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# Application of GIS Technologies to Wildlife Management at DFW Airport

Edwin E. Herricks
*Department of Civil and Environmental Engineering, University of Illinois*, herricks@illinois.edu

Jonathan R. B. Fisher
*Department of Civil and Environmental Engineering, University of Illinois*

Curt Kuehner
*Wildlife Management Officer, DFW Airport*

Michael J. Hovan
*Federal Aviation Administration Airport Technology Research and Development Branch*

### [1]Application of GIS Technologies to Wildlife Management at DFW Airport

Edwin E. Herricks[1], Jonathan R. B. Fisher[1], Curt Kuehner[2], Michel J.Hovan[3]

**Abstract**

As part of a continuing FAA research program in wildlife hazard assessment and management at airports, a GIS Technical Element – DFW was developed for the Wildlife Hazard Advisory System (WHAS). For the DFW GIS data layers were obtained from public sources and supplemented with airport specific information. Data themes were developed to support general analysis of wildlife habitat on the AOA and adjacent airport property, and analysis was extended to a distance of 25 miles from the airport to accommodate all aircraft in high risk airspace. Over 10,000 wildlife report records were integrated with data on birdstrikes and runway utilization. Species flight paths leading to runway conflicts were identified. AOA analyses were supplemented with regional habitat analysis and integrated with aircraft movement plots to identify potential hazards to aircraft safety. The GIS provided a foundation for the 2D and 3D visualization of wildlife hazards for DFW.

**Introduction**

Wildlife management is a complex undertaking, both ecologically and politically. In human-dominated landscapes, understanding and predicting the behavior and abundance of free-ranging wildlife species is further complicated by the dynamics of the interactions that are possible between wildlife and humans. This is particularly the case when considering remediation and management to prevent wildlife collisions with aircraft. As part of the FAA AAR 410 research program directed to wildlife management, the University of Illinois Center of Excellence in Airport Technology has been developing a systems-based approach to address the problems of wildlife at airports. The objective of the activities reported in this paper is to characterize the wildlife hazards to aircraft at Dallas/Fort Worth International Airport (DFW) using Geographic Information Systems (GIS) technology, and to use the techniques developed to improve wildlife management at the airport.

**GIS Data**

The first step in this project was assembling data from several sources to serve as a foundation for future analysis. This included a variety of GIS datasets, estimates of bird abundance, records of wildlife strikes and sightings at DFW airport, and a year-long survey of the wildlife present at DFW. Initial data collection included physical data such as topographic maps and aerial photographs. Additional data layers were developed

[1] Department of Civil and Environmental Engineering, University of Illinois
[2] Wildlife Management Officer, DFW Airport
[3] Federal Aviation Administration Airport Technology Research and Development Branch

using readily available information or airport specific data resources (see Tables 1 and 2 for a complete listing of data collected and their sources).

Table 1. List of GIS data layers collected from existing sources.

| Hazard Attribute GIS Data Layer Name | Source |
|---|---|
| Airport Buildings | DFW |
| AOA fence | DFW |
| City Boundaries | DFW |
| DFW grid system | DFW |
| Floodzones | DFW |
| Intermittent lakes | DFW |
| Land use | DFW |
| Landfills | DFW |
| Noise Countours | DFW |
| Roads | DFW |
| Aerial Photographs (DOQs) | TOP* |
| County Boundaries | TWDB** |
| Land cover | TX GAP |
| BAM hazard layers | USAF |
| Soils | USDA |
| Elevation | USGS |
| Permanent water bodies | USGS |
| Streams | USGS |
| Topographic maps (DRGs) | USGS |
| Waterways | USGS |
| NEXRAD radar locations | Dr. R. Larkin, UIUC |

*Texas Orthoimagery Program
**Texas Water Development Board

Table 2. List of GIS data layers created as part of this research.

| Hazard Attribute GIS Data Layer Name |
|---|
| FAA/DFW strike reports |
| DFW wildlife patrol reports |
| Wildlife remains reports |
| Bird Routes (estimated) |
| Estimated flight paths |
| Potential radar visibility areas |
| Potential volume scanned by radar |
| Ground photos of habitat |

It may be valuable to identify data resources that were particularly valuable in the DFW GIS, and that will also be useful in for GIS development at any airport in the United States.

***Gap Analysis Program*** - One of the most important types of data in the GIS was the land cover data. This data came from the U.S. Geological Survey Gap Analysis Program (GAP), a GIS based system that is designed identify gaps between land areas that are rich in biodiversity and areas that are managed for conservation (NGAP, 2002).

In Texas the land cover classification was completed at a one hectare resolution from satellite imagery, resulting in 100 meter by 100 meter pixels. The GAP data was modified for our analysis, and simplified for display purposes (Table 3).

**Table 3.** Comparison of land cover designations used by GAP to the ones used in generating the autecology matrix and the ones used for display purposes.

| GAP Classification | MatrixClass | DisplayClass |
|---|---|---|
| Rounded-Crowned Temperate or Subpolar Needle-Leaved Evergreen Forest | Evergreen Forest | Evergreen Forest |
| Temperate Broad-Leaved Evergreen Woodland | Evergreen Woodland | Evergreen Woodland |
| Round-Crowned Temperate or Subpolar Needle-Leaved Evergreen Woodland | Evergreen Woodland | Evergreen Woodland |
| Cold-Deciduous Woodland | Deciduous Woodland | Deciduous Woodland |
| Temporarily Flooded Cold-Deciduous Woodland | Deciduous Woodland | Deciduous Woodland |
| Lowland Mixed Evergreen - Drought Deciduous Shrubland | Shrubland (dry/very dry) | Shrubland |
| Medium-Tall Bunch Temperate or Subpolar Grassland | Prairie (wet) | Grassland |
| Short Sod Temperate or Subpolar Grassland | Prairie (dry) | Grassland |
| Cropland (irrigated, row, etc.) | Agricultural Fields | Cropland |
| Water | Lakes/Ponds | Water |
| Urban Area | Urban Areas | Urban Area |

***Local Land Use Assessment* -** The GAP data is ideal for examining large-scale land cover and habitat patterns, since the data exists for the entire state. However, it is not as useful when applied at a smaller scale, such as the airport area. It was desirable to have a more accurate land cover layer for the airport itself to aid in the analysis. To facilitate the creation of such a layer a ground-based survey of the airport was performed in July of 2002 as part of this project. At each point, a GPS reading and digital photographs were taken, and notes were recorded about the habitat type and vegetation. The GPS locations and digital photos were incorporated into the GIS to make it easier to compare the aerial photographs with the close-ups on the ground. A revised DFW habitat layer will be developed using a combination of high-resolution aerial photographs, soil data, and ground-based photographs.

***Bird Avoidance Model* -** Another useful GIS layer is the Bird Avoidance Model (BAM) (USAF, in press). Like GAP, the BAM is GIS based and large scale. The BAM is useful in providing a context for more detailed analysis, or for examining the wildlife hazard for domestic flights.

***Wildlife Data* -** Three sources of data on abundance are described: the Christmas Bird Count, *The Birds of North Central Texas* (Pulich, 1988), and wildlife data collected at DFW. For this research, the main source of abundance data was the Christmas Bird Count (CBC). CBC sites are available for Dallas, Fort Worth, and Lewisville, and the site at Village Creek Drying Beds is close to DFW. When CBC data for unidentified birds was used, counts distributed the unidentified birds among the identified species in the same proportion as reported data. For example, 11.2% of the gulls identified to species were Bonaparte's gulls, so 11.2% of the unidentified "gull species" were counted as Bonaparte's gulls. The third source of information on bird abundance is The Bird Life of North Central Texas (Pulich, 1988). This book provides qualitative descriptions of abundance (abundant, common, fairly common, uncommon, rare, casual, and accidental), which could be used to verify data from the CBC and breeding bird survey. The GIS also utilized wildlife data from DFW and the FAA. An integrated data set was strike data; there were a total of 1,318 strike records at DFW from November 1987 to July 2002.

Wildlife data collected by DFW personnel or contractors was also incorporated into the GIS. Although wildlife patrol reports are intended as a description of the daily wildlife management activities rather than an unbiased sampling of the wildlife population, a total of 10,286 reports were available from January 1999 to December 2001. Because of data inconsistencies or other problems with individual records, only 6,883 of the wildlife patrol report records were actually analyzed in the GIS. The third source of wildlife data was quarterly survey reporting for December 1997 to November 1998 reported by Geomarine, Inc., yielding 1,300 records. This survey provided an accurate accounting of the wildlife on the airport property by trained biologists.

**Other GIS Resources**

In addition to the GIS information developed from national sources, or developed from airport wildlife management efforts, the DFW GIS benefited from other GIS efforts at DFW. These other efforts included a GIS framework for all airport infrastructure, and GIS support for contracting at the airport. It was possible using these GIS resources to develop data themes that incorporate built environment with more natural land use elements. In addition, the WHAS GIS technical element was designed to integrate with the DFW system.

**GIS Utility in Wildlife Management**

A direct assessment of wildlife collision hazard is possible when strike locations are identified and relative strike numbers evaluated. The DFW airport utilizes a grid system as part of their internal GIS, Figure 1. The 1,000 x 1,000 ft grid sections are further subdivided into 16 subgrids, providing a fine scale resolution of 250 ft x 250 ft. Only 115 of the 1,318 strike records have grid locations, allowing development of a strike/location surface, Figure 2. The peak on the NW side of the airport is predominantly pigeons and blackbirds (this may have to do with routes that these birds use to move about the airport) with a second peak on the NE side of the airport, which are mostly hawk strikes. This section of the airport has a large expanse of open grassland, which may attract hawks because of the food resources there. A third peak occurs near the north end of runway 17L/35R, which is adjacent to a wetland. The majority of strike reports did not have specific locations, so all strikes were analyzed by runway. There

Figure 1. DFW Airport with grid overlay

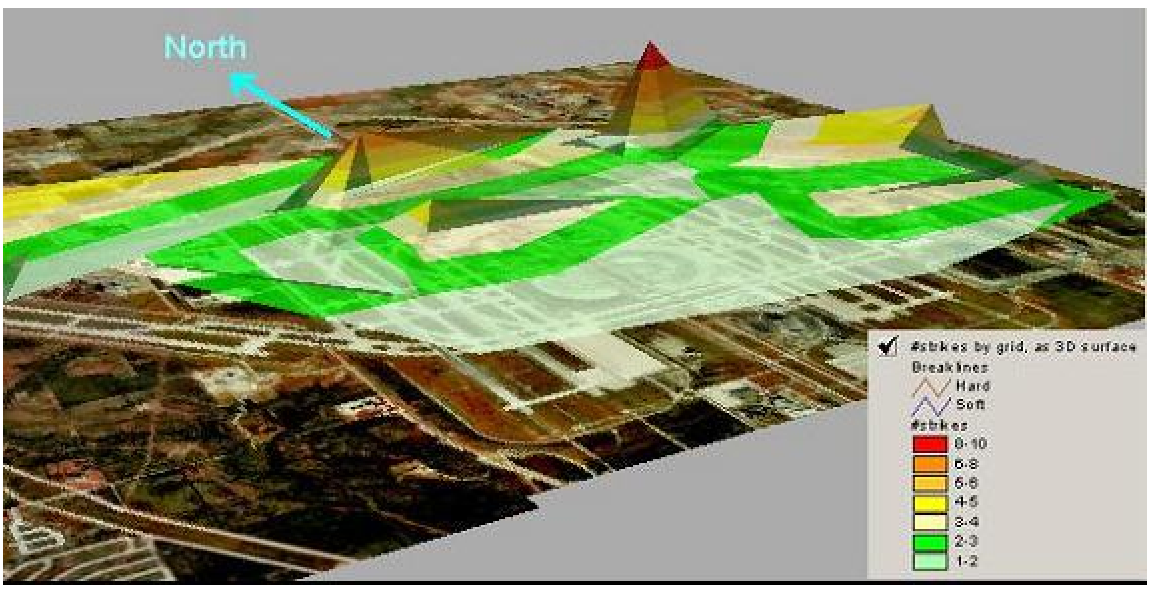


Figure 2. Number of bird strikes per grid, interpolated into a "hazard surface" and viewed from an angle.

were clear differences when runways were compared. Runway 17L/35R had the most


strikes while 13L/31R had the least. Analysis of only absolute numbers can be misleading. For example, it is possible to relate strikes to runway utilization Figures 3 and 4 show the distribution of strikes by runway for north and south flow. In these figures the runway

Figure 3. Strikes by runway during north flow at DFW airport.


Figure 4. Strikes per runway during south flow at DFW airport.

with the fewest strikes during north flow (13R/31L) had the most strikes during south flow. Furthermore, the south flow had far more strikes overall, reflective of the fact that airport operates in south flow three times as much as north flow (DFW International Airport, 1996).

By analyzing the strikes seasonally and by month, the importance of examining changes in the wildlife hazard over time becomes apparent. The pattern is for strikes to peak in May with spring migration (to 112), lessen somewhat during summer, peak again in October during fall migration (to a high of 143), and lessen considerably during winter (to a low of 42 in January). As with the different traffic patterns, certain runways fluctuate between being relatively safe and relatively hazardous from month to month.

It has been assumed thus far that bird abundance is strongly related to the risk of a strike. To verify this assumption, the most commonly struck birds were compared to the most commonly observed birds (from the wildlife patrol reports). The four most common birds are also the most commonly struck, which makes it reasonable to assume that analysis of wildlife patrol reports will be applicable to the strike hazard. Additional insight into wildlife management is obtained from the wildlife reports. Wildlife patrol records for the airport were examined by grid. Two locations with highest report totals were Trigg Lake and the wetland near runway 17L/35R runway. Both of these locations are known to attract wildlife, which may also lead to increased observation. Examining the total number of birds observed found Trigg Lake with 116,482 while grid location Z-16 had 44,260 birds sighted, which is more than the 17L/35R wetland. When the wildlife patrol data is analyzed by species, it is possible to build a record of bird movement on, and around the airport, Figure 5. Based on Mr. Kuehner's observations routes were drawn for several species or groups. When observed routes are superimposed with wildlife patrol data, a good match was obtained for certain species.

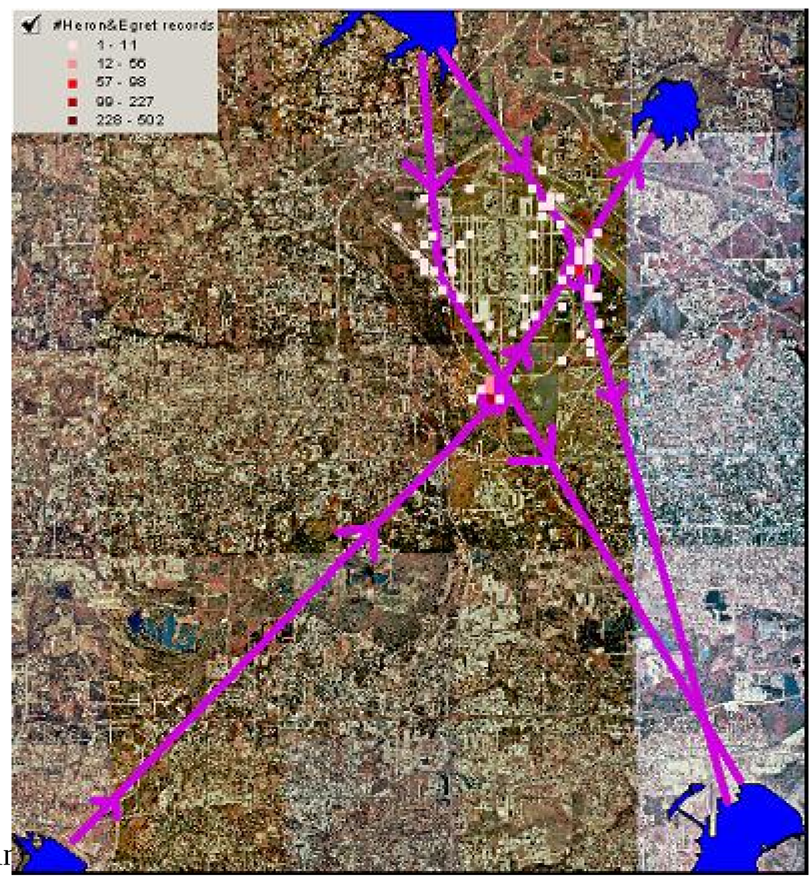

Figure 5. Proposed Egret flight paths and records from wildlife reporting.

We have also been able to use the GIS to provide assistance with the identification of aircraft hazards some distance from the airport operations area. We have developed an autecology matrix, simply a table of bird/habitat relationships, developed from literature information or local observations. It is possible, using the GAP land use information to identify locations where habitats preferred by a species coincide with aircraft movement corridors, Figure 6. Although the airport does not have direct control over high hazard areas identified, it is possible using the GIS to better identify locations of high hazard near the airport and use that information to improve coordination with local agencies to improve airspace safety.

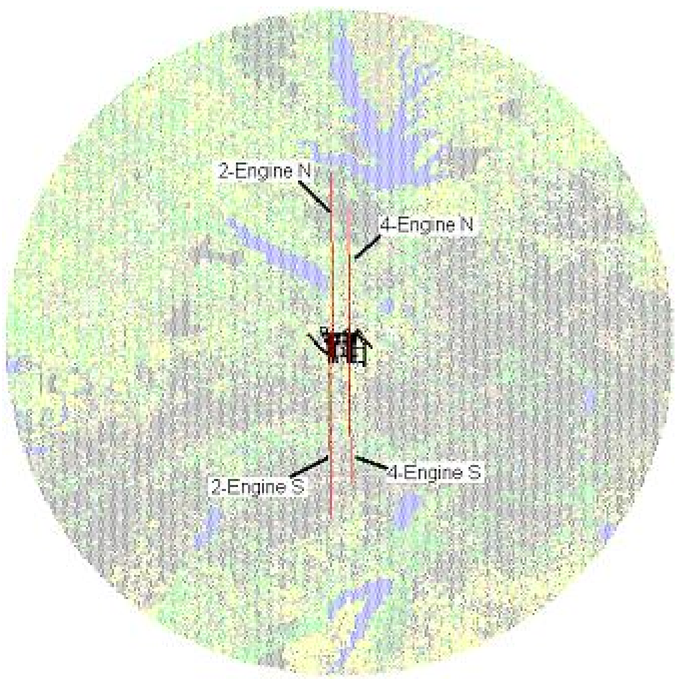


Figure 6. Four typical flight paths at DFW, and their location relative to the airport.

**Conclusions**

The development of the GIS technical element was intended to meet several objectives. One objective was to assist in spatial analysis of wildlife management on and near the airport, and supplement AOA management with a regional systems perspective. A second objective was to provide a platform that would accommodate commonly collected wildlife data from ongoing wildlife management programs. A final objective was to develop methods to help wildlife management personnel, airport management, and the public better visualize the airport environment, and the issues associated with the dynamics of management problems that must consider both wildlife and aircraft movement.

The GIS provided an ideal tool to assist in the management of wildlife on and near the airport. We have found that connecting recorded data with observational experience and literature information, in a spatial context, produces a much better sense of wildlife dynamics. The GIS also supported analysis of the "external" influences on AOA wildlife management problems by providing the platform to relate regional habitat to airport problems. The GIS provided a good tool to consolidate data of various types, including data on wildlife and airport infrastructure. The flexibility of the GIS platform to spatially define data sets, and provide rapid access to baseline information provided a useful tool in mining information from existing data. The GIS also provided options for a variety of data display opportunities, in both two and three dimensions. Three dimensional analysis is particularly useful in this airport management setting that is fundamentally three dimensional. The GIS also provided an ideal tool to better visualize wildlife management issues on, and near, the airport. Two and three dimensional displays, and the capacity to change perspective or analyze detailed data from an identified location, have been shown to be particularly valuable.

The nature of the DFW GIS is evolving. The development of the prototype GIS for DFW was intended as a first step in exploring the utility of GIS technologies in wildlife management. The GIS platform is simply a tool, a tool that can be modified and improved to deal with new information or new analysis needs. We hope that the prototype will now be used in day to day wildlife management, providing an opportunity to evaluate utility and identify needed improvements.

The development of the DFW GIS technical element has demonstrated the utility of a fully developed GIS in support of airport wildlife management. We recognize that other GIS implementation strategies are possible. For example, a basis for DFW GIS implementation was utilization of readily available federal and state GIS information. We are working on a GIS capability for all airports that could be provided at low cost, using existing GIS data. We are also using GIS resources to support real time assessment of wildlife hazards using radar. The GIS provides a resource that assists in guiding radar location and scanning, and a platform for analysis of the extensive data sets produced by radar systems. Finally, the GIS is providing a means of integrating data in support of advanced modeling to better support predictive capacity in wildlife management programs.

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## Acknowledgements

For more information on bird strikes visit
http://www.birdstrikecanada.com/ and http://wildlifedamage.unl.edu

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