BIRD CONTROL AND AIR SAFETY

by V.E.F. Solman

In a sense, the Canadian Wildlife Service has had more than 20 years experience with the problem of bird contacts with aircraft. My personal experience began with a bird which damaged an aircraft during a waterfowl survey flight in 1941. In spite of the low speed of the aircraft and the small size of the duck we hit, the damage to the wing of the aircraft impressed me. In those days of piston-engined aircraft, with low cruising speeds, mechanical damage was sometimes expensive to repair, but there was usually not much danger of the aircraft being lost through contact with birds. The turbine power plants now used are very much more vulnerable to bird damage than the piston engines they replaced.

Fatal accidents have been caused by bird-aircraft collisions since 1910. In 1960 a turbine-engined aircraft crashed at Boston, Massachusetts, after a bird strike. Over 60 lives

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were lost. That crash, and one in 1962, caused by bird damage to the aircraft structure, which resulted in the loss of 17 lives, helped to accelerate research on ways to reduce the bird hazard to aircraft.

The Canadian Wildlife Service has been providing biological information to airport operators to reduce the attractiveness of airports to birds since the late 1940's. In 1962, at the request of the Department of Transport, the National Research Council of Canada appointed the Associate Committee on Bird Hazards to Aircraft. On that committee are represented the Department of Transport, which is responsible for most Canadian airports, the Department of National Defence, which has a similar responsibility for military aerodromes, the major airlines, the engine manufacturers, the National Research Council itself, the Canadian Airline Pilot's Association and the Canadian Wildlife Service.

The committee's studies outlined the magnitude of the problem and the potential for serious accident and loss of human life. Initially, there was emphasis on the engineering aspects of the problem. Consideration was given to designing aircraft and aircraft power plants that would be able to have contacts with birds without suffering serious damage. The engineers soon realized that the forces involved in impacts between birds and high-speed aircraft were so large that it is difficult to design mechanical components of reasonable size and weight to withstand them. For example a 4-pound bird struck at a speed of 300 miles per hour exerts a force of 14 tons, at 600 m.p.h. 57 tons. The other approach to the problem, that of trying to keep the birds out of the way of the aircraft, offered more hope of success.

Biological studies at a number of major airports showed that many species of birds used airport areas for feeding, resting, and even nesting. When we examined the problem in detail, we found that airports were attractive to birds for a number of reasons. The first recommendation of the committee was to reduce the attractiveness by altering the ecology of the airport environment. In many cases that was a relatively simple matter. Garbage dumps and other attractive food supplies could be moved away from airports. Small bodies of water which attracted aquatic and other birds could be drained or filled, or the birds could be prevented from using them. Nesting and perching sites could be eliminated or rendered unusable. The pioneering work on improving the airport habitat to reduce bird attraction has been described by Munro and Harris (1963) and Solman (1966).

Birds that persisted in visiting airports after those changes were made could be driven off by patrols armed with pyrotechnic devices, distress call players, or other mechanical means. Considerable testing of pyrotechnic devices has been carried out. There are now available for airports reasonably reliable shot-gun shells that fire a small explosive projectile. There are, also, good tape players, amplifiers and loud speakers that can be used for that type of bird removal. We have encouraged manufacture of effective automatic acetylene exploders designed to our requirements which work well with certain species of birds. In some countries radio-controlled model aircraft are used to harass birds at airports.

Any mechanical method requires decision on the part of the human operator to use the equipment, to use it effectively, and to use it when necessary. Human motivation is the biggest need in the continuing battle to keep birds out of the way of aircraft.

The committee also investigated the possibilities of using falcons trained to drive birds away from certain airports. Two different techniques of falcon use were tried. Both gave satisfactory results within the limitations of falcon operation. Those limitations include inability to operate in the hours of darkness and unwillingness to fly in high wind or heavy rain. There are also occasions on which the falcons, which are relatively high-strung animals, simply refuse to work. Falcons are being used at some airports in other countries with good results in clearing single species of birds from aerodromes during hours of daylight. Most civil and military flying is a round-the-clock operation. Simpler and more dependable bird-control methods are preferred by most authorities.

The Canadian program of bird removal from airports has been quite successful. One of our major airlines, which was experiencing increasing numbers of damaging bird strikes up to 1965, reported a 20 per cent drop in the number of strikes in 1966. Although it operated many more aircraft in 1967 and experienced an increase in the number of bird strikes, it reported a substantial reduction in the cost of hardware replacement because smaller birds were being struck. The reasons relate to the massive ecological changes which have been brought about by the Department of Transport at a number of major Canadian airports. That work has cost hundreds of thousands of dollars, but you should remember that in the first test cases resulting from the 1960 Boston crash, caused by birds, when over 60 human lives were lost, the Court awarded more than $100,000 per human life lost. The dollar cost of that one crash would likely exceed the cost of reducing the bird hazard to a very much lower level at several major airports.

While take-off and landing strikes of civil aircraft may not cause much hazard to human life, they do result in a variety of expenses to the airline. Take the case of a DC8 taking off on a long flight with a full fuel load and an acceptable level of passenger seat occupancy. On take-off a bird is struck and catastrophic damage occurs to one engine. The pilot has no problem maintaining flight even with a full load, but has a problem of immediately returning to base for an engine change and for rerouting of passengers and baggage on another aircraft. Since his take-off weight is greater than his acceptable landing weight, he must jettison fuel before he can land. In addition to the $200,000 cost of an engine replacement, the airline is faced with the problem of jettisoning thousands of gallons of fuel, of making an emergency landing with its attendant hazards, and then of providing alternate means of travel for the hundred passengers and their baggage. The time of the circuit, fuel jettisoning, and emergency landing may exceed an hour. By that time it may not be possible for the passengers to board another aircraft and still reach their destination in time for important commitments. No one has yet worked out what it costs an airline to seriously inconvenience a hundred passengers, nor what it means in terms of reuse of that airline by the passengers in subsequent flights.

One airline has published a figure of a million pounds worth of mechanical damage each year through bird strikes. Another airline published a figure of a loss of two million dollars over a period of five years. A third airline reported 75 engine changes due to bird strikes in two and one-half years of flying.

Different aircraft-engine types have different bird damage rates and costs even when flown on the same airline routes at the same times. In aircraft that mount engines in pairs close together, when a bird causes one engine to break up catastrophically, portions of the bird or engine may be projected forward and taken into the adjacent engine with subsequent damage to it also.

In many cases the passengers are not aware of the damage caused by a bird strike. If it is a landing strike and does not interrupt too many schedules, the only cost to the airline is for engine replacement and the time lost while the engine is changed.

The most recent strike I investigated involved a single gull and a DC9 aircraft on take-off. Because the aircraft was not too heavily loaded, a prompt landing was possible. The flight lasted 11 minutes. The broken hardware in the engine cost about $60,000, not counting the man-hours involved in repair, reassembly and testing. The inconvenience and loss of goodwill to the passengers was another matter. In that particular case they went forward to their destination on an aircraft of a rival airline. That hurts.

Initially, the civil airlines had about three-quarters of their bird strikes at or near airports and the remainder in flight between airports. The military situation is almost exactly the reverse: fewer strikes at airports and more strikes en route. The high rate of strikes away from bases is related to the role of military aircraft, which make many flights at low altitude and high speed.

In Canada and in other countries that use the F-104 aircraft, it has been found to be particularly vulnerable to serious bird damage. Because it is a single-engined aircraft, an engine strike by a bird may easily involve the loss of the aircraft. During the past three and one-half years, Canada has lost seven F-104's through bird strikes and two more under conditions strongly suggestive of bird impact damage. The Department of National Defence is much concerned about the loss of aircraft because of the possibility of a pilot being killed and the cost of the aircraft.

Major ecological changes have been made at military airports to reduce the bird problem there. However, because many strikes occur away from airports, the committee has been studying the details of bird movements and migrations which could be encountered by aircraft in flight. To do that, we have used the only tool that is really effective, radar.

Much of the information about bird migration that is available in the literature is based on visual observation, either in daylight or by moon watching. In both cases, the birds that are observed are those that can be observed from the ground under the prevailing conditions of visibility.

Some of our radar studies have been made on a continent-wide basis using as many as 18 radar stations. We use continuous time-lapse 16 mm. motion picture photography of the plan position radar scopes to provide permanent records for study. One frame is exposed for each sweep of the radar antenna (six frames per minute). When projected at normal speed, the films compress the time scale by a factor of 240 times and simplify cataloging of observations.

Examination of the film record has shown that many of the early ideas about bird migration were based on incomplete data; the only kind that could be obtained by visual observation. Our recent experience is similar to that of our colleagues using radar in Europe. There, also, earlier data on bird migration times and patterns have been shown by radar observation to have been less than complete.

During either spring or autumn migration birds generally begin their migratory flight when conditions are favourable. Birds flying north in the spring and entering a southward-moving cold air mass usually stop moving north. If the condition is sufficiently severe, they may reverse their direction and move back southward. We have radar films from many points in Canada which show that sort of reverse movement in the face of inclement weather. It appears that movement in favourable weather and back-tracking when the situation gets too bad may be the rule for many species in spring northward migration rather than an exception as we used to consider it.

I will not burden you here with a further discussion on bird migration, which we are now sorting out from about 200 miles of radar time-lapse 16-mm. film. Our studies have shown that the major hazard to aviation caused by mass movements of birds from gull size upward occurs in rather limited times and locations. We believe that it is possible to forecast when and where those major movements will occur in spring and autumn. After the forecast is made, radar surveillance would permit current reports on the movements as they take place. We have already made forecasts and checked their accuracy experimentally for military flying.

Much of the bird migration across Canada is in a general north-south direction and much of the airline traffic is east-west. When you consider that we are dealing with tens of millions of ducks, about 5,000,000 geese, 300,000 sandhill cranes, 100,000 swans, and millions of smaller birds moving across the civil and military air routes twice each year, I am sure you will agree that the possibilities for collision are large during certain short intervals of time and in prescribed locations.

Keeping aircraft away from major bird migrations is not too different from keeping them away from thunder storms. Thunder storms are short-duration phenomena associated with severe turbulence and are potentially damaging to aircraft. Much time and effort go into forecasting the time, place, and duration of thunder storms and into rerouting both civil and military aircraft to avoid them. We believe that as our bird hazard forecast technique improves we can provide bird hazard warnings that will be similar in their value to thunder storm warnings. The regular traffic control procedures by which civil aircraft and most military aircraft are manipulated in the sky can take account of the bird migration hazard in the same way they now take account of thunder storms.

We have made experimental forecasts of high bird hazard situations for military purposes. Details of that work were described by Gunn and Solman (1967). Even in this early stage of our studies we can forecast some of the hazard situations with a good degree of accuracy.

We do not have enough detailed information about the movements of birds to permit the correlations with weather patterns which will be necessary to make really good forecasts of high utility. We are now comparing months of radar bird observations with the weather data from the same and adjacent areas.

One item on which we need much more information is the triggering mechanism which initiates waves of bird migration. For some species we have clues. We know, for instance, that in James Bay we have in October a build-up of blue and lesser snow geese from nesting grounds farther north. We know that large groups of geese will leave the build-up area during a period of several weeks. Each movement will begin within 24 hours after the passage of a cold front at a time when the early hours of the migration movement can be carried on with a strong favourable wind and clear skies.

In other words, we know that two of the four to seven cold fronts that pass through the southern end of James Bay in October of any year will initiate movements of geese.

Those geese will constitute a hazard to aircraft at altitudes between six and ten thousand feet over a route of about 1,700 miles from James Bay to the Gulf of Mexico. The moving geese may occupy an area 100 miles long, 30 or 40 miles wide, and 2,000 feet in depth moving in a southerly direction at a speed of 60 or 70 knots, depending on the strength of the tail wind. Our problem is to determine which of the several cold fronts that go through the area during the critical period are the ones which trip the integrating mechanism in the geese and start their movement. We know that for each cold front that passes without a goose movement, the likelihood of movement on the next cold front is increased. We believe further study will help us understand the triggering mechanism so that we can issue a warning before the beginning of movement. Once the geese are in the air we can use radar to monitor their progress to provide warnings along their route about the likelihood of encountering a quarter of a million geese in any given part of the sky.

Through limitations in distribution of radar height-finding equipment our knowledge of the altitudes of migrants is not as complete as we would wish. By using special radar techniques we hope to get information on bird heights to supplement the information we get from pilots.

As our studies continue and our computer correlations work out more of the fine details of weather effects on bird movement, we believe it will be possible for aircraft to avoid large groups of migrant birds.

Some of the European studies with which we have been involved, including those which we initiated on behalf of the military units in Europe, have suggested that local movements of birds from roosting areas to feeding areas may create a hazard as severe as that caused by major migrations. I refer particularly to mass movements of gulls from large feeding areas such as garbage dumps to resting areas. In one case that kind of movement occurred several times each day and took thousands of gulls across a flight route approaching a major aerodrome. There had been damaging strikes on gulls near that aerodrome which were difficult to understand until radar surveillance showed the type of bird movement and its regularity. Once the timing of bird movement was recognized, it was possible to schedule aircraft landings and take-offs to avoid the major periods of gull traffic.

There are North American situations where gulls and even blackbirds pose a similar problem. We believe it would be useful to study local bird movement patterns around airports for the problem may be more widespread than is now realized.

The technique of time-lapse photography of a radar scope is relatively simple and deserves to be more widely used, not only for bird surveillance but also for recording aircraft traffic patterns.

It would not be difficult to construct a unit to produce time-lapse photographic records of radar-scope traces for use by a dispatcher. Quickly processed time-lapse movie records of what had happened within range of his radar during the preceding 10 or 15 minutes would permit a check of the validity of forecasts of bird movement. That would permit minute adjustments of aircraft traffic patterns to make use of the safe portions of the sky and to avoid those which were heavily cluttered with birds.

By using modern techniques we can carry heavy civilian and military air traffic through the same skies travelled by millions of birds with fewer damaging impacts than have caused loss of life and high costs in past years. For less than the multi-million dollar expenditure which is now required to repair aircraft damage, we can modify the use of presently available radar to save dollars and human life.

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