

The Impact of COVID-19 on Wildlife Strikes: Evidence from U.S. Airports

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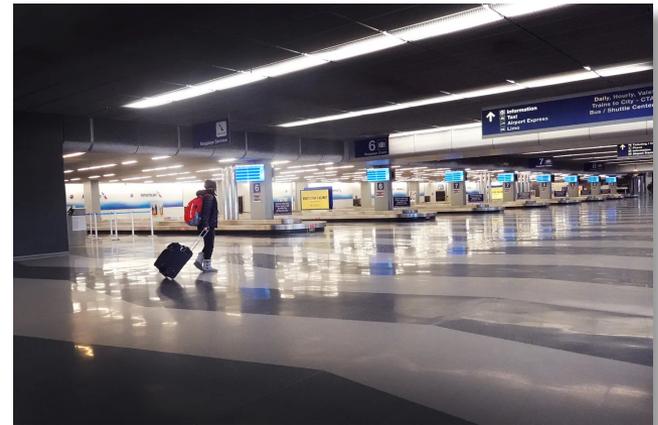
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Introduction

- The COVID-19 pandemic suspended modern human activity on a massive scale.
- Anecdotal evidence, as well as a growing scientific literature, suggests that the COVID-induced “anthropause” generated a behavioral response from wildlife.
- Travel being one of the most impacted industries, aircraft operations were, and remain, dramatically reduced.
- What might be the implications of such a dramatic reduction in aircraft operations for wildlife at or near airports and, therefore, wildlife strike risk?
- We find that, among the airports in our sample, the reported wildlife strike rate increased during the COVID-19 pandemic of 2020.
- The increase in the reported strike rate was most pronounced during “bird rich months” at the airports that experienced the largest reduction in aircraft operations.
- Our models suggest that reported strikes increased 11.5 to 17.5 percent above expectation among the airports in our sample due to the increase in the reported strike rate over the COVID-19 pandemic.



Source: <https://nymag.com/intelligencer/2020/04/heres-why-so-many-planes-are-still-flying-nearly-empty.html>

Photo: Scott Olson/Getty Images

Motivation

COVID-19 lockdown allows researchers to quantify the effects of human activity on wildlife

Christian Rutz , Matthias-Claudio Loretto, Amanda E. Bates, Sarah C. Davidson, Carlos M. Duarte, Walter Jetz, Mark Johnson, Akiko Kato, Roland Kays, Thomas Mueller, Richard B. Primack, Yan Ropert-Coudert, Marlee A. Tucker, Martin Wikelski & Francesca Cagnacci

Nature Ecology & Evolution 4, 1156–1159 (2020) | [Cite this article](#)



Rapid behavioural response of urban birds to COVID-19 lockdown

Oscar Gordo , Lluís Brotons, Sergi Herrando and Gabriel Gargallo

Published: 10 March 2021 | <https://doi.org/10.1098/rspb.2020.2513>

Singing in a silent spring: Birds respond to a half-century soundscape reversion during the COVID-19 shutdown

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Motivation

- Drawing on road traffic literature, wildlife-vehicle collisions may be non-linearly related to vehicle traffic due to changes in wildlife behavior.
- *“Roadkills seem to increase with traffic intensity to a certain point, after which they level off. It seems that very high traffic volumes, noise and vehicle movements have the effect of deterring many animals, hence mortality rates do not increase further with higher traffic flows.” (See link.)*
- Could one conceptualize a similar model for wildlife behavior at airports and wildlife-aircraft collisions?

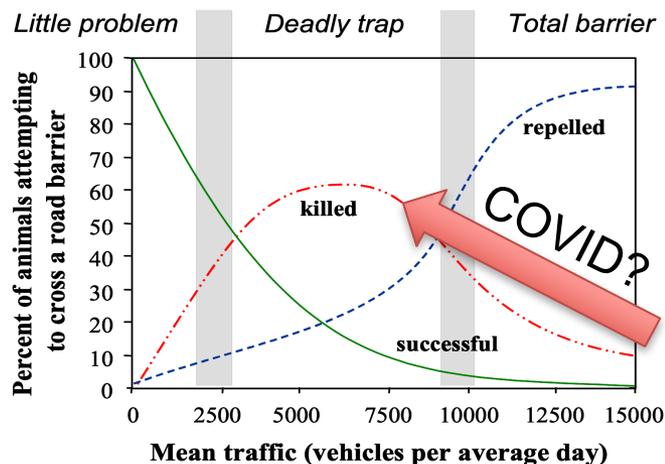
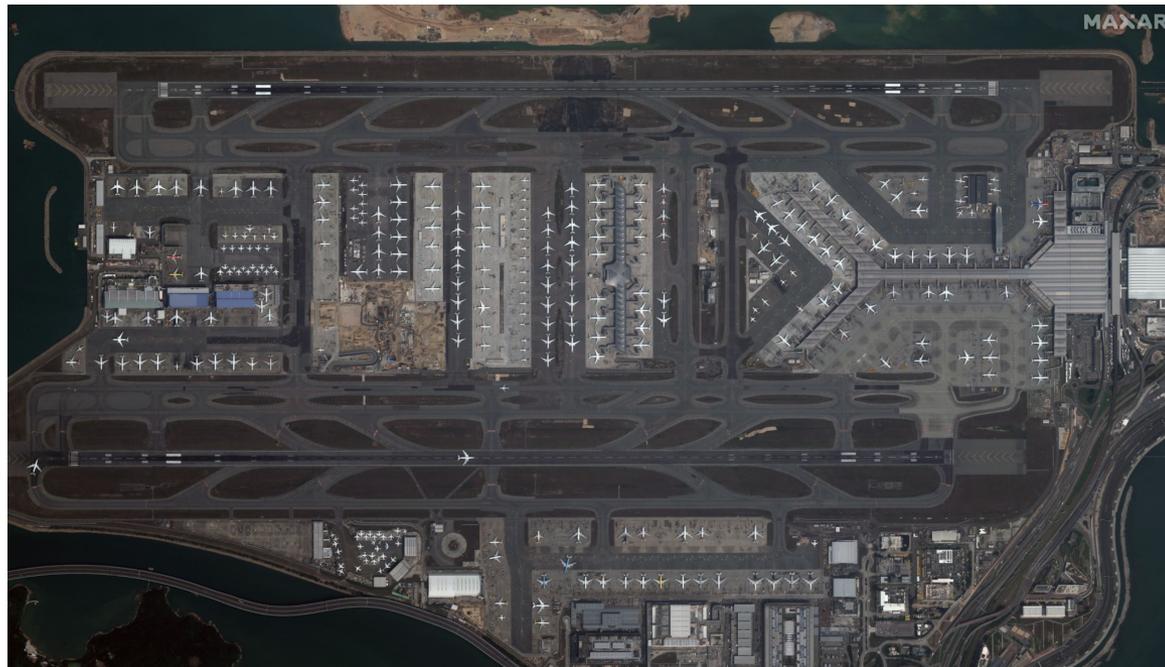


Figure 3.10 Conceptual model of the effect of traffic volume on the proportion of mammals that successfully cross a road barrier. Small roads with little traffic are only a minor barrier to mammals. However, as traffic increases, the number of road kills quickly rises. Roads with very high traffic load, on the other hand, may repel animals and cause the number of kills to be reduced. The model is based on empirical data on police reported moose-vehicle accidents in Sweden. (Seiler, 2003.)

<http://www.diva-portal.org/smash/get/diva2:675281/FULLTEXT02.pdf>

Research Question

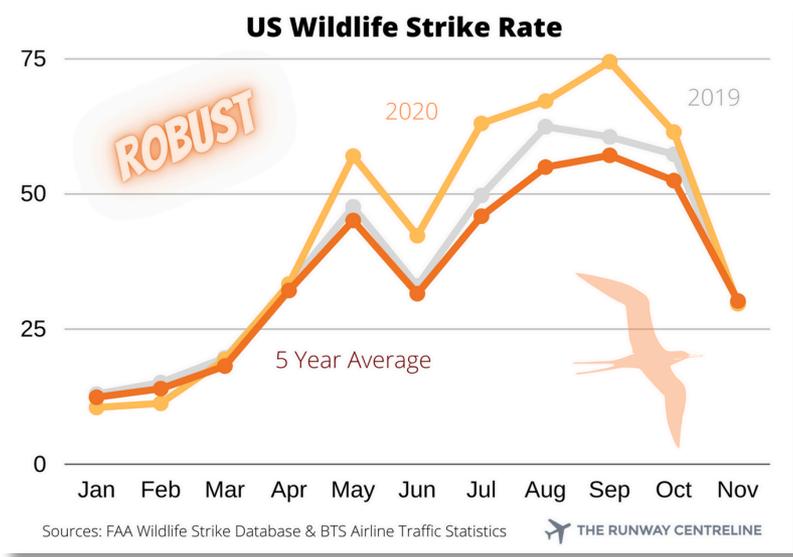
In response to the dramatic decline in aircraft operations, was there a significant increase in the reported strike rate during the COVID-19 pandemic of 2020?



A satellite image taken above Hong Kong International Airport on March 16, 2020.

Retrieved at: <https://www.bloomberg.com/news/features/2020-04-16/coronavirus-travel-what-happens-to-planes-grounded-by-covid-19>.

FYI...



<http://www.therunwaycentreline.com/blog/2021/2/20/covid-19-bird-strike-update-3>

Data

- Data sources:
 - National Wildlife Strike Database (NWSD) (2014-2020)
 - Air Traffic Activity Data System (ATADS) (2014-2020)
- Data sample:
 - 50 of the largest airports based on passenger boardings in 2019.
 - Unit of observation is airport-month.
 - 84 observations per airport for a total of 4,200 airport-month observations.

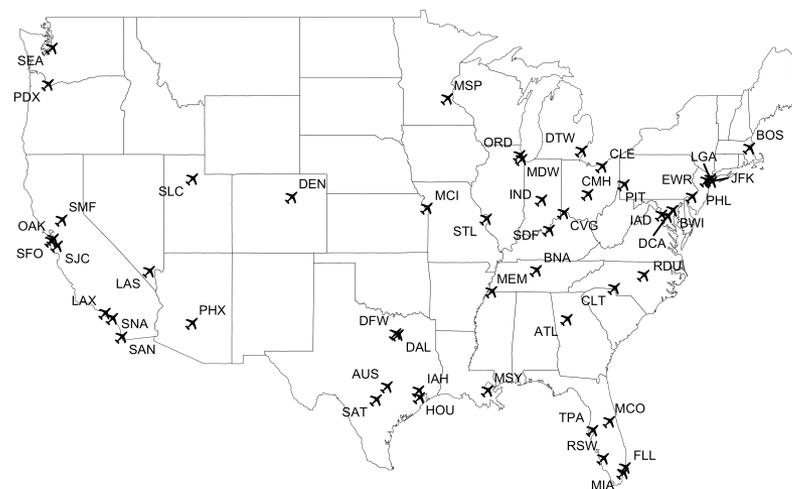


Figure 1. Spatial Distribution of Sample Airports

Response Measure

- The response variable of interest in our analysis is the reported strike rate per 100,000 operations (RSR):

$$RSR_{it} = \frac{\text{Reported Strikes}_{it}}{\text{Total Operations}_{it}} \times 100,000$$

- Here, i denotes airport and t denotes time (month-year).
- Since our strike data is drawn from the civil strike database (NWSD), we remove military operations from total operations.
- A reported strike rate of 50 is interpreted as 50 reported strikes per 100,000 aircraft operations (takeoffs + landings).

Treatment Measure (Part 1)

- The treatment period is defined to be March 2020 to December 2020 (the months where aircraft operations fell below expectation relative to previous years).
- To get a measure of treatment across airports, over time, we begin by generating counterfactual aircraft operations for 2020 at each airport.
- Specifically, we estimate the following predictive model

$$AO_{it} = \alpha + \eta A_i + \gamma(A_i \times M_t) + \delta(A_i \times Y_t) + \varepsilon_{it}$$

using 2014-2019 data.

- Here, aircraft operations (AO_{it}) at airport i and time (month-year) t is specified to be a linear function of airport fixed-effects (A_i), airport-specific month effects ($A_i \times M_t$), and airport-specific linear time trends ($A_i \times Y_t$).

Treatment Measure (Part 2)

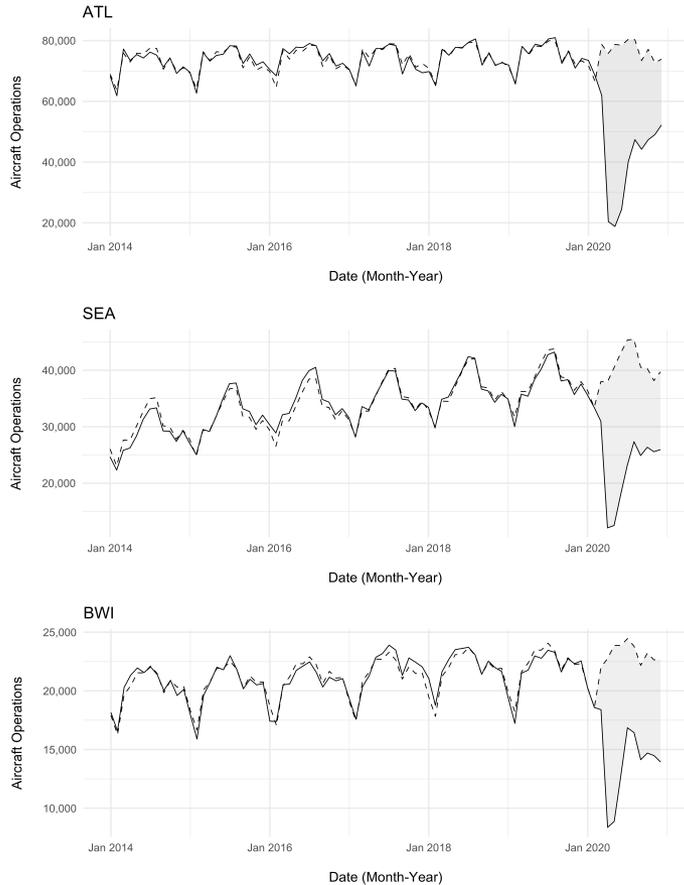


Figure 2. Constructing Counterfactual Aircraft Operations (Example: ATL, SEA, & BWI)

- The simple predictive model performs relatively well on 2014-2019 data with an R-Squared statistic of 0.997 (see Figure 2).
- We use the percent deviation from model expectation for the months March 2020 to December 2020 as our continuous measure of treatment (See Figure 3).

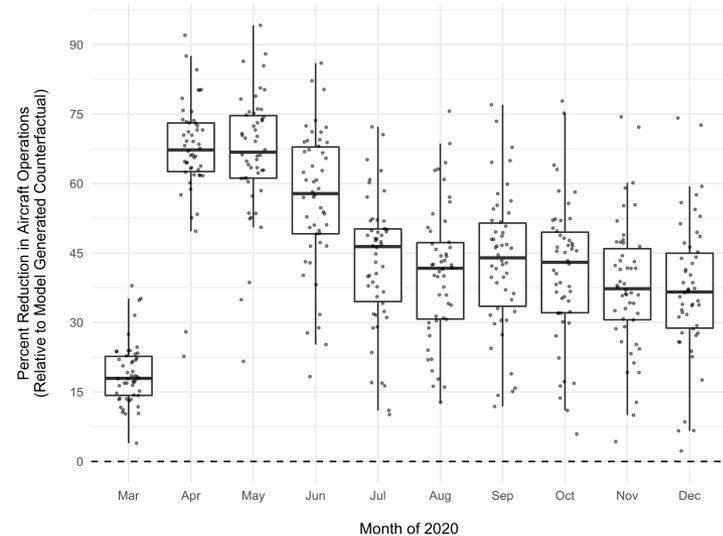


Figure 3. Percent Reduction in Aircraft Operations (Relative to Model Expectation) Over the COVID Months of 2020

Sample Summary Statistics

Table 1. Sample Summary Statistics

	Mean	Stan. Dev.	Min	Max	<i>N</i>
Reported Strikes	10.96	11.85	0	134	4,200
Aircraft Operations	25,456.96	15,726.59	1,881	83,010	4,200
Reported Strike Rate (per 100,000 movements)	52.41	58.15	0.00	816.83	4,200
COVID-19 Reduction in Aircraft Operations (%)	44.90	19.27	2.95	94.10	500

- On average, roughly 11 reported strikes per month.
- Average operational size among the airports in our sample is roughly 25,000 aircraft operations per month.
- Average reported strikes is roughly 52 reported strikes per 100,000 movements (positive skew).
- Reported strike rate varies (1) across airports, (2) by month within year (seasonal), and (3) over time (general upward trend in sample).
- Average estimated treatment—i.e., reduction in aircraft operations—was 45% across airports in our sample over the COVID months of 2020.

Methods: Fixed-Effects Regression Model

- We estimate versions of the following fixed-effects regression model

$$RSR_{it} = \alpha + \eta A_i + \gamma(A_i \times M_t) + \delta(A_i \times T_t) + \beta \text{COVID}_{it} + \varepsilon_{it}$$

- where:
 - RSR_{it} is the reported strike rate at airport i in time (month-year) t ;
 - A_i is a vector of airport fixed effects;
 - $A_i \times M_t$ is a vector of airport-specific month effects;
 - $A_i \times T_t$ is a vector of airport-specific linear time trends; and
 - COVID_{it} is some measure of the treatment period and treatment intensity.
- We consider several different ways to estimate the impact of treatment:
 1. Indicator variable for treatment period.
 2. Vector of indicator variables for each month of treatment period.
 3. Continuous measure of estimated treatment (equals 0 in pre-COVID period).
 4. Continuous measure of estimated treatment that is interacted with the month of treatment indicator variables.

Results (Part 1)

- Figure 4 plots the total sample (1) aircraft operations, (2) reported strikes, and (3) the reported strike rate.
- The sample summary plots show that:
 1. Aircraft operations fell below that of previous years beginning in March 2020.
 2. Reported strikes fell below that of previous years beginning in April 2020.
 3. The reported strike rate appears to be significantly elevated from April 2020 to September/October 2020.
 4. According to pre-COVID data, the most “risky” or “bird rich months” appear to be May-October.

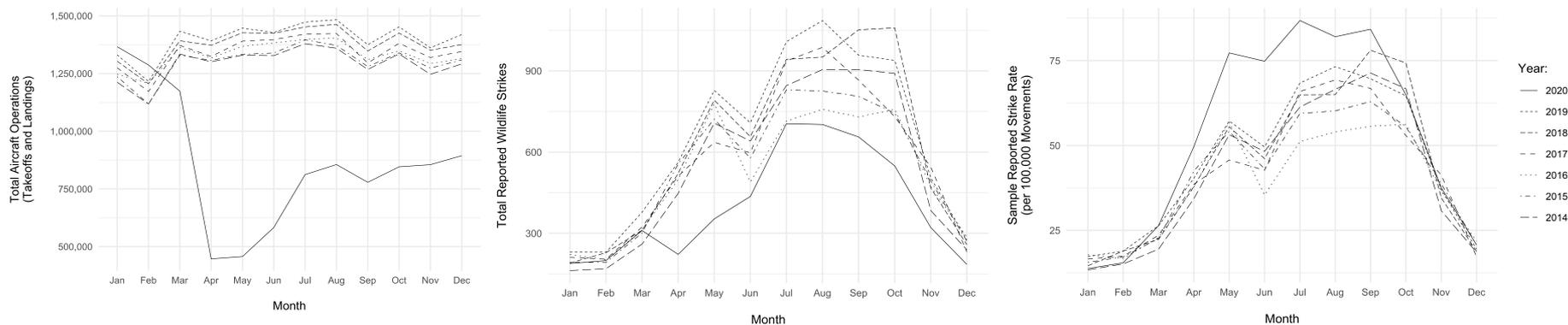


Figure 4. Total Sample Aircraft Operations, Reported Strikes, and Reported Strike Rate (2014-2020)

Results (Part 2)

Table 2. Estimated Effect of COVID-19 Period on the Reported Strike Rate

	(1)	(2)	(3)	(4)	(5)	(6)
COVID (March 2020 - December 2020)	10.680*** (1.86)	5.914*** (2.04)	15.708*** (2.77)	6.744** (3.23)		
COVID (March 2020)					2.583 (3.35)	-2.183 (3.73)
COVID (April 2020)					9.306 (5.93)	4.54 (5.63)
COVID (May 2020)					19.366*** (6.10)	14.600** (5.98)
COVID (June 2020)					22.007*** (7.01)	17.241** (6.71)
COVID (July 2020)					18.862** (7.85)	14.096** (7.14)
COVID (August 2020)					16.893** (7.30)	12.127* (6.73)
COVID (September 2020)					15.182** (6.77)	10.416* (5.82)
COVID (October 2020)					1.935 (4.97)	-2.831 (5.14)
COVID (November 2020)					0.267 (3.22)	-4.499 (3.51)
COVID (December 2020)					0.395 (2.29)	-4.371 (3.28)
R-Squared	0.736	0.763	0.697	0.753	0.738	0.765
N	4,200	4,200	2,100	2,100	4,200	4,200
Airport-Specific Time Trends	No	Yes	No	Yes	No	Yes
Restrict to Bird Rich Months (May-October)	No	No	Yes	Yes	No	No

NOTE: Standard errors in parentheses are robustly estimated using the Huber-White sandwich estimator. Levels of statistical significance given by * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Results (Part 3)

Table 3. Estimated Effect of Operations Reductions (Estimated Treatment) on the Reported Strike Rate

	(1)	(2)	(3)	(4)	(5)	(6)
Estimated Treatment (ET)	0.250*** (0.04)	0.187*** (0.04)	0.331*** (0.05)	0.197*** (0.05)		
ET × March 2020					0.133 (0.18)	-0.014 (0.18)
ET × April 2020					0.144* (0.09)	0.085 (0.08)
ET × May 2020					0.272*** (0.08)	0.219*** (0.08)
ET × June 2020					0.386*** (0.11)	0.326*** (0.11)
ET × July 2020					0.446*** (0.16)	0.373*** (0.14)
ET × August 2020					0.425*** (0.15)	0.351*** (0.13)
ET × September 2020					0.337** (0.13)	0.260** (0.12)
ET × October 2020					0.152 (0.14)	0.079 (0.13)
ET × November 2020					0.016 (0.08)	-0.062 (0.07)
ET × December 2020					0.013 (0.07)	-0.062 (0.09)
R-Squared	0.693	0.721	0.648	0.704	0.694	0.722
N	4,200	4,200	2100	2100	4,200	4,200
Airport-Specific Time Trends	No	Yes	No	Yes	No	Yes
Restrict to Bird Rich Months (May-October)	No	No	Yes	Yes	No	No

NOTE: Standard errors in parentheses are robustly estimated using the Huber-White sandwich estimator. Levels of statistical significance given by * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Results (Part 4)

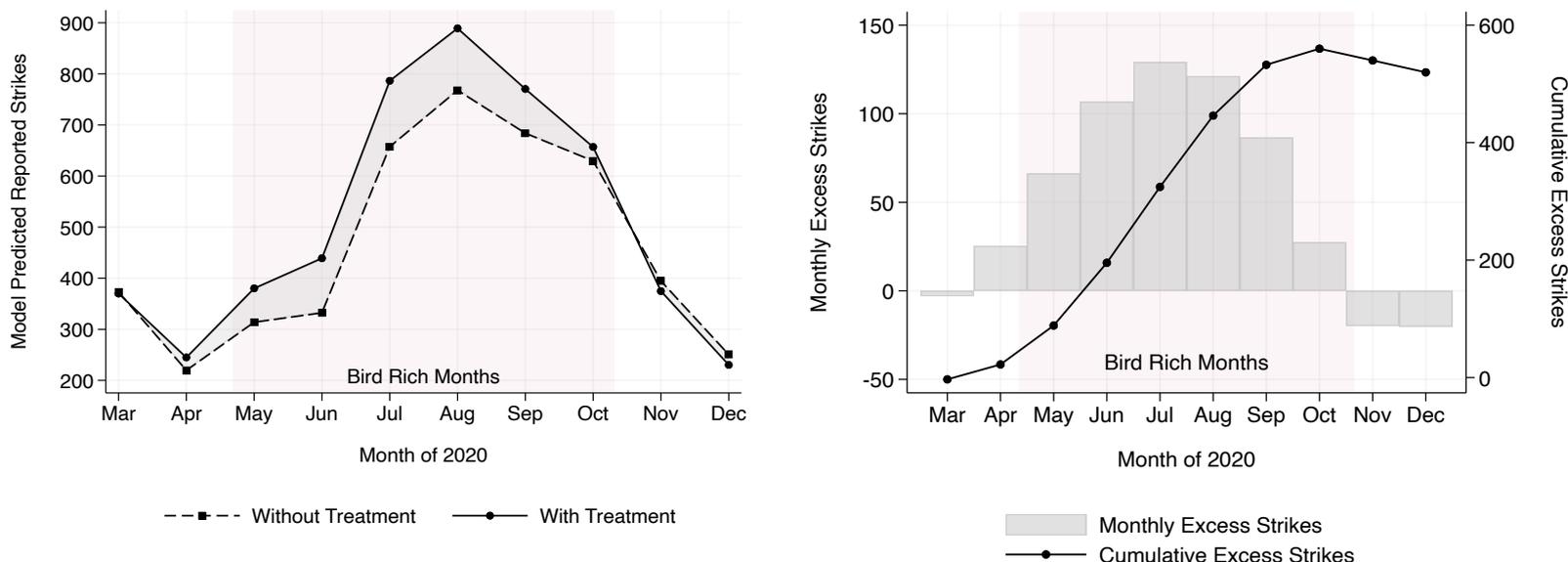


Figure 5. Estimated Excess Strikes During COVID Months of 2020 (Using Model With Airport-Specific Linear Time Trends)

- Using the estimates of column (6) in Table 3, we predict the reported strike rate for the COVID months of 2020 under (1) no treatment and (2) observed treatment (see Appendix [Table A2](#)).
- We then use these predictions to calculate the estimated number of excess bird strikes that occurred over the COVID months of 2020.
- We estimate that, in sum, there were roughly 520 excess reported bird strikes (11.2% increase) among the 50 airports in our sample (see Appendix [Table A1](#) and [Figure A4](#) for estimates from model without airport-specific time trends).

Discussion and Conclusion

- We see our findings as having three potential explanations:
 1. Aircraft movements as a natural “harassment”. Reduction in operations, all else equal, increases wildlife strike risk.
 2. Increase in the reporting rate. Aircraft and airport personnel have more time to inspect/report when operations are reduced.
 3. Changes in wildlife management. Airports reduce management activities as a business response to decline in operations and revenues.
- We plan to investigate (2) and (3) using additional data.
- Regardless, each explanation has important implications:
 1. Airports of smaller operational size may face a higher level of wildlife strike risk, all else constant.
 2. Aircraft and airport personnel may be time-constrained with respect to wildlife strike reporting when airports operate at/near capacity.
 3. Wildlife management at airports is an important tool in reducing wildlife strike risk.

Appendix Figure A1

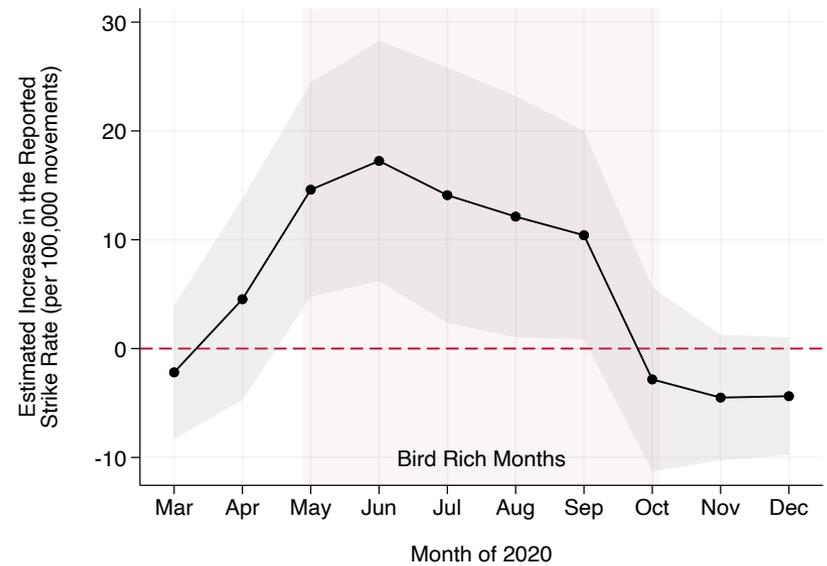
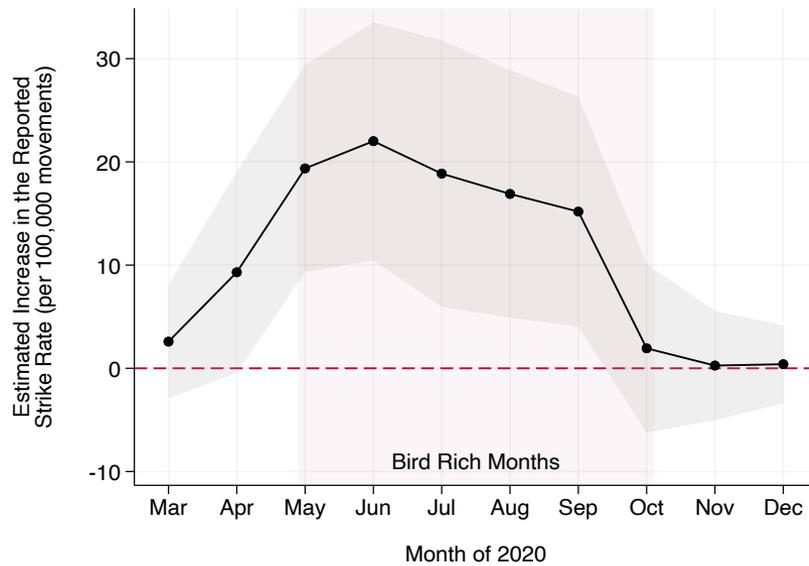


Figure A1. Estimated Increase in the Reported Strike Rate by Month of COVID

Appendix Figure A2

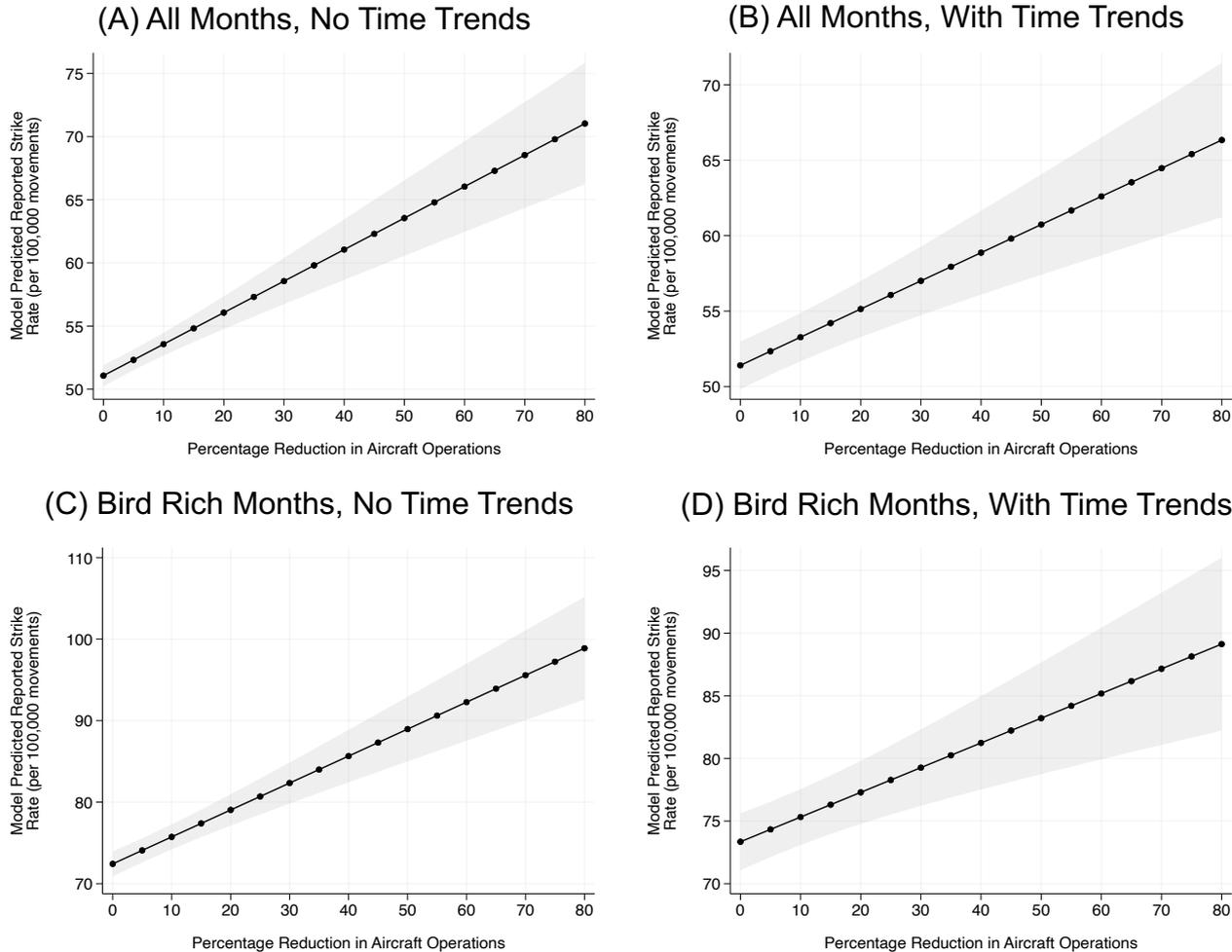


Figure A2. Model Predicted Strike Rate at Increasing Levels of Estimated Treatment

Appendix Figure A3

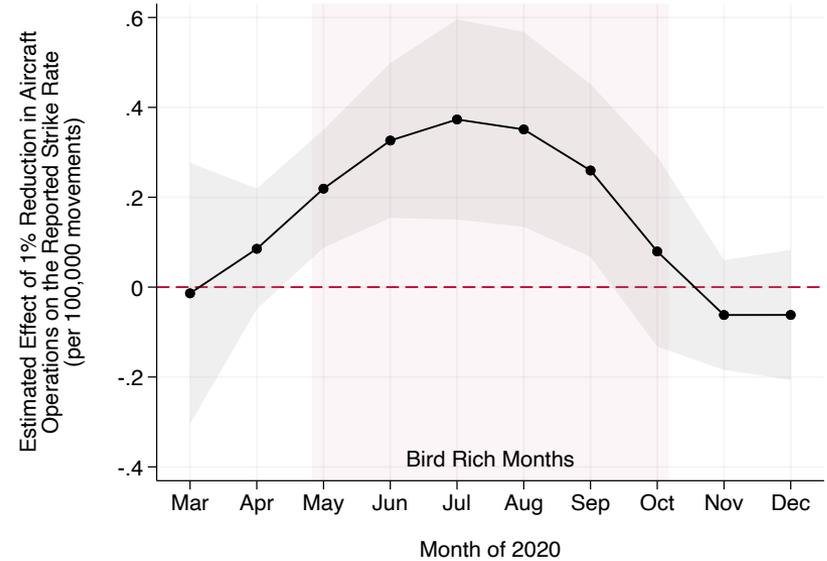
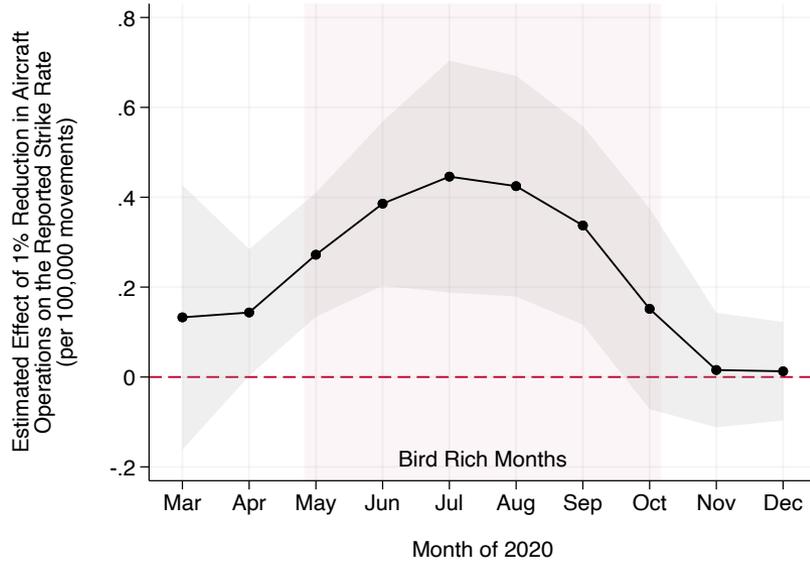


Figure A3. Estimated Effects of 1% Reduction in Aircraft Operations on the Reported Strike Rate (per 100,000 movements) During the COVID Months of 2020

Appendix Figure A4

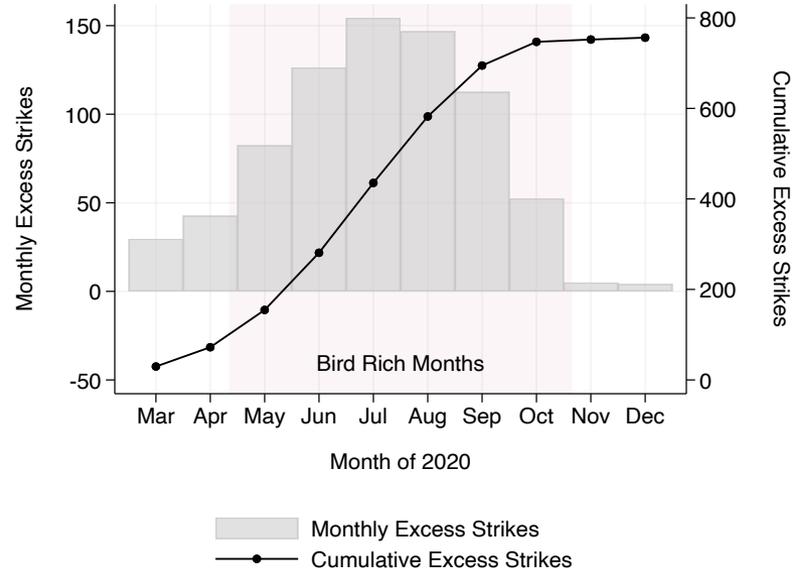
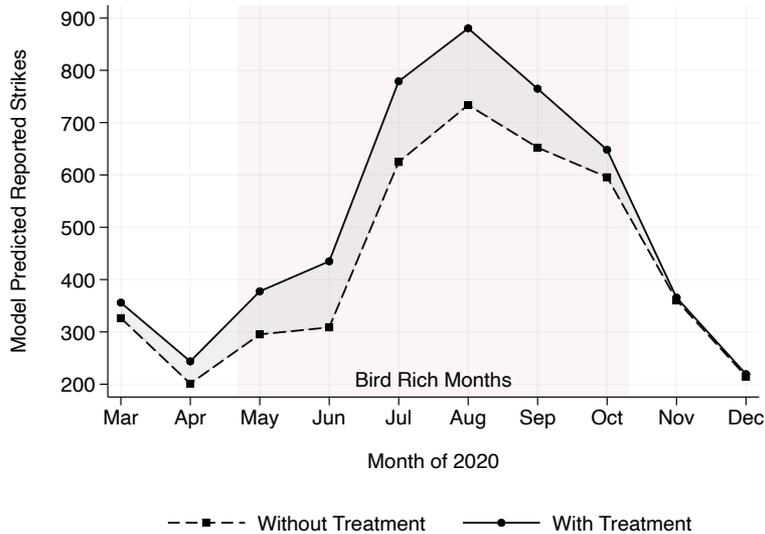


Figure A4. Estimated Excess Strikes During COVID Months of 2020
(Using Model Without Airport-Specific Linear Time Trends)

Appendix Table A1

Table A1. Calculating Excess Reported Strikes Over COVID-19
(Model *Without* Airport-Specific Linear Time Trends)

Month of 2020	(1) Sample Average Predicted Strike Rate Without Treatment	(2) Sample Average Predicted Strike Rate With Treatment	(3) Sample Average Total Operations	(4) Estimated Reported Strikes Without Treatment	(5) Estimated Reported Strikes With Treatment	(6) Excess Reported Strikes	(7) % Change
March	27.8	30.3	23,478.3	326.4	356.0	29.6	9.1
April	45.0	54.6	8,932.7	201.1	243.7	42.7	21.2
May	64.6	82.7	9,136.6	295.2	377.6	82.4	27.9
June	53.0	74.7	11,652.6	308.7	435.0	126.3	40.9
July	76.9	95.9	16,242.0	624.7	779.0	154.4	24.7
August	85.7	102.9	17,112.9	733.6	880.4	146.8	20.0
September	83.8	98.2	15,574.8	652.3	764.8	112.5	17.3
October	70.4	76.6	16,916.5	595.7	648.0	52.4	8.8
November	42.2	42.8	17,101.4	360.6	365.6	5.0	1.4
December	24.1	24.5	17,879.9	215.1	219.3	4.2	1.9
			TOTAL:	4,313.2	5,069.5	756.3	17.5

NOTE: Columns (1) and (2) are derived from model predicted reported strike rates over the COVID months of 2020. The first assumes treatment (aircraft operations reductions) are equal to zero while the second is calculated under observed treatment values. Column (4) is calculated as $\left(\frac{\text{Column (1)}}{100,000}\right) \times \text{Column (3)} \times 50$. Column (5) is calculated as $\left(\frac{\text{Column (2)}}{100,000}\right) \times \text{Column (3)} \times 50$. Column (6) is the difference between columns (5) and (4). Column (7) is calculated as $\left(\frac{\text{Column (6)}}{\text{Column (4)}}\right) \times 100$.

Appendix Table A2

Table A2. Calculating Excess Reported Strikes Over COVID-19
(Model *With* Airport-Specific Linear Time Trends)

Month of 2020	(1) Sample Average Predicted Strike Rate Without Treatment	(2) Sample Average Predicted Strike Rate With Treatment	(3) Sample Average Total Operations	(4) Estimated Reported Strikes Without Treatment	(5) Estimated Reported Strikes With Treatment	(6) Excess Reported Strikes	(7) % Change
March	31.8	31.5	23,478.3	373.0	370.0	-3.1	-0.8
April	49.2	54.8	8,932.7	219.5	244.9	25.4	11.6
May	68.7	83.2	9,136.6	313.9	380.2	66.3	21.1
June	57.0	75.4	11,652.6	332.3	439.1	106.8	32.2
July	80.9	96.8	16,242.0	657.3	786.5	129.2	19.7
August	89.7	103.9	17,112.9	767.8	889.1	121.3	15.8
September	87.8	98.9	15,574.8	683.8	770.4	86.6	12.7
October	74.4	77.7	16,916.5	629.5	656.9	27.4	4.4
November	46.2	43.8	17,101.4	394.8	374.8	-20.0	-5.1
December	28.0	25.8	17,879.9	250.6	230.3	-20.3	-8.1
			TOTAL:	4,622.4	5,142.2	519.7	11.2

NOTE: Columns (1) and (2) are derived from model predicted reported strike rates over the COVID months of 2020. The first assumes treatment (aircraft operations reductions) are equal to zero while the second is calculated under observed treatment values. Column (4) is calculated as $\left(\frac{\text{Column (1)}}{100,000}\right) \times \text{Column (3)} \times 50$. Column (5) is calculated as $\left(\frac{\text{Column (2)}}{100,000}\right) \times \text{Column (3)} \times 50$. Column (6) is the difference between columns (5) and (4). Column (7) is calculated as $\left(\frac{\text{Column (6)}}{\text{Column (4)}}\right) \times 100$.