b>-</b>

TABLE 9A EFFECT - AIRSPEED - WEIGHT OF BIRD

EFFECT	AIRSPEED WEIGHT	0-80		81-100		101-150		151-200		201-250		over 250	
		A&B	C&D	A&B	C&D	A&B	C&D	A&B	C&D	A&B	C&D	A&B	C&D
Loss of Life/Aircraft													
Flight Crew Injured													
Engines Prematurely Changed on:-													
2 engines aircraft				1		5	1						
other aircraft				1		5							
Windscreen Cracked/ Broken				1	1	2				1			
Radome Changed						1		1					
Deformed Structure						2		1					
Skin Torn						3							
Skin Dented				3		13	1					1	
Propeller/Rotor Damaged				1		5							
<b>TOTAL</b>				7	1	36	2	2		1		1	

Notes:- 9.1 Data from Germany is only included for engines and fans in Table 9.

9.2 If, for example, skin is torn in two places, or both windscreens are broken, two incidents are recorded.

9.3 The TOTALS of Table 9A are very low as it includes only damaging strikes where bird weight and airspeed

TABLE 10 COST - FRANCE, DENMARK, SWEDEN AND SWITZERLAND ONLY

TYPE OF STRIKE	INCIDENTS	TOTAL COST (US DOLLARS)
Where cost is known	25	803,000
Where cost is known to be NIL	102	0
AVERAGE COST		\$ 6,322

Notes:-

10.1 The cost includes the following:-

- (a) Engineering rectification costs.
- (b) Loss of revenue.
- (c) Incidental costs, i.e. diverted aircraft, passenger accommodation etc.

10.2 The engineering rectification cost on ENGINES is offset by the hours remaining before overhaul.

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TABLE 11 AIRCRAFT OPERATOR REPORTING STRIKES

OPERATOR	NUMBER OF STRIKES	NUMBER OF MOVEMENTS	STRIKES PER 10,000 MOVEMENTS
<u>DENMARK</u>			
Cimber Air	2	9,360	2.1*
Conair	3	7,012	4.3*
Maersk Air	3	23,486	1.3
SAS	27	85,486	3.2
Sterling Airways	9	47,150	1.9
Others	2	1,966	10.2*
<u>FINLAND</u>			
Finnair	6	-	-
Helicopter Service	1	-	-
<u>FRANCE</u>			
Air France	25	301,660	0.8
Air Inter	22	95,325	2.3
UTA	3	15,474	1.9
Air Ceylon/Afrique	4	21,263	1.9
Air Alpes	1	24,000	0.4
TAT	1	17,000	0.6
Uni Air	1	3,902	2.6*
Euralair	1	-	-
EFS	1	6,765	1.5*
Service de la Formation Aeronautique	3	-	-
<u>NORWAY</u>			
SAS	26	85,500	3.0
Braathen Safe	9	65,604	1.4
Helicopter Service	3	51,842	0.6
Widerøe	1	76,294	0.1
<u>SWEDEN</u>			
SAS	25	-	-
Linjeflyg	30	-	-
Transair AB	2	-	-
<u>SWITZERLAND</u>			
Swissair	52	182,942	2.8
<u>UK</u>			
British Airways European) Scottish & Channel Divs )	141	-	-
British Airways Overseas	50	-	-
British Caledonian	30	-	-
British Island Airways	21	-	-
Dan Air	7	-	-
Laker	8	-	-
Britannia Airways	18	-	-
Cambrian	21	-	-
Court Line	8	-	-
Monarch	4	-	-
MAM	1	-	-
McAlpine	2	-	-
British Midland	9	-	-
British Air Ferries	2	-	-
International Av Services	1	-	-
Air Anglia	4	-	-
British Airtours	3	-	-
Invicta	1	-	-
Air Bridge Carriers	1	-	-
North East	14	-	-
TOTAL	906	-	-

NOTES:- 11.1 The movements of operators who did not report any strikes are not included.

11.2 Leased aircraft are included against the operator.

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## SERIOUS BIRD STRIKE INCIDENTS WORLD WIDE 1974

6.10.74 Douglas PH-MBG Martinair Amsterdam  
DC10-30CF

During night take-off from Amsterdam using full power from runway wet with light rain, birds were struck at approx 140 knots. After rotation but before gear-up vibration felt and flight engineer stated "maximum vibration engines 2 and 3" and that engine 3 N<sub>1</sub> rpm had touched 114%. Thrust was decreased on engine 3 but vibration remained at maximum and engine was shut-down. During shut-down Tower reported seeing flames, there was no fire warning but one extinguisher shot was used. Vibration decreased, and at 2,000 ft aircraft was cleaned up. Increasing power to maintain 277 knots caused vibration to increase and engine 2 vibration reached maximum at 76% N<sub>1</sub>. Fuel jettisoned for return to airport at max landing weight of 191 tons, but last part of tank 2 took too long so landing at 198 tons was prepared. Made radar monitored ILS approach with 2 engine procedure. During the initial approach with flaps 22°, power on engine 2 had to be increased to MCT in order to keep flying level. On the glide path engine 2 kept at 75% N<sub>1</sub>, with varied power on engine 1. Automatic approach down to 100 ft, landing normal with minimum descent at touchdown, reverse idle on engine 1 and 2. Approx 20 dead gulls found on runway, the only complete gull weighed 450 gm (1 lb). The core of engine 3 showed blade rub on compressor stages 2, 3, 4 and each stage had a few blades with nicks or a curled tip. Damage was only slight and operationally insignificant. The core of engine 2 was not damaged, but fan debris caused dents and punctures of inlet duct, and bellmouth seal was pierced near fan speed sensor. No debris passed outside engine cowls.

25.9.74 Lear Jet Business Air Västerås  
24D Service

During early morning take-off struck gulls at 135 kts, 30 ft, both engines were damaged such as to be unserviceable.

12.12.74 SN 601 Air Alpes Chambéry  
Corvette

During take-off struck jackdaws (*Corvus monedula*) at 50 ft, 120 kts. Both engines were damaged and both pitot tubes required replacement (total cost of incident 60,000 US dollars).

AD F 616 168

BIRD STRIKE COMMITTEE EUROPE

LONDON, 24-28 May 1976

Ref: BSCE/11 WP/3

BIRD STRIKES TO ENGINES

J Thorpe - UK

SUMMARY

Data on bird strikes to engines from four countries for 1973 and 1974 has been analysed to show some of the factors affecting strikes and damage.

## BIRD STRIKE COMMITTEE EUROPE

Ref: BSCE/11 WP/3

LONDON, 24th May 1976

### BIRD STRIKES TO ENGINES

#### 1. Introduction

1.1 An earlier version of this Paper was presented under Agenda Item 7 to the Eleventh Meeting of the ICAO Airworthiness Committee in Montreal on 1st March 1976. This version is slightly modified to take account of later numerical information, the text remaining unaltered.

1.2 For some years the Bird Strike Committee Europe has been collecting statistical information from its members. An aspect of major concern has been engine strikes, and this Paper shows some trends from analyses made in this area.

1.3 It should be appreciated that the information in this Paper is only as good as the reporting standard of the Countries from which the information was obtained. Furthermore the sample sizes are in some cases still quite small.

1.4 In view of the above, definite conclusions cannot be drawn; however, although as with many Airworthiness subjects, the figures do not always agree in a tidy manner, possible trends even at this early stage should not be ignored.

#### 2. Source of Information

2.1 Data from France, Germany, Netherlands and U.K. for the years 1973 and 1974 have been used in compiling this Paper, as shown in Table 1. This was in order to provide a wide variety of aircraft and engine types used by countries with a fairly high annual flying rate.

2.2 In order to take account of 2, 3 and 4 engined aircraft the data has been changed from the more usual movements (two per flight), to engine flights (i.e. engine flights =  $\frac{\text{movements}}{2}$  x number of engines per aircraft).

2.3 The weight of bird has been ignored, since in Europe only 1% of cases where the bird is identified, involves a bird weight greater than 1.81 Kg (4 lbs).

2.4 The term "damage" ranges from bent or torn blades sufficient to require replacement, to uncontained engine failure. Cases where blade damage is dressed out, or carried over to the next overhaul, have not been included in the category "damaged". Thus there is considerable variation in the degree to which usable thrust has been lost.

### 3. Discussion

3.1 It is suggested that bird strikes reported as having struck engines are based on the following factors:-

- 1) a strike is dependent on
  - (a) engine location
  - (b) engine frontal area
  - (c) circumstances, i.e. route, time of day, etc.
  
- 2) reported rate is dependent on
  - (a) operators reporting standard
  - (b) how easy to detect
  
- 3) damage is dependent on
  - (a) a strike
  - (b) engine strength

3.2 Much of the data used in this Paper is from many operators, from several countries and using many different routes. Thus it is believed that 1) (c), and 2) (a) and (b) can probably be ignored, allowing this Paper to examine the other factors.

### 4. Results

#### 4.1 Factor 1 (a) - Engine location

4.1.1 This is shown in Table 2, the reported strike rate per million engine flights. The Conway in 707, JT8D in 737, JT9D in 747, JT3D in DC8 and CF6 in DC10 show above average strike rates. These are all wing mounted podded installations, (except for the DC10 which is 2 + 1). The difficulty of drawing conclusions is demonstrated by the considerable differences between the various types of Boeing 707 and the DC8, where similar rates could be expected.

4.1.2 When all the engine types are combined into Table 3, irrespective of aircraft type a clearer pattern emerges. It can be seen that the wing mounted engines have an average strike rate around 4 times that for aft mounted engines.

#### 4.2 Factor 1(b) - Engine frontal area

From Table 3 and Fig. 1 it can be seen that in general where there is a reasonable sample size the trend of increasing strike rate with increasing area is apparent. It is very probable that the larger the engine, particularly with the high by-pass ratio fan engines, the less likely it is that a non-damaging strike will be noticed, in fact the bird can exit through the by-pass leaving no noticeable trace.



#### 4.3 Factor 3(b) - Engine strength

4.3.1 It can be seen from Table 4 that the percentage of reported strikes which cause damage is subject to considerable variation. This gives a measure of each aircraft/engine combination's resistance to bird strike damage.

4.3.2 Subject to the cautionary note of para 1.2 about small samples it can be seen that the mean is 30%, and that the RR Avon in both Comet and Caravelle, Conway in Boeing 707, P & W JT9D in 747 and GE CF6 in the DC10 are significantly above the mean figure. The Avon and Conway are both relatively old engine designs which were produced before the current Airworthiness Requirements on medium (1½ lb) bird testing were introduced. However the JT9D and the CF6 are very recent designs which it might have been expected would have a better resistance to bird strike damage.

4.3.3 The P & W JT8D appears best able to withstand the effect of bird strikes.

#### 4.4 Damage Rates - a combination of all factors.

4.4.1 From Table 2 it can be seen that the worst damage rates reported are the CF6 and the JT9D, whilst the best rates are the Spey in Trident and RB211 in Tristar. The aft mounted JT8D in the Boeing 727 and the Douglas DC9 have an identically low rate, whilst the same engine wing mounted in the Boeing 737 shows the higher rate due to its more vulnerable installation.

4.4.2 Table 5 shows the damage rate per million engine flights for each engine type. The rate of  $79 \times 10^{-6}$  (i.e.  $7.9 \times 10^{-5}$ ) for the JT9D and CF6, falls well within the Reasonably Probable rate in British Civil Airworthiness Requirements, i.e. between 1 per 1000 and 1 per 100,000 flights, whilst other engines are mainly well within the Remote area.

5. Conclusions. Although in some instances there is as yet inadequate evidence, the data from 1973 and 1974 does show some trends that at this early stage should not be ignored.

5.1 Wing mounted engines are more likely to suffer bird strikes than aft mounted engines, perhaps by a factor of about 4.

5.2 The strike rate is, in general, dependent upon engine intake area, although it may not be linear. It is possible that the probability of undetected strikes increases with intake area.

5.3 Some engine designs appear much more prone to damage than others, and relatively low resistance to bird strike damage is not confined to the older designs. Two of the most recent designs, approved to later, but not the latest Airworthiness criteria appear to have the highest vulnerability, namely the General Electric CF6 and the Pratt and Whitney JT9D, and these rates are well within the Reasonably Probable area of BCAR. The limited data available for the Rolls-Royce RB211 does not as yet show this trend.

5.4 The Pratt and Whitney JT8D appears best able to withstand bird strikes, it would be interesting to have the Manufacturer's comments as to the reason for this.

5.5 The results of this Paper support the necessity of continued collection of bird strike data in order to monitor trends in respect of damage to engines and hence decide whether any specific or general action is needed to avoid undue hazard to aircraft from this cause.

Table 1 - Source of Information

Aircraft Type	Engine Type	Germany*	France	Netherlands	UK
HS Comet 4	RR Avon				+
BAC 1-11	RR Spey	+			+
Boeing 707	P & W JT3D		+ †		+
" 707	RR Conway				+
" 707	P & W JT4D		+		+
" 727	P & W JT8D	+	+		+
" 737	P & W JT8D	+			+
" 747	P & W JT9D	+	+	+	+
Caravelle	RR Avon		+		
"	P & W JT8D		+		
Douglas DC8	P & W JT8D		+	+	
" DC9	P & W JT8D			+	
" DC10	GE CF6	+	+	+	+
BAC VC10	RR Conway				+
HS Trident	RR Spey				+
L1011 Tristar	RB 211				+

\*Note 1.1 Data for 1973 only.

† 1.2 Data for 1974 only.

Table 2 - Aircraft Type, Strike Rate and Damage Rate

Aircraft Type	Engine Type	Engine Location	Engine Flights	Number of Engine Strikes	Strike Rate per million engine flights	Number of engine Changes/Repairs	Damage rate per million engine flights
Boeing 747	P & W JT9D	W	228,100	37	162	18	79
Douglas DC10	GE CF6	-	50,600	7	138 *	4	79 *
Boeing 707	RR Conway	W	91,800	12	131 *	6	65 *
HS Comet 4	RR Avon	-	93,900	4	43 *	4	43 *
Douglas DC8	P & W JT3D	W	263,100	57	216	11	42
Boeing 737	P & W JT8D	W	219,400	27	123	5	23
Caravelle	RR Avon	A	267,400	9	34	5	19
Boeing 707	P & W JT3D	W	181,040	15	83	3	17
Boeing 707	P & W JT4A	W	97,860	1	10 *	1	10 *
BAC 1-11	RR Spey	A	445,900	11	25	4	9
Boeing 727	P & W JT8D	A	422,050	16	38	3	7
Douglas DC9	P & W JT8D	A	147,700	10	68	1	7
BAC VC10	RR Conway	A	198,400	7	35 *	1	5
Caravelle	P & W JT8D	A	36,600	0	-	0	-
HS Trident	RR Spey	A	531,900	3	6	1	2
L1011 Tristar	RB 211	-	7,700	2	-	0	0 *
TOTAL/MEAN			3,283,450	218	66	67	20

Notes: 2.1 Engine locations A = Aft, W = Wing mounted

\*2.2 Small sample size, the results should be treated with caution.

Table 3 - Engine Strike Rates.

ENGINE	ALL STRIKES										
	AFT MOUNTED					WING MOUNTED					
	Sq. Metres	Sq. Inches	No.	Engine Flights	Rate †	No.	Engine Flights	Rate †	No.	Engine Flights	Rate †
RR Spey	0.54	845	14	977,800	14	-	-	-	-	-	-
RR Avon	0.52	805	9	267,400	34	-	-	-	-	-	-
P & W JT4A	0.81	1260	-	-	-	1	97,860	10*			
P & W JT8D	0.81	1260	26	606,300	43	27	219,400	123			
RR Conway <sup>A</sup>	0.71	1105	7	198,400	35	12	91,800	131*			
	1.03	1590									
P & W JT3D	1.31	2030	-	-	-	72	444,140	162			
GE CF.6	3.78	5860	2	16,900	118*	5	33,700	148*			
P & W JT9D	4.29	6650	-	-	-	37	228,100	162			
TOTAL/MEAN			58	2,066,800	28	154	1,115,000	138			

- Notes: 3.1\* Small sample size, the results should be treated with caution.
- 3.2 The HS Comet with 4 RR Avons buried in the wing has been excluded.
- 3.3 The RB 211 due to its low hours has been excluded.
- 3.4 The DC10 GE CF6 strikes have been separated into the 2 wing engines, and one aft mounted engine.
- 3.5† The rate is per million engine flights.
- 3.6 Area is cross sectional area at front of compressor.

Table 4 - Aircraft Type - Percentage of Damaging Strikes

Aircraft Type	Engine Type	Engine Location	No. of engine strikes	No. of engine changes/repairs	% of strikes which cause damage/repair
HS Comet 4	RR Avon	-	4 *	4	100*
Boeing 707	P & W JT4A	W	1 *	1	100*
Douglas DC10	GE CF6	-	7 *	4	57*
Caravelle	RR Avon	A	9 *	5	55*
Boeing 707	RR Conway	W	12	6	50
Boeing 747	P & W JT9D	W	37	18	49
BAC 1-11	RR Spey	A	11	4	36
HS Trident	RR Spey	A	3*	1	33*
Boeing 707	P & W JT3D	W	15	3	20
Douglas DC8	P & W JT3D	W	57	11	19
Boeing 727	P & W JT8D	A	16	3	19
Boeing 737	P & W JT8D	W	27	5	18
BAC VC10	RR Conway	A	7*	1	14*
Douglas DC9	P & W JT8D	A	10	1	10
Caravelle	P & W JT8D	A	0*	0	-*
L1011 Tristar	RB 211	-	2 *	0	0*
TOTAL/MEAN			218	67	31%

Notes: 4.1 Engine locations A = Aft, W = Wing mounted

\*4.2 Small sample size, the results should be treated with caution.

Table 5 - Engine Damage Rates

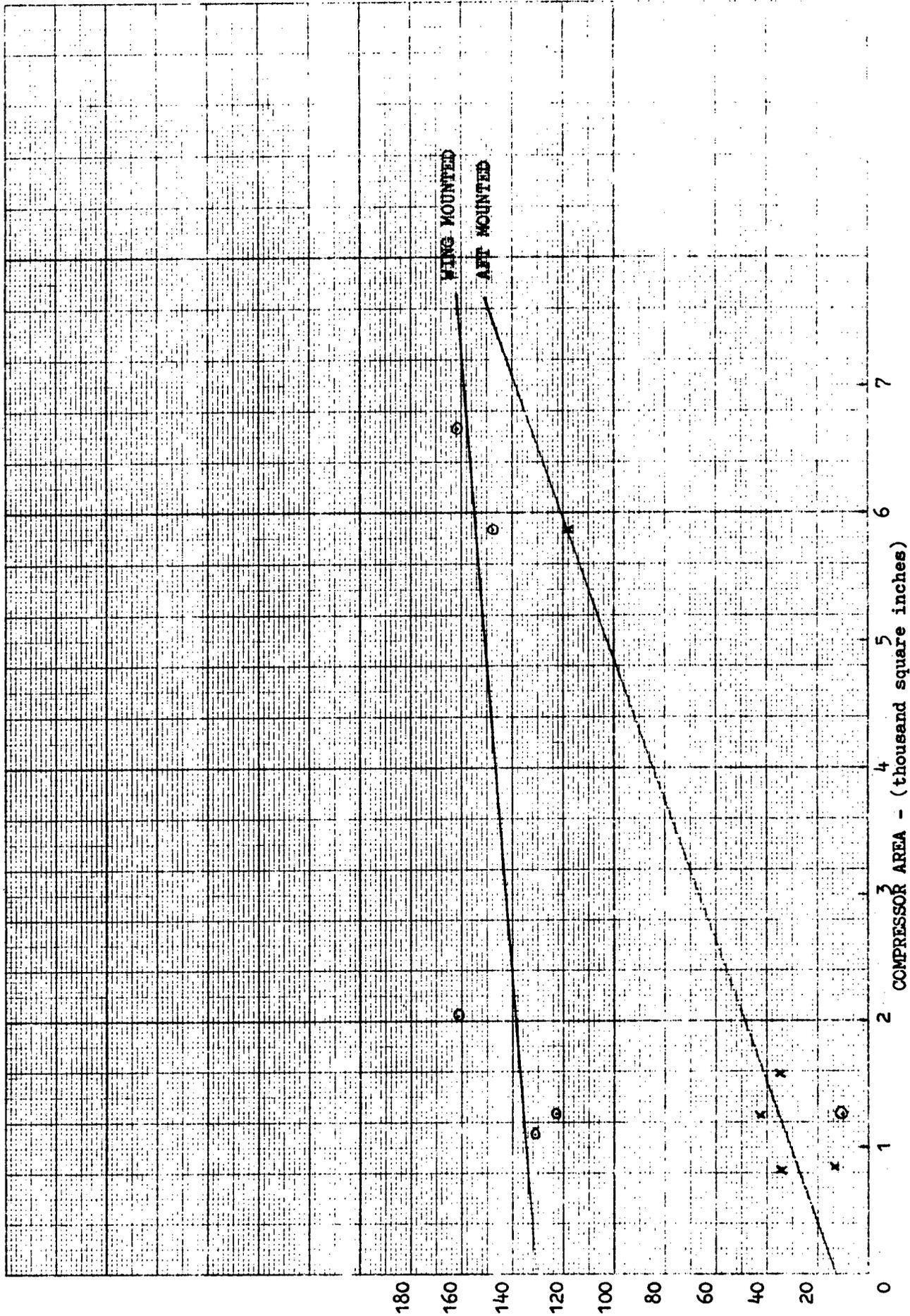
ENGINE	DAMAGING STRIKES									
	AFT MOUNTED					WING MOUNTED				
	Sq. Metres	Sq. Inches	No.	Engine Flights	Rate †	No.	Engine Flights	Rate †	No.	Rate †
RR Spey	0.54	845	5	977,800	5	-	-	-	-	-
RR Avon	0.52	805	5	267,400	19	-	-	-	-	-
P & W JT4A	0.81	1260	-	-	-	1	97,860	10*	10*	10*
P & W JT8D	0.81	1260	4	606,300	7	5	219,400	23	5	23
RR Conway	0.71	1105	1	198,400	5	6	91,800	65*	6	65*
P & W JT3D	1.03	1590	-	-	-	14	444,140	32	14	32
P & W JT9D	1.31	2030	-	-	-	3	33,700	39*	3	39*
GE CF.6	3.78	5860	1	16,900	59*	18	228,100	79	18	79
P & W JT9D	4.29	6650	-	-	-	47	1,115,000	-2	47	-2
TOTAL/MEAN			16	2,066,800	8					

- Notes: 5.1\* Small sample size, the results should be treated with caution.  
 5.2 The HS Comet with 4 RR Avons buried in the wing has been excluded.  
 5.3 The RB 211 due to its low hours has been excluded.  
 5.4 The DC10 GE CF6 strikes have been separated into the 2 wing engines, and one aft mounted engine.  
 5.5† The rate is per million engine flights.  
 5.6 Area is cross sectional area at front of compressor.

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Figure 1

STRIKE RATE ~ AREA



RATE - PER MILLION ENGINE FLIGHTS



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BIRD STRIKE COMMITTEE EUROPE

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Final Paper issued subsequent to the Eleventh Meeting

RADAR STUDY OF WADERS

E W Houghton, F Blackwell,  
T Brough and T A Wilmot, UK

Complete Paper

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(A short version of this paper was given at the  
11th Bird Strike Committee Europe Conference, London 1976)

## A RADAR STUDY OF WADERS

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### SUMMARY

This is a preliminary study of the radar characteristics of two wader species, the dunlin, Calidris alpina, and the oystercatcher, Haematopus ostralegus. Some results are given on the curlew, Numenius arquata, but these are limited because only two were captured. Flight and echo data were obtained by means of a high-resolution auto-following pulse radar from wild birds released from a 90ft tower. A new method of obtaining the multi-aspect dynamic radar echoing area of a target is demonstrated and values are given for the dunlin and the oystercatcher. Bird activity modulation waveforms, spectral diagrams and auto-correlation functions have been analysed for the three wader species.

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## APPENDICES

## 1 INTRODUCTION

During the Nato-Gibraltar Bird Migration Study, the PPI of an S-band (10cm) surveillance radar at Gibraltar revealed in the Autumn broad front movements of large well-spaced echoes at dusk and during the night. Some of the movements came from Europe heading south or south-west into Africa but others from the east could have originated from any part of the Mediterranean and passed into the Iberian Peninsula. A proportion of these targets, many of which consisted of only one or two birds, were sampled by an X-band (3cm) high-resolution automatic-tracking radar and wingbeat spectra were obtained from the echo signal data. The fundamental frequencies of these spectra ranged from 3.5 to 10 Hz and it is possible that the birds producing them could have been waterfowl, especially ducks.

Waterfowl occur throughout the world and many species undertake long migrations. They can be hazardous to aircraft because of their size and numbers. Although their movements in some parts have often been studied by radar, their echoing area and wingbeat spectra for identification purposes have not been extensively investigated. However, a study of the mallard, Anas platyrhynchos, has recently revealed some of their important radar characteristics (1).

Alternatively the echoes in question could have been produced by waders, ie relatively long-legged shore-birds of small to medium size and which also undertake long migrations.

This paper is an interim statement on an investigation to determine the radar characteristics (eg dynamic echoing area and wingbeat spectra) of waders in order to elucidate further the data obtained during the Nato-Gibraltar Bird Migration Study.

## 2 BIRD SPECIES

There are ten relatively common species of waders or shore-birds in Britain which might be suitable candidates for examination. Waders are not the easiest of birds to catch, however, especially when there is a need to have available freshly-caught birds for release at a radar site at a particular time. During this trial only three species of wader were obtained viz. dunlin, Calidris alpina, curlew, Numenius arquata and oystercatcher, Haematopus ostralegus.

The dunlin is one of the smallest and most numerous waders. Its average weight is only 50 g but the peak winter population in England, Scotland and Wales exceeds 300,000 birds and large compact flocks occur. Dunlin are widely distributed and, despite their small size, have been involved in collisions with aircraft and they are particularly troublesome at Vancouver Airport in Canada.

In Britain the dunlin nests on moors and marshes but it is better known outside the breeding season as a passage migrant and winter visitor when it frequents the seashore and mud-flats of both fresh and salt water. Birds which breed as far north as Greenland in the west and western Siberia in the east frequent our shores and migrants winter as far south as North West Africa. Movements of dunlin may, therefore, be detectable by radar at Gibraltar.

The curlew, in contrast with the dunlin, is the largest wader in Europe (average weight 800 g). As a breeding bird in Britain it is more common than the dunlin, nesting on moors, marshes and meadows, and outside the breeding season it frequents mud-flats and estuaries. The peak annual population in England, Scotland and Wales may exceed 50,000 birds. Although it is not generally seen in large flocks, small parties may occur on some airfields and collisions with aircraft have occurred.

Many of the curlew which winter in Britain come from Scandinavia, with some from the Low Countries and the USSR. Curlew from North and Central Europe winter in South Europe and North Africa and some may therefore be observable by radar from Gibraltar.

The oystercatcher is a medium-sized wader (average weight 550 g) which is very common along coasts and in the breeding season it also occurs locally inland. The peak winter population in England, Scotland and Wales, augmented by birds from the Faroes, Iceland, Scandinavia, the USSR and Holland, is in the order of 150,000 birds. Large flocks frequently occur and oystercatchers often create a strike risk on coastal airfields.

During the winter months the oystercatcher is widespread along the northern shores of the Mediterranean and around the Iberian Peninsula and hence may be detected by radar at Gibraltar.

### 3 EXPERIMENTAL WORK

#### 3.1 Capture, Transport and Release of Birds

The birds used in the trial were all caught either in cannon nets or mist nets under a licence granted by the Nature Conservancy Council. They were taken in the late evening or early morning as they were forced up the beach by rising tides at the high tide roosting places on the Dovey Estuary, Dyfed. As soon as possible after capture they were put into boxes or pigeon baskets in which they had plenty of room to stand and move about and were taken by road 65 Km to the radar site at Aberporth. Over a number of days, 2 curlews, 23 dunlins and 25 oystercatchers were transported in this way and all flew strongly on release. Most of the birds were released within eight hours of capture but some caught after nightfall were retained longer than this for release the following morning.

The birds were released individually from a wooden box at the top of a 90ft (27.4m) metal tower using a technique which had been perfected the previous year with feral pigeons Columba livia var. The box used (Fig 1) was originally intended for carrying rabbits and was slightly wider at the base than at the top so that when a number of such boxes were stacked together the ventilation holes could not be cut off. Any such box of similar proportion would satisfy the present requirement. A metal ring was attached to the base of the box so that it could be hauled upside down up the tower. The hinged lid, then forming the floor of the release box, was fitted with a sliding pin catch which could be actuated from the ground. The pull cord for this release catch passed through a number of simple wire loops bound with tape onto the main rope to prevent it from twisting around the main rope or from being blown by the wind and fouling on the tower. When the box was at the top of the tower and all was ready, a sharp tug on the pull cord withdrew the peg and the bottom of the box swung open on its hinge and the bird dropped out.

By attaching the tail end of the rope used to pull the box up the tower to the base of the box some control could be exerted over the box to prevent it from swinging too much in the wind.

Generally two people were required to handle the birds, pull up the box, take care of slack in the rope, operate the telephone link with the radar, pull the release cord and lower the box again.

### 3.2 Radar, Recording and Computing Facilities

The C-band (5.5 - 5.6 cm wavelength) instrumentation pulse radar used for these experiments has a range precision of 8 feet and an angular precision of 0.15 military mils (0.0084 degrees). The diameter of the radar resolution cell at a range of 10,000 feet is approximately 140 feet.

The radar can track automatically a small target and generate 3 dimension positional data in polar coordinates, and an amplitude-time record of the echo signal. Flight and radar echo signal data together with time (GMT or ZT) code and voice descriptor of each radar target were recorded on multi-track magnetic tape for subsequent analysis.

Target trajectory data were fed into the RAE data and computing centre on site, where polar coordinates were transformed into cartesian coordinates and velocity and acceleration information were obtained by means of mathematical curve-fitting procedures. The quantized mean signal levels were also converted to (S/N) ratios and range data pairs.

Wind velocities at appropriate altitudes and times were obtained by using one of the instrumentation radars to track balloon-borne reflectors.

### 3.3 Visual Acquisition and Putting-on Operations

The acquisition and putting-on problems encountered when dealing with a low level moving target were described in some detail in a previous paper (1). As a result of lessons learnt in the mallard trials great improvements were made in the acquisition and putting-on operations for this study.

The difficult problem of where to release the bird was solved by putting it into a box and hoisting it up a 90ft tower. The top of the tower was fully illuminated by the radar beam and at a known distance from the radar. A television camera with a telephoto lens, fixed to the radar aerial, enabled the radar operator to put the radar on to the bird box visually. A telephone line to the tower solved the communication problems. Thus the radar could be set up in all three coordinates and be ready for acquisition immediately the bird was released. Furthermore the radar operator was able to watch the release of the bird on the tv viewer and follow its movements during the initial tracking operation. He also had a limited warning of ground clutter situations by watching the bird's attitude and picture background.

From the roof of the radar building, angular data from special binoculars was used to redirect the radar in those cases when it lost the bird after release (the field of view of the tv viewer was generally too limited for reacquisition).

## 4 RESULTS

The results of the trial held on the 19th, 20th and 21st November 1975 were highly successful with 22 out of 23 dunlins, 12 out of 14 oystercatchers and both curlews being tracked.

Not only did this show a great improvement in the numbers of released birds auto-followed by radar compared with the earlier mallard trial, but there was an improvement in track duration. Whereas the longest mallard track lasted for 100 seconds, the average wader track was 240 seconds duration. The longest track during these wader trials was of a dunlin which was followed for 595 seconds.

### 4.1 Flight Characteristics

A map of the operational area was given in a previous paper (1). With a few exceptions all the waders flew towards the sea and followed the coast line and, unlike the mallard, none dived immediately towards the sea. Most were lost by the

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radar when they flew behind the cliff edge or into a region generating heavy ground clutter. The waders flew in level flight much longer and more slowly than the mallards and about 100-500 ft higher.

The altitude of dunlin flights ranged from 600 to 1000 feet above sea level. The altitudes of oystercatcher flights ranged from 400 to 700 feet ASL. In general the dunlins flew higher than the oystercatchers.

Air speeds obtained from 10 runs ranged from 20 to 29 knots for the dunlins, and 25 to 36 knots for the oystercatchers, when head and tail winds were less than 8 knots.

#### 4.2.1 Dynamic Radar Echoing Areas

We need to know the echoing area characteristics of birds in order to estimate the maximum distances they can be detected and tracked by radar. The echoing area of any moving target made of heterogenous material and complicated in shape is very difficult to measure and specify, because its echoing area is a multi-valued quantity which varies with target aspect and radar parameters.

In the past we have made static radar echoing area measurements on freshly killed birds "set" with their wings close to their bodies or outstretched in flight. The birds were rotated in azimuth and their echoing areas were measured at every azimuth aspect. Echoing area diagrams were plotted in azimuth over 180 degrees from head-on through broadside-on to tail-on aspect. Each diagram was plotted for a single value of radar frequency, radar aerial polarisation and aerial elevation angle.

However, birds flap their wings and their body shape changes in flight, and so it is desirable to measure their echoing areas under dynamic conditions of flight. Opportunities have occurred to make dynamic echo area measurement of birds in flight at suitable vertical and horizontal aspects. Static and dynamic broadside-on aspect echoing area results agree fairly well, but in all cases dynamic values have been found to be smaller than static values (2).

Recently new recording apparatus has been fitted to the Aberporth FPS16 radars, which has made it possible to record continuously target signal to noise ratio and radar range. With these facilities it has been possible to measure and record the relative signal to noise (S/N) ratio versus range of a reference sphere of known echoing area and shortly afterwards of flying birds of a known species. The echoing areas of the birds can then be calculated in terms of the echoing area of the sphere. By exploiting the erratic flight of a released wild bird and using many birds of the same species, a multi-aspect value of dynamic echoing area is created, which can be specified as a mean value with limits of one or two standard deviations from the mean. In Appendix A it is shown that the fluctuations about the mean value are fairly symmetrical.

In practice there are limits to the number of birds which can be captured and released, and the number of days the radar can be obtained. Consequently the results given here are tentative and may be updated in the future. Basically the method is a good one, because for the first time the echoing area is obtained from many birds in a great variety of aspects in full flight. Furthermore the value is a practical quantity because it has been obtained by a radar during normal operation.

The experimental procedure and calculation of results are given in Appendix A. A summary of this work is given here:-

Radar wavelength: 5.6 cms; Aerial Polarisation: Vertical

The signal to noise (S/N) ratio obtained at the output of a radar receiver system from a moving target of echoing area ( $\sigma$ ) is given by the radar range inverse fourth power law equation:

$$10 \log (S/N) = 10 \log (K) (\sigma) - 4(10 \log R/R_0) \dots\dots\dots (1)$$

where K is a constant for a known set of radar and propagation parameters.

R is the radar (slant) range and  $R_0$  is the normalizing range, which for the FPS16 operating on small birds is conveniently made 1 nautical mile.

The logarithms are to the base 10.

If all the quantities are measured or expressed in decibels (dB) we can write equation (1) as a linear equation with negative slope:

$$Y(\text{dB}) = b(\text{dB}) - mX(\text{dB}) \dots\dots\dots (2)$$

Radar echoing area of 12 inch dia metal reference sphere

At the radar operating wavelength of 5.6 cm, the radar echoing area of the sphere is approximately 700 sq cm.

Dynamic radar echoing area of a dunlin

The dynamic radar echoing area of a dunlin was calculated by making use of the (S/N) ratio versus normalized range ( $R/R_0$ ) ratio data obtained from the reference sphere and a number of dunlins, and equations (1) and (2).

$$\text{Dynamic REA of a dunlin} = \underline{4 \text{ sq cm}} \pm 13 \text{ dB}$$

where 4 sq cm is the average value and 13 dB is twice the standard deviation from the mean.

The (S/N) ratio and range data for the sphere and the dunlins were measured on the same day. Over three hundred pairs of data points obtained from fourteen dunlin flights were used to compute the mean value and standard deviation.

Dynamic radar echoing area of an oystercatcher

The dynamic radar echoing of an oystercatcher was calculated in the same way as that of the dunlin:

$$\text{Dynamic REA of an oystercatcher} = \underline{13 \text{ sq cm}} \pm 15 \text{ dB}$$

where 13 sq cm is the average value and 15 dB is twice the standard deviation from the mean.

The (S/N) ratio and range data for two sphere runs and two sets of oystercatcher runs were made on different days. Over 180 pairs of data points obtained from eleven oystercatcher flights were used to compute the mean value and standard deviation.

4.2.2 Bird Activity Modulation Waveforms

If the relatively slowly changing average current component of the bird echo signal is removed there is left a rapidly varying alternating current component called bird activity modulation (BAM). The BAM waveform is generated by periodic wing flapping and transient changes in body shape and movement.

Generally, birds whose physical dimensions are less than the radar wavelength usually produce simple periodic BAM waveforms, while birds whose dimensions are larger than the radar wavelength produce complex BAM waveforms. Usually these BAM waveforms, simple or complex, can be assessed by using an electronic analyzer to extract the Fourier components of the waveform which are displayed as a spectrum

diagram. This is true for steady flight such as during migration, but erratic flight, such as occurs when a wild bird is released, affects the cyclic pattern of the waveform.

The spectrum of an "erratic" BAM waveform can suffer in two ways: the components of the periodic spectrum can be reduced or lost and additional unwanted fluctuating components can be introduced. The consequences of additional components can be mitigated by filtering or, better still if they are caused by stationary pseudo-random effects, by using correlation techniques in place of or before spectrum analysis.

#### The BAM Waveforms of Waders

The BAM waveforms of two dunlins taken from runs O4D and O4I are shown in Fig 2. These waveforms are made by a species which continuously flaps its wings. Both records were taken after the birds had been in flight for about 1 minute. In both waveforms, although there are strong periodic amplitude components, the overall pattern changes from second to second. Furthermore although there are some toothlike pattern similarities they are not clearly similar.

The BAM waveforms of two oystercatchers are shown in Fig 2b. Again there are cyclic components, the overall pattern of which changes throughout. Comparison of the waveforms reveals superficial pattern similarities of a weak kind.

The BAM waveforms of two curlews are shown in Fig 2c. Again there are pattern changes throughout each record. Comparison of the waveforms reveals pattern similarities of a weak kind.

The striking short and long term waveform pattern similarities which are a feature of the BAM waveforms generated by small birds on migration, like the swift, Apus apus, are almost entirely absent in these wader BAM waveforms.

There is no doubt in the case of these released birds that flight tends to be erratic even some minutes after release. Furthermore the physical dimensions of these waders are comparable to or greater than the radar wavelength in use. It seems possible that both these effects are responsible for these very complex fluctuating BAM waveforms which in the form of amplitude waveforms are not easy to interpret.

#### 4.2.3 The Spectra of Waders

The BAM waveforms of all the wader flights were analyzed by means of an electronic spectrum analyser. A moving "strobe" on the spectrum display coupled to an interpolation oscillator, permitted the response peaks to be calibrated accurately.

#### The dunlin

The spectral diagrams obtained from a dunlin, run O4I, are shown in Fig 3a. The top diagram is the analysis of a 40 second portion of the BAM waveform obtained after the bird had been flying about 1 minute. The Fourier analysis was performed on all amplitude levels of the BAM waveform and then the resultant coefficients of the analysis were summed. The bottom diagram is a Fourier analysis of the same BAM waveform, but in this case only the peak values were averaged.

Both diagrams have prominent fundamental responses whose peak values occur at 5.5 Hz for the summed Fourier coefficients and 5.6 Hz for the peak value analysis. Broad second, third and fourth harmonic responses occur at very much lower amplitude than the fundamental in both sum and peak spectrum diagrams.

Spectral diagrams obtained from eight dunlins are shown in Fig 3b. These are 40 second sum analyses such as mentioned above but taken after 1 or 2 minutes of flight time. This is the reason for the fundamental spectral response of run O4I being 5.6 Hz rather than 5.5 Hz as in Fig 3a. Runs O4D, O4H, O4I, O5B and O5E have



similar overall diagrams, while runs 04C, 04F, and 05G have spectra with strong broad harmonic responses. Often the peak values of these harmonic responses are not simple multiples of the peak value of the fundamental frequency, although they are multiples of some element of the fundamental response.

Note that there are a wide range of fundamental component peaks from 5.5 to 7.7 Hz.

#### The oystercatcher

The sum and peak spectral diagrams obtained from the oystercatcher, run 03G, are shown in Fig 4a. Both diagrams have strong fundamental frequency components which peak at 4.9 Hz. Harmonic response occurs in both examples, but the second harmonic response is more prominent in the peak evaluation.

Spectral diagrams obtained from nine oystercatchers are shown in Fig 4b. In the case of the oystercatcher although the spectral diagrams of flight 03G are different in Fig 4a and 4b the peak value of the fundamental response occurs at the same frequency 4.9 Hz. Some of the diagrams like 03G have low harmonic response, whereas others like 03C, 03E, 06C and 06H have very strong harmonic responses. The fundamental responses of the nine oystercatchers ranges from 4.9 to 5.7 Hz.

#### The curlew

The spectral diagrams for summed and peak values of a curlew, run 06D, are given in Fig 5a. Both diagrams have prominent fundamental responses and relatively strong harmonic responses. They are quite different patterns and the peak values of the sum diagram and peak diagram are 4.1 and 3.9 Hz respectively.

The spectral responses of curlews, runs 06D and 06E, are shown in Fig 5b. These are sum diagrams averaged over 10 seconds rather than 40 seconds. The top diagrams were analyzed first, then the second diagrams and so on. This method of analysis enables changes in the spectral pattern to be detected. The fundamental component peak value of 4.0 Hz remains constant throughout this short analysis for curlew, flight 06D, but changes slightly for curlew, flight 06E, from 3.7 to 3.8 Hz.

#### 4.2.4 The Correlation Functions of Waders

The theory and use of correlation techniques for comparing complex BAM waveforms or for searching for the relatively weak periodic wing beat component in a BAM waveform mutilated by severe fluctuations have been given in a previous paper (1). Obviously it is not easy to deal with complex BAM waveforms such as is shown in Fig 2, but the use of spectral analysis usually enables the principle frequency responses to be identified. Auto-correlation and cross-correlation are methods which can be relied upon to deal with the most awkward cases of randomly fluctuating waveforms and they only fail if the signal is absent or very badly distorted.

The wader waveforms were not so seriously mutilated to need correlation techniques, but it seemed worthwhile to look at them with a correlator in order to simplify them and so improve measuring accuracy. An electronic correlator was used to obtain autocorrelation functions.

#### The dunlin

The bottom waveform in Fig 6 is the autocorrelation function of dunlin run 04I after the BAM waveform had been passed through a 20 Hz low pass filter. Most of the randomly fluctuating components of the BAM are confined to the central peak, which is at delay time zero, and the adjacent sidelobes. Although the periodic components which appear at both sides of the central response are distorted and relatively small in amplitude, they are much easier to interpret than the original BAM waveform (also passed through a 20 Hz low pass filter) in Fig 2a. The chief periodic components of this autocorrelation function is 5.7 Hz, and this is most clearly shown in the top autocorrelation function for dunlin 04I, where the 20 Hz filter was replaced by a 9 Hz bandpass filter. Again the fluctuating components of the BAM waveform are confined to the centre of the pattern and adjacent sidelobes, with the periodic

components of low amplitude at each side. The 5.7 Hz sinusoidal timing waveform in the centre of the figure is for comparison purposes. Note there is a small difference in the estimates of the fundamental correlation periodic waveform frequency and the fundamental frequency found by spectral analysis.

### The oystercatcher

The autocorrelation function for the oystercatcher, run O3G, is shown in Fig 7. The very pronounced central and 3 adjacent sidelobes contain most of the complex randomly fluctuating components of the BAM waveform. Again we find there is a small difference between the value of 5 Hz given here for the periodic fundamental component and the peak response of 4.9 Hz given in the spectral diagram of Fig 4a.

### The curlew

The autocorrelation function for the curlew, run O6D, is shown in Fig 8. The fluctuating frequency components are again prominent in the centre of the diagram. In this case the estimated fundamental periodic waveform is 4.2 Hz as compared to 4.0 Hz obtained by spectral analysis.

## 5 COMMENTS AND CONCLUSIONS

1 36 birds were tracked successfully out of 39, and the average track lasted for a duration of 4 minutes. This remarkable improvement in results over those of the mallard trials was due to

- (a) a more imaginative response and greater flexibility in trial planning.
- and
- (b) better release, acquisition and putting-on facilities

Although these advances gave successful trials with three species of wader and the herring gull, Larus argentatus, it is not possible to guarantee what will happen with other species. Duck, for example, tend to seek the nearest water, but the better arrangements should still result in longer useful records.

2 The waders usually circled the release point and then climbed in altitude before settling down to a period of fairly straight and level flight. Even in the periods of fairly uniform trajectory there were continuous aspect fluctuations.

3 Air speeds ranged from 20 to 29 knots for dunlins flying at altitudes 600 - 1000 feet, and 25 to 36 knots for oystercatchers flying at altitudes 400 - 700 feet. These speeds were measured when head and tail winds were less than 8 knots.

4 A new method of measuring, calculating and specifying a multi-aspect value of dynamic radar echoing area has been demonstrated. The dynamic REA of a dunlin is  $4 \text{ sq cm} + 13 \text{ dB}$  and the dynamic REA of an oystercatcher is  $13 \text{ sq cm} + 15 \text{ dB}$ . The new method has also been used to obtain the dynamic REA of the herring gull. This bird has been employed as a reference in the past in other ways of determining radar echoing area. A comparison of the different REA results on the herring gull showing the advantages of the new specification will be reported later.

5 Released waders like released mallards generate very complicated BAM waveforms, which are difficult to interpret. Usually spectral analysis enables the periodic components to be extracted, but in some cases and at low echo signals it may be necessary to use correlation techniques. Perhaps surprisingly for birds that flap along strongly and continuously some of the waders stopped flapping for relatively long periods.

The fundamental frequency components from 9 oystercatcher BAM waveform records measured 1 minute after release had an average value of 5.1 Hz, a standard deviation of 5% and a range of 4.9 - 5.7 Hz. The inflight frequency variations in terms of the average fundamental were 3 to 4% for durations of 40 seconds for any bird (total length of flight about 4 minutes). The two curlew BAM records gave an average value of 4 Hz and a range of 3.9 - 4.1 Hz. 8 dunlin BAM records gave an

average of 6.3 Hz, a standard deviation of 13% and a range of 5.5 to 7.7 Hz. Inflight variations were of the order of 8%.

From cine film, Griffiths (3) found the average wing beat frequency of 8 oystercatchers was 5.95 Hz with a standard deviation of 9% and a range of 5.3 - 6.3 Hz. Five curlews gave an average of 4.64 Hz and a range of 4.5 - 4.9 Hz. 13 dunlins gave an average of 11.91 Hz, a standard deviation of 9% and a range of 10.7 to 13 Hz.

Comparison of the radar and cine-camera results for the oystercatchers and curlews show reasonable agreement, but the dunlin results are markedly different. Griffith's results have often been higher than any radar results and differences up to 20% have been found, but these do not explain the differences in the dunlin results given here.

A possible explanation lies in work done by Vaughn (5). He shows in Fig 11a of his paper the BAM fundamental frequency component of a semi-palmated sandpiper, Calidris pusillus, falling from 11.3 Hz to 7.1 Hz in about 60 seconds after release. 20 seconds after release the BAM fundamental was still above 10 Hz. Griffiths specifically states that several species of small birds were filmed after being released by hand. Almost all the film records were short possibly only 5 seconds or so. Consequently if dunlin behaved like the sandpiper (they have already been shown to be more variable than the oystercatcher) and were hand released the average value obtained by the cine-camera could be much higher than the radar value obtained a minute after release. A convincing explanation of the differences will probably have to await the simultaneous radar and cine-camera recording of another batch of dunlins.

6 Serious departures from the periodic BAM waveform generated by wing flapping do affect measurement accuracy. Indeed the relatively large rapid aspect changes characteristic of released mallard and the waders used in this exercise produced distorted BAM waveforms which could not be measured accurately using the spectrum analyser. Correlation techniques were used to improve these measurements and they yielded slightly higher values than the spectrum results.

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## DYNAMIC RADAR ECHOING AREAS OF BIRDS

By exploiting the erratic flight of a released wild bird and by using many birds of the same species, a fluctuating (multi-aspect) distribution of the echoing area is created. The echoing area of each species is given as a mean value, plus and minus two standard deviations from the mean. We show that the distributions of (S/N) ratios about the mean values are approximately gaussian, and consequently two standard deviations about the average value are a measure of 95% of the echoing area fluctuations.

Note that all values are rounded off to two decimal places, but six places of decimals were used in the calculations.

The method and calculations are as follows:-

12 inch diameter metal reference sphere

Twelve inch diameter metal spheres carried by balloons were tracked and their relative (S/N) ratios and radar ranges were recorded at 5 second intervals. A graph of a typical sphere run, O3A, made during the wader trials is shown in Fig 9. The vertical scale is the relative signal to noise ratio in dB, and the horizontal scale is the normalised radar range ratio in dB.

Note that when the radar (slant) range R is 1 nautical mile, the normalised range (R/R<sub>0</sub>) ratio in dB = 0, and when R is 0.5 nautical miles and 2 nautical miles respectively, the normalised range ratios are -3 dB and +3 dB. Each value of the sphere (S/N) ratio has been plotted at the appropriate value of normalised range ratio. Using a programme to compute the least-square fit and correlation coefficient of 76 pairs of data points a first degree function was sought. A straight line equation of the form:-

$$(S/N) \text{ dB} = 55.34 \text{ dB} - 3.95 (R/R_0) \text{ dB} \quad \dots\dots\dots (1A)$$

was found to give the best fit with a sample correlation coefficient  $r = -0.99$  (the negative correlation coefficient occurs because the (S/N) ratio decreases as range increases). With such an excellent fit the population correlation coefficient  $p = -0.98$  to  $-0.99$  at 95% confidence level. The linear equation (1A) has been drawn through the data points in Fig 9. Ideally one might expect the slope of equation (1A) to be -4 and identical to that of the functional equation (1) in chapter 4, but equation (1A) is best described as an S1 equation (the description given by NBS (4) to an equation with a statistical distribution in the vertical y plane only) because the measured values of the (S/N) ratio fluctuate about the mean value. There are also uncertainties in the value of the (R/R<sub>0</sub>) ratio, but in this project they were very small and can be neglected.

The chief reason for scatter on the (S/N) ratio results is because the echoing area of the sphere includes fluctuating echoing area contributions from the shrouds and the balloon, which although small are not negligible.

The dunlin

A graph of the results taken from 14 dunlin flights shown in Fig 10. The radar parameters were identical with those used during the sphere run. As might be expected with birds showing all aspects from head-on through broadside-on to tail-on positions there is a wide scatter on the (S/N) ratio data.

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A

Using the least-square fit programme on 305 pairs of data points, two regression equations were obtained:-

$$(S/N) \text{ dB} = 33.00 \text{ dB} - 3.85 (R/R_0) \text{ dB} \quad \dots\dots\dots (2A)$$

$$(R/R_0) \text{ dB} = 1.89 \text{ dB} - 0.11 (S/N) \text{ dB} \quad \dots\dots\dots (2B)$$

sample correlation coefficient  $r = -0.65$

population correlation coefficient  $p = -0.57$  to  $-0.71$  at 95% confidence level

The straight line obtained from equation (2A) is shown plotted over the experimental scatter diagram in Fig 10 (two different equations are generated because estimating y from x is not just the reverse of estimating x from y except when the correlation coefficient  $r = \pm 1$ ).

The dynamic radar echoing area of the dunlin is computed by first finding the centre of scatter diagram, using the cross-over of straight lines given by equations (2A) and (2B). This occurs at a relative (S/N) ratio of 44.02 dB and when the normalised range ratio is -2.86 dB. Inserting this range ratio into equation (1A) we obtain the relative (S/N) ratio for the 700 sq cm reference sphere as 66.68 dB. As the sphere and dunlin results were obtained at close range with identical radar parameters we can write:-

Average dynamic REA of a dunlin (over a large number of different aspects) is  $(66.68 - 44.02 = 22.66 \text{ dB below } 700 \text{ sq cm}) = 4 \text{ sq cm approx.}$

A measure of the fluctuating characteristics of the dunlin's echoing area as its aspect changes can be obtained by drawing a straight line, using the functional equation (1), chapter 4, through the cross-over point of the (S/N) data and then calculating the standard deviation of all data points from this mean value line. The distribution of (S/N) ratio fluctuations about the mean is shown in the histogram, Fig 11, for 305 data points. Superimposed on the (S/N) ratio distribution is the equivalent gaussian distribution and by comparison we note the fluctuations are fairly symmetrical about the mean, and the standard deviation is approximately 6.6 dB.

The oystercatcher

A graph of results taken from 11 oystercatcher flights is shown in Fig 10. The radar parameters of trial 03 were identical with those of sphere run 03A, while those of 06 with those of sphere run 07A (not shown) made on different days. The radar parameters of trial 06 results have been adjusted to permit them to be used with those of trial 03. Using the least-square fit programme on 181 pairs of data points, two regression equations were obtained:-

$$(S/N) \text{ dB} = 38.89 \text{ dB} - 3.89 (R/R_0) \text{ dB} \quad \dots\dots\dots (3A)$$

$$(R/R_0) \text{ dB} = 4.61 \text{ dB} - 0.15 (S/N) \text{ dB} \quad \dots\dots\dots (3B)$$

sample correlation coefficient  $r = -0.72$

population correlation coefficient  $p = -0.64$  to  $-0.77$  at 95% confidence level

The straight line obtained from equation (3A) is shown plotted over the experimental scatter diagram in Fig 10. The dynamic echoing area of the oystercatcher is computed in the same way as for the dunlin. The cross-over of lines given by equations (3A) and (3B) is at a (S/N) ratio of 46.52 dB and at the normalised range ratio of -2.13 dB. The (S/N) ratio for the 700 sq cm reference sphere is 63.75 dB at that range ratio.

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Hence we can write:-

Average dynamic REA of an oystercatcher (over a large number of different aspects)  
is  $(63.75 - 46.52 = 17.23 \text{ dB below } 700 \text{ sq cm}) = 13 \text{ sq cm approx.}$

The distribution of (S/N) ratio fluctuations about the mean is shown in the histogram, Fig 11 for 181 data points. As with the dunlin results, the fluctuations are fairly symmetrical about the mean, and the standard deviation is approximately 7.4 dB.

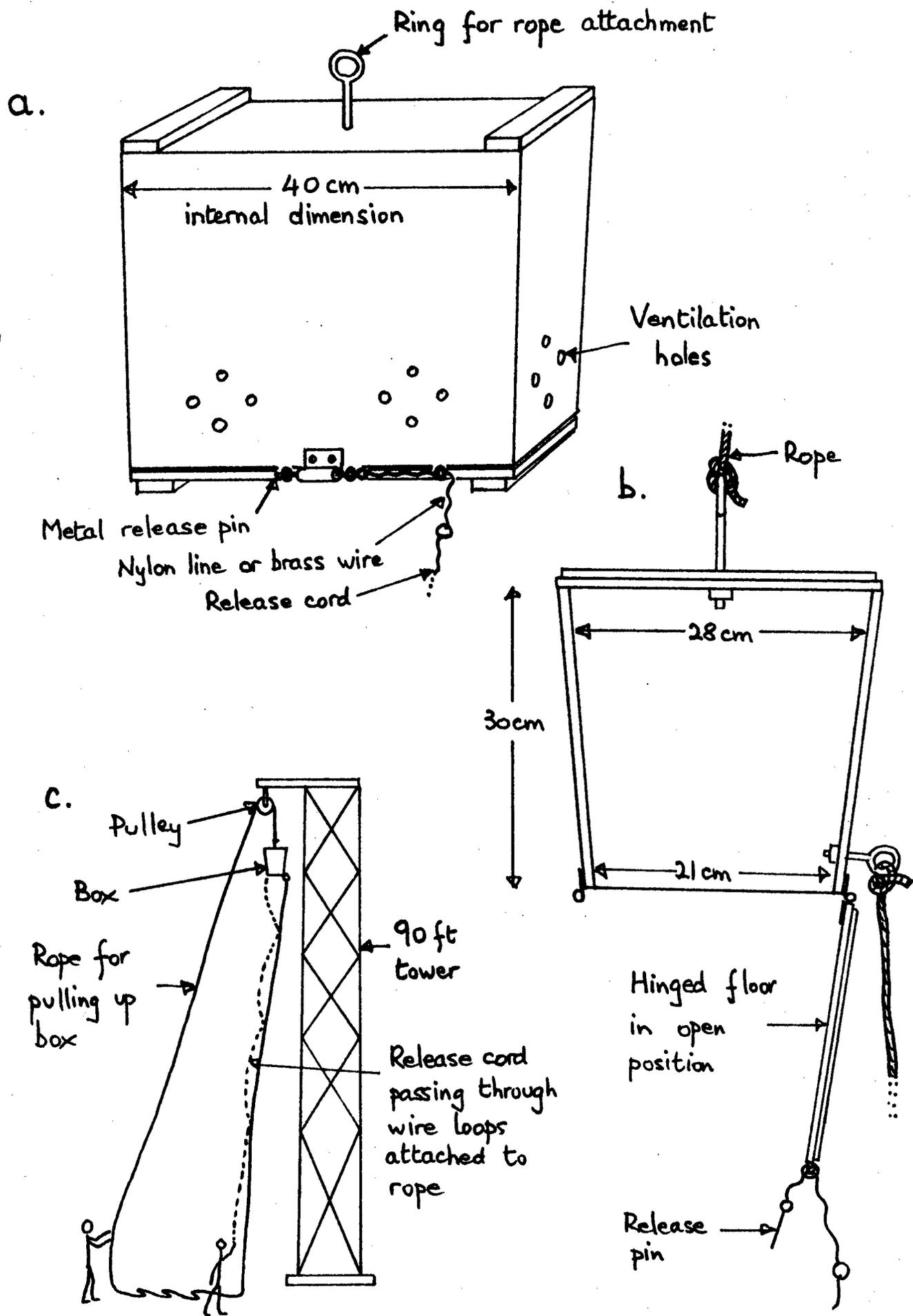
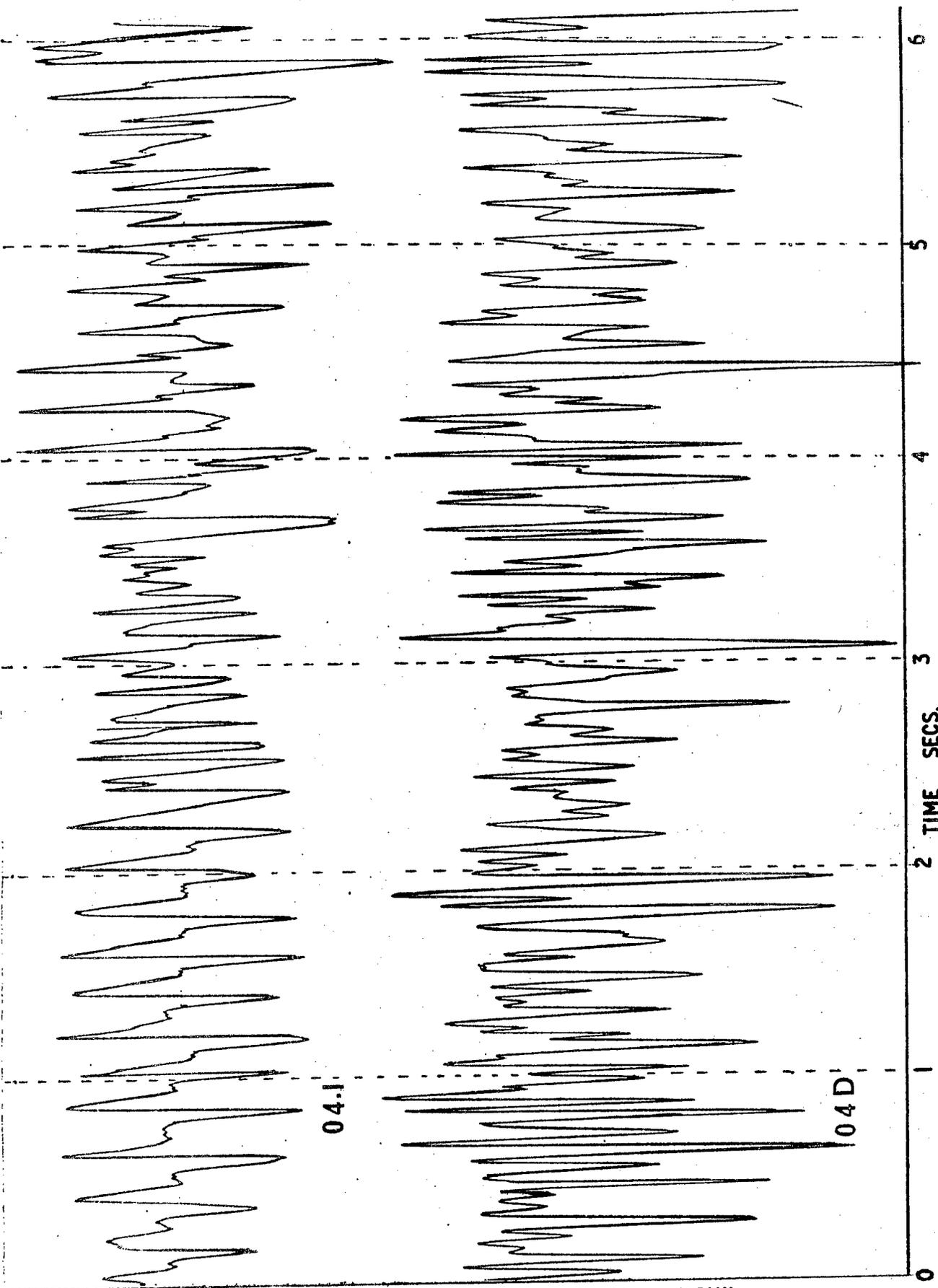


Fig 1 a and b. Aspects of release box.

c. Diagram of tower



RADAR SIGNAL AMPLITUDE



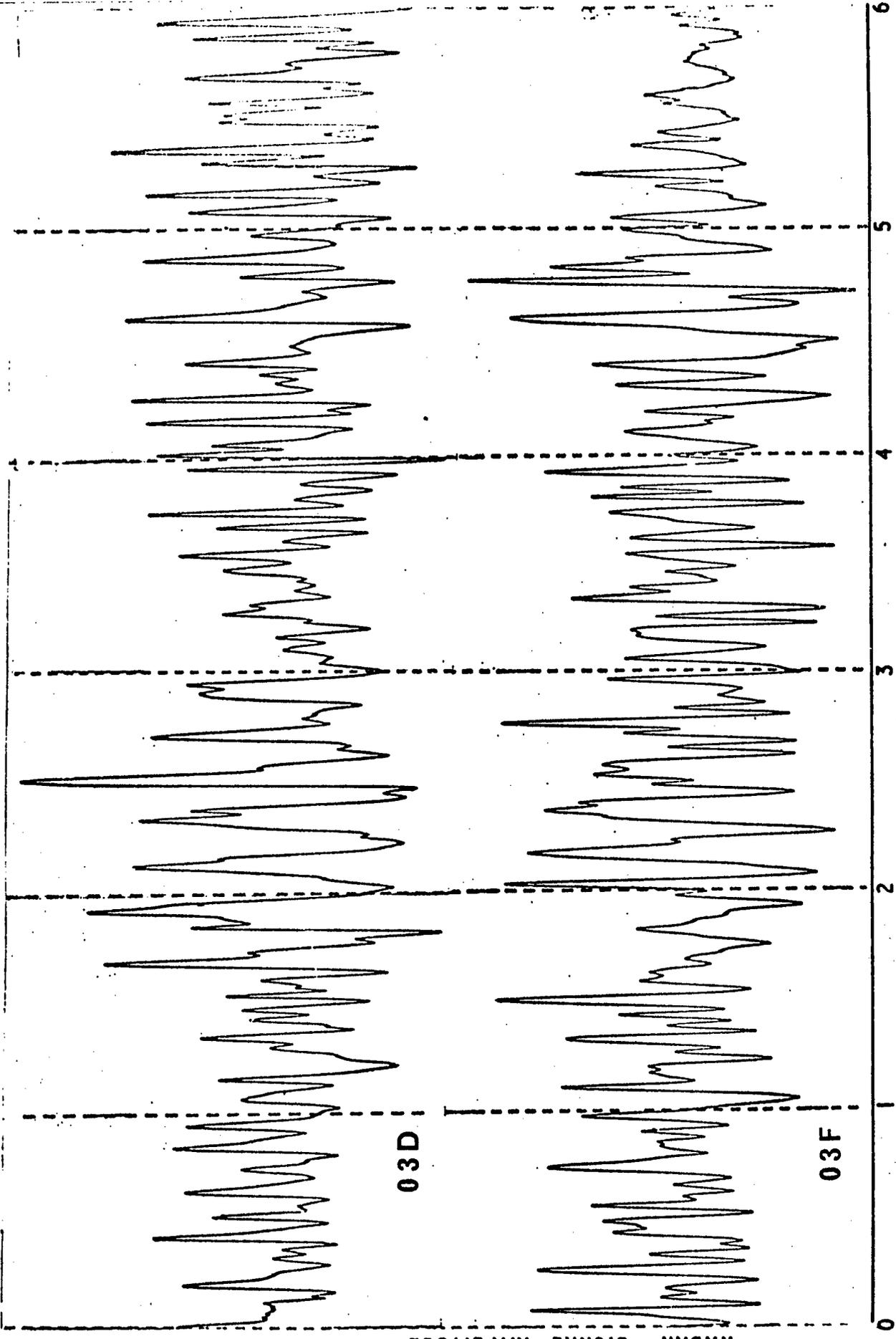
BAM WAVEFORMS OF DUNLINS  
FIG. 2a

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RADAR SIGNAL AMPLITUDE

03D

03F



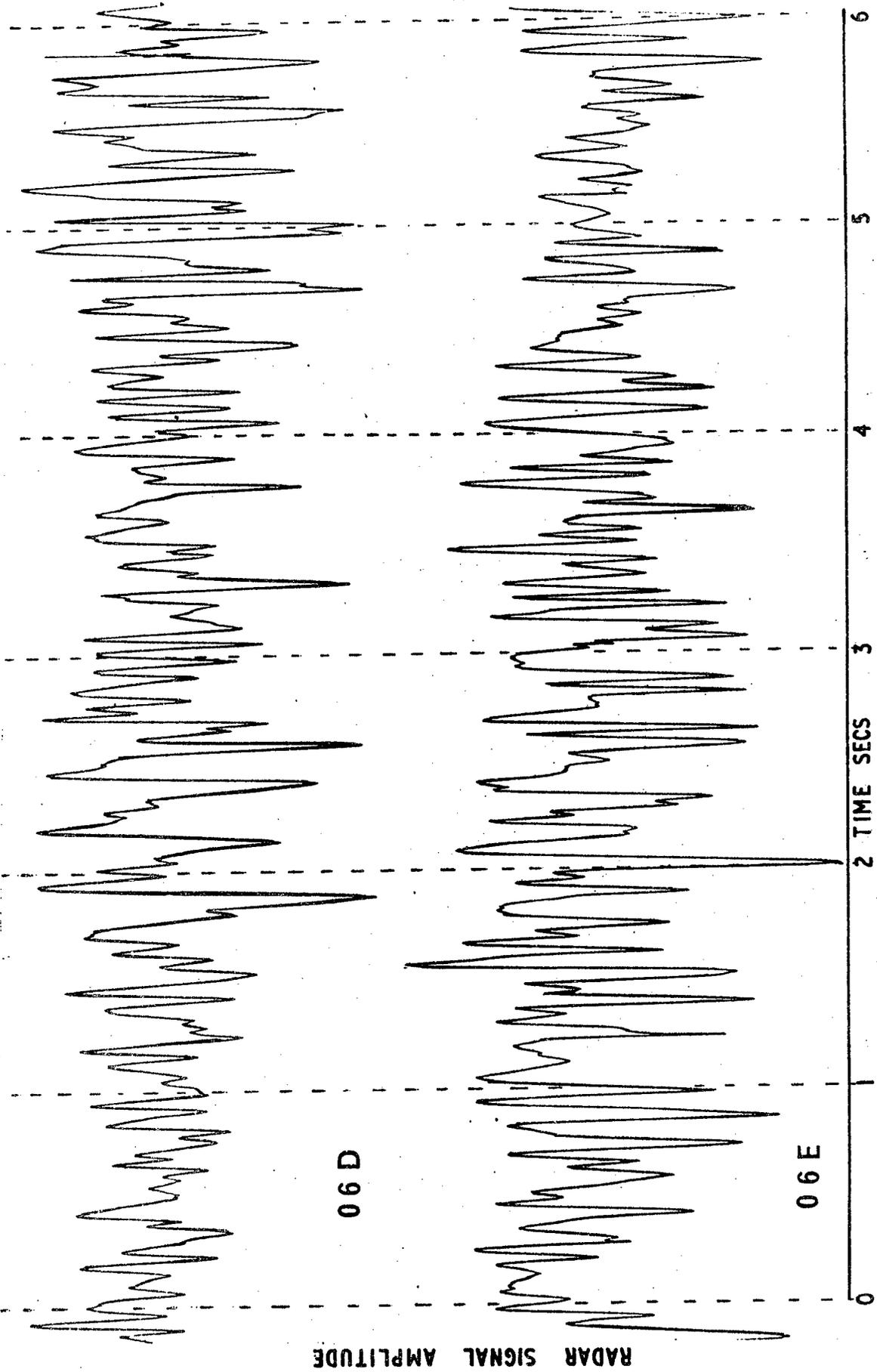
0 1 2 3 4 5 6

TIME SECS.

BAM WAVEFORMS OF OYSTERCATCHERS

FIG. 2b

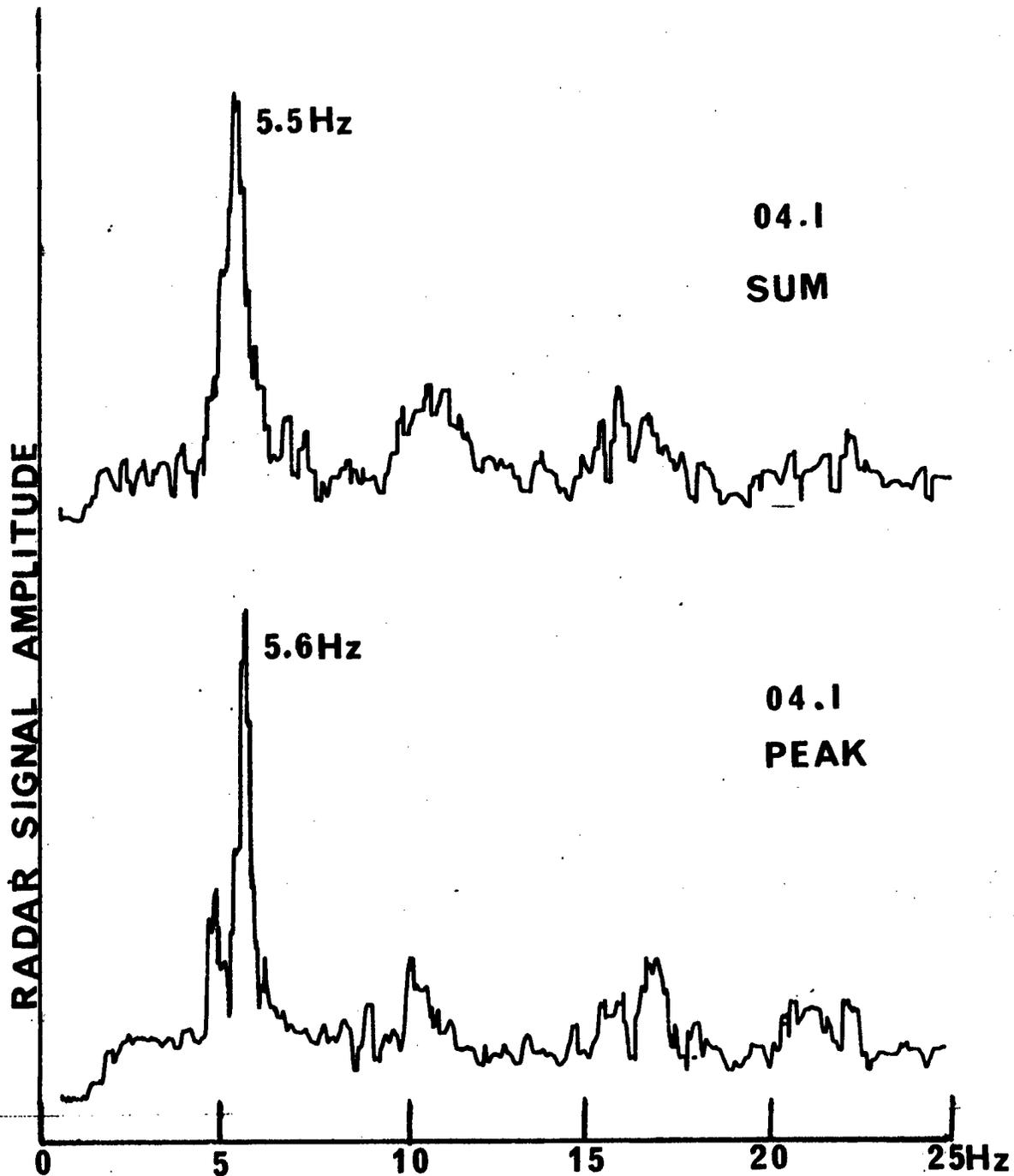
123



BAM WAVEFORMS OF CURLEWS

FIG. 2c.

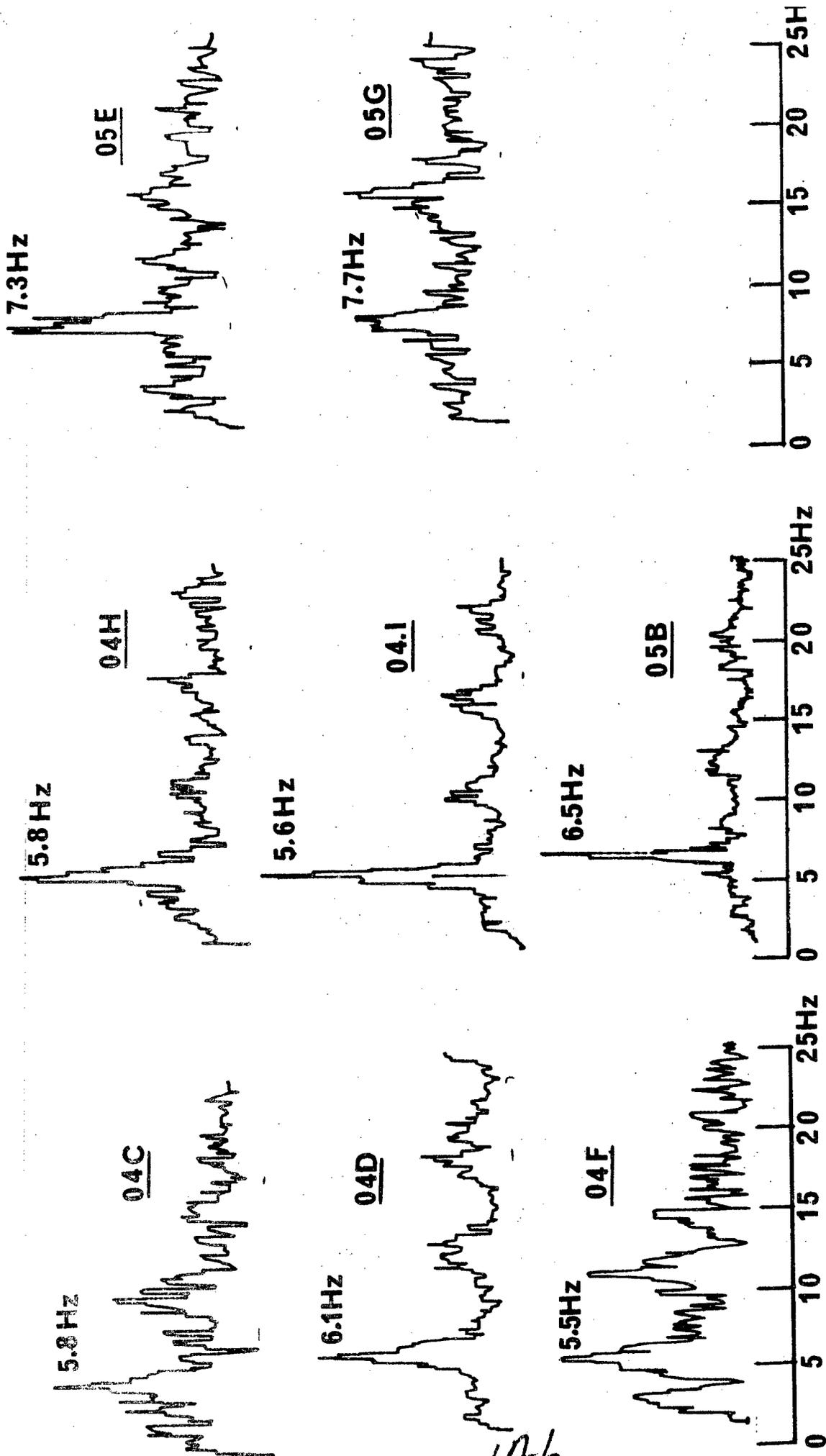
124



**WING BEAT FREQUENCY**  
**SPECTRA OF RELEASED DUNLIN**  
**40 SECS AVERAGE**

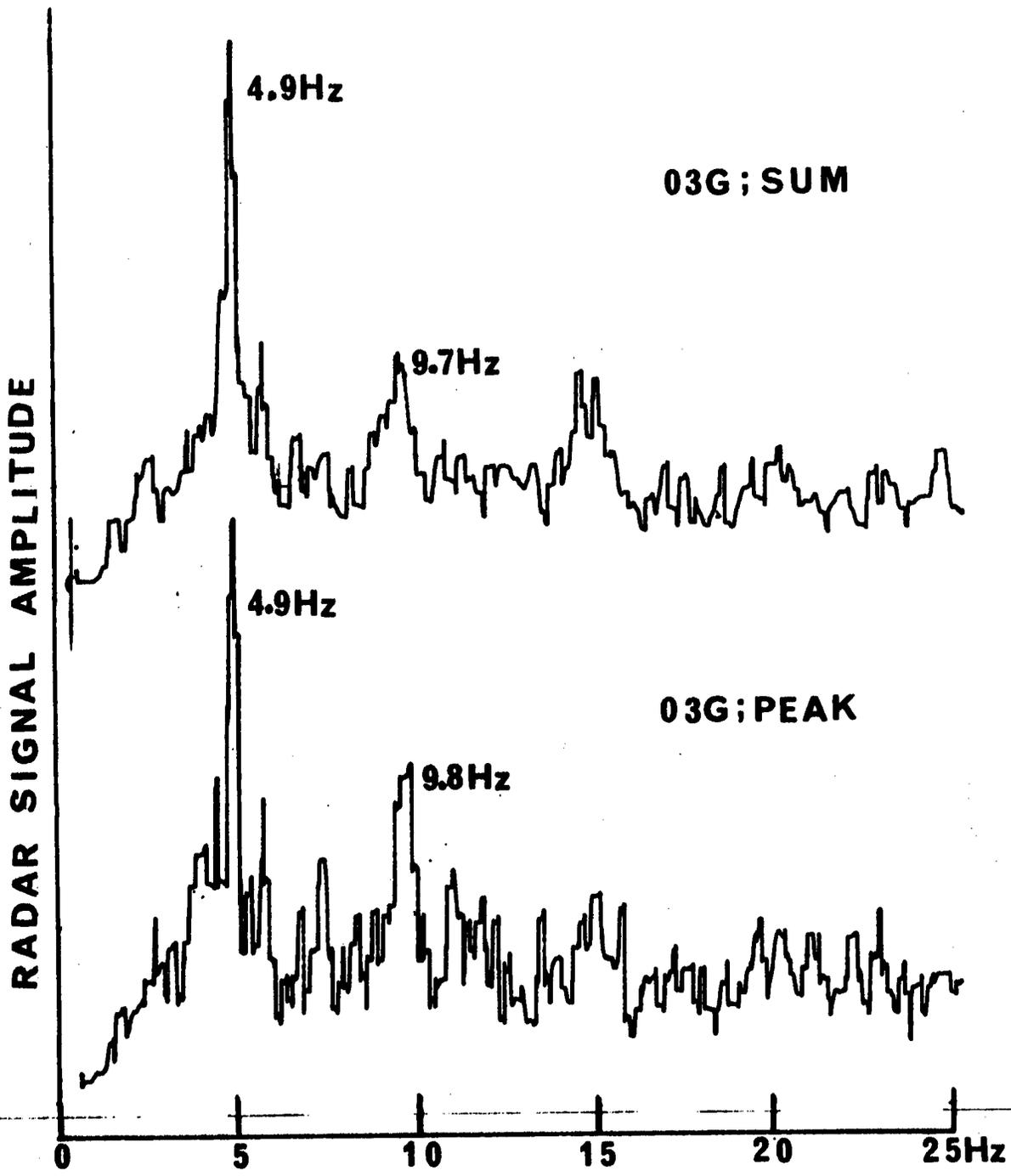
**FIG.3a**

*125*



WING BEAT FREQUENCY  
SPECTRA OF RELEASED DUNLINS (40 SECS AVERAGE)

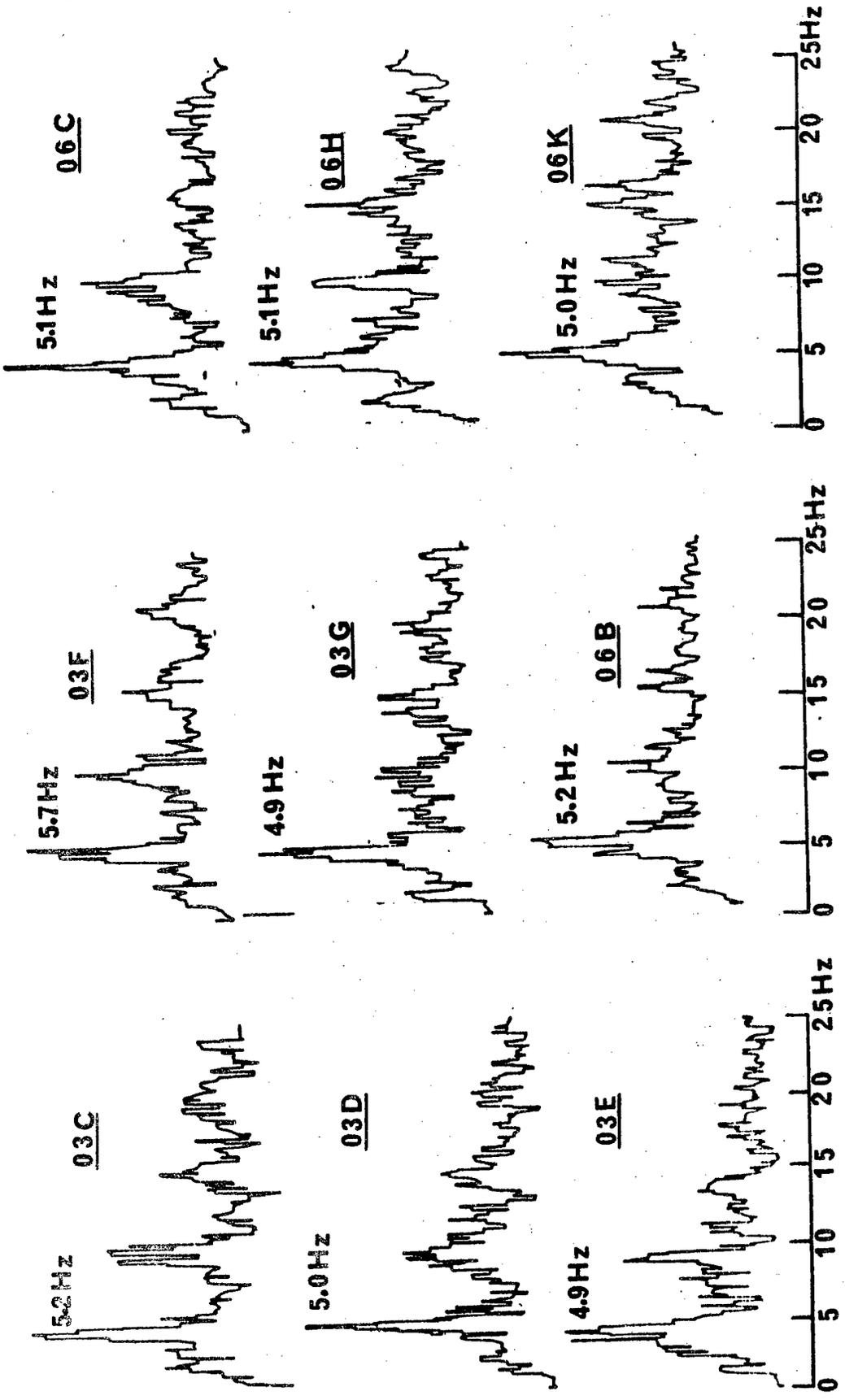
FIG. 3b



**WING BEAT FREQUENCY**  
**SPECTRA OF RELEASED OYSTERCATCHER**  
**40 SECS AVERAGE**

**FIG. 4a**

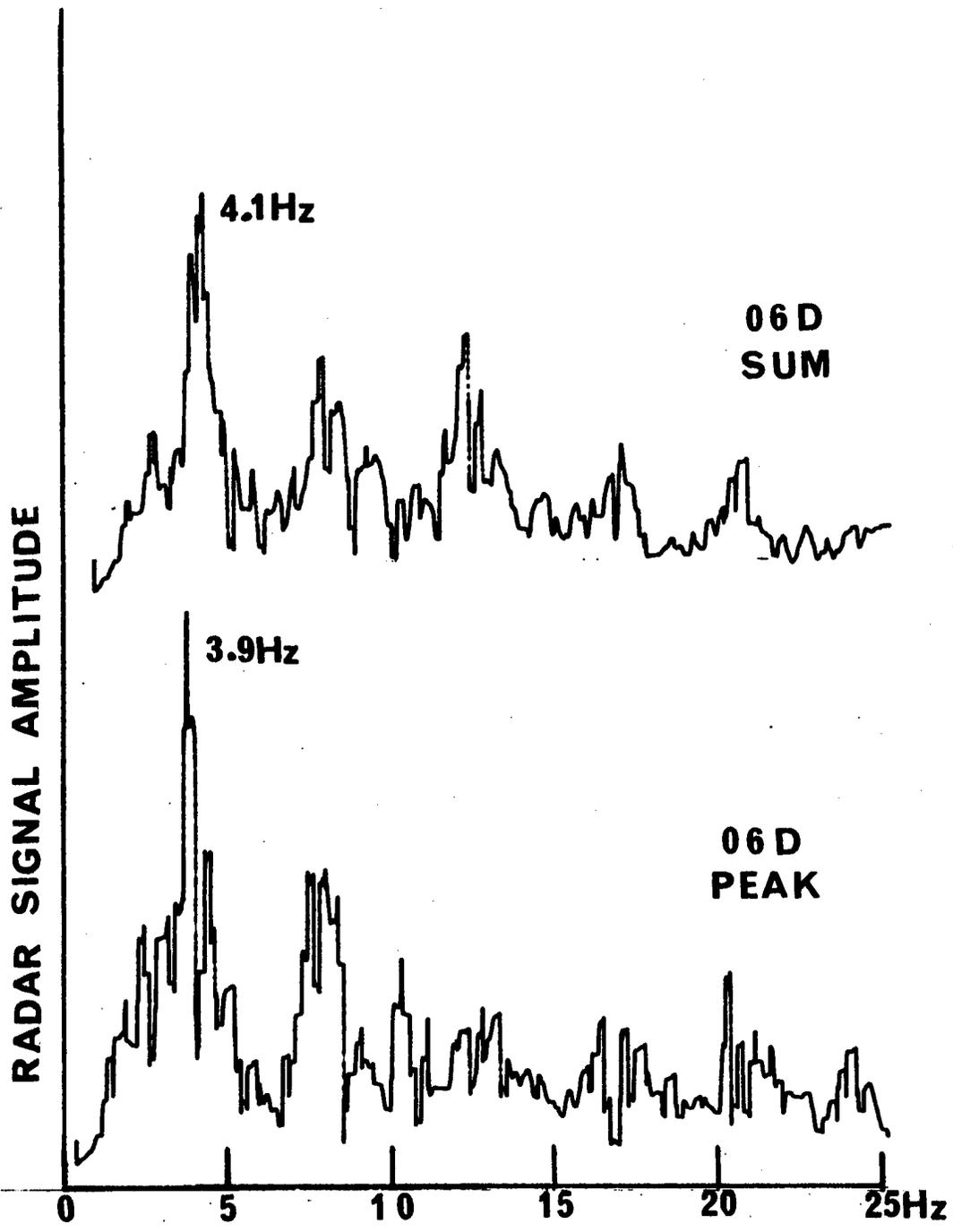
127



WING BEAT FREQUENCY

SPECTRA OF RELEASED OYSTERCATCHERS (40 SECS AVERAGE)

FIG. 4b



**WING BEAT FREQUENCY  
SPECTRA OF RELEASED CURLEW  
40 SECS AVERAGE**

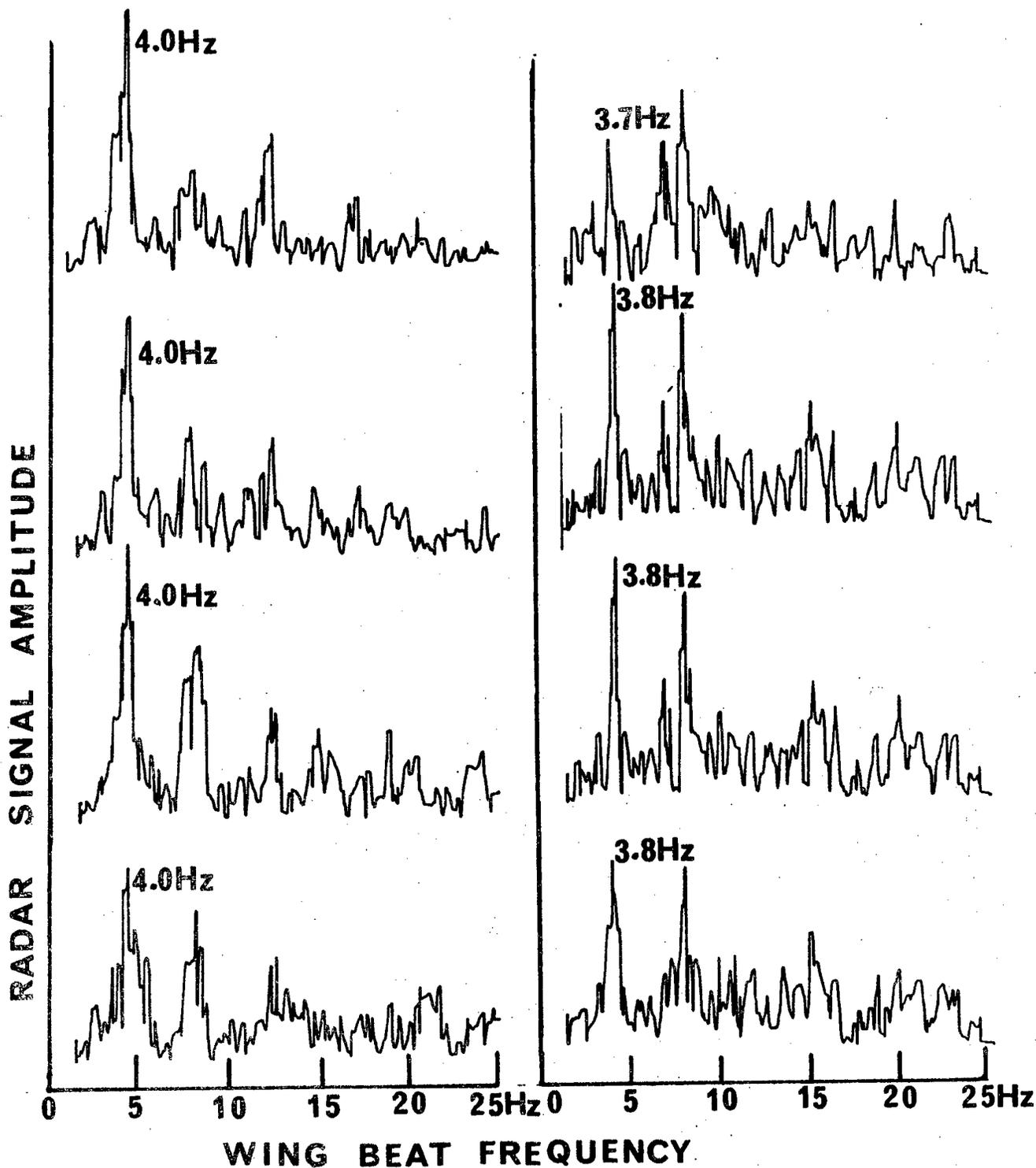
**FIG. 5a**

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CURLEW 06D

CURLEW 06E



SPECTRA OF RELEASED CURLEW (10 SECS AVERAGE)  
TAKEN FROM TWO SEPARATE RUNS 06D & 06E

FIG. 5b

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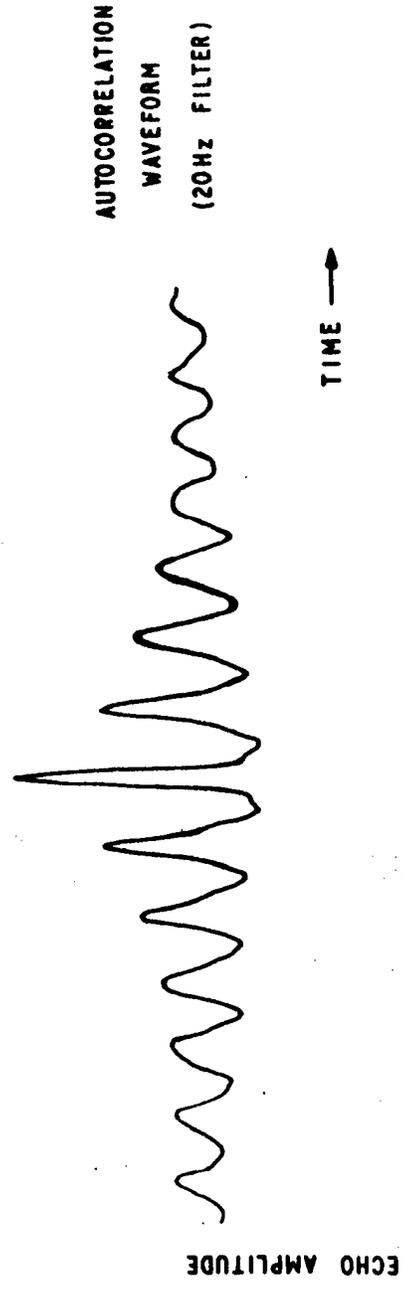
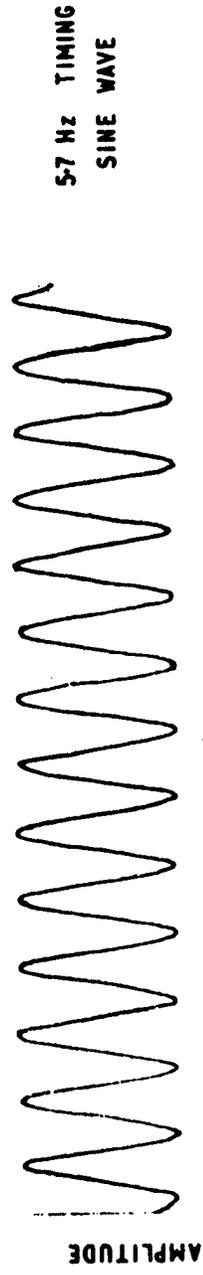
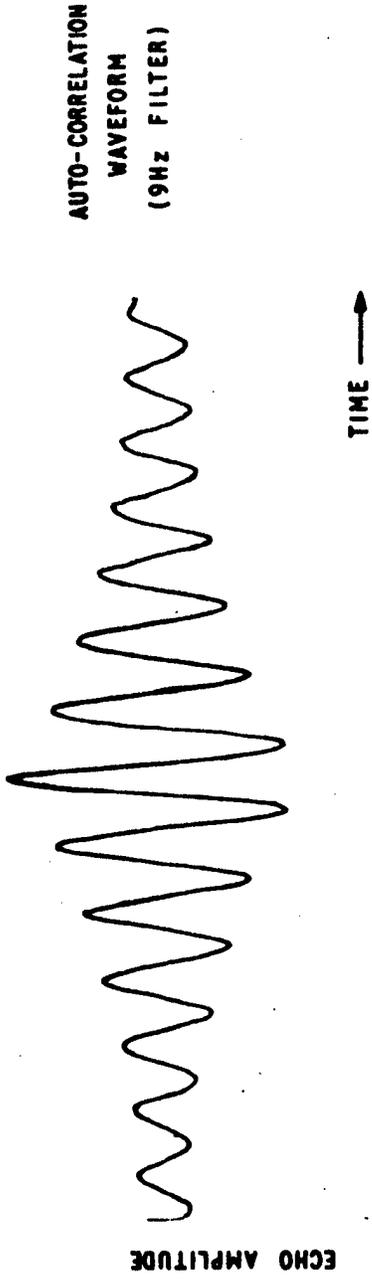


FIG. 6. AUTOCORRELATION WAVEFORMS OF DUNLIN - O4I.

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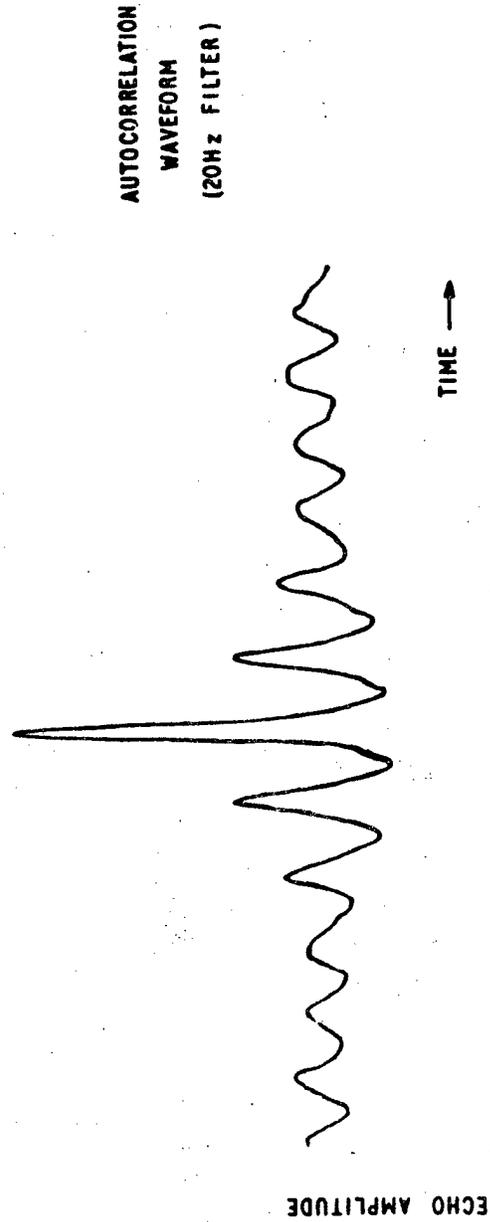
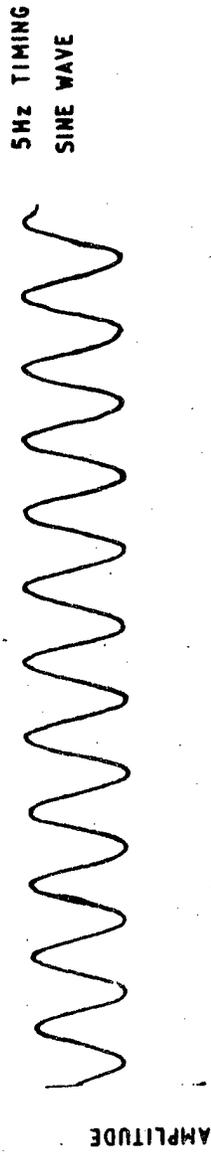
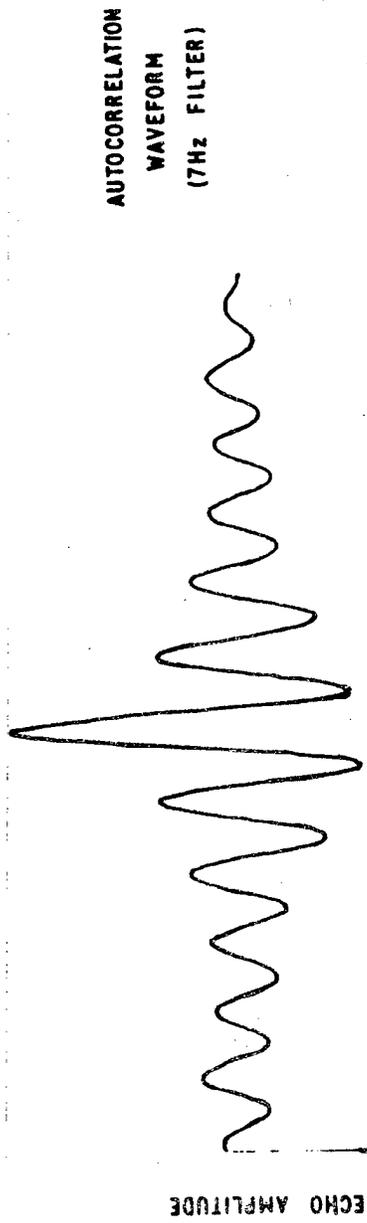


FIG. 7. AUTOCORRELATION WAVEFORMS OF OYSTERCATCHER-O3G.

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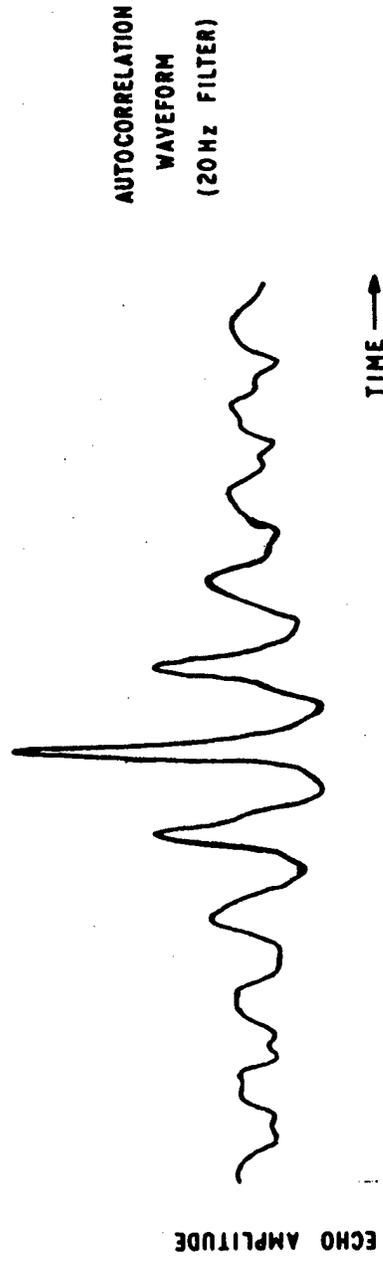
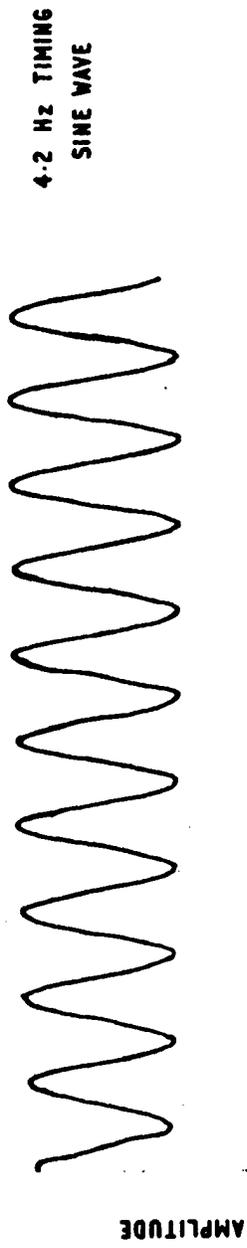
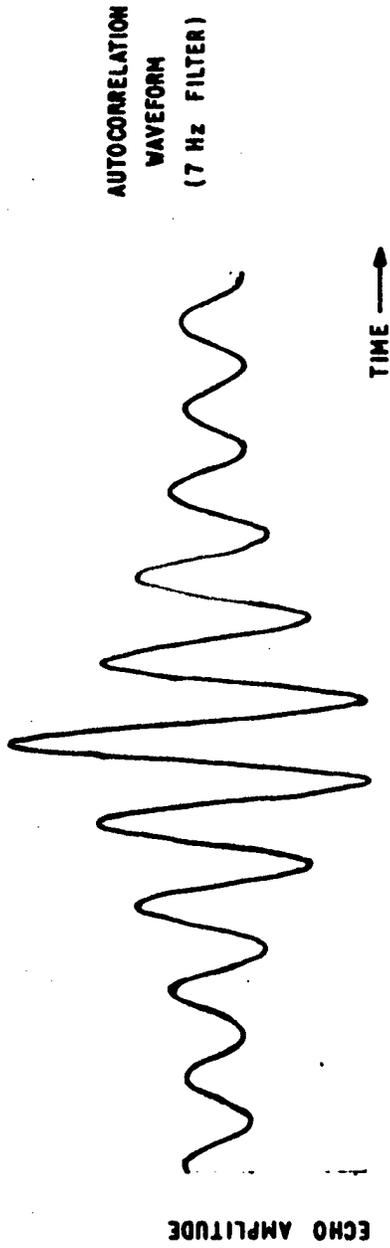


FIG. 8. AUTOCORRELATION WAVEFORMS OF CURLEW - 06D.

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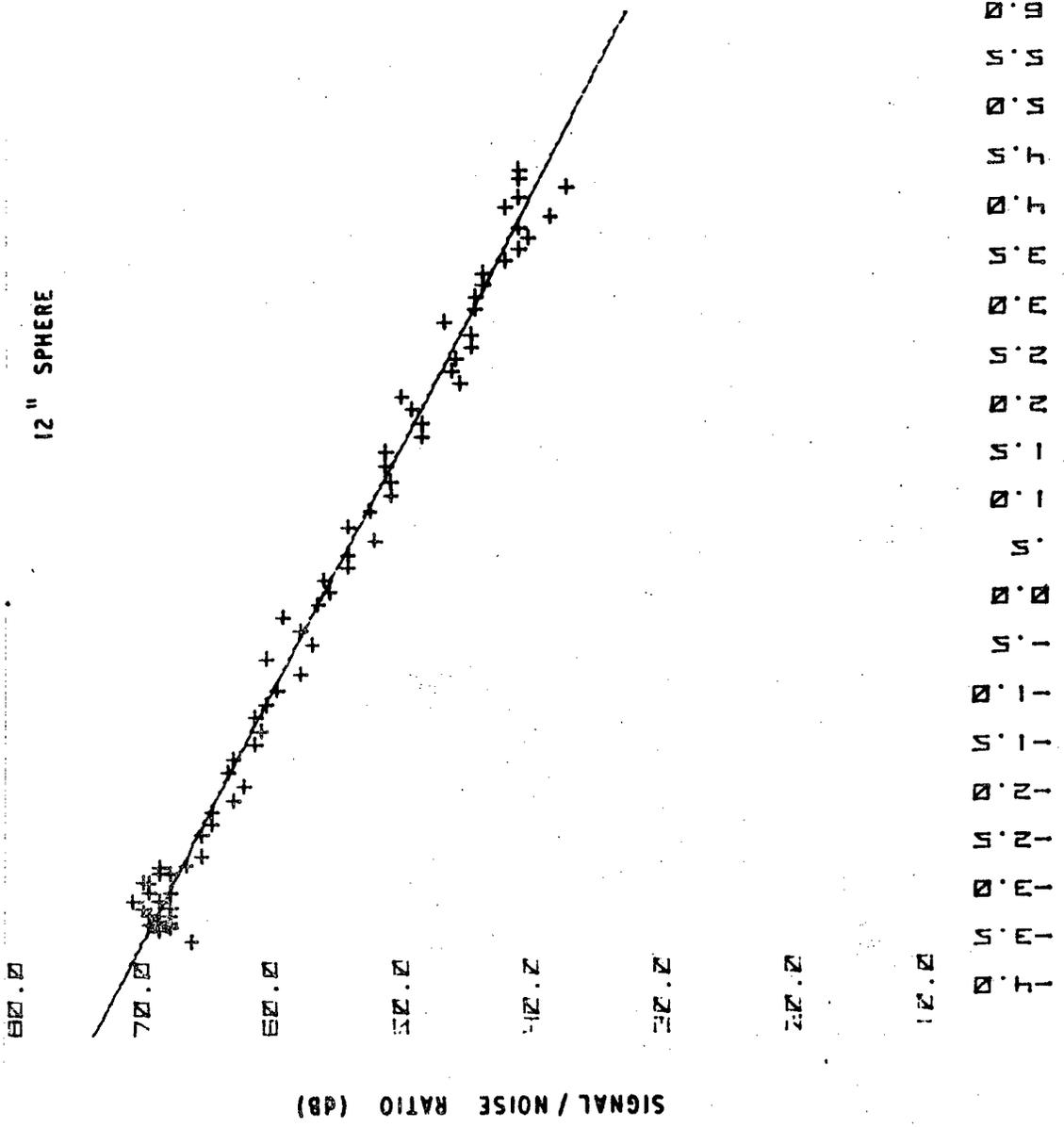


FIG. 9. SPHERE ECHO SIGNAL/NOISE RATIO VERSUS RANGE RATIO

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DUNLIN

OYSTERCATCHER

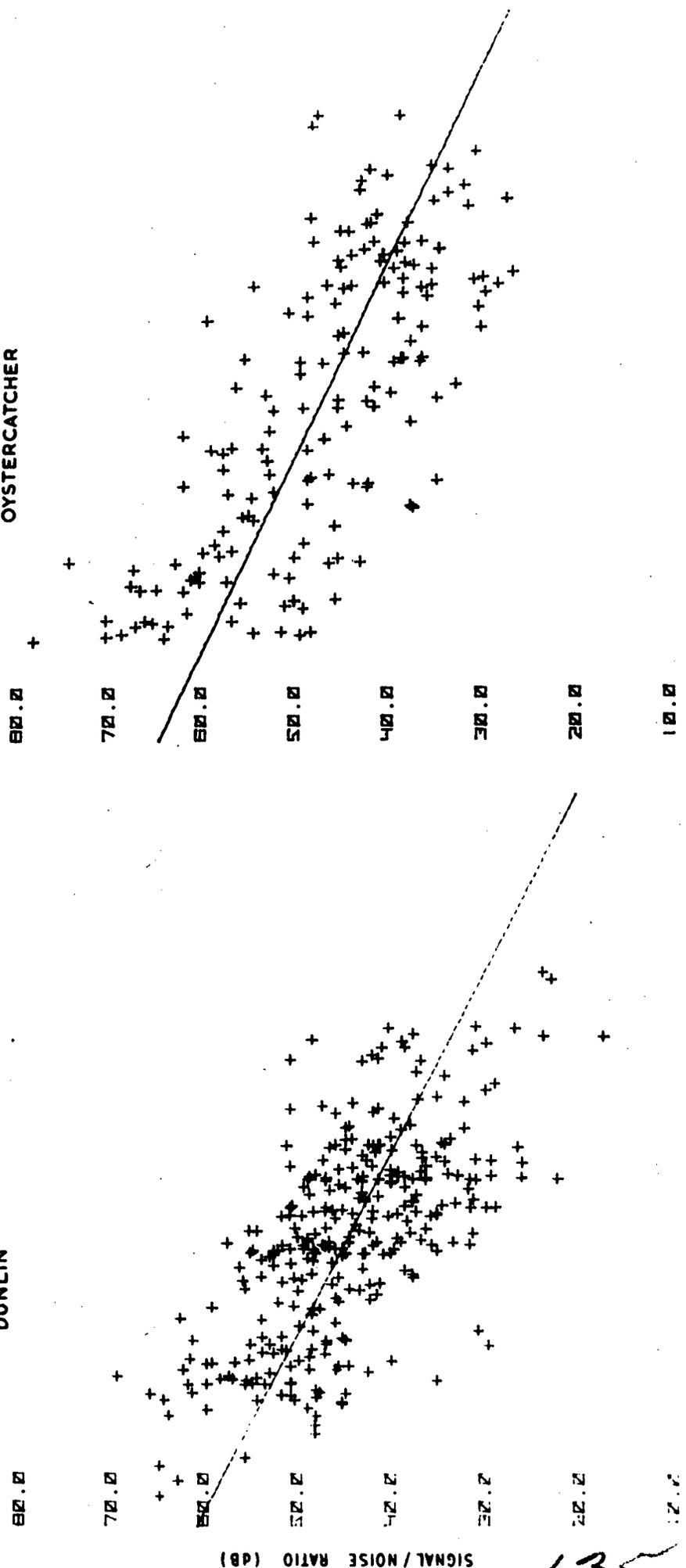
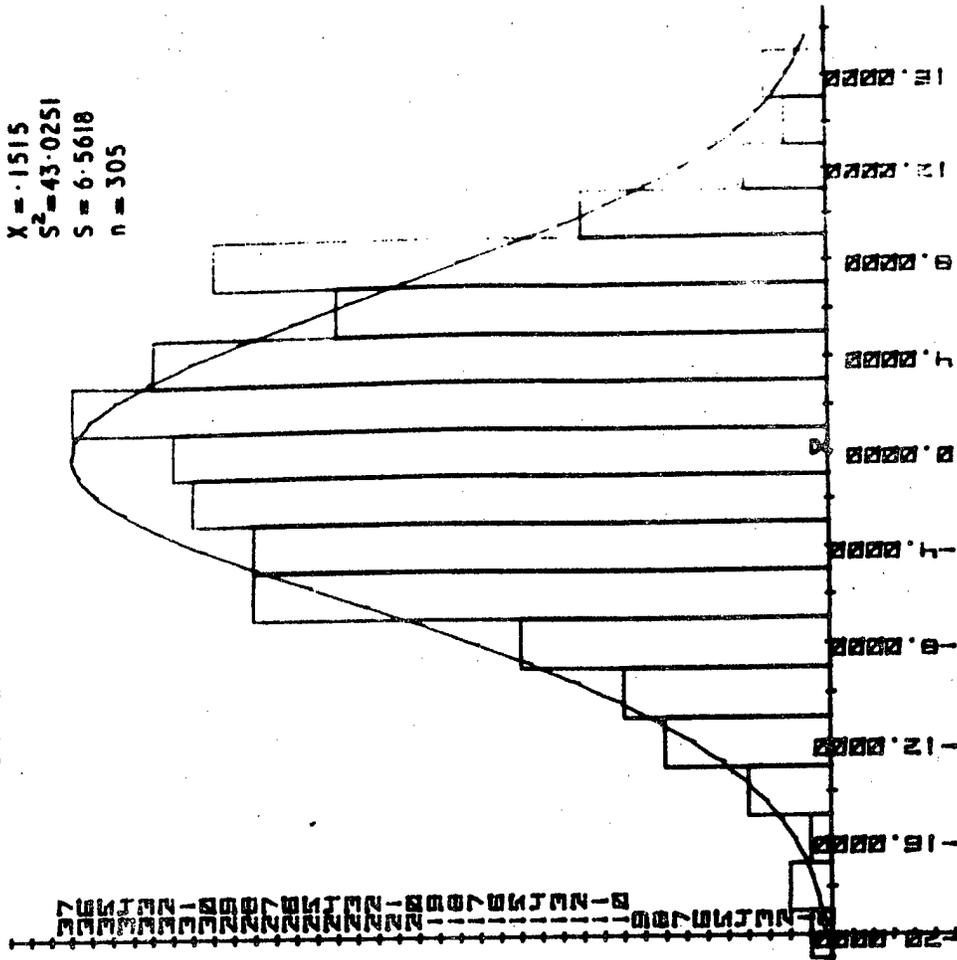


FIG. 10. BIRD ECHO SIGNAL/NOISE RATIO VERSUS RANGE RATIO.

DUNLIN

$\bar{X} = 1515$   
 $S^2 = 43.0251$   
 $S = 6.5618$   
 $n = 305$



OYSTERCATCHER

$\bar{X} = 0645$   
 $S^2 = 54.9650$   
 $S = 7.4148$   
 $n = 181$

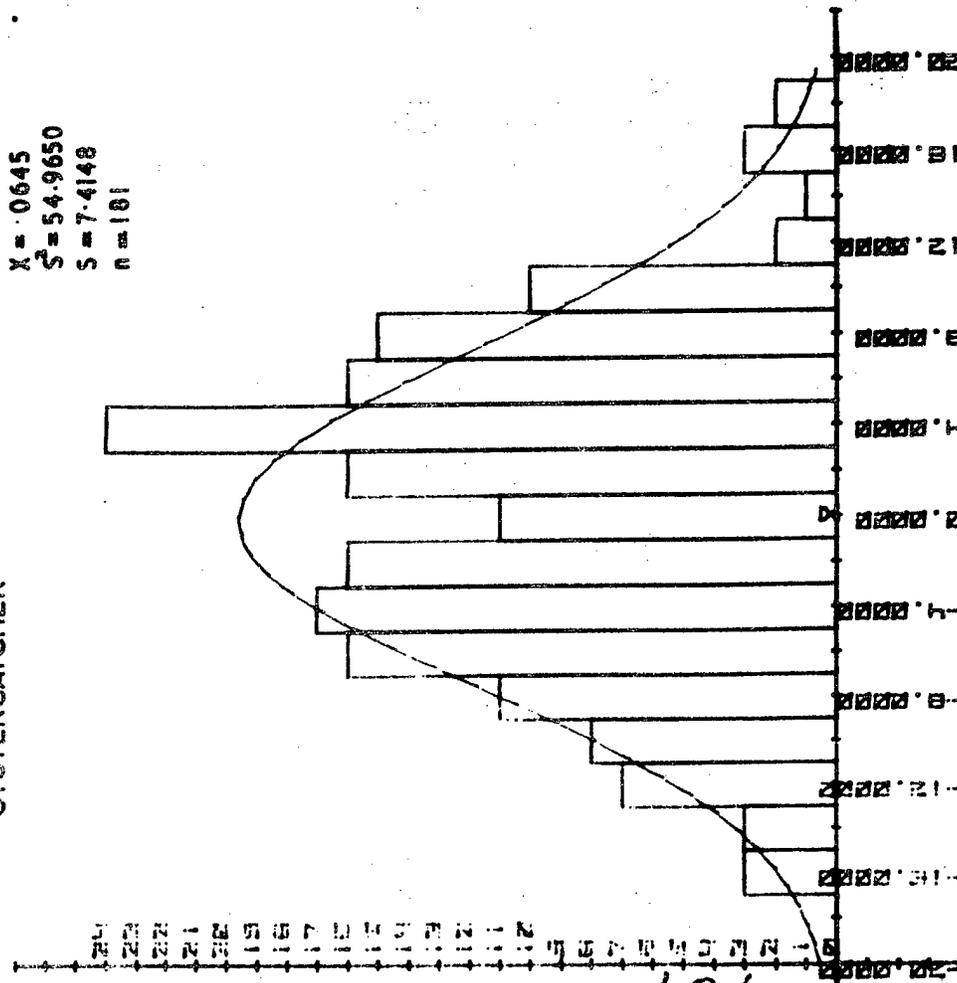


FIG. II.

HISTOGRAMS OF ECHO (S/N) RATIO  
FLUCTUATIONS ABOUT THE MEAN VALUE.

AD F 616 170

BIRD STRIKE COMMITTEE REPORT

LONDON, 24-28 May 1976

Ref: BSCE/11 WP5

MIGRATING BIRDS AND THEIR DANGER TO AEROPLANES

V E Jacoby - USSR



## BIRD STRIKE COMMITTEE EUROPE

## Migrating birds and their danger to aeroplanes

V E Jacoby, USSR

The analysis of more than 1700 birdstrikes in the USSR civil aviation has shown the peaks in the periods of the spring and autumn migrations and in the summer - within the period of the young birds flight and of postnest nomadic phase. The comparison of the birdstrike rate at the southern airports, at the airports of the middle zone and at the northern airports in the European part of the USSR has shown that the wave of strikes comes from the South to the North in parallel with the spring migration wave. Comparison of these data with the seasonal distribution of flight intensity of the civil aviation planes shows that peaks of strikes are connected, in the first turn, with the general increase of birds number at airports during migration and as a result of reproduction. However at the series of airports the tremendous accumulation of settled birds - crows, jackdaws and others - do not represent any danger for planes. The adult migrating and settled birds local nesting at the airports (ducks, lapwings, pigeons, crows, jackdaws) strike with planes extremely seldom. When these birds appear at an airport - the process of fast learning to avoid strikes with planes apparently is taking place by birds. Generalizing the data obtained from the analysis of time of birdstrikes, and the age and species structure of victims we came to the conclusion that collisions occur with the birds who see for the first time a plane at close distance. First of all young, unexperienced, bad orienting birds are victims of strikes.

This conclusion bears direct relation to the selection and carrying out of measures for the prevention of bird strikes during migration:

1. The shooting and catching of both - birds migrating across an airport and the local nesting migrating and settled birds - are completely ineffective and inexpedient.
2. The most effective way is admittedly to create such a situation at airports which would be ecologically unattractive for birds in all aspects.
3. In connection with the fact that it is not always possible or economically justified to create ecologically unattractive situation at an airport - it is effective and expedient to use various means of active bird frightening : pyrotechnic, bioacoustic etc. These means frighten in the most effective way the migrating birds and young birds who appear at an airport for the first time and consequently who are most dangerous for planes.
4. The use, outside an airport, of the network of visual and radar observation posts makes it possible to notify airports at large space about the approach of the birds wave dangerous for flying

planes. On the basis of many years observations at the concrete point it is already possible to forecast mass bird migration in connection with meteorological and other conditions.

It seems to be expedient in the future to connect the adaptive peculiarities of the birds behaviour in flocks during migrations with the forecasting of the nature of mass migration during the day and in the night.

BIRD STRIKE COMMITTEE EUROPE

LONDON, 24-28 May 1976

Ref: BSCE/11 WP6

PROPOSAL CONCERNING THE DISTRIBUTION OF  
BIRD STRIKE REPORTS

L-O Turesson - Board of Civil Aviation, Sweden

Paper to be presented at BSCE - 11 for Working Group Analysis and for the Main Meeting.

Proposal concerning the distribution of bird strike reports.

The present distribution of bird strike reports within the European countries is arranged in a way that the pilot is handing over the report to his company to be forwarded to the aviation authority of the country where the company is working. The reports are analysed annually and the analysis is the following year distributed nationally and internationally. (This includes analysis using the BSCE and the ICAO forms)

In this way it takes a long time until a report is reaching the airport manager of the airport where the bird strike occurred. Sometimes more than one year is passing and the airport manager will not in due time be aware of risks for the air traffic originating from an increasing frequency of bird strikes.

The procedures described here are normally the only ones for international as well as domestic distribution of bird strike reports. In order to improve these conditions the Swedish National Committee for bird strike problems to aviation proposes a supplementary system for distributing according to the following:

1. Domestic distribution

BSCE recommends that the aviation authorities (civil and military) of each country should immediately after the receipt of a report from a bird strike within its own territory submitted by an air company or the airforce of that country, send it to the relevant airport authority if the strike occurred in the airport area or its vicinity.

2. International distribution

BSCE recommends that the aviation authorities of each country should immediately after the receipt of a report from a bird strike which has occurred abroad, submitted by an air company of its own country, send it to the aviation authority of the country concerned to be forwarded to the relevant airport authority if the strike occurred in the airport area or its vicinity.

Note.

Alternatively to the proposed system for international distribution there is a possibility that the air company concerned should send the report to the aviation authority of its home country with a copy to the aviation authority of the country where the bird strike occurred.

Organisers' Note.

Discussed and agreed by Analysis Working Group, and accepted by ICAO representative. Subsequently ICAO have issued the attached State Letter.

INTERNATIONAL CIVIL  
AVIATION ORGANIZATION

ORGANIZACIÓN DE AVIACIÓN  
CIVIL INTERNACIONAL



ORGANISATION DE L'AVIATION  
CIVILE INTERNATIONALE

МЕЖДУНАРОДНАЯ ОРГАНИЗАЦИЯ  
ГРАЖДАНСКОЙ АВИАЦИИ

P.O. BOX 400, SUCCURSALE: PLACE DE L'AVIATION INTERNATIONALE,  
1000 SHERBROOKE STREET WEST, MONTREAL, QUEBEC, CANADA H3A 2R2

CABLES: ICAO MONTREAL  
TELEX: 05-24513  
CENTREX  
OFFICE TEL.:

Ref.: AN 3/32 - 76/111

14 July 1976

Subject: Damage to aircraft caused by bird  
strikes - Provision of bird strike data to  
ICAO

Action required: Submit bird strike data  
as outlined in paragraph 2

Sir,

1. I invite your attention to my letter AN 3/32 - 71/150 dated 28 October 1971 in which I had requested your Government to provide ICAO with yearly analyses of the bird strike data. Approximately twenty-five States have been submitting regularly the required analyses and these have been found to be very useful by the Airworthiness Committee in its study of aircraft design problems related to bird criteria.

2. It has been suggested that the existing bird strike reporting system could be further utilized to identify locations where bird problems have arisen by sending copies of the individual bird strike reports, in Bird Strike/Incident Report Form attached to State letter AN 3/32 - 64/195 dated 5 January 1965, direct to:

- a) the State in which the bird strike is determined to have occurred; and
- b) in the case of a strike in the immediate vicinity of an airport, also to the Airport Authority where the strike occurred.

It is believed that this action would alert local authorities of the possible need to initiate bird control measures. For maximum effectiveness, such reports should be transmitted as soon as they are prepared.

3. May I request your Government to take the necessary action to provide the additional service referred to above. The yearly analyses of the bird strike data requested in State letter AN 3/32 - 71/150 dated 28 October 1971 should continue to be sent to ICAO.

Accept, Sir, the assurances of my highest consideration.

*W.S. Nemezer*  
for Assad Kotaite  
Secretary General

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AD F 616 172

BIRD STRIKE COMMITTEE EUROPE

LONDON, 24-28 May 1976

Ref: BSCE/11 WP 7

HEIGHT DISTRIBUTION OF BIRD MOVEMENTS IN  
SOUTHERN SWEDEN MEASURED BY RADAR SEPT-OCT 1976

B Larsson, Sweden

Complete Paper

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RIV

## BIRD STRIKE COMMITTEE EUROPE

HEIGHT DISTRIBUTION OF BIRD MOVEMENTS IN SOUTHERN SWEDEN MEASURED BY RADAR  
by B. Larsson, Meteorologist, Swedish Air Force

Within the frame of a project of developing methods to reduce bird hazards to aircraft, surveillance radars have been used for several years in order to detect and define areas of especially high concentrations of migrating birds over southern Sweden. But a problem with the "SRE" is that you cannot determine the height of the bird echoes. During the period 25 Sep to 10 Oct 1975 another type of radar was employed in order to find out the height distribution of the migrating birds.

The radar used was a Selenia Meteor 200 (X-band, peak-power 200 kW and beamwidth 1.65 degrees, normally used as a weather and wind-finding radar) located at Ljungbyhed in the southern-most part of Sweden. With the wind-finding equipment it is possible to measure the height of a bird echo with an accuracy of  $\pm 50$  m within a distance of 15 km. Beyond 15 km the radar can only detect flocks consisting of many or/and big birds; mostly due to the low peak power and the fact that a flock will not "fill the beam" at a longer distance. Measuring the height of each echo randomly encountered was found to give an erroneous picture of the height distribution.

However, the PPI was also photographed with Polaroid film every hour from 06 to 14 hrs LMT (Monday to Friday, if there was not too much precipitation). Photos were taken at the elevations of 1.5, 3.75, 6.0 and 9.0 degrees (sometimes also 15 degrees and a RHI photo). The exposing time was 1 to 3 minutes. About 200 pictures were taken and the result can be seen in appendix 3 and 4. The evaluation of the pictures was carried out as follows. Within a "window" with a ground area of 25 km<sup>2</sup> located over a suitable area of the picture all echoes were counted. From the 1.5 degree photo the concentration of echoes in the layer 100 to 200 m was obtained, from the 3.75 degree photo that between 200 and 500 m, and so on. No measurement below 100 m was possible due to many disturbing ground echoes.

In the beginning of the period the weather was rather cloudy and rainy with low cloud bases and mostly southerly winds. Therefore little migration took place. Some days, however, birds were flying between or over clouds even if the lowest cloudlayer was complete. On 5 Oct a rather deep low passed southern Sweden, and behind it a strong northerly wind brought down dry and cold air (see appendix 2). On the following days the most intense migration of Wood-Pigeons for the whole autumn was recorded. As seen in appendix 1 the maximum height repeatedly exceeded 1500 m. On 8 Oct there were so many echoes on the screen in the morning that it was almost impossible to count them on the photo. Therefore no photos were taken at lower elevations between 0630 and 0840 hrs LMT, which, in retrospect was a mistake.

During the period 29 March to 9 April 1976 a new series of measurement using the same technique has been collected. This time also Ronneby and Kalmar were involved (see appendix 5). Visual bird observations made by

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military pilots flying at Angelholm, Ljungbyhed, Ronneby and Kalmar were also collected Monday to Friday during these two weeks. The results from this period are not yet available.

Conclusion

The Meteor 200 is very useful to determine the height distribution of bird migration within a distance of 15 km. If special equipment for the purpose is unavailable, it is possible to take Polaroid photos and to evaluate the echo concentration by hand. At present it is impossible to determine the different species. Radar work therefore should be coupled with field observations of the migrating birds carried out by competent ornithologists. To get a complete picture of the migration pattern over a larger area it is necessary to use the X-band radar in combination with a surveillance (L-band) radar.

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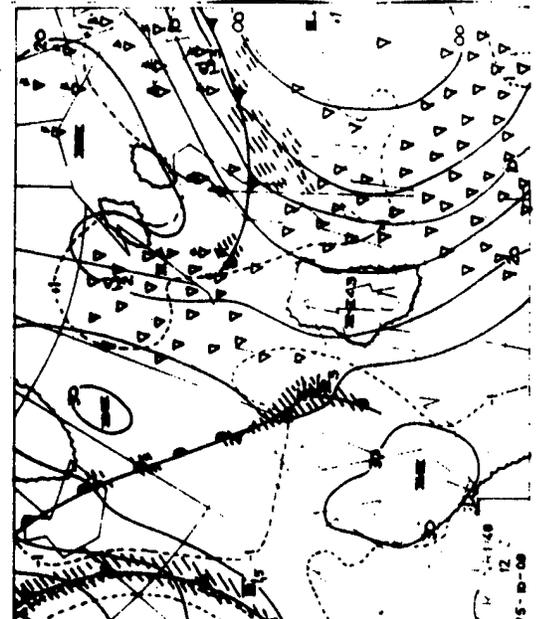
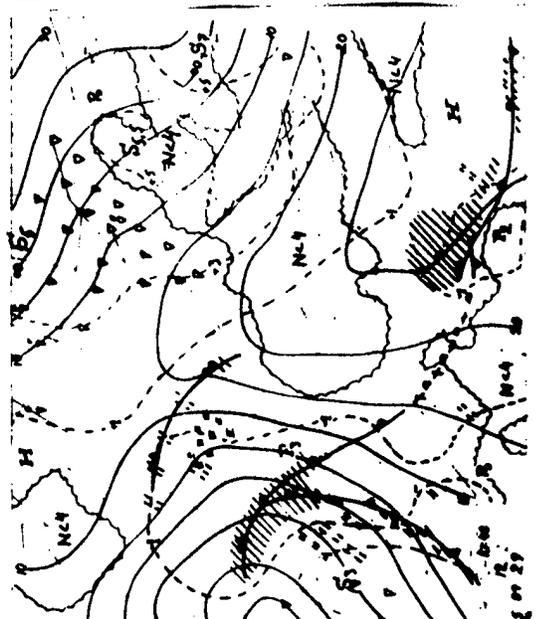
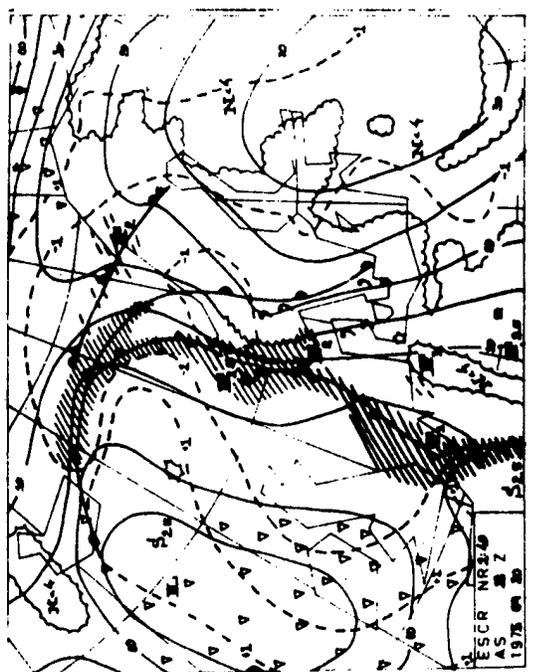
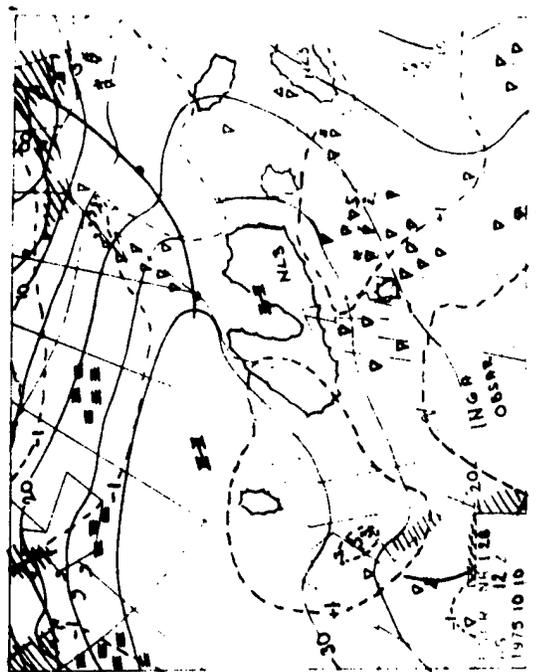
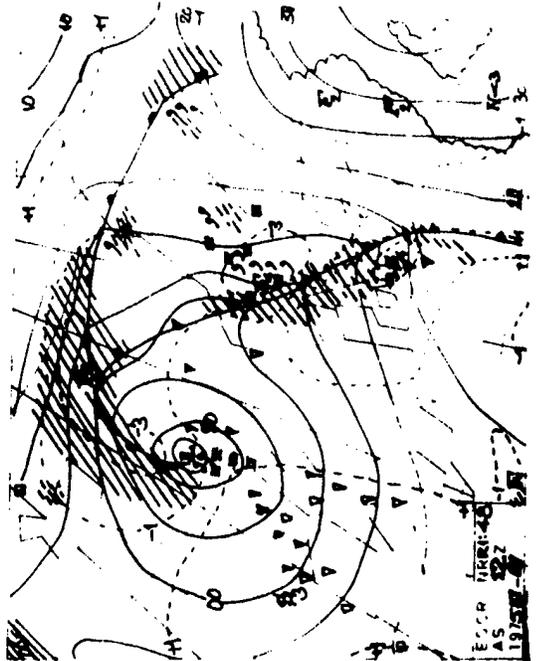


Height Distribution of Bird Echoes evaluated from Polaroid Photographs.

Date	Time (LMT)	Number of Echoes per 100m and 25 km <sup>2</sup>					Maximum Height
		100-200m	200-500	500-1000	1000-2000	2000-3000	
25 Sep	1115	4					200
26 Sep	0920	2					200
29 Sep	0600	-	-	-	22	14	2450
	0640	7	15	7	5		1400
	0835	6	21	11	4		1750
	0945	4	7	2			850
	1100	11	5	2	6		1200
30 Sep	0630	10					200
	0740	20	11	3			1000
	0910	19	10	2	2		1350
	1010	10	6	2	1		1400
	1320	1		2			750
1 Oct	0625	2	2				500
	0650	16					200
	0750	8	4	3			650
	1330	1					200
2 Oct	0600	12	18	17	8		1250
	0700	3	4	1	1		1450
	0800	9	2				500
	0915	8	5				500
	1110	2	3	2			1000
6 Oct	0930	2	2				500
7 Oct	0820	15	4			3	3000
8 Oct	0545	24	19	17	10	9	2200
	0630	-	-	-	13	6	2700
	0650	-	-	-	5	6	2600
	0720	-	-	-	8	3	3000
	0750	-	-	-	11	4	2700
	0840	-	-	-	12	3	2700
	0930	9	15	12	3		1800
	1125	3	3	2			1000
	1305		1	2			1000
9 Oct	0425	15	11	4	2		1700
	0455	18	12	4	3		1200
	0540	11	14	11	8		2000
	0640	21	15	9	9		1400
	0755	3	15	6	5		1350
	0900	9	10	2	1		1550
	1140	3	3	1	1		1550
	1320		3				500
10 Oct	0620	11	11	6	6		1200
	0900	5	11	2			1000
	1030	5	4	3	3		1200
	1150	2	3	2	3		1200

- = No Photo

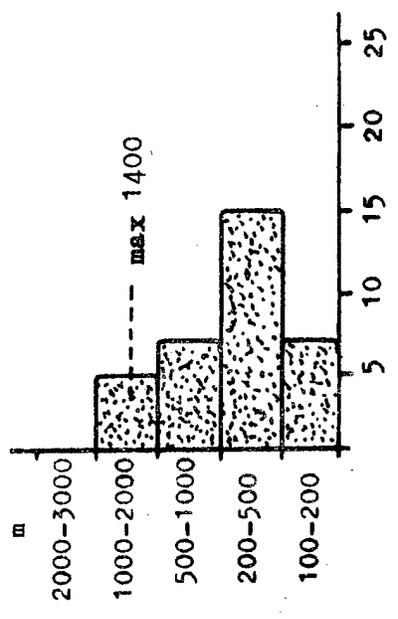
146



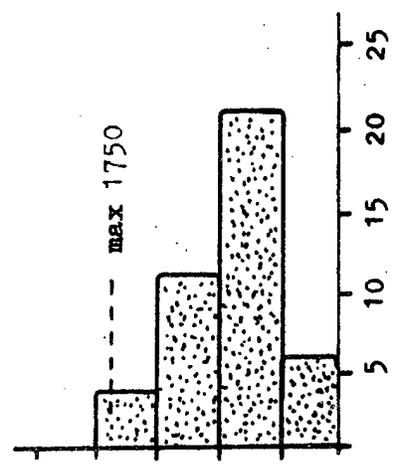
Number of echoes per 100 m and 25 km<sup>2</sup>

Height Layer  
m

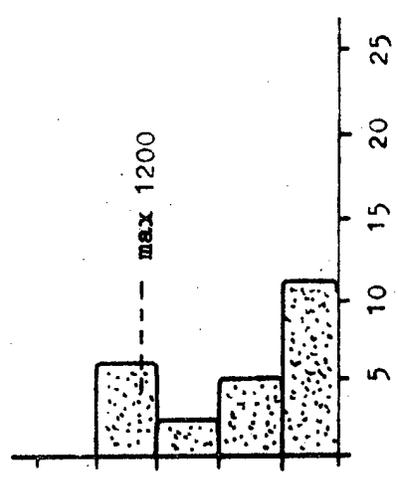
06/07 LMT



09/10 LMT

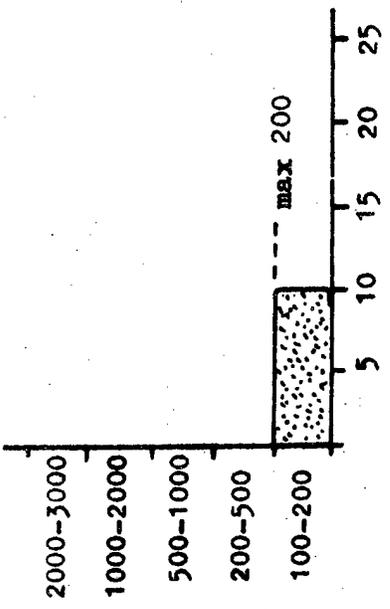


12/13 LMT



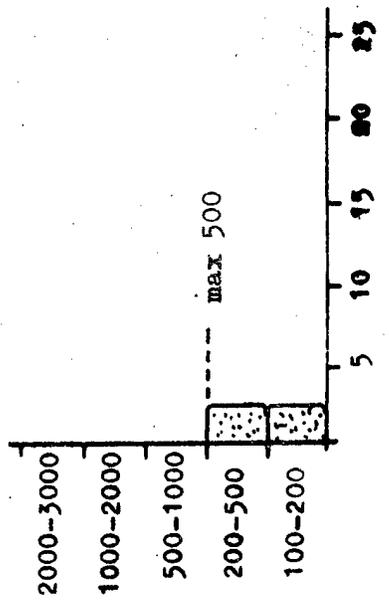
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1000-2000  
500-1000  
200-500  
100-200

Sep 30th



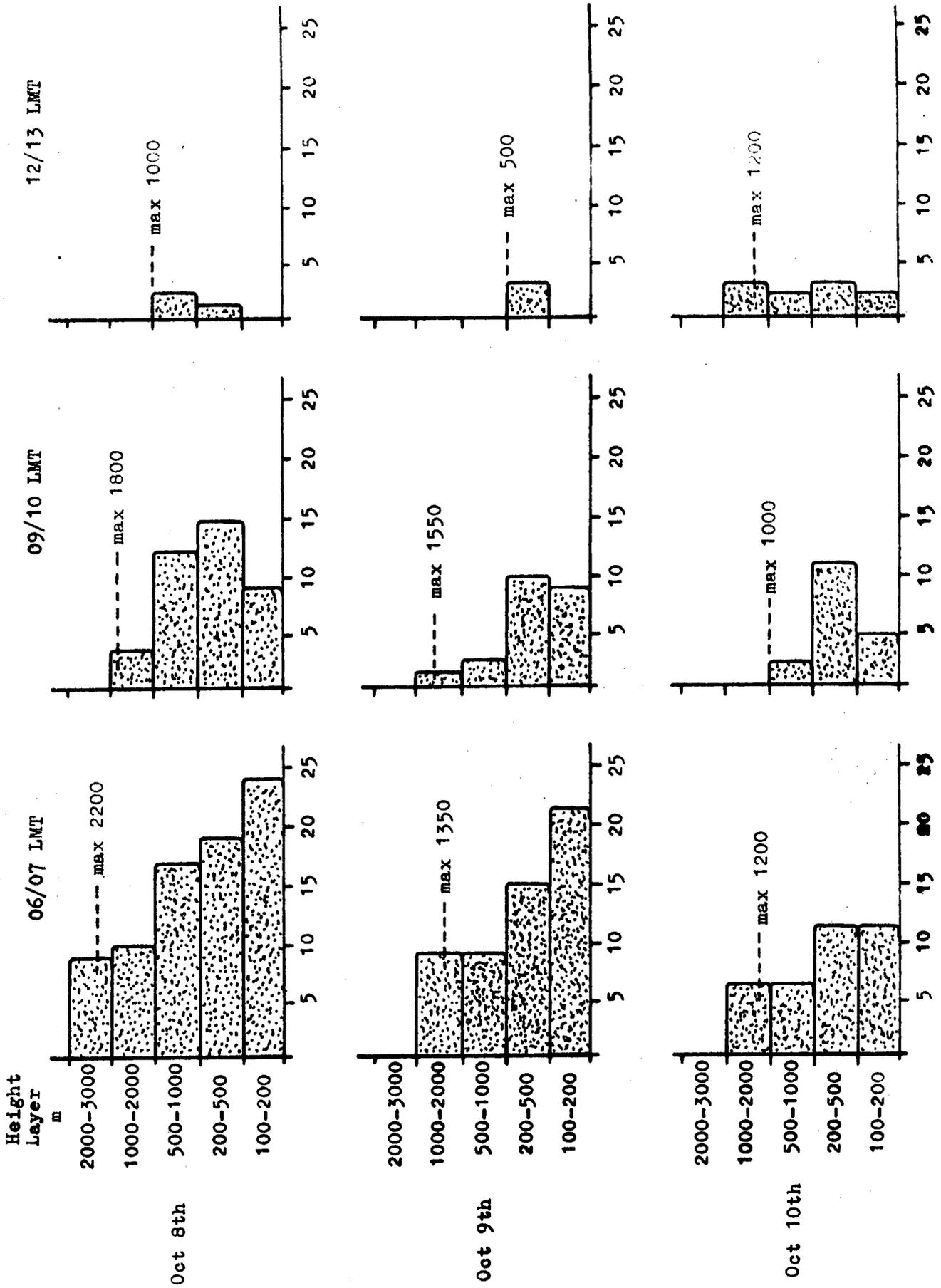
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1000-2000  
500-1000  
200-500  
100-200

Oct 1st

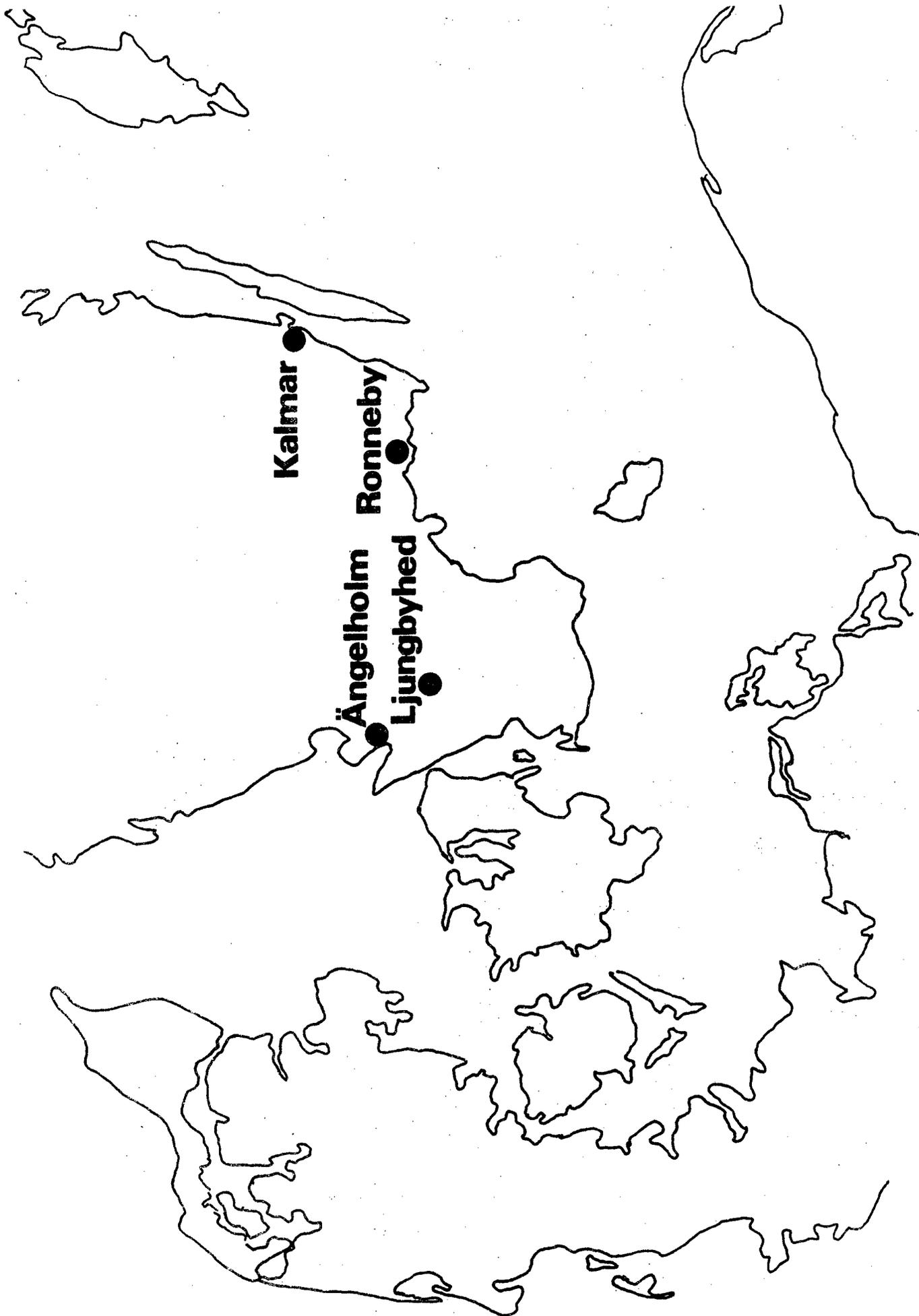


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Number of echoes per 100 m and 25 km<sup>2</sup>



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Kalmar

Ronneby

Ängelholm

Ljungbyhed

051

ADF 616 173

BIRD STRIKE COMMITTEE EUROPE

LONDON, 24-28 May 1976

Ref: BSCE/11 WP/8

CURRENT WORK ON THE PROBLEM OF COLLISIONS BETWEEN  
BIRDS AND AIRCRAFT IN SWEDEN

T. Alerstam and J. Karlson, Sweden

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Current work on the problem of collisions between birds and aircraft in Sweden

Thomas Alerstam & Johnny Karlsson

A project group with representatives from the Air Force, the Board of Civil Aviation and the Department of Animal Ecology, University of Lund, has the mandate to carry out investigations about the problem of collisions between birds and aircraft in Sweden. This work started in 1971, and some recent results and current plans will be briefly described in this report.

The primary goal of the group is to develop a system to forecast important concentrations of migrating birds in space and time. This project involves extensive studies on the process of bird migration over wide geographical areas. Radar and field observations have been conducted in several springs and autumns in order to gather information, essential for a reliable forecast system, about the behaviour of different bird species:

a) Geographical distribution. For many bird species or categories of species the geographical migration patterns have been mapped in detail. Special studies have been devoted to the migration of eider, crane and wood-pigeon, and the migratory patterns of many passerines, both diurnal and nocturnal migrants, have also been analysed.

b) Flight altitudes. Until recently studies on the birds' flight altitudes have been carried out on a small scale only. Some results have been obtained for migrating eider and crane flocks. However, last year Mr. Bertil Larsson, a meteorologist, was adjoined to the group. He is engaged in the study of flight altitudes under different environmental conditions and will inform the BSCE-meeting of his work in a separate report.

c) The influence of weather on bird migration. Short-term variation in migratory intensity is closely related to changing weather conditions. Detailed and reliable forecasts of the risks for bird collisions have to be based on extensive statistical analyses of the association between migratory activity of different

bird species and weather. Such analyses are presently conducted for the relation between weather and (i) the intensity of low-altitude visible migration (diurnal), (ii) the intensity of high-altitude radar migration (diurnal and nocturnal) and (iii) the number of night-migrants trapped at a bird station in the early morning after the preceding night's migration. Multivariate statistical analyses (multiple regression, discriminant and factor analysis) are used.

The results obtained from the studies described above will be combined into a forecast system. Although such a system has not yet been introduced in Sweden, information about the occurrence of bird concentrations based on preliminary studies has from time to time been communicated to aviation authorities.

A brief presentation "Survey of concentrations of migrating birds during the autumn (1 July - 15 November) in South Sweden" (in Swedish) was published in the first part of 1975. This presentation contains three principal sections: (i) Maps illustrating the occurrence of certain abundant bird species in different geographical regions. (ii) Graphs showing the seasonal and diel distribution of intensive migratory activity, (iii) Warnings for high bird hazards over different areas and during different times of the season and the day. These warnings have already been heeded by the Air Force in planning the periods and areas of intensive flight training.

Recent progress in our knowledge about the bird-collision problems in Sweden and the imminent introduction of a "bird forecast system" have called for a general presentation of these topics to all different categories of personnel involved in aviation. For that purpose, a book "Birds and Aviation" (in Swedish) was published in autumn 1975, and is presently used as a tool at a number of different courses. This book contains six chapters.

1) The bird fauna of Sweden - a general presentation. The distribution and densities of different birds in different seasons and in different habitats are presented and related to factors influencing their abundance. Furthermore, a brief overview is given, for example, of population dynamics, inter- and intra-specific competition, predation, hunting and the significance of available food for population sizes.



2) The bird fauna of the airfield. The commonest bird species to be observed at Swedish airfields in different seasons are presented, and notes about their habits and choice of food are included. This chapter is illustrated with photographs of a large proportion of the birds involved and may thus serve as a guide to identification of the species.

3) Bird migration. Migratory habits of North European birds are described on the basis of results from ringing, field observations and radar studies. Relations between breeding, resting and wintering areas are surveyed and migration seasons for different species are discussed. The process of the migration flight is also touched upon, including the speed, altitude and geographical pattern. The association between migration and certain weather variables, particularly winds, as well as the orientational and navigational capabilities of migrating birds are also mentioned.

4) Collisions between birds and aircraft. Statistics about collisions in Sweden from 1967 to 1974 are presented for both civil and military air traffic. Serious accidents from international records as well as six total losses of military aircraft in Sweden due to bird collisions are discussed in some detail.

5) Actions to prevent collisions. The role of vegetation, topography, garbage dumps and different hunting techniques for bird numbers at airfields is discussed, and recommendations are issued. The efficiency of different types of scaring devices, methods of decimating bird populations and techniques of survey of the airfield is evaluated. The basic features of the future forecast system are also described.

6) Table of the Swedish bird fauna. Condensed information about geographical distribution during different seasons, choice of habitat, migration periods, population size and body weight is presented for all Swedish bird species.

The books mentioned above are at the present used in the education of air traffic leaders and other categories of people working at the airports. Furthermore, steps are currently being

taken to include the bird/aircraft-problem in the basic education of all categories of pilots, and the book "Birds and Aviation" is planned to be used as a course book.

The specific bird problems at the airports are investigated by competent biologists, resulting in working plans which, for each airport, describes what can be done to reduce the abundance of birds. Primary attention is directed towards preventive measures, such as making the environment less attractive to birds; it is especially important to minimize the production and availability of food for those bird species that are known to create the greatest problem for the aviation.

At the 10th BSCE meeting there appeared a short report on some experiment with laser beams as a scaring device. The work with this equipment will continue in the future. This summer experiments will be initiated with a machine-gun dummy (originally constructed for military purposes), to test its effect as a bird scaring device. The equipment is composed of a number of mobile "loud-speakers" (pneumatic noise generation). From a remote control unit the loud-speakers can be made to emit a noise identical with that from a machine-gun. The control unit can be placed in a traffic tower or in a car. Compared with conventional gas-cans, this equipment seems to have many advantages: the loud-speakers are easy to move and the exact time and length of their operation can be remotely controlled. These factors may considerably reduce the rate at which the birds become accustomed to the scaring device.

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BIRD STRIKE COMMITTEE EUROPE

LONDON, 8 Sept 1976

Ref: BSCE/11 WP/9

Paper issued subsequent to the Eleventh Meeting

DC-10 INCIDENT AT JOHN F KENNEDY  
INTERNATIONAL AIRPORT

J L Seubert, USA

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Bird Hazards at John F. Kennedy  
International Airport -- The Problem  
and Suggested Remedies

John L. Seubert  
U.S. Fish & Wildlife Service

INTRODUCTION

On November 12, 1975, a DC-10 was lost at John F. Kennedy International Airport because of bird strikes. The Overseas National Airways jet with 139 people on board collided with many gulls on takeoff roll when the aircraft was accelerating past 100 knots. The time was 1310, (24.14 km). the runway was wet, and visibility was 15 miles / The gull flock, estimated at about 100 birds, apparently was on the runway, and a gull (or gulls) was ingested into number 3 engine, which exploded and separated from the aircraft. Abort procedures were initiated and the aircraft was stopped near the end of the 14,572-foot runway/ (4.44-km). All 139 people aboard, ONA employees, survived the accident. The aircraft was destroyed by fire.

Our post-accident inspection revealed the remains of 13 immature herring gulls (Larus argentatus), and two immature and seven adult great black-backed gulls (Larus marinus). Feather remains recovered from the number 3 engine indicated that at least one great black-backed gull had been ingested. This species may weigh as much as 4-1/2 pounds (2.04 kg).

Subsequent to the incident and at the request of the Federal Aviation Administration, the U.S. Fish and Wildlife Service conducted an ecological study of bird hazards at JFK to provide a basis for recommendations to alleviate JFK bird hazards.<sup>1</sup> This paper briefly presents and discusses the results of our investigation which was carried out during the winter of 1975-76.

## THE PROBLEM

JFK has had serious bird problems because there are many area features that are highly attractive to birds--nearby garbage dumps that attract thousands of gulls; the close proximity of Jamaica Bay, an area that attracts thousands of birds of many species; and airport habitat that attracts and supports a variety of species.

### Gull Flocks and Garbage

We consider gulls to be the major hazard to aircraft operations at JFK because of their large size, flocking behavior, and large concentrations throughout the year in the Jamaica Bay area. These populations consist of herring gulls, great black-backed gulls, and ring-billed gulls (Larus delawarensis). Some 500,000 gulls migrate through the New York metropolitan area every fall, and up to 200,000 gulls may overwinter in the area, the largest concentration of gulls on the Atlantic Coast (personal communication, William H. Drury, Jr.; Kadlec and Drury 1968).<sup>2</sup> These large gull populations occur and thrive, to a great degree, because of the abundance of food in the form of garbage in the New York area. The bird problem at JFK is mainly a gull problem, caused principally by the close proximity of two large garbage landfills that attract thousands of gulls. The Edgemere landfill, located on the Rockaway peninsula, is about 7,000 feet southeast, and the Fountain Avenue fill is located about 17,000 feet west of the airport.

### Starlings, Roost, and Food

Starlings (Sturnus vulgaris) are of high potential hazard to aircraft. Some 10,000 starlings fly over the runways at dusk to roost in

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conifer trees in the terminal area. At dawn, the birds return to their feeding grounds, again flying over runways. At least 1,000 starlings have been observed feeding at both Edgemere and Fountain Avenue dumps. Starlings in scattered small flocks have been observed feeding in the bayberry (Myrica sp.) bushes near a runway.

#### Waterfowl, Jamaica Bay, and Pools

Greater scaups (Aythya marila), canvasbacks (Aythya valisineria), black ducks (Anas rubripes), mallards (Anas platyrhynchos), American wigeons (Anas americana), brants (Branta bernicla), and Canada geese (Branta canadensis) also are considered potential hazards to aircraft because they use airport water areas and occur mainly in the fall and winter in large concentrations adjacent to the airport. These waterfowl species feed and rest on the mudflats and the water of Jamaica Bay. Black ducks and mallards have been observed resting in the pot-hole pools located in grassy areas on the airport.

#### Shorebirds and Tidal Flats

Several species of shorebirds (Charadriidae and Scolopacidae) commonly occur on the tidal flats adjacent to the airport during the spring and fall migration periods. At high tide, many of these birds fly to the grassy strips alongside the taxiways and runways.

#### Other Birds and Airport Habitat

Small passerine birds, such as snow buntings (Plectrophenax nivalis), and Lapland longspurs (Calcarius lapponicus) winter at the airport. These open-country species feed and rest in the sandy and short-grass areas of the airport. Large flocks of mourning doves (Zenaida macroura) occasionally fly low over runways to feeding grounds in grassy areas.

Ring-necked pheasants (Phasianus colchicus) inhabit the heavy brush and grassy areas on the airport. Occasionally, a pheasant will fly low over the runways and taxiways.

Pigeons (Columba livia) feed on the airport, and many of them roost in hangars. Incidental to aircraft hazard, pigeon droppings deface and accelerate deterioration of aircraft, buildings, and equipment.

Sparrow hawks (Falco sparverius), marsh hawks (Circus cyaneus), rough-legged hawks (Buteo lagopus), snowy owls (Nyctea scandiaca), and short-eared owls (Asio flammeus) occur on the airport. These raptors generally hunt in the vicinity of runways, crossing them on occasion, particularly early in the morning and late in the afternoon. These birds prey on rodents, rabbits, and small birds. Some hawks may even nest on the airport.

#### Bird Attractants

Birds occur on airports for food, water, shelter, safety, nesting, loafing, and roosting, and for resting during migration. There are many attractants to birds at JFK.

Vegetation.--Most of the vegetation on the airport is composed of beach grass (Ammophila sp.), beard grass (Andropogon sp.), and forbs, which are maintained in a lawn-like condition. Dense growths of common reedgrass (Phragmites communis) make up about one-fifth of the tall vegetation; these robust plants grow to a height of several feet, primarily in low moist spots. Goldenrods (Solidago sp.), sunflowers (Helianthus sp.), and other composites are found mixed with the tall grasses. Scattered bayberry bushes also are present. A few scattered trees and shrubs, primarily black locust (Robinia pseudoacacia), and cherries (Prunus sp.) occur at

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the northwest portion of the airport. Starlings, blackbirds, mourning doves, and other species use airport vegetation for feeding, nesting, and roosting.

Hundreds of exotic Austrian pine (Pinus nigra) trees have been planted for decorative purposes in the Chapel Pool - passenger terminal area. Starlings use these pines as roosting sites.

Water.--Water in rain puddles, drainage ditches, streams, pools, and ponds attracts birds for bathing, drinking, or loafing. Also, water areas are apt to provide a variety of bird foods, such as pondweeds, small fish, tadpoles, frogs, insect larvae, and other invertebrates. Small bodies of water also provide drinking places for mammals.

A 2-acre Chapel Pool is the only man-made impoundment at the airport. It is highly attractive to gulls. Immediately following rainfall, many temporary pools of water form on the automobile parking lots adjacent to Chapel Pool, in depressions of taxiways, along runways, and on roofs of certain airline terminal buildings. Many ponds and nearby marshy areas also are located in grassy areas at the eastern end of the airport between runways. These marshy areas are highly attractive to birds and mammals; one area contains a muskrat (Ondatra zibethica) house.

Storm sewer outlets.--Storm sewer outlets occur around the periphery of the airport. They attract numerous gulls, shorebirds, starlings, and waterfowl.

Tidal flats.--The south, southeast, and southwest edges of JFK airport border Jamaica Bay. The beach and nearby mudflats attract many gulls and shorebirds, particularly at low tide. When the mudflats are

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covered at high tide, many gulls rest on promontories such as a sand spit located directly east of the approach pier of a runway, the pier itself, and the approach pier to an abandoned runway. Gulls fly over critical airport airspace (e.g., runways, approaches), and congregate on the airport.

Buildings.--Several facility buildings, hangars, and equipment sheds provide nesting, resting, and roosting sites for pigeons, starlings, and house sparrows (Passer domesticus).

Mammals.--Field mice (Microtus sp.), Norway rats (Rattus norvegicus), rabbits (Sylvilagus sp.), and black-tailed jack rabbits (Lepus californicus) occur on the airport. These mammals are food sources for avian predators and feral dogs that occur on the airport. Carcasses of mammals also attract gulls.

Waste paper, garbage, and food scraps.--During the time of this study, waste paper and garbage were strewn on the airport. In some instances, employees of airlines had thrown garbage on hardstand areas. Employees were observed feeding food scraps to gulls and other birds at the airport. Waste paper, garbage, and food scraps attract birds.

#### RECOMMENDATIONS

The most effective method of discouraging birds from frequenting JFK airport and vicinity is to make the airport as unattractive to birds as possible, using bird patrols, modifying airport habitats, and changing land-use in the airport area. Thus, the following recommendations are made:

1. Maintain an aggressive and vigilant shotgun patrol, using two or

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more vehicles and operating 7 days a week from dawn to dusk 365 days per year to repel gulls and other birds from the airport.

2. Communicate with the City of New York concerning the severe problem created by the Edgemere and Fountain Avenue landfills that are food sources for birds that are hazards to aviation safety. Make every effort to influence the City of New York to: (a) close nearby garbage landfills or operate them so they will not be primary gull food sources; (b) prohibit the development of proposed landfills near the airport; and (c) pursue modern methods of solid-waste disposal (e.g., the resource recovery systems presently in use at Saugus, Massachusetts).

3. Drain the Chapel Pool and develop alternative landscaping that will be unattractive to birds.

4. Drain and fill all ponds and marshy areas on the airport, and fill all depressions on the parking lots.

5. Remove two out of every three pine trees on the airport, particularly in the Chapel Pool - passenger terminal area.

6. Remove all bayberry bushes, stands of Phragmites, scattered trees, and other vegetation used for feeding, roosting, and nesting.

7. Evaluate, with the assistance of expert consultants, plant species that would be suitable for use on the soil types found on JFK. These should be species that are unattractive to birds, mammals, and insects, and that present no undue fire hazard.

8. Institute and enforce regulations to ban the feeding of birds on the airport.

9. Institute and enforce regulations and/or housekeeping measures that will eliminate litter and garbage on the airport.

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10. Trap or shoot all pigeons, ring-necked pheasants, cottontail rabbits, black-tailed jack rabbits, muskrats, and free-running dogs on the airport. (Consult local and State laws for permission to remove these animals.)

11. Trap or poison small rodents.

12. Remove the old pier extending into Jamaica Bay.

13. Extend drainage outlets farther into Jamaica Bay by several hundred yards.

14. Arrange for the routine and immediate removal of all animal carcasses found on the airport.

15. Modify hangars and other airport buildings to eliminate ponding of water on roofs, and to discourage nesting and roosting of pigeons, house sparrows, starlings, and other birds.

16. Consult with ornithologists/ecologists about ways of lessening the attractiveness of the airport/Jamaica Bay beach to gulls and shorebirds.

17. Hire a full-time wildlife biologist/ornithologist to develop, implement, and direct all bird-management programs and activities at JFK.

18. Maintain accurate and complete records of: (a) bird/plane strikes; (b) activities of shotgun patrols; (c) unusual bird movements and habits; and (d) related bird observations.

19. Provide routine training to bird patrols and all other personnel involved with the bird problem at JFK.

20. Develop an Airport Bird Management Plan for JFK, documenting actions to be taken and target dates when appropriate.

Reducing bird hazards at JFK, as well as at other airports with

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similar problems, takes motivation, money, and time. JFK has instituted habitat alteration and bird patrols that, hopefully, will reduce bird hazards. The situation, however, will require constant vigilance and persistence.

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LONDON, 24-28 May 1976  
Ref.: BSCE/11 WP 10  
W.G. : RADAR

EXPERIMENT OF PRESENTATION OF ACTUAL BIRD INTENSITY  
IN A "0 TO 8" SCALE ON A DISPLAY UNIT

By Cdt T Jacobs  
Belgian Air Force

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EXPERIMENT OF PRESENTATION OF ACTUAL BIRD INTENSITYIN A "0 TO 8" SCALE ON A DISPLAY UNIT

BY CDT JACOBS T.  
Belgian Air Force

Since the bird strike problem "en route" differs completely as far as the military and civil aviation are concerned, and as the Belgian civil aviation shows no real interest for the problem I will limit this lecture to the one main item and/or problem :

" Bird strikes in military aviation "

For the last ten years now, and this since the start of the "Radar Working Group" in 1966, the Belgian Air Force Staff has insisted performing maximum effort to limit the bird strikes to a strict minimum.

After the example of the Royal Netherlands Air Force a Belgian observation system was build up at the radar site Semmerzake. By means of polaroid pictures intensity of bird migration was estimated and migration warnings were reported not only to the Belgian units but also to foreign countries.

An operational instruction was issued and distributed, explaining the complete warning system and responsibilities, including all measures and/or actions as far as flying restrictions were concerned.

Meanwhile ornithologists and scientific specialists finished a research programme.

In 1975 a national bird strike committee was founded. The organisation, control and guard against bird strikes was handed over to the Meteorological Wing of the Belgian Air Force. Furthermore the Radar site at Semmerzake is now (partly) an automatic site and the Military Traffic Coördination Centre (Belga Radar) is equipped with a STANSAAB (Swedish) computer.

Before the automatization of this MTCC, the estimation of the bird intensity was done by the duty chief controller. He was to rely on the polaroid pictures and, of course, on his own experience interpreting these pictures.

Sometimes the interpretation was under- or overestimated which resulted in either :

- ignorance of the strike risks by the pilots (this in case of an underestimation)
- or in unnecessary aircraft groundings (in case of an overestimation)

Tests proved that the video extractor is able to handle bird echoes and therefore a program was written out to enable electronic counting of bird echoes. During the tenth Meeting in Stockholm 1975 Lt Soetens explained the experimental bird counting with a real time computer (see working paper /12). Any committee member who is interested in the technical details and/or lay out of the programme may write to the following address :

BELGIAN AIR FORCE  
SEROS  
Molenstraat 7  
B-9740 GAVERE  
BELGIUM

Of course visitors are welcome on rendez-vous.

#### CALIBRATION

During the last two migration seasons, counting was done electronically. Obtained figures were then compared with the polaroid pictures taken at the same time on a raw video screen. Results of electronic counting were more than satisfactory and after comparing them with the polaroid pictures, fixed intensity rates were inserted into the programme. Thereby the intensity (0 to 8) is now automatically printed out on the electronic display device.

Counting was done in a predetermined sector 20° in azimuth and 10 NM in range. This automatically displayed sector can be put anywhere on the scope providing an indication symbol is put (by means of a rolling ball) in the centre of the sector in which we want to do the counting of the bird echoes.

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## OPERATING PROCEDURES

As soon as a suspected bird echo is observed on the screen by the controllers following procedures are applicable :

1. Start the automatic tracking for one echo (for information there are no speed limits in the programme). If reasonable speed and heading is obtained the controller may be sure, he is dealing with a bird echo.
  2. Select the highest density area.  
As said before, the sector will be displayed on the scope by bringing the indication symbol in the centre of this high density area.
  3. Read out the bird intensity (in 0 to 8 scale).  
After a maximum time of 25 seconds the result is displayed on the screen. The bird intensity can be acquired on each of the 14 control points in the MTCC.
  4. The actual bird intensity is broadcast to all Belgian military airfields specifying intensity per zone.
- Remark : The Belgian territory is divided into two zones :
- The coastal zone : over the sea and along the coast 10 NM inland.
  - Over land : south - east of this line.
5. Flying restrictions become effective depending the bird intensity.
  6. All military traffic on low level over Belgium is informed about the intensity via a broadcast on the flight information frequency (307.7 Mcs.). Pilots can then start all necessary security measures immediately (e.g. visor down, speed reducing, etc.).
  7. In case of intensity "5" or higher all low level traffic is postponed or derouted, depending the zone of high bird intensity.
  8. When reaching intensity "5" a "BIRDTAM" is transmitted to all member nations of the committee.

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## DISPLAY OF BIRD INTENSITY IN THE FLYING UNITS

At this moment the Belgian Air Force is developing an automatic transmission system, allowing the Meteorological Wing to update the wing operation notes. Bird migration warning will complete Met Info.

### CONCLUSION

1. As a reminder, this lecture is only dealing with a procedure to avoid birdstrikes of military aircraft "en route".
2. Our system for automatic echo counting, defining and displaying of bird intensity with the help of a computer is not a technical miracle, but at least, all possible human errors in estimating the intensity are now eliminated.
3. This system is much faster than the polaroid picture taking : from 15 minutes down to 25 seconds.
4. The handling is easy for the controllers.
5. No additional hardware or cost is required.

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BIRD STRIKE COMMITTEE EUROPE

LONDON, 24-28 May 1976

Ref: BSCE/11 WP 11

STARTLING OF BIRDS BY LIGHT, EXPERIMENTAL DEVICES,  
CURRENT RESEARCH

M Laty, France

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## STARTLING OF BIRDS BY LIGHT: EXPERIMENTAL MEASURES; CURRENT RESEARCH

M LATY S.T.NA. PARIS

In conjunction with, and under the instructions of, the "Service Technique de la Navigation Aérienne", the main airport of Marseille - Marignane has established a Research Laboratory which has for several years been carrying out studies on appropriate methods of scaring birds from the airports and keeping them away from the paths of aircraft.

This report states the progress which has been made in current studies and describes two installations. One is designed solely for the protection of airports. The other could fulfil two functions: self-protection of aircraft in flight and the safety of airports. In both cases we attempted to cause the birds to fly off as a result of light sensations.

Before describing the two installations used in the experiments, let us recall some aspects of the anatomy of the eye and of the physiology of vision in birds.

Visually, colours are seen as a result of action by radiation in solar light on the retina. Each colour is distinguished only when a specific intensity of light is obtained: the visual perception of light precedes that of colour.

Birds possess a retina combining both cone-shaped and rod-shaped visual cells.

The rod-shaped cells contain the visual purple; the conic cells enclose at their peak a pattern of oily droplets, whose predominant colours, red, orange and yellow, seem to signify filtration by absorption of short-wave radiation before light penetrates the cones.

The proportion of these types of cells in the retina varies according to the species of bird. Generally, diurnal birds possess a cone-type retina whereas the rod-type retina is usually more prevalent in nocturnal species.

The discolouring capacity of the various radiations in the spectrum with respect to purple differs according to the length of the wave and decreases from red radiations which discolour slowly and poorly to blue-violet radiations which discolour rapidly and completely. The sensitivity of the retina to light seems to be precisely a function of the discolouring chemical action of the various radiations in relation to purple: the more a radiation discolours purple the greater the effect on the retina.

Research has shown that the retina of a bird acts not only as a receiver but also as a centre which can carry out complicated processes of analysis of sensorial messages. The optical nerve seems to be a means of inter-central association and not simply a means of transmitting the single nerve influx.

The presence of transversal as well as longitudinal organisation has been found in the retina of birds. If the activity of the nerve cells which make up the retina is recorded in a pigeon, it can be seen that they do not all have the same properties but that six different groups are present.

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The first group acts as a "vertical detector". These cells are sensitive to the vertical limits present in their field of vision. The cell responds to the image which it forms on the retina if the object has a vertical component. These cells are not stimulated by changes in light or by small objects.

The second group of cells functions as a "horizontal detector". These cells respond if an object with a horizontal component lies in their field of vision but they do not react to small objects or to diffused light.

The cells in the third group are "form detectors". They are brought into play by the edge of the object no matter what its shape.

The fourth group of cells are "detectors of direction of movement". They give a maximum response if the edge of an object moves in a determined direction in the receiving field.

The fifth group comprises cells which react if a convex object moves in the receiving field. These cells are "detectors of convex forms".

The sixth group of cells are "light detectors". Their activity is continuous and proportional to the intensity of the light. These cells are active in the perception of colours.

The cells in the first five groups only respond to contrasts of light in their visual fields according to horizontal, vertical or convex limits. These cells do not respond to uniform light in the whole of the field.

The ganglion cells of a bird's retina transform this quantitative information to qualitative information by means of the optical nerve to the visual areas of the encephalus. Thus they have an analysing role and transmit an interpretation of the image and not the image itself to the cortex.

#### METHODS CURRENTLY UNDER EXPERIMENTATION

At first we tried to assess the reaction of the birds when near flashing lights which were similar to or more powerful than those used on aircraft.

For this purpose we used a 65cm diameter parabolic reflector at whose focal point we placed 2 xenon stroboscopic flash tubes. These provided a flash of 30,000 watts each in  $\frac{1}{20000}$  of a second. The light is white, but each of these lamps can be covered by a coloured filter. Each flash light is controlled by an independent mechanism which varies the flicker speed. A multivibrator regulates the speed of passing from one tube to the other.

After numerous tests had been carried out on the ground on a household refuse tip and at Marignane airport by the Etang de Berre, we noted that the birds flew off only at a distance not exceeding 40 metres when the colour blue was used. Red and white seemed much less effective. The frequency of the flashes had not to be more than 100 cycles per second.

The birds which flew off in this way were herring gulls and jackdaws. It is possible that other species of bird may have reacted differently.

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Following on this first experiment we worked on producing a piece of equipment capable of generating a high degree of light energy which would reach birds at a distance of about 1 kilometre over a field of several dozen metres to either side. To this purpose we used a "barrel" type parabolic reflector which gave out a beam approaching the form of a square cosecant.

The pinpoint source of light impulses consists of 2 tungsten electrodes, open to the air, which are placed around an auxiliary electrode designed to ionise the inter-electrode area.

To control the moment of discharge, the electrodes are placed at a distance from one another in such a way that the disruptive voltage is greater than the load voltage of the condensers; the spark will occur when a sudden and very high over-voltage is applied to the auxiliary electrode.

The very short and intense flash of light given out by the sudden release of energy is accompanied by sound waves and infra-sonic and ultra-sonic waves as a result of the abrupt expansion of the air surrounding the spark. This acoustic radiation can greatly affect the behaviour of the birds; its effect should probably be added to that of the light beam. By rendering sensitive the 2 main distance perception faculties of the bird, this method could make it possible to act simultaneously on the pschovisual part of the brain via the visual area, the thalamus and the optical nerve, and on the psycho-auditive sector; the birds can be induced to fly away by a combined action on the motor projection areas.

After about 100 tests it became evident that the equipment described above caused birds to fly off from the ground up to a distance of 800 metres using 300 Joules energy in 3 microseconds. The total power radiated in the ultra-violet and in the visible range was about 2MW.

We are now experimenting with independent testing of the effects of deflagration and of light.

If this equipment proves effective, it could automatically ensure protection against birds in certain active areas of airports.

In order to ensure the self-protection of an aircraft in flight, the speed of the aircraft must be borne in mind. One possible solution would be to give the bird sufficient advance warning; that is at a great enough distance ahead, so that it has time to get out of the path of the aircraft before it strikes him. For this to happen, the bird must treat the signal sent out by the plane as a forerunner of the "aircraft danger" and the signal must induce the bird to react accordingly and fly away from the impending dangerous object. This is, in a way, what happened with the piston-engine planes the noise of whose engines greatly preceded the aircraft itself. The perception distance of this aural signal gave the bird enough time to locate the danger visually and to prepare to take the appropriate avoiding action. Many collisions must have been avoided in this way thanks to the fact that the birds took avoiding action.

The speed of modern aircraft makes it difficult to use a sonic signal in flight to warn birds of the approaching danger. However, a means of generating a light beam before the aircraft could cause the bird to adopt evasion tactics similar to those used before with slow noisy planes.

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We have construed such a piece of equipment experimentally and are testing it in real conditions.

A laser beam is projected on to a mobile plane mirror oscillating around its axis in the vertical plane. The reflected beam sweeps vertically 1000 times per second a line 100 metres long at a distance of 1 kilometre from the laser. This vertical sweep is taken up by a second mobile plane mirror in the horizontal plane. A sinusoid is obtained which, if observed from a distance of 1 km from the laser/mirror assembly, registers in a square 100m x 100m. The sinusoid, which is composed of the vertical and horizontal sweep, crosses a semi-reflecting mirror. Some of the energy is deflected to a plane mirror arranged in such a way that the reflected beam interrupts at each laser impulse the part of the beam that has crossed the semi-reflecting mirror.

The distance at which the interference occurs is a function of the angle of the semi-reflecting mirror and of the plane mirror.

This "cine-interferometer" device could, if placed in the nose of the aircraft, materialise over an area of about a hectare, with a luminous figure in the form of a sinusoid made up from points of light moving at the speed of the aircraft and preceding it.

The production of visible interferences could have two effects on the bird:

Firstly. When they are far from the plane, by acting on the five groups of retina cells which direct influxes registered by the horizontal, vertical, form, direction, movement and displacement detectors towards the intercentral association channels;

Secondly. When they are in the area of the pyramid caused by the sweep, birds would receive the laser beam. The retinal cells of the sixth group, the light detectors, would then be made sensitive.

Given that most birds have a monocular and a binocular field of vision the sum of whose sectors is near to  $360^{\circ}$  it is possible that the figures produced by interferometry could be seen and analysed from all directions. The aircraft would then efficiently notify the birds of its presence long before its appearance.

At our present stage of developments only experiments in the field will allow us to note the reaction of different species of birds on seeing such a mobile luminous figure in space.

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BIRD STRIKE COMMITTEE EUROPE

LONDON, 24-28 May 1976

Ref: BSCE/11 WP/12

BIRDSTRIKES, GERMAN AIR FORCE 1974-1975

Dr J. Hild, W Germany

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Birdstrikes German Air Force 1974/1975. By Dr. J. Hild, GAF

On the picture you see the development of birdstrikes in GAF during 1974/1975. The absolute number of strikes didn't increase or decrease but the relative number related to 10000 flying hours decreased from 5.3 (1974) to 5.0 (1975) for total number of birdstrikes and from 3.8 (1974) to 3.0 (1975) for the number of inflight birdstrikes.

As to the months, we have partly conspicuous differences between 1974 and 1975 depending on weather situation which influences bird movements. For instance, the mild winter weather in January/February 1975 favoured bird migration, cold weather in springtime (April) 1974 hindered bird movements whereas in April 1975 bird migration was in motion. In August the influence of dryness or moisture and therefore the food for birds is important for movements; in August 1975 we had a moist time and 1974 we had dry periods so that bird migration began in late summer. The same tendency is to observe for September.

The most conspicuous difference in total and inflight number of birdstrikes is to see in March. In this month (1975) we tried a new method for evaluation of bird movement information and publishing birdtam. This method consisted in the fact that we had, round the clock, 2 fully briefed biologists who followed bird movements on maps and analyzed weather reports. So it was possible to publish more detailed birdtam for special areas, to give special amendments and analysis of bird movement tendencies.

As to the birdstrikes on airfields we have a small increasing in absolute numbers but a nearly same number related to number of movements; only 10-15% of strikes induced damages as small birds have been involved. So it seems we succeeded in changing the ecological conditions on airfields.

At the round airfield birdstrikes we had a positive development especially caused by removal of garbage dumps and changing agricultural use in the surrounding of the airfields.

During flight - low level - we found the a.m. positive development in the relative rate 3.8 (1974) to 3.0 (1975).

Very informative is the development of birdstrikes related to damages; since 1970 the values of birdstrikes without damages are increasing, we believe this tendency can be declared by the fact we catch a large part of tall bird's movement by radar and publish birdtam but are not able to observe small bird's movement and single birds in low altitudes. In 1974/1975 there didn't happen accidents caused by a birdstrike, but also informative and interesting will be the fact that in 1974 engines were touched by birds at 37 incidents and in 1975 only in 9 cases.

As to the aircraft-types we observed 1975 a slowly increasing number of birdstrikes for the F 104 and F 4 as well as for helicopter (especially CH 53) but decreasing numbers for all other types.

As to the bird species gulls caused the most strikes followed by small birds, buzzards, starlings, crows and lapwings.



	Take Off/Landing	Round Airfield	Inflight	With Damage	Without Damage	Total
JANUARY	1974 1975	2 3	2 4	2 5	3 4	5 9
FEBRUARY	1974 1975	1 4	3 9	2 5	3 9	5 14
MARCH	1974 1975	4 3	19 6	13 4	11 5	24 9
APRIL	1974 1975	7 8	8 21	9 17	6 16	15 33
MAY	1974 1975	1 5	17 4	14 5	7 7	21 12
JUNE	1974 1975	2 5	12 11	11 8	4 12	15 20
JULY	1974 1975	6 7	11 16	11 10	11 16	22 26
AUGUST	1974 1975	6 6	21 11	9 5	27 18	36 23
SEPTEMBER	1974 1975	7 1	18 12	13 6	15 10	28 16
OCTOBER	1974 1975	4 4	20 33	15 13	18 29	33 42
NOVEMBER	1974 1975	2 3	3 4	6 4	5 3	11 7
DECEMBER	1974 1975	0 1	0 3	0 3	1 1	1 4
TOTAL	1974 1975	32 = 14.8% 36 = 16.7%	134 = 62.5% 134 = 62.3%	105 = 48.6% 85 = 39.5%	111 = 51.4% 130 = 60.5%	216 215

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AD F 614 178

BIRD STRIKE COMMITTEE EUROPE

LONDON, 24-28 May 1976

Ref: BSCE/11-WP13

GROWTH PROHIBITING SUBSTANCES AND EFFECTS ON  
GRASSLAND AREAS

Dr. J.Hild, W Germany

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Growth prohibiting substances and effects on grassland areas

By Dr. J. Hild, GAF

At first we have to make the following assumption which can be proved:

- long grass areas are not so rich in birds as short grass areas -
- the grassland must be mowed once the year in order to hold those areas in a healthy form -
- Flight Safety demands grass should be not too long and dry because of burning danger -

We had to develop a method to reach the aims demanded:

- reducing birds and mowing as well as avoiding burning danger -

In special experiments we tested out various growth prohibiting substances in different mixtures on areas of 2.5 x 10 m (picture 1) and under different soil conditions:

- Field I : dry, sandy with a high part of short growing grass species -
- Field II: wet, with vegetable mould and with a high part of long growing grass-species -
- Field III: moist, with vegetable mould and a high part of long growing grass-species.

The measuring program was the following: first measurement of leaf-lengths before spraying out substances in may, second measurement in july and than every 14 days.

The results you can take from pictures 2,3,4. The thin line shows the values from control areas, the thick line the values from testing areas. You can see a remarkable effect on all areas but this effect is better on short growing grass than on long growing species; the effect is better the dryer the ground is.

This type of experiments is going on in various airfields with the aim to test out these substances also in mixtures with various herbicides under special climatological, vegetational and soil conditions in various areas of Germany and with different concentrations.

Using such substances requires special ecological research before. By this method it will be possible to reach optimal grass-lengths during

vegetation period and to mow once the year in autumn or springtime; but depending on soil and grass -species you have to renounce spraying in order to reach a vegetative recovery of the short growing grass - species.

BIRD STRIKE COMMITTEE EUROPE

LONDON, 24-28 May 1976

Ref: BSCE/11-WP14

A NEW PROBLEM ON SCARING BIRDS ON AIRFIELDS INDUCED BY  
PLANTING TREES AND SHRUBS

Dr. J.Hild, W Germany

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A new problem on scaring birds on airfields induced by planting trees and shrubbs. By Dr.J.Hild, GAF

By directives of the German Ministry of Defence it is not allowed to have fruit bearing trees and shrubbs on airfields; an other order demands planting of trees for protection against noise, air pollution and sight. These two directives seem to stay in contradiction but the reality is that these two demands are completely compatible.

Being based on the assumption that airfields and airports were built into a more or less natural landscape with corresponding bird species we have to realize that the natural form of landscape in most parts of Germany was the wood or shrubb. By cutting down the woods as done at construction of airfields/airports the typical wood birds - mostly small birds-removed, too. Instead of woods and shrubbs large grassland areas were built up, mostly grassland with extensive agricultural use. So the corresponding birds followed : crows, lapwings, pigeons, starlings, hawks. The consequence was : birdstrike problem !

In case we are successful in changing structure of landscape on airfields, that means replacing grassland- and agricultural areas on airfields/airports by woods/shrubbs the birds should change, too, the birdstrike risk could be reduced and the nature could be favoured in its natural development. But there is a very important biological or ecological point which is to consider in order to avoid the contrary. Afforesting of woods on airfields/airports displaces balance of bird species quantitative and qualitative by the changed food conditions and nesting possibilities. By corresponding investigations we know that large and close woods have nearly the tenfold of bird species than grassland areas, but mostly small birds. Afforesting of trees and shrubbs on airfields/airports therefore should avoid large and close areas and should be based on special ecological research. The grassland areas should be planted, so far as possible, very dense with medium size trees and that in an uniform manner avoiding fruit bearing trees and areas which are too large. Between these woody areas should be planted shrubbs consisting on strong, hard and/or thorny species. As example I can give you information about such provisions on Cologne Airport. By more years observation we know that the different types of vegetation now show the following bird densities:

Moist or wet grassland areas:		high
Dry grassland areas	:	light
Old woods	:	high
Young woods, shrubbs	:	light
Water areas	:	high

Regarding number of birds, weight of bird, frequency of appearance and behavior of birds we found the following birdstrike-risk-numerals:

Old wood with pinus and betula	:	3.01
Moist grassland	:	2.41
Swamps	:	2.18
Shrubbs(genista, Erica)	:	2.00 - 1.64
Young wood(picea abies)	:	1.41
Moist, young wood with betula	:	1.29

Regarding the bird species and adding all numerals of all vegetation-types we found the following risk-numerals:

Hawks	:	3.83
Pigeons	:	3.58
Crows	:	3.50
Thrushes	:	3.33
Falcons	:	3.08
Starlings	:	3.08
Lapwings	:	1.25
Small birds	:	1.00 - 1.83

(highest numeral = 7, can only be reached by one bird species in one special type of vegetation). All values for airport Cologne.

AD F 616 180

**BIRD STRIKE COMMITTEE EUROPE**

LONDON, 1976

Ref: BSCE/11-WP15

**BIRD DENSITY AND THE BIRDSTRIKE RISK**

Dr F R Hunt, Canada

This Paper has not been received  
at time of going to press.

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BIRD STRIKE COMMITTEE EUROPE

LONDON, 25 May 1976

Ref: BSCE/11-WP16

TECHNIQUES OF RADAR SIGNAL ANALYSIS RELEVANT TO  
BIRD IDENTIFICATION

This paper has been withdrawn.

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FT

AD F 616 181

BIRD STRIKE COMMITTEE EUROPE

LONDON, 24-28 May 1976

Ref: BSCE/11-WP17

W.G. BIRD-MOVEMENT

LOW LEVEL FLIGHT BIRD STRIKE RISK MAP FOR BELGIUM

By

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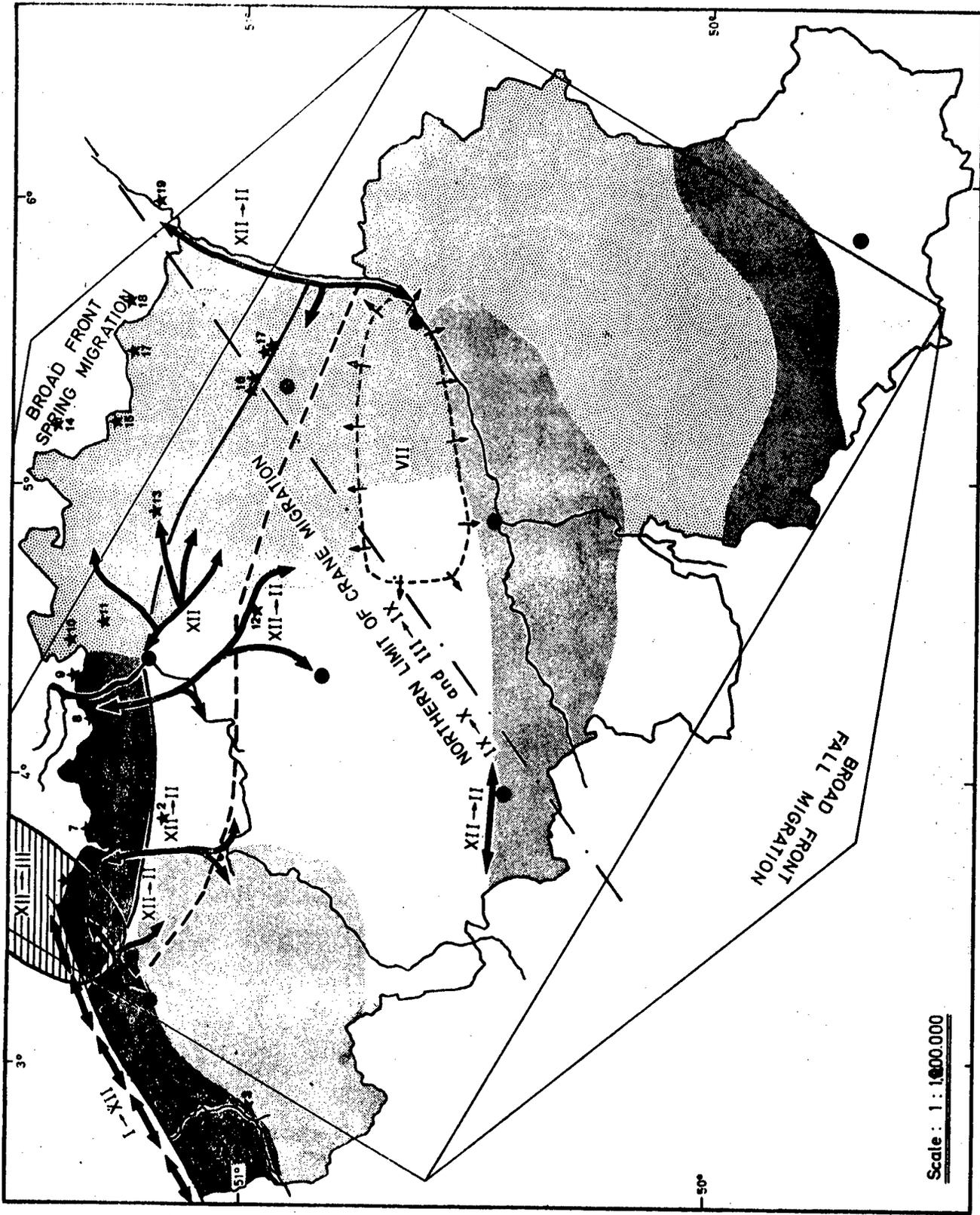
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## LLF BIRD-STRIKE RISK MAP FOR BELGIUM

\* \* \* \* \*

1. This new Belgian Low Level Flight bird-strike risk map contains the main concentrations and movements of birds over Belgium which are considered to be hazardous to aircraft.  
The map is completed with indications giving details on flight level, time and period. A separate list deals with those areas with a high risk (red spots).
2. The map has been drawn up by the Belgian Bird Strike Committee at the request of the Belgian Air Force.  
It has been distributed to all elements of the command and control structure in the BAF and to all the flying units.
3. Special care was taken to meet the requirements of the activities of the BSCE Bird-Movement Working Group, so that this map can easily be integrated into a European bird hazard map.  
Therefore mean bird-density areas and red spots have been defined.
4. The map is based on scientific research but has been simplified and adapted to operational purposes. This has been done in collaboration with ornithologists and aircrew.

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**MAIN BIRD CONCENTRATIONS AND MOVEMENTS**

**LEGEND**

This map includes known concentrations and movements of birds considered to be hazardous to aircraft.

**MEAN BIRD DENSITY**



↑ ↓ Gull and water coastal movements (all year round) flight below 2000 ft will involve a risk.

↔ Loading line of daily gull movements (Dec-Feb) flight below 500 ft in the morning (sunrise - 10 Hr) and in the evening (16 Hr - sunset) will involve a risk.

★ 3 Flights below 1500 ft will involve a risk (see listing).

— Southern limit of gull breeding range (April - June).

--- Southern limit of gull feeding-flights (April - June).

Concentration of starlings during the day.

The arrows indicate the direction of group movements mainly after 17 Hr.

Flights below 500 ft in July may involve a high risk (17 Hr - sunset).

- The following is of general importance :
  - LLF over colonies of Black-headed gull involve a very high risk, especially from April to June
  - LLF along coast always involve a high risk.
  - LLF during Sept. and Oct. involve a higher risk than usual.

Northern limit of Crane migration (Sept - Oct and March - April : 8000 ft).

Flights below 1500 ft, particularly in the morning and evening, will involve a risk (December - March).

Broad front migration, particularly important in March and October. Flights below 2000 ft (day) and 3000 ft (night) will involve a risk above the whole country in periods of high migration density.

I XII Months of the year.

**LOCAL AREAS WITH HIGH RISK FOR LLF BELOW 1500 FT (RED SPOTS)**

NUMBER	GEOGRAPHICAL COORDINATES L.N. L.E.	RISK PERIOD	BIRD SPECIES	AREA SPECIFICATION	ESTIMATED NUMBER OF BIRDS
1.	51°13'45" 02°56'15"	NOV - FEB	GULLS	ROOSTING AREA	30,000
2.	51°10'00" 02°50'00"	APR - JUL	HERONS	BREEDING COLONY	240
3.	50°58'25" 02°51'45"	ALL YEAR		BIRD CONSERVATION AREA	
4.	51°21'15" 03°20'00"	ALL YEAR		BIRD CONSERVATION AREA	
5.	51°15'00" 03°19'00"	NOV - FEB	GEESE	WINTERING AREA	10,000
6.	51°24'00" 03°37'00"	NOV - FEB	GULLS	ROOSTING AREA	50,000
7.	51°21'00" 03°46'00"	NOV - FEB	GULLS	ROOSTING AREA	30,000
8.	51°20'30" 04°10'00"	APR - JUN	GULLS	BREEDING COLONY	2,000 - 10,000
9.	51°23'00" 04°19'00"	NOV - FEB	GULLS	ROOSTING AREA	30,000
10.	51°23'50" 04°25'55"	NOV - FEB	GULLS	ROOSTING AREA	2,000 - 10,000
11.	51°19'00" 04°29'00"	APR - JUN	GULLS	BREEDING COLONY	30,000
12.	50°59'20" 04°31'00"	NOV - FEB	GULLS	ROOSTING AREA	2,000 - 10,000
13.	51°12'05" 04°52'45"	APR - JUN	GULLS	BREEDING COLONY	2,000 - 10,000
14.	51°26'00" 05°10'00"	APR - JUN	GULLS	BREEDING COLONY	10,000
15.	51°17'10" 05°09'35"	NOV - FEB	DUCKS	WINTERING AREA	3,000
16.	50°59'55" 05°16'30"	NOV - FEB	GULLS	BREEDING COLONY	45,000
17.	50°59'20" 05°19'45"	APR - JUN	GULLS	BREEDING COLONY	2,000 - 10,000
	51°15'00" 05°25'00"	FEB - AUG		BIRD CONSERVATION AREA	
	50°57'00" 05°25'00"	FEB - AUG		BIRD CONSERVATION AREA	
	50°58'15" 05°25'50"	NOV - FEB		BIRD CONSERVATION AREA	
18.	51°16'00" 05°35'00"	NOV - FEB	GULLS	BIRD CONSERVATION AREA	2,000 - 10,000
19.	51°12'00" 05°57'00"	APR - JUN	GULLS	BREEDING COLONY	20,000

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BIRD STRIKE COMMITTEE EUROPE

LONDON, 24-28 May 1976

Ref: BSCE/11 WP18

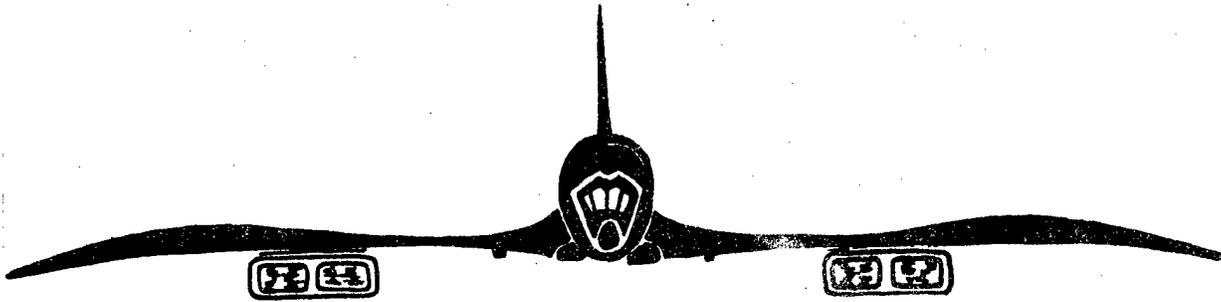
GLOBAL STATISTICAL APPROACH  
TO THE BIRD STRIKE

H Cesbron-Lavau, France

ABSTRACT

The multivariate analysis gives more information from the data collected on the reporting form. Several couples of variables are explored. The main factors leading to a strike are the number of hours of flight and the mean speed of the aircraft.

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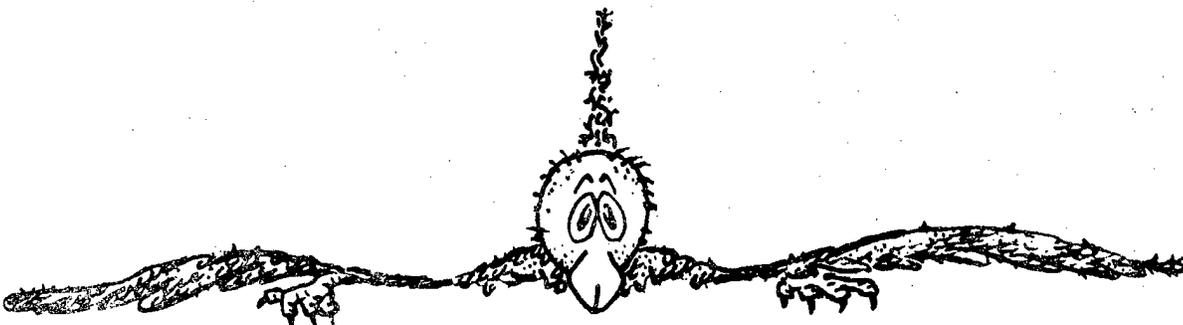
GLOBAL STATISTICAL APPROACH  
TO THE BIRD STRIKE

Abstract : The multivariate analysis gives more information from the data collected on the reporting form. Several couples of variables are explored. The main factors leading to a strike are the number of hours of flight and the mean speed of the aircraft.

Actions : 1 - In each country, to complete the reporting form with the above data (number of hours and mean speed) and with the number of birds and their time of presence on the territory. This will allow a good prediction of the number of strikes in a year.

2 - To analyze the differences, if any, between climb and descent.

3 - To use the relationship between main factors to give generality to local experience.



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GLOBAL STATISTICAL APPROACH TO THE BIRD STRIKE

Henri CESBRON-LAVAU

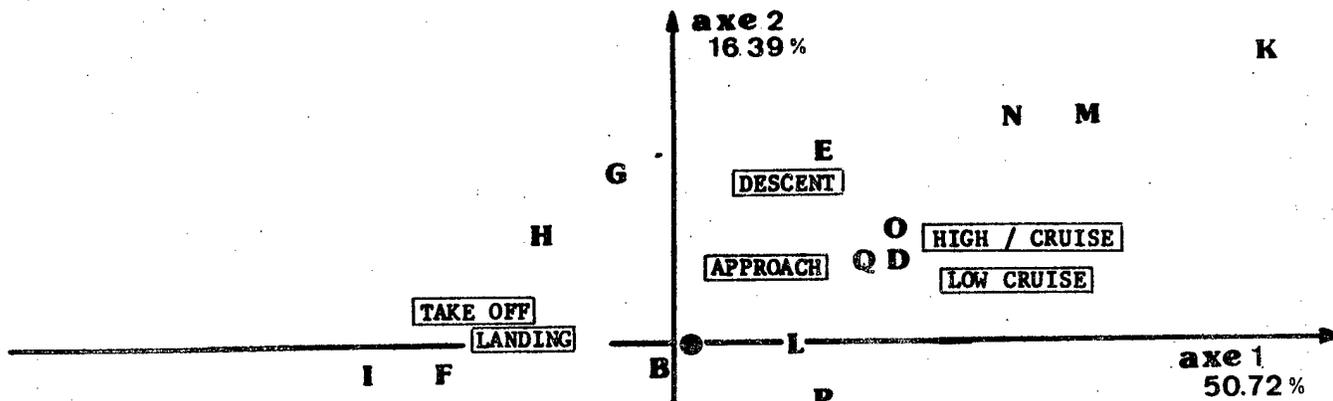
OPERATIONAL RESEARCH GROUP OF THE FRENCH AIR FORCE

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Link between past - to day's souvenir - and future - to day's dream -, statistics may appear as the holy oracle or the disguise of ignorance. In this paper, we'll first show in which way the dead figures coming out the bird strike reporting form help the souvenir. Then, as the Phenix awaking to life among his ashes, the results will indicate how to dig into a few of future's secrets. As the meaning of statistics is relevant to the existence of a policy, it allows for a choice between alternative proposals.

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TAXYING

CLIMB

C

- |                 |                  |
|-----------------|------------------|
| A : Anatides    | O : Hirundinides |
| B : Falconides  | P : Sturnides    |
| C : Strigides   | Q : Apodides     |
| D : Columbides  |                  |
| E : Corvides    |                  |
| F : Larides     |                  |
| G : Ardeides    |                  |
| H : Otidides    |                  |
| I : Phasianides |                  |
| J : Limicoles   |                  |
| K : Turdides    |                  |
| L : Plocéides   |                  |
| M : Fringilides |                  |
| N : Alaudides   |                  |

ANALYSES FACTORIELLE  
BIRD SPECIES • STAGE OF FLIGHT  
(CIVILIAN AND MILITARY)  
FRANCE

HOLDING

194

## 1 - THE MULTIVARIATE ANALYSIS

Many factors bring about a strike. The usual analyses give the variations of one factor at a time. Other methods (as the multiple regression used further) are bound to a linear model. The originality of the "analyse factorielle" used here, is to give a graphic representation of a double-entry array. There is no presupposed model. The map just brings together the point of a factor (let us say the LARIDES (F) among the bird species) with the points of the other factor (as we see on the graphic BIRD SPECIES \* STAGE OF FLIGHT, the TAKE OFF and LANDING) which cooccurs the most.

This has been explained in appendix D of BSCE/10 WP/19. Let's have a look at such maps.

### a/ Bird species versus stage of flight

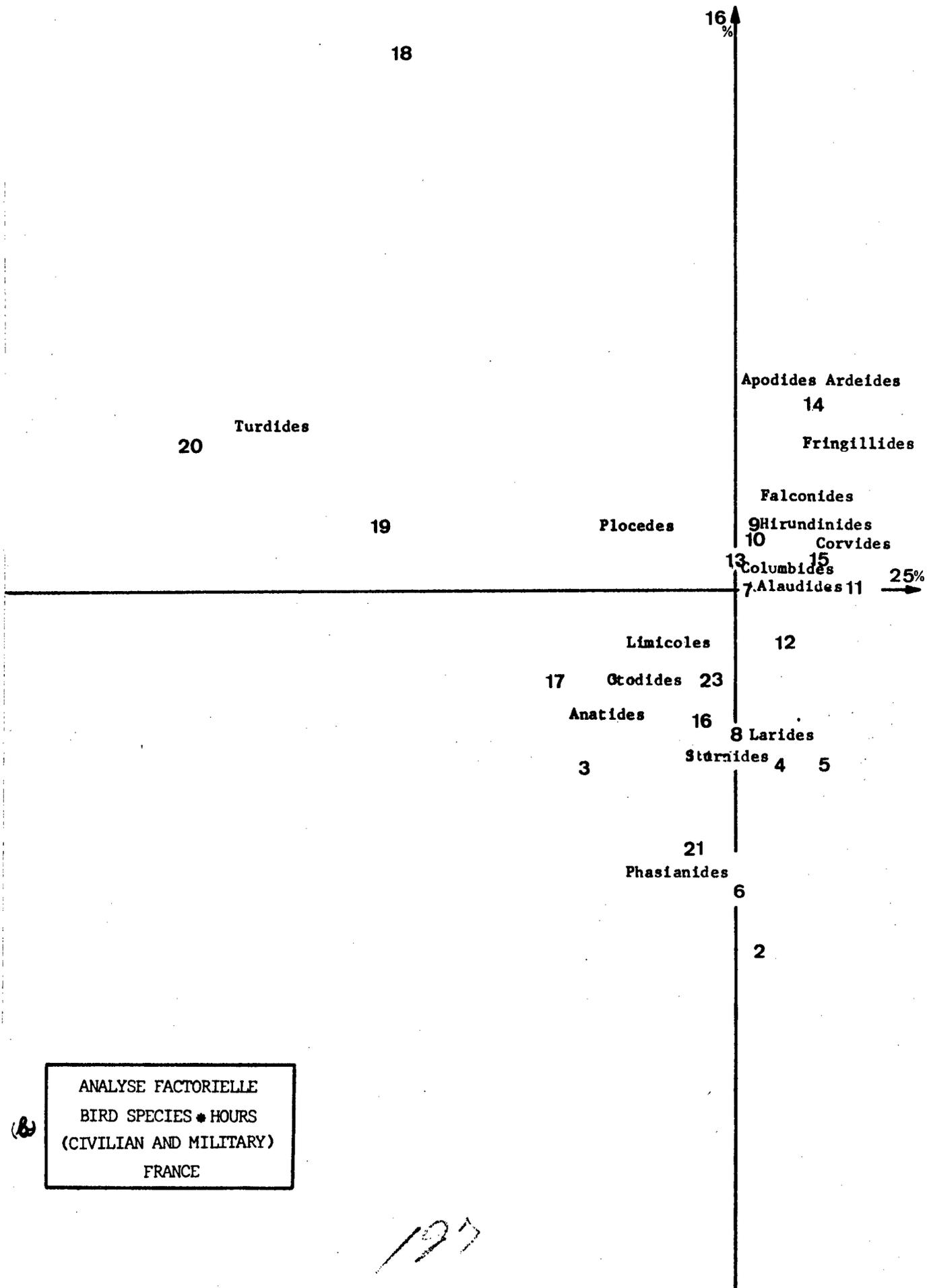
- 17 Bird species
- 9 Stages of flight

The map gives 67,11 % (50,72 + 16,39) of the information from the double entry array. We find near take off and landing, the larides (F), phanisiades (I) and obidiades (H). Falconides (O) is near the center. And this means that we find it in most of the stages of flight. On the other hand, Anatides (A) is very far from the center. As it occurred very few times, it has not reached a level of statistical significance. This is often the fact of points far from the center. So the points on which we have to draw our attention are the one situated in a medium position. They will give us too the meaning of the axis. And this will bring us to a better understanding of the relationship between the two factors. The first axis has a great importance (50,72 %). It goes from the left to the right through higher altitudes.

.../...

The altitudes is then the most important factor to determine the type of species. This is not surprising. But the second axis of smaller importance (16,39 %) brings to an unexpected conclusion. Its meaning is from climb to descent. At a given level of altitude (axis 1), the type of bird species is not the same when the plane goes up than when it goes down. This result may be interesting for ornithologists since it gives different behaviours among the species.

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ANALYSE FACTORIELLE  
 BIRD SPECIES • HOURS  
 (CIVILIAN AND MILITARY)  
 FRANCE

197

axe 2  
29,97  
LANDING GEAR

VIC

20

CES

F27

MS7

707

Dc8

747

727 LEG

NOR AIR FRAME

BEE

ENGINE

NOSE / RADOME

CAR

axe 1  
51,62

AVIONS CIVILS

707 : Boeing 707

727 : Boeing 727

747 : Boeing 747

CAR : Caravelle

F27 : Fokker 27

20 : Mystere 20

BEE : Beeches

DC8 : DC8, DC8F

LEG : Avions légers

AL2 : Alouette 2

DC3 : DC3

FG : Fouga

VAU : Vautour

252 : Nord 252

MET : Météore

VIC : Viconte

DC1 : DC10

MS7 : Paris (MOR 760)

Dc1

ANALYSE FACTORIELLE

LOCATION OF STRIKE \* TYPE OF PLANE  
(CIVILIAN)

FRANCE

(C)

198  
MISCELLANEOUS

b - Bird species vs hours

The information given by the map is lower : 41 %. No particular direction comes clearly out of the double-entry array.

A meaning of the groups appearing may be given by ornithologists.

For instance the feeding hours are grouped together.

Better analysis may be done if we had the time related to sun rise and sun set.

c - Location of strike vs type of plane (civilian)

- 14 types of planes
- 5 locations of strike

A good information is given here (81 %). Axis 1 shows an opposition between "air frame" and "engine". The Boeing's 727, 707 and 747 are placed along this axis. Which is not surprising.

Besides the high percentage above, the dependency between civilian airplanes and location of strike is not that high. (It is given by the square root of the largest eigen-value of the var-covar Matrix and equals 41%). So, it is mostly given by the first axis. The second axis is due to irregular sample.

This will be improved in the next years, when there will be more reporting forms.

.../...

NOSE / RADOME

axe2  
24,83%

AVIONS MILITAIRES

FG : Fouga	B2 : SMB2
F10 : F100	TRA : Transall
3B : Mirage 3B	T3 : T33
3C : Mirage 3C	VAU : Vautour
3E : Mirage 3E	CI3 : CI35
3R : Mirage 3R	JAG : Jaguar
5F : Mirage 5F	MD3 : MD3II,3I2..
3D : Mirage 3D	M4 : Mirage 4,4A
20 : Mystère 20	MS7 : Paris (MOR 760)
4A : Mystère 4A	
NOR : Noratlas 250I	

3c

LANDING GEAR

M4

MISCELLANEOUS

3B

TRA

B2

3E

3R..5F

FG

axe 1

40,64%

ENGINE

VAU

AIR FRAME

MS7

4A F10

JAG  
20c13

3D

(d)

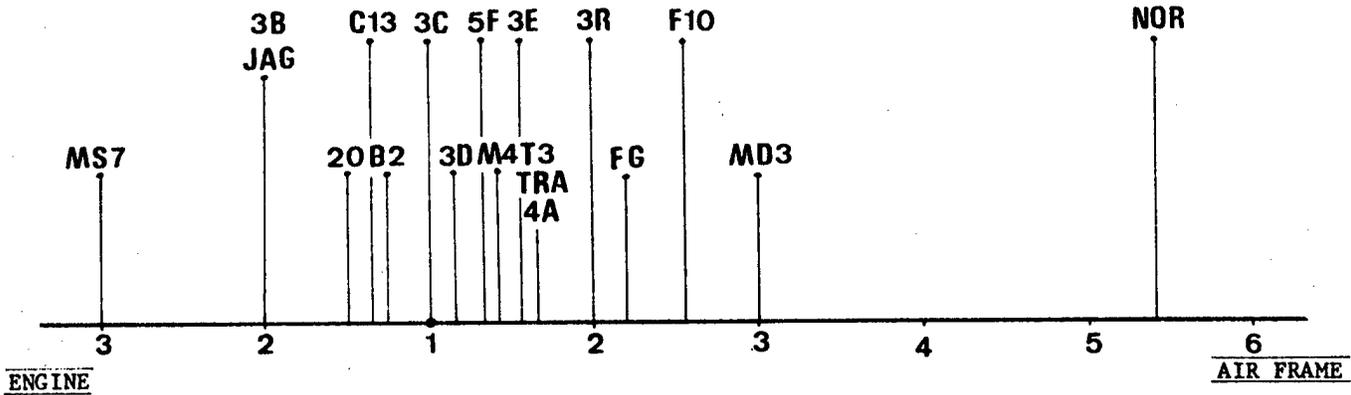
ANALYSE FACTORIELLE  
LOCATION OF STRIKE • TYPE OF PLANE  
(MILITARY)  
FRANCE

MD3

NOR

200

(d) (Military airplanes)



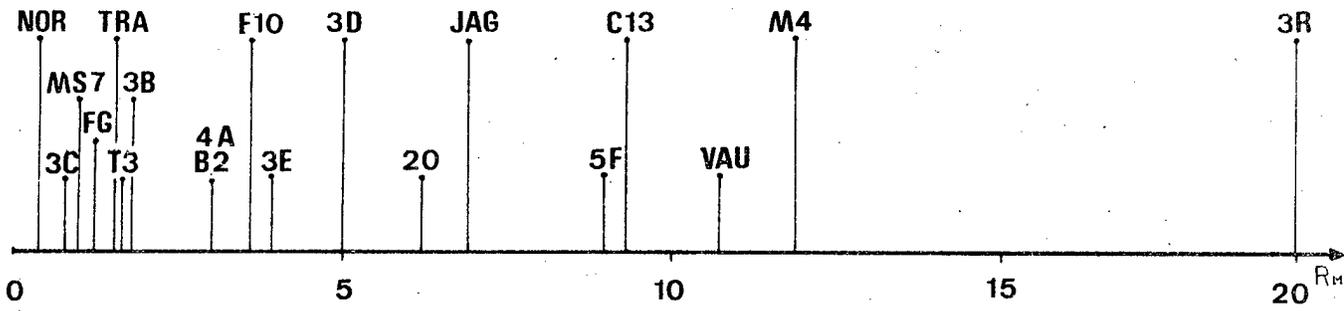
RATIOS : MAX  $\left( \frac{\text{number of Air Frame strikes}}{\text{number of Engine strikes}}, \frac{\text{number of Engine strikes}}{\text{number of Air Frame strikes}} \right)$

**NOTA** : If a plane appears on the right of 1, let say in 2 , it means that AIR FRAME strikes have occurred twice more than ENGINE strikes for this plane.

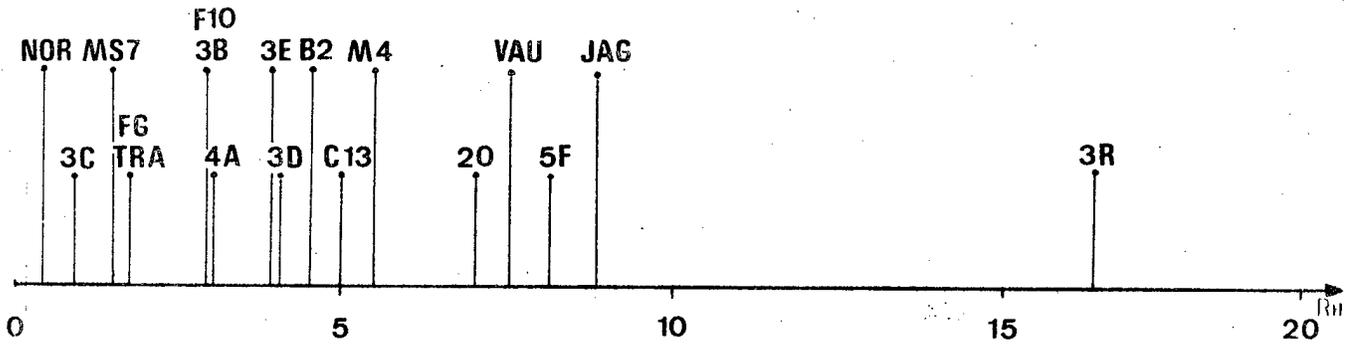
If a plane appears on the left of 1, let say in 2, it means that ENGINE strikes have occurred twice more than AIR FRAME strikes.

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Rate of strikes per 10 000 movements  
(Military airplanes)



Rate of strikes per 10 000 hours of flight  
(Military airplanes)

202

axe 2  
14,15%

TAXYING

747

MET

VAU

HIGH CRUISE

727 BEE

707

FG

TAKE OFF

LANDING

MS7

axe 1  
46,92%

CAR 252

CLIMB

Dc8Dc3

cES

LEG

LOW CRUISE

DESCENT

20

F27

NOR

APPROACH

AL2

3B

HOLDING

ANALYSE FACTORIELLE  
STAGE OF FLIGHT • TYPE OF PLANE  
(CIVILIAN)

(e)

FRANCE

403

axe 2  
29,49% HOLDING

B2  
HIGH CRUISE

MS7

T3

VAU

TAXYING

NOR

F10

TAKE OFF

FG

LANDING

20

axe 1  
38,37%

3R

CLIMB

DESCENT

LOW CRUISE 3E

C13

3D

5F

4A

M4

JAG

3C TRA

APPROACH

ANALYSE FACTORIELLE  
STAGE OF FLIGHT • TYPE OF PLANE  
(MILITARY)  
FRANCE

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d - Location of strikes vs type of plane (military)

- 20 types of planes
- 5 locations of strike

The bound between the two factors is not as tight with military planes (65 %) than with the civilian (81 %). This may be due to the less regular trajectory of a military planes.

However, to compare with the civilian, we give on the following page (d') the ratios comparing air frame strikes to engine strikes.

e - Stage of flight vs type of plane (civilian)

- 20 types of planes
- 9 stage of flight

The information (61 %) is reenforced by a good canonical correlation between the set of planes and the set of stages (given by the square root of the first eigen-value 58 %).

The meaning of axis 1, is "how far from the airport are we ?"  
The meaning of axis 2 is "are we flying through a light or a thick density of birds".

f - Stage of flight vs type of plane (military)

- 21 type of planes
- 9 stages of flight

As below, the information (68 %) is reenforced by a good correlation (50 %). The axes have the same meaning.

.../...

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## II - THE TWO LEVELS OF THE USE OF STATISTICS

How interesting the interpretation of the preceeding maps may be, the airplane specialist usually explores them in order to verify his experience on it. And usually he is amazed to see a confirmation of his experience.

To a certain extent the method brings enthusiasm, on the matters of confirmation.

To verify what we know is better than the converse but what new things can we learn from the map ? First the axes usually give a synthesis of the influence of one factor towards the other. Then our attention is brought on the points which are not located where they were expected. That means, we have to go back to experience and try to find out what may explain the position of these points.

(After verification that the unexpected result is not due to mistakes in the reporting form). As far as we saw it up today, the airplane specialist will try to find an answer to the question why were there at the same place and time a bird and a plane ? Only far back comes very seldom the question : what was the final reaction of the bird and the plane before the occurrence of the strike if any ?

Giving the priority to the man of experience, statistics will take this as an indication for further research.

### *a - Global factors*

In order to compare the weight of different factors leading to a strike, we performed a multiple regression using the stepwise method.

The stepwise method chooses among the factors those which give the better explanation. The score is given by a number between 0 and 1. (1 means that the selected factors give a perfect explanation). As results, the hours of flight and the mean speed at usual level of flying are the two important factors.

.../...

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Although they only explain 40 % of the variable "number of strikes" (score 0,4), the other factors have to be numerous to explain the rest. The importance of these two factors, only related to the aircraft, not to the birds, shows how scarce is the part of the informations collected on the reporting form. For, the hours of flight and mean speed are collected on companies statistics. And I guess that if we had the hours of flight of birds, we would explain another 40 %. The careful registration of the following items number of strikes, mean speed of each type of aircraft, hours of flight by type of aircraft, number of birds by species and mean time of staying, would give a good appreciation of the global efficiency of any policy about bird hazards. But these results will be ex post.

*b - Local factors*

In order to decide ex ante the good opportunities, it is necessary to implement, different policies and to compare the results. Since, the cost of a policy may be high, the implementation will be done locally. However to give a general validity, the results will be related to the preceding relationship.

For instance, it is decided that lights will be on during a week in a particular airport. The efficiency of this policy will be obtained after having related the number of strikes to the number of take-off, , mean speed of planes at take-off, number of alive birds by species.

On another hand, it may be decided to use another route avoiding migrations of bird. The policy's efficiency is given after having related the number of strikes to the number of flights, the mean speed, and the number of alive birds by species.

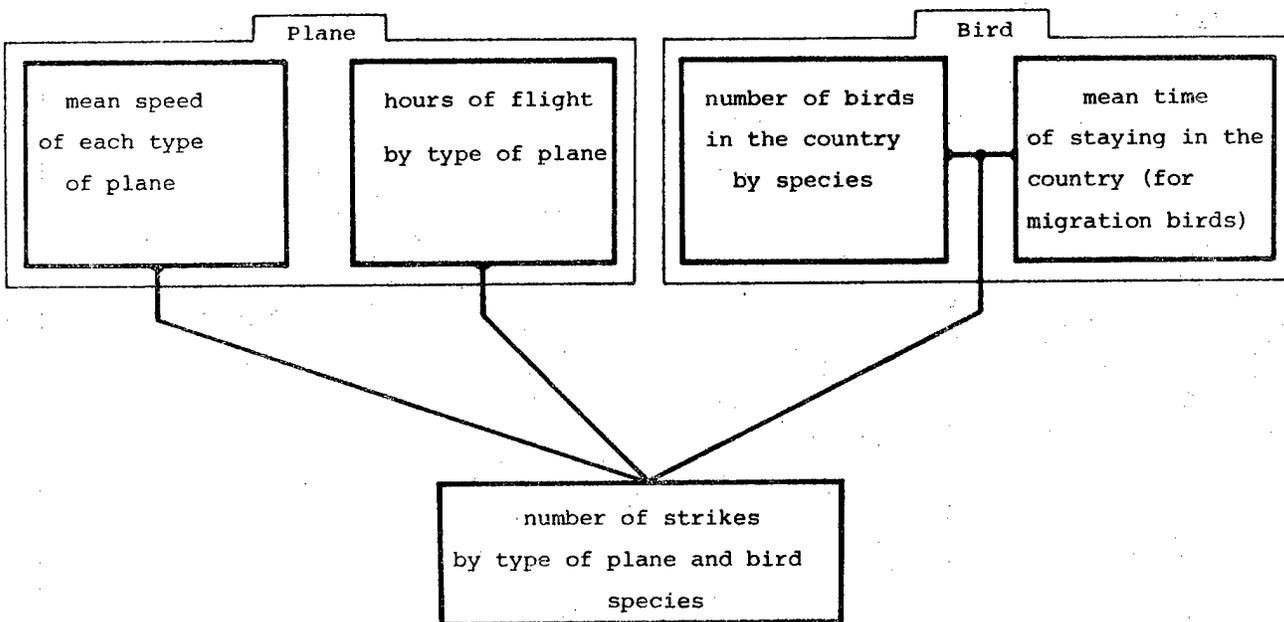
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CONCLUSION

No policy will come out of statistics. But any policy needs to be tested by statistics.

On this matter, the following actions :

1 - To bring together each month the data concerning :



This will bring to a good prediction of the total bird strikes during a year.

.../...

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2 - Another global approach to the birds' behaviour may be done through the differences between climbing and descent. A plane is supposed to be as many times in the first stage of flight as in the second. And statically speaking, the weather conditions, density of birds in the airport environment are the same. So we have there the same stakes for all the variables except what is concerning the plane : stage of flight, speed, noise. These defferencies have an influence on the type of species striken (see first map). It would be interesting that ornithologist's try to find out the birds' reasons. As climb or descent induces different stimuli, this may help to know the stimuli which are effective on each species.

3 - On a particular level, to implement for short time and in one or a few places, different policies. When the number of strikes will be lower than the prediction given by the relationship given by the first action, the policies will be accepted and generalized.

4 - It is obvious to tell that the quality of the further results is bound to regularly filled reporting forms. But, it may be necessary to insist on giving informations to the pilots on the benefit, they may get from good statistics.

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LONDON, 24-28 May 1976

Ref: BSCE/11-WP19

HOW SHOULD FUNDS BE ALLOCATED  
TO STRENGTHEN THE STRUCTURE?

H Cesbron-Lavau, France

ABSTRACT

The use of a method of optimization will help to find how to spend a given amount of money in research and industrial actions on structure for higher security concerning bird hazards.

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HOW FUNDS SHOULD BE ALLOCATED  
TO STRENGTHEN THE STRUCTURE ?

Abstract : The use of a method of optimization will help to find how to spend a given amount of money in research and industrial actions on structure for higher security concerning bird hazards.

Actions : 1 - The location of strikes on the plane should be tested in a blowing-engine.

2 - Fund allocation should be decided according to the following model.

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HOW FUNDS SHOULD BE ALLOCATED  
TO STRENGTHEN THE STRUCTURE ?

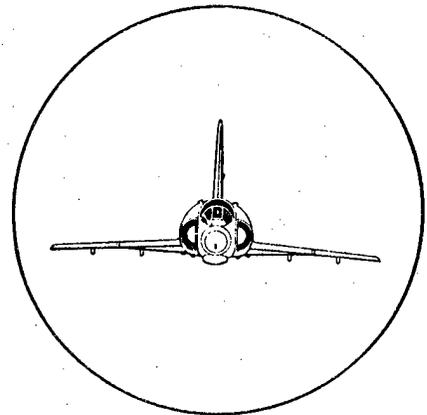
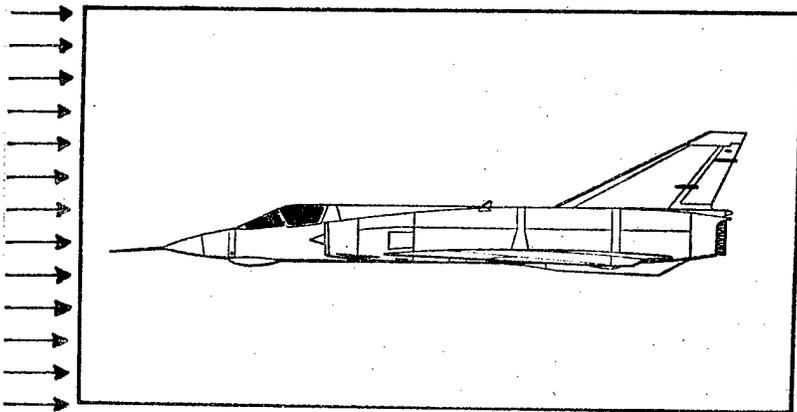
CESBRON-LAVAU HENRI  
OPERATIONAL RESEARCH GROUP

Actions on the structure of an aircraft may be of different kinds for different effects. This paper gives a method for doing best.

1 - Location of strikes on the plane

The number of real strikes is too low to give a precise idea. So an experimental way is proposed.

A scale-model of a given type of aircraft is set in a blower-tunnel.



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The air will fly along the scale-model under aerodynamics conditions. The bird, considered as a dead body - for the plane flies 10 to 20 times faster - will almost follow the air flow.

This will make him avoid certain parts of the plane and strike others. To have an evaluation of the probability  $p_i$  of striking part  $i$ , it is proposed to introduce a scale-model of a bird. This can be a little piece of cotton and to see where the plane is struck. The figure of the plane will have been divided in  $n$  parts homogeneous regarding cost and safety conditions (e.g. wings, engines, air-frame).

Then we can have the probability  $p_i$  for part  $i$  to be  
stricken.

$$p_i = \frac{\text{number of "birds" on part } i}{\text{number of birds on the plane}}$$

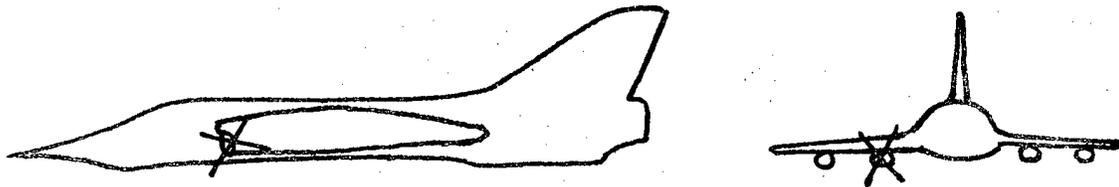
To have a general value, the test will be done several times shooting the  
"bird" from different points uniformly distributed on the section.  
The plane may be in different positions according to the different stages  
of flight.

## 2 - Probability that a shock will cause damage

When a bird strikes the plane on part  $i$ , the probability  $a_i$   
that the shock causes damage will depend on the protection on this part.

$$a_i = \frac{\text{number of shocks causing damage on the part } i}{\text{number of shocks on part } i}$$

This probability can be found by a test with a "gun" towards a real airplane  
or from the reporting forms. The form should have a general figure of a  
plane on which the pilot will mark the place of the shock. With crosses



The probability of a strike on part  $i$  causes damage is then  $p_i = a_i$ .

.../...

### 3 - Relation with cost

The cost of a damage on  $i$ , is divided in two parts.

The technical cost  $C_i$  includes the price of the new piece of equipment and the work to put it on.

The commercial cost  $G \cdot t_i$  where  $G$  is the loss due to a day of immobilization and  $t_i$  the number of days of immobilization.

So the cost of damage on  $i$  is  $C_i + Gt_i$ .

Each value is an average value. The probability of cost due to a strike on  $i$  is then  $p_i = a_i \cdot (C_i + Gt_i)$ .

And the average cost due to strikes on all parts is

$$\sum_i p_i \cdot a_i \cdot (C_i + Gt_i)$$

### 4 - Finding the best allocation

What we want is to have the minimum average cost. This can be done by having high  $p_i$  when  $a_i \cdot (C_i + Gt_i)$  is low, which means when the part  $i$  is well protected (low  $a_i$ ) and the cost of the piece of equipment low (low  $C_i$ ). And to have low  $p_i$  when  $a_i \cdot (C_i + Gt_i)$  is high.

But it is contradictory to have good protection ( $a_i$ ) for low cost ( $C_i$ ). And this is why we'll explain  $a_i$  in terms of cost. A perfect protection of part  $i$  is obtained with a maximum amount of expenses in research  $\bar{k}_i$  and a maximum technical cost  $\bar{C}_i$ .

.../...

Since the improvements have to be done on all the  $n$  airplanes of the fleet, the maximum technical cost is  $n\bar{c}_i$ .

Maximum means here that when  $\bar{k}_i + n\bar{c}_i$  has been spent on part  $i$ , no bird will cause any damage. So more spending on part  $i$  would not bring to a better protection of this part. Otherwise, it can be determined by the maximum amount that an administration would accept to allocate to part  $i$ , assuming unlimited funds.

These maxima are rarely obtained. So let  $K_i$  and  $C_i$  be the real amounts allocated to part  $i$  for research and industrial actions. We have

$$0 \leq K_i \leq \bar{k}_i$$

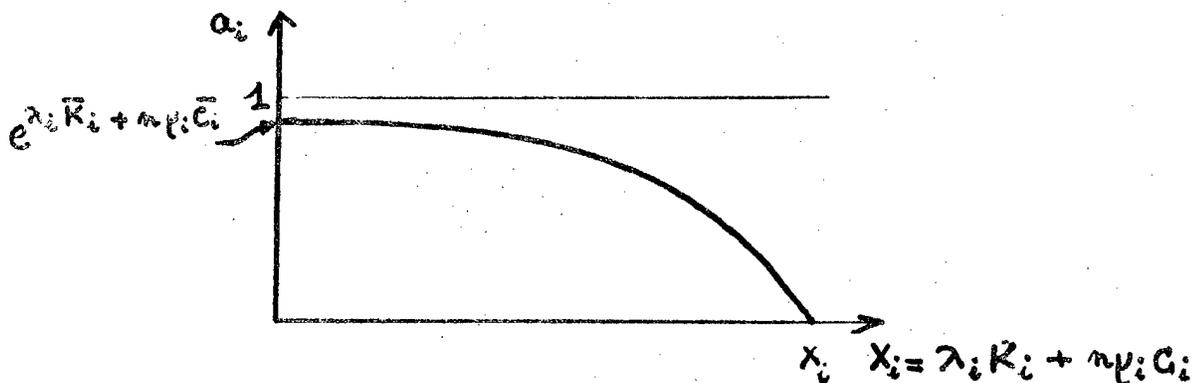
and

$$0 \leq C_i \leq \bar{c}_i$$

We now may relate the probability that a shock will do damage to the deviation between the funds allocated and the maximum useful allocations.  $\bar{k}_i - k_i$  and  $\bar{c}_i - c_i$

Since a pretty good protection is obtained near the maximum or for according to the part in consideration, we will introduce the coefficients  $\lambda_i$  and  $\mu_i$ :

$$a_i = e^{\lambda_i(\bar{k}_i - k_i) + \mu_i(\bar{c}_i - c_i)} - 1$$



The problem is then to minimize  $\sum p_i (e^{\lambda_i(\bar{K}_i - K_i) + \mu_i(\bar{C}_i - C_i)} - 1)(C_i + Gt_i)$

under budget constraints.  $K_M$  will be the total funds for research and  $C_M$  the total funds for industrial actions.

5 - The program of allocation

We may write the preceding formula in a simpler way, if we admit that a big enough amount of fund is allocated to each part  $i$ .

Let us say more than half of the maxima  $K_i$  and  $C_i$

In this case, we have the following approximation :

$$e^{\lambda_i(\bar{K}_i - K_i) + \mu_i(\bar{C}_i - C_i)} - 1 = \lambda_i(\bar{K}_i - K_i) + \mu_i(\bar{C}_i - C_i)$$

So the program of allocation is the solution in  $K_i$  and  $C_i$  of the following problem

$\min \sum_i p_i [\lambda_i(\bar{K}_i - K_i) + \mu_i(\bar{C}_i - C_i)](C_i + Gt_i)$	
where	
$0 \leq K_i \leq \bar{K}_i$ $0 \leq C_i \leq \bar{C}_i$	for all $i$ "
} Technical constraints	
$\sum K_i = K_M$ $\sum C_i = C_M$	}
Financial constraints	

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## CONCLUSION

To convince the financial administrations of a good use of funds to reduce the losses due to bird hazards, the allocation can be given after practical testings by an optimization method.

This method will lead to a compromise between research and industrial cost, depending on the part of the airplane.

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BIRD STRIKE COMMITTEE EUROPE

LONDON 24-28 May 1976

Ref: BSCE/11 WP/20

This Paper gave the ORGANISATION and the AGENDA for the Meeting and has not been reprinted; except for the Timetable, and the List of Papers, located at the front of the Report.

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BIRD STRIKE COMMITTEE EUROPE

LONDON, 24-28 May 1976

Ref. BSCE/11-WP/21

ACCIDENT TO HS 125 EXECUTIVE JET

J Thorpe - UK

SUMMARY

This Paper contains a brief description of the HS 125 Executive Jet accident at Dunsfold on 20th November 1975.

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Accident at Dunsfold Aerodrome to Hawker Siddeley 125-600B  
Executive Jet, G-BCUX on 20th November 1975

1. Dunsfold Aerodrome

- 1.1 The aerodrome is situated in the County of Surrey approx 20 nautical miles South of Heathrow Airport. It is a private aerodrome owned by the Ministry of Defence, leased to and operated by Hawker Siddeley Aviation as a test centre for civil and military aircraft, and as such is not subject to Civil Aviation Authority Licensing procedures. It has a main runway 07/25 of 2127 metres.
- 1.2 The hazard of birds was appreciated at Dunsfold, which had areas of long grass as a deterrent, as well as regular use of gas cannon, shell crackers and broadcast bird distress calls.

2. Circumstances of Accident

- 2.1 There had been activity on the aerodrome by a Harrier jump-jet aircraft and a HS748 twin turboprop immediately prior to the HS125 taking off. Neither of the HS125 pilots nor the Control Tower staff had observed any birds likely to affect the 125, however as the aircraft started its take-off roll two witnesses at different points on the aerodrome observed flocks of birds rise from the ground in confused flight at different places likely to affect the aircraft. The aircraft took-off at 16.11 GMT (sunset 16.04) from runway 07 carrying 7 passengers and 2 crew, and lifted-off at approx the half-way point at 122 kts. At a height of between 50 and 100 ft, after undercarriage had been retracted, the aircraft passed through a flock of birds, which the pilot had seen just prior to impact, with no chance to take avoiding action. There were multiple strikes and both engines surged and completely lost power. The pilot (Commercial Pilot's Licence 11,848 hours and 1327 on HS125), landed straight ahead after selecting undercarriage and flaps down, and the aircraft touched down approx 180 metres before the runway end at a speed of approx 120 knots. The aircraft crossed the end of the runway and continued in a straight line across two grass fields and through three hedges before crossing the A281 main road which

runs North-South about 285 metres from the end of the runway. The aircraft crossed the road at 80 to 90 kts striking a car which was travelling south. The car was demolished and the 6 occupants killed instantly. The undercarrigage was torn off the aircraft which continued on its belly for a further 150 metres before coming to rest. Although fire had broken out on impact with the car, all nine occupants of the aircraft safely evacuated the aircraft before the fire spread. The aircraft was largely destroyed by fire.

### 3. Subsequent Findings

- 3.1 An inspection of the aerodrome revealed 11 dead lapwings (*vanellus vanellus*) in the area corresponding with the impact. The average weight of the birds was found to be 250 gms.
- 3.2 Examination of the engines revealed traces of bird debris in both engines, together with other debris from the hedges. The engines had not suffered any major internal damage.
- 3.3 During the take-off the landing lights and the High Intensity Strobe Anti-collision lights were ON.

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-1-

## BIRD STRIKE COMMITTEE EUROPE

LONDON, 24-28 May 1976

Ref: BSCE/11 WP22

THE ATTEMPT TO GET RID OF THE WOOD-PIGEONS  
(COLUMBA PALUMBUS) FROM ORLY AIRPORT

J L Briot, France

## PRACTICAL APPLICATION &amp; CONCLUSIONS

Since it is quite difficult to affect the distribution of clover, we preferred to affect its abundance (CBDW) by spreading a hormone which essentially kills the Dicotyledones. This was the U46 KV liquid, containing 350 grammes/litre of 2.4 DP, 150 g/l of Mecoprop and 100 g/l of 2.4 MCPA. This herbicide was spread in April 1976 over two sections of land next to the Orly paved area, four litres per hectare and 800 litres per hectare of water.

Unfortunately, since this action is still very recent, no valid statistical results have been established. Nevertheless, it seems, at first view, that this method is effective since no pigeon has been seen on the sections which were treated, and the clover was just below 100% destroyed.

In spite of the lack of tangible results, this study seemed to be a good example of applied ecology. As a great number of authors have repeated, the search for what attracts birds to airports and the consequent modification of the ecology of the airport seems to be the most logical, effective and long-lasting approach.

The Attempt to Get Rid of the Wood-pigeons  
(Columba palumbus) from Orly airport

J. L. BRIOT

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246 rue Lecourbe, 75015, Paris.

INTRODUCTION

The presence of a great number of wood-pigeons at Orly Airport constitutes a primitive hazard for strikes with aircraft and, especially, from April to September. In fact, 32% of the bird strikes recorded between 1965 and 1975 are due to this species (1), the others involving crows (16%), starlings (14%), gulls (12%). These strikes linked to the presence of pigeons have caused six cases of total destruction of jet engines (of which four were B 747's) and nine modifications of flight plan.

Moreover, it has been extremely difficult, perhaps impossible, to use conventional methods of keeping birds away, such as pyrotechnic methods or frightening them with sound, given the surface to be covered and the fact that pigeons do not have distress calls. These two facts caused us to undertake a thorough study of the causes motivating the presence of wood-pigeons on the platform so as to make it less attractive for this species.

I - General Description of the Problem

The following facts resulted from the two series of studies performed in 1972 and in 1974:

I. 1. Origin of these birds and the numbers concerned

These birds are part of the population of breeding wood-pigeons of Paris itself, a population of about 2,000 couples. The total

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(1) Total of bird strikes from 1965-1975, 115. 15 strikes due to pigeons; 50 determined.

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number of birds frequenting the platform fluctuates between 500 and 1000 individuals, according to the season (maximum in June).

I. 2. Characteristics of their movements

The birds make daily trips between Paris and the airport. They leave the capital, starting at 8:00 a. m., in successive waves, according to a precise itinerary between Paris and Orly, in 30 minutes flying time. In June, a precise check has shown that 50% of the birds had arrived at Orly by 10:20 a. m. and 50% had left by 7:10 p. m.

The size of the flights varies between two and 130 individuals; the flights are twice as large in the evening as in the morning; 80% of the flights are made up of about 30 individuals.

The altitude of the flights is between 5 and 200 meters, tending toward an average of 50 meters.

The reason for the movements appeared, essentially, to relate to feeding, since the movements were between the breeding area in the city and the feeding areas in the countryside. Visual observations and analyses of stomach contents have shown that the pigeons:

- . Congregate at large lawns most of the time.
- . Feed mainly on clover and, more precisely, on *Trifolium campestre* and *T. repens*.
- . Pass three hours in actively feeding, five hours at rest (digestion) and 30 minutes in short flights; since the birds are present eight hours and 30 minutes on the platform, there is a potential, substantial danger for aerial navigation.

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## II - Detailed Study of the Trophic Relationship: Clover wood-pigeon

Once we had defined the numbers, the habits, and the food source of our bird population, we next studied, in more detail, the vegetation of the platform and its consumption by the wood-pigeon.

### II. 1. Food possibilities on the Orly platform

Three species of clover have been found: *T. pratense*, *T. repens*, *T. campestre*.

. Their distribution and their relative abundance have been studied during three sampling sessions distributed over 17 known surface zones by the calculation of the percentages of surface covered by each species of clover (method derived from that of Braun-Blanquet, using the abundance-dominance indices).

. The relationship of coverage percentage, consumable biomass of clover was next established in the laboratory for each species (cutting and weighing of the parts above ground [flowers, leaves, stems] on 100% coverage sampling).

. These samplings resulted in the calculation for each sampled zone of the consumable biomass in dry weight (CBDW) by species of clover as well as their distribution modes (diffusion, random or regular) (1).

### II. 2. Consumption of the lawns by the wood-pigeon and the relationship of consumable biomass by dry weight (CBDW) - number of birds (N).

The average number of birds having frequented the 17 zones whose quantity and distribution of feed was known, was calculated in parallel. It appeared that the number of individuals frequenting a given zone depends on the total quantity of available feed (CBDW for the two clovers) when the feed is

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(1) Characterized by the calculation of  $\frac{\sigma^2}{M}$

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distributed randomly. In this case, the almost linear relationship between log N and total CBDW (1) becomes an exponential relationship, as much in May as in July (see graph). On the other hand, whenever the clover is distributed by diffusion, there are no birds whatever the total CBDW is.

To explain it in another way, when the clover is randomly distributed and not in "clumps", and when there is a lot of it, a great number of birds will be seen feeding.

### III - Practical Application and Conclusions

Since it is quite difficult to affect the distribution of clover, we preferred to affect its abundance (CBDW) by spreading a hormone which essentially kills the Dicotyledones. This was the U46 KV liquid, containing 350 g/l of 2.4 DP, 150 g/l of Mecoprop and 100 g/l of 2.4 MCPA. This herbicide was spread in April 1976 over two sections of land next to the Orly platform, four litres per hectare and 800 litres per hectare of water.

Unfortunately, since this action is still very recent, no valid statistical results have been established. Nevertheless, it seems, at first view, that this method is effective since no pigeon has been seen on the sections which were treated, and the clover was just below 100% destroyed.

In spite of the lack of tangible results, this study seemed to be a good example of applied ecology. As a great number of authors have repeated, the search for what attracts birds to airports and the

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(1) Regression equations:

		X = CBDW total
		Y = Log N
Y = 0.64634 x - 0.90763	(July)	r = 0.98095
Y = 0.28897 x - 1.97408	(May)	r = 0.99604

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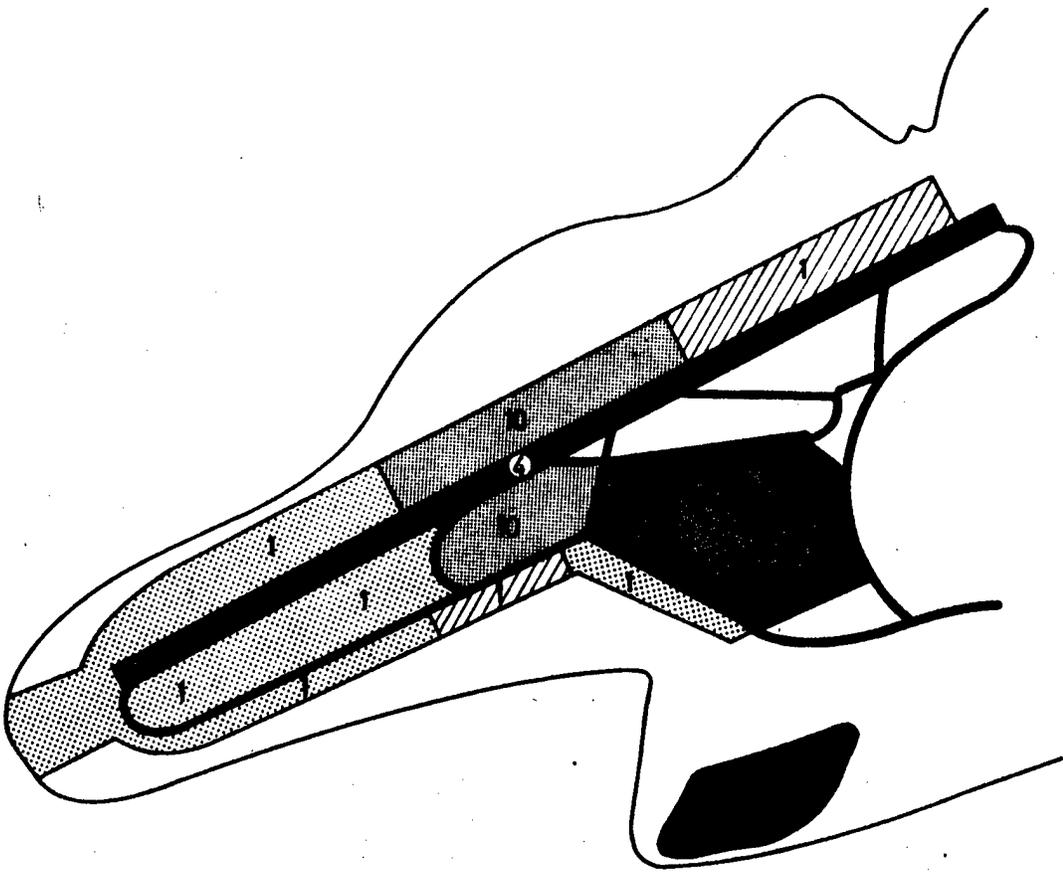
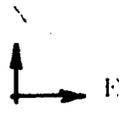
consequent modification of the ecology of the airport seems to be the most logical, effective and long-lasting approach.

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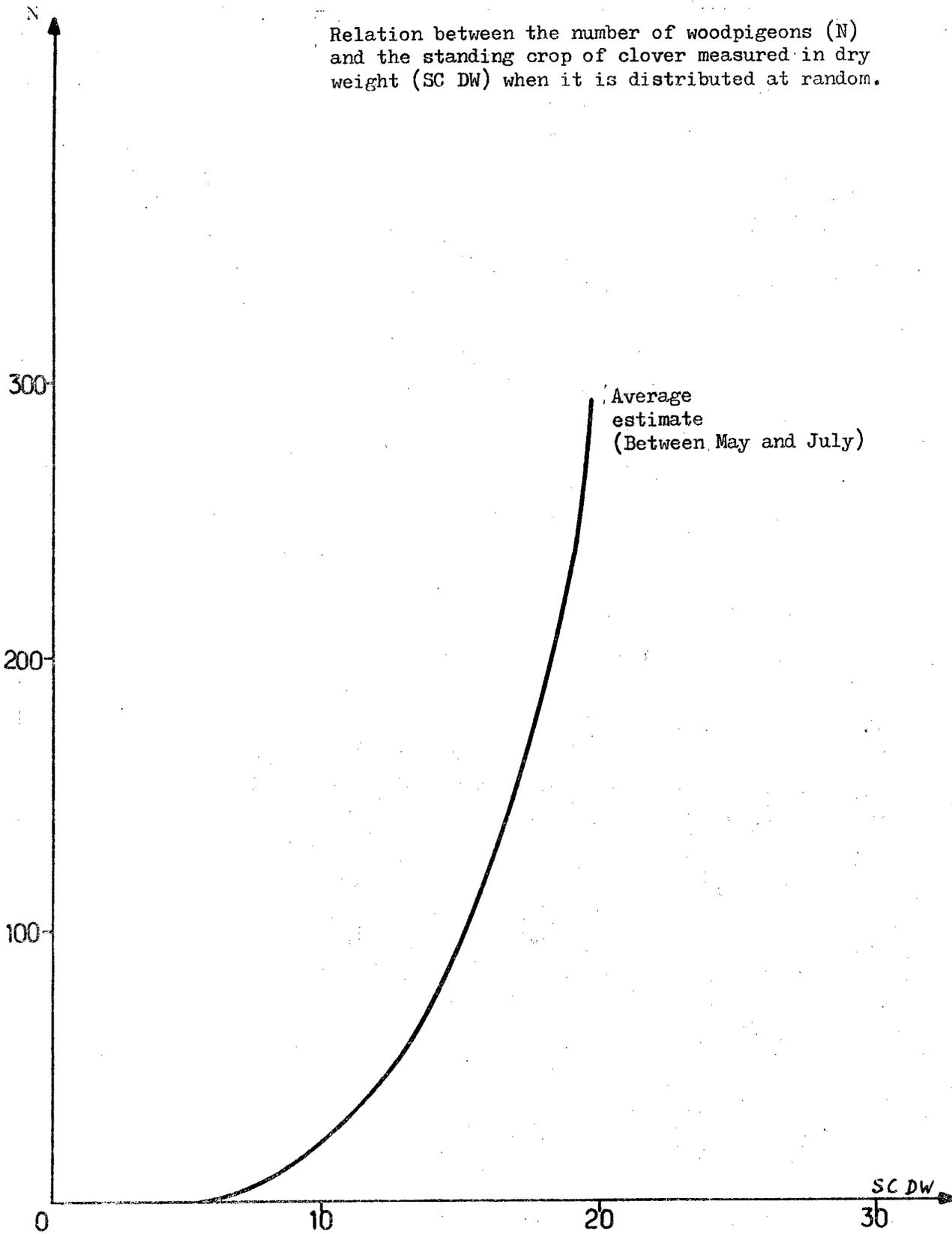
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Numbers of woodpigeons in relation with abundance and distribution of clover



- 
 Contagious distribution of clovers, standing crop of clover very variable  
 (between 1, 6 and 7, 5 g/m<sup>2</sup>)
- 
 Distribution of clovers at random, standing crop very important  
 (between 8, 4 and 13, 1 g/m<sup>2</sup>)
- 
 Distribution of clovers at random, standing crop in the medium  
 (between 3.9 and 4,0 g/m<sup>2</sup>)
- 
 Distribution of clovers at random, very little of clover  
 (between 1,3 and 2,8 g/m<sup>2</sup>)

Relation between the number of woodpigeons (N) and the standing crop of clover measured in dry weight (SC DW) when it is distributed at random.



6-11

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ADF 616 186

BIRD STRIKE COMMITTEE EUROPE

LONDON, 24-28 May, 1976

Ref: BSCE/11-WP23

SYNERGISED ALUMINIUM AMMONIUM SULPHATE IN THE  
CONTROL OF BIRDS AT AIRPORTS

R.J. Stone

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SYNERGISED AMMONIUM ALUMINIUM SULPHATE IN THE CONTROL OF BIRDS  
AT AIRPORTS

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R.J.STONE

Synergised ammonium aluminium sulphate (ammonium alum for short) includes micro additives and is prepared in such a way that it has synergistic properties as a repellent, that is to say, the repellency of the whole is greater than the sum of the repellent properties of each of the ingredients.

Chemical repellents as you will all know, have always been very suspect as a method for bird control because the range of avian chemoreception has been too wide for any chemical previously to have had the breadth of effectiveness to ensure full control. This has not been the fault of the chemical manufacturers, for no scientist yet understands much of the sensory perception in birds apart from the structure of the sensory organs. For example, no one can explain why a chicken with only 24 taste buds can perceive chemical solutions which are imperceptible to a cow with a thousand times as many.<sup>(1)</sup>

It is accepted that birds, like mammals, have the six senses. Of these, sight, hearing and touch have been found generally of little value in achieving a high degree of control over birds at a reasonable level of cost. So, there then remain the chemical senses.

These are commonly divided into three classes: (1) olfaction, or smell, (2) gustation, or taste, and (3) the common chemical sense. Olfaction is characterised by a sensitivity to volatile substances in extreme dilution which accounts for it being described as a distance receptor: the gustatory receptors need a more gross contact with the chemical stimulant: while the common chemical sense which Moncrieff (1951) suggested was the primitive sense with olfaction and gustation later differentiations, is reserved for non-specific stimulants, often an irritant.<sup>(2)</sup> The divisions between smell, taste and the common chemical sense are arbitrary and they can overlap with a single chemical being able to affect all three categories.

Scientists have found that all mammals and birds that have been studied have gustatory organs commonly referred to as taste buds, and that the morphology of olfactory organs is basically similar in all vertebrates, while the fine membranes of the eyes, nostrils and mouth barely cover the free nerve endings in those organs which are, therefore, generally susceptible to irritants, though this is not always the case for pigeons and gray partridge (*Perdix perdix*) have been reported (Soudek, 1929) to be relatively insensitive to strong ammonia solutions.<sup>(3)</sup>

It is, however, difficult to consider the sensory systems of birds collectively because there is so substantial a variation not only in development between species, but also, apparently, in sensory perception and the reaction to it among individuals within each species.

From my own studies of birds and their reactions to repellent chemicals I have come to the conclusion that the answers to the problems of bird control lie in a chemical or chemicals which will effectively repel over the whole of the sensory thresholds, i.e. degrees of perception, of birds of all species.

In this search, I discovered that by varying my methods of preparation of the synergised ammonium alum and by varying in micro amounts the synergistic ingredients, the potency and range of effectiveness could be varied at will from a mild preparation suitable for general garden use to one which has been found to date capable of repelling every bird and mammal against which it has been tested. If we do find one able to resist then we shall increase the potency accordingly.

This wide range of effectiveness, covering as it does all species of birds and mammals, has been derided and the product condemned as an *annibus nostrum* - something of a quack remedy: but I have found that mammals and birds do have the same basic sensory perception, and, as the material is made more potent and of wider range of effectiveness, what repels the normally insensitive members of any one species will also repel members of other species of similar insensitivity irrespective of whether they are birds or mammals. This is not just my own opinion: in Japan, Professor Udagawa, a



highly experienced worker in this field for over thirty years, goes even further. Following successful laboratory and field trials on the control of birds, he is so convinced of the overall efficacy of the material at a high level of potency, that he is using it in an attempt to rid the populated and tourist areas of Hokkaido, the Northern island, of the vast numbers of snakes - particularly the poisonous vipers.<sup>(4)</sup>

In trials with this material it is important to keep in mind that different 'strengths' of the material are available: that, where necessary, the potency and the range of activity can be increased over any one or two or all of the chemical senses until, so far as I can determine, full control is achieved. The importance of this cannot be overstressed for in past years workers in this field have tended to test only one strength - often the mildest - and if that was not immediately effective to damn the whole product out of hand.

Synergised ammonium alum is a fine or micronised powder varying from white through various colours. In so far as safety is concerned it has been cleared for use under the U.K. Ministry of Agriculture's Safety Precautions Schemes not only for veterinary use on all animals and in homes, but, also, on plants and trees of all species, including vegetables, cereal and other crops and fruit for human consumption, both growing and in store. Normally, with the milder preparations, no recommendations are necessary, but with the stronger, more potent material it is advisable that operators use masks, not for safety, but because its repellent factors apply possibly more to humans than to other species of animal life.

It may be applied either as a dry powder by means of a powder applicator, or, mixed with water, sprayed by helicopter or light 'plane as at the Ben Gurion International Airport, or by any type of agricultural, horticultural or garden sprayer. The Israeli workers found it easier and more effective to spray powder when there was rain and the liquid when it was dry. Both were equally effective even during their very heavy February cloudbursts.<sup>(5)</sup>

An application rate of 35-lb. (16-kg) powder in 40-gallons (180-litres) of water preferably with a pH of under 5 and at a temperature of

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about 20°C. has been found adequate for one acre of actual spray and this costs between £20 and £50 according to the strength of material used. But it is not normally necessary to spray over the whole of the area.

Effectiveness from one spraying can last two or three months or even longer according to local conditions, the strength and quantity per area of the material used, alternative sources of food and the degree of chemosensory perception of the birds in the area.

To date, the synergised ammonium alum has been tested three times on airfields. The first was in 1973, in the United States at Dekalb Peachtree Airport and the adjoining Dekalb County Landfill in North-East Atlanta,<sup>(6)</sup> when there were present representatives from the University of Georgia, the airport authorities, the F.A.A., the Department of the Interior, etc., etc. The landfill at the edge of the runways received all the county's garbage amounting to some hundred tons daily. This was shredded and spread by bulldozers over 200 acres on two sides of the airfield to the delight of about 1,000 birds, including doves, grackles, starlings and blackbirds which visited daily between 17.00 and 20.00 hours.

These birds were a continuous hazard during the evenings: strikes were frequent and after one which resulted in the deaths of seven passengers, closing of the airport was considered.

In the tests, one application of the synergised ammonium alum was reported to have kept the birds from the runways; but clearing them from the landfill garbage was, of course, another matter. The report shows that the repellent was sprayed on the garbage on August 21st, 1973, followed by a second spraying eight days later on August 29. Apparently it was expected that effective repellency would continue through layers of hundreds of tons of garbage, and, indeed, a reduction to a maximum of 10% of the numbers of birds prior to the trial was shown at any one time. But the tests were not, for some unknown reason, continued.

The second test, which was at Ben Gurion International Airport in 1974, had the same type of problem. The garbage dump for the City of Tel Aviv was on the perimeter and full control of the birds there could not be obtained although they were cleared from the

runways as in America despite there being horticultural crops in those areas. However, when the birds returned after migration it was decided to spray again but at ten times the previous rate and trials at Ben Gurion International Airport were recommenced in September, 1975, when, as you have heard from Mr Dar, the birds were successfully kept from the runways with one spray of synergised ammonium alum; and the garbage dump, which was hand-sprayed with the repellent after each unloading, was also kept free from the birds.<sup>(5)</sup>

Here, I should add that it is reported that bird strikes are common at this airport and that all other known methods of bird control had been tried but without success.

Airports would not, however, appear, in general, to be of particular appeal to birds, and I submit that evidence of successful repellency of birds from various crops is of greater value than control at airfields. In this connection, the synergised ammonium alum now has an impressive folio of successes in several countries in trials carried out under the supervision of government and institutional authorities.<sup>(7)(8)</sup> Outstanding, are the results of trials, again in Israel, over several years under the direction of Mr Y. de Wolf, Director of the Department of Crop Protection of the Israel Ministry of Agriculture.<sup>(9)(10)</sup> Many were carried out in the testing stations of the Volcani Institute which are spaced over the deserts, and in these and at farms situated around wells sunk in the desert, migratory birds of many species travelling from Russia to Africa and back, were repelled from crops when they, the birds, were obviously at their last stages of hunger and thirst after crossing long stretches of desert. Yet, in all but one case, the crops treated with the repellent were saved while the untreated controls were completely ravaged.

In conclusion, I would say that synergised ammonium aluminium sulphate can apparently be brought to sufficient degree of potency to repel all birds from airports.<sup>(11)</sup> I would also stress the need, when testing the material, for careful study to be made of the reactions of the birds to the material so that the correct grade of material for each airport may be made, and in this I shall be pleased to advise and assist wherever possible.

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September 10, 1973

TO: DR. HOCHBERG

SUBJECT: "CURB" APPLICATION - DEKALB COUNTY LANDFILL AND DEKALB PEACHTREE AIRPORT

The DeKalb County Landfill is located adjacent to the DeKalb Peachtree Airport in Northeast Atlanta. This landfill has been used for about seven years as the county's dumping ground for garbage. Garbage is hauled to a large shed located at the entrance to the landfill, dumped into a large pulverizer and spread over a 200 acre area by bulldozers. The landfill has been quite an attraction for the feeding of doves, grackles, starlings, and blackbirds. Surrounding areas of the airport have been desirable for roosting and perching for many of these birds. Up to 1,000 birds may be observed on a given day. The largest concentration of birds are usually seen in the evening between 5:00 - 8:00 P.M. and appears to be increasing rapidly.

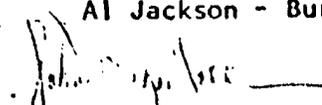
Six months ago a flock of birds flew into the engine of a small jet plane taking off and resulted in the death of seven passengers. This disaster has developed into a controversy about either closing the airport or the landfill to prevent further risk of other such incidences. Both the airport and landfill are in dire need of a way to solve their bird problem.

On August 21, a study was initiated with hopes of reducing the large population of birds in such areas. Three areas at the landfill and one at the airport were designated as test plots. (See attached sketch) The treated plots ranged from  $\frac{1}{4}$  -  $\frac{3}{4}$  acre in size with an adjacent replicate serving as the control plots. "Curb" was applied in the described forms by means of a pressurized 50-gallon tank attached to a jeep. Applications were made between 6:00 - 8:00 A.M. on a very clear and calm day. On August 29, a second application was made on the same plots at the landfill. Unfortunately, there was not enough material left to repeat the airport plot.

In summary, the two applications seemed to reduce the total population of birds. In order to evaluate the total effectiveness of "Curb", it will be necessary to repeat applications on a much larger scale.

The following people were involved in this study:

John Howell - Rachele Laboratories  
Charles N. Dobbins, D.V.M. - University of Georgia  
Stanley A. Vezey, D.V.M. - University of Georgia  
Tom Helton, County Agent - Ext. Service, University of Georgia  
Edward S. Weeks - Sanitation Dept., DeKalb Co.  
L. M. Dunston - Rachele Laboratories  
Doc Manget - Airport Manager, DeKalb Peachtree Airport  
Representative from F.A.A.  
Donald W. Hawthorne - Dept. of Interior  
Al Jackson - Bureau of Sport Fisheries & Wild Life

  
John Howell

JH/th  
cc: L. Zoller

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## PLOT

## 1ST TREATMENT

A (1/4 acre)	10 gal. $H_2O$ + 8 1/2 lb. powder + 1 gal. emulsion
B (1/2 acre)	20 gal. $H_2O$ + 17 1/2 lb. powder + 1 gal. emulsion
C (1/4 acre)	10 gal. $H_2O$ + 8 1/2 lb. powder
Airport (3/4 acre)	30 gal. $H_2O$ + 27 1/2 lb. powder + 1 1/2 gal. emulsion

## OBSERVATIONS

## MORNING

## EVENING

## TREATED

## CONTROLS

## TREATED

## CONTROLS

8/21/73

8/21/73

A		48 sparrows	Few birds
B		No birds	No birds (Windy)
C		No birds	No birds (Windy)
Airport		40-50 starlings	

8/22/73

8/22/73

A	No birds	No birds	48 sparrows, 2 doves, 3 blackbirds	No birds
B	Few	Plenty	5 doves	96 starlings
C	No birds	No birds	No birds	No birds
Airport			No birds	No birds

8/23/73

8/23/73

A	No birds	No birds	48 sparrows, 3 doves, 2 blackbirds	
B	3-4 doves	108 birds	8-10 doves	108 birds
C	No birds	No birds	1 dove	No birds
Airport			No birds	3 crows

8/24/73

8/24/73

A	No birds	No birds		
B	6 doves	72 starlings		
C	No birds	No birds		
Airport				

## PLOT

## 2ND TREATMENT

A (1/4 acre)	10 gal. $H_2O$ + 8 1/2 lb. powder + 1 gal. emulsion
B (1/2 acre)	20 gal. $H_2O$ + 17 1/2 lb. powder + 1 gal. emulsion
C (1/4 acre)	10 gal. $H_2O$ + 8 1/2 lb. powder

## OBSERVATIONS

Similar to above with possible reduction of total population of flocks.

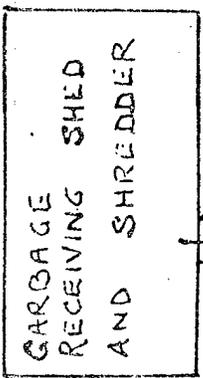
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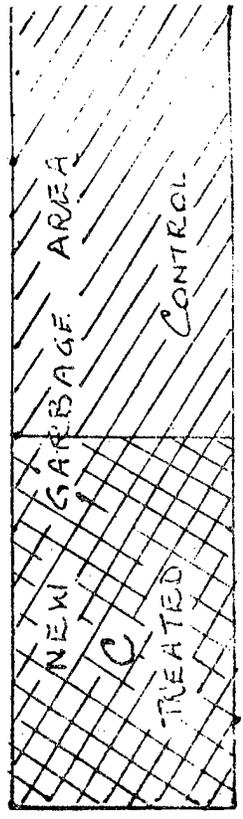
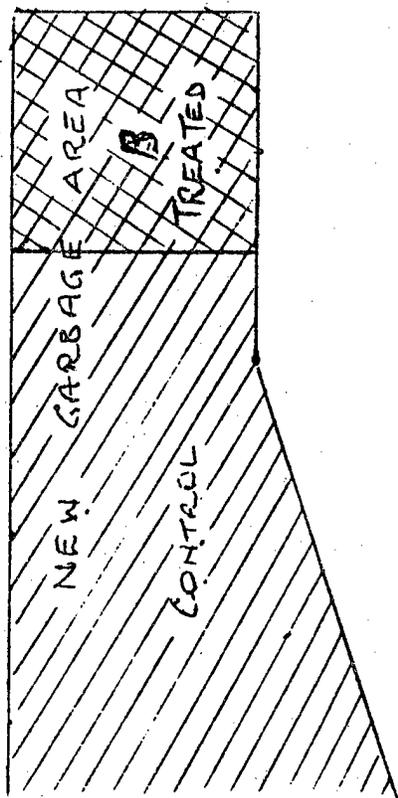
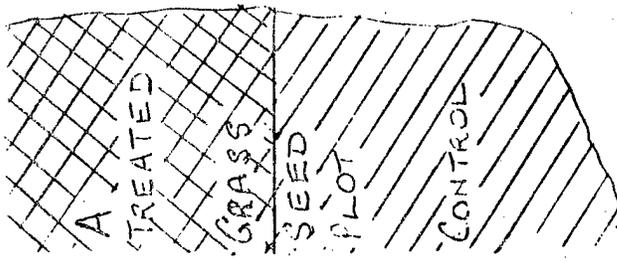
DEKALB COUNTY LANDFILL

(APPROX 200 ACRES NOT TO SCALE)

OLD GARBAGE



SHREDDED GARBAGE TAKEN BY TRUCK TO NEW GARBAGE SPREADING AREAS AND SPREAD BY BULLDOZER.



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ADF 616187

BIRD STRIKE COMMITTEE EUROPE

LONDON, 24-28 May 1976

Ref: BSCE/11 WP24

BIRDSTRIKE - THE AIRPORT MANAGER'S BRIEF

Squadron Leader T S Austin, RAF, UK

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BIRDSTRIKES - THE AIRPORT MANAGER'S BRIEFIntroduction

1. Birds represent a hazard to aircraft in the air. An aircraft striking a bird may suffer damage to its engines, its structure or its windscreen. The severity of the damage will depend on the weight of the bird, the speed of the aircraft and the strength of the part struck. At best a birdstrike will result in a delay or a diversion and a maintenance test, at worst it could result in a catastrophic accident. In Europe, civil aircraft strike a bird about once in every 1500 flights and once in every 2000 take-offs and landings. Military aircraft suffer a rather lower take-off and landing rate but have more en-route strikes because they carry out more flights at low level. Several military and civil aircraft are lost each year due to birdstrikes and the cost is considerable.

The Airport Manager's Responsibility

2. The Airport Manager must be responsible for ensuring that all measures are taken to make operations from his airfield as safe as possible. The birdstrike problem has been studied for many years by specialists in several fields and their advice is readily available. Therefore before starting bird scaring, the Airport Manager should first check on help and advice available from:

- a. Local ornithological and agricultural authorities.
- b. National aviation agencies.
- c. International literature.

The Principles of Birdstrike Prevention

3. The basic principles of birdstrike prevention are:

- a. On or near the airfield, keep the birds away from aircraft.
- b. En-route keep the aircraft away from birds.

4. On the Airfield. A study should be made of past birdstrikes and the number of aircraft movements in order to assess the risk and allocate resources to counter-measures. This should be compared with studies made at other airports with a similar style of operations.

5. Establish which species of birds are present on the airfield. Then discover if and why they are nesting, roosting, or feeding. If birds are nesting or roosting, make the area unattractive to them by changing the habitat, or harassment, or both. If they are feeding, remove the food supply by, for instance, closing garbage dumps, changing crops, or allowing the grass to grow long and hide the food source.

6. Habitat changing must be done with care because there is a risk that an even more dangerous species may replace that which is displaced. Bird scaring must be carried out scientifically to ensure that the birds do not adapt to the harassment. The operators must be trained to respond to new threats instantly and to trends intelligently. This requires good communications, adequate resources, a highly motivated organisation and, above all, efficient supervision.

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7. Off the Airfield. The Airport Manager's responsibility for en-route is to ensure that the operators have available to them information on local bird migrations as they vary with time of year, time of day, and the weather. Details of the effect of local agricultural seasons and changing water conditions, which require local study and knowledge, should be combined with the international migration situation and presented to the operator in such a way that he is able to assess the risk to his operation. The operator should also be provided with facilities so that he can get more detailed information from specialists if he so desires. He should be made aware of services available to him in the planning phase and during actual flight.

8. Birdstrike Check List. The birdstrike problem will initially require:

- a. A statistical survey.
- b. An ornithological survey.
- c. An agricultural survey.

From these surveys will come:

- a. A definition of the threat.
- b. A formulated plan.

Which in turn will lead to:

- a. An allocation of resources.
- b. A works services programme.
- c. A training programme for personnel.

Once birdscaring operations are under way, there will be a requirement for:

- a. A reporting system to local and national levels.
- b. A user information system.
- c. A monitoring system to judge effectiveness and modify operations to meet the changing threat.
- d. A programme to maintain personnel motivation.

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ADF 616188

BIRD STRIKE COMMITTEE EUROPE

LONDON, 24-28 May 1976

Ref: BSCE/11-WP25

REACTIONS OF MIGRATING BIRDS TO LIGHTS AND AIRCRAFT

RONALD P LARKIN, JOSE R TORRE-BUENO  
DONALD R GRIFFIN AND CHARLES WALCOTT

USA

**ABSTRACT** Midair collisions between birds and aircraft pose a hazard for both. While observing migrating birds with a tracking radar, we find that birds often react, by taking evasive maneuvers, at distances of 200-300m to both searchlight beams and the approach of a small airplane with its landing lights on. Appropriately arranged lights on aircraft should decrease the hazard of collisions with birds.

N.B. This Paper is printed in the United States' "Proceedings of The National Academy of Sciences" Vol. 72, No. 6, pp. 1994-1996, June 1975, and is not reproduced here.

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ADF 616 189

BIRD STRIKE COMMITTEE EUROPE

LONDON, 24-28 May 1976

Ref: BSCE/11 WP 26

SUMMARY OF TESTS CARRIED OUT AT THE  
INTERNATIONAL BEN GOURION AIRPORT (LOD)  
WITH "BIRD REPELLENT RETA"

D DAR, ISRAEL

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SUMMARY OF TESTS CARRIED OUT AT THE INTERNATIONAL  
BEN GOURION AIRPORT (LOD) WITH "BIRD REPELLENT RETA"

As a result of observations carried out from September 1974 at the Ben Gourion International Airport at LOD we were able to note that out of all the species of birds in the area surrounding the runways partridges and seagulls, and to a lesser extent Lapwings, could be of greatest danger in collision with aircraft landing or taking-off.

Partridges

Flocks of 8-12 partridges (Perdrix Bartavelle, Rock Partridge, Alectoris graeca) move around in the runway areas and sometimes cross the runways without being noticed from a distance; this has been observed several times using field-glasses and it seems likely that if a jet aircraft were to land or take-off while these relatively heavy birds were present, they could be sucked in by the engines.

Seagulls

Different types of seagulls spend the winter in Israel; they usually arrive from Eastern and North-eastern Europe from October/November and remain at this time by the sea; only the Black-headed gull (Larus ridibundus) leaves the shores during the day and searches for food inland, mainly on rubbish dumps; these gulls are often seen in very large flocks - several hundreds on smaller dumps and several thousands and more on large dumps. The flight of several hundreds of gulls at altitudes of several metres, several tens and even hundreds of metres certainly presents a very great danger to aviation. More so in winter the gulls land and even rest on the runways themselves and in nearby fields. The Black-headed gulls return each evening to the sea-shore for the night.

These findings have enabled us to set up two quite distinct experiment projects.

The first series of tests was intended to see whether at least the use of one of our "bird repellent Reta" formulas over parallel strips on the runways could prevent the presence of ground birds near to the runways and especially prevent the partridges from crossing the runways in their search for food.

The second series of tests was intended to see whether the treatment of rubbish dumps using the same "bird repellent Reta" product could reduce the size of the daily population of gulls at these refuse dumps.

The tests were carried out during the periods 1974-1975 and 1975-1976. The observations were made periodically by the author during the winter of 1974-75 and daily by S Birnbaum (agronomer) and the author during the 1975-76 period.

Location of the tests

For ease of observation the first series of tests (A) was carried out the length of the main runway 26-08 and on the North side, and the second series (B) on the municipal dump near to Yahoud which enabled movement

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between the two observation posts without too great loss of time.

(A) The length of runway 26-08.

The runway 26-08 runs East-West over 4000 metres; on its North side it is bordered by a 50 metre wide strip which is given over to fodder crops, tares and oats. This strip was treated and the crop was about 10cm high at the start of treatment.

(B) The municipal refuse dump - Yahoud.

This dump is situated alongside a drainage canal with V-shaped banks and to the North; to the South and to the West is a fenced off radio transmission station with 2 directional antennae (Log periodic antenna); the dump consists of 2 sections: the first is a strip 140 metres in length by 25 metres and the second is in the shape of a trapezium of almost 4000m<sup>2</sup>. The refuse trucks dump the refuse from the town in piles, side by side, and the refuse is not treated or moved at all, at least not during the duration of the tests. Most of the refuse is household rubbish, food scraps and kitchen refuse with a great deal of packaging of all kinds, cardboard boxes, plastic containers and cloth containers; also to be found is workshop refuse and scraps from slaughterhouses and butcher shops.

#### 1974-75 period

The treatment was carried out on the 6 February 1975 by means of a Bell 47 helicopter with 30kg of "Reta" per hectare diluted in 150 litres of water over the strip parallel to the runway and with 90kg per hectare (ie 1 kg of "Reta" in 5 litres of water) on the refuse dump and the Northern edge of the canal. The sky was slightly overcast during the morning when the treatment was applied and heavy rain followed after the treatment at the end of the afternoon, during the night of the 6th and all day on the 7th.

Parallel to the 26-08 runway treatment was carried out on two strips each 45 metres wide by 1000 long and separated by a space of 1000 metres which was not treated. Observations were made intermittently 3-4 times per week at different times of the day for one month until the 6th March.

#### Results and findings from the 1974-75 test period

During the month 6 February to 6 March no partridges were seen at all alongside the runway or on the two areas treated and some were seen several times on the sample non-treated areas and on the cultivated fields round about.

On the municipal dump: it seemed that the number of gulls generally had diminished, that the time spent by the gulls above the dump was considerably reduced and that the times at which the gulls visited the dumps had become very irregular.

The results of tests carried out in this period seemed sufficiently interesting and promising to encourage further testing during the following year, on a larger scale with daily continuous observation and with as exact recording as possible.

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### 1975-76 test period

An initial treatment was carried out over the length of the 26-08 runway on the 27 and 28 January over an uninterrupted area of 3000 metres by 46 metres using a Leland Snow S-2 crop spraying plane with 30kg of "Reta" in 150 litres of water per hectare. A second treatment was carried out on the 17 February on the same strip using a Bell 47 helicopter with 33.3 kg of Reta in 200 litres of water per hectare. Both treatments were carried out in good weather conditions, the first in wind which was within the norm for aerial treatments.

On the refuse dump, on the 15 February a treatment was carried out using a Bell 47 helicopter with 200 kg of Reta per hectare (ie 7.5 litres of water for 1 kg of Reta) over a total area of 2 hectares; from the 18 February daily dumps of refuse were sprayed daily, firstly using a sprayer mounted on the back with a Holder engine and later, for simplicity, using a manual Léhavot spray with pre-set pressure and at a rate of 0.5 to 1 kg of Reta per truck load depending on circumstances and a concentration of 1 kg of the product in 10 litres of water; on wet days the spraying was replaced by a powdering of the area which the rain fixed to the refuse.

### Findings from the 1975-76 period

(A) Test alongside the 26-08 runway; the strip treated was divided into 4 numbered areas from 1 to 4 East to West. The number of birds was noted, mostly Lapwings (Vanellus vanellus), and the time they remained on the area; to compare the findings with one another the coefficient C was taken so that -

$$C = \frac{\text{number of birds X time spent on the area in minutes}}{\text{hours of observation}}$$

The first aerial treatment was carried out on the 27 and 28 January; it was interrupted on the 27th after the first load due to mechanical problems and resumed the following day. This treatment was not successful although the reason for this is not known with any certainty but it is likely that it was not carried out correctly; the second treatment was carried out on the 17 February by helicopter and was effective from all points of view. The findings which followed were not continued because observation was transferred to the Yahoud refuse dump. After this second treatment the number of Lapwings and Partridges decreased notably, down to zero on the area treated, whereas the number of Lapwings remained constant and the number of Partridges increased on the surrounding areas, allotments, roads and fallow ground; at this time the flocks of partridges divide and partridges are most often seen in pairs, cf. drawing and table "A".

(B) On the Yahoud municipal dump the number of gulls in the air and on the refuse dumps was noted as accurately as possible: the number of birds of other species was estimated: starlings, (Sturnis Vulgaris) Cattle Egrets (herons Ardeola ibis), bulbuls (Pyenotus capensis), sparrows, doves and pigeons and swallows at the end of the period.

The behaviour and the number of birds of different kinds during a typical day at the end of January and the beginning of February can be described as follows:



6.30 Arrival from SE, in large waves, of starlings reaching in 15-20 mins a population of 1000-1200 and setting down on antennae and various cables and antenna braces.

6.45 Arrival from the West in groups of 4-6 of herons up to 7.00 reaching a number of 12-20.

6.50-7.00 Arrival from the West in waves of 30-50 of gulls reaching between 200-400 in 15-20 mins. Gulls land unfailingly and directly on the refuse of the morning and of the previous day. (Each refuse skip was marked and dated with coloured ribbons).

At the same times we noted about 50 pigeons and doves, a few dozen sparrows and between 10 and 20 bulbuls.

From 9.00 the number of starlings goes down to 400 and increases to 1000-1200 towards the end of the day from 14.30-15.00. Towards 16.00 the starlings leave the area. The number of doves, pigeons, herons, sparrows and bulbuls remains static until about 16.00.

During the day groups of gulls leave the area and come back after 20-30 mins. So this means that there are always 150-400 up to 16.00 according to the weather. From time to time large groups of gulls 100,200,300 settle either on the nearest antenna (never on the second antenna which is 150m away) or inside the enclosed area of the radio transmission station, or on the banks of the canal. Resting time may be more than half an hour.

From 16.30 there are practically no more birds in the area. This typical timetable is a few minutes earlier every day whilst the time of departure of the birds remains more or less constant, a bit earlier in bad weather and a bit later in fine weather.

On the 15 February the whole area was treated with "Reta" in quantities of 20 kg per 1000m<sup>2</sup>, that is both dumping areas and the North bank of the canal over a distance of 250m; the bank is covered with dense grass 10-15cm high.

During the 3 days following the treatment no significant modification in the number of birds was observed nor any modification in the behaviour of the starlings, pigeons, doves, bulbuls and herons; but this was not the case for the gulls; on the 16 February the doves settled on the banks of the canal as on previous days but as from 17 February the gulls no longer settled on the banks and this continued to the end of the season.

From the 18 February the daily refuse was treated with "Reta" each heap was only treated once. As from the 18 February we noted a very significant decrease in the number of gulls settling on the refuse heaps, but the gulls continued to fly low, skimming over the refuse. We observed that the gulls almost certainly did not eat any longer; on several occasions we noted with field glasses, a gull pick up a piece of refuse in its beak, fly with it for a few seconds, drop it and land immediately on a puddle to drink. At the same time the gulls became sensitive to different noises: the arrival of the refuse truck, the taking-off of an aircraft or the working of the engine-driven sprayer; they then disappeared for a much longer time; before treatment these noises did not have any effect on the gulls' behaviour.

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On several occasions the official in charge of the anti-bird campaign in the aerodrome transmitted by loud speaker cries of distress (using a Dutch tape); before the treatment the effect of these transmissions was temporary to begin with, the gulls left the area for about 20 mins and then hardly at all; after treatment the effect of these transmissions was more constant but always temporary.

From the 23 February we used a very noisy reaction fog-emitter (pulsefog) and the gulls left the area immediately but came back after periods ranging from  $\frac{1}{2}$  hour to 2-3 hours.

From the 2 March we met the first gulls between 6.30 and 6.45 by turning on the pulsefog and by directing the nozzle at the gulls. These first gulls (scouts) then departed Westwards and no more returned. The area remained empty of gulls to the end of the day and this continued to the 3 April. As from the 3 March the gull-scouts no longer came in groups of 10-30: one gull would come alone and leave as soon as the pulsefog was set in operation. Several times the mere sight of the equipment, painted in violent red and blue, even before its sometimes laborious starting-up, was enough to cause the gull to leave.

From the 2 of March also the number of starlings fell drastically from more than 1000 to about 50. About the same time as the almost total disappearance of the gulls. In the region in general the number of starlings remained constant for another 2-3 weeks.

The last daily treatment of the refuse heaps was carried out on the 26 March and continuous observation ceased on the 28 March. From the 29 March we carried out intermittent observation. On 3 April we observed 50 gulls on the site at 10.30. On the 4/5 April between 60-80 at 9.30 and on the 6 April we observed 75-200 gulls between 7.00 and 8.30. Observation ceased finally from the 7 April.

On the various public dumps in the region we observed no significant modification in the number of gulls until the 26 March; as from the 26 March the number of gulls on these dumps diminished visibly although no count was carried out of drawings and table "B".

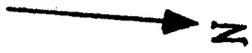
This report was written taking into account the observations, counts and the report made by the agronomer S Birnbaum.

Tel-Aviv, May 1976

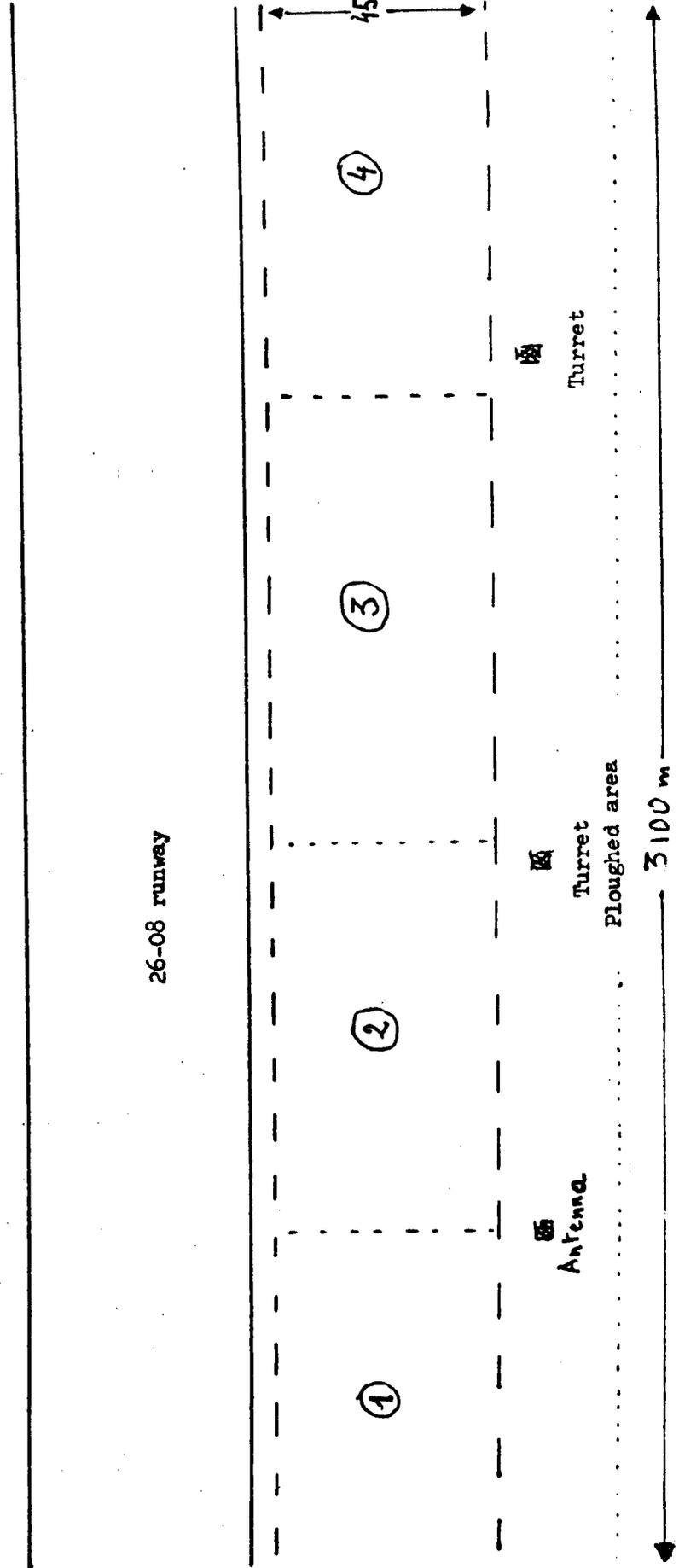
Guyora Dar

Agronome  
Assia Maabarot

Tab A1



Treated strip along 26-08 runway



253

Number and behaviour of Lapwings and Partridges on the treated strip parallel to the 26-08 runway.

Breeds date	6				7				8				9				10				11				12				13				14				15				C	
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4						
21-1									- 0 0 -	- 0 0 -	- 1 4 -										2																				1415	
22-1					0 6 15 4	0 10 1 0	0 15 10 0														0 5 14 0	0 2 6 0	0 0 0 0																		338	
23-1						0 0 10 0	0 0 0 0	0 0 1 0													0 0 4 0	1 0 0 6																			53	
25-1									0 25 5 0	0 0 5 0	0 0 0 0	0 0 0 0									0 20 0 0	20 0 0 15																			48	
26-1					0 4 2 0	0 0 4 0	0 1 1 0	0 0 3 0													0 0 6 0	0 0 6 0	0 15 0 0																		147	
27-1					10 30	60	60 30		0 2 2 0	0 0 0 0	0 0 0 0	0 5 0 0									0 3 0 0	0 0 0 0																			59	half treatment by aircraft
28-1					0 0 0 0	0 0 0 0	0 6 1 0	0 1 4 0													0 2 4 0	0 2 12 0	0 2 12 6																		25	half treatment by aircraft
29-1					0 0 1 0	0 0 0 0	0 0 0 0	0 0 2 0																																	45	
30-1					60				0 1 1 0	0 0 7 0	0 0 12 0	0 0 0 0									0 0 1 0	0 0 0 0																			53	
1-2					0 0 1 4	0 0 0 0																			0 1 2 0	0 0 0 0															13	
2-2					5 5				0 0 0 0	0 0 0 0	0 1 0 0	0 3 0 0									0 2 0 0	0 1 2 0	0 0 1 0																		66	
3-2											0 0 6 0	0 0 3 0									0 0 2 0	0 0 0 0	0 0 0 0																		92	
4-2					0 0 0 1	0 0 0 1	0 0 2 2	0 0 2 3													0 0 0 5	0 0 0 2	0 0 0 4																		150	
8-2					0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0													0 0 0 0	0 0 0 0	0 0 0 0																		0	
9-2					0 0 1 0	0 0 4 0	0 4 6 0	0 2 10 5													0 0 0 0	0 0 0 0																			211,5	
17-2	TRAITEMENT HELICOPTERE																																									
18-2																					0 0 0 0	0 0 0 0	0 0 0 0																		0	
22-2					0 0 0 0	0 0 0 0	0 0 0 0																																		0	
24-2					0 0 0 0	0 0 0 0																			0 0 0 0	0 0 0 0	0 0 0 0														0	
25-2					0 0 0 0	0 0 0 0	0 0 0 0																		0 0 0 0	0 0 0 0	0 0 0 0														0	
26-2					0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0																	0 0 0 0	0 0 0 0	0 0 0 0														0	
27-2					0 0 0 0	0 0 0 0	0 0 0 0																		0 0 0 0	0 0 0 0	0 0 0 0														0	
29-2					0 0 0 0	6 0 0 0	0 0 0 0	0 0 0 6													0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 2																	50	
4-3					5			60													0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0																	0	
7-3					0 0 0 0	0 0 0 0																			0 0 0 0	0 0 0 0	0 0 0 0														0	
8-3									0 0 0 0	0 0 0 0	0 0 0 0																														0	
9-3									0 0 0 0	0 0 0 0	0 0 0 0																														0	
11-3					0 0 0 0	0 0 0 0															0 0 0 0	0 0 0 0	0 0 0 0	0 0 0 0																	0	

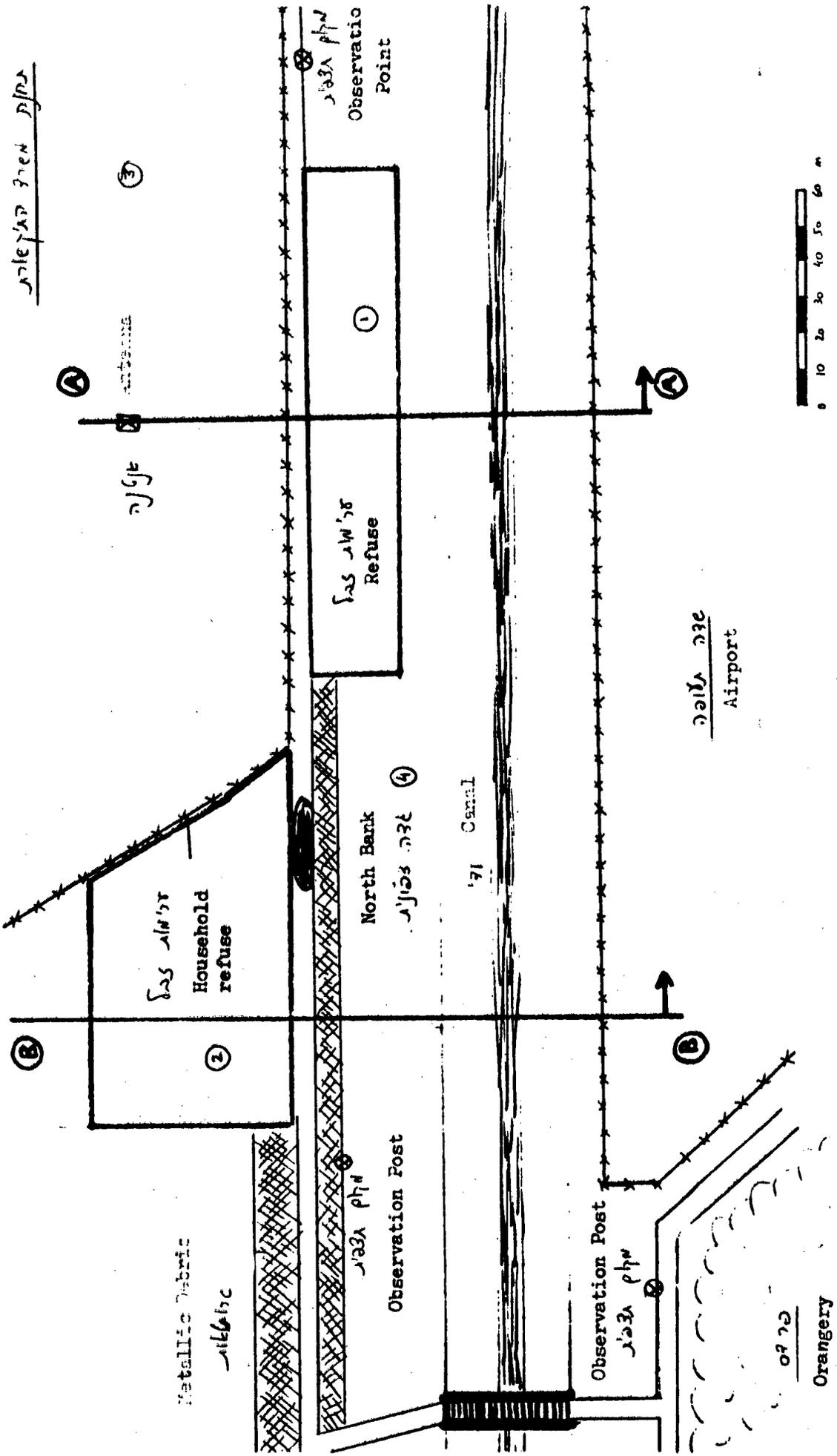
N.B. In each case the upper figure gives the number of lapwings and/or partridges in the corresponding area and the lower figure gives the time in minutes the same birds have spent on the same area.

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מספר תעודת זהות: 12345678

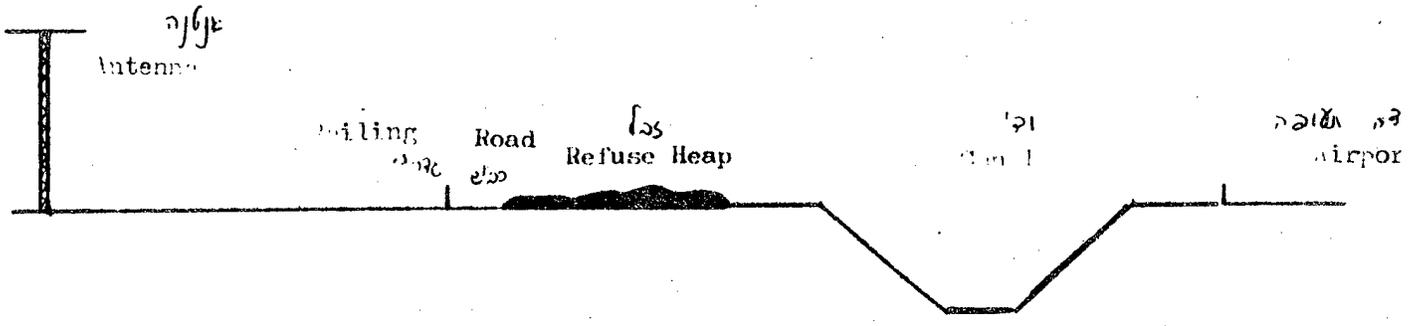
Tab B1: Municipal Dump - Yehoud

Radio Transmission Station

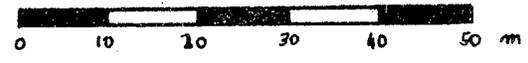
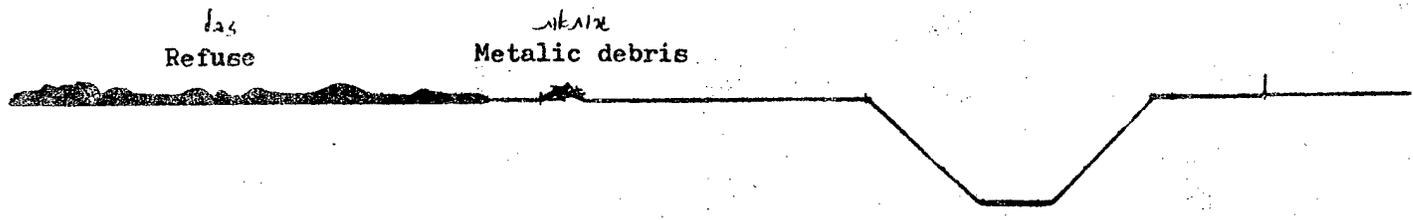


Tab B2

(A) - (A)



(B) - (B)

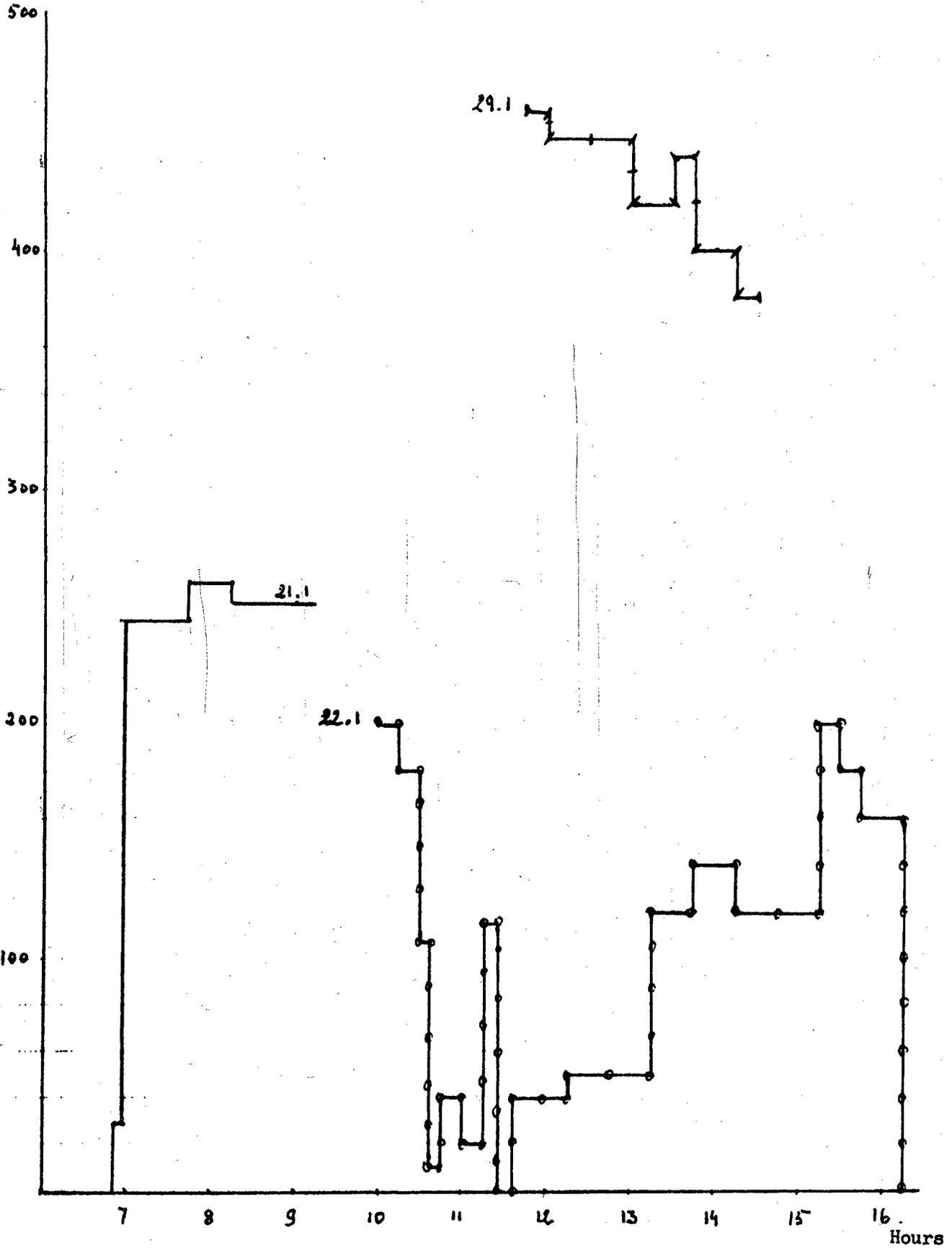


256

21.1 - 22.1 - 29.1

Tab B3

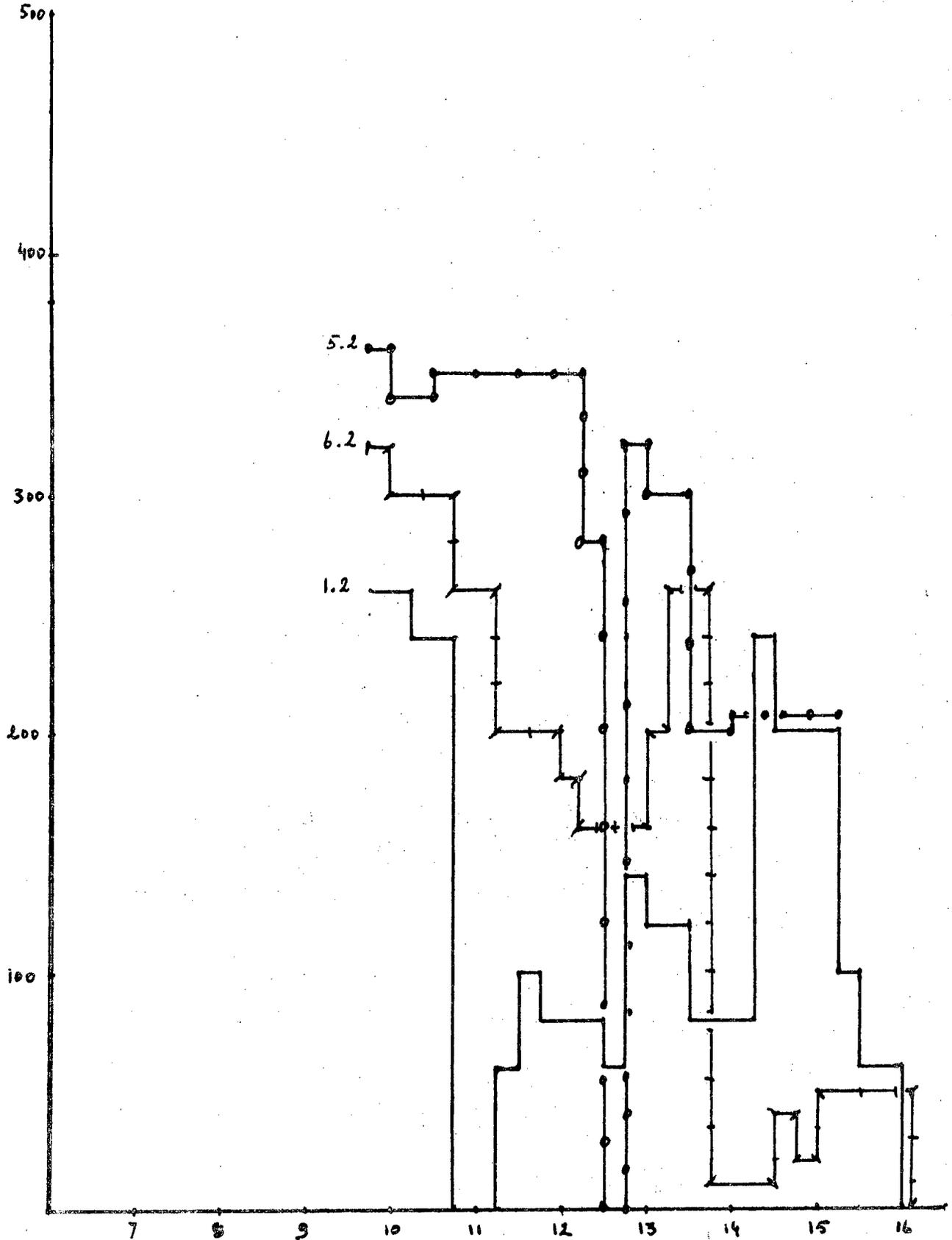
Number  
of gulls



257

1.2 - 5.2 - 6.2

Tab B4

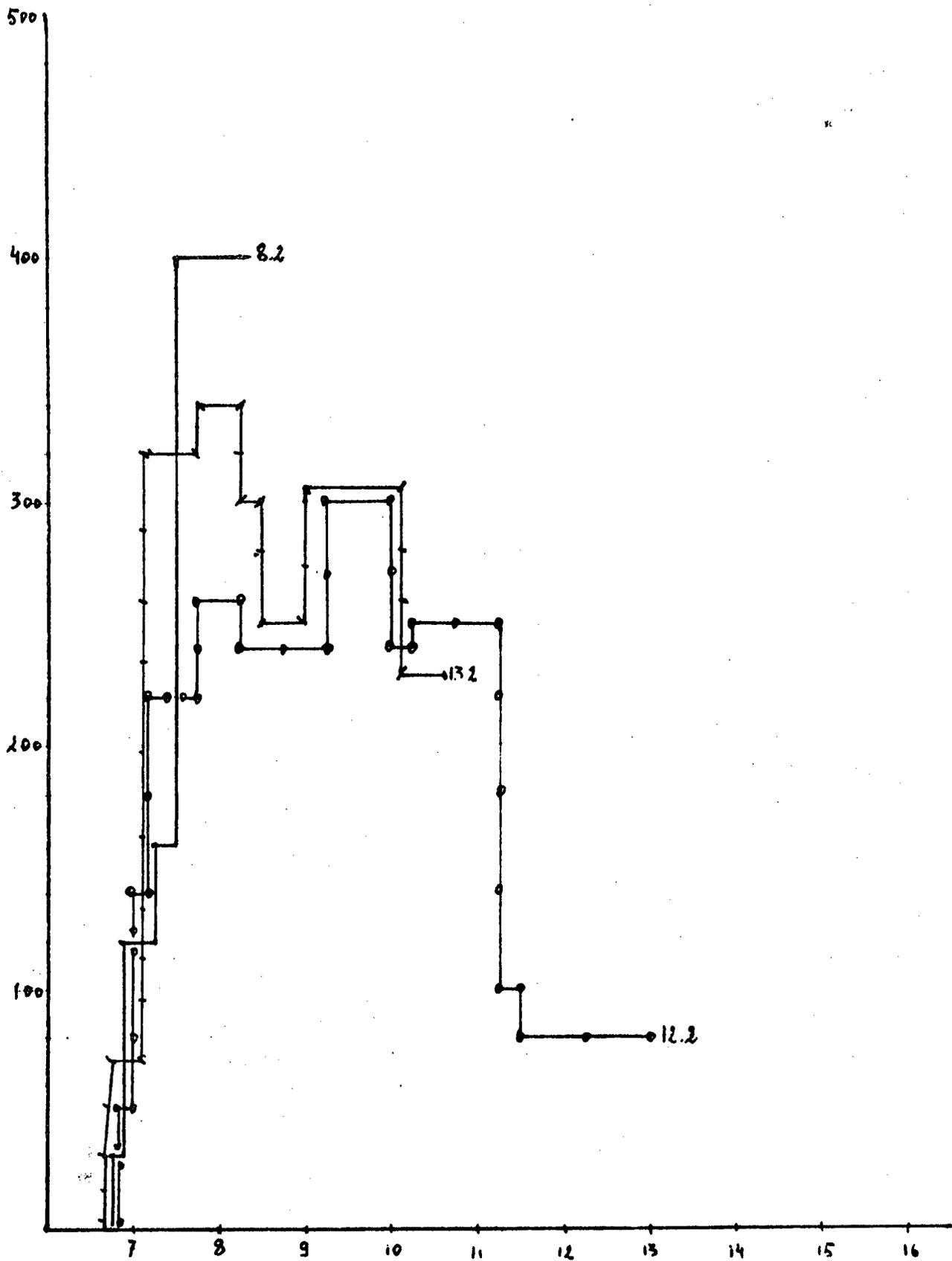


258



8.2 - 12.2 - 13.2.

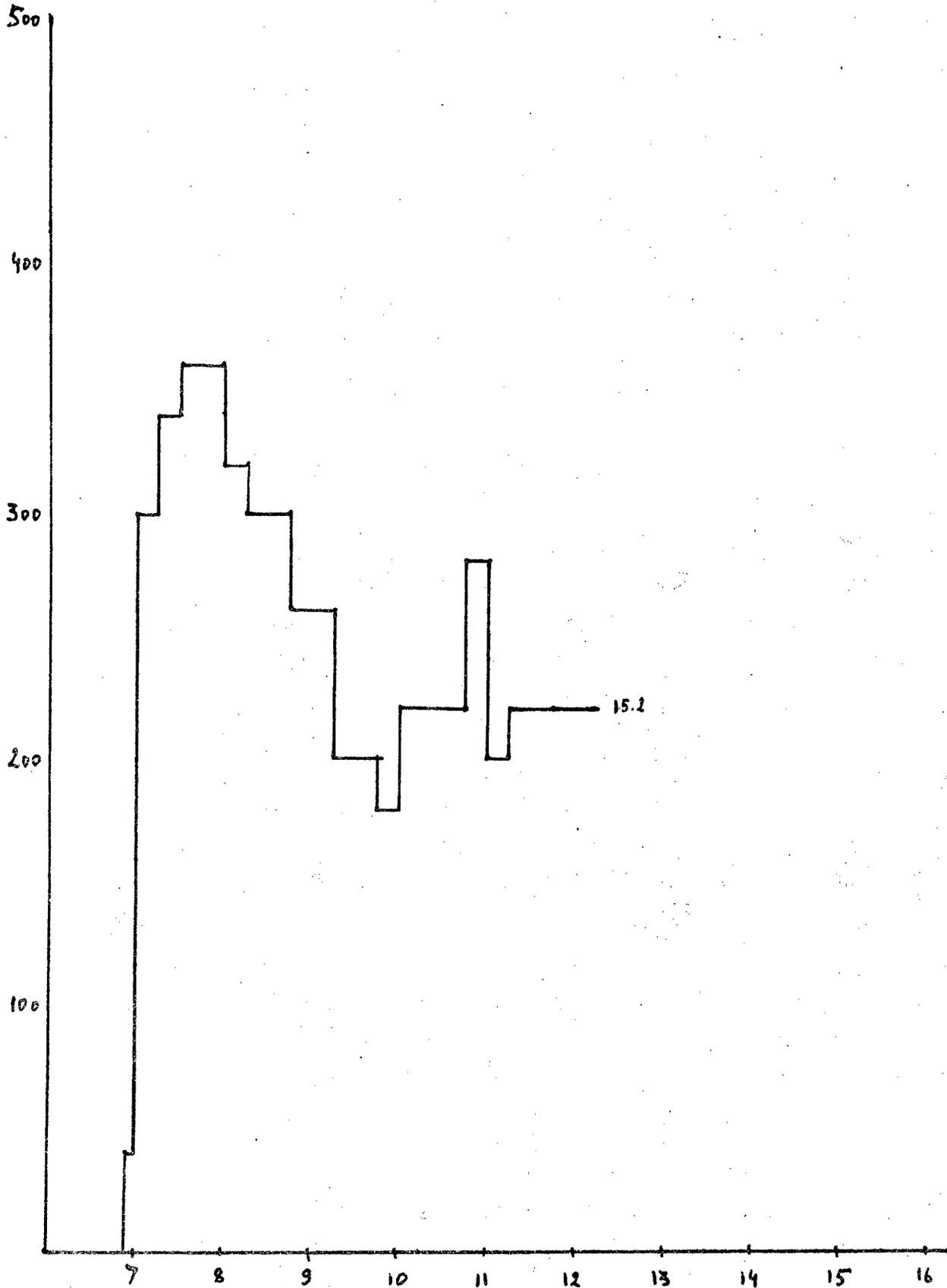
Tab B5



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15.2.

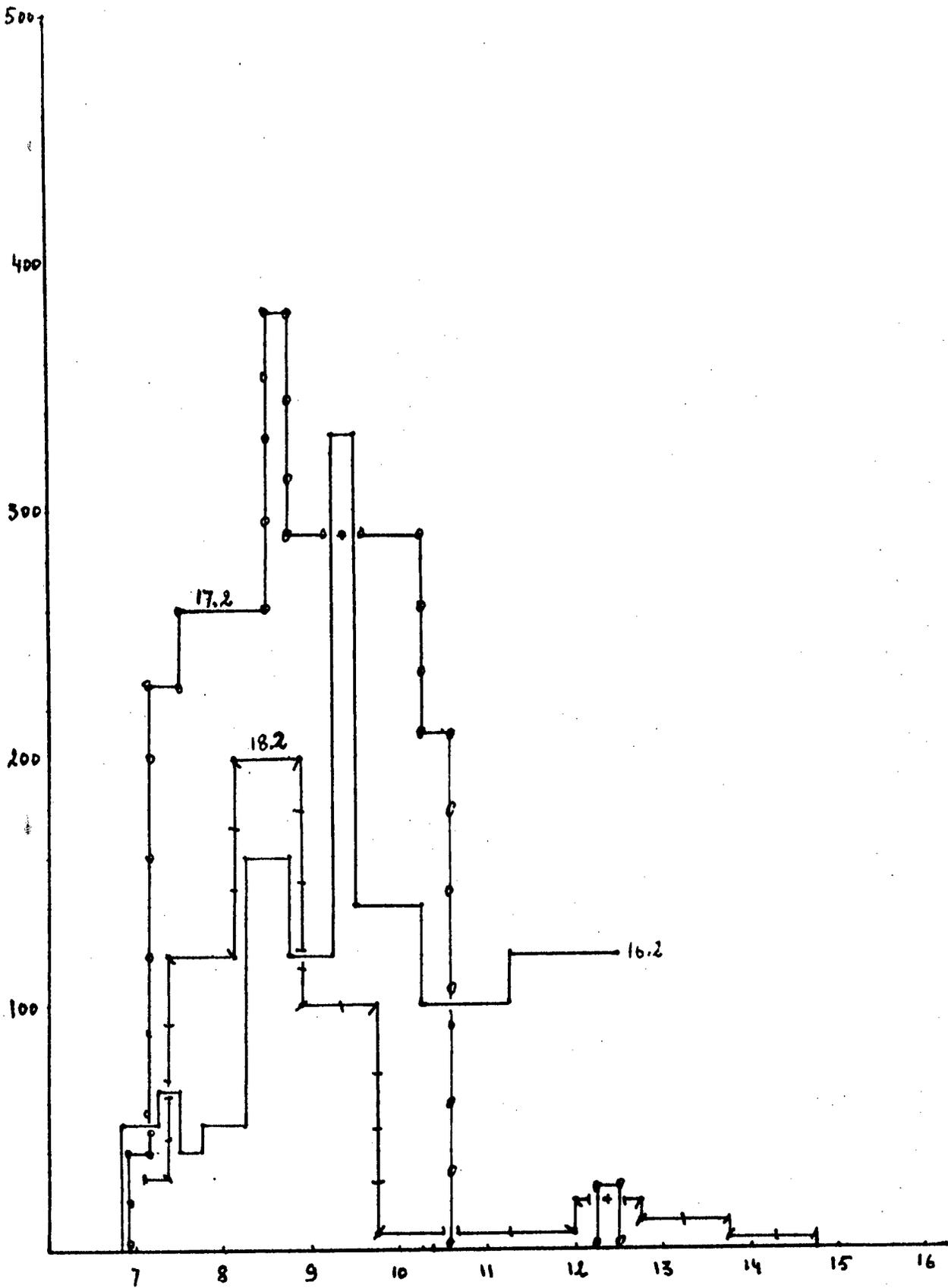
Tab B6



260

16.2 - 17.2 - 18.2

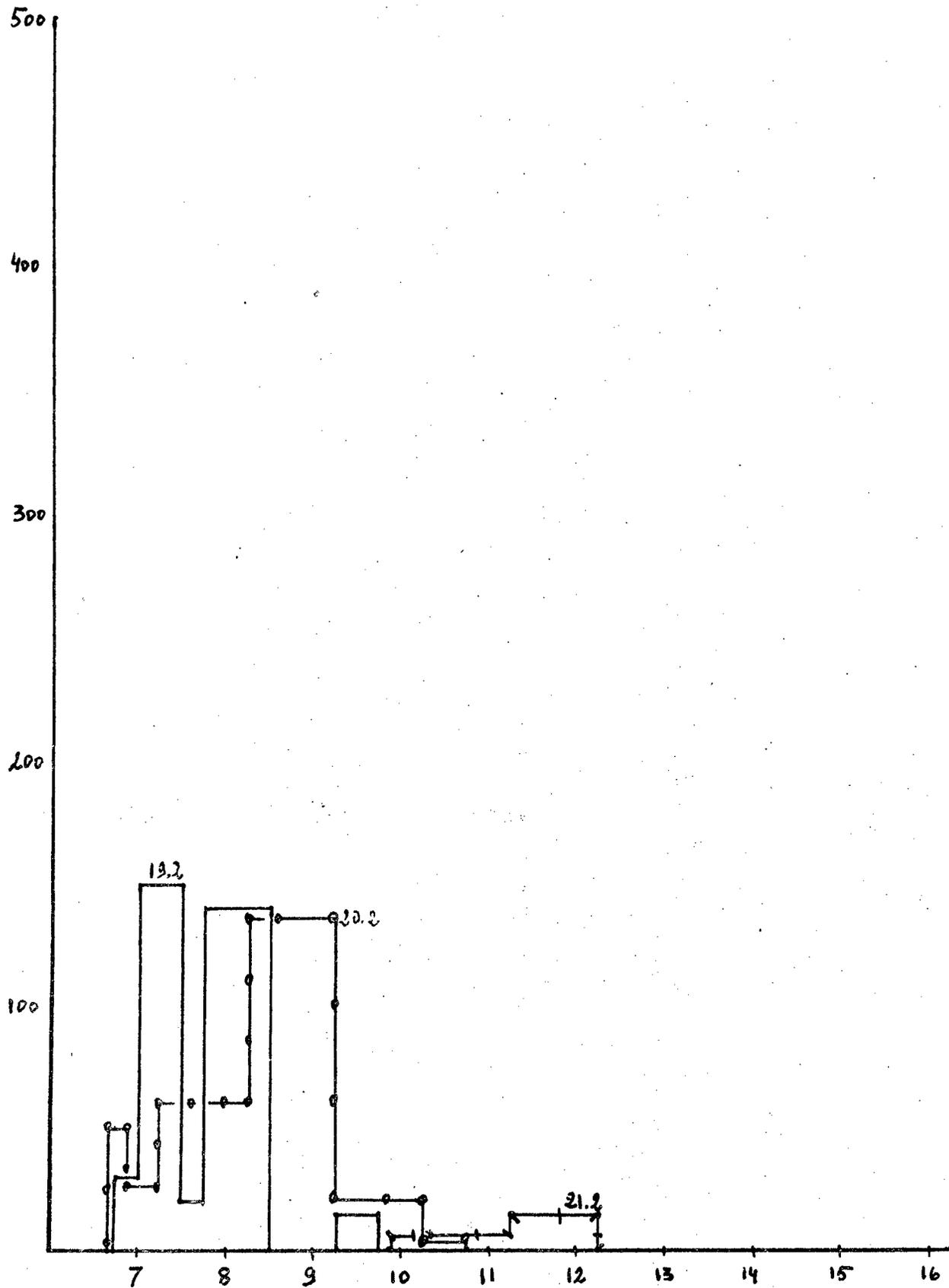
Tab B7



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19.2 - 20.2 - 21.2

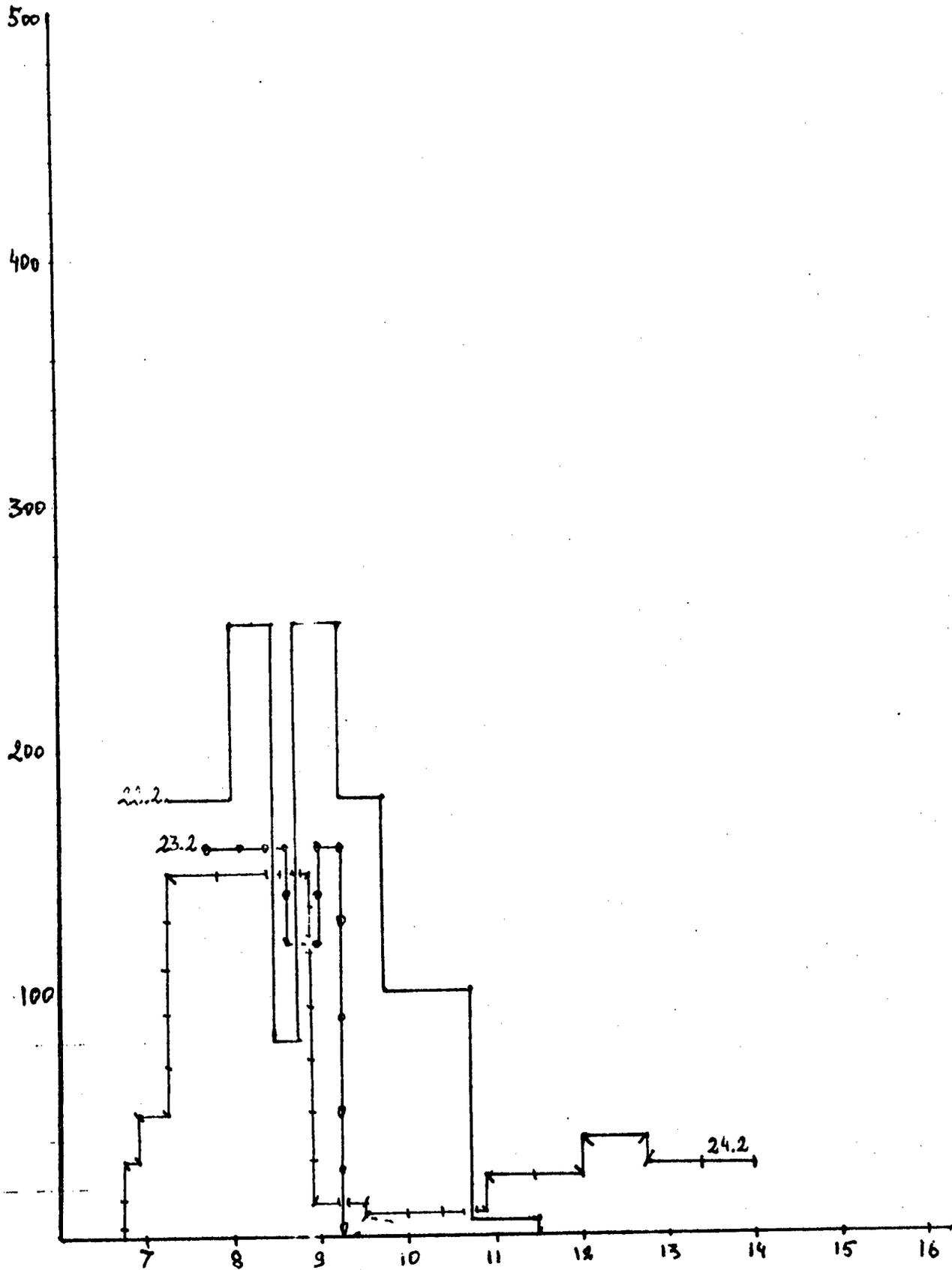
Tab B8



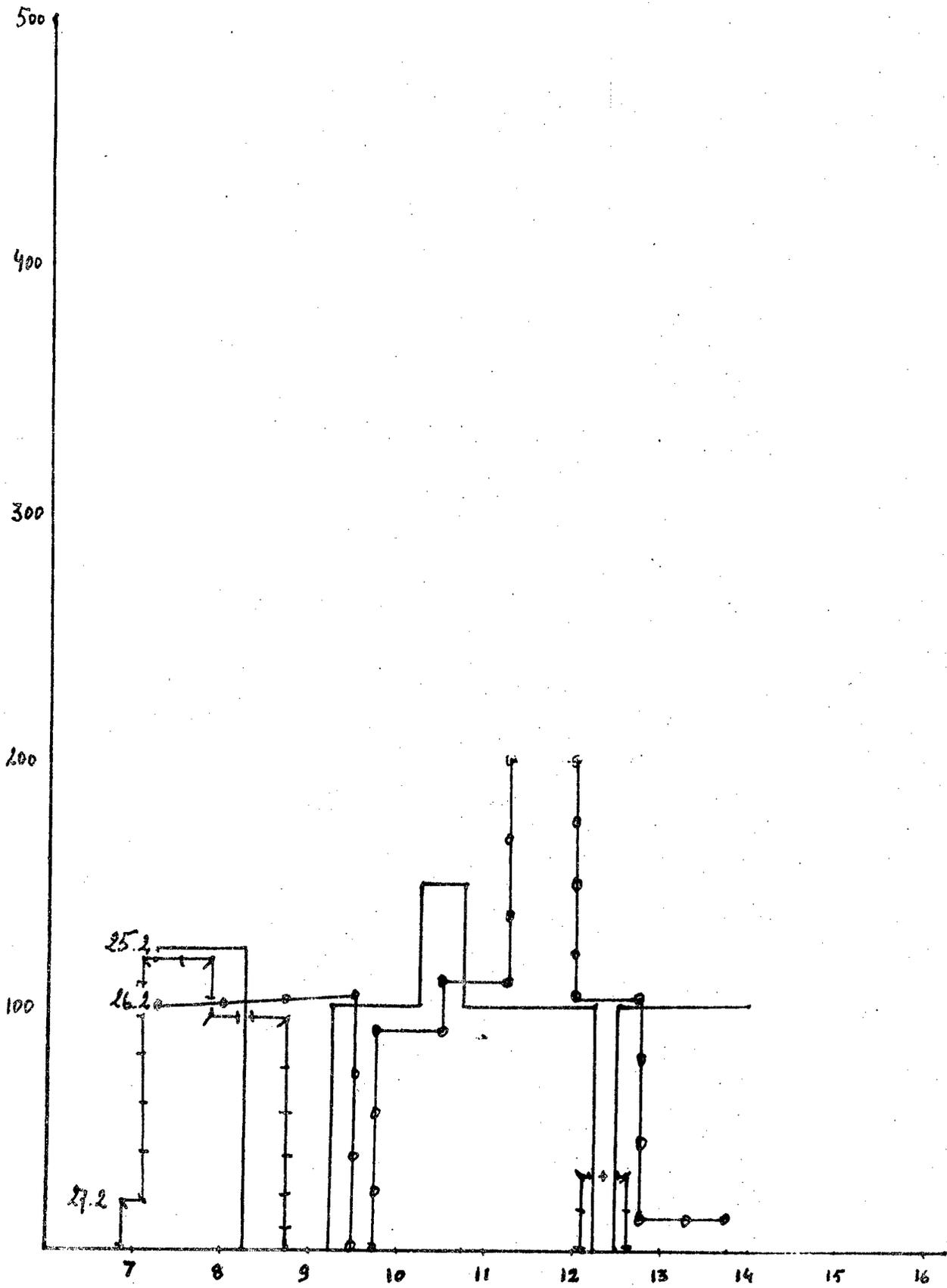
262

22.2 - 23.2 - 24.2

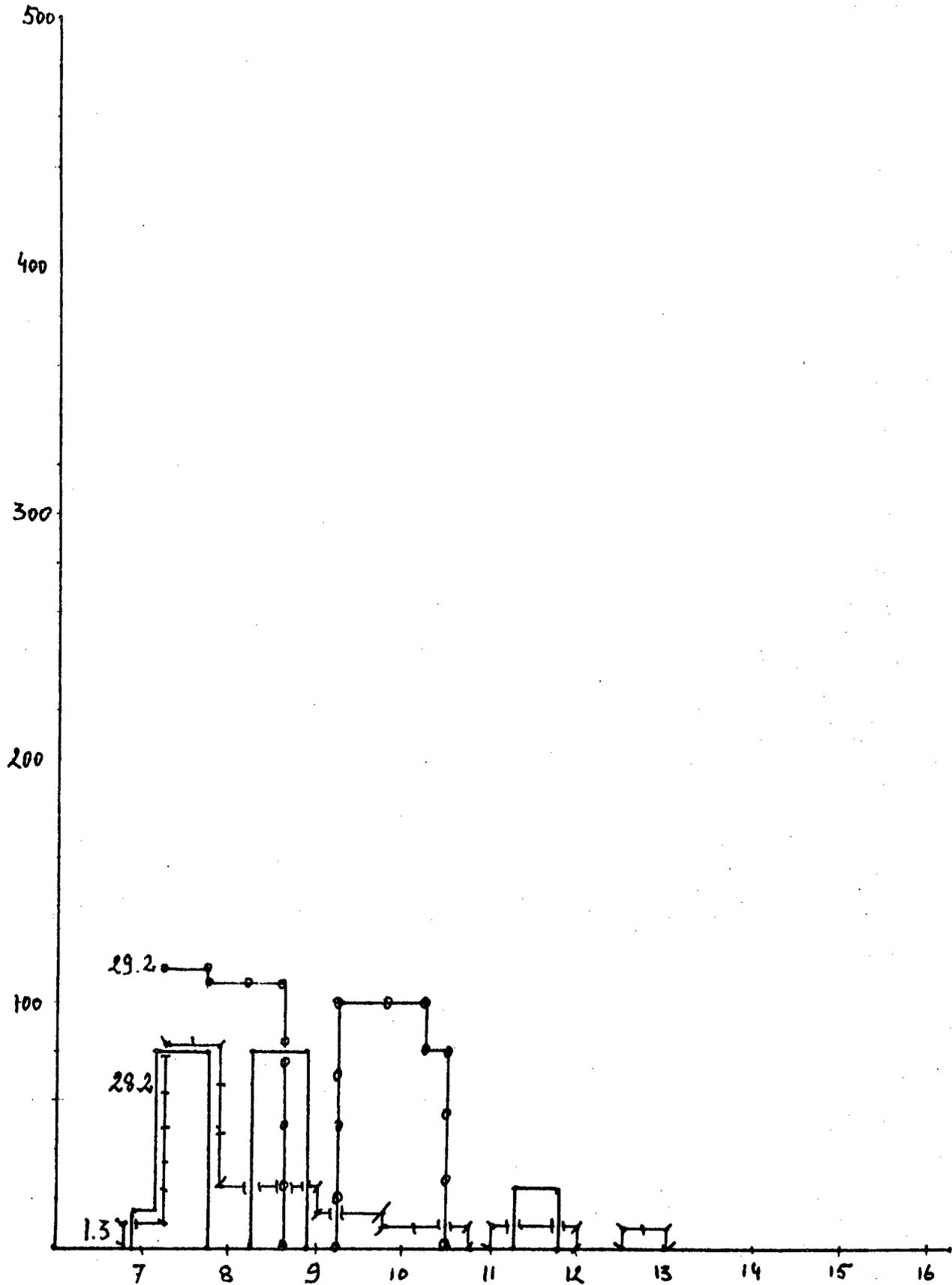
Tab B9



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Number and Behaviour of Gulls on Yehud Municipal Dump

Date	Weather	Hour of arrival of first gulls	Number of gulls in first wave	Hours											Number of gulls on banks of canal		
				6-7	7-8	8-9	9-10	10-11	11-12	12-13	13-14	14-15	15-16				
21-1	☉	6:55	30	80	250	250	250										150
22-1	☀	-	-		120	100			70	150	30	50	120	120	100	175	100
29-1	☁	-	-									150	450	400			150
1-2	☉	-	-						80	250	80	120	80	200	60	60	150
5-2	☁	-	-						80	350	100	350	280	300	200		150
6-2	☁	-	-						100	300	200	175	250	10	50		175
8-2	☉	6:45	30	80	120	400											120
12-2	☁	6:50	50	0	50	220	250	300	250	150	150	0	80	80			175
13-2	☀	6:50	30	70	320	250	225										200
15-2	☀	6:55	40	40	200	350	300	200	200	120	200	helicopters	helicopters				200
16-2	☁	6:50	50	50	100	160	120	50-100	100	120							120
17-2	☀	6:50	40	40	50	230	380	290	210	0	0	150					0
18-2	☁	-	-	0	30	120	200	100	6	6	5	20	10	5	0	0	0
19-2	☀	6:45	30	30	0	150	100	150									0
20-2	☀	6:45	50	0	30	0	60	140	4	20	0	3	0	0	0	0	0
21-2	☀	-	-						5	5	0	15	0	0	0	0	0
22-2	☀	-	-		180	250	180	100	0	5	0	0	5	0	0	0	0
23-2	☁	-	-		100	120	160	0	0	0	0	0	0	0	0	0	0
24-2	☁	6:45	30	0	50	30	150	150	15	10	25	40	30				0
25-2	☁	-	-				125	175	100	50	150	100	100	100			0
26-2	☁	-	-				100	100	100	100	200	100	15				0
27-2	☁	6:55	20	20	0	120	100	0	0	0	0	30	0	0			0
28-2	☁	6:55	15	15	0	80	80	0	0	0	15	0	0	0			0
29-2	☁	-	-		50	115	110	100	30	80	0	0	0	0			0
1-3	☁	6:50	10	10	0	80	25	15	0	10	10	10	0	0			0
2-3	☀	6:20	10	0	0	0	0	0	0	0	0	0	0	0			0
3-3	☀	6:31	7	0	0	2	0	1	0	0	0	0	0	0			0
4-3	☀	6:45	7	0	0	6	0	0	0	0	0	0	0	0			0
5-3	☁	6:45	2	0	0	5	0	0	0	0	0	0	0	0			0
6-3	☉	6:30	4	0	3	0	0	0	0	0	0	0	0	0			0
7-3	☉	7:20	1	0	0	20	0	0	0	0	0	0	0	0			0
8-3	☀	6:50	1	0	0	50	0	0	0	0	0	0	0	0			0
9-3	☀	7:20	1	0	0	0	0	0	0	0	0	0	0	0			0
10-3	☀	-	-				2	0	0	0	0	0	0	0			0
11-3	☀	6:30	1	0	0	0	0	0	0	0	0	0	0	0			0

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Number and Behaviour of Gulls on Yaboud Municipal Dump

Date	Weather	Hour of arrival of first gulls	Number of gulls in first wave	Hours											Number of gulls on banks of canal	
				6-7	7-8	8-9	9-10	10-11	11-12	12-13	13-14	14-15	15-16			
12-3		8:00	1	0	0	0	0	0	0	0	0	0	0	0	0	0
13-3		6:45	1	0	0	0	0	0	0	0	0	0	0	0	0	0
14-3		7:30	1	0	0	0	0	0	0	0	0	0	0	0	20-0	0
15-3		7:00	4	0	0	0	0	0	0	0	0	0	0	0	0	0
16-3		7:25	15	0	0	16-0	0	0	0	0	0	0	0	0	5-0	0
17-3		6:42	1	0	0	0	0	0	0	0	0	0	0	0	0	0
18-3		7:44	1	0	0	0	0	0	0	0	0	0	0	0	0	0
19-3		8:15	3	0	0	0	3-0	0	0	0	0	0	0	0	0	0
20-3		-	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21-3		8:50	1	0	0	0	0	0	0	0	0	0	0	0	0	0
22-3		10:15	60	0	0	0	0	0	0-60-0	0	0	0	0	0	0	0
23-3		8:00	1	0	0	0	0	0	0	0	0	0	0	0	0	0
24-3		7:15	1	0	0	0	0	0	0	0	0	0	0	0	0	0
25-3		9:05	1	0	0	0	0	0	0	0	0	0	0	0	0	0
26-3		-	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27-3		-	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28-3		-	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29-3																
30-3																
31-3																
1-4																
2-4																
3-4									50	50						
4-4									60-80	60-80						
5-4									80	80						
6-4									75-200	75-200						

Note: In each case the upper figure gives the total number of falls on the area and the lower figure gives the number of sitting gulls on the refuse.

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BIRD STRIKE COMMITTEE EUROPE

LONDON, 24-28 May 1976

Ref: BSCE/11 WP/27

BIRD STRIKE PROBLEMS OF THE  
PROJECTED AIRPORT MÜNCHEN II

Johannes Maron, Flughafen München GmbH

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## BIRD STRIKE COMMITTEE EUROPE

## Bird Strike Problems of the Projected Airport München II

Author: Johannes Maron, Flughafen München GmbH

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The request of Flughafen München GmbH (Airport Company München) to plan and construct a new airport for München in the area of Erding / Freising was approved by German authorities in August 1969. This new airport should replace München-Riem now in operation. München-Riem can no longer meet the demands of modern air traffic. It has only one runway. Extension or enlargement are impossible because the airfield is encircled by settlements and the suburbs of München.

The site of the new airport - size 2600 hectares = about 6500 acres - is provided in the area between Erding and Freising about 15 miles north of München. In this region agriculture is predominant.

81 farmyards and 25 smaller houses with nearly 500 inhabitants are concerned and have to be removed. The farmyards are widely dispersed except of a small village named Franzheim where most of the dwelling houses are situated.

Some slides shall give you an impression of the landscape. The ground is absolutely flat and completely cultivated. We find meadows and acres but no coherent woods, only groups of trees and shrubs.

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In the west of the projected airfield flows the river Isar. The banks on both sides are in a depth of 500 to 600 m covered with mixed woods (firs, beeches, birches, oaks, etc.), shrubbery and small patches of gravel or grassland. Around the new airfield there are mostly cultivated acres and pastures, only in the south and north-east we find patches of moorland - remnants of the former large moors south of the river Donau. In the beginning of this century the peat had been removed and the soil cultivated.

Animals and birds in this area are numerous. Already in the first stage of designing of the new airport we investigated the ornithological situation in this area and contacted Dr. K e i l, Frankfurt, to support us in taking precautionary measures against the hazards of bird strikes.

Observations of typical birds are available since 1961.

Those gentlemen who participated in the meeting in Munich in 1972 will remember my report given on the ornithological situation in this area.

127 different kinds of breeding birds were registered, furthermore the migrating birds.

Endangering air traffic are especially the flocks of gulls, lapwings, crows, furthermore pigeons, hawks, buzzards, pheasants, partridges, wild ducks and various limicolous birds.

Two main problems are confronting us.

1. Air traffic demands to keep away all kinds of birds dangerous to aircraft and provoking bird strikes.
2. Environment protection requires measures to compensate the loss of breeding and abiding places of the concerned birds, especially those which are already reduced due to the growing influence of civilization on our natural resources.

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- To item 1) a) Though no lakes or larger ponds exist in this rather moist area there are a lot of brooks and ditches between the river I s a r and the I s a r canal, some of them crossing the projected airfield. They have to be guided around the airfield and remain open. Two trenches for draining and leading off the rainwater from run- und taxiways were originally planned underground. For technical reasons they now will be held open and run parallel to the runways. To keep birds away a dense net of wires stretched across the ditches is provided.
- b) The soil of and around the airfield contains a layer of gravel 10 to 20 m deep which is industrially usable for all types of constructions. Many gravel-pits especially in the direction to München are in operation and extending north into the area of the new airport. We too need huge amounts of gravel for our own purposes. To avoid long transport lines the gravel must be taken from the vicinity of the airfield. The level of groundwater there is close to the surface and after exploiting lakes of great dimension remain. We must take care that all gravel-pits around the airfield have to be refilled, at least established in a way not attractive to birds.
- c) The wooded banks of the river I s a r are preferred by birds of prey. All aircraft departing to the west are crossing these banks. In order to avoid bird strikes flying instructions have to regard this.
- 3  
2-11

- d) Most of the ground between the runways and the southern part is reserved for later use. Agricultural management in the common manner is undesirable. We are developing a plan with different possibilities i.e. planting Christmas-trees cultures, producing grass for bull raising, or creating patches with pure soil where grass grows sparsely and needs no care.

To item 2) The Flughafen München GmbH and the authorities concerned with environment protection endeavour to preserve the original character of this area. It is intended to create new locations similar to those lost inside the airfield. Plans are worked out with proposals how to insert the airfield in the present landscape.

We hope to construct a new airport where we can avoid the hazards of bird strikes and which otherwise fits well into this typical Bavarian region.

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ADF 616191

BIRD STRIKE COMMITTEE EUROPE

LONDON, 24-28 May 1976

Ref: BSCE/11 WP 28

MILITARY AIRCRAFT  
BIRDSTRIKE ANALYSIS  
1974

Prepared by: Squadron Leader T S Austin RAF  
MOD (Directorate of Flight Safety (RAF)) - UK

AF/627/74  
MOD(DFS(RAF))

24 May 1976

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ANALYSIS OF MILITARY BIRDSTRIKES - 1974

1. Because of the security regulations in the countries concerned 6 out of the 9 nations, who supplied information, were unable to provide aircraft or airfield movements. Therefore their strike rates could not be calculated. Information was received from the following countries:

Belgium  
Canadian Armed Forces (Europe)  
Denmark  
France  
Netherlands  
Norway  
Spain  
Sweden  
United Kingdom

2. It was not possible to compare aircraft of different Air Forces operating in similar roles due to the lack of strike rates.

3. This data supported what is now known to be the normal pattern of birdstrikes in that 80% of birdstrikes occurred below 1,000 feet, 46% occurred above 250 knots. 51% of recorded strikes occurred during the low level, en route and attack phase of flight, whilst 41% occurred in the vicinity of the airfield either during take off or landing.

MOD(DFS(RAF))  
London

24 May 1976

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TABLE 1

COUNTRY	NO OF STRIKES	NO OF MOVEMENTS	RATE PER 10,000 STRIKES
Belgium	NK	NK	4.20
CAF Europe	22	23,580	9.33
Denmark	44	135,282	3.25
France	121	NK	1.23
Netherlands	125	NK	NK
Norway	37	NK	NK
Spain	11	NK	NK
Sweden	172	284,400	6.0
UK	459	NK	NK
<b>TOTAL</b>	<b>238 (991)</b>	<b>443,262</b>	<b>4.43</b>

Note 1-1 Only 3 Nations supplied movements data.

1-2 Figures in brackets are total figures but are not used for calculation of strike rate.

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TABLE 2 - AIRCRAFT TYPE

TYPE (a)	AIRCRAFT (b)	NO OF STRIKES (c)	NO OF MOVEMENTS (d)	RATE PER 10,000 MOVEMENTS (e)	
Jet	<u>Belgium</u>				
	F/TF 104G	NK	NK	7.52	
	Mirage 5B	NK	NK	5.65	
	Fouga Magister	NK	NK	1.64	
	T33	0	NK	0	
	Falcon 20E	0	NK	0	
	<u>Caf Europe</u>				
	CF 104	21	NK	NK	
	CF 133	1	NK	NK	
	<u>Denmark</u>				
	Hunter	1	1,700	5.9	
	F 35	12	24,239	4.9	
	F 100	11	22,806	4.8	
	F 104	10	28,208	3.5	
	T 33	5	19,172	2.6	
	<u>France</u>				
	Mirage )				
	Mystere IV )				
	F 100 )	73	NK	3.20	
	SHR2 )				
	Vautour )				
	Jaguar )				
	Etandard IV m )	12	NK	4	
	CM 170R )				
	T/RT 33 )	21	NK	.62	
	MS 760 Paris )				
	C 135F )	4	NK	4.30	
	Mystere XX )	3	NK	2.23	
	DC8 )	0	NK	0	
	Caravelle )	0	NK	0	
	<u>Netherlands</u>				
	F 104	49	NK	NK	
	NF-5	60	NK	NK	
	<u>Norway</u>				
	F 5	20	NK	NK	
F 104	9	NK	NK		
Falcon 20C	0	NK	0		
<u>Spain</u>					
Mirage	1	NK	NK		
F 5	3	NK	NK		
T 33	1	NK	NK		
T 6	2	NK	NK		

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(a)	(b)	(c)	(d)	(e)
	<u>Sweden</u>			
	SAAB 32	58	44,300	13.09
	SAAB 35	55	134,500	4.09
	SAAB 37	16	16,400	9.7
	SAAB 105	37	45,200	8.2
	<u>United Kingdom</u>			
	Buccaneer	60		
	Canberra	42		
	Comet	1		
	Dominie	11		
	Gnat	5		
	Harrier	43		
	Hunter	37		
	HS 125	2		
	Jaguar	22		
	Jet Provost	51		
	Lightning	22		
	Mikrod	14		
	Phantom	45		
	Victor	4		
	Vulcan	18		
	VC 10	7		
<b>Turboprop</b>	<u>Belgium</u>			
	C 130H	NK	NK	5.07
	<u>Can Europe</u>			
	Nil			
	<u>Denmark</u>			
	Nil			
	<u>France</u>			
	C 160 Transall	6	NK	1.08
	DR 140 Mousquetaire	1	NK	0.2
	MR 1150 Atlantic	5	NK	4.0
	MB62 Frogate	5	NK	1.84
	<u>Netherlands</u>			
	Piper Cub	3	NK	NK
	Beaver	1	NK	NK
	<u>Norway</u>			
	Nil			
	<u>Spain</u>			
	Light Trainer	1	NK	NK
	<u>Sweden</u>			
	Safir 91	1	18,600	0.5
	Balldog	4	17,500	2.3

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(a)	(b)	(c)	(d)	(e)
	<u>United Kingdom</u>			
	Andover	7	NK	NK
	Argosy	1	NK	NK
	Belfast	2	NK	NK
	Britannia	6	NK	NK
	Hercules	36	NK	NK
	Jetstream	2	NK	NK
Piston	<u>Belgium</u>			
	SF260M	NK	NK	0.58
	DC3	0	NK	0
	DC6	0	NK	0
	Pembroke	0	NK	0
	<u>Caf Europe</u>			
	Nil			
	<u>Denmark</u>			
	C54	2	2,102	9.5
	C47	2	6,243	3.2
	Chipmunk	1	24,072	0.4
	L 18c	0	961	0
	KZ-VII	0	5,779	0
	<u>France</u>			
	N2501 Noratlas	10	NK	0.72
	SA23 Aztec	2	NK	4.0
	P2V7 Neptune	2	NK	4.0
	Flamant	1	NK	0.2
	DC6	0	NK	0
	CAP 10/20	0	NK	0
	Broussard	0	NK	0
	<u>Spain</u>			
	Light Trainer	1	NK	NK
	<u>Sweden</u>			
	Safir 91	1	18,600	0.5
	Bulldog	4	17,500	2.3
	<u>United Kingdom</u>			
	Bassnet	1	NK	NK
	Bulldog	2	NK	NK
	Chipmunk	5	NK	NK
	Devon	4	NK	NK
	Hastings	1	NK	NK
	Pembroke	2	NK	NK
	Shackleton	1	NK	NK
	Varsity	5	NK	NK

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(a)	(b)	(c)	(d)	(e)
Helicopter	<u>Belgium</u>		<u>HOURS</u>	<u>PER 10,000 HOURS</u>
	HSS-1	0	NK	0
	<u>Caf Europe</u>			
	Nil			
	<u>Denmark</u>			
	H-500	2	3,563	5.6
	S-61	0	2,736	0
	Alouette	0	2,494	0
	<u>France</u>			
	NK	3	NK	1.38
	<u>Netherlands</u>			
	NK	10	NK	NK
	<u>Norway</u>			
	Sea King	1	NK	NK
	UH1B 204	1	NK	NK
	<u>Spain</u>			
	NK	3	NK	NK
	<u>Sweden</u>			
	NK	5	4,200	10.7
	<u>United Kingdom</u>			
Gazelle	8	NK	NK	
Puma	11	NK	NK	
Sioux	0	NK	0	
Wessex	4	NK	NK	
Whirlwind	4	NK	NK	

TABLE 2A

TYPE	AIRCRAFT	NO OF STRIKES	NO OF MOVEMENTS	STRIKE PER 10,000 MOVEMENTS
JET	-	869		
TURBOPROP	-	74		
PISTON	-	52		
HELICOPTER	-	47		
UNKNOWN	-	0		

NOTE: Insufficient data to calculate strike rates.

2.4

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TABLE 3 - AIRFIELDS

AIRFIELD	NO OF STRIKES	NO OF MOVEMENTS	RATE PER 10,000 MOVEMENTS
(a)	(b)	(c)	(d)
<b>1. DOMESTIC (data from own country with known no. of movements)</b>			
<u>DENMARK</u>			
Karup	5	33,324	1.50
Aalborg	8	25,179	3.18
Skrydstrup	6	30,584	1.96
Vaerlose	5	24,965	2.00
<u>SWEDEN</u>			
F1	11	23,500	4.70
F3	3	16,200	1.90
F4	4	18,300	2.20
F5	16	39,700	4.00
F6	6	13,900	4.30
F7	2	20,400	1.00
F10	4	20,100	2.00
F11	3	21,200	1.40
F12	3	13,900	2.20
F13	7	19,400	3.60
F15	2	13,000	1.50
F16/20	4	28,900	1.40
F17	4	18,100	2.20
F21	4	19,100	2.10
<u>UNITED KINGDOM</u>			
Thorney Island	16	35,052	4.56
Fianingley	8	30,462	2.63
Leuchars	8	34,917	2.29
Topcliffe	7	29,150	2.40
Lynnham	7	66,196	1.06
Fairford	7	23,334	3.00
Cottesmore	6	36,037	1.66
St Mawgan	6	29,964	2.00
Waddington	6	20,804	2.88
Benson	5	19,882	2.51
Kinloss	5	25,862	1.93
Shawbury	5	41,549	1.20
Erize Norton	4	19,720	2.03
Seampton	4	18,929	2.11
Binbrook	3	29,559	1.01
Cranwell	3	75,978	0.39
Leeming	3	65,532	0.46

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(a)	(b)	(c)	(d)
<u>UNITED KINGDOM cont.</u>			
Marham	3	20,756	1.45
Abingdon	2	45,101	0.44
Andover	2	22,772	0.88
Barkston Heath	2	27,594	0.72
Chivenor	2	39,640	0.50
Coltishall	2	30,010	0.66
Coningsby	2	35,122	0.57
Honington	2	32,723	0.61
Lossiemouth	2	39,202	0.51
Manston	2	25,792	0.77
Tern Hill	2	80,298	0.25
Valley	2	96,469	0.21
Wittering	2	44,675	0.45
West Raynham	2	12,611	1.59
2. <u>DOMESTIC</u> (Incomplete data)			
<u>BELGIUM</u>			
Beauvechain	NK	NK	2.67
Kleine Brogel	NK	NK	2.11
Florennes	NK	NK	1.26
Melsbroek	NK	NK	0.83
<u>CAF EUROPE</u>			
Baden-Sokllingen	2	NK	0.85
Lahr	2	NK	0.85
<u>FRANCE</u>			
Avord	3	NK	0.72
Chateaudun	3	NK	1.53
Cognac	4	NK	0.49
Dijon	4	NK	0.75
Hyerres	3	NK	4.00
Istres	4	NK	0.73
Landivisiau	2	NK	4.00
Lorient	5	NK	4.00
Metz	4	NK	0.67
Nimes	2	NK	4.00
Salon	3	NK	0.21
Reims	2	NK	0.56
<u>NETHERLANDS</u>			
Leeuwarden	6	NK	NK
Ypenburg	4	NK	NK
Twenthe	8	NK	NK
Volkel	7	NK	NK
Soesterberg	2	NK	NK
Gilze-Rijen	5	NK	NK
Woensdrecht	2	NK	NK
Eindhoven	2	NK	NK

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(a)	(b)	(c)	(d)
<u>NORWAY</u>			
Sola	2	NK	NK
Orland	4	NK	NK
Bodo	6	NK	NK
Andoya	2	NK	NK
<u>UNITED KINGDOM</u>			
Aldergrove	3	NK	NK
Belfast Harbour	3	NK	NK
Farnborough	2	NK	NK
Pershore	2	NK	NK
3. <u>DOMESTIC AIRFIELDS WITH SINGLE STRIKES</u>	28	NK	NK
4. <u>FOREIGN</u>			
Ramstein	2	NK	NK
Gutersloh	2	NK	NK
Wildenrath	3	NK	NK
Akrotiri	3	NK	NK
Luqa	7	NK	NK
5. <u>FOREIGN AIRFIELDS WITH SINGLE STRIKES</u>	35	NK	NK
6. <u>EN ROUTE</u>	532	NK	NK
7. <u>UNKNOWN</u>	150	NK	NK

TABLE 3A - SUMMARY OF LOCATION

Domestic	229	1,555,453	1.47
Domestic (Incomplete data)	133		
Foreign	52		
En Route	532		
Unknown	150		
	1096		

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200



TABLE 4 - BIRD SPECIES

Common Name	Latin Name	Approx WT (g)	Category	No of Strikes	% Based on 442
Black Headed Gull	Larus Ridibundus	300	B	6	1.4
Herring Gull	Larus Argentatus	1100	B	19	4.3
'Gulls' (inc Common Gull)	Larus Spp	300-1800	B	122	28.9
<u>TOTAL GULLS</u>				147	34.6
Lapwing/Peevit	Vanellus Vanellus	200	B	51	11.5
Oyster Catcher	Haematopus Ostralegus	550	B	7	1.6
Flover	Pluvialis Apricaria	220	B	12	2.7
Eider	Somateria Mollissima	2000	C	1	0.2
Heron	Ardea Cinera	1800	B	1	0.2
Feral Pigeon	Colomba Palumbus	600	B	36	8.1
Pigeon	Colomba Livia	250	B	7	1.6
Pheasant	Phasianus	1200	B	2	0.5
Partridge	Perdix Perdix	420	B	5	1.1
Bussard	Buteo Buteo	900	B	8	1.8
Kestrel	Falco Tinnunculos	250	B	9	2.0
Hawk	Accipiter	350	B	2	0.5
Crow	Corvus Corone	550	B	4	0.9
Rook	Corvus Frugilegus	400	B	6	1.4
Starling	Sturnus Vulgaris	100	A	19	4.3
Swift/Swallow/Martin	-	14-40	A	49	11.1
Thrush	Turdus Philomelus	70	A	6	1.4
Blackbird	Turdus Merula	100	A	1	0.2
Fieldfare	Turdus Pilaris	115	B	3	0.7

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A

Tawny Owl	Strix Aluco	300	B		2	0.5
Owl	Strigidae Spp		B		1	0.2
Bar Tailed Godwit	Limosa Laponica		B		1	0.2
Horned Owl	Bubo Bubo	300	B		1	0.2
Teal	Anas Crecca	900	B		2	0.5
	Anas Spp		B		3	0.7
Wader	Charadriidae Spp	400-530	B		3	0.7
Puffin	Fratercula	5500	B		1	0.2
Crane	Grus Grus	40-110	D		1	0.2
	Passeriforme	13-22	A		14	3.2
Whinchat	Saxicola Rubetra	35	A		1	0.2
Snow Bunting	Plectrophenax Nivalus	12	A		1	0.2
Blue Tit	Parus Caeruleus	75	A		1	0.2
Grey Shrike	Lanius Excubitor	20	A		1	0.2
Linnet	Carduelis Cannabina	23	A		1	0.2
Muscovey Duck	Caririna Moschata	100	B		1	0.2
Pipit	Anthus Spp		A		1	0.2
Dunlin	Erolia Alpina		A		1	0.2
	Stringforme Spp		B		3	0.7
Sandgrouse	Pseudops Bengalensis	3200	B		1	0.2
Vulture	Fringilla Coelebs	22	C		1	0.2
Chaffinch	Motacilli Alba	25	A		2	0.5
Westtail	Alauda Arvensis	40	A		2	0.5
Skylark	Sterna Hirundo	100	A		17	3.8
Tern	Philomachus Pugnax	100	A		2	0.5
Ruff or Reeve			A		1	0.2
UNKNOWN					573	
TOTAL					1015	

Notes:-

4.1 Bird weights and Latin names can be obtained from Canadian Field Note No 51, by G Kaiser, unless there is positive evidence to the contrary, the AVERAGE weight should be assumed.

4.2 The bird Categories based on current Civil Airworthiness requirements are:-  
 CAT A below .1 kg ( $\frac{1}{4}$  lb)  
 CAT B .11 to 1.81 kg ( $\frac{1}{4}$  to 4 lb)  
 CAT C over 1.81 kg to 3.63 kg (4 lb to 8 lb)  
 CAT D over 3.63 kg (8 lb)

4.3 Those birds not positively identified should be tabled as Unknown.

- 4.4 Large (CAT C or D) birds are often not positively identified, but the Category these are assumed to be in should be stated.
- 4.5 Percentages should be based on the total of identified birds.
- 4.6 A Flock should be regarded as more than 2 birds.
- 4.7 The percentage in Table 3A should be based on the total of strikes where the number of birds is known.
- 4.8 Table 3 could be repeated restricted to own country only.

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TABLE 5 - MONTH OF YEAR - STRIKES IN EUROPE ONLY

MONTH	WEIGHT UNKNOWN	CAT A & B	CAT C	CAT D	TOTAL	NO OF MOVEMENTS	STRIKES/10,000 MOVEMENTS
JANUARY	6(14)	20(31)			26(45)	117,222	2.21
FEBRUARY	7(11)	11(18)			18(29)	129,697	1.38
MARCH	17(34)	16(22)			33(56)	136,948	2.40
APRIL	24(32)	8(12)	(1)		32(45)	166,405	1.92
MAY	26(38)	12(23)	(1)		38(62)	185,928	2.04
JUNE	26(45)	26(28)			52(73)	167,852	3.09
JULY	26(37)	27(54)	(1)		53(92)	157,088	3.37
AUGUST	55(67)	28(54)			83(121)	160,978	5.15
SEPTEMBER	36(55)	30(38)			66(93)	153,219	4.30
OCTOBER	57(69)	26(44)		(1)	83(114)	152,640	5.43
NOVEMBER	13(21)	23(32)			36(53)	126,570	2.84
DECEMBER	6(11)	22(28)	(1)		28(40)	96,693	2.89
UNKNOWN	-	-	-	-	-	-	-
TOTAL	299(434)	249(384)	(4)	(1)	548(823)	1,751,256	3.12

Note: 5.1 Only 3 Nations supplied movements data

5.2 Figures in brackets are total figures but are not used for calculation of Strike Rate.

TABLE T - AIRSPEED

AIRSPEED (KNOTS-1AS)	WEIGHT UNKNOWN	CAT A and B	CAT C	CAT D	TOTAL	% BASED ON 770
0 - 80	12	27			39	5.06
81 - 100	11	52			63	8.18
101 - 150	34	135			169	21.94
151 - 200	37	52	3		92	11.94
201 - 250	26	21	1		48	6.23
OVER 250	255	101	2	1	359	46.62
AIRSPEED UNKNOWN	99	45			144	-
<b>TOTAL</b>	<b>474</b>	<b>433</b>	<b>6</b>	<b>1</b>	<b>914</b>	

TABLE 6A - ALTITUDE

ALTITUDE (FEET)	WEIGHT UNKNOWN	CAT A and B	CAT C	CAT D	TOTAL	% BASED ON 929
0 - 499	255	282	1		538	57.91
500 - 999	147	56	2	1	206	22.17
1000 - 2500	111	47			158	17.00
OVER 2500	21	4	2		27	2.90
HEIGHT UNKNOWN	118	44	1		163	-
<b>TOTAL</b>	<b>652</b>	<b>433</b>	<b>6</b>	<b>1</b>	<b>1092</b>	

Note: 6.1 No information from Sweden on Altitude

6.2 Data from Sweden included under Weight Unknown.  
in airspeed total.

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TABLE 7 - FLIGHT STAGE

STAGE	WEIGHT UNKNOWN	CAT A and B	CAT C	CAT D	TOTAL	% BASED ON 916
Taxying	-	2	-	-	2	0.21
Take-Off	70	101	2	-	173	18.88
L/L, En-route and Attack	350	119	2	1	472	51.52
Climb	13	9	-	-	22	2.40
Cruise	8	5	-	-	13	1.41
Recovery	4	4	-	-	8	0.87
Descent	2	1	-	-	3	0.32
Final Approach	22	19	1	-	42	4.58
Landing	53	112	-	-	165	18.01
Touch and Go/ Overshoot	3	13	-	-	16	1.74
Unknown	133	41	-	-	174	-
<b>Total</b>	<b>658</b>	<b>426</b>	<b>5</b>	<b>1</b>	<b>1090</b>	

Note: 7.1 Data from Spain entered under stage unknown

7.2 Data from Sweden entered under weight unknown

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TABLE 8 PART OF AIRCRAFT STRUCK

PART	WEIGHT UNKNOWN	CAT A	CAT B	CAT C and D	TOTAL	% BASED ON 1217
Nose (excluding radome and windscreen)	87	12	38		137	11.25
Radome	39	5	11		55	4.51
Windscreen	131	23	52		206	16.92
Fuselage (excluding the above)	102	11	55	1	169	13.88
Engine:	141	26	77	2	246	20.21
1 Engine struck			2		2	0.16
2 Out of 3 struck						
2 Out of 4 struck						
3 Out of 4 struck						
All struck (on multi-engined aircraft)						
Wing/intake	109	21	75	2	207	17.00
Rotor/Propeller	9	3	22		34	2.79
Landing Gear	29	9	42		80	6.57
Empennage	5	-	4	1	10	0.82
Under Wing Stores/Tanks	39	2	29	1	71	5.83
Part Unknown	55	12	29	1	97	-
TOTAL	746	124	436	8	1314	

Note: 8.1 Engine intake combined with wing.

8.2 Data from Sweden in weight unknown column.

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TABLE 8B EFFECT - AIRSPEED - WEIGHT OF BIRD

EFFECT	AIRSPEED		0-80		81-100		101-150		151-200		201-250		OVER 250	
	A&B	C&D	A&B	C&D	A&B	C&D	A&B	C&D	A&B	C&D	A&B	C&D	A&B	C&D
Loss of life/Aircraft														
Flight Crew injured	1												1	
Engine prematurely changed	2		1		6				3				14	
Windscreen cracked/Broken													6	
Radome changed													2	
Deformed Structure			2		2								11	2
Skin Torn					4				2				1	
Skin Dented	3		1		1				4				29	
Propeller/Rotor Damaged	1		2		12								1	
Aircraft System Lost					2								5	
Underwing Stores/Tanks Damaged													1	
													10	1
TOTAL	7	-	6	-	32	-	12	1	9	3	100	3		

Note: 8b-1 Data from Spain and Sweden is not included.

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TABLE 8A - EFFECT OF STRIKE

EFFECT	WEIGHT UNKNOWN	CAT A	CAT B	CAT C	CAT D	TOTAL	% BASED ON 1133
Loss of Life/Aircraft	1					1	0.08
Flight Crew Injury							
Major							
Minor	1		1			2	0.17
Slight							
Premature Engine Change on a							
Single Engined Aircraft	16	2	6	1		25	2.20
1 on a 2 Engined Aircraft	25	3	10			38	3.35
1 on a 3 Engined Aircraft							
1 on a 4 Engined Aircraft	1	1	6			8	0.70
2 on a 3 Engined Aircraft							
2 on a 4 Engined Aircraft			1			1	0.08
3 on a 4 Engined Aircraft							
All Engines on a Multi	1					1	0.08
Windscreen Cracked/Broken	16	5	7			28	2.47
Radome Changed	7	1	2			10	0.88
Deformed Structure	54	2	19	3		78	6.88
Skin Torn	41	5	42	1		89	7.85
Skin Dented	72	15	61	2		150	13.23
Propeller/Rotor Damaged	8	1	3			12	1.05
Aircraft Sytem Lost	1	1	3			5	0.44
Underwing Stores/Tanks Damaged	19	2	13	1		33	2.91
Miscellaneous	25	2	5			32	2.82
Nil Damage	380	79	160	1		620	54.72
Unknown	2		2			4	-
TOTAL	670	117	341	9		1137	

NOTE: 8A-1 DATA from Spain not included.  
8A-2 DATA from Sweden included in weight unknown column.

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BIRD STRIKE COMMITTEE EUROPE

LONDON 27 MAY 1976

REF: BSCE/11 WP/29

BIRD CONTROL UNITS IN THE RAF

Talk given by Sqn Ldr T S Austin, UK

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## BIRD CONTROL UNITS IN THE RAF

Mr Chairman, Gentlemen

I have been asked to give a short talk on Bird Control Units and the way that they are employed in the Royal Air Force. Before I talk about this I would like to first of all mention the history and how they came into being.

In about 1965, the Sappho equipment and bird distress calls were introduced into the Royal Air Force. The equipment was fairly bulky and as such it was found convenient to mount the equipment in the Station Fire and Crash Vehicles. As a consequence, bird scaring on airfields generally became a secondary duty of the fire and crash services, initiated by the local Air Traffic Controller. Unfortunately, because it was a secondary duty and the firemen had received no training and also because of shift work, very little expertise was built up on the subject of bird scaring and even those keen members who had developed sufficient knowledge quite frequently were not available when bird scaring was required. It is not surprising, therefore, that when we look at the on-airfield bird strike records for the period 1964 to 1971, we find that there was no great or indeed there was no improvement at all. In 1971, the Directorate of Flight Safety decided to set up a trial; 12 teams of 3 men each were formed to be Bird Scaring Units. These men were required to work on full time bird scaring operating from dawn to either dusk or the end of night flying and were also required to perform bird scaring operations during week-ends and the over periods when flying was not taking place. The teams were initially trained in the correct use of the bird scaring equipment, they were also told a little bit about bird hazards and what caused birds to come to airfields and how to recognize bird attractions both on and around the airfield and then they were set into operation on 12 Stations for a trial which was to last 2 years. The monitoring of this trial was done by means of daily bird counts. These bird counts were used to assess whether the team were in fact reducing the number of birds on the airfield, and at the same time, counts were taken from the local ornithologists and from the local areas to show that overall there was no decline in the residential bird population. These counts did in fact show that there was quite a large reduction in birds on those airfields where the Bird Control Units had operated or were operating.

However, it is not just in the reduction of birds that we can assess the effects of Bird Control Units. We could also look at the Bird Strikes. In 1972, when the airfield Bird Strikes overall in United Kingdom increased by 20%, the Bird Strikes on the 12 Stations where Bird Control Units were operating decreased by 10% whilst 12 other Stations with similar high risk potential and chosen to compare directly with these Stations, their Strikes rose by 150%. While further check was made of the effectiveness of Bird Control Units, this was in relation to the cost of the Bird Strikes. During the first 6 months of 1973, all Bird Strikes in United Kingdom were assessed for cost and it was found that on the 12 Stations with Bird Control Units there were 15 Strikes at an average cost of £400 each. Whilst on the remaining Stations in the United Kingdom, there were 50 Strikes and the average cost was £3,600, a very big difference. The reason for this difference was that on the Bird Control Unit Stations there was no engine and very little airframe damage caused by the Strikes and the reason for this was that the effect of the Bird Control Units was to get rid of the gulls, lapwings and other large birds which tend to flock on the runways and can cause multiple serious Strikes to aircraft taking off and landing. As a result of this trial, the Director of Flight Safety prepared a paper that also examined the previous 10 years Bird Strikes for airfields and they discovered that 80% of the Bird Strikes in the UK on airfields occurred on just 20 military airfields whilst the remaining 35 or 40 produced only the other 20%, so the figure of 20 Stations was taken to be the most cost effective and the calculation was made based on this figure. Each bird Control Unit was estimated to cost between £8,000 to £10,000 per annum. A team of 3 men of the rank of Corporal and below plus a vehicle. Each Strike that would occur on a Bird Control Unit Station was estimated to save somewhere in the region of £3,000. With an average yearly record of something like 200 Strikes throughout the UK Service Stations and estimating that 80% of these would occur at the 20 airfields at which the Bird Control Units would be established we came out with a figure that the overall cost of the Bird Control Units would be something like £200,000, but the overall saving of the Bird Control Units would be something in the order of £450,000 so that we assess the 20 Bird Control Units in one full year will save us approximately £250,000 on Bird Strikes. This paper was presented, and has been accepted by the Air Force and 20 teams have now been set up with a date for commencing operation of the 1 July this year.

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14 August 1946

## REPORT ON THE ELEVENTH MEETING OF THE BSCE (LONDON 24-28 MAY 1976)

## 1 INTRODUCTION

1.1 This report is composed of the following three parts:

- a) The Chairman's Report (Part 1)
- b) The report on the work done inside Working Groups of BSCE (Part 2)
- c) The conclusions resulting from b) (Part 3)

1.2 The Chairman's Report, mentioned under a) above, contains a brief description of the proceedings of the Meeting, the organisational and administrative arrangements for the conduct of the Committee's business and for its future work.

1.3 The report on the work done inside working groups mentioned under b) above supplements and/or supersedes the previous reports on this subject. It consists of a summary of the points made during the discussion in BSCE WG's on the subjects considered during the 11th Meeting and as such it serves to support the conclusions reached and the Recommendations which have been agreed by that Meeting.

1.4 The conclusion resulting from this Report, as contained in its Part 3 was reviewed by the Committee during its 11th session, and amended slightly by the chairman for editorial purposes. As a consequence of this, Part 3 is in fact superseding the draft circulated during the meeting, included in this report for information only (Section 1 of the Report refers).

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## PART 1

## CHAIRMAN'S REPORT

## 1 GENERAL

1.1 The Eleventh Meeting of the BSCE and its Working Groups was held from 24 to 28 May 1976 at Church House, Westminster, in London. A list of participants with addressees is attached in Section 2, of the Report.

1.2 At the opening meeting, the meeting accepted the following agenda:

Item 1: Presentation of papers.

Item 2: Report of the work done by each Working Group.

Item 3: Review of the existing terms of reference of BSCE Committee.

Item 4: Review of the existing terms of reference of BSCE WG's.

Item 5: Review of the need for a Vice-Chairman, agreement of responsibilities and Terms of Office.

Item 6: Election of the BSCE Chairman and Vice Chairman.

Item 7: Establishment of new Working Group.

Item 8: Next meeting.

Item 9: Any other business.

1.3 The meeting was chaired by Mr Ferry elected for a two year period at the end of 9th meeting.

1.4 Mr New of MOD (Procurement Executive) UK acted as Secretary of the meeting and was in charge of the administrative, typing and printing, and interpretation arrangements at the meeting.

## 2 COMMITTEE ARRANGEMENT

2.1 The Committee, at the end of the 10th meeting found it necessary to elect a Vice Chairman - See Section 9, Part 2 para 2.4.

2.2 The Chairman ending his term at the 11th meeting, was elected for a further period of one year.

## 3 PROCEEDINGS AT THE MEETING

3.1 Discussions on the objects considered by the Committee in accordance with the Agenda are reported in Section 9, Part 2, and the recommendations formulated as a result of these discussions are contained in Part 3.

## 4 WORK PROGRAMME UNTIL THE NEXT MEETING

4.1 At the end of this meeting, the Committee agreed on the following

work programme until the next meeting:

#### 4.1.1 Work to be done inside Working Groups

##### 1) Work to be done inside Bird Movement Working Group:

- i) check if Bird Hazard maps (BSCE/10 WP 30 page 2.3 referring to Annex 15, Appendix 1 and Doc 8126-AN/872/2 Appendix G pages AGA 0.2.1, RAC 6.1 and 6.4 refer) are published by all State members of BSCE. This work was deferred until the next BSCE meeting.
- ii) prepare a revised edition of bird concentration and movement maps already in use.
- iii) study bird strike risk maps for large areas from data provided by States.

##### 2) work to be done inside Communications Working Group:

- i) prepare and circulate the complete list of addressees for Notam circulation
- ii) test of the circulation of NOTAM dealing with bird movement during Spring migration 1977 under the procedure already used during 1974 and 1975
- iii) prepare a compilation of the already agreed practice (format of the message, code used, prefixes) to be published in the 11th Meeting Report with the final aim of becoming a part of Documentation published by ICAO.
- iv) study the need to collect "Flight Procedures" already used for bird avoidance.

##### 3) work to be done inside Aerodrome Working Group:

- i) ensure that all information about bird dispersal devices in use in each state are available and prepare a summary giving the assessed efficiency.
- ii) collect national regulations applying to garbage dumps and controllable bird movements,
- iii) study and prepare a document to be used as a check list by airport managers on measures used and remarks made about them. This document will be based on WP24/BSCE11 (the Airport Manager's Brief), revised and extended.

##### 4) work to be done inside Analysis Working Group:

- ia) make sure that all BSCE States are using the new BSCE forms for the Annual Analysis of bird strikes recorded by each state (Civil and Military analyses)
- ib) circulate a revised format for the analysis of Military and Civil Strikes, to simplify the work done in each country.
- ii) produce BSCE bird weight classification, to avoid inconsistencies in reporting.

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- iii) continue the special analysis on strikes to engines, with an investigation oriented to the ability of intakes and engines to withstand birdstrikes with a liaison with AEA Technical Affairs Committee.
  - iv) Study the effectiveness of the use of aircraft landing lights for scaring birds away from the aircraft flight path
  - v) explore the possibility of using computer facilities for analysis and storage of bird strike data.
  - vi) publish the analysis of Bird Strikes in Europe for the 3 years period of survey (1972-73-74).
- 5) work to be done inside Radar Working Group:
- i) circulate and finalise the document relating to obtained radar bird observation and bird strike probability.
  - ii) analyse the various computer aided bird density evaluation methods.
  - iii) prepare a note explaining the feasibility of an automatic warning device to be used on aerodromes when the birds activity is above a given limit.
- 6) work to be done inside Structural Testing Working Group:
- i) collect details on the testing programmes and results achieved by various laboratories on bird impact structural tests.
  - ii) collect, analyse and group together methods of analysing the bird impact resistance of structures in order to draft a manual on "Design Guidance"

#### 4.1.2 Other Activities

- 1) to continue studies aimed at the use of a warning network (combination of radar or visual observation on the spot, NOTAM code, communication system, interpreting centre, phraseology to be used by controllers) for aircraft in the vicinity of aerodromes.
- 2) to continue studies aimed at a uniform method of displaying permanent information in order to obtain a uniform coverage of Europe and its immediate vicinity.
- 3) to develop a common basic policy with other organisations in order to standardise BSCE methods (or improved methods) aiming at reducing the bird hazard whenever possible.
- 4) to continue studies on the actual cost of bird strikes and the cost effectiveness of the use of the aforesaid methods.

#### 4.2 Work on the above subjects was assigned as follows:

- a) if not differently stated in the following, work on subjects listed on 4.1.1 from 1) to 6) is assigned to each WG's chairman.
- b) the Chairman of the BSCE will take part in work assigned in para 4.1.1 under 1) i), 2) iii), 3) iii), 4) i), 5) ii), the work being undertaken primarily by the WG's chairmen (recommendations BSCE/10 D5 and for BSCE 11 Section 1 refers).

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c) work on the subject listed under 5) i) in para 4.1.1 to be undertaken by Dr F Hunt (National Research Council, Canada)

d) work on the subject listed under 3) in para 4.1.1 to be undertaken by Dr W Keil (German Federal Republic)

## 5 ARRANGEMENTS FOR THE NEXT MEETING

5.1 The Committee did not develop a specific Agenda for its next meeting because this depends to a considerable degree, on the progress achieved by each working group on the work programme outlined in para 4 above.

5.2 It was however agreed, that for the time being, the following points should be retained for possible consideration at the next meeting:

- a) tentative list for future meetings
- b) preparation of a generally acceptable document regarding
  - i) the relation between obtained radar bird observation and bird strike probability
  - ii) a check list for airport managers when a problem dealing with bird activity appears on an aerodrome
  - iii) the evaluation of the bird risk in large areas in terms of biomass
  - iv) the ability of a certain aircraft, parts of aircraft, and engines to withstand birdstrikes
  - v) guidance on Structural Testing of Airframes for eventual inclusion in the ICAO Airworthiness Technical Manual.
- c) future organisation of BSCE (possibility of a permanent secretariat).
- d) submission of reports for future BSCE meetings.
- e) election of BSCE Chairman.

5.3 The Committee accepted that the various Working Groups would present to the Committee reasonably firm proposals on the subjects listed in 5.2b) so that at its next meeting, the Committee would be able to make firm recommendations.

5.4 Regarding the subject of Working Group tasks it is accepted that

- i) the report presented by the Working Groups' Chairmen to the Committee will have three sections:
  - 1) review of the work already completed and the recommendations from the previous Working Group
  - 2) progress report of the work done during the previous year
  - 3) chairman's report on discussions, with recommendations reached.
- ii) the Report will be available and circulated before the opening of the plenary session of each BSCE meeting.

5.5 As to the venue for the next meeting of the Committee, it was noted that this problem will, in the future, be difficult to solve satisfactorily. The Chairman proposed to publish a list showing, according to actual practice, the tentative programme for the next five years. As new countries are now fully participating, the list could be extended. For the time being, Belgium declare that, due to difficulties, they can not host the 1977 meeting. Switzerland has already started arrangements for 1978. So the location and date of 1977 meeting could not be agreed upon.

The Chairman will explore whether the 1977 meeting could be held in Paris as an alternative solution.

5.6 It has been proposed as an ICAO suggestion, that a Bird Strike World Conference be held in conjunction with the next BSCE annual meeting. As the arrangements to be made for a World Conference usually takes more than one year, it is doubtful whether such a meeting could take place in 1977.

It was noted that, apart from the participation of Australia, New Zealand and few other countries already active on these problems, BSCE meetings gathered together most of those with experience in bird strike problems from Military and Civil Aviation.

## 6 ACKNOWLEDGEMENTS

The Chairman, on behalf of the whole Committee, expressed his gratitude for the impressive and efficient organisation of the meeting at short notice and, to all who have contributed to the success of the meeting.

A special mention should be made of the visits to:

- 1) the RAF Museum at Hendon where in a short time a complete review of the progress made in aeroplane design was seen. The UK film "Bird Strike" was shown in the cinema.
- 2) London Heathrow Airport where the work of the 24 hour a day, 7 days per week Patrols dealing with birds on the airport, were described. One of the specially equipped vehicles was made available for inspection.

## 7 PRESS COVERAGE

"Aviation Week and Space Technology" gave publicity to the BSCE meeting in their 24 May issue and on 7 June issue gave a large coverage to the Conference and its conclusions.

## PART 2

## REPORT ON THE BSCE ELEVENTH ANNUAL SESSION

## 1 INTRODUCTION

1.1 The 11th report on the BSCE annual session relates to the work done inside Working Groups, which assembled at the same time, and by the Committee as a whole when dealing with its specific tasks.

1.2 As all papers presented during the session appear in Section 6 of the Report, this part will cover the following subjects:

- a analysis of work done by each Working Group
- b review of the administrative problems
- c review of actions to be performed following the recommendations
- d special problems

## 2 DISCUSSION OF SUBJECTS RELATED TO THE BSCE

2.1 Before entering into the discussion of specific items mentioned under para 1.2 above, the Chairman felt that the tasks given to him each year, if properly dealt with, do not leave enough time to think about the future of the BSCE and act as a representative of the BSCE to International Organisations. This last work, deemed urgent, calls for frequent interviews in differently located headquarters. As the Editing Committee is now firmly established and provided guidance during the session, the Chairman proposed the election of a Vice-Chairman (see item 5 of the Agenda) in order to have a team all the year long.

Some other problems have arisen during the year and call for analysis. The specific points were:

- a Study of the administrative structure
- b next meeting (date, duration and location)

Although these matters have no direct influence on the work carried out during the session, it has been noted that they should be recorded in a proper way and be part of the Report. They appear under item b) under para 1.2 above.

2.2 Even though the Committee recognized that some shortcomings existed in its way to solve problems, it has been felt unnecessary to enter into too abrupt changes without having time to test the validity and the efficiency of the modifications. It was expected that, if still necessary, members would raise this matter again at the next suitable opportunity.

## 2.3 Reports on working groups:

2.3.1 These appear under Section 5 of the main Report and reflect the nature and specific tasks of each Group.

It will be noted that the reports are now presented, under uniform format and arrangement of contents.

2.3.2 Time allowed for this item has not permitted a long discussion. However, three points have been realised

a) from the Analysis Working Group Report: the necessity of a specific bird weight distribution has been noted.

It has been agreed to use the following:

very small	below 110g ( $\frac{1}{2}$ lb)
small	between 111g and 681g ( $1\frac{1}{2}$ lb)
medium	between 681g and 1.81kg (4 lb)
large	between 1.82kg and 3.63kg (8 lb)
very large	over 3.64kg

It has been noted that the compilation of Civil Incidents in a Quarterly Information Bulletin was very useful and should continue.

b) from Communications Working Group: some reserves have been formulated on the direct use of the NOTAM code for bird activities. One State was still advocating plain language instead of coded messages. A compromise has been reached by the combination of issuing the message in NOTAM groups before the plain language form when a bird warning is issued by this particular State.

c) from Aerodrome Working Group: some States have not yet provided their comments on Part 3 of ICAO Airport Service Manual (Bird Control and Reduction). It has been agreed that a summary of all States' comments will be sent in the near future, and that some new parts will be drafted for ICAO consideration.

2.4 The Committee has revised its Terms of Reference and work programme of Working Groups. The Terms of Reference appear in Section 7 of the Main Report and the Work Programme in Section 9, Part 1, para 4.

2.4.2 A Vice-Chairman has been appointed with terms of reference (see Section 7.3 Main Report) discussed and approved (Mr L-O Turesson from Sweden will be the Vice-Chairman for the 1976-1978 period).

2.4.3 Attention has been called to the number of Working Papers, which are steadily increasing in number and complexity. The Chairman was asked to prepare a summary of all Working Papers published from the 1st annual session to the present day with a classification following the Working Groups' Terms of Reference. The summary will be published as a BSCE circular and will provide a basis for the Editing Committee to select Working Papers.

Some future Papers could then appear in the main Report only as summaries because they should have been subject to discussion inside the Working Group, or they cover a matter already well explored.

2.4.4 The problem of a permanent Secretariat, proposed during the 10th session of the BSCE, has not progressed. However as some international organisations have shown an increasing interest in the work done and because they are now asking BSCE to prepare notes or documents it has been felt that a beginning of a solution could be offered by these organisations.

2.4.5 According to normal practice the Chairman of the BSCE is elected for a period of two years, which could be renewed. The present chairman, whose mandate was due to end during the 11th session had to follow this practice. However after discussion it was agreed that he should be re-elected for one more year, in order to provide an overlap with the Vice-Chairman. This will avoid a too complete change in philosophy and ease representation to International bodies.

2.5 Action to be taken:

2.5.1 A new Working Group has been firmly established under the title "Structural Testing of Airframes".

2.5.2 A proposal for another new Group has been studied and as a result it was decided that the work connected with "Flight Procedures" should be added to the Communications Working Group, which will revise its Terms of Reference accordingly.

2.5.3 The Chairman of the BSCE or the Vice-Chairman have been charged to visit all relevant authorities at a convenient level, to obtain better liaison and understanding. It is hoped that some minor problems inherent in national ways of thinking could then be solved.

2.5.4 The chairman has been asked to pursue the Committee action with insurance companies and to start action with the International Air Transport Association, the Guild of Air Traffic Controllers, the International Federation of Air Line Pilots Associations, the European Airports Association, Association of European Airlines and generally all organizations concerned with safety and reliability of air transportation.

2.5.5 Recommendations emerging from the Working Groups are included in Section 1 of the main Report.

## PART 3

## CONCLUSIONS RESULTING FROM SECTION 9 OF THE 11TH MEETING REPORT

1 As a routine, BSCE meetings end with the adoption of recommendations. Only those of a general nature are shown below because some are addressed to the Chairman as assigned tasks on behalf of the Committee and reflect the conclusions of the meeting:

## Section 1, Recommendations

- A 1 Bird concentration maps
- D 1 Reporting System
- D 2 Identification of Remains
- D 3 Ask ICAO to request each State (circulation of Bird Strike reports)
- D 4 Application measures of D-3
- D 8 Information on strikes provided to AEA
- E 3 Radar data
- G 2 National Committee Documentation
- G 3.1 List of Recommendations issued by previous meetings
- G 3.2 ICAO Standard Weights
- G 3.3 Information on strikes provided to Airport Associations

2 The time lapse being too short to allow a general consultation on the presentation of this Report and the redrafting of recommendations issued by Working Groups and approved by the Committee the only conclusion formulated by the Chairman is:

Conclusion 1: As International Publications (see ICAO Doc 9137-AN1898 edition 1975 Airports Service Manual, Part 3) and BSCE code of practice are available and agreed, all States are requested to ensure that methods used on airports are in full accordance with the above documents.

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