Association between interspecific nest-site competition and breeding success of tree swallows (*Tachycineta bicolor*)

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Abstract
Tree swallows (*Tachycineta bicolor*) and northern house wrens (*Troglodytes aedon*) are secondary cavity nesters that readily occupy manmade nest boxes. At the Beaverhill Natural Area, the two species compete for use of artificial boxes due to the limited number of nesting sites in the area and the inability of either species to excavate their own nest cavities. Although both species exhibit territorial defensive behaviour, only the northern house wren commonly destroys nests and eggs of other birds. This study assessed whether nest site competition from northern house wrens impacted nesting success and nest occupancy of tree swallows. To do so, we monitored artificial nest boxes weekly from June to August 2026 across three distinct grids (road, spiral, new). Historically, only the spiral grid has included house wren nests. The proportion of boxes occupied by tree swallows was significantly lower in the road grid and highest in the new grid. Regardless of these differences, our results show that tree swallows' nest success and fledging success did not differ in response to the presence of house wrens between grids. This suggests that other factors, such as habitat quality, weather, or food abundance, may be more important in shaping tree swallows' nest success and fledging success at the Beaverhill Natural Area than the presence of house wrens.

Introduction

Aerial insectivores, such as swallows, flycatchers, and nightjars, have experienced significant population declines in Canada since 1970 (Birds Canada and Environment and Climate Change Canada, 2024). Tree swallows (*Tachycineta bicolor*) are aerial insectivores, breeding across North America (Winkler et al., 2020). Despite being a common species in Canada, their population has declined steadily since 1970 (Birds Canada and Environment and Climate Change Canada, 2024). Their decline is likely due to a combination of anthropogenic factors like insecticide use and habitat loss on their breeding grounds as well as along their migration path and wintering grounds (Blyth et al., 2019).

Tree swallows have relatively restrictive habitat preferences, typically breeding in open fields near wetlands and along bodies of water (Winkler et al., 2020). As secondary cavity-nesters, tree swallows naturally depend on the presence of woodpecker-excavated cavities or hollow dead trees for nest sites (Winkler et al., 2020). Since they cannot create their own nest cavities, tree swallow breeding populations may be limited by the number of available nesting sites or by a lack of woodpeckers in the area (Newton, 1994). They will readily use artificial nest boxes, which are commonly used as a conservation strategy to improve their breeding success and reduce competition for nesting sites (Norris et al., 2018).

In addition to anthropogenic stressors like habitat loss and insecticide use, tree swallows face competition for nest sites from other cavity-nesting species, including the northern house wren (*Troglodytes aedon*). Northern house wrens are abundant birds that will use manmade nest boxes (Johnson, 2024) and are known to take over the nests of other cavity-nesting birds by destroying eggs and killing nestlings of competitors, or simply building their nests on top of an existing one (Belles-Isles and Picman, 1986). House wren males often construct multiple unused nests, which they defend with territorial behaviour (Finch, 1990). Northern house wrens prefer habitats at the edges of forests or grasslands with shrubs (Johnson, 2024), which can overlap with the open habitat preferences of tree swallows.

Although tree swallows are larger and arrive earlier on the breeding grounds, northern house wrens can destroy or take over tree swallow nests once they arrive, resulting in tree swallows' total nest failure (Finch, 1990). Tree swallows may interfere with and usurp the nests of other birds (Wiebe, 2016), but northern house wrens tend to be more aggressive in doing so and are more likely to attack eggs and nestlings of competitors (Scerbicke et al., 2024), including tree swallows.

This study considered whether there is a link between tree swallow's nesting success and competition by northern house wrens. Both species naturally breed in central Alberta, where they compete for nesting sites in areas with appropriate habitats for both. At the

Beaverhill Natural Area (BNA), tree swallows typically nest in artificial boxes, maintained in three distinct grids: "road grid", "new grid", and "spiral grid". Of these three grids, only the spiral grid offers suitable nesting habitat, willow shrubland, for both tree swallows and house wrens, with both species occupying boxes in this grid in previous years. Due to competition for limited resources (Miller, 2010) and northern house wrens' aggressive behaviour (Scerbicke et al., 2024), I expected tree swallows nesting in the spiral grid to occupy fewer artificial boxes and have lower fledging success compared tree swallows nesting in the road and new grid.

Methods

Study Site

This study was conducted in the Beaverhill Natural Area (53.3644 N, -112.54620 W), approximately 10 km west of the town of Tofield, Alberta, Canada. The natural area contains grasslands, aspen-balsam poplar forest, and wetlands, as well as Beaverhill Lake. The depth and extent of the lake fluctuate depending on precipitation (Key Biodiversity Areas, "Beaverhill Lake"). The BNA is recognized as an Important Bird Area due to its significance to bird populations and their conservation (BBO, “About BBO”).

The Beaverhill Bird Observatory (BBO) has maintained tree swallow nesting boxes in the area since 1984 (BBO, "Tree Swallows"). There are currently three grids of nest boxes with differing habitat conditions. The road grid consists of 66 nest boxes along Township Road 510 adjacent to agricultural fields. The spiral grid has 92 boxes situated along the historical edge of Beaverhill Lake, now a grassland habitat with new-growth willows and aspens. The new grid has 50 boxes, located in open grassland with sparse willows close to the current southern boundary of the lake.

Study Species

Tree swallows are long-distance migratory passerines in the family *Hirundinidae*. They arrive at their breeding grounds in Alberta by late April to early May and begin migrating to their wintering grounds by early to late July (Winkler et al., 2020). Nest-construction begins shortly after their arrival to breeding grounds, usually by mid-May (Winkler et al., 2020), and nests are composed of dry grass and feathers. Clutch size is typically between 5 and 7 eggs (Winkler et al., 2020). Eggs are incubated for 10 to 20 days (Winkler et al., 2020) and chicks usually fledge at 18 to 20 days old (Winkler et al., 2020). Tree swallows nesting in artificial boxes fledge an average of 4 to 5 young (Norris et al., 2018). At the BNA, the first tree swallow eggs have typically been reported by mid- to late May and the first nestlings by early to mid-June.

Northern house wrens arrive at the BNA later than tree swallows, building nests by early June, and laying eggs by mid- to late June (Johnson, 2024). Northern house wrens will nest in existing tree or rock cavities, but, like tree swallows, also readily use man-made nest boxes (Johnson, 2024). Males may begin nest construction immediately after arriving at their breeding grounds (Johnson, 2024), and often construct multiple nests which will later be completed by the female (Finch, 1990). Northern house wren nests are made of large piles of woody twigs that may completely fill an artificial box, lined with grass and animal hair. They prefer nesting in areas with shrubs or other woody vegetation (Johnson, 2024).

Data collection

I conducted weekly nest box surveys with the aid of another intern between mid-May and early August, 2026. Heavy summer downpours disrupted data collection for two weeks between June 23, 2026 and July 2, 2026, as the BNA was inaccessible due to significant flooding in the area.

We identified the species occupying a nest box by the difference in materials used by house wrens and tree swallows. We recorded the species using the box, level of nest completion (“partial” if a box had a small amount of grass or twigs present, “full” if the box had several layers of grass, and “lined” if the nest had a clear cup lined with feathers), presence of adult birds, number of eggs and temperature (warm or cold), number of nestlings, and their age. We considered empty nest boxes as inactive. We did not check nest boxes if there were nestlings older than 16 days, as stress during this period of development could cause them to fledge prematurely.

We recorded nests as successful if there was fecal matter present in the box indicating that at least one older nestling had occupied the box and had subsequently fledged. We considered a nest as failed if there was no fecal matter after previously having eggs or nestlings, or if all nestlings were deceased in the box. We recorded the number of successfully fledged young as the total number of nestlings minus any deceased nestlings found in the box.

Statistical Analysis

I conducted all statistical analysis using R 4.5.1 (R Core Team, 2025), created plots using the R package ggplot2 (Wickham, 2016), and formatted the data using the package dplyr (Wickham et al., 2026). I used chi-squared tests to analyze the difference in the proportion of boxes occupied by tree swallows and the proportion of successful tree swallow nests between the three grids. I used a one-way analysis of variance (ANOVA) test to assess the difference in the mean number of tree swallow fledglings per nest box between the three grids.

Results

I found that tree swallow nest box occupation differed significantly between the grids ($X^2 = 14.098$, d.f. = 2, $p < 0.05$, Figure 1). The new grid had the highest rate of tree swallow box use at 96.0%, and the road grid had the lowest occupancy rate at 68.2%. 81.1% of spiral grid boxes were occupied by tree swallows. The majority of the boxes that were not used by tree swallows in the road and new grids were inactive, while boxes unused by tree swallows in the spiral grid were predominantly occupied by house wrens. The road grid was the only one in which deer mice (*Peromyscus* sp.) occupied nest boxes. In some cases, multiple species occupied a box throughout the season. For example, house wrens usurped several tree swallow nests in the spiral grid, and in the road grid, tree swallows took over a mouse nest. For this analysis, I labelled a box as a swallow-occupied box if tree swallows occupied it for long enough to lay eggs. Boxes that were later usurped or destroyed by house wrens are represented as failed tree swallow nests in Figure 2. Although we observed some house wren presence and nest interference in the new grid, we did not observe any house wren eggs or young in this grid.

I found no significant difference in the proportion of tree swallow nests that fledged at least one chick between the grids (X^2 = 0.147, df = 2, p = 0.929, Figure 2). Because our data collection was disrupted due to site flooding during the period that many young were ready to fledge, we were unable to determine the outcomes of two boxes, as house wrens had already covered up the tree swallow nests with twigs by the time we were able to check them. I also found no significant difference between the grids in the average number or percent fledged per tree swallow brood (F = 0.864, d.f. = 2, p = 0.424, Table 1).

I found that, out of the 12 failed tree swallow nests in the spiral grid, 8 (66.7%) were likely caused by house wrens (determined by the removal of tree swallow nesting material, eggs, or nestlings followed by house wrens occupying the box). Although no house wrens laid eggs in the new grid, we observed evidence of their interference with some tree swallow nests. Two tree swallow nests in the new grid were taken over by house wrens before the tree swallow nestlings could fledge. It is possible these were house wren dummy nests, as we did not find any wren eggs or nestlings in the new grid. We also observed house wren nest materials added after tree swallow nestlings had fledged and vacated a box in both the spiral and new grids.

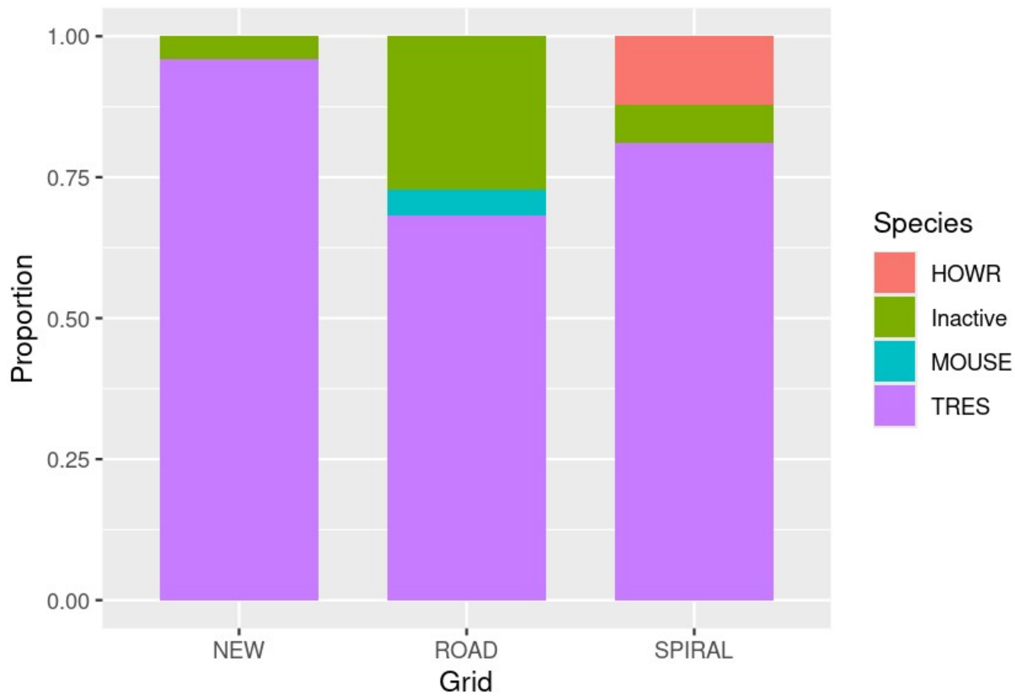

Figure 1. The proportion of nest boxes occupied by each species observed in each grid. The road grid had the lowest tree swallow occupancy at 68.2%, followed by the spiral grid (81.1%). Tree swallow occupancy was highest in the new grid, where 96.0% of boxes were used by tree swallows. The difference in the proportions of boxes occupied by tree swallows and those that were either inactive or occupied by another species was statistically significant (X^2 = 14.098, d.f. = 2, $p < 0.05$).

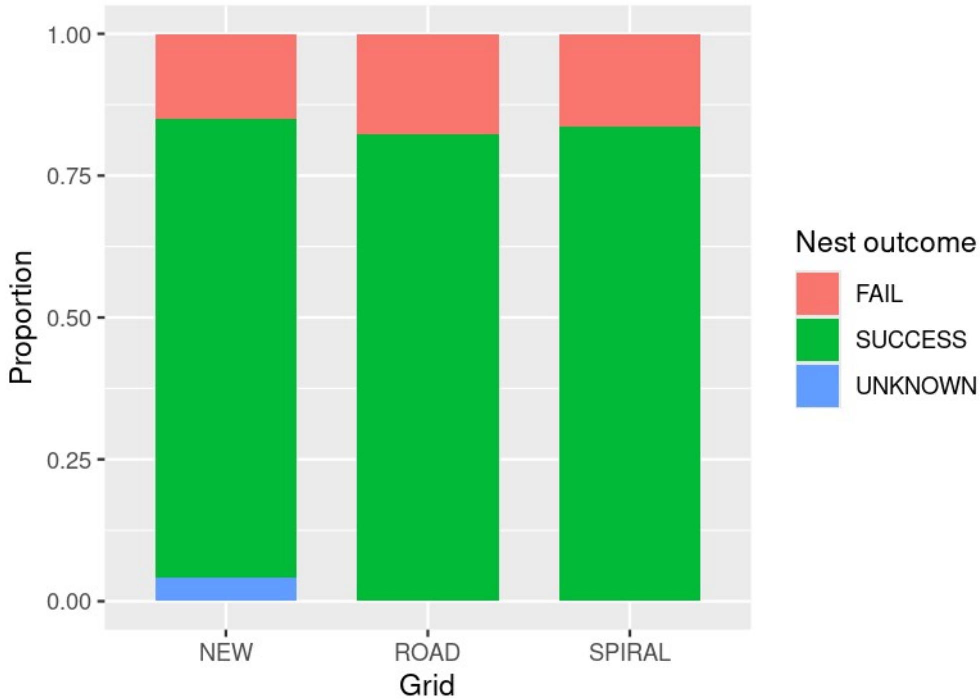

Figure 2. Outcomes of tree swallow nests in each grid. A nest was considered to be a success if at least one nestling fledged. We were unable to determine the outcomes of two nests in the new grid due to flooding causing an interruption in our data collection in June. The difference in the proportion of successful nests was not statistically significant between grids (X^2 = 0.147, d.f. = 2, p = 0.929).

Table 1. The average number and proportion of young successfully fledged per tree swallow nest in each grid. The difference in the average number of young fledged per nest was not significant between the grids (F = 0.864, d.f. = 2, p = 0.424).

Grid	Number of tree swallow nests with eggs	Average number of fledglings per nest	Proportion of brood fledged
New	45	4.6	73.6%
Road	45	4.0	71.7%
Spiral	73	4.4	72.9%

Discussion

Our study found that the grids did not differ in tree swallow nesting success despite the greater house wren presence in the spiral grid. We did, however, find that the grids differed significantly in tree swallow nest occupancy. The road grid had the lowest proportion of tree swallow-occupied boxes, and the new grid had the highest. It is possible that our results were confounded by other differences between the grids, such as habitat and other types of interspecific interactions. The road grid differs from the other two grids in habitat, interspecific interactions, and anthropogenic interference, all of which likely impacted the results for that grid. Many boxes in the road grid are paired, with two boxes in close proximity, in order to reduce competition interference from mountain bluebirds (*Sialia currucoides*). Since tree swallows are less likely to use a box so close to another occupied tree swallow box (Wiebe, 2016), most of these pairs had only one box occupied, which may explain the lower occupancy rate in the road grid. Although mountain bluebirds historically have nested in the road grid (BBO, unpublished data), we did not observe them this year and therefore they were not a factor in tree swallow success.

Only the road grid is directly adjacent to both a road and agricultural fields. Dunn and Hannon (1992) found that roadside habitats have significantly fewer insects in early summer than habitats near lakes, which may reduce the fitness of tree swallows nesting along the road. Similarly, a study by Stanton et al., (2016) determined that tree swallows nesting in agricultural areas spent more time away from their nests foraging than those in natural grasslands. It is likely that the tree swallows in the road grid face the additional challenges of lower food abundance due to their habitat, which may explain why their success rate was similar to the other grids despite the lack of competition from house wrens.

The unusual weather in the BNA in 2026 undoubtedly affected the results of this study. June and July of this year were abnormally rainy, receiving over 200 mm and 100 mm of rain respectively (Environment and Climate Change Canada, 2026). The BNA was significantly flooded in late June; the ground of the spiral and new grids was completely submerged for several weeks. It is highly likely that the population of tree swallows at the BNA was impacted by the inclement weather. Cold, rainy weather negatively impacts the success of tree swallow nests, measured by both the ability of nestlings to fledge and the survival of parent tree swallows (Cox et al. 2020). We observed several failed nests following rainstorms in June and deceased adult tree swallows were found intermittently throughout the field season. We also observed unusually late tree swallow broods, with eggs being laid well into July after previous nest failures. In one case, the late clutch of eggs was abandoned by the parents in August, when tree swallows have typically already left the area. The extenuating circumstances of the weather during our study could explain lower occupancy and success rates across the grids.

Our results do not conclusively show that house wrens affect the overall success of tree swallow nesting although some specific nest failures were caused by house wrens. Further examination into this subject should examine data across several years to reduce the impact of weather on the results. We also did not consider the association between the distance between house wren nests and tree swallow nests in their likelihood to succeed; this might be examined using multi-year data in one grid. The changing habitats of the new and spiral grids may mean that house wrens will become more common in future years. Future work should consider whether there is any association between the number of successful tree swallow nests and changes in house wren occupants in the spiral grid over time.

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