THE DEVELOPMENT OF A GLOBAL DATABASE ON BIRD MOVEMENTS AND BIRD STRIKES IN MILITARY AND CIVILIAN FLIGHT

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Abstract

In order to serve the flight safety community and mufti-disciplinary research projects a global database on bird movements and bird strikes in military and civilian flight is being developed at the International Center for the Study of Migration at Latrun. The information system will include biological and statistical data from various sources that have been collected through the years such as satellite telemetry, ground surveys, motorized glider flights, bird ringing data, radar tracking data, meteorological and climatic data as well as civilian and military bird strike data from around the world. The information system will be used to evaluate the rate and cost of global bird strikes and develop a GIS (Geographic Information System)-based regional model of bird movement. The principal behind the system is that of data sharing, those parties providing data will have access to the system for their particular needs. EMC [2], the leading developers of data storage systems and Lockheed Martin, are cooperating in this project. The potential of benefits of the information system are immense. The system can be used to promote awareness of reporting and documentation of bird strike data through the Internet, get more organizations to publicize their data, help implement the research conclusions in safety work groups and promote cooperation on a global scale.

Keywords

Military aviation, civilian aviation, birdstrikes, database, mishap investigation. GIS

Introduction

Civil and military air traffic have increased significantly during the last decades. Military aircraft now fly at low altitude and high velocities during day and night, using fire zones in several countries. The rate of civilian air movements has increased significantly during the last decade. In addition, the cost of commercial and military aircraft has increased two fold during the last decades. Due to these reasons, the potential for damage caused by birds has increased dramatically. A preliminary evaluation of the cost of damage to aircraft was presented at the 23rd IBSC meeting (Leshem 1996). It was estimated that only 15-30% of the actual damage to civilian and military aircraft is reported.

A European database of military bird strikes has been established in the Royal Netherlands Air Force (RNLAF) (Buurma & Dekker 1996). By now, the database contains information on about 30.000 bird strikes from 13 air forces covering a period of 5 to 19 years. The Israeli Air Force (IAF) suffered 3092 air collisions with birds in the last 25 years, an average of 258 birdstrikes per year, losing 8 aircraft and three pilots were killed. Between 1989-1993 US Air Force (USAF) suffered 13,427 collisions with birds/animals - an annual average of 2,658 collisions, losing approximately three aircraft every year due to bird strikes. Sixty percent of the collisions occurred during the five months of migration, with damage ranging from 50-80 million dollars a year. It is estimated that the Navy and the Coast Guard suffer similar levels of damage due to bird strikes.

In many air forces the data is still not collected and analyzed systematically and many others are withholding publication of the data because of security regulations. For these reasons, it is almost impossible to get an accurate global picture of the rate and number of bird collisions in military flights.

A quick scan through the literature reveals that the situation in civil aviation is similar to military flights (Thorpe 1994, Dolbeer *et.al.* 1995) and only about 20-30% are reported.

In the last three years, three four engine aircraft were destroyed by birds: On September 5. 1995, a Boeing E3A AWACS hit a flock Canadian geese in Elmendorf, Alaska, killing 24 people and destroying the aircraft. On July 14, 1996, another AWACS collided with birds, at Aktion. Greece, and was totally destroyed. On July 15. 1996, a Belgian C-130 Hercules collided with a flock of Starlings, at Eindhoven, Netherlands, killing 35 people.

In an effort to evaluate the rate and cost of global bird strikes and develop a GIS (Geographic Information System)-based regional model of bird migration, we are developing a global database on bird movements and bird strikes in military and civilian flight at the International Center for the Study of Migration at Latrun.

Research Objectives

1. To develop a multi-disciplinary information system of bird movements on a global scale for biological research.
2. To develop a GIS-based model of soaring bird migration for Europe and the Middle East, incorporating historic bird movement and meteorological data in order to enable the prediction of future bird movements.
3. To develop a Global Birdstrike database of military and civilian flight.
4. To process and analyze the data on a global scale.
5. To evaluate the direct and indirect damage to military and civilian flight.
6. To promote awareness of reporting and documentation of bird strike data by using Internet and other tools that will make the information easy to access (see Transport Canada's website as an example: www.tc.gc.cai aviation/ aerodrme/ birdstke/ main.htm).
7. To help implement the research conclusions in safety work groups and promote cooperation on a global scale.

Methods of Database Development

In order to serve a muiti-disciplinary research and flight safety community and fulfill the above objectives, an Ornitholooical Information System is being established at the International Center for the Study of Migration at Latrun (figure 1). This information System will consist of biological and statistical data from various sources that have been collected through the years. Biological data sources include satellite telemetry, ground surveys, motorized glider flights, bird ringing data, radar tracking data, meteorological and climatic data and more.

EMC²

The Enterprise Storage Company

Figure 1: Flow Chart For Proposed Global Bird Movement and Bird Strike Database

International Center for the Study of Bird Migration at Latrun

* Use of several of the data sources must first be authorized by the respective organizations/researchers*

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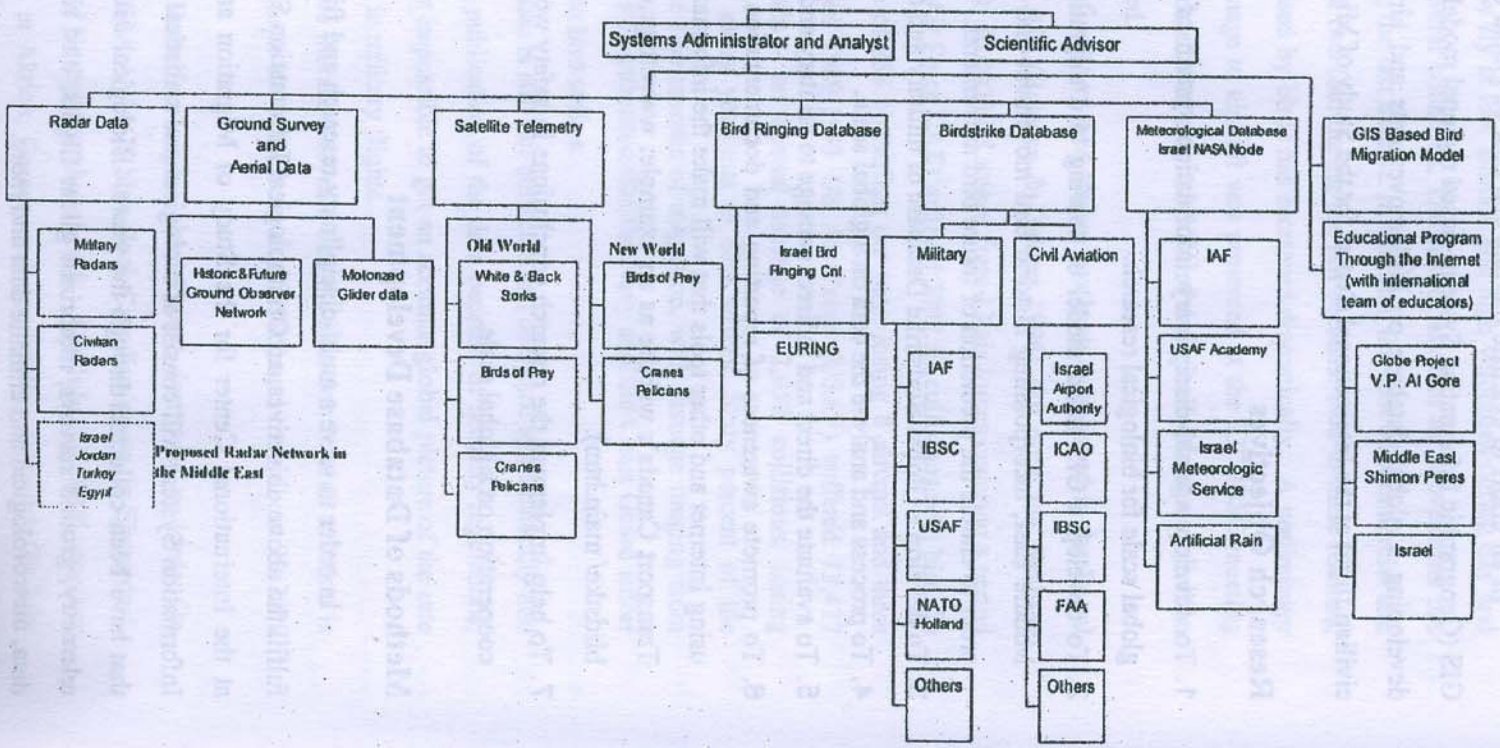


Presently, the migratory bird movement model for autumn and spring migration in Israel and the Middle East is being developed using GIS as the key tool for analysis, integration and geospatial display of historic biological, climatic, meteorological and topographic data to create an empirical model which will be expanded to Europe in the future. Nesting and wintering grounds will be modeled in the second stage. Weather plays a major role in the spatial and temporal dynamics of bird movements and understanding these factors are essential for designing a strong predictive model. Therefore, the interaction between climatic variables and soaring birds migrating over Israel will be studied on a local scale as well as the interaction between meteorological events and the timing of bird migration on a larger/global scale. This model is being developed in cooperation with the USAF Academy, Colorado Springs, USA and can be used to improve flight safety in the region and serve as a template for other regions around the world.

Presently, the birdstrike and biological data on bird movements are collected locally by hundreds of governmental bodies, air forces, academic and non governmental organizations. Some efforts have already been made to accumulate data on a broader scale such as IBIS by ICAO (Pinos 1996) for civilian flight and the RNLAF for military flight (Buurma & Dekker 1996). Unfortunately, the global picture is still only partial. The importance of integrating local databases into a global information system is essential since a large proportion of bird strikes with airlines occur out of national borders.
The development of a global database of bird movements and bird strikes may seem ambitious and unattainable. The development of such an information system is dependent upon the fulfillment of several basic requirements:

1. Data storage reaching a level of terabytes (1000 Megabytes and above).
2. Simple and efficient system for data transfer.
3. Architectural design for fast and efficient access of data for all end-users.
4. Free access for all participating parties to the global database.
5. Relatively easy integration of data from various sources and resolutions while maintaining data integrity.

When assessing the computer technology available today, one of the best solutions for such data transfer is the Internet, with one condition, a leading computer company that can lead the development and maintenance of such a large database.

EMC^2, the storage enterprise architects based in Hopkinton, Massachusetts USA, developed the revolutionary Integrated Cached Disk Array (ICDA) the basis of the Symmetrix family of products, is designed to provide rapid delivery of enterprise storage and data retrieval solutions. EMC^2 provides data storage solutions for mainframes as well UNIX-based and PC platforms. Within a few years EMC^2 has become the number one supplier of large storage systems and tripled their level of sales in 1996 compared to 1993 ($2.3 billion). The third author, Vice President for research of EMC ^{2,} who lead the revolution in data storage development, has volunteered to lead the development of the information system described, through EMC^2. On the first stage, EMC^2 is funding several research students, a data systems developer, and has provided EMC^2's facilities and experience for the establishment of the global database. Lockheed Martin has also joined EMC^2's initiative. The Chairman of the Board. Mr. Norman Augustine, visited Latrun in 1997 and was impressed by the educational potential of the project and the importance to flight safety. Lockheed Martin, one of the leading companies in military and civilian aeronautics, space, radars and high-tech development, found this multi-disciplinary project based in Latrun, extremely important and donated $350,000 for the project.

Future Benefits of the System

As this system is only in its second year of development, we would like to describe only a few of the possible benefits of the system. It is more then likely that trends not seen on a local scale in bird movements and flight safety will by elucidated through global analysis. In this paper, we will only refer to those benefits directly related to flight safety and not to the biological implications.

1. The global database will provide an essential tool for air collision investigations on a local scale by comparing local and global data.

2. Developing a global system will increase cooperation with other civilian and military aviation organizations that until now have not published data especially third world countries. For example, during Leshem's visit to Ethiopia in January 1998, as the guest of the Ethiopian Air Force Commander, it became evident that the Ethiopian Air Force has not developed a bird strike database. Following the visit, the Ethiopian military and civilian flight authorities decided to establish a national database and join the global database. Many air forces are reluctant to publish their bird strike data or are not collecting them systematically. We have no doubt that a global project will encourage many countries to join or at least establish their own database.
3. To develop a global collection of accompanying relevant data through the Internet such as photographs of bird strike damage, documentary and educational videos, bird remains identification systems and air collision investigation reports.
4. To develop strategies for safer flight planning. In the following section we will describe a cooperative pilot project with El Al Airlines (the national carrier of Israel) showing the potential of global data analysis.

El Al Pilot Study

Approximately, 50 percent of El Al's bird strikes occur in Ben Gurion International Airport and 50% in 40 international airports around the world. We plan to analyze the rate of daily and seasonal bird strikes at each of the 40 airports El Al flies to, with the intention of changing El Al's flight scheduling to reduce the risk and cost of bird strikes during take-off and landing. Once solid data is accumulated and significant results obtained, El Al aims to initially change the time table of cargo flights, as that of passenger flights is very rigid. Four data sources have been chosen at random in order to demonstrate the potential for changing flight schedules (figure 2). The line across the four graphs shows the recommended time for El Al cargo landing and takeoff in order to reduce the risk of bird strikes. This minimum cutoff for takeoff and landing was chosen arbitrarily. This is a pilot example, before changing flight schedules, the **data should be analyzed according to the flight rate**. The results can be implemented by other airline companies as well.

Figure 2: Number of bird strikes per hour of dav for two countries and two airports. The data provided is number of bird strikes and **not according to flight rate.**

Figure 2a: All Japanese airports. 1996 (n=318)

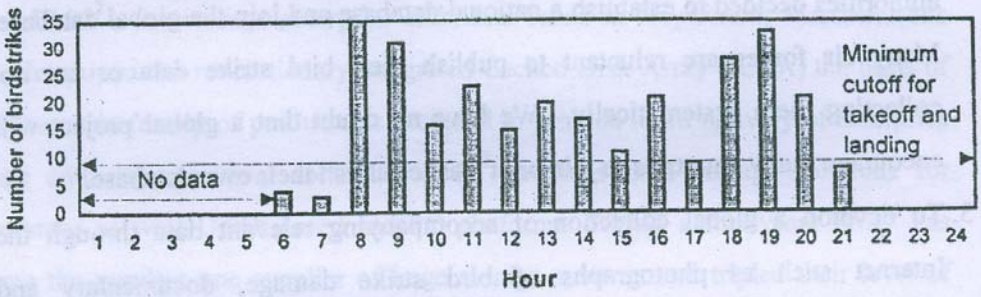


Figure 2b: All Canada airports. 1997 (n=715)

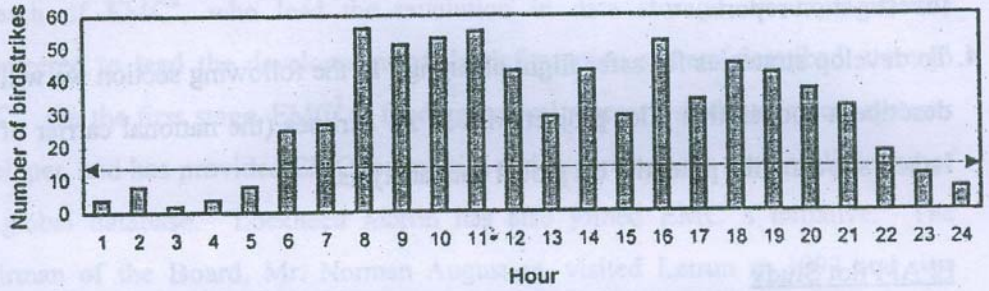


Figure 2c: Ben Gurion International Airport. Israel . 1987-1997 (n=239)

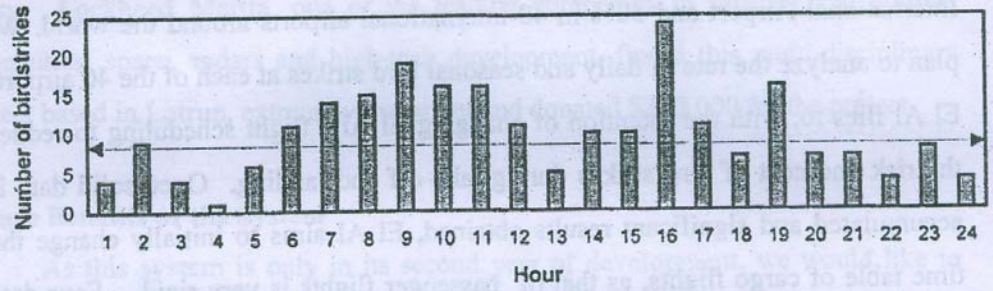
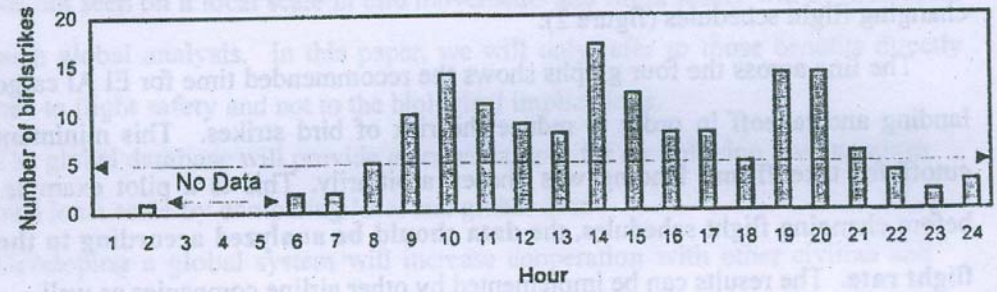


Figure 2d: Schiphol International Airport. the Netherlands. 1997 (n=155)



5. A global database providing easy access for researchers and flight safety administrators will significantly improve the connection and collaboration between both communities.
6. The global database will be most beneficial to organizations that are not directly associated with research and flight safety, such as: educational programs - children can use data for school projects, tourism - when and where to see birds, general public - raising awareness and understanding of these issues.

Issues to be discussed

1. IBSC as a leading organization of the project.
2. Methods of encouraging civilian and military organizations to cooperate.
3. Establishing a committee of experts to supervise the project.

This project is initiated by the International Center for the Study of Bird Migration at Latrun, Tel Aviv University and The Society for the Protection of Nature in Israel, sponsored and technically advised by $EMC^{2.}$

Two Ph.D. students are leading the project from two separate aspects. Sharnoun-Baranes is developing the biological database and Tamir is developing the binlstrike database. Yom-Tav and Leshem are the scientific supervisors. Mr. Shimon Peres, the former Prime Minister of Israeli has agreed to be the chairman of the Middle East project and has approached US Vice President Al Gore to preside as the global chairman. The project is open for anyone who is interested in joining and actively participating, providing their own experience and data.

Acknowledgments

We would like to express our special gratitude to the third author. Vice President of EMC^2, for his motivation, vision for the future and his support of this project from the first stages, as well as to Nadav Kedern and Dr. Yoav Raz from EMC^2. To Mr. Norman R. Augustine, the Chairman of the Board of Lockheed Martin, for his assistance and generosity and to Brig. Gen. (ret.) Joshua Shani, President of Lockheed Martin - Israel, for his personal enthusiasm and involvement. To El-Al Airlines for their cooperation, especially Capt. Eelan Hight. To the IAF pilots and officers involved in the flight safety issues. To Tel Aviv University and the Society for the Protection of Nature. To Dr. Ronen Kadmon, Hebrew University and Prof. Pinhas Alpert, Tel Aviv University. To the Israel Airport Authority for their cooperation, especially Yair Ganot, Uri Or-Lev, Haim Levi and Jerry Yashon. Last but not least to Maj. Gen. (Ret.) Musa Peled C.O.B. of the Armor Memorial at Latrun, to Brig. Gen. (Ret.) Menashe Inbar and David Gal'am, who decided to develop with us the unique combination of the heritage of the past with the high-tech of the future.

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November 11, 1995: An American Airlines DC-10 collided with a flock of gulls while taking off at JFK. The aircraft was destroyed. 139 passengers were rescued.

September 15, 1988: The remains of a Boeing 737 that collided with a flock of speckled pigeons during take off at Bhardar, Ethiopia. Out of 105 passengers and crew members, 35 people were killed, 21 were badly wounded and the rest were injured.

July 14, 1996: E3A AWACS collided with birds while taking off at Aktion, Greece and was totally destroyed.

September 5, 1996: Remains of a Boeing E3A AWACS that hit 12 Canadian Geese in Elmendorf, Alaska, killing 24 people.

September 25, 1997: Mr. Shimon Peres, former Prime Minister of Israel, meeting with Vice President of EMC², Mr. Moshe Yanai and his team and Dr. Leshem. Mr. Peres accepted the invitation to act as honorable chairman of the project in the Middle East.

July 15, 1996: Remains of a Belgian C-130 Hercules that collided with a flock of starlings at Eindhoven, The Netherlands, killing 35 people and wounding 6.

November 6, 1997: At the International Center for the Study of Bird Migration, Armor Memorial, Latrun: In the center, Mr. Norman R. Augustine, Chairman of the Board, Lockheed Martin, left Maj. Gen. (ret.) Musa Peled, C.O.B. Armored Memorial, right (near stork) Prof. Dan Amir, Pro-Rector, Tel Aviv University.