ASSOCIATE COMMITTEE
ON
BIRD HAZARDS TO AIRCRAFT

NATIONAL RESEARCH COUNCIL, OTTAWA, CANADA

FIELD NOTE NUMBER

59

PROGRESS REPORT ON OPERATION BIRD TRACK 1964 THROUGH 1969

H. BLOKPOEL

OTTAWA

NOVEMBER 1971

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In the belief that rapid exchange of information is of the utmost importance to a solution of the bird problem, the Associate Committee on Bird Hazards to Aircraft has decided to release rough field notes as soon as they are produced, rather than to wait until these data would normally appear in formal reports.

These field notes are produced for information and will not usually receive the editorial care usually given to formal reports.

It is hoped that other groups will contribute similar notes on an exchange basis.

M.S. Kuhring
Chairman
Associate Committee on
Bird Hazards to Aircraft
National Research Council of Canada

PROGRESS REPORT ON OPERATION BIRD TRACK

1964 THROUGH 1969

H. Blokpoel

Canadian Wildlife Service

September 1971

INTRODUCTION

Operation Bird Track is a project sponsored by the National Research Council's Associate Committee on Bird Hazards to Aircraft, to reduce the number of in-flight bird strikes by developing a system to forecast or warn of dangerous bird movements (19, 21). The project was started in fall 1964 by Dr. W.W.H. Gunn, on contract with the Canadian Wildlife Service.

Since the start of Operation Bird Track about 40 published and unpublished reports have been written on various aspects of the project. The purpose of this note is to survey objectives and methods, summarize results, review aims, and catalogue reports and publications to the end of 1969.

OBJECTIVES AND METHODS

Operation Bird Track was started with the idea that, if birds migrate under certain weather conditions only, it might be possible to predict bird migration using the weather forecast. The first objective of the project was to obtain an idea of the volume and pattern of bird migration across Canada. Radar surveillance was considered the best method because large areas could be covered effectively and continuously at relatively little cost. Advantages and disadvantages of bird detection with radar were described by Eastwood in his book 'Radar

Ornithology' (42). Gunn reported on camera equipment to film the radar screen (15) and wrote a guide for judging the pictorial quality of radar film (20). Both the still-camera time-exposure technique using Polaroid film and the method for taking time-lapse motion pictures were described by Solman (40). Screens of 25 radar stations in 7 provinces were filmed, most of them for one or two migration seasons, some for three or more (Table 1).

To express the density of bird echoes an arbitrarily chosen 9-step scale was used. Echo density was determined by comparison with a set of nine pictures showing the standard densities, running from 0 (no bird echoes on the radar screen) through 8 (the whole screen covered by bird echoes). The different echo densities were given the following classes of migration density:

Echo density	Migration density
0	None or almost none
1	Very light
2	Light
3	Light-medium
4	Medium
5	Medium-heavy
6	Heavy
7	Very heavy
8	Extremely heavy

This method was briefly described by Fryers (13). Because (a) bird movements in different directions often occurred simultaneously and (b) films from all radar stations were to be assessed in exactly the same way so as to permit comparison using a computerized system, Richardson designed a new system in 1966 for assessing radar films in which each movement of birds ("event") is separately evaluated (29). Date, time, density, direction and echo size were "read" from the films and coded on punch cards (29). Radar films were assessed by P.P. Desfosses and his assistants.

To study the correlation between the weather and the density of migration Richardson and Gunn (34, 35) made a detailed study of the radar data obtained at Canadian Forces Base (CFB) Cold Lake in east-central Alberta.

In the meantime, even before the Cold Lake data had been completely analyzed, Fryers (13), then Base Meteorological Officer at CFB Cold Lake, made a pilot effort to forecast the density of bird migration (spring and fall 1966) based on the local weather forecast and general information on weather-migration correlations provided by Gunn. Using Richardson's preliminary results (pers. comm.) Blokpoel attempted to forecast density of nocturnal migration over Cold Lake in fall 1968 (7) and, on a routine basis for operational use, in fall 1969 (8).

When the first migration forecasts were made, it became desirable to quantify the bird strike hazard. Although the 0-8 density scale provides a method to classify the bird density, one needs to know the number of birds and flocks in the air to calculate the probability for an aircraft to hit a bird. To find the numerical relationship between the steps of the 0-8 density scale, Blokpoel compared the densities observed on film of a Cold Lake surveillance radar with those obtained by moonwatching (2) and those detected with a vertically aimed track radar (6).

When the routine migration forecasts were made, it became also evident that height information was urgently required. Attempts to study the height of migration using the Range Height Indicator of a height finding radar near Cold Lake yielded no results (13), but during fall 1968 and 1969 the altitude of bird migration was more successfully studied with an M33C Tracking Radar at the Primrose Lake Evaluation Range, about 30 miles north of CFB Cold Lake (5, 6).

When assessing the radar films from the various airports, high-density, short-range, local movements of recurring nature were often observed. As these flights frequently occurred in the close vicinity of airports they were considered as possibly hazardous to air traffic. A special code for assessing and recording local movements was designed by Richardson (29).

Because migrating Whistling Swans had caused the crash of an airliner, special studies were made of their migration using visual observations (3), radar (32) and telemetry (38).

Because the Canadian Armed Forces also experience bird strikes in Europe, Canadians have been instrumental in starting radar studies in some European countries. Dr. V.E.F. Solman, Canadian Wildlife Service, is now the chairman of the European working group "Radar/Weather/Birds". Roost movements observed on radar films taken in Metz, France, in spring and fall 1965 were described by Desfosses (10).

To publicize Operation Bird Track, seminars were given at universities, articles written for flight safety and other magazines, and papers read at various meetings by Blokpoel (6, 7), Gunn (14, 17, 18, 38), McDonald (22), Myres (24), Richardson (30, 31, 34), Solman (19, 39) and Sladen (38). At the beginning of the project, Myres provided a bibliography of papers on radar bird detection (23), since updated in 1969 (25). He also discussed the use of radar in wildlife management (28). Copies of all reports may be borrowed from the secretary of the Associate Committee on Bird Hazards to Aircraft, National Research Council, Ottawa, Canada.

SUMMARY OF RESULTS

A. Radar studies at CFB Cold Lake and Primrose Lake

A.1 General patterns of migration

Results for the area around CFB Cold Lake are given by Richardson (34) who studied radar films covering the periods 1 April-10 June 1965 and 10 September-30 November 1966. Richardson (34) reported:

> "Both short duration local flights of birds and long distance broad-front movements were recorded by the Cold Lake radar. The term "broad-front" refers to the fact that most migratory flights appeared to move evenly across the radar coverage area; they were not noticeably concentrated along particular narrow routes. My study of the Cold Lake data dealt only with the long distance movements and not with the local flights.
>
> "Migration in Alberta and Saskatchewan was not along a north-south axis, but rather predominantly NW in spring and SE in autumn. Nevertheless small movements in other directions did occur. Flights in directions other than NW in spring and SE in autumn usually occurred when the wind direction was following relative to the observed direction of movement (Richardson and Gunn, in prep.).

"Variation through the year.-- As one would expect, the normal amount of long-distance bird movement varied markedly through the year.

"Peak activity occurred in September and May, with October and August also having relatively intense movement. While there was less movement in June and July than in spring or autumn, there was much more through the winter. In each month from May to October, more than 75% of the nights had peak intensity 2 or above, while in each month from December to March, more than 75% of the nights had a peak intensity of 2 or below . . . Winter was obviously by far the least hazardous time of year from the bird strike viewpoint.

"Variation through the day.-- The amount of bird activity varied rather predictably with the time of day as well as the time of year. During the migration seasons, the amount of long-distance migration was usually much larger at night than during the day. . . In general, the intensity was low during the day, rose rapidly after sunset to a peak before or near midnight, and then dropped gradually.

"In summer the daytime intensity was similar to that in the migration seasons, but the nocturnal intensity was generally lower than the usual nocturnal intensity in spring or autumn."

Richardson's data suggest that in the summer and particularly during the spring and autumn it is least hazardous to fly during the daylight hours. He mentions that this conclusion must be qualified since daytime bird echoes are usually bigger than those observed at night, suggesting that at night birds or flocks or both are, on the average, smaller than during the day, and that consequently

> ". . . the chances of having a bird strike are greater at night, but given that a strike has occurred, the chances of it being serious are greater in the daytime. As yet we do not know the relative importance of these two effects, quite possibly it will be different for large commercial and transport aircraft from that for high-performance jets."

A.2 <u>Correlation between weather factors and density of migration</u>

Richardson and Gunn (35) investigated the influence of pressure tendency, temperature, humidity, speed and direction of surface wind and cloud extent on the density of migration over the Cold Lake area. Only wind direction, pressure trend and humidity showed consistent and significant correlations. However, Richardson (34) found that once surface wind direction has been used to predict migration volume at Cold Lake, the use of the other weather parameters did not seem to give a statistically improved predictive ability. Richardson and Gunn did not consider precipitation (considered an unfavourable factor by Lack (44)) or upper-air winds (in a preliminary analysis Blokpoel found that north-westerly upper-air winds are favourable factors for normal fall migration).

A.3 Forecasts of density of migration at CFB Cold Lake

The operational migration forecasts Blokpoel (8) made during fall 1969 were more accurate than the ones he made during fall 1968 (7) and those made by Fryers (13) during spring and fall 1966. As the correlations between weather and migration became better understood, the migration forecasts improved. Yet even in fall 1969 the forecasts had limited accuracy. However, all but one inaccurate migration forecast could reasonably be explained as being the "result" of (a) faulty use of the prediction guidelines, (b) inaccurate weather forecast, or (c) an unusual situation. To check the forecast system regardless of the accuracy of the weather forecast, Blokpoel (8) also made migration post-predictions (based on reports of the actual weather instead of the weather forecast) using the latest results of Richardson (34). Whereas the migration forecasts were made by three different people (and often in a hurry), the post-predictions were made at leisure by presumably the most experienced man. The fact that the migration post-predictions had a high accuracy (88% of 512 hours, 87% of all 52 nights and 82% of the 22 nights which had at least one hourly density of 5 or higher) indicates that, given the right working conditions, the migration forecast could be accurate enough for operational use.

A.4 Determination of numbers of birds corresponding with the steps of the 0-8 density scale

Both the results from moonwatching during fall 1967 (Blokpoel (2)) and those from the M33C radar study in fall 1968 (Blokpoel (6)) were few and inconclusive. The scarce data indicated that the relationship between the steps of the scale and the corresponding number of birds in the sky was probably linear at least for the higher densities. Many more data are required to solve this problem.

A.5 Height of migration at Primrose Lake

The vertically aimed M33C track radar used by Blokpoel (6) detected birds flying higher than 1,200 feet above ground level. Of the night migrants flying above 1,200 feet, 50% were on the average below 3,500 feet, 90% below 5,000 and 99% below 10,000 feet. The highest bird echoes were recorded at 14,200 to 14,400 feet above ground level. The birds did not show a clear preference for any particular height band although there were indications that cloud cover and upper air wind influenced the height distribution on nights with heavy migration. The main drawbacks of the M33C radar were its inability to detect birds below 1,200 feet and its frequent breakdowns.

B. Radar studies for stations other than Cold Lake

B.1 Migration survey

Although most films of the different radar stations (Table 1) have been assessed, there is as yet no comprehensive report on the observed migrations. Data from different radar stations are often very difficult to compare because of differences in equipment, settings and geographical surroundings. Film from some radar stations was hard to assess, often because techniques were used to get rid of undesirable echoes, including those of birds. It seemed more promising to start with an in-depth analysis of one station (Cold Lake), to be followed by a study of other stations in a larger, but essentially similar area. Richardson is now preparing a report on data for six stations in the Canadian prairies (Edmonton, Calgary, Alsask, Regina, Yorkton and Beausejour).

B.2 Other migration studies

Migration of Canada Geese through the interior of British Columbia was observed on Kamloops radar films by Myres (26).

Very conspicuous off-shore movements were detected on Holberg radar films by Myres (27), who suggested they were caused by migrating Brant Geese. A large goose flight observed on Fort William radar films was reported by Speirs and co-workers (37).

Starlings departing from their roost for migration were seen on radar films from Toronto and London, Ontario by Richardson and Haight (33).

Attempts to track Whistling Swans during their spring 1968 migration over central Pennsylvania with an M33C radar at State College were unsuccessful, but visual observations indicated that many swans were stalled by a broad belt of rain and fog (Blokpoel, 3). Richardson (32) studied the movements of swan echoes using radar film from London. In spring 1969 Sladen and Gunn (38) tracked radio-equipped birds on migration from Chesapeake Bay wintering grounds to Arctic breeding grounds. The swans were tracked from light aircraft and trucks.

B.3 Bird hazard quantifications for Toronto and Thunder Bay

Gunn and Cockshut (16) computed probabilities of bird strikes during aircraft take-off and climb-out, using estimates derived from radar photography at Toronto International Airport during heavy bird activity on October 22-23, 1964. For a DC-8 climbing to 10,000 feet, the strike probabilities ranged "from about 1 in 20 for songbirds to 2 in 1,000,000 for geese". Similar calculations were made by Speirs et al. (37) for a period with heavy goose migration over Thunder Bay. They concluded that for a DC-8 the chance of collision with geese was in the order of about 1 in 6,500 take-offs.

B.4 Local movements

It is generally impossible to tell the bird species from the size and shape of its echo on the screen (Blokpoel (4)), but a peculiar form of the echo, simultaneous field observations and circumstantial evidence made the identification possible in a few cases: local starling movements observed on radar film from Toronto and London were reported by Richardson (36) and pelican flights over the Air Weapons Range at Primrose Lake were mentioned by Blokpoel (1).

The Calgary films showed a variety of local movements; those consisting of ring and arc echoes were reported by Blokpoel and Desfosses (9). Edmonton films studied by Desfosses (11) showed local bird movements as ring and arc echoes and as lines or wedges of echoes. Desfosses (12) found that in the Montreal area ring and arc echoes originated at a variety of locations.

Some roost return movements were also observed. Although there is no proof, it is very likely that the ring and arc echoes were caused by starlings leaving their roost.

REVIEW OF AIMS

Military operations

Fighter aircraft often fly fast and low, both day and night. Training flights may be postponed when weather is very poor. When a gull-sized bird is sucked into a single-engined aircraft, the plane may crash. Two thrush-sized birds, sucked in one after another, may have the same effect.

The Canadian Armed Forces would, therefore, benefit from an accurate system to forecast or warn of movements of birds, both big and small. Forecasts at CFB Cold Lake of the heaviest bird movements (i.e., migration at night in fall) were of limited accuracy but it was concluded that under optimal conditions (availability of radar film covering the previous night, accurate weather forecast, experienced bird forecaster) the majority of the migration forecasts could be accurate enough for operational use. McDonald (22) suggested that the forecast service be expanded to all major flying units in the Canadian prairies.

Concurrently research is needed to determine whether a simple device can give quick and accurate information on height and density of current migration. Modern, modestly priced radars with a fixed, vertically aimed beam may well be able to provide this information. The Associate Committee began field-testing such a radar in 1970. If the results are favourable, every air base with fighter squadrons could be equipped with such a "bird radar", which samples height and density of all migration between 50 and 15,000 feet altitude. These data could be used (a) as a warning and (b) to check old and prepare new migration forecasts (instead of using films of a PPI scope of a surveillance radar).

Civil operations

When discussing the bird strike problem of civil aviation, Gunn and Solman (19) concluded that ". . . for commercial operators, we are concerned mainly with the take-off, climb-out, approach and landing regimes, and chiefly with small birds in dense flocks, medium-sized birds (e.g., gulls) in relatively dense flocks or large birds (geese, swans, cranes, or vultures, for example) flying individually or in flocks . . .". The airline companies would benefit from accurate forecasts or warnings of location, height, density, direction and speed of migrating high-hazard birds (19). Some of this information is provided in a booklet issued by the Canadian Department of Transport (41). However, these maps, covering almost all of Canada, are necessarily rather approximate. It would be useful to draw similar maps on a larger scale (e.g., per province). Further data from existing literature and bird club reports, along with studies of radio-equipped birds (38), will refine such maps.

Although bird maps tell pilots in general terms during what period and in what area to be on the alert for birds, they do not provide a warning for imminent hazards. Information on which to base such warnings could be obtained from a network of field observers who phone their sightings to a central agency, which evaluates the observations and decides whether or not to issue a warning. This was done in West Germany during the Common Crane migration (43). Such a system requires much organization, does not work at night and would probably be ineffective in sparsely populated areas. However, warnings from refuges or reserves, where large numbers of migrating birds (especially waterfowl) are observed departing en masse, would be very helpful.

Another method to obtain real-time information on high-hazard migration is the combined use of a surveillance and track radar. The AASR-1 is the long-range surveillance radar at many civil airports and can detect bird flocks if properly adjusted. At most airports height information on the birds can only be obtained when they fly through the relatively small air space covered by the Precision Approach Radar. Thus additional radar equipment is required to obtain height information. Compared with a height finding radar, a track radar might be a less costly, though perhaps less efficient, tool to obtain this information.

Local bird movements, observed on radar films, have been reported only for Edmonton (11), Calgary (9), Montreal (12), Toronto (36) and London (36). But even in these cases the density, height and often the species of the birds involved were unknown. Radar films made at important airports (both military and civil), should be studied for such movements. When necessary, supplementary field studies should be carried out to determine species, height and numbers of birds involved.

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Table 1. Locations and seasons with radar film taken in Canada for Operation Bird Track from 1964 through 1969. S - spring, F - fall.

	1964	1965		1966		1967		1968		1969	
	F	S	F	S	F	S	F	S	F	S	F
Alsask, Alta	x	x	x								
Beausejour, Man.	x	x									
Calgary, Alta.	x	x	x								
Cold Lake, Alta.		x	x	x	x	x	x	x	x		x
Dana, Sask.	x	x	x								
Edmonton, Alta.	x										
Falconbridge, Ont.	x										
Fort William, Ont.		x	x								
Halifax, N.S.			x								x
Holberg, B.C.		x									
Kamloops, B.C.		x	x								
London, Ont.	x		x	x	x	x	x	x			
Lowther, Ont.	x										
Mont Apica, Que.		x									
Montreal, Que.	x	x	x								x
Moosonee, Ont.	x	x	x								
Quebec, Que.		x	x								
Regina, Sask.		x	x		x	x		x	x	x	
Sault St. Marie, Ont.				x							
Saskatoon, Sask.										x	x
St. Margaret, Que.			x								
Sydney, N.S.			x								
Toronto, Ont.	x		x	x	x	x	x	x			
Vancouver, B.C.		x	x								
Yorkton, Sask.		x	x								