The Association of Nest Box Negligence with Tree Swallow (*Tachycineta bicolor*) Reproductive Outcome

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Abstract – The decline of Tree Swallow (*Tachycineta bicolor*) populations in North America since the 1980s has been dramatic. Conservation efforts include using nest boxes as artificial next sites for swallows. While these artificial nesting cavities have shown reproductive benefits, their effectiveness to promote reproductive advantages can be influenced by a number of factors including location and maintenance. Weekly monitoring of nesting activities and neglections took place at the Beaverhill Bird Observatory in Alberta, Canada. A comparative analysis of data collected in 2023 and 2024 indicated lower hatching success in correlation with higher negligence rates, although it could not be concluded as statistically significant between breeding seasons and among grid types. Further research is necessary to optimize nest box care and maintenance for effective conservation.

Introduction

The sharp decline of bird populations worldwide has garnered the attention of scientists and the general public. Aerial insectivores, birds that catch insects in flight, are among the most affected in North America, which includes Tree Swallows (*Tachycineta bicolor*) (Kardynal and Imlay 2022). Tree Swallow populations have steadily declined in North America and other regions since the 1980s (Kardynal and Imlay 2022). The driving factors of these declines are environmental changes, including pesticide use, climate change, and urban expansion. The introduction of nest boxes served as a conservation technique in order to restore species that require cavities for nesting (Kardynal and Imlay 2022). Nest boxes offer reproductive advantages such as greater clutch sizes, higher fledging success, and increased nestling survival (Dale et al. 2021). Nest-site supplementations additionally allow birds to settle earlier, resulting in earlier egg laying (Norris et al. 2018; Dale et al. 2021). While nest boxes have been seen as a successful

management technique for the recovery of many swallow species, these avian sanctuaries are typically in areas of higher predation and/or reduced food availability (Norris et al. 2018). Other aspects besides the areas where nest boxes are placed may negatively impact the reproductive success of Tree Swallows. One of these factors includes the maintenance of the boxes (Norris et al. 2018).

The design, size, and material of nest boxes can affect the suitability for birds, potentially creating ecological traps if poorly designed or maintained (Norris et al. 2018; Dale et al. 2021). For example, when nest boxes are unable to withstand environmental fluctuations or extreme climate events, nests can fail, resulting in serious harm, death, or nest abandonment (Norris et al. 2018). These incidents, led by negligence, can be identified as any physical disruption to the condition of the nest box, influencing its ability to provide a safe environment for the Tree Swallows. These neglections include missing tops/sides, missing wires, faulty wires, fallen boxes, or boxes in complete disassembly. This does not include checking the nests at vulnerable times, during which nestlings are at their most critical stages of development.

Methods

Study Site

I collected data from a population of Tree Swallows naturally occupying artificial nest boxes maintained by the Beaverhill Bird Observatory (BBO) located near Tofield, Alberta, Canada. Tree Swallows migrate north for breeding purposes in the spring/summer, after which they return south towards Central and South America (Blyth et al. 2019). Tree Swallows have been monitored at the observatory since its establishment in 1984 (Beaverhill Bird Observatory [accessed 2024]). There are three artificial nest box sites or "grids" in which Tree Swallows are monitored: the Road Grid, the New Grid, and the Spiral Grid. The Road Grid is located along the fence line of Township Road 510, encompassing 58 nest boxes. The New Grid is located in the northeast sector of the Beaverhill Natural Area (BNA), found at the end of BBO Boulevard, which contains 50 nest boxes. The Spiral Grid is found in the northwest of the BNA, containing 90 nest boxes, and is the grid closest to Beaverhill Lake (Figure 1).

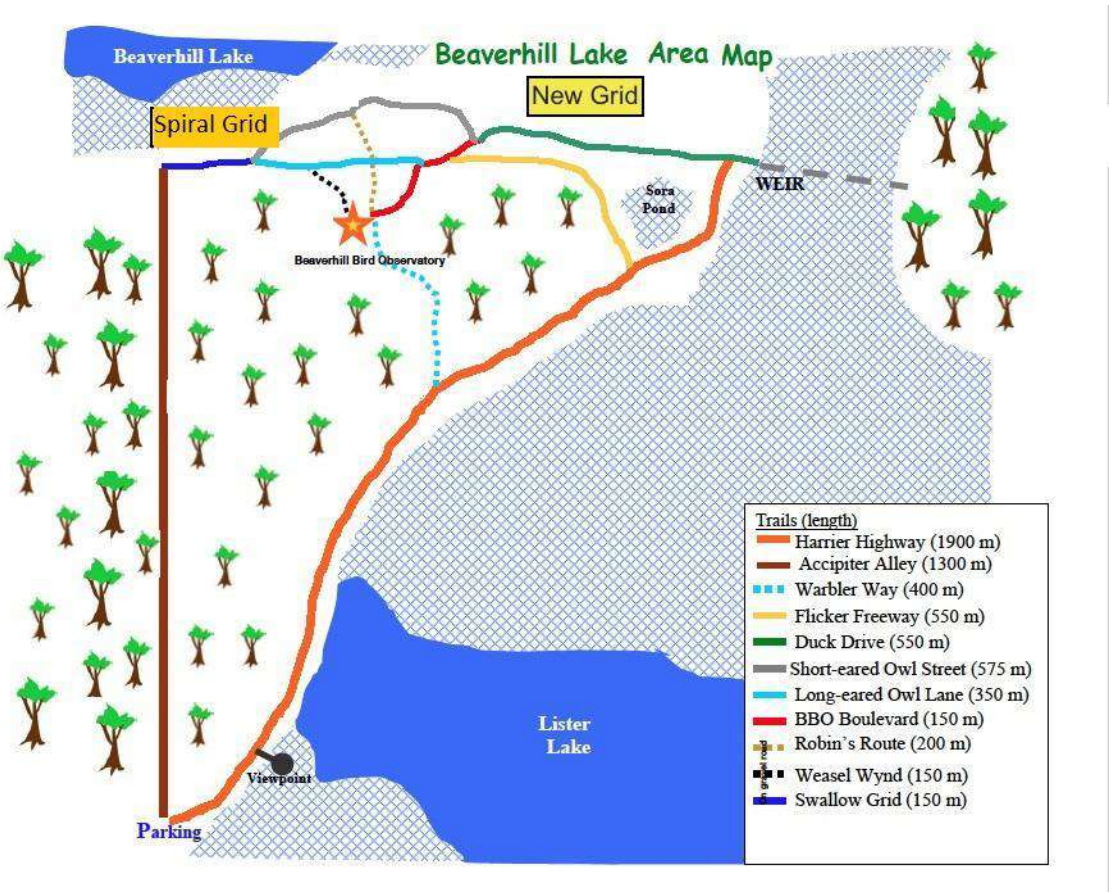

Figure 1. Beaverhill Bird Observatory trail map including the distribution of Tree Swallow grids. The Road Grid is excluded from this version of the trail map. Trail map was provided to interns by the Beaverhill Bird Observatory, within the Tree Swallow Internship Manual.

Nest Boxes

The nest boxes at the BBO are small wooden boxes with a hole located at the front, allowing birds to enter them. The boxes are secured to poles and are spaced approximately 25 metres apart from one another. The boxes can either be opened from the top or the side. These are secured to the rest of the box using screws and wiring (Figure 2a). Boxes that open from the top have a wire over the top secured to screws on either side below the lid. Side opening boxes have a hinged side with the wire at the bottom to keep the dies closed. It is important that staff and volunteers ensure the wire is securely fastened, as the boxes can be vulnerable to the elements if they are not closed properly.

Data Collection

Tree Swallow nest boxes were monitored over the course of the 2024 breeding season, at least once a week, lasting from May to early August. Nest checks consisted of monitoring and recording all activity taking place in the box. This included nesting state (active or inactive), building stage (partial, full, or lined nest), the presence/absence of an adult (Figure 2b), and the number of eggs and/or nestlings present (Figure 2c). The temperature (warm or cold) of the eggs was also recorded. Collecting this data provided information regarding the stages of offspring advancement, aiding in determining approximate hatching and fledging dates. By monitoring the nests, we are provided with a better understanding of the activity of the current Tree Swallow population inhabiting the area. It also allowed volunteers to estimate the dates in which the nestlings would be in the most critical stages of their development, so as not to disturb them and risk early fledging. Any signs of negligence were also recorded. This meant identifying any boxes that had missing lids/sides, faulty wiring, or were found to be completely demolished. This data would inform other interns of any boxes that needed lid and/or wire replacements, and which nests could be at risk of failure.

Figure 2. a) Nest box located in the New Grid at the Beaverhill Bird Observatory. b) Presence of an adult Tree Swallow in a nest box. c) Presence of eggs in a nest box.

Analysis

Nest box data collected from the 2023 and 2024 breeding seasons were assessed and compared to investigate the effectiveness of the nest boxes at the BBO. By doing a comparative analysis, information regarding the state of the boxes, the maintenance practices, and their durability in varying conditions offers insight into the effectiveness of the boxes over time. The goal in comparing data from two different breeding seasons is to assess if there is a significant difference in the reproductive output and determine the root causes of failed nests. Using Excel and Jasp softwares, analyses of this season and comparisons between the two seasons, and a Kruskal-Wallis test for grid comparison were conducted in an effort to determine the effectiveness of the nest boxes at the BBO. The response variables in relation to nest box neglections included: clutch size, number of hatched eggs, and number of fledglings. These outputs were compared for the 2023 and 2024 breeding seasons to establish any significant differences in reproductive success. Each grid type at the BBO was also analyzed and compared to one another for the 2024 season, in order to detect any weak areas that need to be addressed.

Results

A comparative analysis of the data from summer 2023 and 2024 indicated a noticeable difference in 1) missing lids/sides, 2) faulty wiring, 3) demolished boxes, along with a decrease in the number of eggs hatched and the number of fledglings (Figure 3). Despite these changes, there was little variation in the timing of laying, hatching, and fledging across both years, as seen in Figure 4. A breakdown of the 2024 data revealed that the Road Grid experienced the highest number of recorded neglections, likely due to a lack of interns properly securing the wires on boxes. In addition to this, the Road Grid is most exposed to the elements, meaning that failing to secure the wires efficiently will cause these boxes to be most at risk of failing. In contrast, the New Grid experienced the fewest number of neglections, and is likely due to it being surrounded by vegetation (i.e. tall grass and shrubs) that protects it from outside influences.

There was a notable inverse relationship between the number of neglections and the number of hatched eggs, which can be seen in Figure 5. As the Road Grid had the highest neglect rate, it exhibited the lowest proportion of number of hatched eggs. Conversely, the New Grid, with the fewest neglections, had the highest number of nestlings (Figure 5). Initial analysis using

JASP proved to be difficult, as the data did not meet normality conditions, even after transformation. A one-way ANOVA was unable to be performed, thus the Kruskal-Wallis test was employed instead. The test showed that there was no significant difference in the number of eggs hatched across the different grids (Figure 6).

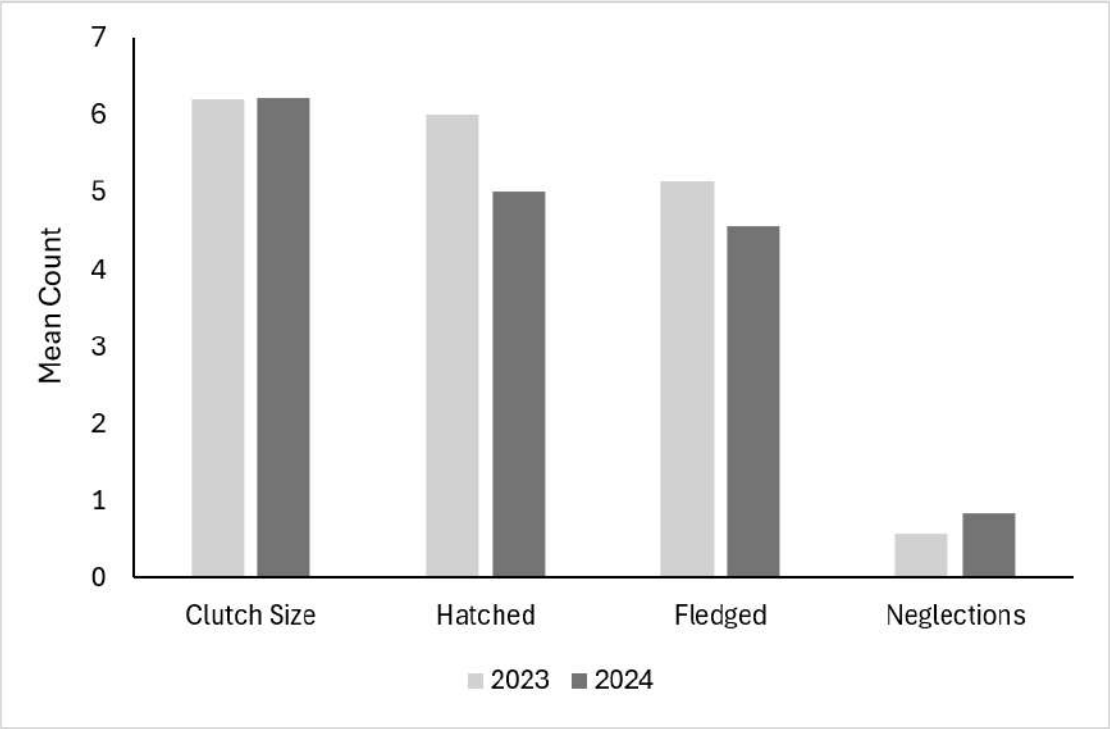

Figure 3. Mean number of Tree Swallow clutch size, hatched eggs, fledged, and neglections during the 2023 and 2024 summer seasons across all three grids at the BBO. Raw data from both years were averaged and compared to one another. Graph created using Excel.

	2023						
	First Egg Date	Incubation Start Date	Clutch Size	Incubation Length (days)	Hatch Date	Number Hatched	Do Not Disturb Nest Starting:
Mean	25-May-23	30-May-23	6.2	11.7	12-Jun-23	6	28-Jun-23
Total			1161			1009	

	2023						
	Fledge	Fail	Number Fledge	Primary Reason for Fail	Neglections	Inactive	Check for Fledging On:
Mean	89.90%	10.10%	5.1	Predation	0.6	2.9	06-Jul-23
Total	179 boxes		862		8	52	

	2024						
	First Egg Date	Incubation Start Date	Clutch Size	Incubation Length (days)	Hatch Date	Number Hatched	Do Not Disturb Nest Starting:
Mean	26-May-24	31-May-24	6.2	14.3	15-Jun-24	5	01-Jul-24
Total			1146			941	

	2024						
	Fledge	Fail	Number Fledge	Primary Reason for Fail	Neglections	Inactive	Check for Fledging On:
Mean	86.00%	14.00%	4.6	Wind	0.8	2	09-Jul-24
Total	178 boxes		816		20	44	

Figure 4. Comparison of the data from the 2023 and 2024 breeding seasons. Includes means and totals of data from 2023 and 2024. 'Do Not Disturb Nest Starting' refers to period in which nest boxes should not be checked as nestlings are in critical stages of development. Figure made using Excel.

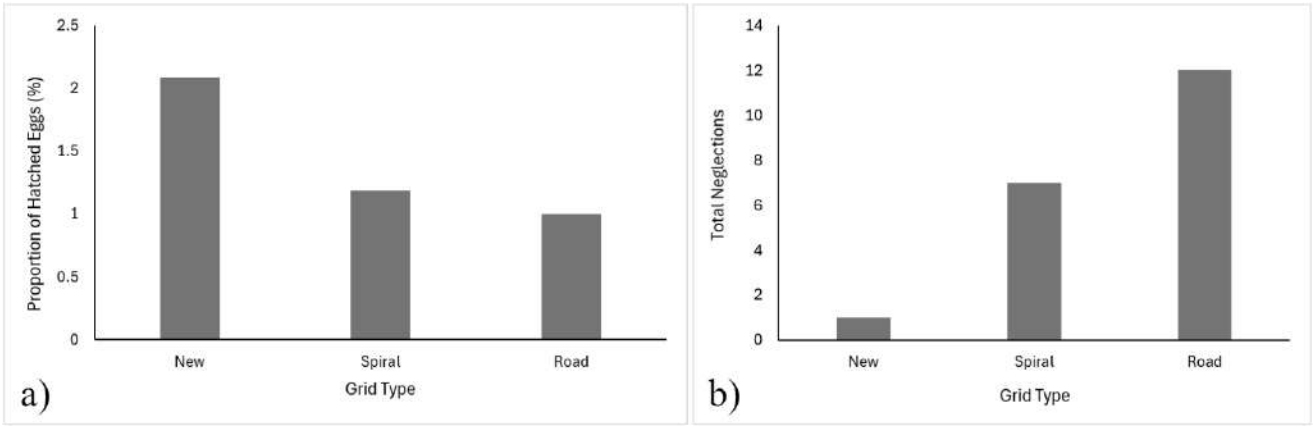

Figure 5. Graphs achieved by using Excel. a) Proportion of hatched eggs in the different grids at the BBO. Proportion was multiplied by 100 in order to demonstrate results as a percentage. b) Total number of recorded neglections per grid type.

Kruskal-Wallis Test

Factor	Statistic	df	p
Grid	4.049	2	0.132

Figure 6. Results of the Kruskal-Wallis Test. Number of eggs hatched per grid type was input into JASP software and analyzed. As data did not meet normality conditions for a one-way ANOVA, a Kruskal-Wallis test was done instead.

Discussion

The results of this report indicated that while some instances of nest failure were observed, they did not significantly impact the overall reproductive success of Tree Swallows in terms of number of nestlings and fledged birds. Although a noticeable difference was observed, it was not statistically significant. Therefore, it cannot be concluded that the nest box condition significantly influenced the reproductive outcome. Other studies have demonstrated that Tree Swallows are generally negatively affected by changes in their environment, such as disturbed habitats (Blyth et al. 2019). Although these effects were not observed in 2024, or in comparison with the 2023 data, it is recommended that further research be conducted at the Beaverhill Bird Observatory to investigate this issue. To prevent further incidences of negligence, the BBO should address any underlying factors that contributed to past instances of nest box failure and enhance the training of interns to ensure box maintenance is performed properly.

Over the next few breeding seasons, it is essential that the number of hatchings, nestlings, and fledglings be monitored, as well as nest box neglections. Further research might explore other factors influencing reproductive outcomes to better understand the complexities of nest box utilization (Dale et al. 2021). Developing a better understanding of the population of Tree Swallows in the Beaverhill area includes researching the factors that may positively or negatively influence their reproductive output. Should there continue to be a decrease in reproductive output over the next few breeding seasons, this issue's significance can increase; thus, providing opportunities and urgency to improve the condition of the nest-site supplementations (Kardynal and Imlay 2022). Although the results of this report were not significant, it is still important to implement strategies to prevent any potential nest failures. Enhancing maintenance practices, even with inconclusive data, could still contribute to increased

positive outcomes for the nest boxes. Small improvements over time such as increased communication on nest box conditions and education on proper maintenance, could have a beneficial effect on future breeding seasons. In order to ensure nest boxes remain a successful conservation technique, it is important that they are carefully managed and adjusted to the needs of the birds that inhabit them.

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References

Beaverhill Bird Observatory. [date unknown]. Edmonton (AB): Beaverhill Bird Observatory. About BBO; [accessed 2024 June 29]. https://beaverhillbirds.com/welcome/about-bbo/.

Blyth M, Paine CWE, Paine CET. 2019. The decline in nesting success of Tachycineta bicolor (Tree Swallow) over 38 years on Hardwood Island, Maine. Northeastern Naturalist. [accessed 2024 July 24];26(2):236-250. https://www.jstor.org/stable/48688900.

Dale CA, Reudink MW, Ratcliffe LM, McKellar AE. 2021. Effects of urbanization and nest-box design on reproduction vary by species in three cavity-nesting passerines in the Okanagan Valley, British Columbia, Canada. Can J Zool. [accessed 2024 June 29];99(2):141-147. https://doi.org/10.1139/cjz-2020-0028.

Kardynal KJ, Imlay TL. 2022. Ecology and conservation of avian aerial insectivores. Can J Zool. [accessed 2024 June 28];100(10):615-616. https://doi.org/10.1139/cjz-2022-0076.

Norris AR, Aitken KEH, Martin K, Pokorny S. 2018. Nest boxes increase reproductive output for tree swallows in forest grassland matrix in central British Columbia. PloS ONE. [accessed 2024 July 3];13(10):1-12. https://doi.org/10.1371/journal.pone.0204226.