Is Tree Swallow (*Tachycinata bicolor)* reproductive success jointly influenced by weather conditions (temperature/rainfall) and human disturbance?

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Introduction: Each year the effects of climate change continue to reshape historical weather patterns, making weather more unpredictable (Pendergrass, 2017). Meanwhile, as human populations rise, anthropogenic disturbances continue to affect bird populations throughout Canada (Saracco, J, 2022). In this report, I will be discussing my research surrounding Tree Swallows, and if their reproductive success is jointly influenced by weather conditions along with human disturbance.

A 2015 (Priddle, 2015) report from Beaverhill Bird Observatory (BBO) discovered that rain did not directly affect the nestlings' success to a significant level; however, if it reaches an extreme level of drought, it will then likely affect nest success. This report is further supported by a 2016 BBO report (Nakonechny et al. 2016) that was able to discover that rain does not have a significant effect and fledgling success on a year to year basis. Lower temperatures often bring high winds, which limit Tree Swallow feeding on aerial insects, leading them to lay their eggs more spread apart in time or spend less time incubating (Lombardo et al. 2019). One study used experimental heating to find that when temperatures of nests are higher, parents are able to spend more energy and resources into embryonic investment such as shorter off bouts in order to better maintain nest temperatures and therefore lead to better incubation and hatching success (Ardia, 2009).

In this study, I focused on the potential impacts that climate change could have on Tree Swallow populations, through temperature and precipitation. I hypothesize that only one of the two conditions I am testing will end up proving to be significant. After reading BBO research papers on this subject I predict that it is likely that temperature will have a significant impact that is different between grids while rainfall may not have large, or any impact at all in this particular study. It is worth acknowledging however that there are other studies that contradict my hypothesis, which is why I chose this research question. As for these conditions affecting different grids in different ways, I predict that the weather conditions of each grid will behave differently, and in the end, the new grid will have a higher success rate due to reduced stresses such as insecticides, noise pollution and exhaust pollution (Yong, 2019). Through weekly data surveys at Beaverhill Bird Observatory, I collected data that would allow me to perform a comparative analysis between the differences of incubation success in terms of the percentage of successful hatches compared to eggs laid. I used the collected data to answer the following question. Do rain and temperature affect TRES fledging success depending on where they nest?

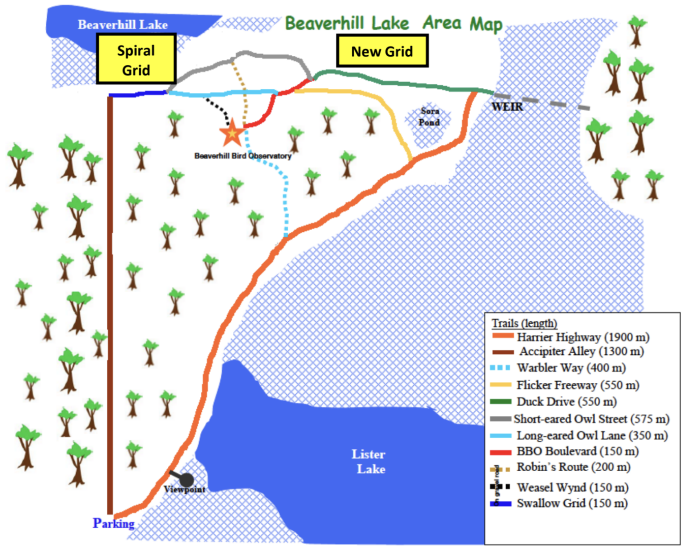
Methods

Study site

Data was collected from nest boxes located in and near the Beaverhill Natural Area (BNA), near Tofield Alberta (Figure 1). For this paper data from two grids were used. The first of these grids is called the road grid, where nest boxes are located between township road 510 and a field of crops. The road grid has 68 artificial nest boxes. The other grid is called the new grid, located in the BNA with minimal human disturbance. The new grid, established in 2013, has 50 nest boxes

and is found northeast of the Beaverhill Bird Observatory (BBO)'s buildings, slightly off BBO Boulevard. In addition to these two grids, the BBO also maintains nest boxes on a third grid (the spiral grid), which was not included in this study.

Figure 1) This figure shows a map of the Beaverhill natural area and where the new grid is situated. The road grid is located east of the bottom left corner of this map. (Picture credit BBO)



Field Data collection

From April to early August 2025, surveys of the nest boxes were conducted weekly. Each box was checked by uncoiling a wire wrapped around a nail outside the box and opening the lid (Figure 2). The number of eggs and/or nestlings from each box were recorded. In addition, I noted whether eggs were warm or cold, meaning if they had been recently incubated by parents. For the nestlings, age was documented by looking at day by day tree swallow growth pictures and comparing them with nestlings. At the end of the nestling period nests were recorded as either a success or failure based on whether or not feces were left behind after fledgling, If feces were left behind it meant a success, since in successful nests, parents stop removing feces during the final few days before fledglings leave the nest. The lay date for each egg was recorded as well by counting back from the day the last egg was laid and counting one day for each egg laid. Finally, once all data was collected, we compared the road grid data with the new grid data and performed a statistical analysis.

Figure 2) 

This figure shows a nest box on the new grid. The nest can be checked by uncoiling the wire that is attached to the nail on the side of the box and then lifting the lid. The picture was taken by myself (Kai Dunkley).

Weather variables

Nest box data from the road grid and new grid were performed by tracking lay dates and hatch dates for each individual nest box. Then lay dates and hatch dates along with rainfall and temperature data (Government of Alberta, 2025) from the Shonts weather station, which is 5 km south of BBO, were used to calculate the average daily temperature and rainfall during each nest incubation period during the 2025 breeding season.

Tree Swallows General Information

Tree Swallows are migratory birds that migrate north during the spring and summer in order to breed. They feed mostly on flying insects (Lombardo et al. 2019) and in the case of this study location, nest inside of human built nest boxes. They usually lay between 6-8 eggs that take around 14 days to hatch. Once hatched, hatchlings remain in their nests for between 15-22 days before they fledge and become independent.

Data analysis

The software R and R Studio (R core team, Version 2025.05.0+496) were used to perform all the analysis and created plots using the package ggplot2 (Wickham 2016). A general linear model was applied along with a betabinomial family to analyze the effects of temperature (°C), rain (mm), and grid (new, road) on fledging succes (# nestlings that successfully fledged out of a clutch). Fledgling success rate was predicted by using the number of nestlings that successfully fled from the nest as the response variable while using the interaction between rainfall and location as well as temperature and location as the predictor variables.

Results

Temperature and grid placement were significantly correlated with tree swallow fledging success. Tree swallows fledged more nestlings at higher temperatures ($z = 2.332$, $p = 0.0197$,

Figure 3). Tree swallows also fledged more nestlings at the road compared to the new grid (z = 4.161, p < 0.001, Figure 4). Rain was found to have no effect on tree swallow fledging success (z = -0.711, p = 0.477).

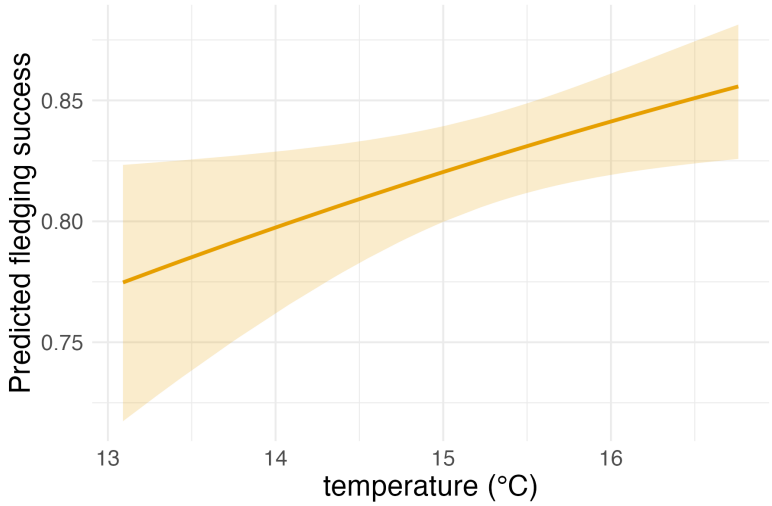


Figure 3)

This figure is a line graph that provides a visual representation towards how predicted fledgling success and temperature interact. As seen in the graph, it is apparent that as temperatures rise, the chances of fledgling success rise as well.

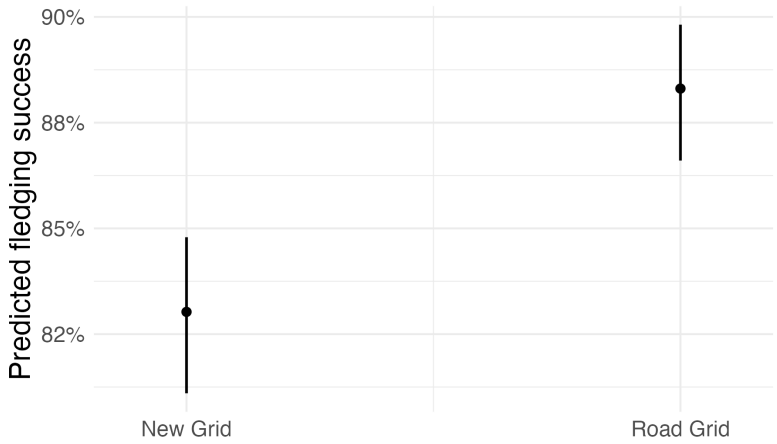


Figure 4)

This figure shows the differences between nest boxes in natural areas and nest boxes in agricultural areas with more human disturbance. The predicted fledgling success rate for the new grid is approximately 83% while for the road grid it is just below 89%, although each data point has a 95% confidence interval. The graph shows a significant difference between areas since the p value is less than 0.05.

Discussion

The data analysis showed that rain was not correlated with fledgling success, while temperature was correlated. As for the second part of the research question, the road grid had a higher predicted fledgling success when compared to the new grid. This was surprising, as it was not what I expected or what past studies have shown (Ghilain & Bélisle, 2008). This would possibly be because it is further from a forest and therefore has less shaded areas, leading to higher temperatures, which in turn warms nests, requiring less incubation from parents, and leading to warmer egg temperatures (Ardia, 2009). However temperatures in and near the nests were not collected as part of this project. As for why rain was not correlated while temperature was, I believe it may be because, except in severe cases like an extreme drought or many days in a row of rain, the amount of rain during the whole incubation period is not substantial enough to cause a difference between nests. Therefore, only a select few years would actually produce significant results for this experiment type (Priddle, 2015). Temperature, on the other hand, had a larger difference between the minimum and maximum mean averages, likely contributing to the results being significant. This proves that differences in temperature affect tree swallow nest success disproportionately compared to precipitation, as temperature had a significant effect, while precipitation did not in this experiment. Overall, this study provided important results as for how nests in different areas are affected by both rainfall and temperature.

Conclusion

The results achieved in this study can provide us with useful information as to how the effects of both climate change and increased human disturbance may affect Tree Swallows. In this case, the results of the study actually provide an optimistic outlook for the future. Grids facing more anthropogenic disturbance turned out to have a higher fledgling success rate. Along with this, nests that had higher average temperatures during incubation also were more likely to have success. Of course, I presume that this is only up to a certain temperature which means we should still try to limit the effects of climate change as much as we can. In conclusion, this study shows that while tree swallow populations are declining, climate change may not be the most prominent cause.

One caution to these conclusions is that correlation does not prove causation (Barrowman 2014). Correlation means two variables change together, while causation means one variable directly causes the other to change. Thus, the variation in temperature could be related to other environmental factors such as food supply, and not incubation directly.

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