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A TRIAL TO ESTABLISH IF OBSERVATION OF BIRD ACTIVITY IN THE UK USING AIRFIELD RADARS CAN PROVIDE A MEASURE OF THE BIRD HAZARD

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ABSTRACT

Military aircraft operating in the UK low flying system often suffer substantial birdstrike damage. It is possible that a radar-based bird hazard warning system, similar to those employed by other European nations, may be able to identify days on which a particularly high birdstrike risk occurs in the UK. This report describes a trial to determine if bird activity can be observed in the UK lower airspace using a number of airfield radars. The degree of correlation between the radar observation data and the birdstrike statistics during the same period is a measure of the potential effectiveness of a active bird hazard warning system.

A TRIAL TO ESTABLISH IF BIRD ACTIVITY IN THE UK CAN BE OBSERVED ON AIRFIELD RADAR SYSTEMS TO PROVIDE A MEASURE OF THE BIRD HAZARD

1. BACKGROUND

1.1 Analysis of birdstrike data shows that the bird hazard to military flying in the UK mostly affects those aircraft with a low flying role. Over 90% of all RAF birdstrikes take place at heights below 2,000 ft and approximately 70% of these occur outside the influence of airfield bird control. There is also a seasonal variation in the relative bird hazard due to the variation in species, population and activity of the birds which are resident during the different periods of the year. In particular, there tends to be an increase in the number of serious birdstrikes during the Spring and Autumn migration. During 1990, some 450 birdstrikes took place in the UK system resulting in damage to 205 aircraft. Whilst the general bird hazard for each month of the year is well documented, there is a requirement for a more precise system to detect those days on which intensive bird activity takes place. Timely bird hazard warnings can then be provided to aircrew.

1.2 Although ornithologists in the UK during the 1950s were some of the first to use radar to study bird movement, in contrast to other European nations, this technique has never been employed to measure and report the relative birdstrike risk. It has always been considered that the UK, which is located at the end and beginning of the migration routes to Scandinavia and North Africa, has a diffused bird movement which could not easily be observed.

1.3 During the Autumn migration in 1990, a RNLAF camera was fitted to a console of an air defence in East Anglia to record the bird migration between Holland and the UK. Although, for technical reasons, only a snapshot of the migration was recorded, there was sufficient data to conclude that the UK does experience periods of intense movement of birds similar to that observed on the Continent. The next step was to ascertain whether established radars in the UK could observe intensive bird activity and to evaluate the potential of the radars to form part of a bird hazard warning system. The trial commenced on 1st March 1991, using airfield radars at 26 locations grouped in 6 geographic regions and will continue until 31st March 1992 so that data from 2 Spring and 1 Autumn migrations will have been obtained. This paper provides an analysis of the results obtained from the airfield radar bird observation trial between March and November 1991.

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2. OUTLINE OF THE TRIAL

2.1 The 26 nominated airfields were able to provide observations over a substantial area of England and Wales and some parts of Scotland. The Air Traffic Control Officers at each airfield was asked to log any bird activity that was observed on the search radar system and send a consolidated report of the observations to the Inspectorate of Flight Safety (IFS) at the end of each month. The monthly report was to include the date and time of the observation, location of the flock, direction of movement and a subjective judgement of the bird intensity on a scale of 1 to 3. A sample of the report form is attached at Figure 1. Each unit was issued with photographs of bird returns observed on Watchman and AR1 radars to assist in this task. The stations (with radar types) which participating in the trial are shown in Figure 2.

2.2 At IFS, the radar observation reports were entered into a database which also stored information on the number of RAF birdstrikes which took place in the UK. The two data sets were than compared to see if there was a correlation between them and, most importantly, whether such a correlation could have provided a measure of birdstrike risk warning. In essence, the trial consists of two discrete methods of sampling the bird density in the UK airspace each day; firstly by observing the bird activity on radar and, secondly, noting the number of birdstrikes - and thus the degree of bird hazard - that took place during normal flying operations.

2.3 From the encouragingly large number of radar observations recorded during the period 1 March 91 to 30 November 91, it has been possible to make some estimates of the performance of airfield radars types in detecting the various species of birds which are active in the UK during the Spring, Summer and Autumn months. It has also been possible to achieve an understanding of the procedures and equipment which would be required to develop a practical bird hazard warning system.

3. OVERALL RADAR PERFORMANCE IN DETECTING BIRDS

3.1 Radar Type. Prior to the start of the trial, advice was sought from a number of experienced air traffic control staff on the likely performance of airfield radars in detecting bird activity. It was generally believed that the processed-type display used on the Watchman and AR15 radars would probably exclude bird returns and it was therefore anticipated that the older ACR430 and AR1 would provide the majority of the observations. This proved not to be the case; the majority of reports came from Watchman equipped units although units with AR15 also performed well. However, the numbers of participating AR1 and ACR430 units

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was much smaller than those equipped with the more modern radars and the poor performance of the obsolescent types may well have been a product of other factors such as serviceability and siting. A total of 198 reports were received by IFS and Figure 3 shows the number of observations which were reported for each radar type.

3.2 Serviceability. Periods of poor serviceability of some of the participating radars resulted in fewer bird observations than may otherwise have been expected. There were no observations units because of technical problems. In addition, the technical performance of the Watchman at one unit, which is well sited to observe bird activity in the Wash area, was substandard during the period.

3.3 Anomalous Propagation. Anomalous propagation (or ducting as it is often called) is caused be certain weather conditions and results in radar returns being received from many times the normal range of the radar equipment. Some units found difficulty in distinguishing bird returns from that of 'ana prop' and indeed, this problem was so severe in the area covered by Manston's AR1 that the unit could not confidently provide any observations.

3.4 Other Factors. There were clearly other factors which resulted in rather fewer observations from some units than would reasonably been expected. It was anticipated that those units sited near bird-attracting areas, such as coastlines and lakes etc, would have been in a better position to observe bird movement than some other sites. The results from Lossiemouth, Brawdy and Cottesmore proved this to be so. However, the lack of observations from equally well sited units was rather surprising.

4. RESULTS

4.1 Range. The ranges at which the bird targets were detected are illustrated in Figure 4. The average detection range for the Watchman radar was 6.7 nautical miles(nm) and 4.7nm in each case of the AR15 equipment. Although Watchman was able to detect some bird activity out to 25nm, 79% of the observations were less than 10nm The relatively short overall detection range is to be expected. The birds are generally confined to the lower levels - below 1500 feet - and present a small target to the radars. This perhaps self evident result does indicate the type of radar-based system which would be best suited to providing birdstrike hazard warnings. Such a system would consist of a number of small, strategically sited, short range radars to provide sampling of bird activity which would provide an interpolated measure of the birdstrike risk for areas within the U K Low Flying System.

4.2 Significant Days. It is possible to obtain a broad appreciation of the intrinsic bird hazard in the UK lower airspace during Spring, Summer and Autumn by analysing birdstrike statistics for each season. During Mar to May 91, there was a 88% chance that either one birdstrike or no birdstrikes would occur on any single working day. The 'one or no birdstrike days' may be considered to be the norm and the days on which 2 or more birdstrikes took place may have been associated with an increase in bird activity; such days can be considered significant in comparing birdstrike data with that from the radar observations. During the Summer - June to August 91 - the norm was 4 or less birdstrikes per day and in the Autumn it was 3 or less each day.

4.3 Spring (March to May 1991)

a. March March 91 marked the start of the trial and coincided with the Spring bird migration. Some units were able to commence observations from the beginning of March but delays in the postal system resulted in others not receiving the trial instructions until the end of the first week. Moreover, as a result of the Gulf Crisis, there were fewer low level sorties flown in the UK during March 1991. This doubtlessly resulted in fewer birdstrike. Nevertheless, there was a strong correlation between the significant days and those days when a high number of observations took place. The graph at Figure 5 shows this correlation clearly, the peaks representing periods of increased birdstrike risk. There were 2 such peaks during March; a large period of activity on the 13 and 14 March and a medium peak between the 19 to 22 March.

b. April. The level of low flying activity was quite high during April 1991 although there were fewer birdstrikes than during the previous month. Nevertheless, a correlation again existed between the birdstrike data and the radar observations, although it was not as marked as that of March. The results, at Figure 5 show that there were 4 peaks of activity which took place on the 10, 16, 24 and 29 April.

c. May 91. The Spring migration was complete by the end of Apr and the number of radar observations during May was substantially lower than the previous 2 Months as shown on the graph at Figure 6. This may be attributed to the size of the bird species - and their associated radar reflectivity - which are predominately active during the Summer in the UK. The smaller birds - such as swifts, swallows, house martins etc - are particularly active and, later in the Summer, the fledglings take to the air. Unfortunately, there was little information on the birdstrike reports to confirm

that the aircraft were colliding with these 'stealth' species. However, in most cases, the aircraft suffered either slight or no damage, an indication of low impact energy and therefore a low bird-weight. There was only one occasion - 8 May - when there was a correlation between birdstrikes and observations. On that day, a total of 5 observations were made in North Scotland, the East Midlands, West Midlands and the West; the 2 birdstrikes were discovered after flight.

4.4 Summer (June to August 1991)

a. June There was very little fit between the occurrences of birdstrikes during June and the very few radar observations that were reported (See Figure 6). Again, the smaller species of birds seemed to be responsible for the majority of birdstrikes; this was indicated by the high proportion of 'no damage ' incidents which took place during the month.

b. July The correlation between the few radar observations that took place in July and the large number of birdstrikes is inconclusive. Only on one day, 8th July, was there more than one radar observation. On this occasion the 3 observations were reported from the East Midlands and East Anglia areas. One birdstrike on that day was at the airfield where one of units that reported an observation is sited.

c. August There was no discernable correlation between birdstrikes and radar observations during August 1991.

4.5 Autumn (September to November 1991)

a. September The weather during September 1991 was unusually hot and this may have delayed the start of the Autumn migration. There was little evidence of large scale movement of birds on radar and birdstrikes damage during the month suggested that the smaller species birds were involved. Three radar observations occurred on 18th September. These were all reported by the same unit and was probably due to a local phenomenon.

b October There was a sharp rise in the number of radar observations in the latter half of October 1991 indicating perhaps strong migration activity - there was at least one observation reported on each working day from 15th to the end of the month. However, unlike March 1991, there was no clear correlation between the birdstrikes and the observations

c November The relatively high number of radar observations continued into November 1991 with only a small decline towards the end of the month. Again, there was no positive correlation between birdstrikes and radar observations - Figure 9 referrs.

4.6 Intensity. Paragraph 2.1 described the method used for reporting the intensity of bird activity for each radar observation. Although, subjective judgement by the radar operators is a rather crude and highly criticised technique, 28 of the 43 days on which at least one intensity '3' was reported also coincided with a birdstrike peak. Moreover, the coincidence of intensity 3 were most marked during March, April and early May and again in late October.

4.7 Time of Observations. The time that observations are made is an important parameter in any potential bird hazard warning system. If the observations tend to occur during the latter part of the day, it would be quite impossible for a bird hazard warning to be issued to aircrew engaged on early morning sorties. The graph at Figure 10 shows the number of observations that were made for each 2 hour period from 0600 hours to 2200 hours; the first column represents the observations which took place between midnight and 0600 hours. There were no observations between 2200 hours and midnight. It can be seen that the observations were biased towards the morning to early afternoon period with 42% taking place prior to 1000 hours. The observations occurring between 0600 and 0800 hours (20%) may be associated with bird activity during the dawn period.

5. SUMMARY

5.1 A total of 198 radar observations of bird movement were reported between 1st March and 30th November 1991 from the 26 units which are participating in the IFS airfield radar bird activity observation trial. The following points summarise the analysis of the reports that were received during this period:

a. Of the 26 participating units, 15 submitted one or more reports during the period. It would seems that there are a number of factors other than technical performance, such as siting and serviceability, which influence the ability of airfield radars to detect bird activity.

b. Watchman and AR15 equipment which have processed displays demonstrated a good ability to observe bird movement. Of the older radars with unprocessed displays, 2 observations were reported from a ACR 430 unit but the AR1 did not detect any bird activity during the period.

c. Many of the radar returns from bird-type targets would have been suppressed by display processing. It is therefore likely that the potential number of bird observations which could be extracted from the pre-processed signal would be far greater than that reported by the operators.

d. The average range of detection of bird activity was 6.1nm. The Watchman radar demonstrated a slightly superior range to that of the AR15.

e. Birdstrike and radar observation reports were examined for correlation between the data sets. During the first part of the period, the strongest correlation took place in March corresponding to the Spring Migration. A good correlation took place in Apr and progressively poorer correlations occurred during the Summer. The reverse of this trend occurred in the second half of the period although the Autumn did not provide any strong correlation.

f. The degree of correlation between birdstrike and radar observation data is probably consistent with the bird species which are prevalent in the UK during March to November. The large migratory birds may be active during Spring and Autumn whilst the smaller birds - the 'stealth' species - become more abundant in the Summer months.

g. The reported intensity of each bird flock was based on the subjective judgement of the radar operator on a scale of 1 to 3. There was a reasonable coincidence between reports containing intensity '3' and those days on which both a high number of birdstrikes and radar observations took place.

h. Radar observations took place at various times of the day from 0315hrs to 2045hrs. However, most took place from early morning to early afternoon.

IFS(RAF), MOD London February 1992

List of

1. Bir
2. Loc
3. Num
4. Wat
5. Rad
6. Rad
7. Rad
8. Rad
   Oct
9. Rad
10. Dis

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9. Radar Observations and Birdstrikes - November 91
10. Distribution of Time of Radar Observations

D/IFS(RAF)/115/10/4/2

IFS AIRFIELD RADAR BIRD OBSERVATION TRIAL

RADA

TO: FS2c(RAF)
Inspectorate of Flight Safety
Ministry of Defence
Adastral House
Theobalds Road
London WC1X 8RU

MONTHLY RETURN OF BIRD ACTIVITY OBSERVED BY RADAR

Unit: RAF BRAWDY Radar Type WATCHMAN

Month JUL 91

Date	Time	Location	Direction	Intensity	Remarks
15 JUL	0935	160°/06	SE	LIGHT	
17 JUL	0619	240°/10	SW	HEAVY	
24 JUL	1017	140°/10	E	MEDIUM	

Note 1: Direction of movement of observed intensity in degrees true
Note 2: Give location of centre of bird intensity as distance (nm)/degrees true from airfield

Figure 1

RADAR BIRD OBSERVATION TRIAL 1991

LOCATION OF RADAR UNITS

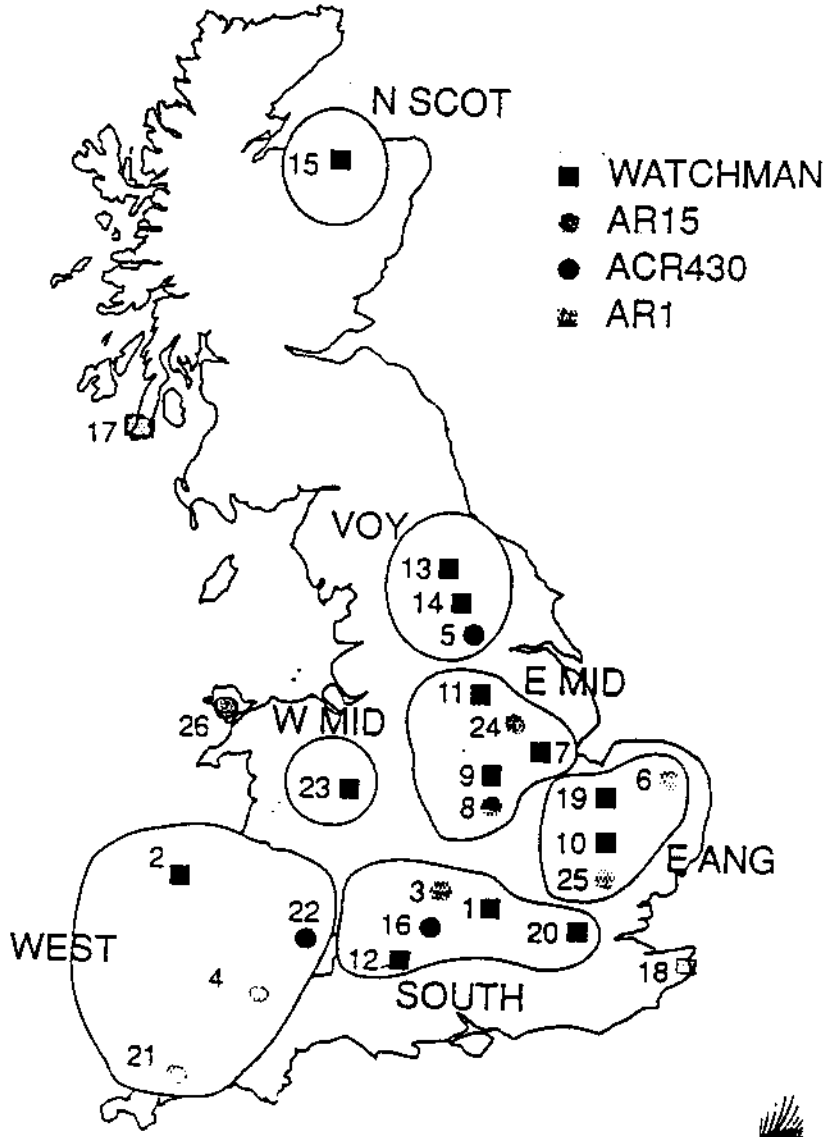


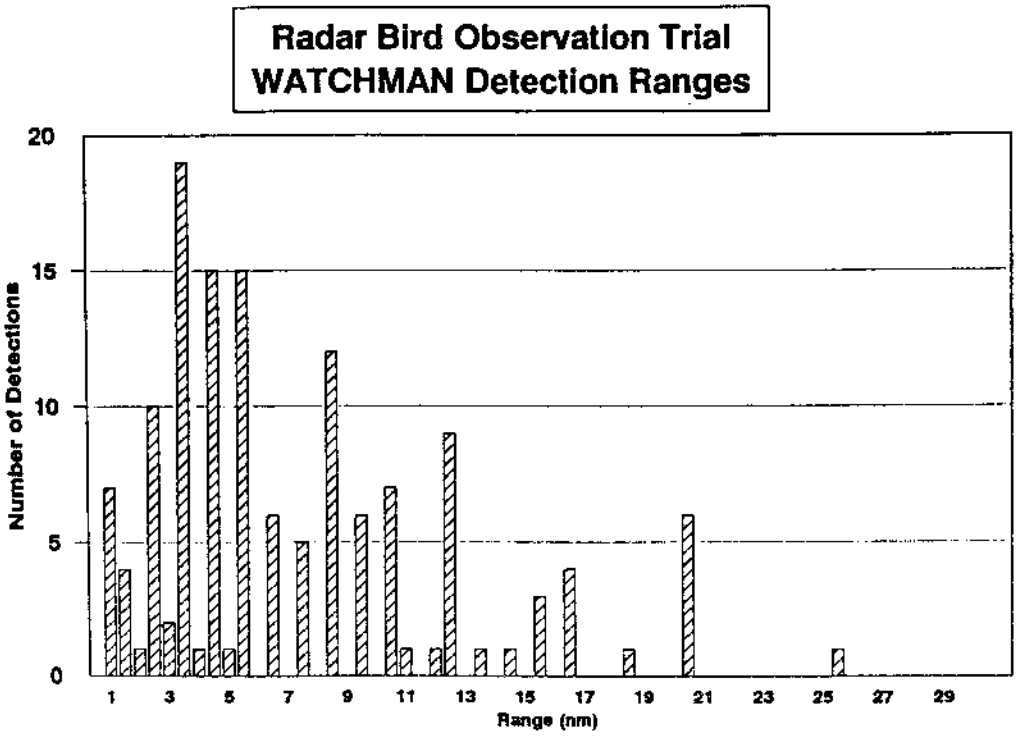
Figure 2

SUMMARY OF RESULTS
Number of Observations By Radar Types

	Watchman	AR15	ACR430	AR1	Total
March	23	13	0	0	36
April	37	13	0	0	50
May	10	4	0	0	14
June	5	2	0	0	7
July	8	3	0	0	11
August	8	4	0	0	12
September	5	2	0	0	7
October	25	5	1	0	31
November	22	7	1	0	30

TOTAL 198

Figure 3


Radar Bird Observation Trial
WATCHMAN Detection Ranges
Number of Detections
0
5
10
15
20
1
3
5
7
9
11
13
15
17
19
21
23
25
27
29
Range (nm)

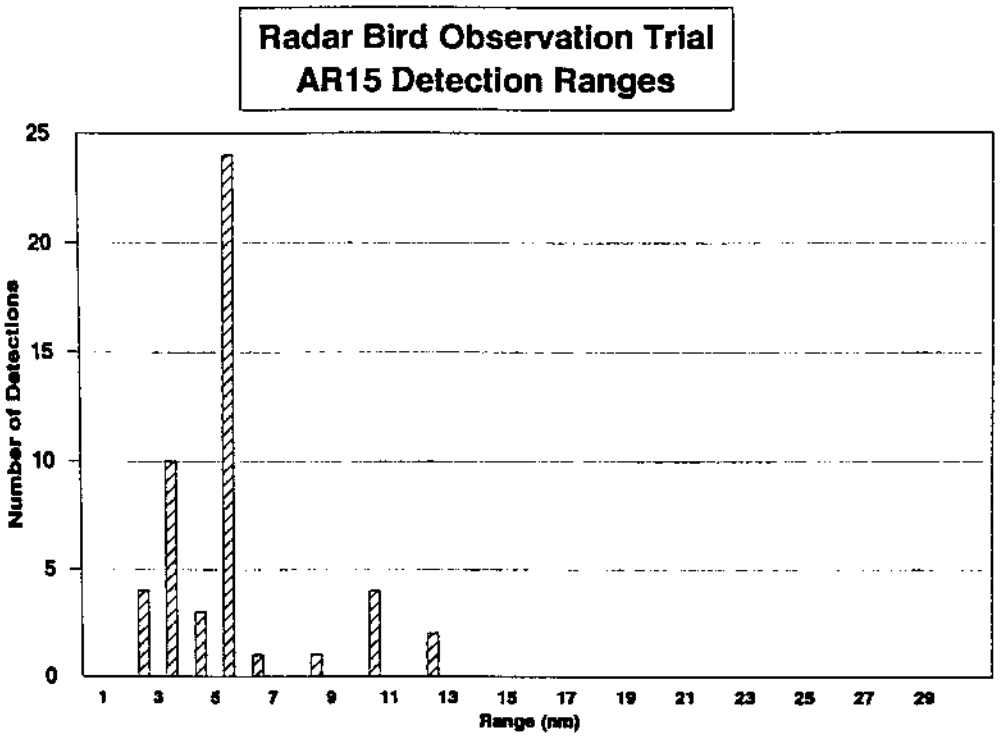
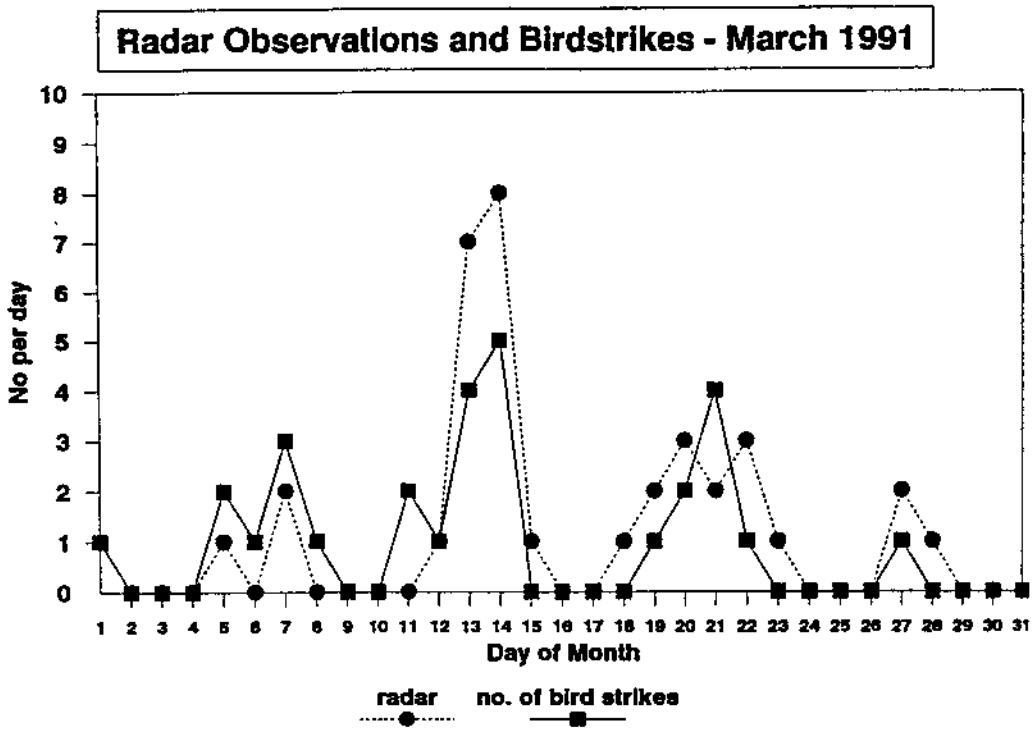

Radar Bird Observation Trial
AR15 Detection Ranges
Number of Detections
0
5
10
15
20
25
1
3
5
7
9
11
13
15
17
19
21
23
25
27
29
Range (nm)

Figure 4


Radar Observations and Birdstrikes - March 1991
No per day
Day of Month
radar
no. of bird strikes

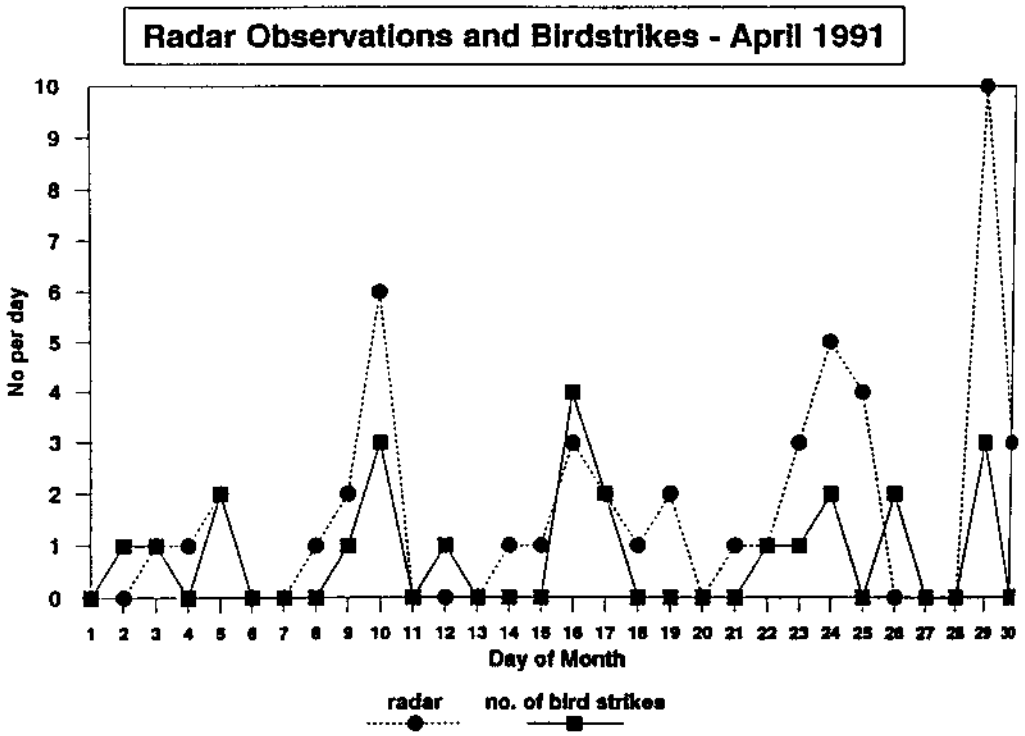
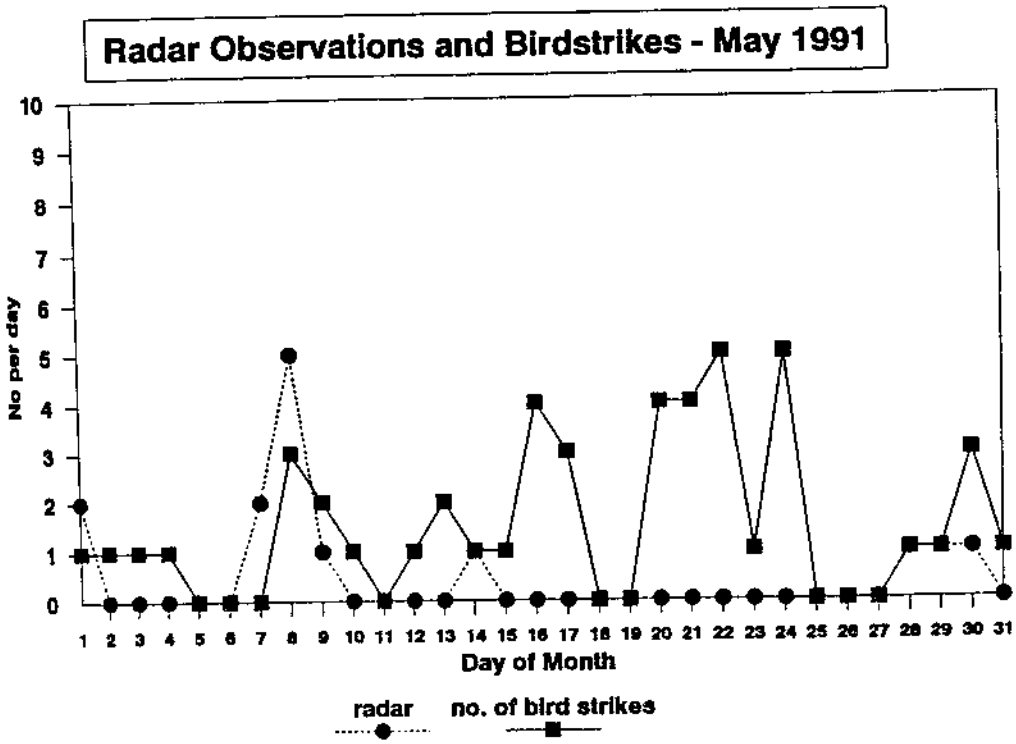

Radar Observations and Birdstrikes - April 1991
No per day
Day of Month
radar
no. of bird strikes

Figure 5


Radar Observations and Birdstrikes - May 1991
No per day
Day of Month
radar
no. of bird strikes

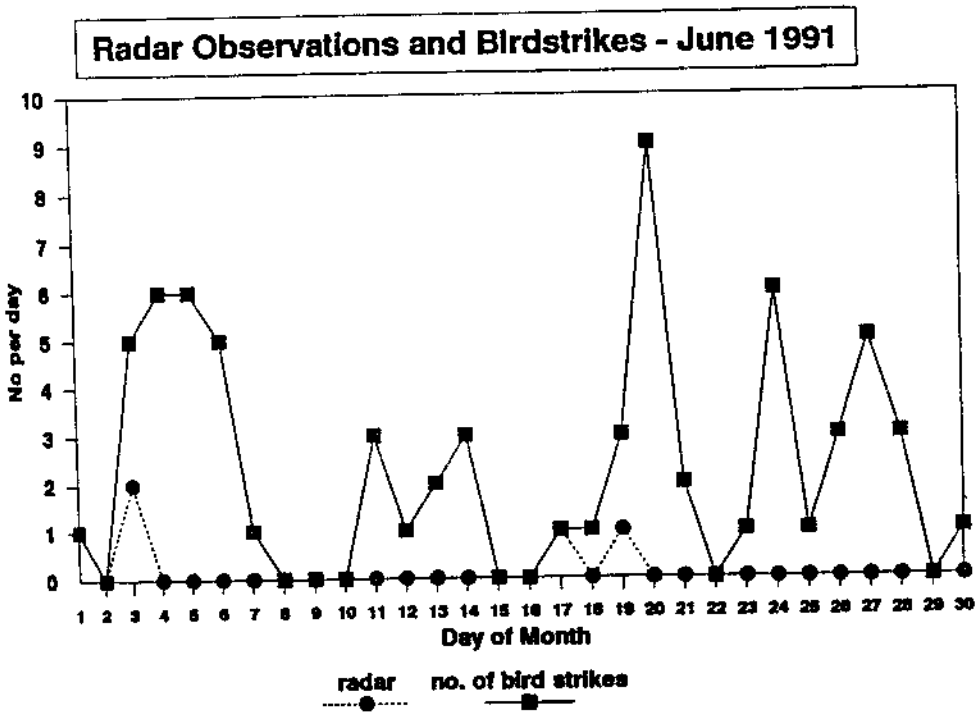
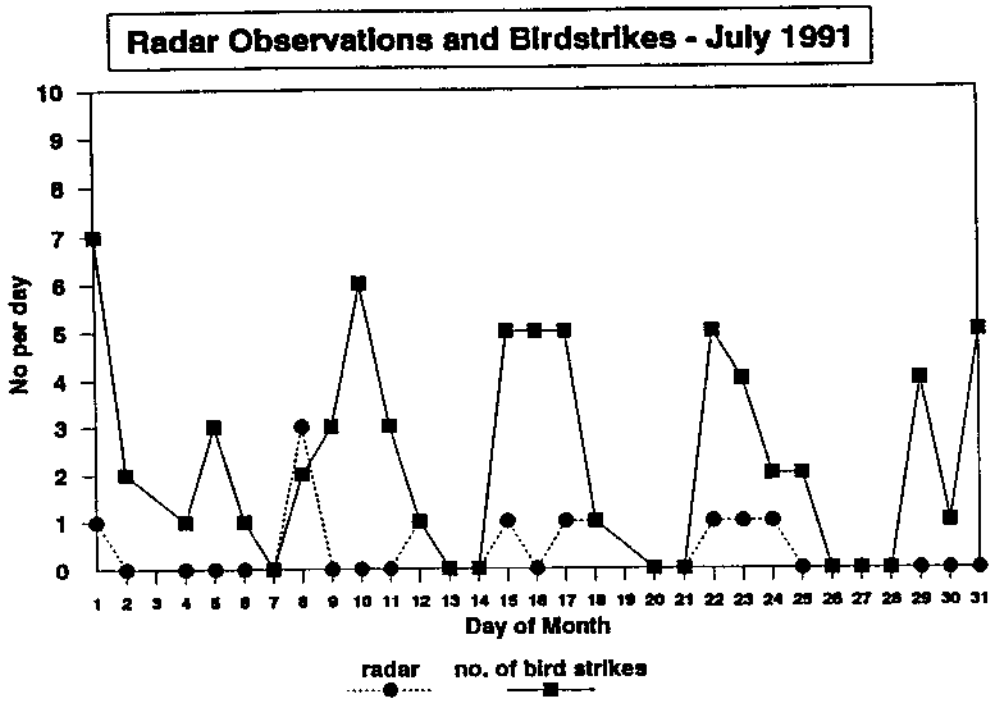

Radar Observations and Birdstrikes - June 1991
No per day
Day of Month
radar
no. of bird strikes

Figure 6


Radar Observations and Birdstrikes - July 1991
No per day
Day of Month
radar
no. of bird strikes

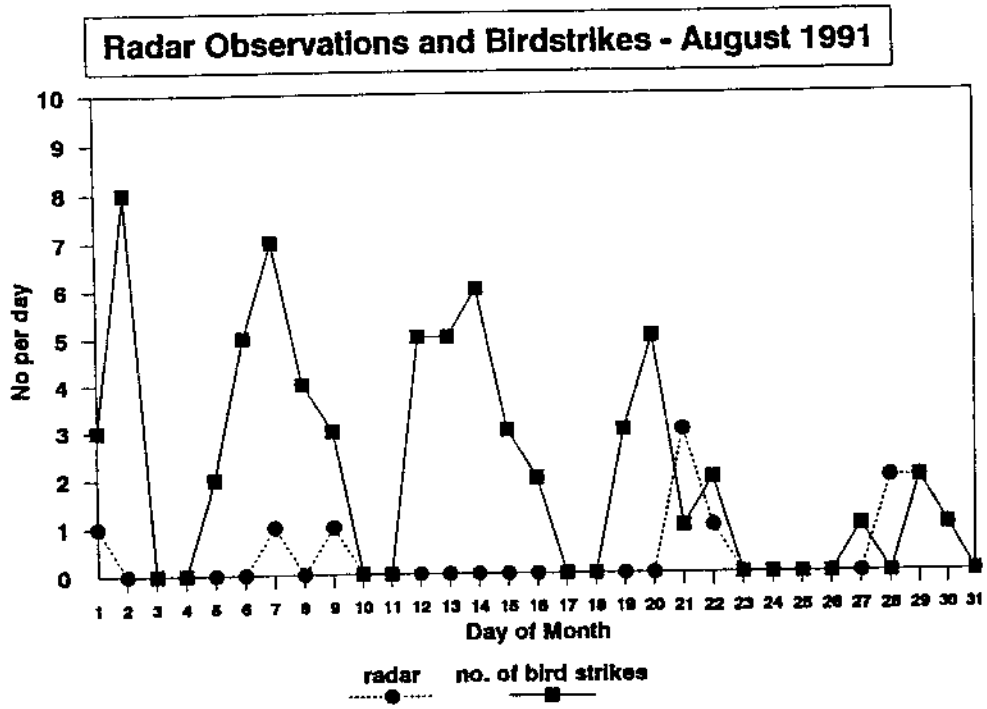
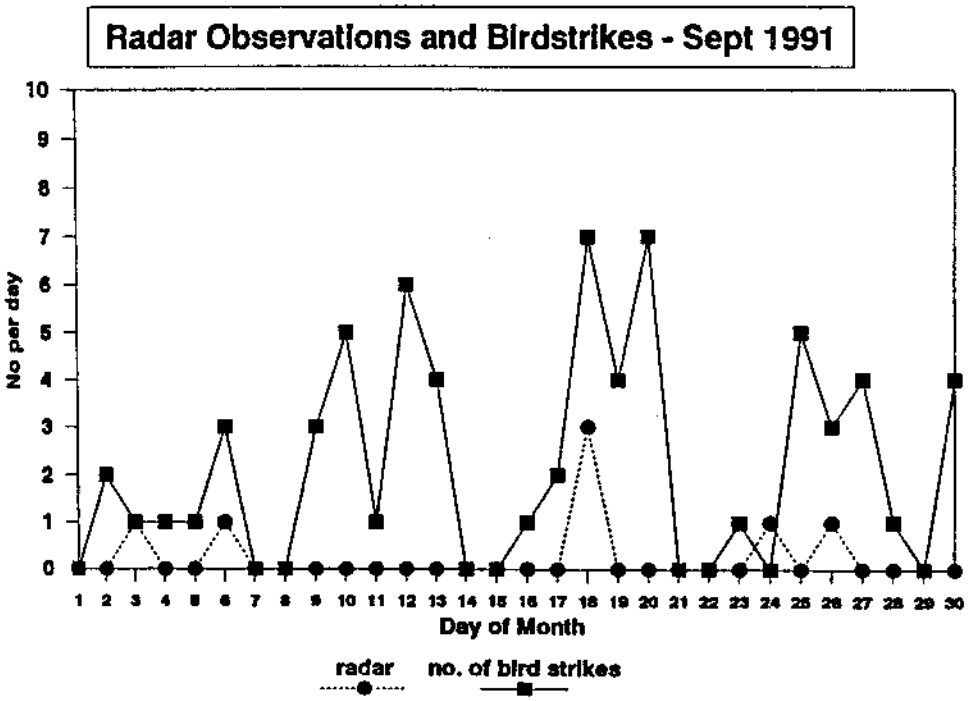

Radar Observations and Birdstrikes - August 1991
No per day
Day of Month
radar
no. of bird strikes

Figure 7


Radar Observations and Birdstrikes - Sept 1991
No per day
Day of Month
radar
no. of bird strikes

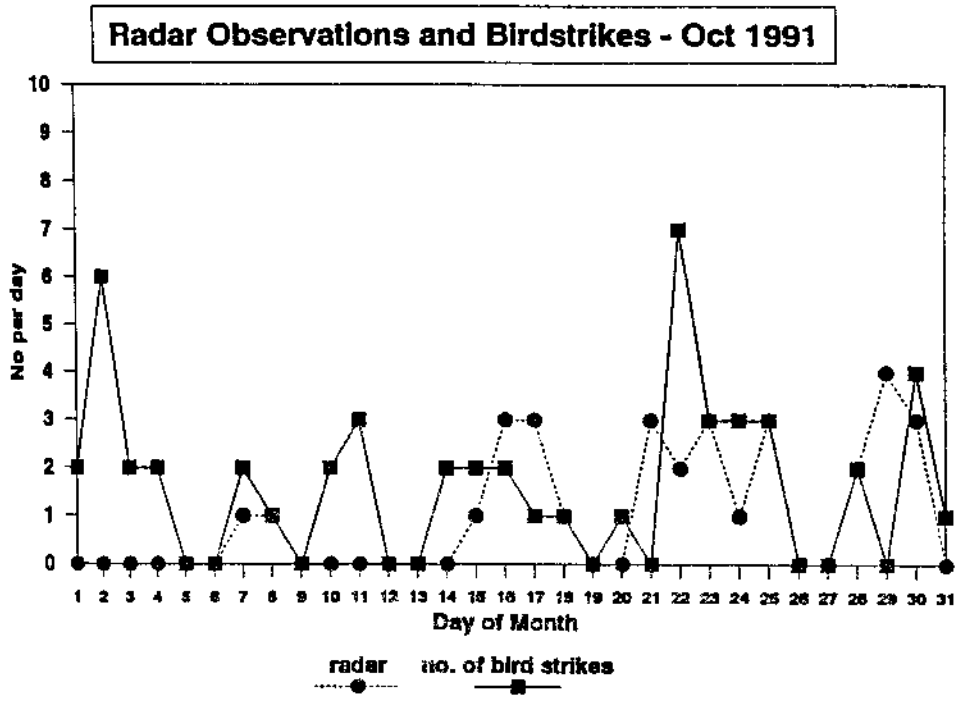
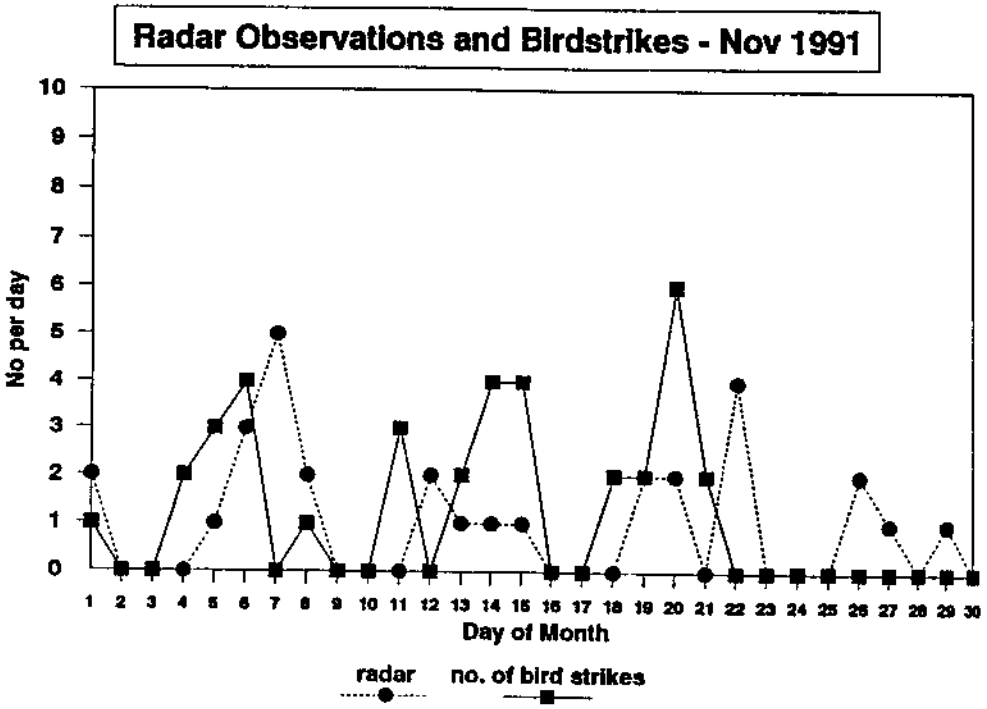

Radar Observations and Birdstrikes - Oct 1991
No per day
Day of Month
radar
no. of bird strikes

Figure 8



Radar Bird Observation Trial
Distribution of Time of Observation

Figure 9

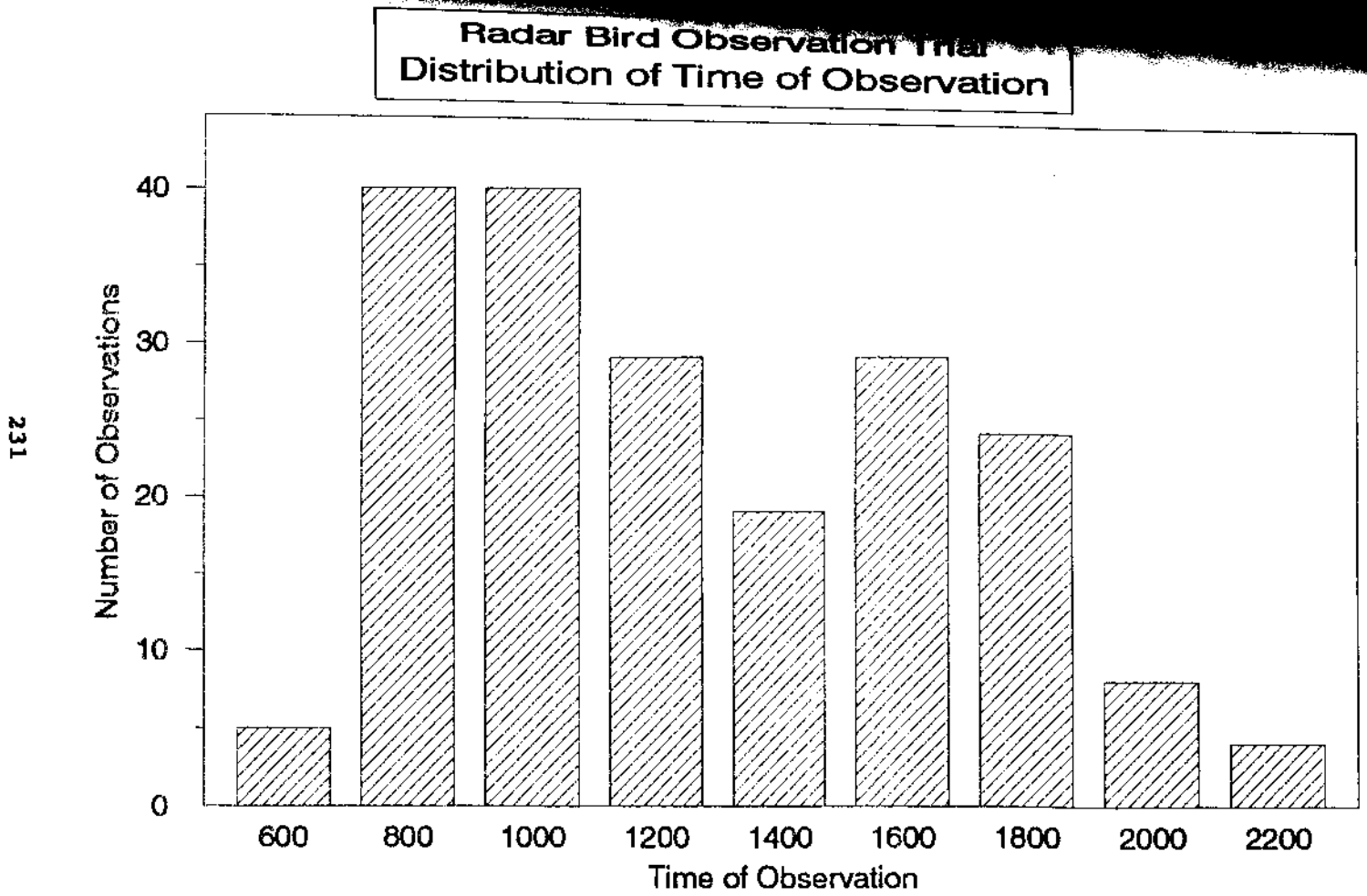

Radar Bird Observation Trial
Distribution of Time of Observation
Number of Observations
0
10
20
30
40
600
800
1000
1200
1400
1600
1800
2000
2200
Time of Observation

Figure 10

FIVE METHODS
ISRAEL

Haim Alfiya
Israel Raptor Informat

Israel is a land bridge
Europe and Asia, to
over Israel (280 specie

Nocturnal migration
radar. Since then, five
listening to calls, rada
been found to be the

Three years of resear
migration. Radar data
night.

During these three ye
first three hours of the
of the expected migrat