The effects of the 2021 heatwave on House Wren (*Troglodytes aedon)* nest success in the Beaverhill Natural Area

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Introduction

As global climate change progresses, bird species will face many new pressures. One of these pressures will be a rise in regional temperatures (Schneider, 2013). Predictions done by Schneider, indicate a minimum temperature increase for the province of Alberta of two degrees Celsius by the year 2080, followed by a decrease in the overall summer humidity that will affect future ecosystems within the province (Schneider, 2013). Studies have shown that these new higher temperatures are already affecting passerine populations across the planet, indicating the importance of examining this question with regards to passerines in Alberta (Conrey et al. 2016; Sharpe et al. 2021). In 2021, a heatwave struck Alberta setting over 200 new heat records across the province (Butler 2021) and raising temperatures to over 35 degrees Celsius in the Tofield region (Environment and Climate change Canada, 2021). This period of high temperatures lasted for approximately three weeks with intermittent days of cooler temperatures between the end of June and the beginning of July (Environment and Climate change Canada, 2021). Previously, a coastal heat wave known as “The Blob” decimated thousands of bird species across the northwestern coast of North America, resulting in significant shifts in the overall population and damaging bird populations across the coast (Mapes, 2018). This example establishes the potential of a mass decline in populations in similar extreme weather events. While the 2021 heatwave was not as extreme (Mapes, 2018), this report will examine how this extreme weather event affected the success of House Wren nests in the Beaverhill Natural Area (BNA hereafter).

Troglodytes aedon (commonly known as the House Wren), is a small bird native to regions across the Americas (Udvardy and Farrand 1994). They are a tree cavity-nesting species known to use nest boxes, that inhabit urban areas, farmland, and the edge of woodland areas (Udvardy and Farrand 1994). In the BNA, the House Wren nest boxes are located within the Aspen parkland ecosystem. This environment is ideal for the House Wren as it is frequently lightly forested interspersed with stretches of open prairie (Bork et al. 2013).

While studies have been conducted in recent years examining the effect of heat on passerines, there have been little to no studies performed on North American cavity-nesters, like the House Wren. When studying passerines in warmer prairie climates, Sharpe et al. (2016) and Conrey et al. (2021) each found a correlation between the air temperature and the survival of the young. However, both studies were performed on open nesting species as opposed to a cavity nester. A study performed on cavity-nesting species in the Mediterranean revealed that heat did not seem to affect the survival of nestlings but found that size and mass of nestlings were negatively affected (Salaberria et al. 2014). The study by Salaberria et al. found evidence that cavity nests provide a microclimate, sheltering the nestlings from the effects of higher temperatures. This microclimate combined with the shelter of the aspen trees could provide sufficient protection to limit the effects of the heat on the House Wren nestlings in the BNA.

Methods

Nest boxes were examined in the BNA, located on the south shore of Beaverhill Lake near Tofield, Alberta. The 99 nest boxes monitored were divided into 4 Grids. Grids A, C, and D were set out in a 5x5 grid, while grid B was set out in a 3x8 pattern. Throughout mid-May, until early August of 2021, myself and my fellow intern Claudia Gracie de la Cruz performed weekly inspections of these boxes to examine the contents of the nests within. In these inspections, we would record what nesting materials were being used and how full the nest box was to establish if a House Wren was constructing a nest. House Wren nests were identified and marked as initiated when the box was more than halfway full of twigs and lined with grasses. Since House Wrens may create multiple “Phantom Nests”, we included all nests in our data that had been identified as belonging to a House Wren as “Initiated Nests”. The nests were checked for number of eggs, egg temperature, and nestlings. When House Wren nestlings were found, they would be aged using a photographic aging guide and then the box left alone until the young would have reached 30 days old (a week after fledging). This was done to prevent early fledging in the House

Wren nestlings and to prevent high levels of stress on the chicks. These factors can often lead to premature chick death which would damage the population. After the nestlings fledged, the nests would then be examined for the presence of fecal sacs. House Wren parents remove fecal sacs from nests to reduce the risk of predation for much of the nestling period (Petit et al. 1989) and will stop removing fecal sacs in the few days pre-fledging (Personal Communication, 2021). The presence of fecal matter in the nest typically indicates chick survival and a successful fledging. Successful nests were defined as nests where the nestlings fledged.

The data from previous years was examined starting with the year 2015 when grid D was established. The data from previous years were gathered using similar methods by previous interns. Data from 2016 was not available for this study as no internships were examining House Wrens that year. Climatic data were taken from the SHONTS research station operated by the Government of Alberta. The SHONTS station was chosen at it was the closest weather station to the Beaverhill Bird Observatory. This data was accessed from a database maintained by Environment and Climate Change Canada. When examining weather data, the number of days over 30°C was used as an identifying characteristic of high temperature. In previous studies, the probability of nest success began to decrease at temperatures of 35°C (Conrey et al. 2016, Sharpe et al. 2021). However, 30°C was decided as a reasonable measurement of extreme temperature as the previous studies were conducted in climates that are warmer than the Tofield region (Sharpe et al. 2021, Conrey et al. 2016). The dates examined and counted differed from year to year but, were always between the first and last checks done by the Beaverhill Bird Observatory interns.

Results

When examining the number of days over 30°C, 2021 is higher than the mean and standard deviation set by the previous five years (Figure 1). This suggests a significant difference in the number of days over

30°C when we compare 2021 with the previous years of study.

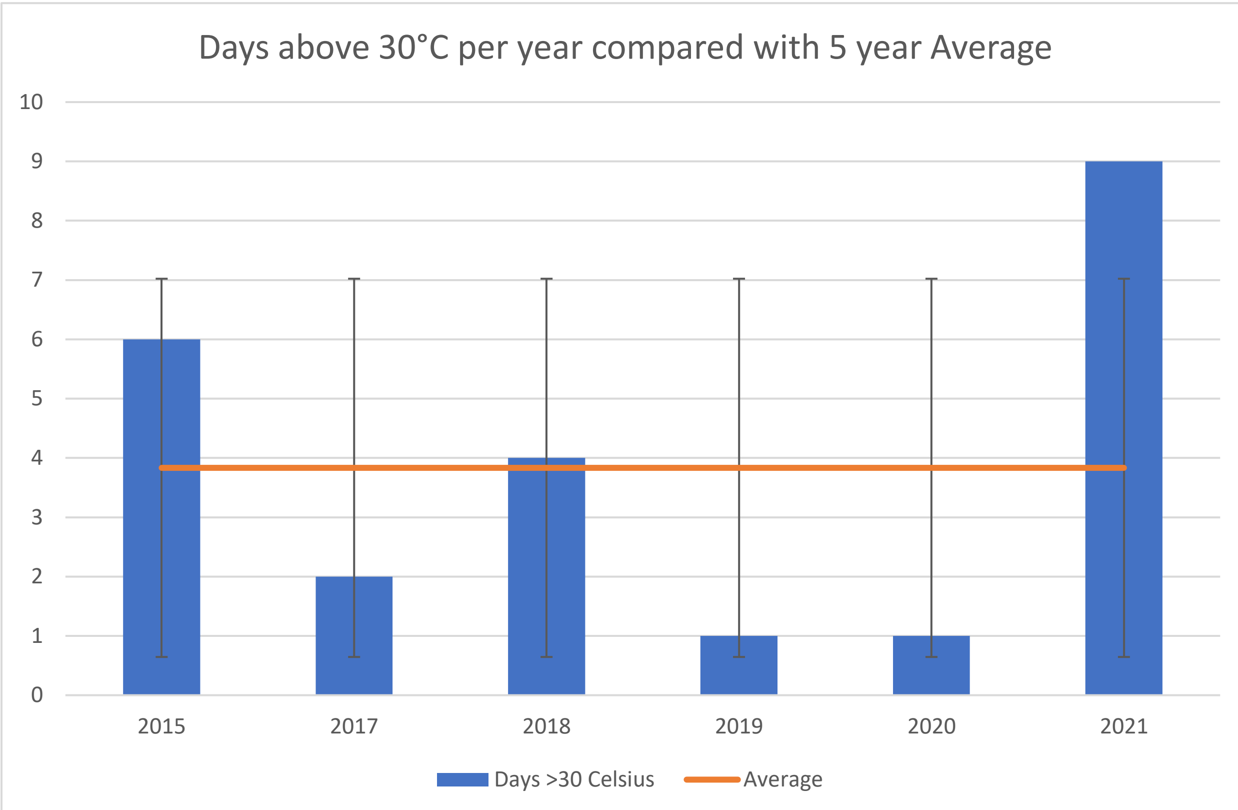

Figure 1: The number of days over 30°C every year compared with a 5-year average. The days that were counted were between the first and last nest box checks done by the Beaverhill Bird Observatory interns. Temperature data was acquired from Environment and Climate Change Canada databases on the number of days that were hotter than 30°C. The average and standard deviation for the number of days above 30°C were then calculated using the five years where data on house wren nesting was available.

Next, data was assembled to see if there was a reduction in nests initiated per grid. If there was a reduction in the number of nests initiated, the chance of correctly identifying trends in nest success may be affected. The average number of nests initiated per grid was examined per year and an ANOVA test found that there was a significant difference between the average number of nests initiated per year (F-score= 5.555, $\alpha<0.05$). A non-paired t-test was then used to compare the average initiated nests per grid in 2021 against the average nests initiated per grid over the 5 previous years with available data; it was found to not be significantly different from this average ($\alpha=0.170986$, $\alpha>0.05$).

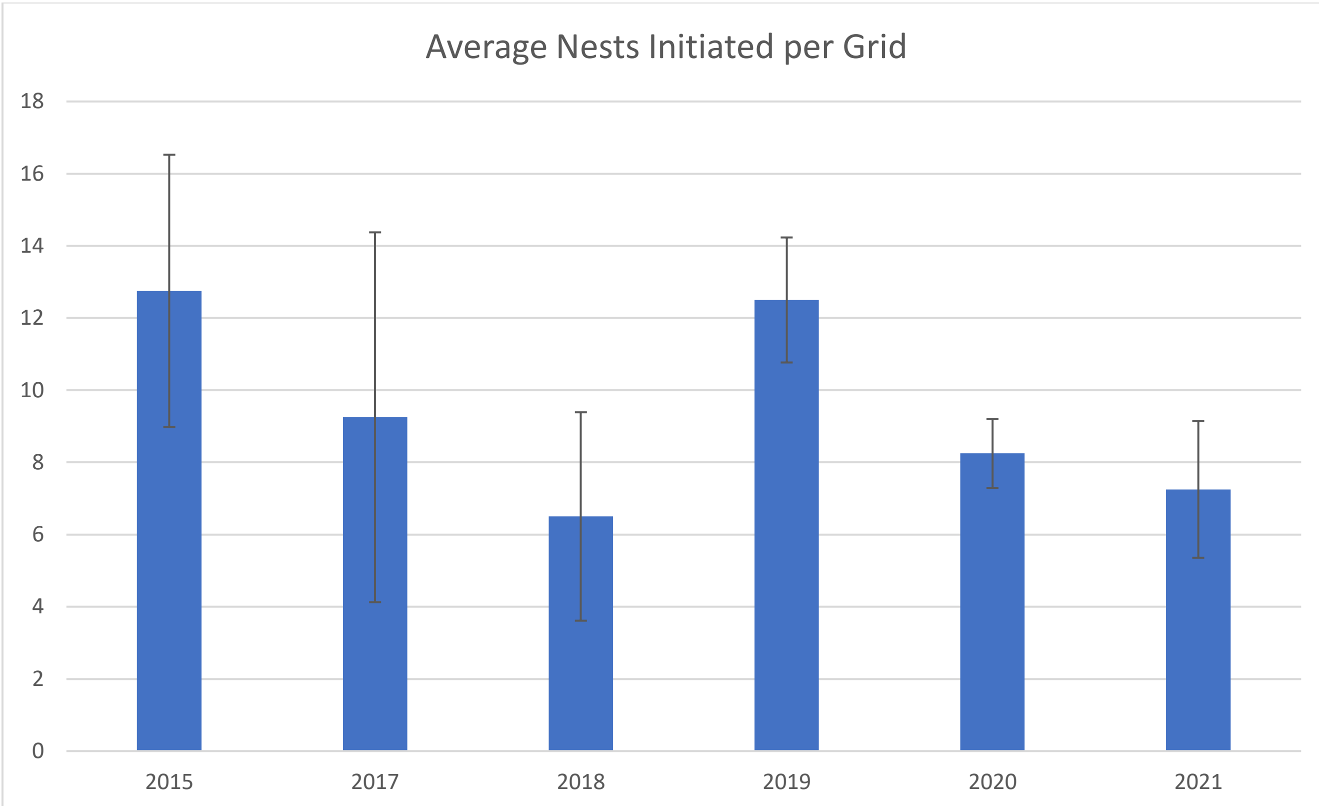

Figure 2: Average number of nests initiated per grid over 6 years. The average number of nests initiated per grid was calculated for each year along with a standard deviation. An ANOVA test revealed that there is a significant difference between the average number of nests initiated per year (F-Score=5.555, $\alpha<0.05$ df=5,19).

Finally, the nest success rate was compared with the success rates of the previous years. The success rate was calculated by dividing the number of successful nests by the number of nests initiated . An ANOVA test found that there was a significant difference between the nest success rates between years (F-Score=3.32, $\alpha<0.05$). A Chi-Square test comparing the success of the boxes in 2021 was compared against the average success rate of the previous five years of data and was found to be significantly different from the average success rate of nest boxes (7.827>7.815, $\alpha<0.05$).

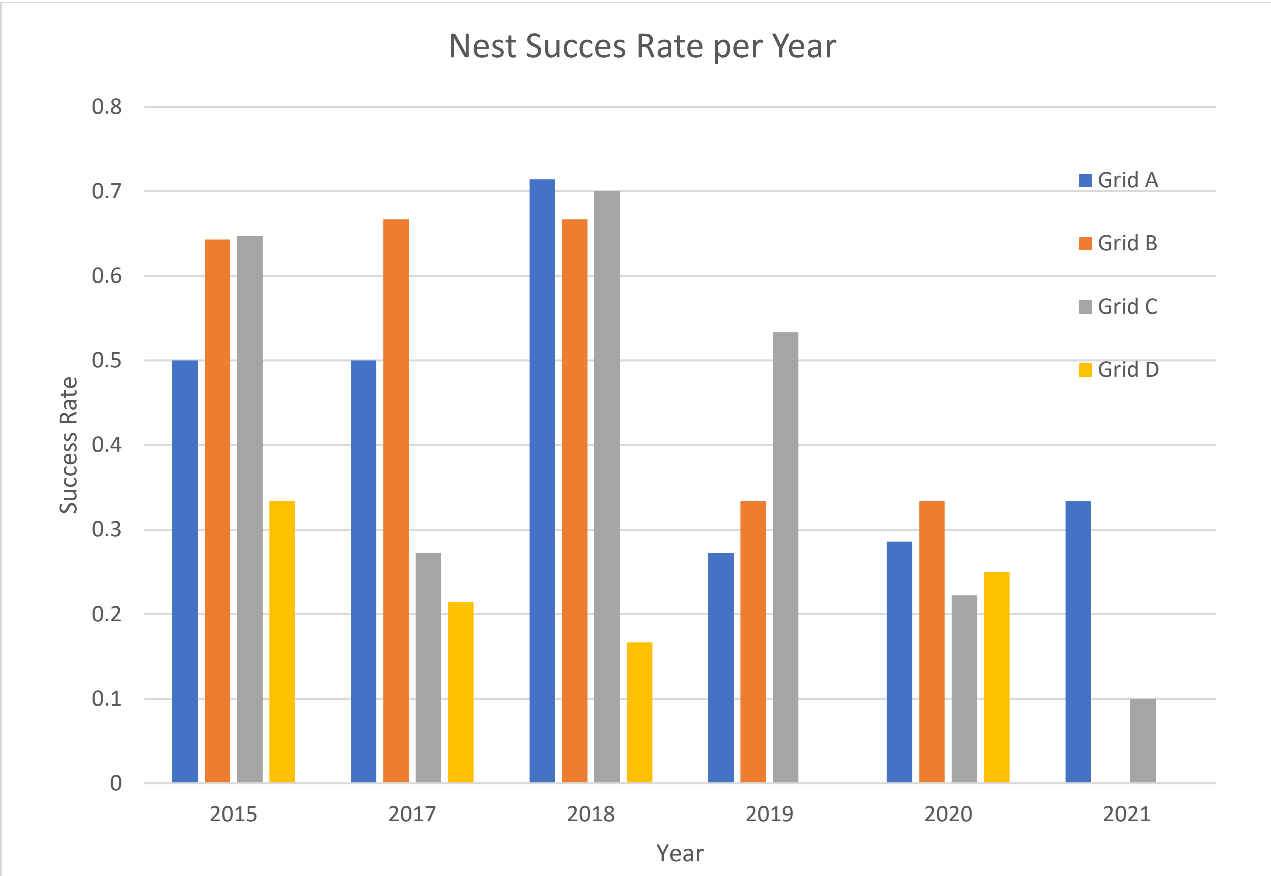

Figure 3: Nest success rate per year divided by grid. The nest success rate was determined by comparing the number of successful nests with the number of nests initiated. The success rates for Grid D in 2019 and Grids B and D in 2021 were zero since there were no successful nests within these grids. An ANOVA test was used to compare the success rate per year and found evidence that there was a significant difference year to year (F-Score=3.32, $\alpha<0.05$ df=5,19).

Discussion

The statistics suggest that nest initiation, which occurred prior to the heatwave, was not affected in 2021; however, nestling survival during the weeks of the heatwave was affected. First, Figure 1 suggests that 2021 was significantly warmer than the previous 5 years, and an outlier in terms of heat. It is also worth noting that the majority of these hot days occurred from the end of June until mid-July (Environment and Climate Change Canada, 2021), which is when many House Wren chicks were hatching. There were also fewer successful nests compared with the 5 years previous, suggesting that the heatwave may have impacted the success of the nestlings (Figure 3). It is also important to note that in 2021, there were two grids with no successful nests (Figure 3). The only other year to have no nests succeed in a grid was in 2019. Nest initiation was not significantly lower than in years previous (Figure 2), suggesting that this data was not likely affected by changes in the number of individuals nesting in the BNA. This finding fits more with the findings of Conrey et al. (2016) and Sharpe et al.(2021) as both studies found that as temperatures rose, the nest success of passerines was negatively affected. What is important to note is that the temperature where nest success began to decrease in these studies was at 35°C (Conrey et al. 2016, Sharpe et al. 2021), while our findings suggest that for House Wrens in the aspen parkland ecosystem, nest success decreased at 30°C. It is also important to note that house wrens have a distribution across North America (Udvardy and Farrand 1994), meaning that populations located in warmer areas of the continent may not experience the same heat effects as the populations in the Beaverhill Natural Area.

While this data suggests that heat had an impact on the nest success of House Wrens, further study is warranted on the degree that heat impacts the House Wren. To avoid disturbing the nestlings and causing early fledging, we were unable to gather more substantial data seen in other studies such as nestling dehydration and size and mass at fledging (Salaberria et al. 2014). Data such as this could provide a further link between heat and nest success in fledglings as well as provide more data on the effect heat has on the nestlings themselves (Salaberria et al. 2014). While this may be impossible to do without disturbing the nestlings, data on similar species that are less sensitive could be useful for our understanding of the effects heat is having on birds in the Aspen Parkland. It is also worth noting that House Wren males build multiple nests in hopes that a female will choose one of his nests and mate with him (Di Silvestro, 2010). This means that there is the possibility that fewer females chose to lay their eggs in nest boxes in 2021 and instead laid their eggs in other cavities. While this is unlikely to have had a big impact on our data, it may have influenced some of our results. Because of these factors, I would recommend a future study build upon our findings. Potentially, by using an infrared thermometer or iButtons, we could get a better picture of the temperatures nestlings face inside of nest boxes, without disturbing the nests. Furthermore, as data continues to be collected, it would be important to compare the results of a future heatwave on House Wrens with the results found in this study. These studies would be able to provide a more accurate picture of the potential future of house wrens in the Beaverhill area.

As our climate continues to change, we must continue to monitor the effects of our changing world on the species that surround us. This study has already revealed a potentially negative effect on House Wren populations during a heatwave. As these heatwaves become more frequent, it is important to examine the effects these heatwaves may have on the various bird species in Alberta. By examining other species, we can get a better picture of the effects that climate change will have on Alberta's ecosystems and bird populations. By better understanding these effects, we can see how to best protect and understand the birds that surround us.

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