HOW TO GET RELIABLE INFORMATION ON THE BIRD STRIKE RISK?

by Jürgen Becker
German Military Geophysical Office
Mont Royal
D-56841 Traben-Trarbach
Germany

Summary

The paper shows that knowledge about the spatial and temporal distribution of bird species dangerous to aircraft is mostly incomplete. The requirements for coverage, assessment and actuality of the data describing the bird strike risk can be best achieved combining geographical, biological, weather and radar data.

Key Words: Statistics, Risk Assessment, Migration, Warning Systems, Radar, flock density, Bird Populations

1. Introduction

The probability of a bird strike is directly proportional to the number of birds within the fligh path of the aircraft. The extent of damage depends on the weight of the bird and the speed of the aircraft. Therefore areas and times with high bird densities, especially of larger birds should be avoided by air traffic. This is only possible if reliable three-dimensional informatio of bird intensity (best as kilos of birds per cubic km) is available. If quantitative data ar missing, the data base should put emphasis on bird species identified as particularly dange-ous to aircraft. The data must be actual and presented in a format familiar to pilots.

2. Bird species involved in bird strikes

The main source for the assessment of bird species as a bird strike hazard is the examinatio of bird remains found after a bird strike. Between 1977 and 1991, 2257 bird remains, after collisions with military aircraft, were examined by the German Military Geophysical Office. A total of 111 bird species was found, but only 15 species caused frequent bird strikes (KÜSTERS, 1993). The bird strikes between 1981 and 1994 left 2304 bird remains for identification. 750 incidents caused damage to aircraft. Table 1 shows the weight categories of the birds identified in relation to the effect of the strike. Bird species between 450 and 1199 g must be considered as particularly dangerous to aircraft. Common species as buzzard, wood pigeon and herring gull belong to this category. In the category 110 to 449 g common species as the black-headed gull, lapwing and kestrel are mostly involved in bird strikes. In the category ≥ 1200 g it is the mallard (KÜSTERS, 1993), a common and widespread spe-cies. It has to be kept in mind that birds of medium weight and frequent occurrence are the main problem.

3. Spatial distribution of birds

The bird density and the bird strike hazard varies considerably from area to area often over very short distances. It should be stressed that information on the density of many bird spe-cies causing considerable bird strikes are not available for most countries. Even in countries as the Netherlands or the UK, where national bird counts were performed by thousands of amateur ornithologists, the knowledge is fragmentary with regard to common birds. Species identified as dangerous to aircraft (see Chapter 2) have widespread distribution. Only the herring gull is mostly located near the coast. Black-headed gull and mallard are common on lakes and rivers all over Germany but with seasonal differences. Buzzard, kestrel, lapwing and wood pigeon are similarly widespread in agricultural areas. It is impossible to limit the bird strike risk caused by these species to well defined small areas. The known important bird areas in Europe (e.g. GRIMMETT and JONES, 1989) are chosen mostly for conservation purposes with special regard to threatened species. Nevertheless these areas create often a considerable bird strike risk, and they should be avoided by aircraft. But a considerable pro-portion of bird species dangerous to aircraft is not limited to such a network of bird areas. Therefore bird strike prevention requires the knowledge of countrywide concentrations of medium-sized and large birds and their seasonal variations.

4. Temporal variations of bird density

Most species that do congregate at special sites, do not so throughout the year. In general the temporal variations of bird density often exceed the spatial differences perhaps with the ex-ception of the Wadden Sea. These facts can be shown by the winter movements of grey geese in Germany (MOOIJ, 1995). Fig. 1 shows the mean numbers of grey geese at important roosting places in September, November and January. This pattern can vary from year to year, and also for a short time due to weather and food sources. Also the bird species representing the main bird strike hazard vary in their distribution throughout the year:

- wood pigeon and lapwing are short-distance migrants congregating in suitable areas for several weeks
- the buzzard population increases considerably in winter
- gulls are spread over larger areas outside the breeding period.

If the bird density is estimated not only on breeding, roosting and wintering areas but also in altitudes important for air traffic (military low level flights, climb and approach) local and large scale migratory movements must be considered.

5. Assessment of the bird strike risk

An exact assessement of the bird strike risk requires data on the actual bird density countrywide and at any time. This requirement cannot be fulfilled completely.

Visual counts are normally performed in areas of ornithological importance and are often limited to systematic groups (waterfowl, waders, raptors etc.) or seasons (breeding or wintering birds). Moreover the surveys are only repeated after longer intervals, and do not consider the flight activity of birds. Therefore the data are never actual. The evaluation of the data with regard to the bird strike risk raises an additional problem (KARLSSON, 1977). As the bird density varies considerably from country to country it is difficult to lay down international rules for the definition of a bird strike risk area. All attempts of quantification (HEIRMAN 1975, HOLM-JOENSEN 1975, KARLSSON 1977) differ considerably. Whereas visual counts of birds on the ground provide at least reliable numbers, the visual observation of migrating birds is only a rough indicator due to the limited visibility. In summary, one can say that visual observation cannot provide sufficient information for the assessment of the bird strike risk.

A different attempt to assess the bird strike risk is based on radar observations (for the principles see BUURMA and BRUDERER, 1990). The echo intensities are calculated electronically or estimated by comparison with model pictures of the radar screen. The exponential 0 - 8 scale of bird intensities used in different countries was developed in the Netherlands (TENGELER, 1973) and Denmark (CLAUSEN, 1973) at long-range air defence radar. The adaptation to different radar systems requires a thorough calibration. Nevertheless all radar equipment used for ATC purposes have a loss of bird information due to radar horizon and data processing. Therefore only a limited amount of echo signals is at the disposal of the electronic counting system. The calculated bird intensities are not really quantitative. This is the reason that BUURMA (1994) demands an ideal dedicated bird radar, that is a small three-dimensional volume scanning radar for automatic bird detection above and around airfields and shooting ranges. On the other hand a countrywide coverage would require a considerable number of these dedicated bird radar systems.

6. Advantage and limits of the different information systems

6.1 Geographic information Systems (GIS)

A geographic information system (GIS) has in principle the same problems as tradi[tional] maps (KARLSSON, 1977, BECKER, 1990); coverage, assessment, and actuality. A GI[S] consists of tools to collect, store, manipulate, and present spatial information. In applicati[on] of a GIS several phases can be distinguished (BUCX, 1990):

- Data selection: an inventory is made of relevant geographical information
- Data integration: user demands are formulated
- Extrapolation and prediction: models are applied

Special demands on bird strike risks are bird strike locations, bird strike risks for missi[on] preparation, bird strike risks in local areas. Models on bird strike risks refer to the spatial a[nd] temporal patterns of bird migration. The GIS has many advantages compared with themat[ic] maps, e.g. the combination of different data and the answer to specific questions. Neverthe-less the GIS can only be really useful for the prevention of bird strikes if the problems men-tioned in Chapter 3-5 can be solved. Due to the great variability in bird density the bird strike hazard often varies considerably over very short distances and in a short time. These impor-tant differences must be considered in the GIS if it will be a useful tool. Therefore the system needs a continuous scientifically proved update.

6.2 Bird Avoidance Model (BAM)

The Bird Avoidance Model (BAM) is designed to determine the bird strike hazard on [the] low-level flight routes in the continental United States (SHORT, 1982). The BAM was de-veloped as a flight planning tool when creating or altering low-level routes or when schedu-ing missions or times of particular flights. It is a predictive model which can be used to pre-dict relative levels of bird strike risk. The BAM was first restricted to waterfowl, but the new BAM includes population and migration dynamics of additional bird species, such as raptors, gulls, cranes, and pelicans which also pose a significant threat to aircraft (RUHIN, 199[2]). BAM's approach to risk quantification is based on the accuracy of bird counts. It calculates the relative risk of a bird strike by integrating biological and geographical data into a GIS. In the future, weather components and radar data will be integrated. The BAM is a successful information system referring to continental America where bird migration always covers parts of the country. For the special conditions of Central Europe the system would require a higher resolution and a continuous update.

6.3 Bird Strike Warnings/BIRDTAM

The bird strike warnings in Europe were introduced by military authorities with the purpose to reduce the number of enroute bird strikes. The systems are mostly based on radar obser-vations (BECKER 1986, 1992). In contrast to GIS and BAM the systems are concentrated to the dynamic aspects of bird concentration due to migratory flights. Nevertheless the main problems are similar:

- the coverage is often incomplete, especially if the radar parameters are not optimized for bird detection. The number of radar stations included in the system is often too small. Therefore an extrapolation of the observation data to adjoining areas is necessary
- the assessment of bird intensities is sometimes inadequate (see chapter 5)

- the actuality is only guaranteed if the system runs continuously. As a certain delay between the observation time and the validity of the warning must be accepted local bird movements cannot be considered by the system.

In spite of these objections the bird strike warnings have proved useful for the prevention of bird strikes during low-level flights. The artificial limits of warning areas and validity times are in contrast to the ornithological reality but nonetheless adapted to the requirements of jet pilots (BECKER, 1994).

7. Conclusions

The information on the actual bird strike risk is incomplete in most countries, and will be so in the future. Therefore the authorities responsible for prevention of bird strikes have to consider how accurate the information must be for the requirements of the pilots:

- If certain areas can be avoided without problems a general information on bird density may be sufficient.

- If alternate routes or altitudes are possible the evaluation requires reliable data as actual as possible.

- If a certain area must be crossed exact data on dangerous bird species and their flying behaviour are indispensable for establishing spatial or temporal conflict-free routes

- If countrywide information is necessary actual data can only be determined by a network of radar equipment.

All existing systems to assess the bird strike risk have their limits. The best solution of the problem is a combination of geographical, biological, weather and radar data as successfully achieved in Israel (LESHEM, 1990, 1992) and planned in the United States (RUBIN, 1994).

8. References

Becker, J. (1986). The use of radar data for birdstrike prevention in Germany. BSCE 18/WP5: 82-92

Becker, J. (1990). Mapping the birdstrike risk. BSCE20/WP19: 179-182

Becker, J. (1992). State of affairs concerning the birdstrike warning system in Central Europe BSCE21/WP18: 153-161.

Becker, J. (1994). The significance of Birdtams/Birdstrike Warnings for military and civil aviatio BSCE22/WP35. 257-262.

Buex, T.H.M. (1990): Towards a geographic information system (GIS) on bird strike risk. Lecture during the 6th meeting „Bird Hazard at Low Level", The Hague, 15pp.

Buurma, L. (1994). High bird densities assessed by radar, a ROBIN report. BSCE22/WP32. 223-242.

Buurma, L. and B.Bruderer (1990). The application of radar for bird strike reduction. BSCE20/WP36:373-445.

Clausen, P.R. (1973). Electronic counting of birds. BSCE8/WP 8-2, 6pp.

Grimmett, R.F.A and T.A. Jones (1989). Important bird areas in Europe. ICBP Technical Publication No. 9, Cambridge/UK, 896 pp

Heirman, J. (1975). A Belgian bird strike risk map hazard on numbers of birds to the unit of area BSCE10/WP11, 6pp.

Holm-Joensen, A. (1975). European bird hazard map. BSCE10/WP23, 3pp.

Karlsson, J. (1977). Surveys of bird concentration areas as a tool in aviation safety work with an example from Sweden. BSCE12/WP13, 6pp.

Küsters, E. (1993). Fünfzehn Jahre Vogelrestbestimmung im Amt für Wehrgeophysik. Vogel und Luftverkehr 13: 36-47.

Leshem, Y.(1990). The development of a bird migration real-time warning system for the Israeli Air Force. BSCE 20/WP12. 93-102.

Leshem, Y. (1992). Predicting regularity of bird migration in global bottleneck areas, on a daily, seasonal and yearly scale, and ist implementation in Israeli Air Force and civilian flight. BSCE21/WP25: 243-258.

Mooij, J. (1995). Ergebnisse der Gänsezählungen in Deutschland. 1988/89 bis 1992/93. Vogelwelt 116:119-132.

Rubin, D.J. (1992): Low-level airspace bird strike hazard evaluation and using a GIS to integrate bird population dynamics into an Aircraft Bird Avoidance Model. BSCE21/WP90: 387-389.

Short, J.J. (1982). Evaluating the Bird Avoidance Model. BSCE16/WP25, 20pp.

Tengeler, J (1973). Detection of birds by radar. Rapport LEOK No.18.705/0.371, Oegstgeest/NL, 12pp.

TABLE 1: Percentages of bird strikes with/without damage in relation to weight categories of bird species involved (n=2304 strikes)

Weight category of bird species	Bird strikes With damage	Bird strikes without damage
< 110g	16 %	59 %
110-449 g	27 %	19 %
450-1199g	53 %	20 %
≥ 1200 g	4 %	2 %

FIGURE 1: Important roosting areas of grey geese in Germany during September (09), November (11) and January (01) in the period 1988/89 to 1992/93 (from MOOIJ, 1995)