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Can the Timeframe of Reported UAS Sightings Help Regulators?

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Can the Timeframe of Reported UAS Sightings Help Regulators?

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Abstract

Remotely controlled small aircraft, otherwise known as Unmanned Aircraft Systems (UAS) or drones have started to impact the United States National Airspace System by interfering with the safe flight of aircraft. As the UAS industry continues its expected growth into the future, lawmakers, as well as regulators at the Federal Aviation Administration (FAA) and the aviation community must be able to predict when there will be more UAS craft in the air that could cause an interruption to air traffic so that more resources can be allocated optimally to counter the threat of UAS craft. The purpose of this study to determine if there is seasonal variation in the calendar year when a plane would be more likely to encounter a UAS using reported sightings data from the FAA. The data collected contained 36 months of sightings from June 2015 – July 2018. This study will give the aviation community the ability to better forecast high demand of reported sightings. Regulators and anyone operating within the manned airspace would be better informed by knowing what times of the year yield a higher frequency of UAS sightings so that appropriate mitigation and safety strategies can be developed and followed. Further, the FAA can also engage in preemptive educational strategies in an effort to avoid unsafe incidents. According to the results, the months of May and June, followed by December and January, will have the highest incidence of UAS sightings.

Introduction

The skies will be getting more crowded as the Unmanned Aircraft System (UAS) or drone industry continues its expected trend of growth in the years to come ("FAA Aerospace Forecast" 2018). UAS are already interfering in the aviation community, an example includes London's Gatwick Airport having been shut down for more than 30 hours and disrupting about 11,000 people stuck at the airport in December of 2018 (BBC News, 2018). As the UAS industry grows, there will be anincreased concern that UAS will be flown into areas where they pose a potential threat to flying manned aircraft. With this threat, planners must be able to predict the most likely time of year these systems will create a situation like that of US Airways Flight 1549 where an Airbus A320 experienced a bird strike two minutes after takeoff and was forced to land in the Hudson River ("2009: Flight 1549 crew praises smart, calm passengers." 2016). With this concerning likelihood,the past sightings of UAS can be instrumental in providing data to estimate peak times of the year when these craft might pose a threat to aircraft. The collated data can then be used to ensure mitigation processes are used more effectively.

Literature Review

An Unmanned Aerial System (UAS) is known by several different interchangeable terminologies ranging from unmanned aircraft, Unmanned Aerial Vehicle (UAV) or drone. UAS has a broad definition to fit a wide variety of craft.The Federal Aviation Administration (FAA), which is the United States' civilian agency responsible for the safety of civil aviation, defines a small UAS as an unmanned aircraft which is less than 55 pounds and its associated elements (Duncan, 2016; Federal Aviation Administration, 2016). Each UAS follow the same basic principles of how manned aircraft achieve lift and fly. There are two major categories of UAS, rotor and fixed wing. Each can be broken down into subcategories based on engine type, number of engines, or body style, but rotor type craft fly like helicopters and fixed wing craft fly just like regular airplanes (Marloh, 2017).

Outside of these categories, the FAA classifies all UAS into two broad groups based on aircraft weight to determine registration requirements. Small UAS are craft that are less than 55 pounds and large craft are those that are more than 55 pounds. Of the estimated 1.6 million UAS in operation in the United States, the majority of privately owned UAS craft are categorized as small. ("FAA AEROSPACE FORECAST," 2018).

No matter the operation, it is important to understand the historical context of unmanned flight. The use of unmanned aircraft has been around for almost as long as the use of manned heavier than air aircraft(Dulo 2016). The groundbreaking foundation of modern unmanned aircraft was laid in 1918 with the development of Gyro-Stabilization and Guidance

Systems for unmanned aircraft (Dulo 2016). After this initial introduction, the role of unmanned aircraft started to expand into numerous applications. Due to the growth of consumerism and the accessibility of cheap, small unmanned aircraft, there has been a marked increase in UAS sightings which has raised concern over safety ("FAA AEROSPACE FORECAST," 2018). Therefore, concern over the safety has escalated.

Since the beginning of unmanned aviation, the role of unmanned aircraft has been broad and has served several functions. The primary and most common roles for UAS began within the military, and these uses have crossed over into the government, commercial, and private sectors. Some of the most common civilian and military operations of UAS include aerial photography, search and rescue, target practice, decoys, intelligence, surveillance, reconnaissance, aerodynamic research and development, and recreation. Because of the wide range of applications for unmanned aircraft, the potential number of crafts can be staggering ("UNMANNED AERIAL SYSTEMS: FAA Continues Progress," 2018). It is the use of recreational UAS that will give safety managers the most cause for concern.

To begin to address the safety considerations of UAS operations by non-military operators, this research attempts to address the current state of sightings. There are no published evidence-based studies about the frequency of UAS sightings throughout a year, most of the literature focuses just on the estimated number of units in the United States. The FAA estimates the total number of hobbyist UAS craft to increase by 80% from 1.6 million to 2.4 million by the year 2022 as seen in Table 1 below ("FAA AEROSPACE FORECAST," 2018).

Table 1

Total Model Fleet (in millions)

Year	Low	Base	High
2017	1.10	1.10	1.10
2018	1.50	1.60	1.73
2019	1.76	2.00	2.35
2020	1.87	2.20	2.73
2021	1.92	2.30	2.94
2022	1.96	2.40	3.17

Even using the low end of the expected growth of UAS over the next five years, regulators and anyone operating within the manned airspace would be better informed by knowing what times of the year yield a higher frequency of UAS sightings so that appropriate mitigation and safety strategies can be developed and followed. Further, the FAA can also engage in preemptive educational strategies in an effort to future incidents.

Research Methodology

This research used a chi-squared goodness of fit statistical test using FAA data of monthly UAS sightings from 2015 – 2018. The FAA has collected UAS sighting data from across the United States from pilots, law enforcement, and individuals across the United States including Hawaii, Alaska, and the District of Columbia. The data was publicly available and spans from November 2014, when this data archive originated, through June 2018 ("UAS Sightings Report," 2018). For the purposes of the research, a monthly average was created using the three years of data. Other variables in the data set included location, time of day, whether the craft was in restricted airspace, type of report, reason for the report, and the individual who initiated the report.

The research questions developed for this study were 1) does the month of the year have an impact on UAS sightings in the United States and 2) is there a difference between months of the year for sightings of UAS. The null hypothesis and hypothesis are listed below:

H0: There is no significant difference in UAS sightings between months of the year.

H1: There is a significant difference in UAS sightings between months of the year.

If there is a significant difference between months, it will be important to determine what months are outside the expected sightings per month to employ mitigation, safety, and education strategies.

Results

Data collected represented the entire reported time series of UAS sightings by the FAA beginning in June, 2015 and ending in June, 2018. The histogram in Figure 1 shows the raw number of monthly reported sightings. The histogram visually indicates a general upward trend of the frequency of reporting UAS sightings, but also a seasonal pattern of increased sightings dependent upon the month of the year.

A monthly average was calculated for each month using the three years of data to develop an average sightings per month across the United States (Figure 2). Using this average, there were a total of 1933 total sightings for the averaged year. Figure 2's histogram indicated that the most sightings per month are during

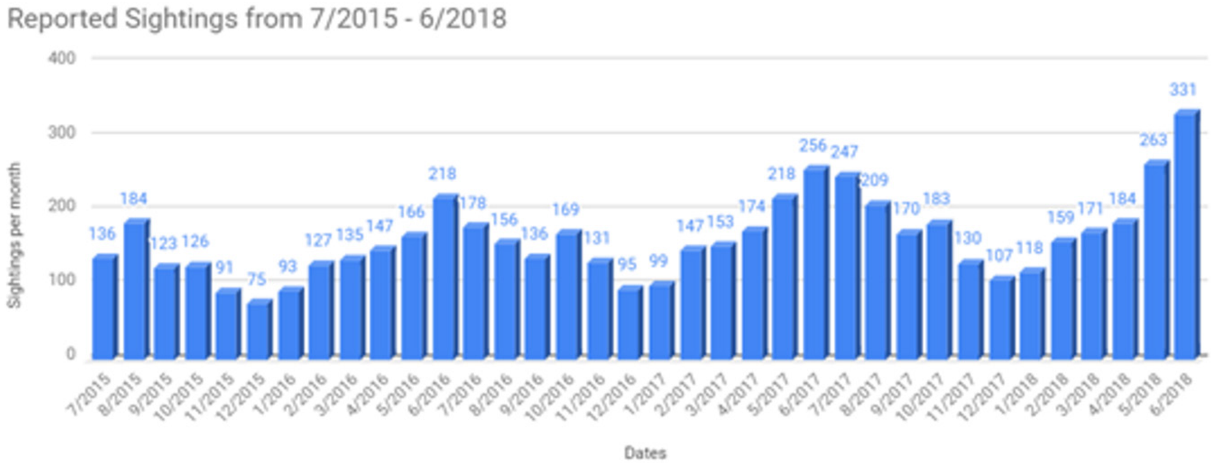

Figure 1. Reported UAS sightings by month, FAA (2018)

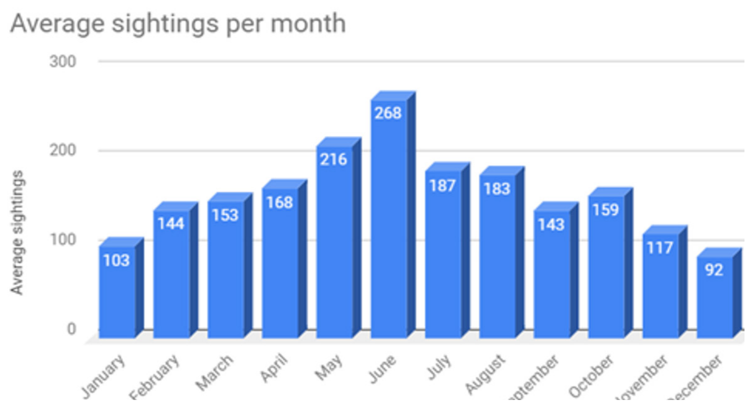

Figure 2. Monthly average of reported UAS sightings June 2015 – June 2018.

Table 2

Total Sightings Chi-Squared Test from July 2015 - June 2018

Month	Sightings (Avg)	Percent from Expected
January	103	13%
February	144	1%
March	153	0%
April	168	0%
May	216	11%
June	268	43%
July	187	3%
August	183	2%
September	143	1%
October	159	0%
November	117	7%
December	92	18%

the summer with the most average sightings happening in June at 268, and the least average in December at 92 sightings.

In order to see if the months were statically significant from one another, a chi-squared goodness of fit test was conducted. Conditions of counted data, independence, randomization, and expected counts assumptions were all satisfied. With a total sample size of 1933 sightings and a degree of freedom of 11, the statistical power of this study is 1.0 indicated there is a large enough sample size that the results will be very reliable. For this test with a degree of freedom of 11 and using a significance level of 0.05, the chi-square cutoff score for significance was 19.675. Along with conducting a chi-squared goodness of fit, the study included the percent from the expected sightings per month to see if there were any months that were outside the average as seen in Table 2.

Table 2 shows the months of January, May, June, and December vary the most from the average expected sightings per month. This information should be useful for aviation community planners and safety managers to target special preparations for safety mitigation and educational resources during these months. The conclusion assumes there are more reported sightings because there are more UAS in operation. This result also makes sense as hobbyists probably increase their operations during the summer months because of favorable weather. December and January strongly indicate a seasonal spike due to holiday sales and gifts. Table 3 contains the results of the chi-squared test completed using StatCrunch statistical analysis tool.

Table 3

Chi-Squared Test Results for the Averaged Year

N	DF	Chi-Squared	P-value	Expected Sightings
1933	11	164.04501	<0.0001	161.0833333

The observed chi-squared result of 164.05 was greater than the cutoff score of 19.675 along with a P-value of less than 0.0001 and it being less than the 0.05 for the significance level. The null hypothesis can be rejected and accepted the alternate hypothesis concluding that there is a significant difference in UAS sightings between months of the year can be accepted.

Conclusion

Each month of the year is different in terms of the number of UAS sightings, aviation community planners, safety managers, and all those in the UAS industry will want to pursue a strategy of allocating their finite resources during the times of the year where there is a higher likelihood of countering UAS. UAS flights spike as favorable weather draws out hobbyists, so June should have the most resources allocated to counter UAS threats. Also, December and January show increased sightings indicating that as holiday promotions spike, hobbyists and gift recipients begin their UAS careers.

As the number of UAS is expected to rise in the next several years, using the knowledge of when they are most likely to be spotted can better prepare aviation community planners and safety managers. Community planners and safety managers would utilize the FAA's Public Safety and Law Enforcement Toolkit found on their website to be more prepared. The toolkit entails the rules and authorization that public safety and law enforcement officers have, information about local and state regulations, and drone safety (FAA, 2019). As officials refresh their knowledge of how to address UAS operations per FAA instruction, there are numerous technologies and procedures that are identified if they need to address the UAS. For example, one option available are jamming systems that can override the command, control, and communication system that are used to control the UAS and bring it to the ground. The use of this data about the seasonal changes in the use of UAS could spur safety managers to proactively refresh their regulation and safety knowledge to have the most up to date information and prepare for the expected bump in reported sightings. The future of UAS and other unmanned systems is bright, but ensuring public safety is paramount. This research informs officials when a UAS is most likely to be flown, so that they will be able to counter those threats more effectively.

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