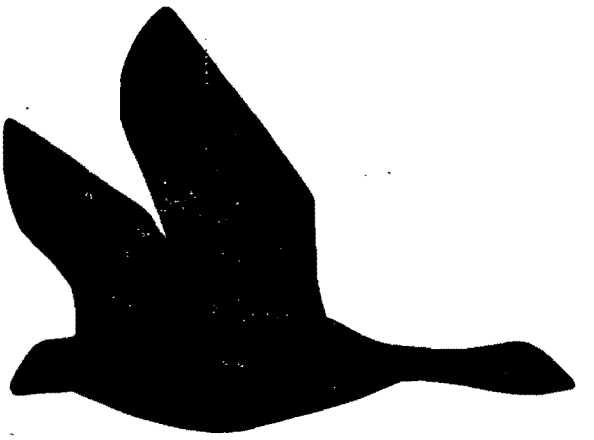
SPRING MIGRATION OF CANADA GEESE THROUGH THE OTTAWA AREA: A HAZARD TO FLIGHT SAFETY



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SPRING MIGRATION OF CANADA GEESE THROUGH THE OTTAWA AREA: A HAZARD TO FLIGHT SAFETY.

by

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SUMMARY

1. Time-lapse films were made of the screen of the AASR-1 surveillance radar at Ottawa International Airport during a study of the height of migrating songbirds in spring 1975. Unexpectedly, large numbers of "goose echoes" were observed moving across the screen. Visual observations indicated that most of the "goose echoes" represented flocks of migrating Canada Geese.
2. From counts of "goose echoes" on the radar films, a total of 2909 flocks of Canada Geese (estimated at almost 180,000 birds) migrated through the Ottawa area during 22 April to 14 May 1975. The geese migrated on a broad front, with only 14% more flocks east than west of Ottawa.
3. Of 22 periods of Canada Goose migration in spring 1975, 11 were major flights, usually beginning at 0500 hr and ending by late morning.
4. The flocks of Canada Geese which migrated through the Ottawa area (average flight direction of 17^{o}) likely originated from staging grounds (stop-over areas used for feeding and resting) along the northeast shore of Lake Ontario, the St. Lawrence River as far east as Morrisburg and in northern New York State. Rivers and flooded farm fields in the Ottawa area were used by staging Canada Geese with the largest concentrations occurring on the Ottawa River near Thurso (10,000 birds) and at Plantagenet (15,000 birds).
5. Estimates of the heights of the migrating Canada Geese from both visual and radar data were in close agreement and averaged around 1500 ft to 2000 ft agl.
6. Major flights occurred with variable wind directions and low wind speeds. Migration did not occur during precipitation. The lack of well defined weather systems during the Canada Goose migration made it impossible to determine which weather factors or systems would be conducive to major

migration in future years.

7. It is unlikely that a system can be developed to accurately predict the dates, times and numbers of migrating Canada Geese. It is recommended that SADE (Sector Automatic Detection Equipment, developed and tested by Dr. F.R. Hunt, N.R.C., Ottawa) be used to warn of actual hazardous movements of migrating geese and other species flying in large flocks.

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2. Dates and periods for which time-lapse films were made of the screen of the AASR-1 radar at Ottawa International Airport from 14 April to 25 April 1975.

INTRODUCTION

Canada Geese are widely distributed over North America. They winter from southern Canada to northern Mexico. Each spring they migrate north to breeding grounds which extend throughout most of Canada with the exception of most of the Arctic Islands, the Maritime provinces, southern Quebec and south and central Ontario (Godfrey, 1966). Canada Geese are one of the earliest waterfowl to begin migration in the spring.

There are several sub-species of Canada Goose that vary not only in color and size but also in the areas they use for breeding and over-wintering. The Canada Geese which migrate through the Ottawa area are among the heaviest sub-species and belong to the South Atlantic population which winters along the south Atlantic seaboard of the United States (Fig. 1). That population consists of the Atlantic Canada Goose, Branta canadensis canadensis, and Todd's Canada Goose, Branta canadensis interior (Addy and Heyland 1968).

During migration, geese often spend several days at stop-over areas (or staging grounds) to feed and rest. The rivers and flooded farmland in the Ottawa area provide suitable staging habitat for Canada Geese. Thus, in addition to migratory flights over the Ottawa area, there is much local low altitude goose activity around Ottawa as the staging geese make their daily flights between feeding and roosting areas. The hazard to aircraft is, therefore, twofold and due not only to migrating geese engaged in long distance migratory flights but also to staging geese engaged in local flights.

In 1974 STOL aircraft were put into service between Ottawa and Montreal (Air Transit). The Ottawa airport for those aircraft is at Rockcliffe on the south shore of the Ottawa River. The spring concentrations and heavy migratory flights of Canada Geese in the Ottawa area were therefore

a hazard to the STOL aircraft and, in fact, to all air traffic approaching and departing the numerous aerodromes in the Ottawa area (Fig. 2) and cruising at low altitudes.

During spring 1975 a radar study of the height distribution of migrating songbirds was jointly undertaken by the National Research Council and the Canadian Wildlife Service. As part of that study 16-mm time-lapse films were made of the AASR-1 surveillance radar display at Ottawa International Airport. Several migratory flights of Canada Geese were observed on the radar films. To assess the hazard to flight safety posed by those migrating flocks, the Ministry of Transport (MOT) requested that the goose data be analysed. The Canadian Wildlife Service carried out the analysis with the financial support of MOT.

The purpose of this report is to present information on the dates and times, numbers, directions, distributions, and heights of the Canada Geese that migrated through the Ottawa area in spring 1975. A more detailed report will be submitted for publication in the scientific literature.

METHODS

Visual observations

Records of observations of staging and migrating Canada Geese in spring 1975 were obtained from biologists and bird-watchers. In addition, many records were provided by the personnel of the Ottawa Air Traffic Control Tower. All records are listed in Appendix 1.

Surveillance radar

Time-lapse 16-mm films were taken of the master scope of the 23-cm AASR-1 surveillance radar at Ottawa Airport from 14 April to 13 June 1975. Beginning at 1900 hr on 25 April, there was 24 hr per day film coverage; dates and times of filming prior to 25 April are given in Appendix 2. The range was set at 60n mi (111 km) (Fig. 2) until 17 May after which it was at 40n mi (74 km). The elevation angle of the radar was 3.0^{o}. The screen was fitted with a clock and date tab. The antenna made six revolutions per minute. Every second radar sweep was recorded on one film frame. Solman (1969) outlined the camera set-up and the Manual of the Civil Aviation Branch (Canada Department of Transport, 1967) described the AASR-1 radar.

Film records of the AASR-1 surveillance radar at Winnipeg International Airport during 1970-1972 showed that flocks of Snow Geese migrating within the range of the radar produced relatively large, non-fluctuating echoes moving on a fairly straight course and at a steady speed (Blokpoel, 1974). All echoes with those characteristics on the films of the Ottawa radar screen were considered to be "goose echoes".

Based on visual observations, the majority of the geese migrating through the Ottawa area were Canada Geese, although there were also scattered sightings of other goose species such as Brant Geese. Because heavy movements of "goose echoes" on the radar films were in good agreement with the recorded visual observations of migrating Canada Geese, we concluded that the great majority of the "goose echoes" on the radar films made at Ottawa during 22 April to 18 May 1975 (the period for which there are records of visual observations of Canada Geese) were caused by migrating flocks of Canada Geese.

The radar films were analysed using a Vanguard Film Analyser which had a variable speed control and which presented the filmed image on an 18 cm^2 ground-glass projection screen. Numbers of "goose echoes" were estimated by running the radar film and counting the total number of echoes per hour crossing a straight line perpendicular to their direction of movement. The length and position of that line were varied according to the direction, spread and visibility of the echoes during the hour in order to intercept the greatest number of "goose echoes". Most counts were made between 20 n mi (37 km) and 30 n mi (56 km) southwest of Ottawa. The times of all counts were converted to the time over Ottawa to eliminate possible recounts of echoes when the counting line was occasionally repositioned. Time conversion was based upon an average ground speed of 45 knots (72 km per hr) for a flock of migrating geese (Meinertzhagen, 1955; Speirs et al., 1971; Blokpoel, 1974). The directions of the migrating flocks of Canada Geese were determined by running the radar films and manually tracking the paths of a sample of "goose echoes" on a sheet of transparent paper taped to the ground-glass projection screen.

In this report, the Ottawa area refers to the 60n mi (111 km) range under radar surveillance. All times are Eastern Standard Time and directions are in degrees True North. All heights are given as altitudes above ground level (agl).

Weather data

Weather records provided by the Ottawa Weather Office included: speed and direction of the surface wind (hourly); atmospheric pressure (hourly); precipitation (continuous) and 850-mB maps (twice daily).

RESULTS

Staging geese - visual observations

Open rivers and flooded farmlands provide safe roosting areas for Canada Geese enroute to northern breeding grounds. In spring 1975, there were several staging areas used by Canada Geese near Ottawa (Fig. 3). The Ottawa River near Thurso supported great concentrations of staging Canada Geese which numbered around 10,000 birds (R. Foxall, pers. comm.). The largest number of Canada Geese in the Carlsbad Springs area occurred 27 April when 5,000 to 6,000 geese were present (R. Poulin, pers. comm.). From 2,000 to 4,000 Canada Geese were observed staging south of Vernon. R.K. Ross (pers. comm.) reported hundreds of Canada Geese at LacDeschênes, just south of Aylmer. E. Johnson (pers. comm.) reported 15,000 Canada Geese near Plantagenet and thousands of geese in the Finch area. These data are not complete and Canada Geese likely staged in other areas around Ottawa during spring 1975.

Further south, from 10,000 to 15,000 staging Canada Geese were reported at Wolfe Island by T. Humberstone (pers. comm.). He also reported 10,000 to 20,000 Canada Geese staging in the Lakeport area. Thousands of Canada Geese stopped-over at the Upper Canada Bird Sanctuary in Morrisburg.

S. Browne provided data on the distribution of staging Canada Geese in central New York State for spring 1972, which was a typical year. Major concentrations occurred in the Finger Lakes area and at Lake Oneida and the Lowville-Glenfield area (Fig. 3). There were also good numbers of Canada Geese on southern Lake Ontario, however, most were westerly around Thirty-Mile Point.

Peak numbers of Canada Geese in New York State usually occur in the first two weeks of April. In 1975, the majority of the Canada Geese remained at the staging grounds longer than usual but most left before

1 May and the last large flights occurred 10 May (S. Browne, pers. comm.).

Although certain staging grounds are traditional and are used year after year, there is yearly variation in the total numbers of geese using an area as well as in the timing and duration of that use. The timing of the onset of spring and the amount of available sheet water determine the number and distribution of the geese in most areas. Initially, the geese use open sections of rivers and lakes. As spring progresses, sheet water becomes important. Later, as the land dries, the staging geese are again restricted to the more permanent bodies of water.

Staging geese - radar

Several thousand Canada Geese stage along the Ottawa River near Thurso (R. Foxall, pers. comm.) and at Plantagenet (E. Johnson, pers. comm.) (Fig. 3). From 22 April to 24 April 1975 the radar films showed that the majority of the "goose echoes" which moved in from the lower half of the radar screen and continued northerly disappeared from view in the Thurso and Plantagenet areas. Although we have no visual reports to confirm the exact date and time of arrival of large numbers of Canadas at Thurso and Plantagenet, we feel confident that the radar data indicated the arrival of large numbers at those staging grounds. Similarly on 3 and 4 May 1975, we believe that "goose echoes", which appeared on the radar screen in the vicinity of Thurso and Plantagenet and moved northerly, were caused by flocks of Canadas departing from those staging areas. This does not imply that Canada Geese did not arrive at or depart from the staging grounds at Thurso and Plantagenet on other dates. Geese may have landed or taken off during periods of heavy migration through the Ottawa area but the density of "goose echoes" on the radar display at those times made it impossible to detect such movements. We were unable to reach

any reliable conclusions regarding movements in and out of other staging sites in the Ottawa area using the radar films, most probably due to the smaller numbers of geese involved.

The large number of active aerodromes in the Ottawa area and the similarity of some aircraft echoes to "goose echoes" (especially when aircraft were engaged in local flights such as circuits) made it difficult to detect local flights of the staging geese. Low altitude movements at staging grounds some distance from Ottawa would not be detected due to the high angle of elevation (3^{o}) of the radar. On those few occasions when we were able to detect local movements of the geese, the most common times were around 0500 hr and 2000 hr.

Migrating Geese - chronology

Reports of visual observations which we received indicated that most Canada Goose migration into or through the Ottawa area during spring 1975 occurred from 22 April to 14 May. A total of 2909 "goose echoes" were counted on the time-lapse radar films. Using an average flock size of 61 birds (based on visual observations of 123 flocks of migrating geese in the Ottawa area), close to 180,000 Canada Geese migrated through the Ottawa area in spring 1975 (assuming that all "goose echoes" did represent flocks of Canada Geese).

There were 22 periods of Canada Goose migration through the Ottawa area ranging from 1 hr to 15 hr duration (Fig. 4). There were, however, only 11 periods of Canada Goose migration which could be called heavy flights or major waves. A major wave of migration was arbitrarily defined as any period of continuous migration during which the hourly counts of goose echoes exceeded 20 for at least two consecutive hours. A major wave usually lasted for 6 or 7 hours, beginning about 0500 hr (Fig. 5) and peaking around 0800 hr (Fig. 4). The initiation of early morning migratory flights is likely related to the time of sunrise (Bellrose, 1967), but may be influenced by weather factors and the birds' migratory readiness.

Migrating Geese - directions

Representative samples of "goose echoes" were traced during the peak hours of several of the major waves of migration to determine the directions of the flights. The directions varied from 340^{o} to 37^{o} with an average flight path of 16.7^{o} (Table 1).

If we assume no change in direction, the apparent destination of Canada Geese migrating over the Ottawa area was Ungava Bay. Assuming

a straight flight path from the staging grounds to Ottawa, it appeared that the numerous flocks of Canada Geese passing through the Ottawa area originated from among those tens of thousands of geese staging along the northeast shore of Lake Ontario, the St. Lawrence River as far east as Morrisburg and in northern New York (Fig. 3). The migration chronology of those geese (S. Browne, pers. comm.) fits with that of Canada Geese through the Ottawa area.

Migrating Geese - distribution

To obtain more detailed information on the distribution of the flocks of migrating Canada Geese, we calculated the numbers of "goose echoes" to the east and west of the city of Ottawa. Most of the hourly counts of "goose echoes" on the radar films were made with the counting line divided into two sections by an imaginary line which passed through Ottawa and was parallel to the average migration direction. Separate counts for the two sections were tallied (Table 2). On the average, the flocks of geese were distributed on a broad front as they migrated through the Ottawa area, with only 14% (about 400) more flocks east than west of Ottawa.

Migrating Geese - heights

The minimum detectable height of a target of known size can be estimated for any range of the AASR-1 radar (Table 3). By noting the range at which the majority of the flocks of Canada Geese appeared and disappeared on the radar display screen, we determined that most flocks of geese migrated through the Ottawa area at heights under 1500 ft (457 m).

Estimates of the heights of migrating flocks of birds vary

according to the observer. Height estimates provided by the Ottawa ATC Tower personnel were probably the most reliable of those we received from reporting observers. Height estimates by ATC personnel of 55 flocks of migrating Canada Geese showed that the flocks usually flew at approximately 1500 ft (1513 ft or 461 m). We received reports of migration occurring from 500 ft (152 m) to 3,000 ft (914 m). When the heights of the flocks of migrating Canada Geese were weighted to account for the variation in flock size, the average height of the migrating geese was close to 2000 ft (1969 ft or 600 m) indicating that generally, larger flocks occurred at somewhat greater altitudes. R. Poulin, who observed many flocks of migrating Canada Geese at Ottawa during spring 1975, told us that he too noted that larger flocks usually flew higher.

Migrating Geese - effect of weather

Weather has a significant influence on the daily variation in intensity of bird migration (reviewed by Lack, 1960 and Nisbet and Drury, 1968). We examined the weather conditions during which major numbers of Canada Geese migrated in spring 1975.

We found that major flights occurred with poorly defined weather conditions (Fig. 6). That is unusual because, generally, most northward migration in spring occurs with a high pressure system to the east and a low pressure system to the west, a combination which produces following winds. However, from mid-April to mid-May 1975, weak low pressure systems were predominant over eastern Ontario.

Individual weather factors during the migratory flights were also examined. The geese did not migrate during periods of precipitation.

Pressure tendency showed no definite trend and major flights occurred with rising, falling and fluctuating pressures. Most migration took place when the winds were light at both the surface and at approximately 4,800 ft (850 mB). Directions of surface winds ranged from northerly to easterly, except during the last major flight which occurred with southwesterly winds. Upper wind directions (at 4,800 ft) were more variable. Major flights occurred with following winds, head winds and northwesterly and easterly crosswinds. It is likely that major flights occurred with wind directions which were energetically unfavourable to migrating geese because following winds were rare at Ottawa during mid-April to mid-May 1975. Although the winds were "unfavourable" in direction, they were low in speed.

We did not obtain information useful for predicting future major flights due to the lack of clear-cut weather systems during the periods of migration of Canada Geese through the Ottawa area in spring 1975. The absence of such weather systems was likely responsible for the numerous major flights in 1975. It may well be that in future, with different weather conditions, Canada Goose migration through the Ottawa area will take place mainly in only a few, very large, major flights.

DISCUSSION AND CONCLUSIONS

Radar data on the Canada Goose migration through the Ottawa area were collected fortuitously when filming the AASR-1 surveillance radar at Ottawa to obtain information on the direction of the spring songbird migration. We attempted to modify our on-going study of the songbirds to collect as much data on Canada Geese as time and other commitments would allow. For those reasons, we did not obtain records of routine observations from local bird watchers nor did we identify selected "goose echoes" on the surveillance radar as to species, as was done, for example, by Blokpoel (1974) who had a light aircraft vectored to determine the species responsible for a "goose echo".

Canada Geese compose the bulk of the geese migrating through the Ottawa area in spring. Other species such as Snow Geese and Brant Geese likely make up less than 5% of the total. We were unable to compensate for the fact that a few of the "goose echoes" may have been caused by those other species of goose or by other birds migrating in large flocks.

Compared with other years, the onset of spring in 1975 was rather late and although it delayed the songbird migration somewhat, it had little effect on that of the Canada Geese (R. Poulin, pers. comm.). It was, in addition, an extremely dry spring. Many of the flooded farm-fields used by staging geese dried up relatively early, forcing the geese on to the rivers and likely contributing to the greater-than-usual numbers of geese on the Ottawa River near Thurso.

Visual observations for the Ottawa area indicated that by 16 May 1975, all major Canada Goose migration was over. Filming the radar screen continued to 13 June 1975 and during that time there were several periods when numbers of "goose echoes" were observed. Due to the lateness of the season and the lack of corresponding visual records, we do not believe that those "goose echoes" were caused by Canada Geese. Thus, in addition to migrating Canada Geese, many

other species may also constitute serious hazards to low flying aircraft around Ottawa.

We were able to document the seriousness of the hazard to aircraft caused by the Canada Goose migration through the Ottawa area in terms of dates and times, numbers, directions, approximate heights, and location and intensity of use of various staging grounds in the vicinity of Ottawa during spring 1975. We had hoped that, by examining the weather conditions during migration, we would be able to draw up guidelines useful to predict when Canada Goose migration would occur in future springs. The poorly defined weather conditions during the 1975 spring migration made it impossible to develop such a system of prediction. Had conditions allowed the development of a prediction system, it would still have been impossible to predict, quantitatively, the density, distribution and height of the flocks of migrating Canada Geese.

Of greater value in air traffic control is the Sector Automatic Detection Equipment (SADE) developed by Hunt (1975). This real-time warning system provides a count of all echoes at least the size of "goose echoes" for a certain sector of the radar screen. That equipment was used operationally with satisfactory results for the first time during spring and fall 1975 at Ottawa International Airport (Hunt, 1975; Holford, 1975). SADE alerted air traffic controllers to potentially hazardous migratory flights, providing information on location and number of flocks involved.

ACKNOWLEDGMENTS

This study was made at the request of the Ministry of Transport which together with the Associate Committee on Bird Hazards to Aircraft provided financial support.

We thank F.D. Bertrand, Chief, Air Traffic Control, Ottawa, who allowed us to film the screen of the AASR-1 radar. The Air Traffic Controllers at Ottawa International Airport, in particular D. Holford, were extremely helpful and co-operative.

The camera and film were provided by the Associate Committee on Bird Hazards to Aircraft of the National Research Council of Canada. T. Hammell maintained the camera during the study.

Weather data were provided by the Ottawa Weather Office. Records of observations of staging and migrating Canada Geese were provided by volunteers whose names and contributions are given in Appendix 1.

P.L. Madore helped to draft the figures. The Communications Research Center provided the Vanguard film analyser. J.E. Bryant critically reviewed the manuscript.

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Table 1. Directions of representative samples of "goose echoes" observed on films of the screen of the AASR-1 radar at Ottawa International Airport in spring 1975.

Date (1975)	Period (EST)	Direction (^{o} True North)			
		Range	Mean	Standard deviation	Sample size
29 April	0600-0900	11^{o} - 30^{o}	19.5^{o}	7.2	12
1 May	0600-0700	4^{o} - 22^{o}	14.0^{o}	5.7	13
5 May	0800-0900	340^{o} - 37^{o}	11.0^{o}	16.0	9
8 May	0500-0600	359^{o} - 23^{o}	14.2^{o}	7.3	13
9 May	0700-0800	8^{o} - 31^{o}	19.9^{o}	6.2	12
11 May	0400-0500	14^{o} - 37^{o}	21.4^{o}	5.8	12

Table 2. Total number and distribution[+] of "goose echoes" observed on films of the screen of the AASR-1 radar at Ottawa International Airport in spring 1975.

Date (1975)	Total Number of "goose echoes"	"goose echoes" east of Ottawa Number (%)
22 April	40	*
23 April	37	*
24 April	45	31 (69%)
26 April	15	*
28 April	113	60 (53%)
29 April	339	210 (62%)
30 April	321	188 (59%)
1 May	338	185 (55%)
2 May	25	*
3 May	206	153 (74%)
4 May	160	75 (47%)
5 May	147	93 (63%)
6 May	91	40 (44%)
7 May	57	26 (46%)
8 May	342	180 (53%)
9 May	160	89 (56%)
10 May	188	109 (58%)
11 May	235	119 (51%)
12 May	16	*
14 May	34	16 (47%)
	2909	1574 (57%)

+ the number of "goose echoes" to the east and west of a line passing through Ottawa and parallel to the direction of migration.

* the distribution of "goose echoes" to the east and west of Ottawa was not determined.

Table 3. Range and corresponding height below which a flock of migrating Canada Geese (assumed to represent a 1 m^2 target) would not be detected by the AASR-1 surveillance radar at Ottawa International Airport (data provided by F.R. Hunt, Radio and Electrical Engineering Division, N.R.C.)

Range (n mi)	Height (ft agl)
20	67
30	267
40	599
50	1063
60	1659
70	2387

Figure 1. Ranges of two sub-species of large Canada Geese (after Hines and Schoenfeld, 1968).

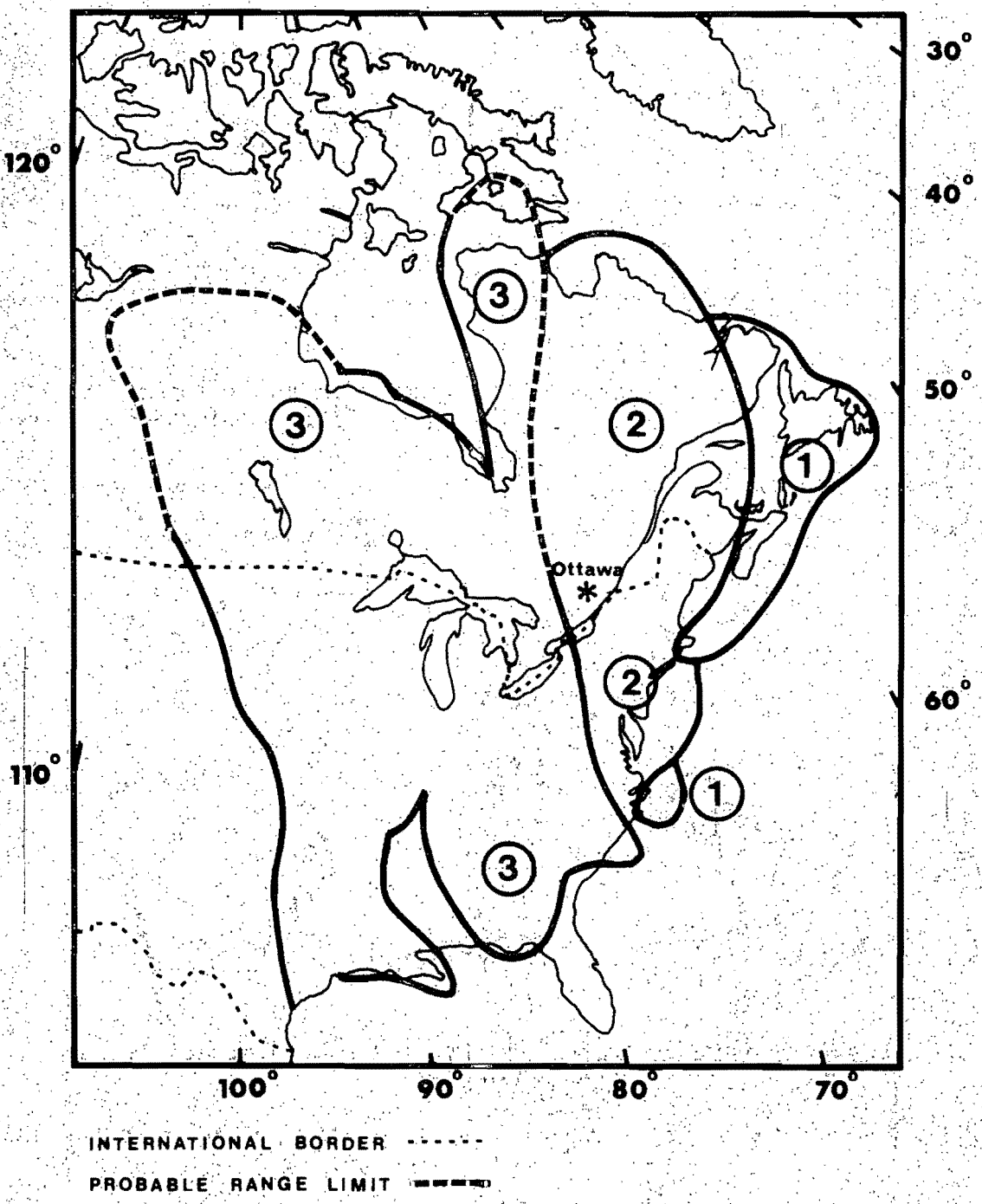


Figure 2. Aerodromes in the vicinity of Ottawa (after aeronautical charts 31 NE, August 1974; 31 SE, December 1974; 31 SW, July 1975; and 31 NW, July 1975).

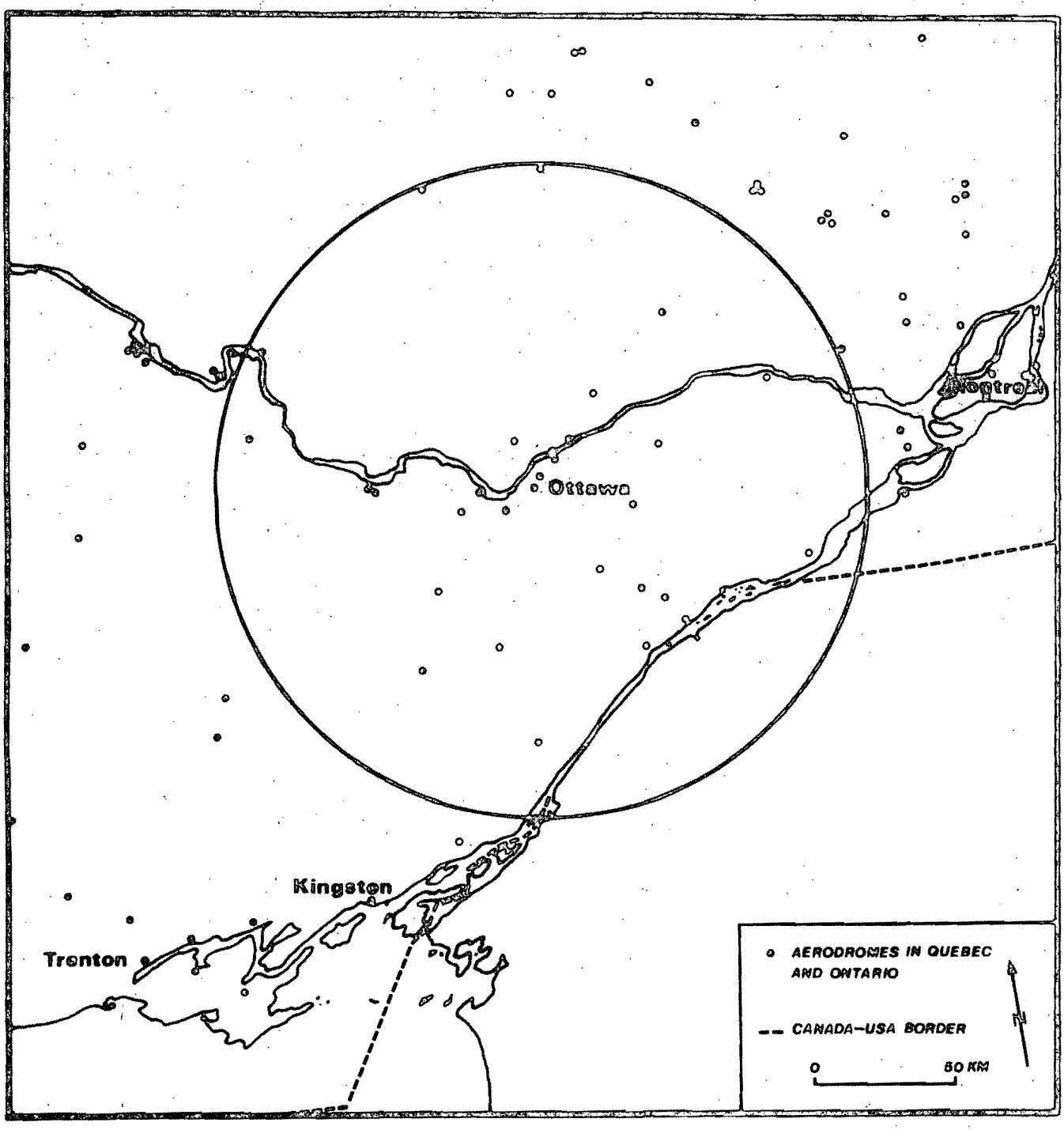


Figure 3. Staging areas used by Canada Geese and the average distribution and direction of "goose echoes" observed on films of the screen of the AASR-1 radar at Ottawa International Airport in spring 1975.

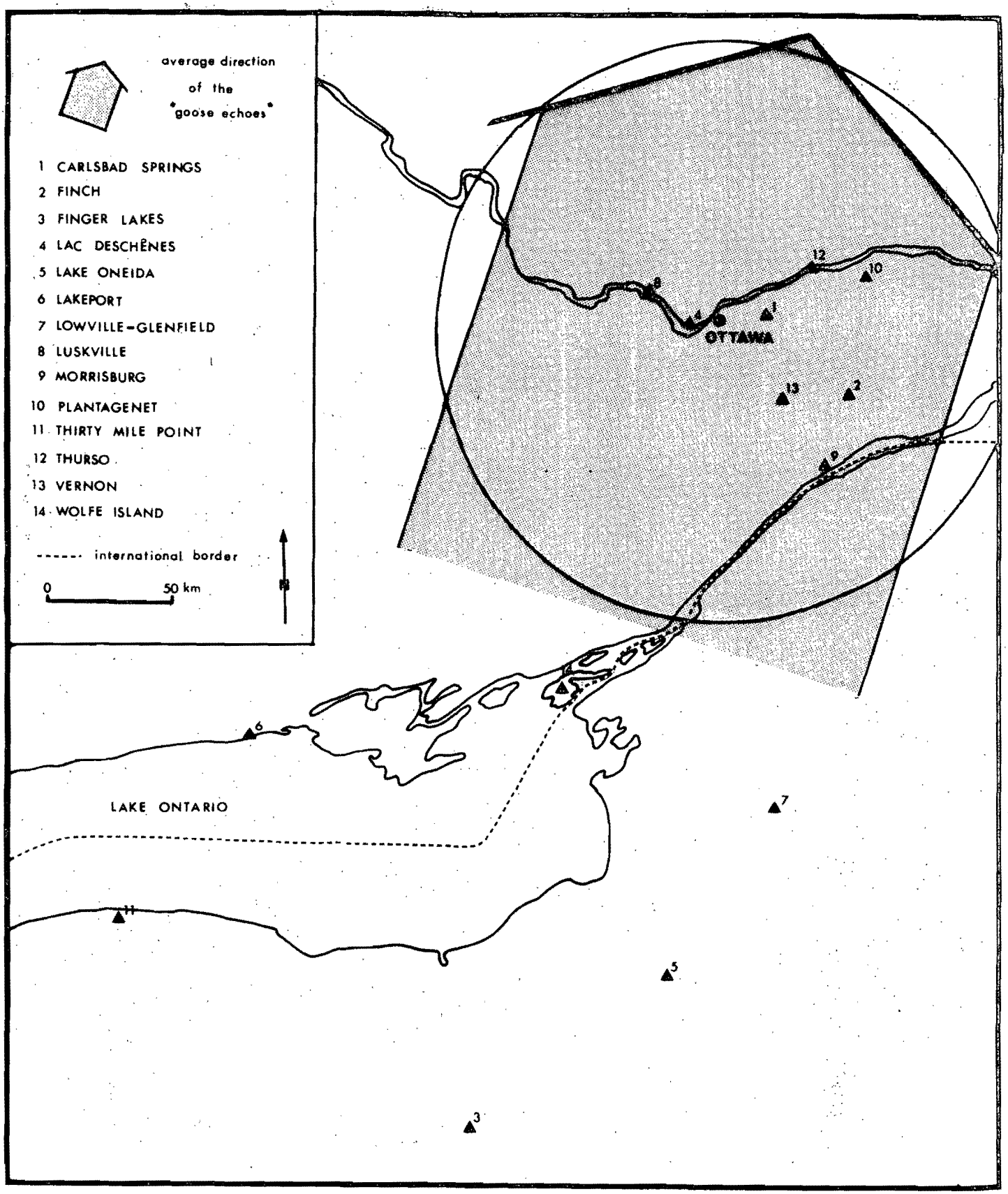


Figure 4. Hourly counts of "goose echoes" observed on films of the screen of the AASR-1 radar at Ottawa International Airport in spring 1975.

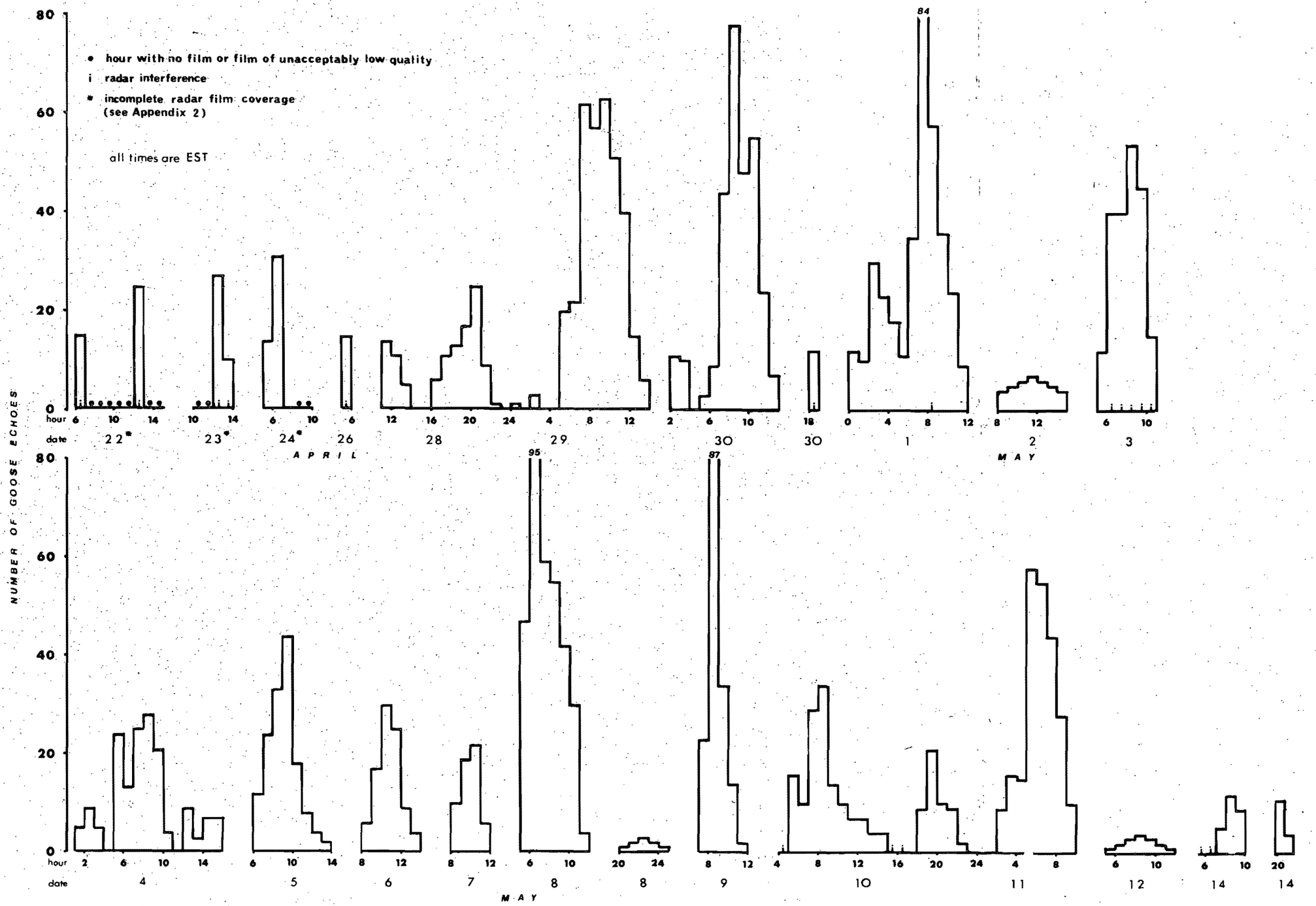


Figure 5. Periods when major numbers of "goose echoes" were observed on films of the screen of the AASR-1 radar at Ottawa International Airport in spring 1975.

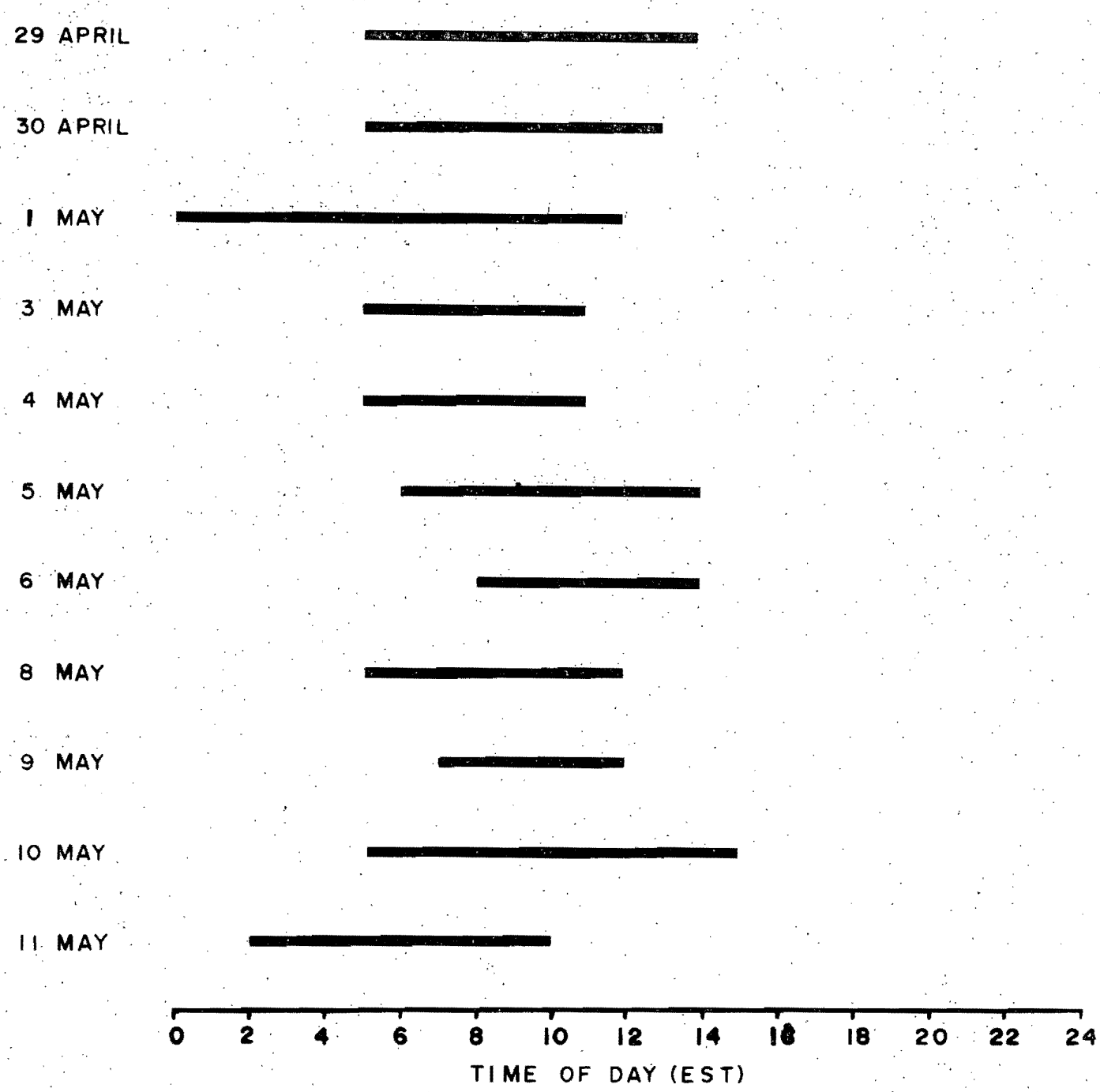
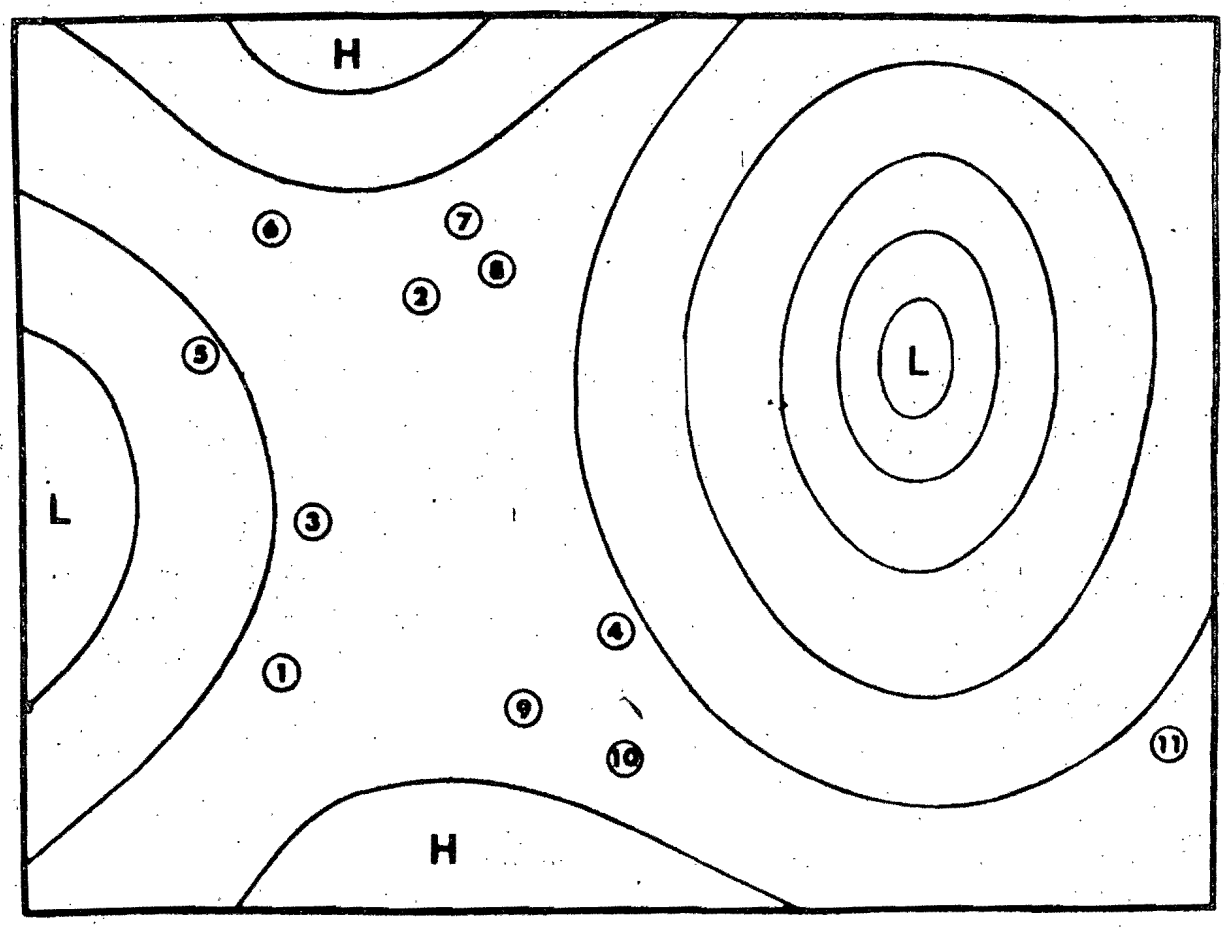


Figure 6. Generalized weather map showing the approximate location of Ottawa relative to high and low pressure areas for the 11 major flights of Canada Geese through the Ottawa area in spring 1975.



MAJOR WAVES OF CANADA GOOSE MIGRATION:

1- 29 APRIL
2- 30 APRIL
3- 1 MAY
4- 3 MAY
5- 4 MAY
6- 5 MAY
7- 6 MAY
8- 8 MAY
9- 9 MAY
10- 10 MAY
11- 11 MAY

Appendix 1. Records of observations of staging and migrating Canada Geese made in and around Ottawa in spring 1975.

Date (1975)	Period (EST)	Location	Estimated Number of Flocks/Birds	Estimated Height (ft. a.g.l.)	Estimated Direction	Observer
10-29 Apr.	-	Carlsbad Springs, Ont.	-	"staging"	-	R. Poulin
18 Apr.	1230	Leitrim, Ont.	"several"/-	"flying"	-	H. McLeod
22 Apr.	0900	Ottawa Airport	1/30	2000	NE	A. Francis
22 Apr.	1045	Ottawa Airport	1/24	1500	NE	D. Pinhey
23 Apr.	0700	Ottawa Airport	2/100	1000	SE	M. Lush
23 Apr.	0727	Ottawa Airport	1/6	500	N	W. Lessard
23 Apr.	0919	Ottawa Airport	3/150	1000	N	D. Pinhey & G. Chenier
23 Apr.	0921	Ottawa Airport	1/25	1500	N	D. Pinhey
23 Apr.	0926	Ottawa Airport	1/50	1500	N	G. Chenier
23 Apr.	0929	Ottawa Airport	1/20	1500	N	G. Chenier
23 Apr.	0933	Ottawa Airport	1/150-200	1500	N	G. Chenier
23 Apr.	0942	Ottawa Airport	1/25	2000	N	G. Chenier
23 Apr.	0950	Ottawa Airport	1/50	2000	N	G. Chenier
23 Apr.	0954	Ottawa Airport	1/50	1500	N	G. Chenier
23 Apr.	0958	Ottawa Airport	3/150-200	1500	N	G. Chenier
23 Apr.	0958	Ottawa Airport	1/25	1500	N	G. Chenier
23 Apr.	1135	Ottawa Airport	1/30	1500	N	D. Pinhey
23 Apr.	1740	Ottawa Airport	2/100-150	1500	NE	M. Lush
27 Apr.	-	Carlsbad Springs, Ont.	-/5000-6000	"staging"	-	R. Poulin
28 Apr.	0630	Ottawa Airport	4/60-100	1000	E	M. Pacey
28 Apr.	1815	Ottawa Airport	1/50+1/100	3000	-	S. Partington
28 Apr.	1846	Ottawa Airport	1/100	1500	N	P. Ault
29 Apr.	0648	Ottawa Airport	1/35	1000	N	D. Lay
29 Apr.	0708	Ottawa Airport	3/275	1500	N	W. Walker
29 Apr.	0923	Ottawa Airport	1/50	2000	NE	R.M. Angus
29 Apr.	0927	Ottawa Airport	1/35	2000	S	W. Walker
29 Apr.	-	Griffith, Ont.	5/225	"very high" (6000+)	-	L.W. Billingsley

Appendix 1. Records of observations of staging and migrating Canada Geese made in and around Ottawa in spring 1975.

Date (1975)	Period (EST)	Location	Estimated Number of Flocks/Birds	Estimated Height (ft. a.g.l.)	Estimated Direction	Observer
30 Apr.	early morning	Ramseyville, Ont.	-/260	-	-	R. Foxall
30 Apr.	0747	Ottawa Airport	2/200	500	NE	R. Harrington
30 Apr.	0750	Ottawa Airport	2/150	500	NE	W. Walker
30 Apr.	0805	Ottawa Airport	2/125	400-500	SE	R.M. Angus
30 Apr.	0810	Ottawa Airport	1/200	3000-4000	SW	R.M. Angus
30 Apr.	0810	Ottawa Airport	1/250	3000	N	R.M. Angus
30 Apr.	0910	Ottawa Airport	3/250-300	3000	E	R.M. Angus
30 Apr.	0914	Ottawa Airport	1/200	3000	NE	R.M. Angus
30 Apr.	0926	Ottawa Airport	1/150	1000	N	R.M. Angus
30 Apr.	-	Ottawa Airport	3/50	1000	NE	R. Harrington
1 May	early morning	Ramseyville, Ont.	-/204	-	-	R. Foxall
1 May	0623	Ottawa Airport	1/36	500	100°	R. Harrington
1 May	0659	Ottawa Airport	1/100	700	300°	R. Harrington
1 May	0659	Ottawa Airport	1/24	700	250°	R. Harrington
2 May	0900-1100	Ottawa	1/35	-	NE	G. Caulderwood
3 May	early morning	Ramseyville, Ont.	1/13	-	-	R. Foxall
3 May	0905	Ottawa Airport	1/50	2000	100°	G. Chenier
3 May	-	Port Hope , Ont.	10/3000	-	N	F.R. Hunt
4 May	early morning	Ramseyville, Ont.	-/57	-	-	R. Foxall
4 May	0623	Ottawa Airport	1/50	1500	NE	W. Guigues
4 May	0728	Ottawa Airport	1/32	1000	E	R.A. Gould
4 May	0819	Ottawa Airport	1/150	500	E	R.M. Angus
4 May	0900-1100	Ottawa	1/45	-	NE	G. Caulderwood
5 May	early morning	Ramseyville, Ont.	-/74	-	-	R. Foxall
5 May	0823	Ottawa Airport	1/50	600	160°	G.M. Braden
5 May	0900-1100	Ottawa	1/27	-	NE	G. Caulderwood
5 May	-	Lake St. Francis, Ont.	-/5000-10000	-	-	H. McLeod

Appendix 1. Records of observations of staging and migrating Canada Geese made in and around Ottawa in spring 1975.

Date (1975)	Period (EST)	Location	Estimated Number of Flocks/Birds	Estimated Height (ft. a.g.l.)	Estimated Direction	Observer
6 May	early morning	Ramseyville, Ont.	-/236	-	-	R. Foxall
6 May	1016	Ottawa Airport	1/128	6000	210°	D. Osborne
6 May	1133	Ottawa Airport	2/80	1500	200°	M. Pacey
7 May	early morning	Ramseyville, Ont.	-/55	-	-	R. Foxall
7 May	-	Ottawa River at Luskville, Que.	"great numbers"	-	-	Tardiff
8 May	before 0600	Ottawa	-	-	-	S.D. MacDonald
8 May	0630-0715	Ottawa	-/2200	-	many N, some E, a few S	S.D. MacDonald
8 May	early morning	Ramseyville, Ont.	-/3267	-	-	R. Foxall
8 May	0641	Ottawa Airport	7/75	ground to 1500	N	M. Pacey
8 May	0706	Ottawa Airport	1/150	1000	140°	M. Pacey
8 May	0714	Ottawa Airport	4/200	1000	300°	M. Pacey
8 May	0715	Ottawa Airport	1/300	1000	120°	M. Pacey
8 May	0721	Ottawa Airport	4/100	1000	180°	M. Pacey
8 May	0725	Ottawa Airport	2/30	1000	300°	S. Partington
8 May	0733	Ottawa Airport	3/75	500 to 1500	180°	S. Partington
8 May	0735	Ottawa Airport	1/40	1000 to 2000	250°	P. Ault
8 May	0739	Ottawa Airport	1/50	1500	180°	S. Partington
8 May	0741	Ottawa Airport	2/25	2000 to 4000	230°	S. Partington
8 May	0758	Ottawa Airport	1/45	2000	140°	M. Pacey
8 May	0816	Ottawa Airport	1/200	4000	220°	P. Ault
8 May	0925	Ottawa Airport	2/75	1500	040°	P. Ault
8 May	0936	Ottawa Airport	1/150	2500	360°	P. Ault
8 May	2200	Ottawa	-	low	-	P. Angehrn
8 & 9 May	-	Plantagenet, Ont.	-/15000	-	-	E. Johnson
9 May	early morning	Ramseyville, Ont.	-/247	-	-	R. Foxall
9 May	0500-0700	Ottawa	-/"many"	-	-	P. Angehrn
9 May	0550	Ottawa Airport	3/200	1000	360°	B. Dyck
9 May	0600	Griffith, Ont.	1/100	"fairly high"	NE	L.W. Billingsley

Appendix 1. Records of observations of staging and migrating Canada Geese made in and around Ottawa in spring 1975.

Date (1975)	Period (EST)	Location	Estimated Number of Flocks/Birds	Estimated Height (ft. a.g.l.)	Estimated Direction	Observer
9 May	0617	Ottawa Airport	1/85	1000	E	S. Partington
9 May	0633	Ottawa Airport	1/150	2000	E	S. Partington
9 May	0633	Ottawa Airport	1/20	1500	E	S. Partington
9 May	0651	Ottawa Airport	1/200	1500	E	B. Dyck
9 May	0746	Ottawa Airport	6/400	1500	ENE	J. Littlewood
9 May	0751	Ottawa Airport	1/150	1700	NW	J. Littlewood
9 May	0900	Ottawa	4/250	1000 to 2000	N	G. Gibson
10 May	early morning	Ramseyville, Ont.	-/203	-	-	R. Foxall
10 May	0550	Ottawa Airport	3/250	1500	NE	A. Francis
10 May	0600-0630	Ottawa	5/400	low	N	P. Angehrn
10 May	0615	Ottawa Airport	1/117	1500	NE	A. Francis
10 May	0700	Ottawa	"several"/-	-	NE	G. Caulderwood
10 May	0730	Ottawa River, Ottawa	1/-	1000	-	two fishermen
10 May	0737	Ottawa Airport	1/150	2000	NE	B. Dyck
10 May	0800-1000	10 mi SW of Perth, Ont.	3/130	-	N	F.R. Hunt
10 May	0823	Ottawa Airport	2/75	1000	NE	B. Dyck
10 May	0930	Ramseyville, Ont.	-/16	"on ground"	-	G. Caulderwood
10 May	1839	Ottawa Airport	1/60	2500	110°	W. Lessard
10 & 11 May	-	Gananoque, Ont.	-/300	-	-	G. Raines
11 May	early morning	Ramseyville, Ont.	-/710	-	-	R. Foxall
11 May	0515	Ottawa Airport	1/31	1500	NE	A. Francis
11 May	0550	Ottawa Airport	1/60	1500	065°	K.B. Buchanan
11 May	0605	Ottawa Airport	3/150	1500	045°	A. Francis
11 May	0630-0700	Ramseyville, Ont.	6/-	-	N to NNE	G. McGee
11 May	0653	Ottawa Airport	5/350	1500	045°	A. Francis
11 May	0740	Ottawa Airport	1/150	1500	N	R.E. Williams
11 May	1100	Point Gatineau, Que.	1/300	"very high"	NE	G. Caulderwood
12 May	0500	Ottawa	2/-	-	NE	P. Angehrn
12 May	0800	Griffith, Ont.	1/60	"very low"	NE	L.W. Billingsley

Appendix 1. Records of observations of staging and migrating Canada Geese made in and around Ottawa in spring 1975.

Date (1975)	Period (EST)	Location	Estimated Number of Flocks/Birds	Estimated Height (ft. a.g.l.)	Estimated Direction	Observer
13 May	early morning	Ramseyville, Ont.	-/2	-	-	R. Foxall
14 May	early morning	Ramseyville, Ont.	-/45	-	-	R. Foxall
14 May	0700	Ottawa River, Ottawa	1/-	-	-	two fishermen
14 May	"night"	Ottawa River, Hull, Que.	-	-	-	two fishermen
14 May	-	Upper Canada Bird Sanctuary near Morrisburg, Ont.	"flocks of thousands"	-	-	"Ottawa Citizen"
15 May	0645	Blackburn Hamlet, Ottawa	-	-	-	G. McGee
15 May	0830	Rockland, Ont.	1/-	-	-	S. Fraser
15 May	-	Ottawa	1/30	"very low"	NE	M. Blokpoel
15 May	-	Masson, Que.	-	-	-	G. McGee
15 May	-	Ottawa River, Ottawa	1/-	"very high"	-	two fishermen
16 May	-	Thurso, Que.	2/9	"flying"	SW	G. McGee
16 May	-	Ottawa River near Thurso, Que.	-/12	"sitting"	-	G. McGee
18 May	early morning	Ramseyville, Ont.	-/43	-	-	R. Foxall
22 May	-	Ottawa River	-/60	"on river"	-	G. McGee
24 May	early morning	Ramseyville, Ont.	-/1	-	-	R. Foxall
-	-	Finch, Ont.	"thousands of geese"	-	-	E. Johnson
-	-	Upper Canada Bird Sanctuary, near Morrisburg, Ont.	1800	-	-	H. McLeod
-	-	South of Vernon, Ont.	-/2000-4000	"staging"	-	R. Poulin
-	-	South Nation River flood plain (Hghwy 31), Ont.	-	"staging"	-	R. Foxall
-	-	Lac Deschênes, Que.	"100s"	"staging"	-	R.K. Ross
-	-	Ottawa River near Thurso, Que.	-/>10000	"staging"	-	R. Poulin
-	-	Wolfe Island, Ont.	-/10000-15000	-	-	T. Humberstone
-	-	Lakeport, Ont.	-/10000-20000	"resting on the lake"	-	T. Humberstone

Appendix 2. Dates and periods for which time-lapse films were made of the screen of the AASR-1 radar at Ottawa International Airport from 14 April to 25 April 1975.

Filming began		Filming ended	
Date	Time	Date	Time
14 April	1940	15 April	0645
15 April	1830	16 April	0620
16 April	1820	17 April	0635
17 April	1940	18 April	0650
18 April	1820	19 April	0715
19 April	1830	20 April	0630
20 April	1830	21 April	0440
21 April	1930	22 April	0635
22 April	1000	22 April	1135
22 April	1835	23 April	0640
23 April	1140	23 April	1410
23 April	1830	24 April	0640
24 April	1805	25 April	0015