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CURRENT STATUS OF THE USAF BIRD AVOIDANCE MODEL (BAM)

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ABSTRACT

The Unites States Air Force (USAF) has been developing versions of a Bird Avoidance Model (BAM) through the efforts of the USAF Bird Aircraft Strike Hazard (BASH) Team since the early 1980's. It was recognized early in the developmental phases of the first models that avoiding birds on low-level routes and ranges was the only solution to the significant problem of bird strikes to these military operations nationwide. The early versions of BAM were limited in coverage, biological data, and resolution. With the advent of sophisticated Geographic Information System (GIS) technology and the enormous advances in computational capability, the modern versions of the USAF BAM have become increasingly robust and user friendly. The current version of BAM, released to the USAF in 1999, incorporates data layers from a very large number of sources to display risk surfaces at 1Km resolution for the entire continental United States for each two-week period of the year and four daily time periods. All available data on over 60 bird species considered most hazardous to flight operations, as well as hundreds of environmental variables, infrastructure, and aeronautical charts are incorporated into the model. The user interface is an extremely simple, menu-driven package that allows pilots and schedulers to assess hazards on chosen routes with minimal effort and in mere minutes. More sophisticated analyses, down to the level of the original data layers, are possible for other user groups. These applications are available on CD for the personal computer and over the internet, with both options fully interactively capable. Preliminary reports from the user community have indicated savings of several million dollars in USAF aircraft assets in just the first year of operation. Demand from the military community outside the continental US as well as the civil aviation community indicates a necessity for expansion of the BAM to other areas of the world and for continued refinement of data layers. It is apparent that international cooperation in the development of models will be necessary to ensure more global coverage and perhaps most importantly, compatibility of systems between cooperating nations. The USAF has demonstrated its willingness to

share its technology and experience to ensure such interoperability between cooperating agencies and nations.

Key Words: Avoidance (maps, preflight planning, warning systems), Detection (radar), Engineering (mathematical models), Hazard Management (forecasting, risk assessment).

Each year the United States Air Force (USAF) reports approximately 3,000 bird strikes to its aircraft. These incidents cost nearly $50 million on average. In the last fifteen years, the US Air Force has suffered the loss of 17 aircraft and 34 aircrew fatalities. The other services report higher strike rates per flying hour and suffer similar losses. Civilian aircraft are not immune to this problem, and US airlines report nearly $100 million in annual losses. Most bird strikes occur around airfields where habitat management, bird dispersal techniques, and active population control can be employed. For military aircraft however, the majority of catastrophic incidents occur on high-speed, low-level and range missions where bird control is not possible. The only alternative in these environments is to avoid known bird concentrations. This is where the Bird Avoidance Model (BAM) comes into play.

The USAF has been developing versions of the BAM through the efforts of the USAF Bird Aircraft Strike Hazard (BASH) Team since the early 1980's. It was recognized early in the developmental phases of these models that avoiding birds on low-level training routes and ranges was the best, and perhaps only solution for dealing with this significant hazard to military operations. The early versions of the BAM had limited geographic coverage, incomplete biological data, and crude resolution. Nevertheless, these early models provided measurable reduction in the hazard to flight operations. It was always recognized that more effort needed to be placed in refining and automating the models to further reduce the hazards. With the advent of sophisticated Geographic Information Systems (GIS) technology and the enormous advances in computational capability, the modern version of the USAF BAM has become increasingly robust and user friendly.

The current BAM, released to the USAF in 1999, is a GIS-based program using commercial software that integrates historical information on bird distributions and abundances with various geographic and environmental factors. Data were derived from numerous sources such as field surveys, satellite imagery, meteorological monitoring stations, and radar imagery. The model creates graphic risk surfaces for determining the relative degree of hazard for any location in the Continental US. Data on bird populations and movement patterns comes from numerous government and private sources and is the result of literally millions of hours of field work from biologists, refuge managers, amateur bird watchers, and volunteers. Thirty years of data from over ten thousand locations throughout the country are evaluated and used as the basis for the model. Standard inverse distance weighted interpolation algorithms fill in the gaps between the surveyed locations so that each square kilometer of the US has a unique risk value assigned. Total coverage of the US BAM is 7.7 million square kilometers.

The initial version of the model includes over 60 species considered most hazardous to flight operations. Large birds such as waterfowl and raptors, and flocking species such as blackbirds and gulls constitute the greatest threat. The basis of the bird species data rests on large, long-term, nationwide survey methodology. Namely, data from the annual Christmas Bird Counts conducted by the Audubon Society of the US and the Breeding Bird Surveys organized by the US Fish and Wildlife Service. These enormous data sets provide baseline distribution and abundance data for all species of interest in the model but are only available for two periods of the year. Migratory data were derived from numerous data sets including Hawk Migration Association of North America surveys, bird banding recoveries, and data from wildlife refuges throughout the country. Arrival and departure dates for migrant birds were mapped from thousands of locations and “contour” maps of arrivals and departures for given species created from these data. This established a chronology of bird movement patterns for the continent and formed the basis for a standard GIS time series analysis to predict the movement of birds between known wintering and breeding grounds. These data sets were calculated so that each period of the year and various daily time periods of activity were covered for the entire country.

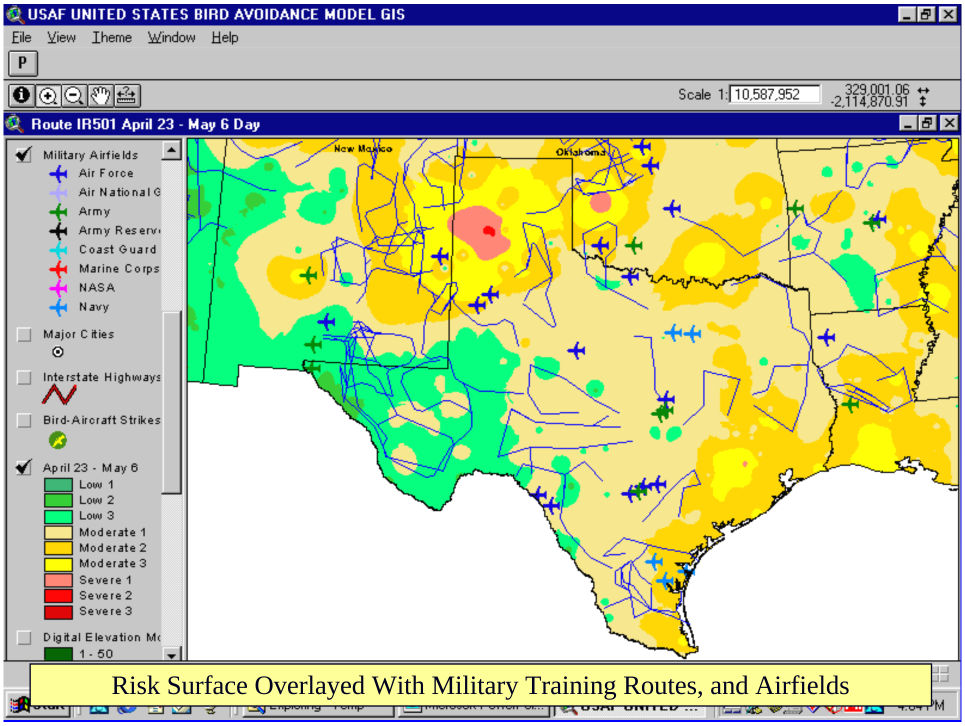
Risk surfaces were then generated using the available data and normalized by body weight for each species. The individual risk surfaces were then cumulatively added and a total risk calculated. Risk is depicted on a color-coded logarithmic scale as total mass of birds per volume of airspace. Data are available for each two-week interval of the year and for four daily time periods. A color-coded graphic display, in a GIS map format is available for each data layer and the scale of coverage can be selected by the user.

The user interface for the new BAM is an extremely simple, menu-driven, PC-based program that allows flight planners, route designers, aircrew, and environmental planners to select the geographic location, time of year, and time of day that they desire to fly a particular route. These queries can be accomplished with little effort and in mere minutes. Relative risks for each operation can be assessed by comparing routes to each other or by comparing various temporal alternatives on individual routes. Safest times and locations can then be selected by the user. The model also has numerous geographic and environmental data sets that can be overlaid on the bird risk surface. For example, the user can zoom in on a portion of the country, display the bird risk, and overlay roads, airports, aircraft operating areas, terrain maps, land uses, or a variety of climatic information such as temperature or precipitation on the computer display.

The model has been distributed by the Air Force Bird Aircraft Strike Hazard (BASH) Team to various users throughout the country. While the program and data needed to generate the Bird Avoidance Model require enormous amounts of computer space, the products of the model are available over the internet or alternatively on CD for the ultimate users. Full interactive capability is available through each avenue of access. Anyone with internet capability is able to access the model through various venues, with redundant sites available in the near future. There is also a much more sophisticated version of the BAM available for planning and research purposes or for those select users requiring more detailed analysis capabilities and breakdown of constituent data sets.

The new BAM provides a tremendous planning tool for the aviation community to reduce the incidence of bird strikes to aircraft. Organizations employing early versions of the model have reported reductions in their bird strike rates of as much as 70%. This equates to savings in the millions of dollars annually. The new model provides much more data and at a resolution orders of magnitude better than the previous models.

Our work is not done however. We need more field tests of the model, refinement of some of the data layers, expansion to areas outside the US, and ultimately provision of near-real time updates to the model using technologies such as doppler radars and satellite telemetry. The US Federal Aviation Administration is researching application of the current BAM for the US civilian flying community. Collaborations are also being explored to extend this technique to countries in Europe and the Middle East. The Department of Biology at the Air Force Academy, in collaboration with the USAF BASH Team and other agencies, may offer to continue such work as long as sponsoring agencies support these efforts with funding and other resources. Demand from the military community outside the continental US as well as the civil aviation community indicates a necessity for expansion of the BAM to other areas of the world and for continued refinement of data layers. It is apparent that international cooperation in the development of these models will be necessary to ensure more global coverage and perhaps more importantly, compatibility of systems between cooperating nations. We will continue to encourage agencies and nations to work together to assure such compatibility. Ultimately, we hope to make the skies a bit safer for those who share them with the birds.



Risk Surface Overlayed With Military Training Routes, and Airfields