A Visual Analysis of the FAA Wildlife Strike Database and Migration Patterns of Birds in the Eastern Region

John Lancaster, Brian Corl, Joe Lewis, and Maria Valencia-Devin

Abstract - This project looks at the FAA Wildlife Strike Database and its relationship with migratory patterns of various bird species. A variety of angles are analyzed such as the significance of where Gull strike occur, the location of the Eastern regions busiest airports and their relation to strikes, the top bird strikes in each state, and the pattern of strikes for certain birds over multiple years. Using tools such as ManyEyes and Processing to help with the analysis there are some conclusions reached that show there are patterns that the FAA may want to study.

Index Terms - FAA, Processing, ManyEyes, Information Visualization, Bird Migration, Bird Strikes, Eastern Region, Airports, and Aircraft.

---

1. Introduction

The problem of wildlife, specifically birds, striking aircraft has been an issue in commercial airline industry for a long time. The results of these strikes are currently about $500 million dollars in damage each year and cause aircraft to be out of service for about 500,000 hours [2]. According to George, the amount of bird strikes is on the rise which should cause major concern for the industry not just for the downtime and monetary losses but for the potential safety concerns it raises for pilots and their passengers [2].

The objective of this paper is to observe and evaluate statistics of bird strikes and migratory patterns of some birds using visualizations techniques. Through this analysis it is hoped that some insight to the major causes of these bird strikes may be discovered to begin to understand what can be done to avoid them and share the sky more cohesively.

1. 1 Species and Region of Study

This analysis will specifically look at the Eastern region of the continental United States and focus on the major airports contained therein. It will also concentrate on the birds that are recording the majority of the strikes and their migratory patterns.

The following are the bird species of focus:

- Gulls
- Mourning Dove
- American Kestrel
- Killdeer
- European Starling
- Sparrows
- Horned Lark
- Rock Pigeon
- Barn Swallow
- Red-tailed Hawk

1.2 Perspective of Analysis

There will be multiple approaches of how the data is analyzed. By looking at visualizations of different data it is hoped that some correlation may be discovered. The following perspectives will be explored:

- An analysis between two major migratory locations of Gulls and the amount of strikes during the period of one year.
- The location of the Eastern regions busiest airports and the differentiation in the amount of bird strikes.
- An analysis of the top bird struck by state in the Eastern region.
- An analysis of the top birds struck per year over multiple years.

2. Tools

2.1 Processing

Processing is an open source programming language tool used to create visualizations. Using Java, applications can be created to display many kinds of visuals from color scales to animation. Initially, Processing was created to assist the learning of programming through visual means but for the purpose

of this class and our assignment; it can be leveraged to create a visual to depict the information we have concluded in our studies.

2.2 IBM ManyEyes

ManyEyes is an open experiment for anyone to participate in. Using existing data sets or by importing your own, one can create various information visuals to share online. We will import our data collected from the FAA Bird Strike data, specifically highlight the top birds hits and the locations. Using this data and the available templates, we can two-dimensional visuals such as a geographic map. Using this tool, we provide another insight on our study through our created visual.

3. Methods

3.1 Gull Strike Analysis

Specifically for our study, we wanted to create a visual that reflected the relationship between migratory patterns of Gulls and the amount of strikes. We learned that Gulls breed in Northern states during the summer and migrate south for the winter. Using a 2- dimensional array with alternating colors of black and white to highlight what location most strikes occurred over a year's period. The following steps highlight the approach taken to create a visual reflecting this information between two locations: Florida and Michigan (Figure 1).

1) Exported entire FAA Database to MS Access
2) Calculate number of Gulls struck throughout the entire database by month and state location. (See Results) (Ms Excel)
   - Filtered by Florida and each month
   - Summated the total amount of gulls struck for that month
3) Explored Processing site to decide what type of visual could be used to depict what location had more strikes in a particular month
4) Selected 2-dimesional array based on its ability to create a color matrix. Based on the color, one could conclude which area had more strikes during a particular month
5) Based on the results, we used Processing to code a visual to depict which location had more strike incidents of Gulls per month in the form of a 2-dimensional array of colors (either black or white). (See Results) (Source Code in Appendix B)

3.2 Airport Analysis

Our next visualization was a map that compared the number of airports per state to the number of overall strikes in that state. In order to visualize this data we took the information from our exported FAA database and queried on the amount of strikes per state between the years of 1990-2011. We then utilized an FAA report that contained a list of the busiest airports in the United States. We restricted our visualization data to the EST airports found within the top 50 busiest on the list. Similar to the previous visualization, we used ManyEyes to create this map comparison (Figure 2).

1) Exported entire FAA Database to MS access.
2) Queried to find the appropriate data set.
   - Eliminated all columns except species and state
   - Queried to count the number of each species, grouped by state
   - Filtered for EST states and the top 10 birds
3) Exported the results into an excel spreadsheet and added the number of airports per state, gained from the FAA report
4) Imported the results to ManyEyes, selected US country map and generated the visualization
5) Chose to split the maps so that both visualizations could be displayed at once

3.3 Top Birds Strikes by State

In regards to highlighting the distribution of the tops birds struck in the EST time zone, we decided to use ManyEyes to visualize this because it offered many applicable options that could be leveraged and offered interactivity. We were able to prepare a dataset based on an extract from FAA's Bird strike database. Using the geographic map option, we will have to ability to create interactive visual to highlight the variance in bird strike occurrences. The following steps highlight the approach taken to create a visual reflecting this information (Figure 3).

1) Exported entire FAA Database to MS Access
2) Zoomed into necessary data (MS Excel)
   - Eliminated all columns except State, Species, and created CountofSpecies
   - Filtered for states only in the Eastern Time Zone
   - Filtered for the top ten birds species
3) Imported created dataset into ManyEyes and created – (FAA Top 10 Birds Strikes x EST Data Set) (See URL in Appendix A)
4) Selected Country Map- US to visualize Dataset
5) Geographic Map created (See Results)
   - Map Depicting Top Birds struck in the Eastern Time Zone

3.4 Top Birds Strikes over Many Years

Our final visualizations consisted of the same set of data displayed two separate ways. This visualization is comprised of an interactive line graph and stack graph that displays the number of strikes per year for each

species.. Our data set was refined to only include the top 10 species hit in a time span from 1990 to 2011. Each graph can display one or more species at a time, the line graph represents the total per species while the stack graph represents the total of all species with color-coded sections to show how many of each species contributes to the year total. (Figures 4 and 5).

1) Exported entire FAA Database to MS access.
2) Queried to find the appropriate data set.

- Eliminated all columns except species and incident year
- Queried to count the number of each species, grouped by incident year and then species
- Filtered for EST states and the top 10 birds

3) Exported the results into an excel spreadsheet and modified the output into a format that would allow ManyEyes to create the visualization we wanted
4) Imported the spreadsheet into ManyEyes, selected line graph and stack graph and generated the visualization.

4. Results

The following visuals highlights our findings around the FAA's bird strike data. They also help point out insights around the top birds struck and the location as well as the relationship between birds migratory patterns, specifically Gulls and the amount of times they have be struck in either Florida and Michigan throughout the entire year.
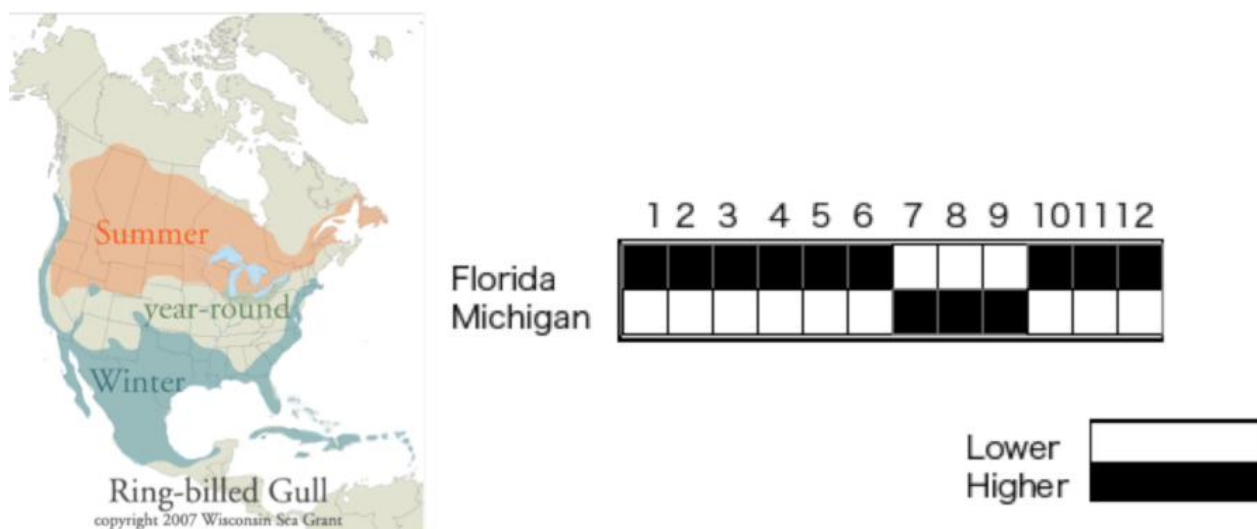
Figure 1. Map Depicting Gull's Migratory Patterns vs. Processing 2-Dimensional Array. Difference each month of Gulls struck in each location. The 2-D could be utilized to depict which location was higher or lower that month.

January	February	March	April	May	June	July
54-136	59-212	188+	58-251	44-108	43-107	23-79
5-21	2-10	7-23	9-25	16-34	5-13	75-316

August	September	October	November	December		State
20-44	23-55	52-302	67-252	58-235		FL
79-288	55-175	55-143	32-104	1		MI

Table 1 - Number of Gulls struck throughout the entire FAA database by month and state location. Top rows reflected gulls struck in Florida vs. the bottom rows reflecting those struck in Michigan.
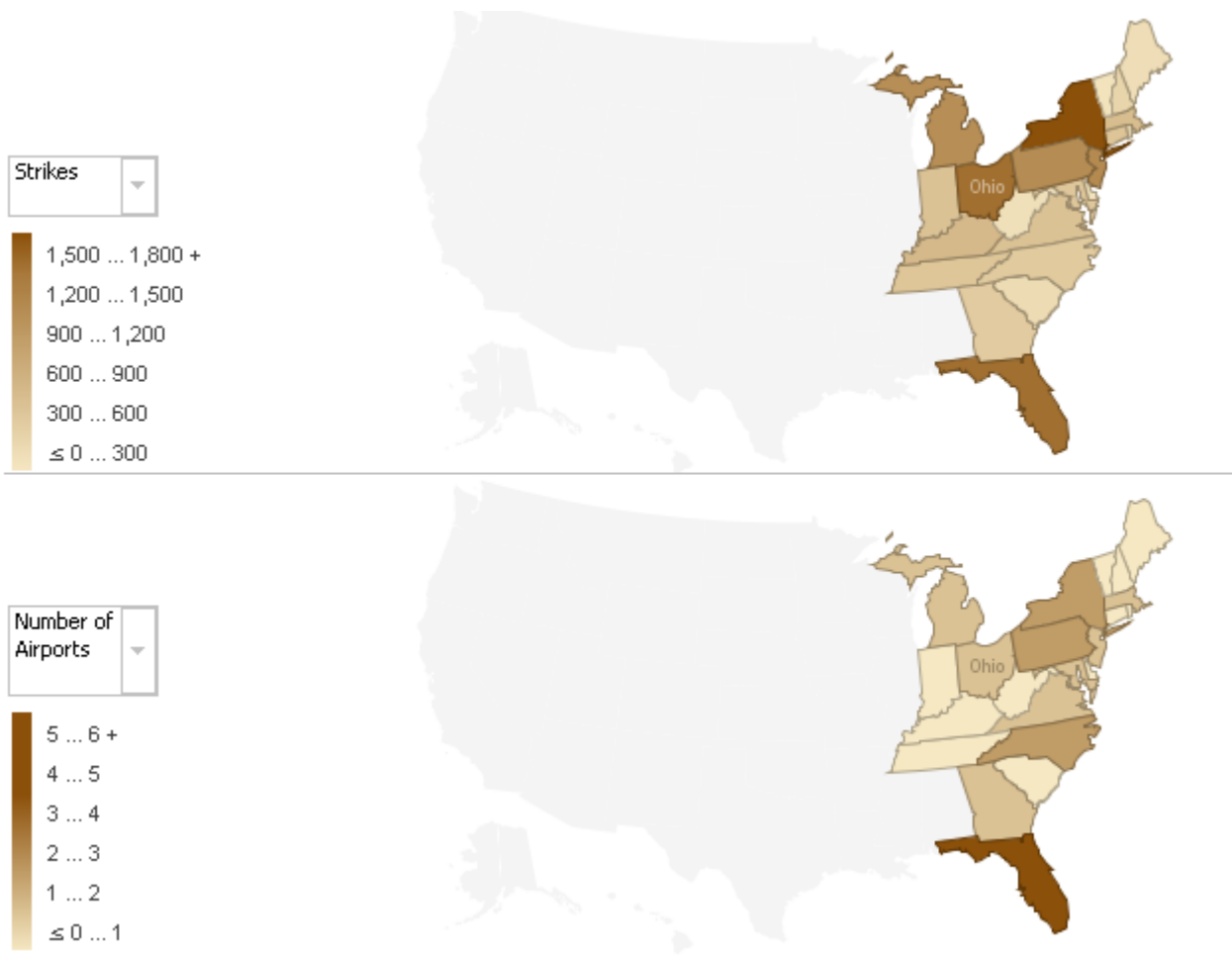
Figure 2. Map depicting the number of birds struck per vs. the number of airports per state. Number of birds struck per state(top), number of airports per state(bottom)
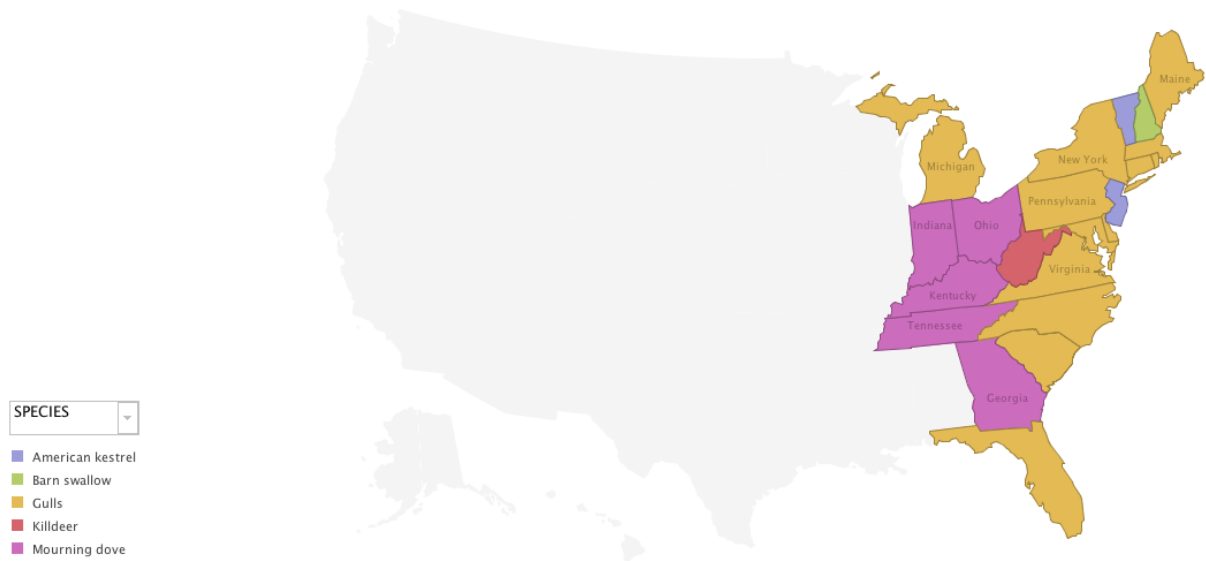

Figure 3. Map Depicting Top Birds struck in the Eastern Time Zone. Only 5 species are shown because these were the highest by state regardless of the top 10 struck.
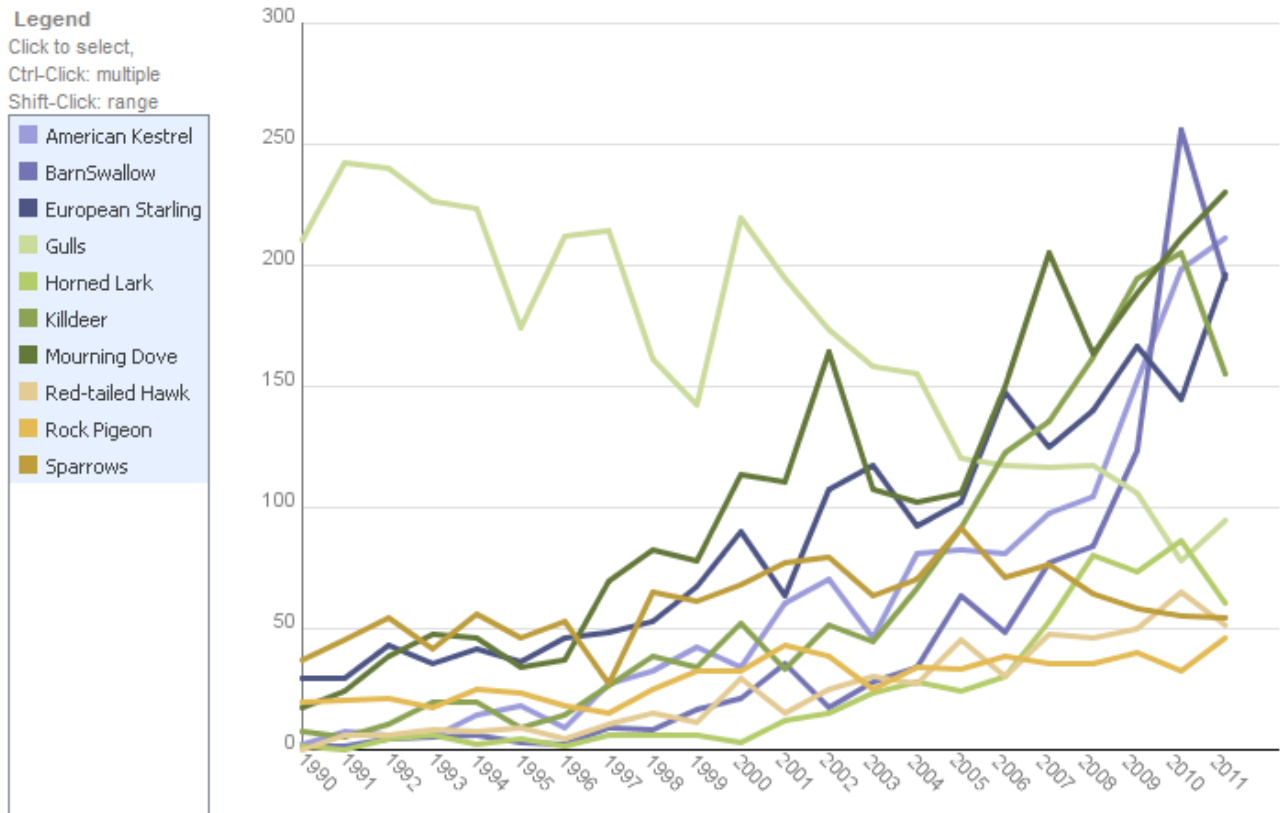
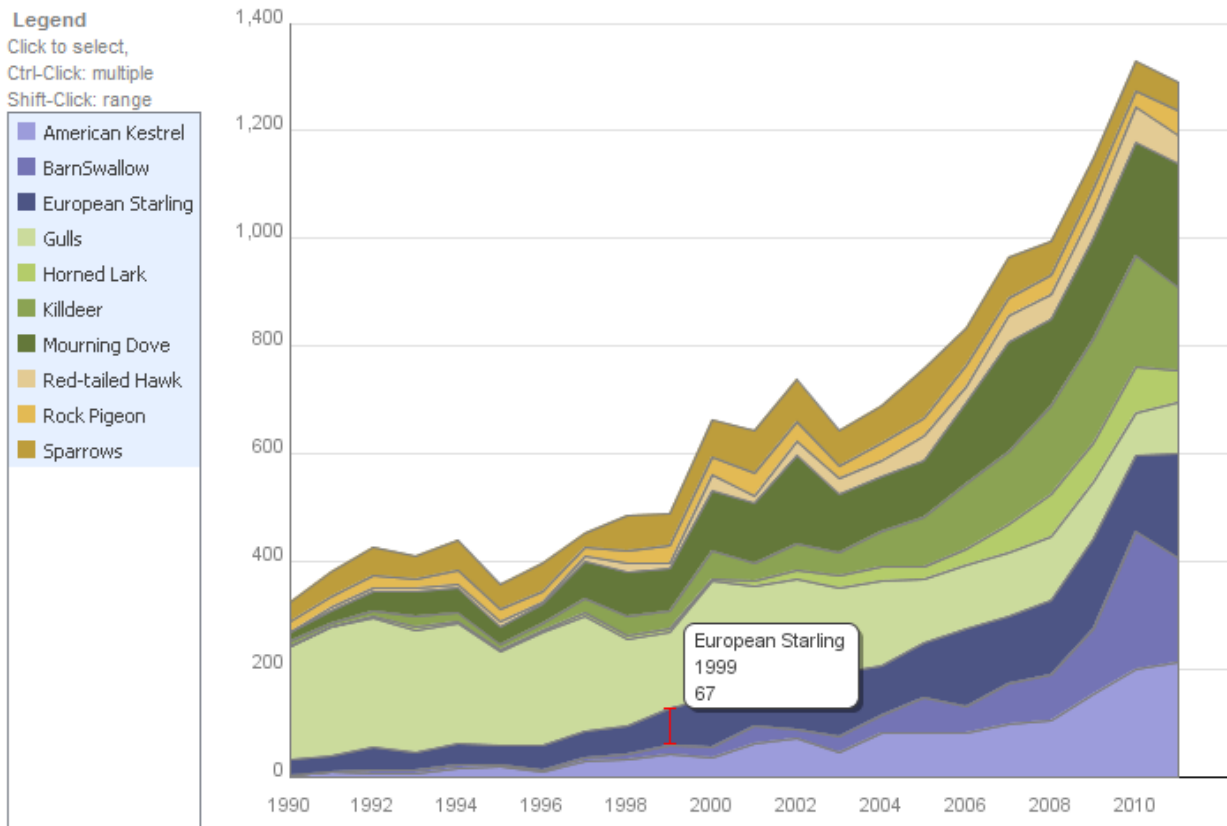Figure 4. Species struck per year. Line graph of species struck per year(Interactive version: http://www-958.ibm.com/v/140609)

Figure 5. Stack graph of species struck per year(Interactive version: (http://www-958.ibm.com/v/140610)

5. Interpretation

5.1 Gull Strike Analysis

Looking at the Migratory map, Gulls are present in the south more during the winter. This is also reflected in the 2-dimensional array. Florida is higher than Michigan during the winter. On the other hand, during the deep summer months (July, August, September) there are more strikes in Michigan than Florida. Looking at Table 1, most of the strikes in Florida occur in March/ October. As for Michigan, most occur in July

5.2 Airport Analysis

Unsurprisingly, states with more (busy)airports usually a higher amount of wildlife strikes than those with little to no busy airports States with known higher populations tended to be the states in the above maps that had more strikes and busy airports. This is likely due to the presence of more people.

5.3 Top Birds Strikes by State

Not only are gulls the most frequent bird struck, they are also more dominant along the Eastern Coast states (FL, ME, SC, NC, VA, DE, MD, etc.). This can be tied to the fact that they are mainly sea birds. Mourning Doves are the 2nd most and more prominent inland (TN, IN, KY, OH, etc.). Out of the top 5, Killdeer are the least struck

5.4 Top Birds Strikes over Many Years

The stack graph makes it readily apparent that the number of strikes for our top 10 species have been increasing. This could be due to increased levels of air traffic as time goes on. A surprising abnormality was the Gull species. As time went on most species encounter more strikes, however gulls were struck less. 2010 was observed as having the most strikes recorded in our timeframe.

6. Discussion

6.1 Gull Strike Analysis

Since we've discovered that the strikes of Gulls tend to be much larger in the states where their migratory pattern shows they are residing, it leads us to believe that there is some significance that the FAA may need to take into consideration if it doesn't already. Bird migratory patterns are not something that change drastically quickly, but rather over a long period of time. Although the nature of studying bird migration patterns is difficult because there are millions of birds covering thousands of miles there have been some breakthroughs in technology that may be able to help establish a better idea of how these migration patterns are playing out. Some of this new technology includes miniaturized GPS

devices that can be applied to individual birds and new satellite technology that is being developed (by International Cooperation for Animal Research Using Space [ICARUS] project) that can provide global tracking data for many understudied species [1].

The data that was discovered in this analysis supported what was previously thought.

6.2 Airport Analysis

Going into this analysis we were under the assumption that the where there were more busy airport there should be more bird strikes. For the most part this assumption was true, but there was one state that stood out as being different, Ohio. Ohio only has one major airport yet it claim the same number of birds strikes as the state of Florida, which has four major airports.

This lead us to believe that another metric that should be taken into consideration should be is the actual amount of flights that depart from each one of these airports so they can be correlated better to the number of strikes. This way there might be a flight to strike ratio that can adapted to analyze the impact to flights and to the bird population of that area.

6.3 Top Birds Strikes by State

This analysis was started with the ten species showed to be prominent on the FAA strike database. As we looked at each state we were able to narrow down the species count to five. As mentioned in our interpretation there are two bird species that seem to dominate the Eastern region in the amount of bird strikes, the Gull and the Morning Dove. We initially thought that there would be a wider variety of species spread across the different states.

If there is further study on this subject we believe they there maybe some aspect in the specific birds themselves that may cause the higher strike rates . This could be altitude of flight, sight or hearing restrictions they may have, or even the locations they choose to nest.

6.4 Top Birds Strikes over Many Years

Before this analysis we had no preconception of what sort of patterns we would discover looking at strikes over a long period. Most of the top species are showing an increase but there is no clear indication of what is causing the increase. It could be because that there are more airplanes in the sky, it could be that the population of these species is increasing, or it could be because the migration patterns have shifted to the detriment of the birds.

The one major species that is bucking this trend is the Gull. Over the last 10 years the amount of Gull strikes has decreased by over 75%. Again, there is no apparent reason for this decrease.

7. Conclusion

From the research and analysis that we have conducted in this paper there definitely seems to be a correlation between migratory bird patterns and many of the strikes that have been logged by the FAA. We believe that the FAA should at least take into consideration the trends and patterns of the birds that are causing the majority of the strikes. The FAA should also pay attention to the population increases and decreases of the birds that are causing the most strikes.

There is definitely opportunity for further research in many areas that we have covered. There are many correlations that can be done with flight data and bird data that may yield some new insights to the increase of bird strikes. The FAA should take into consideration the new technologies that are becoming available to help track bird migration and emerging patterns.

References

[1]. Bridge, Eli S., Kasper Thorup, et al. "Technology on the Move: Recent and Forthcoming Innovations for IVacking Migratory Birds." *BioScience*. 61.9 (2011): 689-98.

[2]. George, Fred. "Increasing Vulnerability To Bird Strikes." Business & Commercial Aviation 104.3 (2009): 40-43. Business Source Complete. Web. 6 Mar. 2012.