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# BIRD MOVEMENTS AROUND AIRPORTS: A CRITICAL ISSUE IN THE SPECIFICATION OF AVOIDANCE SYSTEMS

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## SUMMARY

Quantifying, qualifying and predicting low level bird movements is the key issue hampering the certification of bird strike prevention measures in the control zone of airports as well as "en route". Bird control at the runway itself is already succesfull at many airports. Less wide spread, and limited to military aviation, but technically speaking ripe for improvement, are large scale warning systems indicating mass bird migration. However, the 'bottom-up' and 'top-down' approach together do by far not solve all bird strike problems. A geographical comparison of the (low level) altitude distribution of military bird strikes from EURBASE indicates a missing link, just outside visual range but also below the coverage of most radars. This risk is posed by local bird flights over up to some tens of kilometers especially in coastal and wetland areas. Integrated radar and visual observations in The Netherlands show that also a significant part of long distance migratory flights may occur at low level, even at night. Local and migratory flights may accumulate along topographical barriers or leading lines at locations considered for airport construction.

This presentation is a plee for the classification of these complex problems. This should happen in such a manner that existing ornithological knowledge will help to develop rules of thumb to be used in integrated bird avoidance systems. There are fundamental, psychological as well as political reasons why operational bird prediction models should be backed up by bird detection devices. Problems with wild geese wintering in The Netherlands may serve as an example.

Key Words: Statistics, Military Aviation, Local Movements, Bird Populations, Detection, Radar

EURBASE altitudeprofile (%) local birdstrikes

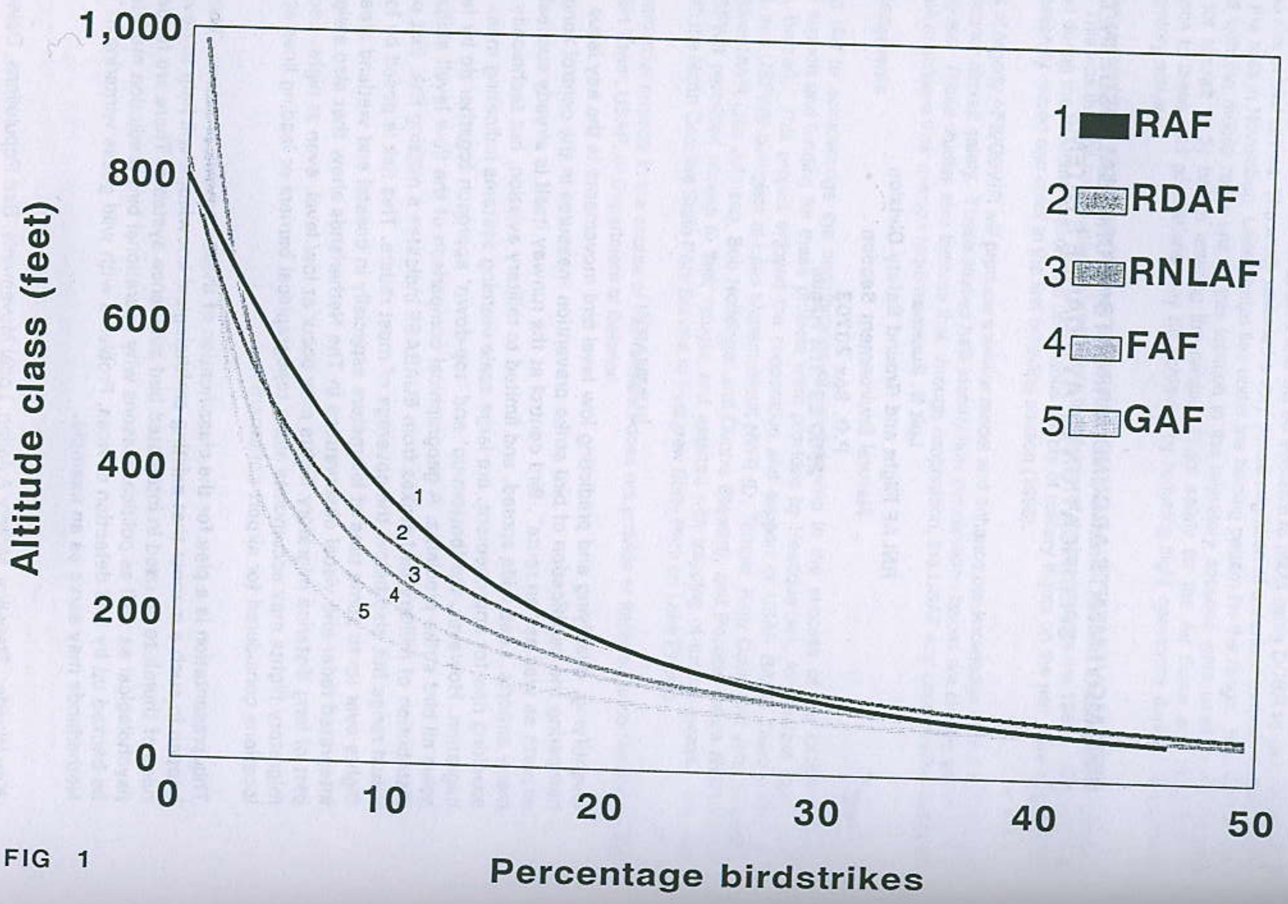



FIG 1

**Introduction**

Becker (1996) summarized the discussion in the Low Level WG on 'en route' bird strike prevention during the last ten years. He is perfectly right in his conclusion that we should head for an integrated approach, "combining geographical, biological, weather and radar data". My statement of today is that we only can make such integrated prevention operationally stable when we succeed in <u>classifying</u> and subsequently <u>standardising</u> the different prevention elements. In other words: we must develop and speak the same language in order to communicate about the <u>predictable and non-predictable</u> aspects of the bird strike risk. Predictable risks are in principle open for <u>certifiable</u> preventive measures resulting in a quantifiable risk reduction. But also the remaining non-predictable types of bird danger can be brought under control to a certain extent. Remote sensing of bird movements has a proven potential in real time warning systems (Buurma & Bruderer 1990, Leshem 1994). This paper aims to stimulate better communication on the improvement of avoidance systems by focussing on the critical issue of low level bird flight.

**Evidence from military statistics**

Bird control at the runway itself is already succesfull at many airports. Less wide spread, and limited to military aviation, but technically speaking ripe for improvement, are large scale warning systems <u>indicating</u> mass bird migration in higher airlayers. However, the 'bottom-up' and 'top-down' approach together do by far not solve all bird strike problems. A geographical comparison of the (low level) altitude distribution of military bird strikes from EURBASE indicates a substantial problem, just outside visual range but also below the coverage of most radars: figure 1. This risk is posed by local bird flights over up to some tens of kilometers, especially in coastal and wetland areas.

*Bird strikes may indicate the year-round average altitude distribution of birds* (almost) irrespective of the time spend and distance covered by aircraft at different heights. This is only the case when we select so-called 'local' strikes e.g. during take-off, landing and overshoot (Buurma 1984). During these flight phases the flight path of the aircraft has a fixed angle to the earth surface. The European Military Bird Strike Database (EURBASE, see also Buurma & Dekker 1996) offered the possibility to compare this selection (N=2582) from five west-european air forces. In figure 1 we fitted curves through the altitude distributions in 100-ft classes. The results look rather simular, but when we inspect the curves closer i.e. at 300 ft (ca 100 m) and compare the two extremes, GAF and RAF, we find that the UK-birdstrikes at this height are three times more frequent than those over Germany. The conclusion is therefore that the RAF not only suffers from a higher bird strike rate (see Buurma & Dekker 1996), but (as the curves are percentual) also from a different type of risk than the GAF. Apparently the bird population above and around the British Isles, which is dominated by coastal and wetland species, flies higher and at a larger

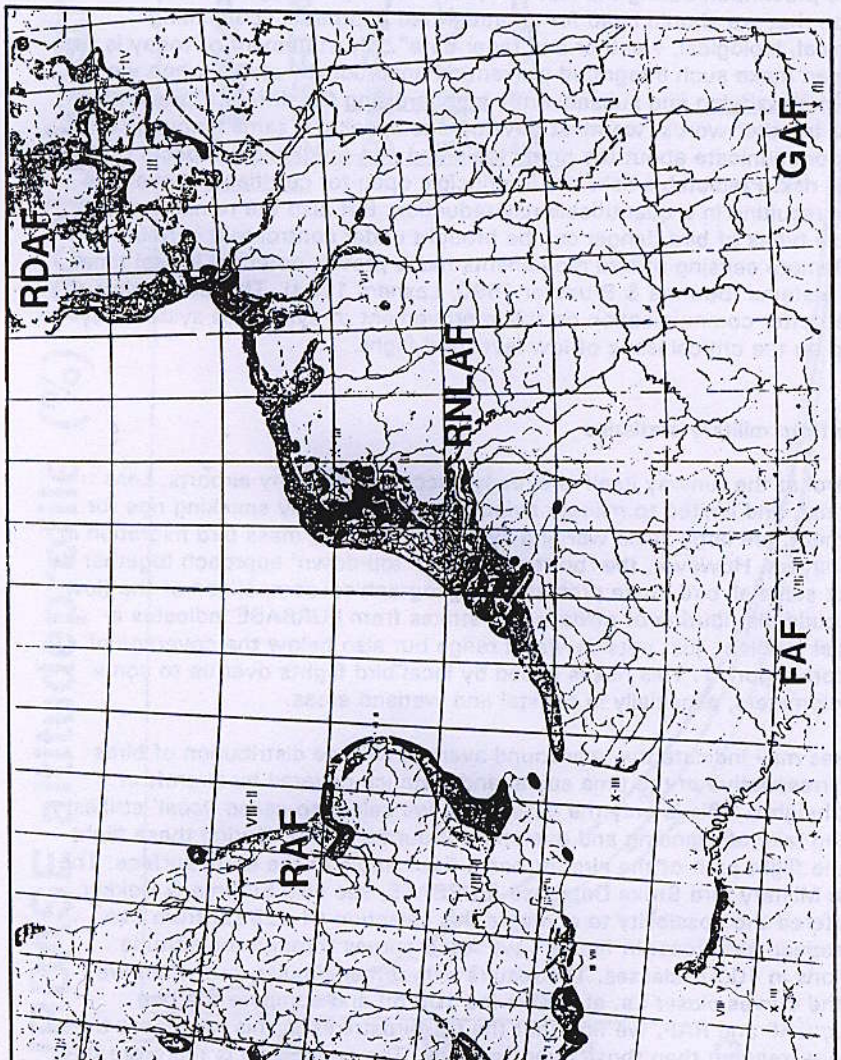



FIG 2

scale than the average bird above the European mainland. This becomes even more obvious when we check the other air forces and bird distribution maps.

**Evidence from bird(strike) distribution maps**

Firstly, figure 2 shows a part of the BSCE birdrisk map indicating zones of light, moderate and heavy birdstrike risk. This international map, developed in the Seventies under the leadership of Dr. J.Hild, is based on best professional judgement about 'total bird meat densities'. It clearly indicates how the main bird areas are concentrated in the flat wetlands along the coast and in river delta's. It is also obvious that RAF and RDAF are mostly confronted with these birdrich zones while FAF and GAF (in this order) have their low level flying over the less risky inland, where wetland species are much scarcer. This sequence of air forces fully fits with the sequence of the curves in figure 1.

The correlation between the type of curve and the air force flying area can be detailed further when we look at the RNLAF, having a position in the middle, on the map as well as among the altitude curves. The centre of flying activity of this air force is in the SE part of the country, avoiding the dense human population in the fertile polders below sea level in the west. Figure 3 (top) shows the bird sanctuaries and bird strike risk map from the AIP Netherlands. The dashed line denotes the boundary between heavy and moderate risk from figure 2. Five airbases are plotted as rectangular black figures. The (average) height of each symbol gives the bird strike rate as well as the trend over the last 10 years. Going from ESE to WNW the five bases show an increase in average local bird strike rate corresponding to the increase in general bird density. The safest base near the border with Germany (Twente AFB) and the base with the highest bird strike ratio (Leeuwarden AFB) were subjected to an equally intense bird strike prevention program. At TW we were able to apply habitat modification succesfully (Dekker & Van der Zee 1996), but at LW we still have to develop additional prevention measures. Here the nearby waddensea, one big nature area, generates tidal mass movements of birds far inland. Further, the very fertile grasslands of the region around the base attract big numbers of 'culture following' species among gulls, ducks and waders. A special and growing problem are geese in winter (see below).

The problems at LW AFB correspond with those at Schiphol airport near Amsterdam. Of course both airfields have full-time Airport Bird Control, but also the spatial planning and bird attracting developments in a certain area <u>around</u> the airport must be considered (Klaver 1994, Buurma 1994a). The present EURBASE data do reflect the fact that local bird movements in wetland areas usually occur at such a scale that structural measures are politically impossible. This is becoming very apparent in the present Dutch debat where to create a second major airport. All possible locations (black dots with white asterisk) are near important bird sanctuaries or in zones where migratory birds tend to concentrate. Figure 3 (bottom) illustrates the classical view on autumn migration (taken from Tinbergen 1949). Our own radar study near Hook of Holland (Buurma & Van Gasteren 1989) shows an even more intense flying

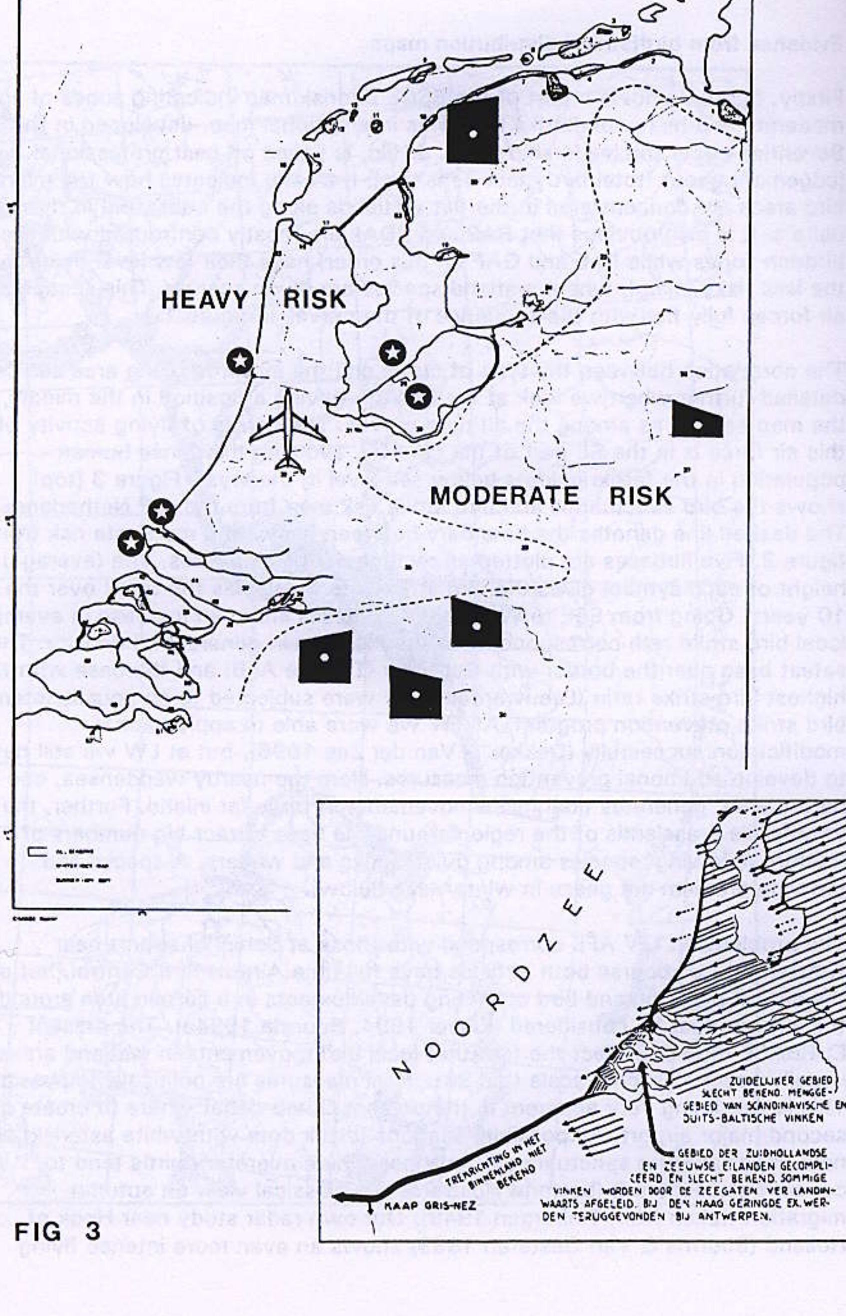

AIP NETHERLANDS
BIRD SANCTUARIES AND BIRD STRIKE RISK
RAC-6-1-0
HEAVY RISK
MODERATE RISK
NOORDZEE
ZUIDELIJKER GEBIED SLECHT BEKEND. MENGGE-GEBIED VAN SCANDINAVISCHE EN DUITS-BALTISCHE VINKEN
GEBIED DER ZUIDHOLLANDSE EN ZEEUWSE EILANDEN GECOMPLICEERD EN SLECHT BEKEND. SOMMIGE VINKEN WORDEN DOOR DE ZEEGATEN VER LANDINWAARTS AFGELEID. BIJ DEN HAAG GERINGDE EX. WERDEN TERUGGEVONDEN BIJ ANTWERPEN.
TREKRICHTING IN HET BINNENLAND NIET BEKEND
KAAP GRIS-NEZ

FIG 3

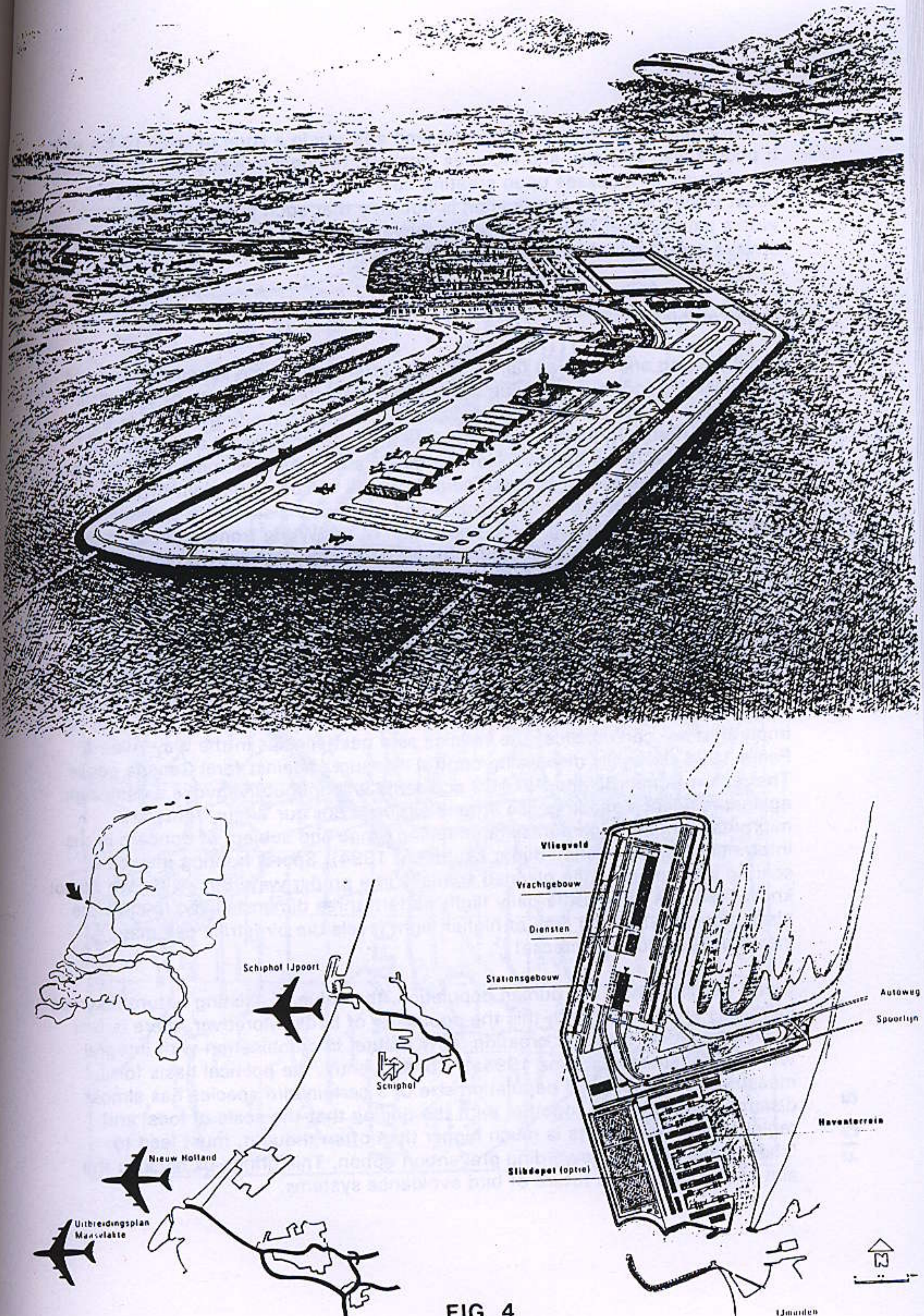

Vliegveld
Vrachtgebouw
Diensten
Stationsgebouw
Autoweg
Spoorlijn
Haventerrein
Slibdepot (optie)
IJmuiden
Schiphol IJpoort
Schiphol
Nieuw Holland
Uitbreidingsplan Maasvlakte

FIG 4

activity parallel to the coastline over land and sea in a zone of over 10 km wide. It occurs also at night, and includes local and regional movements. At present the discussion focusses upon creating new land in the North Sea along the coast (figure 4). The complication is not only that such hugh infrastructural works usually overlap with the birds flyways but also that these works almost always create new bird concentration areas themselves!

**goose problems**

Local feeding and roosting flights follow patterns and time schedules that can be measured and to a reasonable extent be predicted. A wealth of biological knowledge on the behaviour of most bird species is already available in the literature. It should therefore be possible to model the spatial and temporal aspects of the flying behaviour of the main categories of common bird species. The most crucial aspect is flying height, which will be dependent of wind, thermal conditions, type of landscape and especially distance to be covered. Illustrative is the growing winterpopulation of the White fronted goose in the vicinity of Leeuwarden AFB (figure 5). NE of the city of Leeuwarden there is a lake area (black) where 40.000 White fronts gather for the night. They feed on the grasslands in the surroundings and regularly cross the flight path of (mostly landing) aircraft.

The number of White fronted geese near Leeuwarden have grown from 2.000 in the Sixties to the present figure. This parallels the total number wintering in The Netherlands which grew to almost a million individuals. However, this does not imply that we can consider the species as a pest species in the way Allan & Feare 1994 did while discussing control measures against feral Canada goose. The recent Concorde and AWACS accidents will undoubtly invoke a campaign against resident Canada geese around airports. But our White fronts are migrants from an hugh eurasiatic breeding range and subject of concern in the international conservation debat (Aubrecht 1994). Sports hunting may be a scaring instrument when planned spatially in a proper way. But so far we do not know how this affects the daily flight pattern three dimensionally. In case the birds cross the hunting area at higher flight levels the birdstrike risk may increase in stead of decrease!

Given the growth of the human population, the value of existing nature reserves increases and parallel with this the popularity of birds. Moreover, there is fast growing political basis for creating 'new nature' in combination with integral watermanagement (Buurma 1994a). Consequently, the political basis for measures to reduce total population size of a certain bird species has almost disappeared. This fact together with the finding that the scale of local and regional bird movements is much bigger than often thought, must lead to 'sharing the air' as a rewarding prevention option. This brings us back to the aim of this paper: the future of bird avoidance systems.

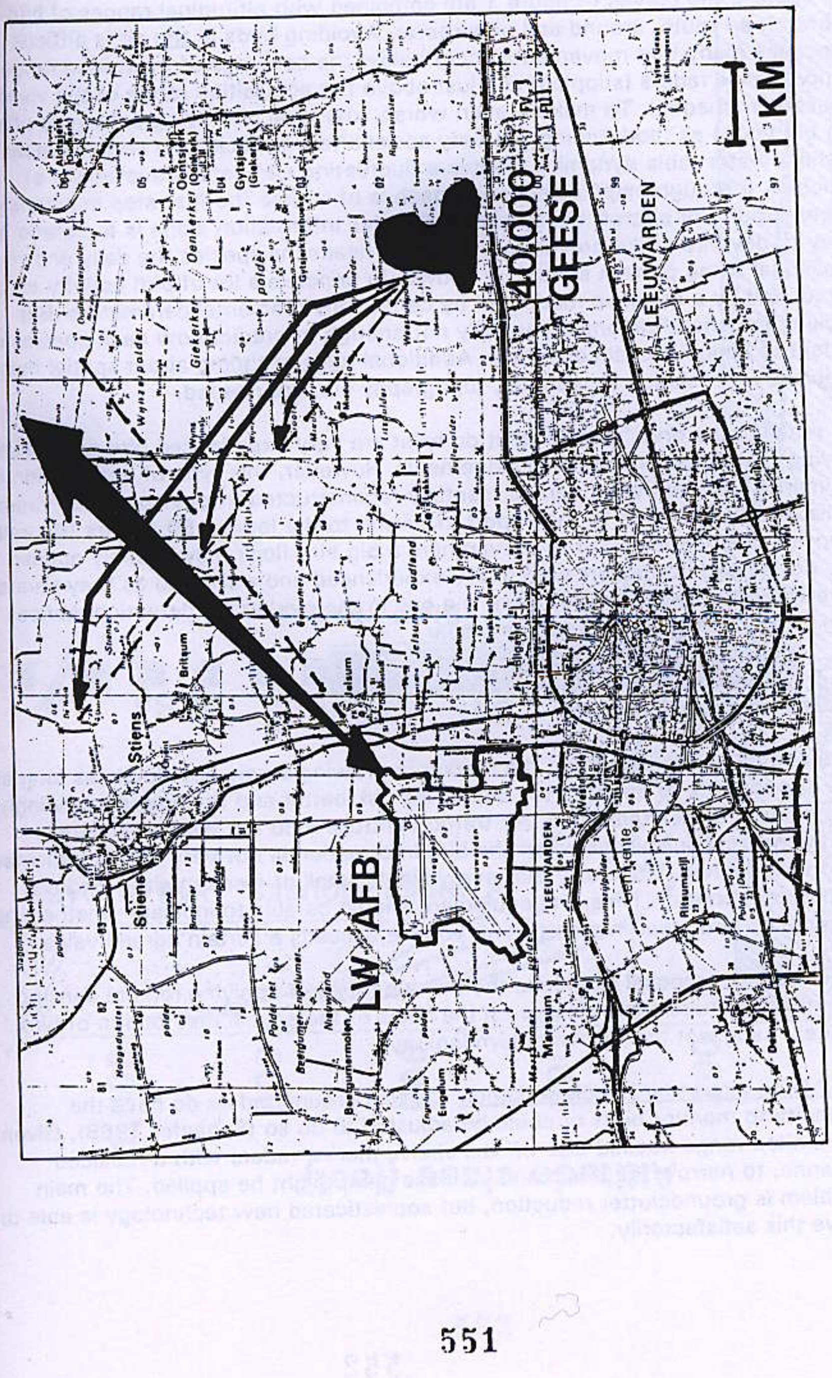



FIG 5

**radar in avoidance systems**

In figure 6 the curves of figure 1 are combined with altitudinal ranges of bird control: en route, around and on airports. Avoiding birds in the air is difficult because many bird movements occur below the coverage of most long range surveillance radars (stippled) and just above the acquisition range of the visual observer (shaded). To make it even worse, low level bird flying activity is often in big flocks as food finding is a very social affair, especially in wetland areas where water table dynamics creates a fluctuating and patchy availability of food. A thorough map/calendar approach is of course the first step in planning new airports or aircraft flying routes. But this information alone is too static for day-to-day bird strike prevention. For each headache species the daily and seasonal flying pattern should be known. In principle a lot of bird activity can be predicted by a dynamic model fed by certain environmental parameters. But scientific generalizations are usually not enough to predict how each species will adapt to specific local conditions. Additional rules of thumb about spatial flying behaviour in relation to weather, topography etc. are needed.

In practice the only 'models' that do exist are very experienced bird controllers giving their 'best professional judgement'. However, this type of anticipation is primarily based on what can be mentally reconstructed from visual observation. This is usually limited to the airport itself and to the lowest 50 meters (Buurma, Lensink & Linnartz 1986). But even here a big bird flock may sudenly appear. As not all bird controllers are equally experienced and alert, and as they cannot overview the whole airport, there is a gap in the market for detection devices based on remote sensing such as radar.

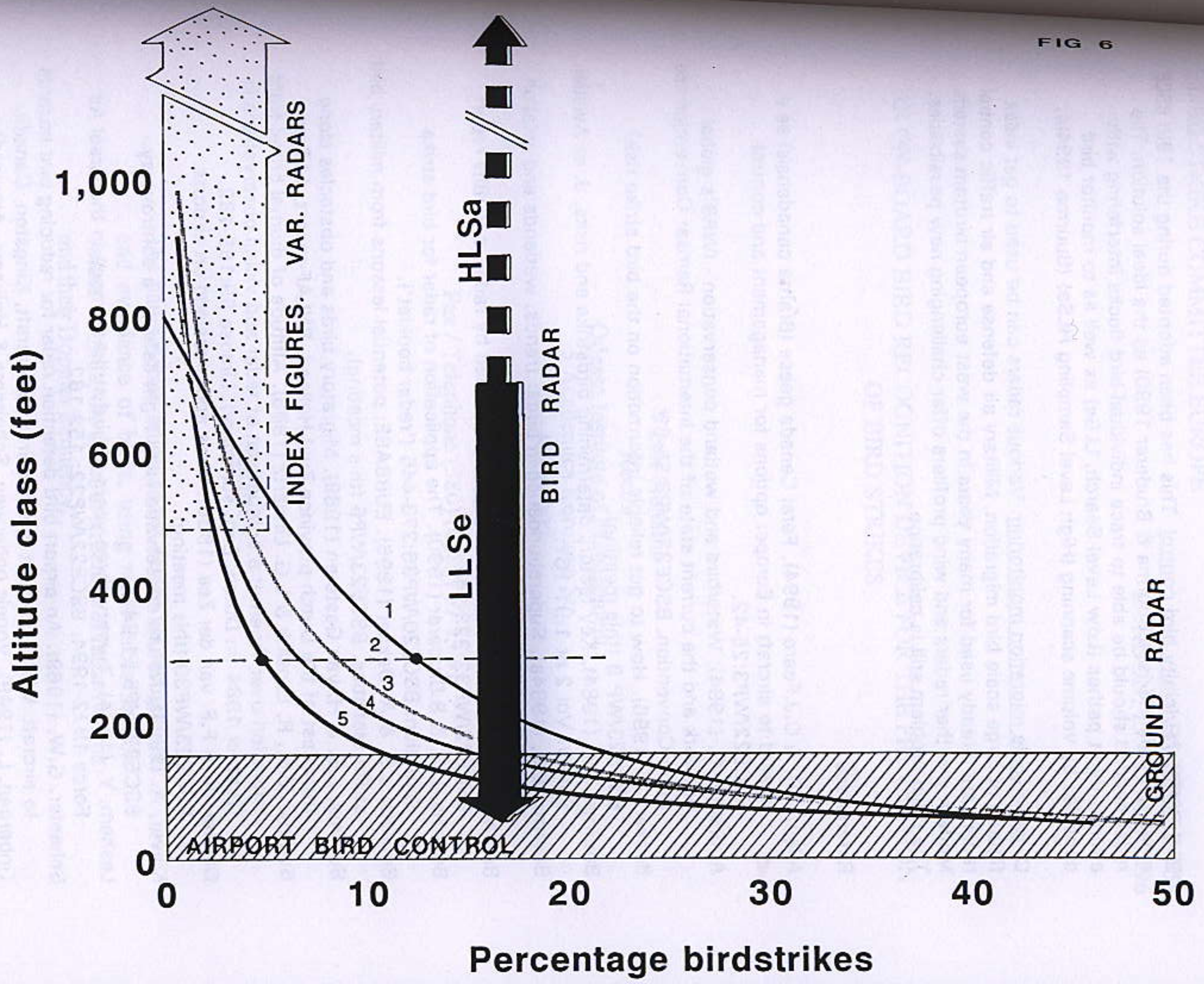
**radar in avoidance systems**

The above mentioned gap in the market is growing surely but slowly as long as we are not able to quantify the bird strike risk better and to show convincingly the amount of risk reduction. Air traffic controllers do not wish to accept additional responsibilities when the bird information is not very clearly indicated and well defined. Obviously, not every single small or medium sized bird can kept under control. Thus, the equipment should be able to indicate whether the amount of bird meat in a certain air volume exceeds a certain agreed value.

Figure 6 is a proposal to reduce the many options of applying remote sensing into three altitude/scale classes on the basis of the spatial distribution of bird strikes. I suggest the following terminology.

A. 2-D on-airport bird flock detection Certain ground radars do have the capacity to monitor birds or could be adjusted to do so (Schaefer 1969). Given the limited range needed also off-the-shelve marine radars with a replaced antenna, to narrow the beam and increase gain, might be applied. The main problem is groundclutter reduction, but sophisticated new technology is able to solve this satisfactorily.

FIG 6



Altitude class (feet)
1,000
800
600
400
200
0
0
10
20
30
40
50
Percentage birdstrikes
INDEX FIGURES. VAR. RADARS
HLSa
LLSe
BIRD RADAR
GROUND RADAR
AIRPORT BIRD CONTROL
1
2
3
4
5

B. 3-D airport vicinity bird control This has been adopted during the 19th BSCE meeting in Madrid (see Buurma & Bruderer 1990) as the ideal solution. The radar needed should be able to trace individual bird flocks interfering with aircraft flight pathes (Low Level Search, LLSe) as well as to monitor bird densities by volume scanning (High Level Sampling HLSa) (Buurma 1994b).

C. large scale migration monitoring Various radars can be used to get index figures of large scale bird migration. Military air defense and air traffic control radars are already used for many years in the west european birdtam system. Modern weather radars and wind profilers offer challenging new possibilities. The main problem still is calibration.

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