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Airport Bird Threat in North America from Large Flocking Birds (geese) (as Viewed by an Engine Manufacturer)–Part 1

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OVERVIEW

In worldwide aviation operations, bird collisions with aircraft and ingestions into engine inlets present safety hazards and financial loss through equipment damage, loss of service and disruption to operations. The problem is encountered by all types of aircraft, both military and commercial.

Modern aircraft engines have achieved a high level of reliability while manufacturers and users continually strive to further improve the safety record. A major safety concern today includes common-cause events which involve significant power loss on more than one engine. These are externally-inflicted occurrences, with the most frequent being encounters with flocks of birds. Most frequently these encounters occur during flight operations in the area on or near airports, near the ground instead of at cruise altitude conditions.

This paper focuses on the increasing threat to aircraft and engines posed by the recorded growth in geese populations in North America. Service data show that goose strikes are increasing, especially in North America, consistent with the growing resident geese populations estimated by the United States Department of Agriculture (USDA). Airport managers, along with the governmental authorities, need to develop a strategy to address this large flocking bird issue.

This paper also presents statistics on the overall status of the bird threat for birds of all sizes in North America relative to other geographic regions. Overall, the data shows that Canada and the USA have had marked improvements in controlling the threat from damaging birds - except for the increase in geese strikes.

To reduce bird ingestion hazards, more aggressive corrective measures are needed in international air transport to reduce the chances of serious incidents or accidents from bird ingestion encounters. Air transport authorities must continue to take preventative and avoidance actions to counter the threat of birdstrikes to aircraft.

The primary objective of this paper is to increase awareness of, and focus attention on, the safety hazards presented by large flocking birds such as geese. In the worst case,

multiple engine power loss due to large bird ingestion could result in an off-airport forced landing accident. Hopefully, such awareness will prompt governmental regulatory agencies to address the hazards associated with growing populations of geese in North America.

BIRD INGESTION ACCIDENTS WITH FATALITIES

Although costs associated with birdstrikes are incurred by most airlines, they generally do not have the leverage to drive airport managers to institute more effective airport bird hazard controls. Unfortunately, it is the safety threat posed by birds at and near airports, sometimes in the aftermath of an accident, that focuses the need for improved airport bird control programs. This is illustrated from selected well-known events in the history of fatal accidents.

- In September of 1988, a Boeing 737-200 ingested a large number of speckled pigeons in both engines during takeoff at Bahar Dar, Ethiopia. During the air turn-back, both engines lost power. While attempting an off-airport landing, the aircraft struck a river bank and burned.

- In January of 1995, a Falcon 20 encountered a large flock of lapwings during initial climb from LeBourget, France. Bird ingestion damage to the affected engine resulted in an on-board fire from uncontained engine fragments impacting the aircraft fuel system. During the air turnback, the aircraft struck the ground and was destroyed.

- In September of 1995, a US Air Force AWACs aircraft encountered a flock of Canada geese during takeoff rotation at Elmendorf Air Force Base near Anchorage, Alaska. Both left wing engines had ingested geese and lost power. The aircraft crashed.

These events all of which involved fatal injuries point out the need for better bird hazard control programs at and near airports as well as the need to enforce the existing bird control measures and operating procedures.

THREAT POSED BY LARGE FLOCKING BIRDS - GEESE

Although the frequency of ingesting large birds in migratory or intermediate flocks has been very low, observed geese populations have been increasing in size in North America and have been accompanied by an increase in goose strikes to aircraft in the United States.

Geese Population Growth in North America

Geese population measurements provided by the USDA show a significant (10:1) increase in the resident Canada goose population in North America in recent years. The number of resident (non-migrating) geese has increased from ~200,000 in 1970 to over ~ 2,000,000 in 1997. See Figure 1.

***USDA National Wildlife Research Center**
***John L. Seubert, Biologist, USD**

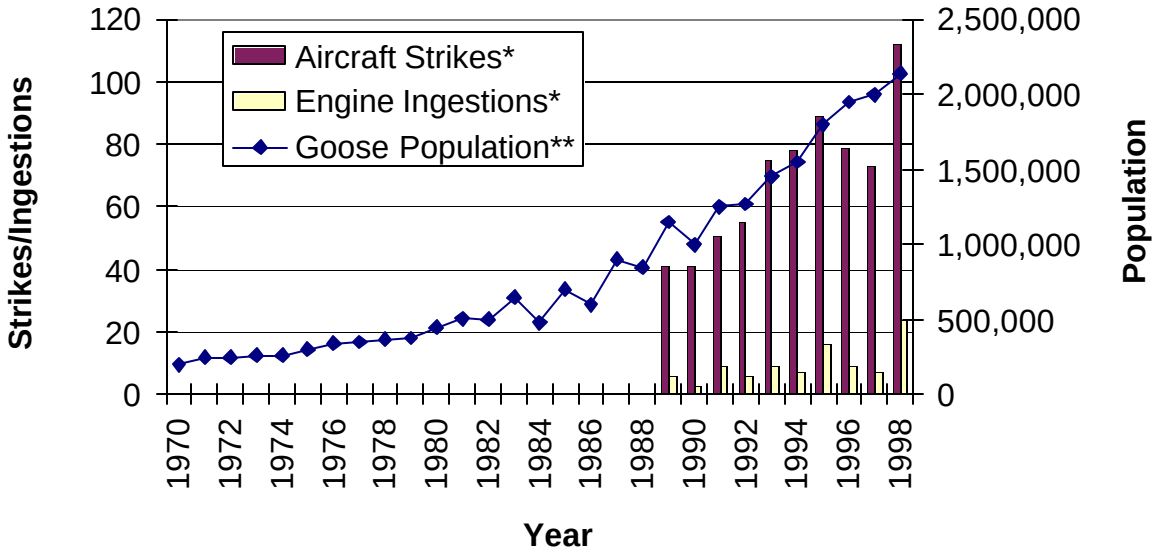

Figure 1 North American Resident Goose Population Growth and Aircraft Goose Strikes & Goose Ingestions in the USA.

Goose Strikes Increases in USA

Birdstrike data (aircraft and engine strikes) in the USA, as compiled in the FAA database, show a significant increase in number of goose strikes during the past 10 years, consistent with the increasing goose population in North America, as also shown in Figure 1. Strikes prior to 1989 do not appear as comparable industry data were not available in the FAA database.

Analyses of these industry data in the USA show that the increase in goose strikes to aircraft (and engines) is statistically significant and the rate of "strikes" is currently growing by approximately 3-4% per year. Figure 2 shows the growing trend in yearly rate of aircraft strikes by geese along with 95% confidence bands. If the growing population of these geese in North America is not arrested, it is estimated that the number of aircraft strikes by geese will increase from 110 strikes per year in 1998 to approximately 300 aircraft strikes per year by the year 2008. This estimate reflects the expected increase in aircraft operations in future years as well as the estimated unabated increase in geese population.

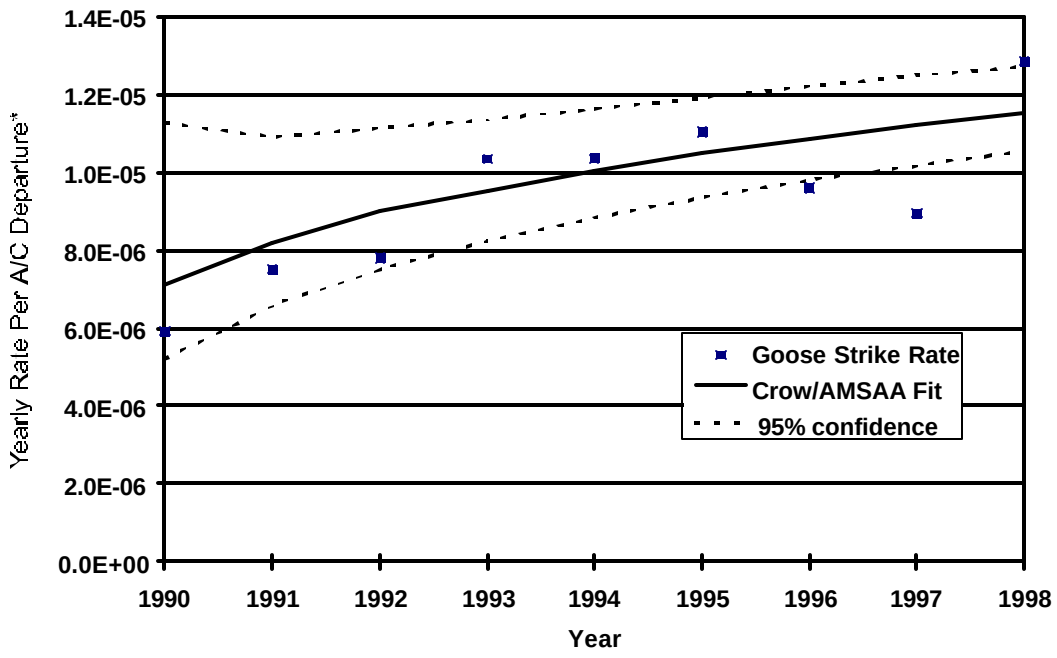

Figure 2 Annual Aircraft Goose Strike Rates in North America

Conclusions

1. The increasing goose ingestion rate per aircraft departure is real and appears to be related to the growing population of Canada Geese and Snow Geese in North America.

2. The increasing number of goose strikes in North America in recent years is related to both the increasing number of aircraft operations (i.e. departures) and the growing population of Canada Geese.

Recommendations

1. Airport Authorities need to implement effective wildlife management programs on airports to address the growing population of geese as well as other flocking birds. There needs to be zero tolerance for grazing geese at airports.

2. The US Department of Interior's US Fish and Wildlife Service need to initiate actions to humanely reduce the rapidly growing population of geese and remove them from airports and airport vicinities to mitigate the hazard to aviation as posed by geese flocks.

The Threat - Case History Examples

Commercial high bypass turbofans have established an outstanding record of safety with respect to the world wide bird threat exposure. The concern is that with the growing goose populations in North America, the threat of a multiple engine goose ingestion on takeoff, which is now extremely remote, will increase to an unacceptably high level. The following case histories provide supporting evidence of the damaging consequences from geese flock encounters and the need to address the growing geese population.

B747 Geese Encounter at Calgary

An illustration of a geese flock exposure with single engine ingestion was a Boeing 747 encounter with a flock of Greater Canada Geese on approach to Calgary in 1992. This encounter is shown in Figures 3 and 4. This event resulted in one goose being ingested in the left outboard engine. Damage to the engine was heavy and fortunately there was no significant power loss.

Figure 3 Boeing 747 Encounter with a Flock of Canada Geese just prior to Bird Ingestion in Outboard Left Wing Engine. Birds appear to be unaware of aircraft's presence.

Figure 4 Same Event a short time later. Birds are now aware of aircraft and have initiated evasive actions.

E4 Snow Goose Encounter in Nebraska

An illustration of a goose flock threat with multiple engine ingestions, was an encounter by an E4B aircraft (a military version of the B747-200) where two of the four engines were heavily damaged. The bird collision occurred at nighttime while climbing through a flock of migrating geese over Nebraska. As the aircraft climbed in darkness at approximately 2230 feet altitude, two miles beyond the departure end of the runway, multiple impacts were felt and the aircraft yawed to the left.

Geese were ingested in numbers 1 and 2 engines; numbers 3 and 4 were undamaged. The throttles on engines numbers 1 and 2 were retarded, the crew declared an emergency and returned the aircraft to a safe landing.

Inspection of the aircraft revealed damage to numbers 1 and 2 engines. Typical damage is shown in Figure 5. The engine cowl had dents and tears in the wing leading edges, leading edge flaps, trailing edge mid-flaps, flap track canoe and radome. There was evidence of 21 goose impacts on the aircraft. A total of 49 geese were confirmed as killed based upon bird debris evidence and actual recovered dead birds:

- There were 38 dead carcasses of Snow Geese and Blue Geese found in a field beneath the impact location.

  In the midair collisions, 5 geese had become (embedded) passengers when they boarded the aircraft by penetrating through holes and tears in the aircraft

surfaces at various locations such as the radome nose, wing leading edges and flaps.

- A birdstrike investigation and shop disassembly of the numbers 1 and 2 engines was conducted. It was concluded from ultra-violet light evidence and an analytical map of blade damage measurements that 4 geese were ingested into the No. 1 engine and 2 geese entered the No. 2 engine.

Based on thrust measurements during previous engine tests with fan blade bulge deflections of the type noted, it was determined by measured blockage factors that both engines had suffered significant loss of thrust.

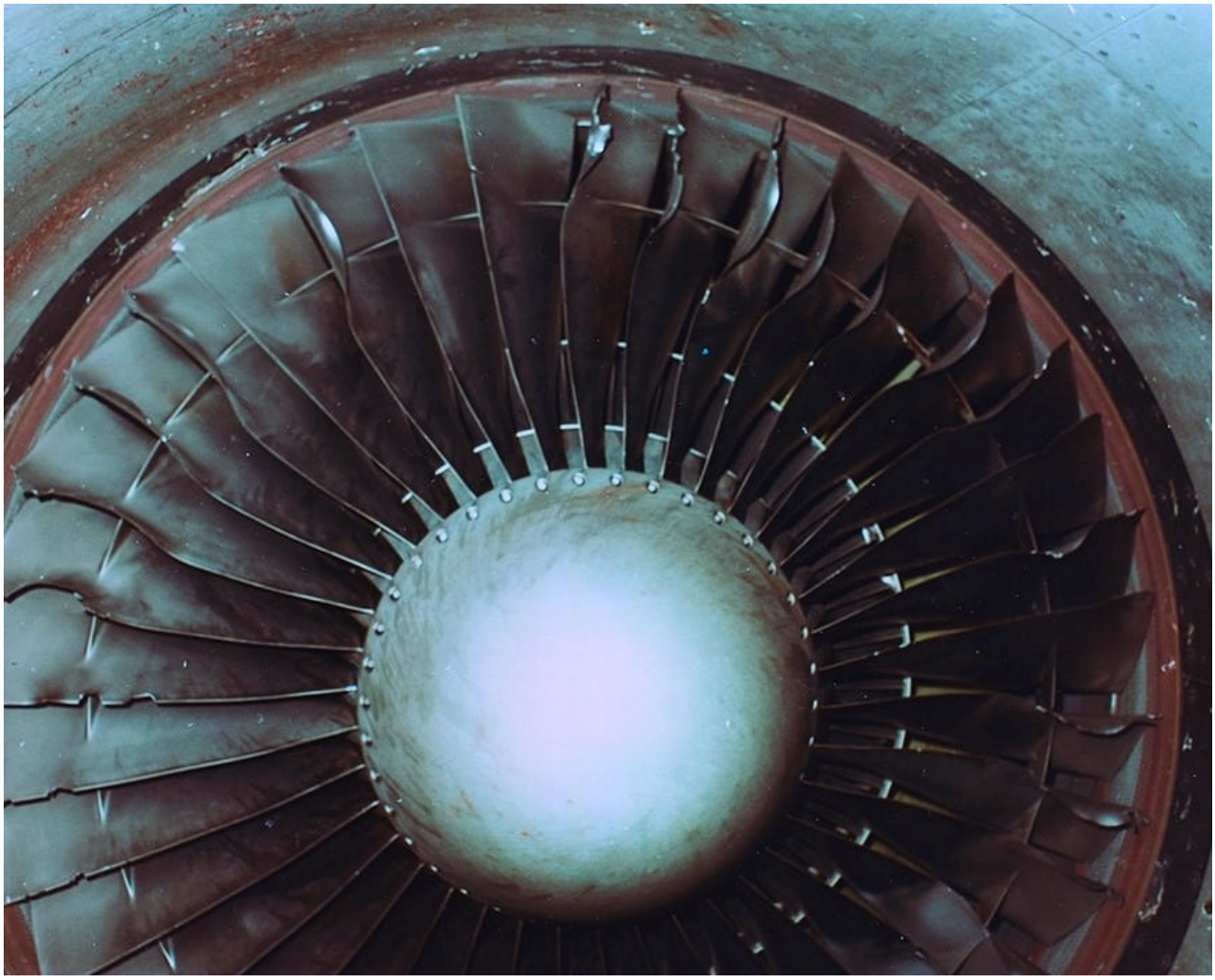

Figure 5 Results Of Multiple Geese Ingested Into A Turbofan Engine (Position 1, E4B Event)

BIRD INGESTION STATISTICS

Although the perceived threat from the growing geese population in North America has been increasing in recent years (and needs to be addressed), progress appears to have been made in reducing the damaging bird strikes through improved awareness and more effective airport bird hazard control programs worldwide.

The following statistics attempt to quantify this progress for selected geographic regions. Reasons for the improvements and lessons learned, if known, are mentioned.

Damaging Bird Ingestions

Experience has shown that virtually all bird ingestions that result in damage to an engine (thirty percent of all ingestions) are reported to manufacturers. There are many more bird ingestions with no damage and these are not reported consistently. Focusing on these "damaging" bird encounters provides a consistent method of establishing a "relative bird threat".

Relative bird threat as used here is defined as the ratio of the "damaging" bird ingestion rate for a given region (or country) to the rate of "damaging" bird ingestions in North America between 1972 - 1980. This baseline time period was chosen because it represents the introductory years of wide body aircraft operations; also, awareness of the threat and major focus of airport bird hazard control programs were initiated about 1980 in many countries, such as India and Canada.

Relative bird threat as defined provides a consistent method to compare the bird threat at various locations and to show chronological trends. For this paper, bird ingestions during revenue service on the CF6 family of engines were studied for four time periods from 1972 through 1995 as shown in Figure 6 and 7.

Bird Threat Worldwide

Figure 6 shows the statistics for the relative bird threat and trends for selected geographic regions. The results show that consistent improvements have been made since 1980 in North America, the Pacific Rim States, Europe, Asia and the Nordic States, notably Sweden. However, little improvement has been noted in the African regions.

Progress in the Scandinavian countries since 1980, as shown in Figure 6, reflects the bird control initiatives by the airport managers at Copenhagen. There had been two prominent flocking-bird ingestion events involving gulls at Copenhagen in 1976 and 1983 which resulted in major fan engine damage. Since then, significant improvement has been observed there.

The reduced bird threat in Asia has been attributed primarily to efforts initiated in India. The benefits in India since 1980 reflect the dedication of the government and the excellent ongoing work being conducted by their field scientists to reduce the presence of kites, scavenger vultures, and white-backed vultures near airports.

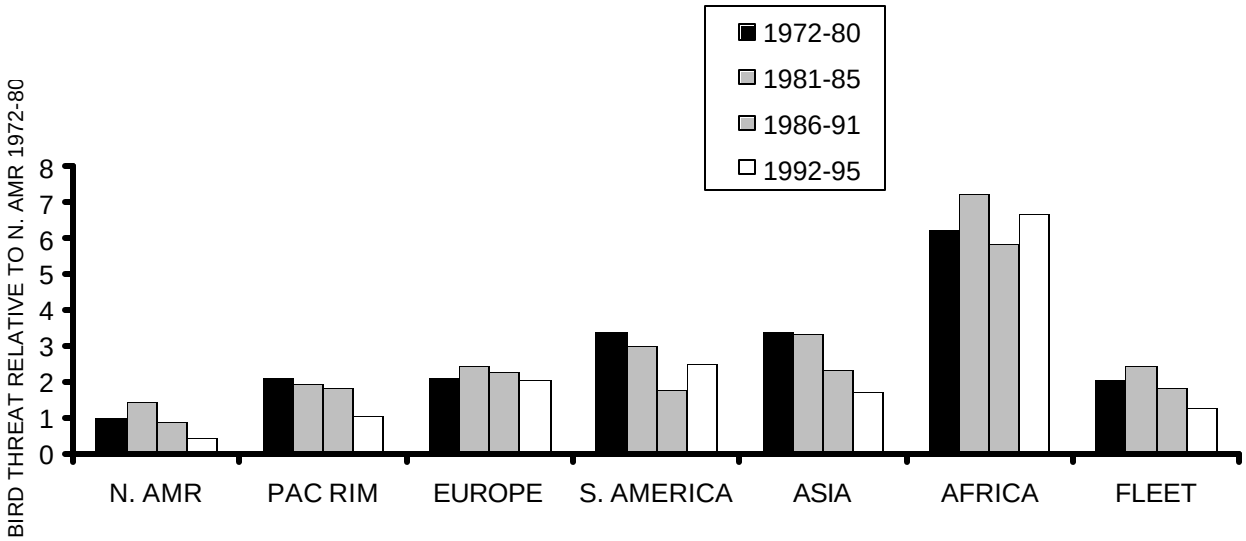

Figure 6 Worldwide Bird Threat and Trends by Geographic Region

Bird Threat in North America

Progress in North America, as shown by country in Figure 7, was attributed in part to efforts in Canada since 1980. This was a direct result of the dedication of Transport Canada, the airport managers in Canada, and airport bird patrol teams. The active bird-control patrols using their whistles and poppers and the use of trained predator birds at some locations have been effective. The high traffic at selected airports in the United States has a tendency to keep birds flushed from the active airport runways and may, along with active bird hazard control programs, be contributing factors to the relatively low damaging rates in North America.

The high traffic rates in North America result in large numbers of damaging birdstrikes each year. Hence, airport operators need to further improve their airport bird hazard controls to further mitigate the threat posed by birds - especially the growing flocks of geese.

Status

These statistics represent the damaging bird ingestions at those airports which accommodate wide-body transports powered by CF6 engines. An independent analysis of damaging bird ingestions to CFM56 engines on B737, A320 and A340 aircraft, which included many of the smaller regional airports, showed similar trends.

The results of these statistics of damaging birdstrikes show that where aggressive bird control efforts were undertaken, measurable reductions of damaging rates have been achieved. In other words, the methodology exists and damaging birds can be controlled when the commitment is made.

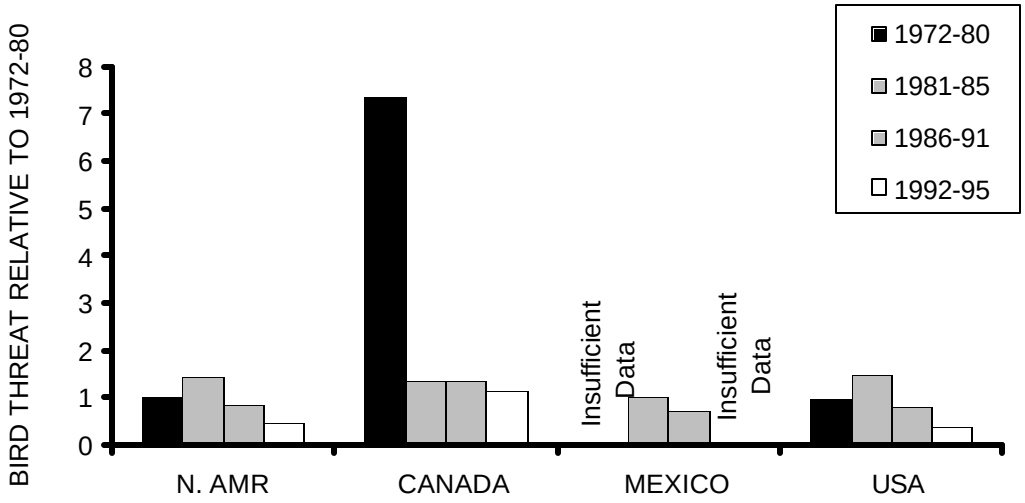

Figure 7 Bird Threat and Trends in North America

CONTROLLING BIRDS AT AIRPORTS

The presence of a flock of birds on or near an active runway signals that improvements in the bird control program are required at that airport. It may also indicate that there are adverse contributing factors just beyond the premises of the airport, such as bird sanctuaries, crops, garbage landfills, abattoirs (slaughterhouses), or unsanitary local conditions. In these cases, the need for corrective actions by other regulatory agencies, working with airport authorities and local governments, is required.

Bird control programs must include passive and active measures that deter birds. Passive airport terrain features include proper surface water drainage, removal of undesirable vegetation near runways, and control of insects and small mammals. Active bird hazard control patrols must regularly check for the presence of birds near runways and frighten them away using such means as loud bangs, trained predator birds, or other techniques.

Engine manufacturers generally are not involved in, nor do they have directly useful experience regarding, the control of birds and FOD at airports. The authorities at airports must assume this responsibility to assure that airport bird control programs are effective, remain active, and are more widely disseminated and applied. Timing is urgent: lessons learned from history should be heeded:

- In 1987, the authorities in Ethiopia had been advised of a safety threat from flocking birds due to a lack of adequate airport bird hazard controls in that country. In 1988, during a revenue service departure from Bahar Dar, Ethiopia, a Boeing 737-200 ingested birds in both engines and lost power - as described earlier.

- On 22 September 1995, a US Air Force AWACs aircraft encountered a flock of Canada Geese during takeoff rotation from Elmendorf Air Force Base near Anchorage, Alaska. Canada Geese had been roosting near the departure runway. Investigation determined that both left wing engines ingested geese and lost power. The aircraft crashed and all crew members were fatally injured. In July of 1995, the USAF Bird Aircraft Strike Hazard (BASH) Team had visited Elmendorf and identified habitat problem relative to the presence of flocks of Canada geese. Not all of the BASH Team recommendations had been implemented on the date of the accident.

BIRD AVOIDANCE GUIDELINES

Recognizing that the bird threat appears to be growing at a number of airports worldwide, the following guidelines are proposed to aid in pilot training and awareness of bird threats in the skies we fly.

Pilot educational training, both initial and recurrent training, must include an awareness of what constitutes a bird hazard exposure and the possible consequences. It must be recognized that the worst threat is from flocking birds, especially gulls, kites, pigeons, and waterfowl (geese/ducks) - due to the potential for a multiple engine power loss. Encounters with birds must be avoided. Pilots must not challenge the birds.

Effective Pilot Communication with the control tower in response to reports of “bird activity in the airport vicinity” is needed to determine key facts on the severity of the bird threat, such as:

- the locations of the birds with respect to the active runway and flight plan,
- flock size or number of birds and direction of travel,
- type (or size) of birds.

Bird avoidance procedures by the pilot as part of his pre-departure planning may be the best method of, and last resort for, preventing a major bird ingestion incident. The presence of flocking birds on or near an active runway is a threat that must be corrected before an aircraft departs - afterwards may be too late. Bird patrol teams with their ground vehicles may need to be sent out repeatedly to disperse the birds.

Effective bird avoidance requires that control towers take the responsibility to alert crews to the presence of birds on or near the active runways. Pilots must take the responsibility to avoid the birds where possible. Airport managers must assure bird hazard control programs are in place and include active bird patrol teams to disperse the birds.

SUMMARY

Birds are one of our world's most precious resources and need to be protected. However, it must be recognized that the presence of birds at and around airports poses a safety threat to aircraft operations and thus to humans as well.

It is of paramount importance, therefore, that the bird control measures discussed in this paper be implemented at any airport experiencing a bird hazard in order to reduce, or, hopefully, eliminate, this very real cause of potentially fatal accidents. Airport bird hazard control programs should be reviewed with particular emphasis on the control of flocking birds, such as gulls, pigeons, waterfowl (geese/ducks), etc. The data presented in this paper on the experience with damaging bird encounters on aircraft engines clearly show that the methodology exists and damaging birds can be controlled when the commitment is made.

Pilot initial and recurrent educational training must emphasize an awareness of what constitutes a bird hazard threat and the possible consequences. Pilots must not challenge the birds!

Airport Authorities need to implement effective wildlife management programs on airports to address the growing population of geese as well as other flocking birds. There needs to be zero tolerance for grazing geese at airports.

Where necessary, the US Department of Interior's Fish and Wildlife Service need to initiate actions to humanely reduce the rapidly growing population of geese near airports to mitigate the hazard to aviation as posed by geese flocks.

THE AUTHOR

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Summary

This paper focuses on the increasing threat to aircraft and engines posed by the recorded growth in geese populations in North America. Service data show that goose strikes to aircraft and engines are increasing, especially in North America - consistent with the growing resident geese populations estimated by the USDA. Airport managers, along with the governmental authorities, need to develop a strategy to address this large flocking bird issue.

This paper also presents statistics on the overall status of the bird threat for birds of all sizes in North America relative to other geographic regions. Overall, the data show that Canada and the USA have had marked improvements in controlling the threat from damaging birds at airports - except for the increase in geese strikes. It will always be necessary for airport operators and regulatory authorities to ensure that extreme ingestion encounters are avoided. Effective airport bird hazard controls are needed now and must be maintained in the future.