RADAR BIRD OBSERVATION AND BIRD STRIKE WARNINGS IN THE WESTERN BALTIC REGION

Wilhelm Ruhe Dipl.Met. M.Sc.
Bundeswehr Geo Information Office, Biology Section
Mont Royal, D-56841 Traben-Trarbach, Germany
Tel: +49 6541 18 734
Fax: +49 6541 18 767
Email: WilhelmRuhe@bundeswehr.org

Abstract

The western part of the Baltic Sea is a very rich bird area. The sea itself is a favoured place for water birds and the surrounding coastal zones and islands are the temporary roosts of millions of migrating birds. During autumn and spring they regularly cross the Western Baltic Region on their flyways from and to their breeding areas in the Arctic's. Although species dependent, there is a close correlation between bird migration waves and weather conditions. Bird strike risk, especially for military low level training, is dramatically increased in times of severe bird migration.

For this reason the Bundeswehr Geo Information Office (BGIO) is operating a modern automated radar based bird migration observation system. A network of air defence radar stations provide continuous clutter information on non aircraft moving objects in the airspace over Germany and adjacent areas, which are the basis of BIRDTAM-Warnings. Radar observations and meteorological data in high temporal and spatial resolution also provide an excellent data base for further improvements of the current operational Bird Strike Risk Forecast Model.

The observation, warning and forecasting System will be explained and examples of bird migration waves as well as evaluations and guidance for the Western Baltic will be presented.

Key words: radar, bird migration, bird strike warning, BIRDTAM, bird strike risk forecast

1. Introduction

The countries, surrounding the western Baltic, Denmark, Sweden and Germany are located below major palearctic flyways. Millions of birds pass the airspace of these countries and are concentrating over the Western Baltic. Many birds also find their roosting, wintering and breeding habitats on the sea and around the Baltic shores (DURINCK et al., 1994). Due to the high risk of bird strikes Denmark and Germany, both east and west, developed methods of bird strike prevention. Denmark installed an widely automated radar based observation and bird strike warning system, which is still in use. The Military Forces of the former German Democratic Republic lost several military planes and even pilots were killed. Due to the rich environment and high potential of bird strikes, especially in the northern half of the country, the Military Meteorological and Ornithological Service of the GDR developed a complex messaging system for bird observations. Daily ornithological reports and forecasts were given to the military headquarter and preventive actions were taken.

During the 1960th, when the Military Forces of the Federal Republic of Germany experienced several serious incidents and losses of military single engine aircraft due to bird strikes, the German Military Geophysical Office (GMGO), Predecessor Organisation of the Bundeswehr Geo Information Office (BGIO) was instructed to develop methods of bird strike prevention. In the consequence a System of bird observation, both visual and by radar, immediate reporting and warning as well as bird strike risk forecasting was initiated and implemented on a routine basis. Due to the long experience and following the principles of this well approved guidance strategy, the components of this system have continuously been improved and are still under development, as being shown in the presented case studies for the Western Baltic Region.

2. Characteristics of the Baltic Region

The Baltic sea, formed after the Ice Age approx. 10,000 years ago, is a non tidal sea, covering about 415,000 km². There is only a narrow and shallow in- and outlet to the Atlantic Ocean between Denmark and Sweden causing only little exchange of salt water from the Atlantic into deeper layers. Due to the major inflow of fresh water by large rivers the upper layer consists of brackish water of little salinity. Although the maximum depth is about 450 metres, the mean depth of the Baltic Sea is only approx. 55 metres and especially in Danish, German and Polish coastal waters only 5 to 10 metres, forming large lagoons.

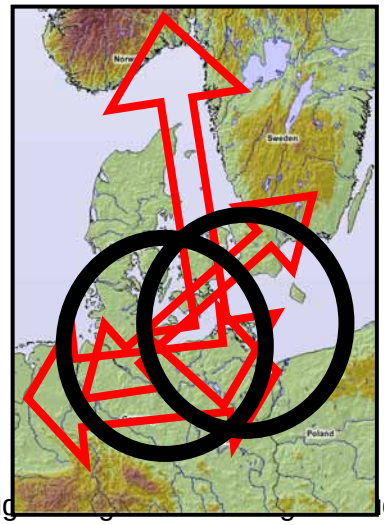

Figure 1. *The Western Baltic Region. Arrows mark main bird migration routes. Circles show the radar dection ranges of the radars at Rügen and near Fehmarn.*

Althoug des b western parts is relatively mild and humid. Eastern and northern parts however, are much more under continental influence and experience cold and severe winters with ice cover for 5

to 6 months. This results in a quite poor flora and fauna of the marine environment in latter parts, whereas in the Western Baltic the environment is much richer and are the wintering areas of many marine birds. Rich habitats, many ecological niches and good food sources provide very good breeding conditions for many bird species around the Baltic coasts (HEATH & EVANS, 2000).

The narrow straits of the Western Baltic Region are well known migration routes, like the so called “Vogelfluglinie” between north-eastern Germany via the Danish Isles and Sweden [*Figure 1*]. During Spring and Autumn millions of birds pass this area, using the coastal region and Islands as stepping stones. Some stay for a while in near coastal areas for feeding and recovering before passing the open sea (LOHMANN & RUTSCHKE, 1991). Large birds like cranes and geese are the most impressive species, but there are many more birds on migration which are usually not to be seen, because of their nocturnal migration behaviour and/or due to high altitude migration.

3. Bird observation and messaging

Because of the high risk of bird strikes during migration periods and the special risk in military low level aviation an efficient and immediate warning system needed to be installed. Historically the weather observation network has been the most reliable and closest to real time observation and messaging system. Therefore reporting has long ago been adapted to the World Meteorological Organisation (WMO) message standards. The synoptic weather observation network, consisting of approx. 150 stations in Germany are still part of the bird migration observation system. The observers are trained and assigned to monitor those migrating birds which are indicator species for widespread and dangerous to aircraft migration. They have to report from certain minimum flock sizes and certain flight altitudes on. Additionally the military flight safety ground control units, operating airport surveillance radars, are assigned to report bird migration activity, classified by the international 0 – 8 intensity scale and reported via Geo Information Units on the WMO-Network.

Meanwhile the former remote accessible system of automatic computer based video recordings at air defence radar systems has now been completely replaced by continuously digital recording of 3-dimensional radar plot data (RUHE, 1999). This system has now become the modern basis of the online observation and warning system. It consists of 17 air defence radars, covering Germany and adjacent areas. Filtered primary radar plot data that include moving targets, which are not aircraft (no response to the secondary radar) are stored in data files in 20 minutes intervals. These files are automatically called off and transmitted via modem link to the Bundeswehr Geo Information Office where they are automatically being displayed on a GIS platform and interpreted by experts [*Figure 2*].

The Western Baltic is primarily monitored by two radars of a new generation of phased array radars, which provide pencil beam technology with a high resolution of 3-dimensional detection [*Figure 1*]. One is located on Rügen Island and the other is located south of Fehmarn Island. Data are collected within a circular range of 100 nm and up to 15,000 ft msl. There is a wide overlap amongst the two radars. Together the two radars cover the area of North-eastern Germany and the Western Baltic, including the Danish Isles, Bornholm, the most southern part of Sweden and the very north-western part of Poland.

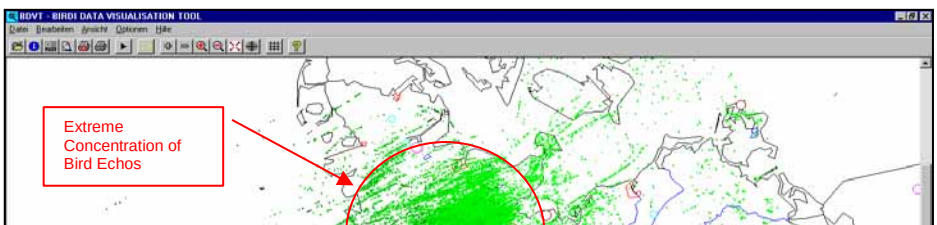

Figure 2. *Composite Radar echoes of eastward migrating birds in a 20min time interval.*

4. Bird strike warning

As the plot data are from different types of radars with inhomogeneous and flexible filter settings and as they are influenced by atmospheric disturbances, interpretation is done in the Bundeswehr Geo Information Office in Traben-Trarbach by experts, doing the intensity classification and identifying the relevant altitude range of bird migration (RUHE, 2001). Their expertise is finally transmitted into the computer system, dealing with the data processing of all bird observation messages. Incoming bird migration messages and radar data interpretation messages are automatically evaluated, processed and transmitted as bird strike warnings (BIRDTAM) and BIRDTAM-Situation-Updates. Foreign bird information from the neighbouring countries, e.g. Denmark and the Netherlands are also incorporated. BIRDTAM immediately cause flight restrictions to jet-aircraft training missions.

BIRDTAM are provided as soon as a critical intensity (Level 5) is observed for validity time ranges of 2 – 4 hours and in areas with fixed geographical grids of 1°Latitude X 1° Longitude elements. The upper altitude limit is set to approx. 2/3 of all echoes. The lower limit is generally at surface level. Danish BIRDTAM are submitted at a fixed schedule. The upper limit is always set to 4000 ft agl. There is no overlap between German and Danish BIRDTAM. The boundary is set to 55°N Latitude.

5. Bird strike risk forecasting

For planning and scheduling flight training and missions, every morning a Bird Strike Risk Forecast for a period of 24 hours and an additional outlook for the following 3 days (only Mondays and Thursdays) is evaluated and transmitted on the basis of ornithological conditions and meteorological forecasts. The forecast area is limited to Germany and adjacent coastal zones. The evaluation algorithm is based on a decision tree diagram which is worked through by the meteorologist in charge of the forecast office (RUHE, 2001). There are different algorithms for each season. The most important input is the current weather forecasts of wind direction and wind speed (surface and aloft), temperatures, temperature changes and weather phenomena for departure areas and passing zones of migration. During migrating seasons an update is evaluated around noon with the additional information of observed bird migration.

During autumn and winter migration the departure zone stretches from Southern Scandinavia across the Baltic Sea towards Poland. Highest migration intensities across the Western Baltic usually occur when there is a remarkable temperature drop and/or snowfall spreading southward. During Winter especially water birds and geese move west- to southwards when severe wintry conditions develop in the Scandinavian and/or Northern to Eastern Baltic, leading to extended ice cover in coastal areas, rivers and lakes. However these birds tend to move back when conditions improve again. In spring time west to south-westerly winds and a remarkable rise in temperature are favourable conditions. In summer there is little migration but quite a lot of bird activity near coastal zones and inland, especially when thermals develop during the day.

Using the specific ornithological knowledge, actual bird observations and current meteorological forecasts, it is possible to supply special guidance for special military needs on request, e.g. exercises. These guidance are worked out by the experts of the Biology Section of the Bundeswehr Geo Information Office. It may contain a present situation evaluation, a generally 24 hour forecast and an outlook for the coming days, besides an information about general aspects of bird strike danger in the region during the time period of interest.

6. Bird activity analysis

A comprehensive bird activity analysis is needed to get more precise guidance. There are numerous ornithological articles in literature with a lot of details on single aspects. Maps of important bird areas are available but not all of them are relevant in respect to enhanced bird strike risk. For the special needs on bird strike prevention guidance issues, a comprehensive study has to be undertaken. The goal is to set up an expert information system (RUHE, 2000), combining above outlined components and incorporating a sophisticated bird avoidance model.

There are now already enormous amounts of radar data and the number of data is continuously growing. The first attempt, that recently started, is to set up a computer data base, to get easy access to specific data and to standardise requests which are then automatically displayed as graphs or tables [*Figure 3*]. Detailed studies on the temporal and spatial distribution of bird activity can be extracted. For the western Baltic which is almost the most risky region of the German sphere, concerning bird strike incidents, a more than 2 year series on 3-D radar data exists. Quite simple, but very important, information is the annual and daily cycle of activities in specific areas. Comparisons of seasonal characteristics already reveal systematics which are in some cases strongly coupled with certain weather patterns.

Relevant meteorological data are archived automatically from numerical forecast models. Since several years. Selected meteorological parameters are stored continuously in 3-hours intervals on a 1°Lat.X1°Long grid over central Europe. Simple comparisons already demonstrate a close correlation of some parameter to bird activity.

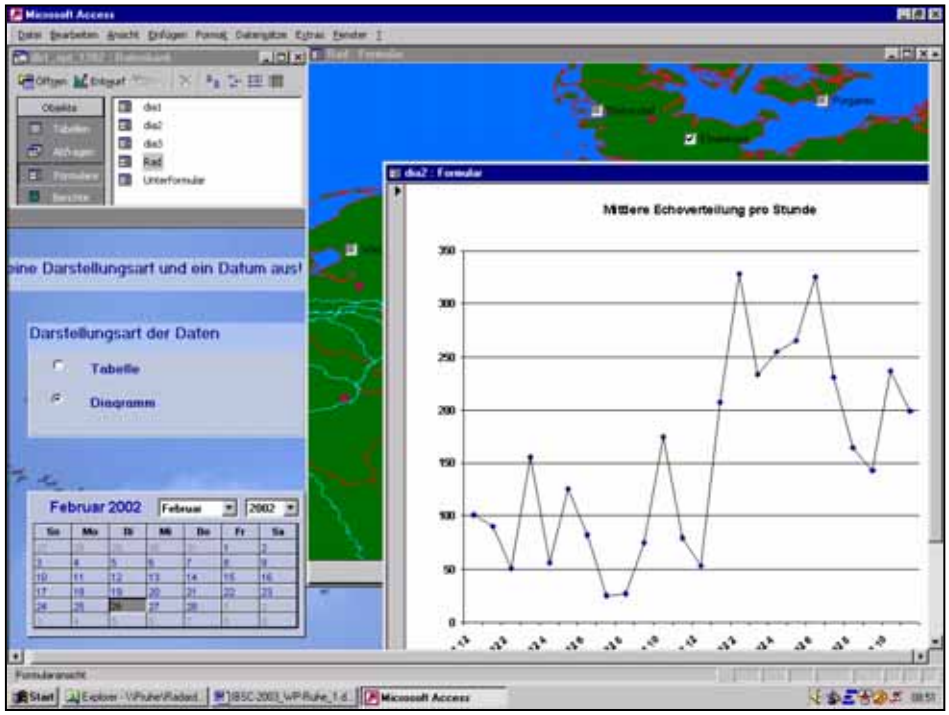

Figure 3. *Data base evaluation of a daily bird activity pattern in the range of a single radar station.*

7. Bird strike statistics

The efficiency of bird strike prevention actions is difficult to evaluate, as there is no possibility to show what could have happened without having taken these actions. Bird strike statistics is the only means to demonstrate that there is an advantage of special guidance. The Biology Section of the Bundeswehr Geo Information Office has been instructed by German Forces Authorities to present a detailed and scientifically based bird strike statistics report and a report on the effectiveness of bird strike prevention actions each year.

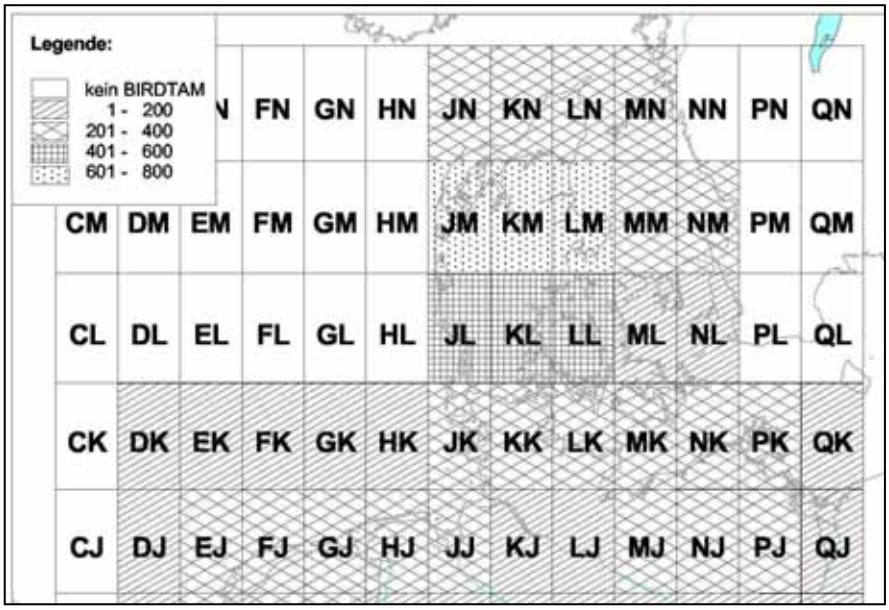

Figure 4. *BIRDTAM Statistics 2001. All Intensities. Displayed are categories of hours per year.*

Throughout recent years it reveals, that the number of bird strikes during flight phase is equal or even less in the Western Baltic than in more southern parts of the country, although there is a much higher risk in that area. The number of issued BIRDTAM, of course is higher in the Western Baltic than in inland areas. However, in comparison with Danish BIRDTAM there are less hours of active warnings within one year [*Figure 4*] . This also demonstrates that due to a better real time observation system, there are not necessarily more flight restriction hours. They are just more precise.

8. Conclusions

It is shown that recent developments towards a sophisticated real time bird observation warning and forecasting system have been quite successful already, although there is still a lot more to be done and to be improved.

Radar observations document the enormous numbers of migrating birds. They also reveal migrating routes, as well as there daily, seasonal and annual activity patterns. They are the most important data base for an expert information system.

The BIRDTAM-System is an effective tool for providing more biological flight safety. In case of the Western Baltic bird strikes have already been reduced as statistics proves.

Not to forget: The presentation of radar data very much supports to convince pilots and authorities to take the bird strike risk really seriously.

9. References

DURINCK, J. et al, 1994. Important Marine Areas for Wintering Birds in the Baltic Sea. Report to the European Commission EU DG XI Research Contract No. 2242/90-09-01, 110 pp. Ornis Consult, Copenhagen.

HEATH, M.F. & M.I. EVANS, 2000. Important Bird Areas in Europe: Priority Sites for Conservation. 1: Northern Europe. BirdLife International, BirdLife Conservation Series No. 8, Cambridge, UK.

LOHMANN, M. & E. RUTSCHKE, 1991. Vogelparadiese – Ost- und Mitteldeutschland. Band 3, Verlag Paul Parey, Berlin und Hamburg.

RUHE, W. 1999. The German Military Geophysical Service Bird Migration Observation, Warning and Forecasting System: New Developments towards an Automated Bird Migration Information System. Proceedings – Bird Strike '99, Vancouver, 219-224.

RUHE, W. 2000. AVIS – Entwicklung eines Automatisierten Vogelzug-Informationssystems. Vogel und Luftverkehr, 20/2, 69 - 73.

RUHE, W. 2001. Über den Stand der Radarornithologie und Vogelschlagwarnung in der Bundesrepublik Deutschland, 21/1, 5 - 11.

RUHE, W. 2001. Bird Strike Risk Forecasting – A Modelling Approach. Proceedings – Bird Strike 2001, Calgary, 68 - 72.