Impact of a Selective Experimental Grid on Northern House Wren (*Troglodytes aedon*) and Tree Swallow (*Tachycineta bicolor*) Nesting Distributions within the Beaverhill Natural Area

By: Lauren Undheim

Beaverhill Bird Observatory

Student Internship

September 7, 2025

Abstract

According to historical monitoring data, Northern House Wren (HOWR) nest counts have been steadily declining over the last twelve years within the Beaverhill Natural Area – a trend that may hinder the easily accessible wellness information provided by nest boxes. In 2025 an experimental grid, "Grid E" was established in order to first determine whether selective nest boxes (boxes with Northern House Wren inserts) would have an impact on the species occupancy within the grid, and secondly determine the distribution of occupied boxes between grids A, B, C, D, and E. Ultimately, Grid E was exempt from the tests as there were no count values greater than zero, therefore the Fisher's Exact Test to determine the impact of selective inserts on species distributions was not administered. A Chi-square test-of-independence was conducted to determine whether there was a significant difference in Northern House Wren versus Tree Swallow nesting distributions between the four remaining grids, and the null hypothesis failed to be rejected with a p-value of 0.14, x^2 value of 5.52. As a result, I could not conclude that Tree Swallow/Northern House Wren distribution was dependent on Grid location, meaning any differences may have been due to chance rather than indicative of a preference. The causes of the decline of Northern House Wrens in the nest boxes in Beaverhill Natural Area remain unknown.

Introduction

Northern House Wrens were first studied in the Beaverhill Natural Area by Michael Quinn in 1986 and 1987 (Quinn, 1989), then with internships beginning in 2013. According to Quinn (1989), the breeding success of the Northern House Wren is determined by an array of factors, including a lack of available nesting cavities, vegetation structure and interspecific competition. Tree Swallows have been known to precede Northern House Wrens in their nest establishment, while Northern House Wrens notoriously supersede the Tree Swallow's nest boxes, resulting in an ongoing feud for nesting cavities (Quinn, 1989).

The decline in Northern House Wren (*Troglodytes aedon*) nest box habitation in the Beaverhill Natural Area has become increasingly evident as the years progress. Results from the 2013 internship, for example, remarked a lower nesting density compared to those of Micheal Quinn in 1986 and 1987. There was a 28% occupation rate in grid A (7/25) and 25% occupation rate in grid B (6/24) in 2013 (Butler 2013). Comparatively, Quinn's statistics indicated a 43% occupation rate in grid A (10/23) and 58% occupation rate in grid B (14/24) (Butler, 2013). Furthermore, the 2017 comparison of Northern House Wren grid occupancy from 2014 to 2017 didn't yield a significant difference in nest/nestling quantities over the years, but mentioned Grid B was facing an apparent decline in the number of both nests and nestlings (Antoniw & Golly, 2017). The most recently completed internship (2024) observed only three successful Northern House Wren nests out of 99 available boxes of which 55 were occupied; 52 boxes containing Tree Swallow (*Tachycineta bicolor*) nests (Bilodeau, 2024). This means – given the 99 available nest boxes – only 3% were successfully occupied by wrens. It's important to note these results were all derived at different stages of grid development and inclusion, but a correlation between increasing year and decreasing occupation is still discernible.

Artificial nest boxes have proved to be reliable homes for cavity-nesting birds, including Northern House Wrens and Tree Swallows. Compared to natural cavities, it's been shown they increase clutch sizes and decrease predation rates (LlambÍas & Fernández, 2008). Likewise, Finch (1990) found an increase in vacant boxes lessened the destruction of Northern House Wren nests as serial predation was alleviated by a lower predator reward rate, ultimately a result of high nest box density. This means Northern House Wrens have higher mortality rates when their nesting cavity options are limited, an occurrence which may be diminished by the introduction of a new, separate grid, “Grid E”. Furthermore, Quinn (1989) determined that, in the Beaverhill Natural Area, Northern House Wrens bred more in the presence of nest boxes, aligning with his prediction that bird boxes increase Northern House Wren breeding density and suggesting that cavity availability is primarily what limits this density. Quinn (1989) also mentioned that vegetation structure may have an impact on Northern House Wren breeding success, specifically sparsely treed areas. Therefore, Grid E’s success is also dependent on its more heavily forested, southern location.

Finch (1990) suggests, while intraspecific competition may result from a lack of nest sites and lead to encroachment, interspecific competition has its own notable consequences. Northern House Wrens are known for taking over nests and destroying the offspring of both conspecifics and other species to acquire nests, nutrition, and mates (Pribil & Picman, 1991). One factor accounting for these usurpations is the competition between Northern House Wrens and Tree Swallows for a limited number of nesting cavities. More Tree Swallows mean less available nest boxes for Northern House Wrens (Finch, 1990). Therefore, the addition of box inserts selecting for Northern House Wren’s smaller size should decrease interspecific competition, reduce interference with Tree Swallows and increase the number of Wren nests.

I hypothesized that the addition of selective nesting cavities would increase the number of Northern House Wren nests as interspecific/intraspecific competition rates are reduced and habitat needs are met. I predicted there would be a greater proportion of Northern House Wren nests in Grid E and a greater proportion of Tree Swallows in Grids A, B, C and D, which lack selecting inserts and reside in sparser, northern locations. Within Grid E, I predicted the five nest boxes with inserts would contain a greater proportion of Northern House Wren nests, while the four nest boxes without inserts would have a greater proportion of Tree Swallow nests, also because they lack preventative methods. From my study, I aimed to determine whether there was a significant difference in bird species distribution among the five grids, as well as between nest boxes lacking/including inserts within Grid E. I hoped my results would provide insight into the decline of Northern House Wrens in nest boxes in the Beaverhill Natural Area and increase applicable knowledge of nesting conditions for future years.

Study site description and Methods

The study was carried out at the Beaverhill Bird Observatory (BBO), located within the Beaverhill Natural Area (BNA), northeast of Tofield, AB, Canada; a federally recognized Bird Sanctuary (Beaver County, n.d.). Located in the Central Parkland Region, the BNA is home to an extensive list of bird species, marshes, aspen-balsam woods and grassland habitats, making it an ideal location for conservation, monitoring, birding and other recreational opportunities (Alberta Parks, 2025).

There are four grids of nest boxes located within the Beaverhill Natural Area: grids A, B, C and D. Grids A and B are located closer to the BBO lab while grids C and D reside across a weir, east of the lab. The Northern House Wren (HOWR) nest boxes are located in a five-by-five arrangement in grids A, C and D, while grid B contains a three-by-eight set-up. In total, there are 99 pre-built HOWR nest boxes in the study area. For the study, my fellow HOWR intern and I added a three-by-three experimental grid, "Grid E", for a total of 108 HOWR nest boxes. Grid E boxes were located between Grids A and B, down Warbler Way – a more southern location residing deeper in the forest – in order to select against human disturbance while selecting suitable wren vegetation cover (Figure 1). The nest boxes were composed of the same plywood material as those in other grids, but boxes A1, A2, A3, B1 and B2 had an additional 1-⅛" metal Portal Protector screwed over the entrance to select for Wrens. Boxes B3, C1, C2 and C3 were unadulterated, with the same 1-¼" entrance found on the Northern House Wren nest boxes in grids A, B, C and D.

Nest boxes in grids A, B, C and D were fully cleaned and prepared by May 22, then monitoring began on May 25, continuing weekly on variable days due to weather conditions and availability conflicts. Grid E was established on June 1, with monitoring commencing on June 8. In each box, data was recorded regarding species (Spp.) which included HOWR, Tree Swallows (TRES) and others (such as the Northern Flying Squirrel). Nesting state was then documented and – if active – recorded as building (partial, full, or lined), eggs (number present), or nestlings (number present). If these requirements were not met, the nest was recorded as inactive (full, partial, or lined). If eggs were present with no adult (A), a finger was gently placed on the shell and recorded as warm (W) or cold (C). If an adult was found on the eggs (P-remained), the temperature was recorded as warm. If there were nestlings in the box, they were aged using the reference guide provided by Brown et al. (2013) until the age of 7 days for Northern House Wrens, 10 days for Tree Swallows to prevent early fledging. Nest box monitoring resumed at 25 days – a week past fledging – and nests were recorded as successful (present fecal matter, young absent) or unsuccessful (absent fecal matter, dead young remained).

Given that there was only one successful Northern House Wren nest within the Beaverhill Natural Area HOWR grids - fledglings absent, fecal matter present - success was not a requirement for a counted nest. Instead, nest boxes were included if considered "active" at any point in the season, meaning a nest reached the lined/partial/full status with or without the presence of offspring. If a nest box was usurped at some point in the season - seen in 13 nest boxes over four months of monitoring (6 instances of HOWR taking over a TRES nest, 3 instances of TRES taking over a HOWR nest, 5 instances of Northern Flying Squirrels taking over TRES nests) - it was counted for each bird species that inhabited it. Only first broods were included.

To determine whether there was a significant difference in Northern House Wren/Tree Swallow nest distribution between boxes with/without inserts in Grid E, I used *Microsoft Excel 365* (Microsoft, 2025) to sort and organize my monitoring data from *Google*

Sheets (Google, 2025) (nesting counts of each bird) in table format. Given the 2x2 nature and small sample size of the results, a Fisher's Exact Test was conducted using *GraphPad* (GraphPad, 2025).

To determine whether there was a significant difference in Northern House Wren/Tree Swallow nest distribution between grids A, B, C, D and E, I sorted the monitoring data counts from *Google Sheets* (Google, 2025) in *Microsoft Excel 365* (Microsoft, 2025). Expected counts were calculated using the formula (row total) x (column total) / grand total, then a Chi-Square test of independence was conducted where $x^2 = \sum((O-E)^2/E)$.

Results

In the 2025 monitoring season, only one Northern House Wren nest was successful. Located in Grid C, the eggs were first recorded on June 8 with a clutch size of 4, then recorded as "hatched" on June 21 with a brood of 4 nestlings. In this same time period, there were 32 successful Tree Swallow nests dispersed around grids A, C and D. The eggs of these nests were first recorded May 11 - June 23 with an average clutch size of 4.63 (n=35), ranging from 1-8 eggs/clutch. The Tree Swallow hatch date range was recorded between May 18-June 29 with an average brood size of 4.5 (n=32), ranging from 1-7 nestlings/brood.

Regarding my first test determining whether there was a significant difference in nest distributions of Tree Swallows and Northern House Wrens within Grid E, I was unable to conduct the Fisher's Exact Test as there were no active nests of either species at any point in the season. Therefore, I could not determine whether there was/wasn't a significant relationship in bird species as a result of insert presence/absence.

Since Grid E had a count value of zero for both species, it was also excluded from my second analysis: the Chi-Square test-of-independence. The test was run on the remaining grids; A, B, C and D, to see if Tree Swallows and Northern House Wrens had any discernible preferences in nesting between grids. Based on the analysis, there was not a statistically significant difference in bird distribution ($x^2 = 5.52$, df = 3, $p = 0.14$). The p-value, $0.14 >$

0.05, means each species' placement may have been due to chance rather than external factors indicating a preference. As well, the x^2 value of 5.52 < 7.81 (with a critical value of $p = 0.05$) confirms I failed to reject my null hypothesis and, ultimately, distribution was not grid-dependent (figure 2).

Discussion

Due to the lack of occupancy within Grid E – no Northern House Wren or Tree Swallow nests found throughout the season – I was unable to determine whether the nest box inserts selected for Northern House Wrens or lacked a statistically significant difference in preference altogether. This same data insufficiency prevented me from including Grid E in the Chi-Square test-of-independence, meaning I could not include the experimental grid in establishing the existence of a potential grid-based species' inclination.

One possible explanation for the absence of Northern House Wren and Tree Swallow nesting data in Grid E is the timing of establishment. While Grids A, B, C and D were in place in previous years, Grid E had to be physically "set-up," meaning none of the nest boxes were available for usage before June 1; the date of grid completion. According to Brown (2001), House Wren breeding seasons take place from late April to early September, while the Tree Swallow breeding season takes place between May and September (Roof & Harris, 2001). The experimental grid's establishment after the commencement of both species' breeding season suggests Northern House Wrens and Tree Swallows in the Beaverhill Natural Area may have begun the nest-building/settlement process before Grid E was constructed.

Northern House Wrens are known for their double brooding (Brown, 2001), a fact assumed to increase the proportion of Wrens despite the late-season establishment time. However, according to Quinn (1989), larger polygyny rates among Northern House Wrens in the natural area may be the result of shorter breeding seasons, resulting in only one brood.

Another possible explanation for the lack of Northern House Wrens in Grid E is the highly territorial nature of these birds. Finch (1990) suggests male House Wrens are very likely to return to previous nesting cavities, building dummy nests to protect their territory. This justifies the 13 HOWR nests found throughout grids A, B, C and D; only 1 deemed successful by the end of the season, all others used as "dummy nests". These findings imply Northern House Wren territory exempted Grid E in 2025 as there hadn't been previous breeding in that area/those boxes, therefore the birds had no reason to build fake (or real) nests in order to defend the grid.

Our decision to establish Grid E south of Grids A and B was an attempt to determine whether the denser, southern location would remove the limiting factor of vegetation structure – to see if it could be considered an element resulting in the significant distribution difference between grids. However, Quinn (1989) mentions that vegetation structure isn't an indicator when the minimum vegetation cover has been met. As a result, it can be assumed all five grids met the vegetation cover requirement for Northern House Wren nesting sites, rendering the "denser coverage" of Grid E indeterminate. Contrastingly, Belles-Isles and Picman (1986) found that female House Wrens prefer sparsely vegetated areas, as denser areas increase the probability of nest attacks by other Wrens. This might indicate the experimental grid was too densely covered to be considered advantageous for the birds. Another consequence of competition and predation is the Northern House Wren preference for cavity nesting – an inconspicuous solution that isn't always accessible in natural environments (Belles-Isles & Picman, 1986). In this case, Wrens will choose the second best option' nest boxes. However, if the Beaverhill Natural Area has an abundance of natural cavities, this could explain the decline of Northern House Wrens in grid nest boxes, and their absence in Grid E.

While I was unable to include Grid E in my Chi-Square test-of-independence, I could still analyze grids A, B, C and D. The results of this test determined that Northern House Wren and Tree Swallow nest distributions were not significantly different, suggesting the two species were spread independent of location/grid. This opposes my original prediction that Tree Swallows would be more abundant in Grids A, B, C and D due to location and a lack of House Wren-selecting inserts on the nest boxes.

One possible explanation for this is – as previously mentioned – the Northern House Wren vegetation cover requirement being met in all four grids, rendering it ambiguous in creating a distribution imbalance. Likewise, Tree Swallows are known to prefer more open woodland areas (such as grid borders) – building nests where Northern House Wrens are absent (Finch, 1990). If each grid contained enough boxes spanning mixed vegetation covers, interspecific competition might have been reduced, leading to the comparable distribution of Tree Swallow and Northern House Wren nests in all four locations. This also suggests that the abundance of nest boxes – 108 in the Beaverhill Natural Area – might play a role in reducing competition between bird species for territory.

In the case of reduced interspecific competition, Finch (1990) suggests that intraspecific competition – primarily between Northern House Wrens – may be most responsible for nest box interference. While the distributions were not significant, Tree Swallows built more nests than Northern House Wrens in grids A, B, C and D, 32 of which were successful (as opposed to only 1 successful Northern House Wren nest). With conditions ideal for interspecific competition reduction, the limiting factor for Northern House Wrens may have been interference from conspecifics (rather than Tree Swallows, as assumed).

Conclusion

Determining ideal nesting conditions for bird species is crucial to understanding the gradual decline of Northern House Wrens from nest boxes within the Beaverhill Natural Area. This knowledge ensures such conditions are met so Northern House Wrens may continue to be monitored for years to come. By directly tracking the traits of these birds, general well being is accessible and evident, meaning potential concerns may be easily observed and reported.

The aim of this study was to determine whether there was a significant difference in bird species distribution among the five grids, also between nest boxes lacking/including inserts within Grid E. I hoped my results would provide insight into the decline of Northern House Wrens in nest boxes at the Beaverhill Bird Observatory and contribute applicable knowledge of nesting conditions for future years.

Grid E was exempt from all distribution analysis, so it could not be used to determine whether the addition of selective nesting cavities would raise Northern House Wren nest counts. Furthermore, it could not be used to determine whether the addition of an experimental grid would lead to a significant difference in bird species proportions between the five grids. Analysis of the four remaining grids resulted in an insignificant bird species distribution, where there was not a notable difference in Tree Swallow versus Northern House Wren nest placements.

To better understand the ideal nesting conditions of Northern House Wrens, an earlier established experimental grid would ensure timing was not a limiting factor. Likewise, an increased number of Grid E nest boxes for a larger sample size – comparable to those of Grids A, B, C and D – would ensure nest box quantity was not restricting and proportionate. Lastly – to test the effects of location without inserts – the development of Grid E in an area with significantly altered vegetation would test the effects of vegetation density/scarcity on Northern House Wren nesting preference. The cause(s) of the decline in nesting House Wrens in the Beaverhill Natural Area remain unknown and should be investigated in the coming years.

Acknowledgements

I would like to thank the Beaverhill Bird Observatory staff for the opportunity to monitor and research Northern House Wrens within the Beaverhill Lake Natural Area in an encouraging, educational environment. I would also like to thank my mentor Zach Antoniw, and Willow Zilliox for their guidance, advice and optimism throughout my research. Thank you to Jana Teefy for her approval and suggestions on our experimental grid, and thank you to Judah Flynn for assisting me in the monitoring process. I thank Geoff Holroyd for comments on an earlier draft of this article. The internship was funded by Alberta Conservation Association, and TD Friends of the Environment grants to Beaverhill Bird Observatory.

Appendix

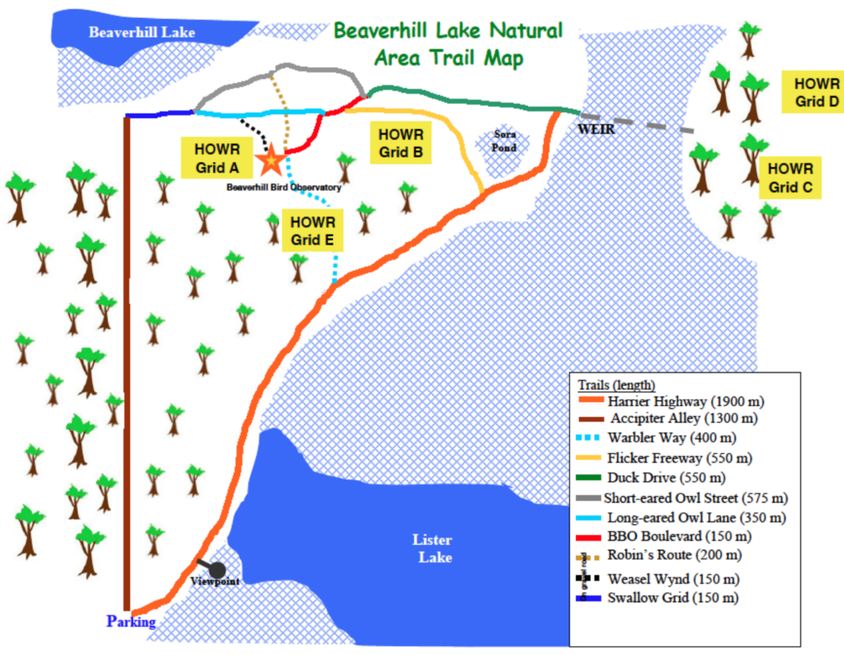

Figure 1. Beaverhill Natural Area depicting the locations of Northern House Wren Grids A, B, C, D, and E (experimental).

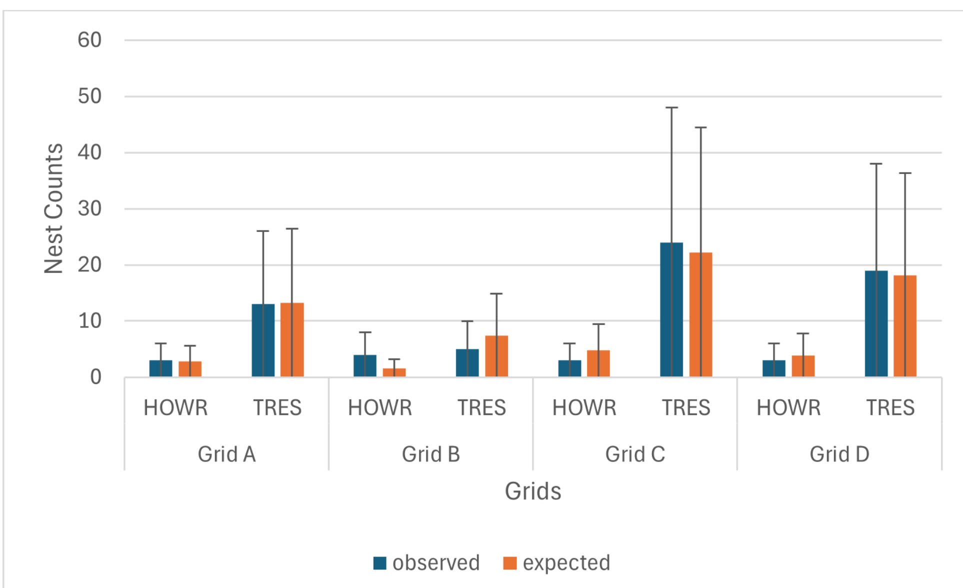

Figure 2. Observed vs. expected counts of Northern House Wren (HOWR) and Tree Swallow (TRES) nests in each grid from the 2025 monitoring season. Error bars represent 95% confidence intervals.

Figure 3. 1-⅛” Metal Birdhouse Portals used to select for Northern House Wrens in Grid E; placed on boxes A1, A2, A3, B1 and B2.

Bibliography

Antoniw, Z., Golly, S. (2017). *Comparison of House Wren (Troglodytes aedon) Grids over Four Years at the Beaverhill Natural Area: Number of Nests with Nestlings.* https://beaverhillbirds.com/media/1719/2017-antoniw-golly-howr-internship-final.pdf

Beaver County. (n.d.). *Recreation Areas*. Retrieved August 9, 2025, from https://www.beaver.ab.ca/tourism/recreation/recreation-areas

Belles-Isles, J., Picman, J. (1986). Nesting Losses and Nest Site Preferences in House Wrens. *The Condor*, 88(4), 483-486. https://doi.org/10.2307/1368275

Bilodeau, B. (2024). Influence of orientation on nest box occupation rates of House Wrens (Troglodytes aedon). https://beaverhillbirds.com/media/2522/house-wren-monitoring-17.pdf

Brown, J. (2001). *Troglodytes aedon* (on-line). Animal Diversity Web. https://animaldiversity.org/accounts/Troglodytes_aedon/

Butler, M. (2013). *Comparing the Nesting Density of House Wrens (Troglodytes aedon) in Artificial Environments with Natural Environments*. Beaverhill Bird Observatory. https://beaverhillbirds.com/media/1700/house-wren-meagan-butler.pdf

Finch, D. M. (1990). Effects of Predation and Competitor Interference on Nesting Success of House Wrens and Tree Swallows. *The Condor, 92(3), 674-687.* https://doi.org/10.2307/1368686

Llambias, P., Fernández, G. J. (2008). Effects of nestboxes on the breeding biology of Southern House Wrens *Troglodytes aedon bonariae* in the southern temperate zone. *Ibis, 151(1), 113-121.* https://doi-org.login.ezproxy.library.ualberta.ca/10.1111/j.1474-919X.2008.00868.x

Pribil, S., Picman, J. (1991). Why House Wrens Destroy Clutches of Other Birds: A Support for the Nest Site Competition Hypothesis. *The Condor, 93(1), 184-185.* https://doi.org/10.2307/1368624

Quinn, M. S. (1989). *Factors Regulating the Breeding Population, Reproductive Success and Mating System of House Wrens (Troglodytes aedon) at Beaverhill Lake, Alberta* [Master's thesis, University of Alberta]. University of Alberta Institutional Repository. https://doi.org/10.7939/R3G44HV9V

Roof, J., Harris, M. J. (2001). Tachycineta bicolor (on-line). Animal Diversity Web. https://animaldiversity.org/accounts/Tachycineta_bicolor/