# Habitat Context and Interspecific Interactions Shape Tree Swallow (*Tachycineta bicolor*) Reproductive Success at Beaverhill Natural Area

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## Abstract

Tree Swallows (*Tachycineta bicolor*) are obligate cavity-nesters that readily occupy artificial nest boxes, but habitat context and interspecific interactions can influence their reproductive success. This survey was done by examining how habitat differences and the presence of Icterids and *Sturnus vulgaris* were correlated with clutch size and nesting outcomes at Beaverhill Lake Natural Area, Alberta. Nest boxes were checked weekly during the 2025 breeding season across three grids: the "natural-habitat" New and Spiral Grids, and the agriculturally dominated Road Grid. Clutch size, nest occupancy, fledging success, and Icterid presence were recorded. Tree Swallows in the New and Spiral Grids laid larger clutches, occupied more boxes, and fledged more young than swallows in the Road Grid, where Icterid and Starling activity was higher. ANOVA showed a significant correlation of Icterid presence on nesting success, but not on clutch size. Descriptive data suggest that resource limitations, human disturbances and heightened interspecific interactions were correlated with reproductive outcomes in the Road Grid. Observations also indicate that swallows may habituate to Icterids, potentially lowering nest defense against other intruders. The results demonstrate that habitat quality, resource availability, and the surrounding ecological community jointly shape Tree Swallow productivity, highlighting key considerations for managing nest boxes in both natural and human modified landscapes.

## Introduction

Tree Swallows (*Tachycineta bicolor*) are obligate cavity-nesters, naturally drawn to nesting sites such as broken tree limbs, hollow stumps, or downed trees (Aitken and Martin, 2008). Naturally occurring cavities like these are often scarce, particularly in regions like the Beaverhill Natural Area, where the forest is relatively young (Beaverhill Bird Observatory, n.d). Advantageously, *T. bicolor* exhibits flexible nesting behavior and readily takes up man-made nest boxes in North America (Birds of the World, 2020). These artificial crevices have undoubtedly enhanced Tree Swallow productivity (Norris et al., 2018); however, reproductive outcomes are also shaped by the habitat context in which birds' nest. Natural habitats in the region with abundant trees, shrubs, grassland, and marshy areas, provide multiple perching and nesting opportunities for Tree Swallows and other species, reducing direct competition. In contrast, agricultural fields and human-modified landscapes often offer limited resources, concentrating birds and increasing interspecific interactions.

The Beaverhill Natural Area provides a diverse range of habitats for wildlife, some including marshland, forest edge, interior forest, open water, grassland, and areas influenced by agricultural development. The Natural Area is an internationally recognized Important Bird Area (IBA), in which over 270 avian species have been reported (Beaverhill Bird Observatory, n.d.). Some notable wildlife that actively coexist with *Tachycineta bicolor* in the Natural Area are Icterids and European Starlings (*Sturnus vulgaris*). Starlings are commonly known for their dominance in driving out smaller, native songbirds from their cavities (Birds of the World, 2020). Studies have also shown that New World Icterids are neophobic (Mettke-Hofmann et al., 2013), especially migrating ones. In natural habitats, the abundance of alternative resources allows these species to remain more dispersed, whereas in resource-limited agricultural areas, interactions may be intensified. This dynamic could influence Tree Swallow reproductive outcomes in ways beyond direct competition.

In Alberta, some of the most common members of the Icteridae family

include the Yellow-headed Blackbird (*Xanthocephalus xanthocephalus*), Red-winged Blackbird (*Agelaius phoeniceus*), Brown-headed Cowbird (*Molothrus ater*), Brewer's Blackbird (*Euphagus cyanocephalus*) and the Common Grackle (*Quiscalus quiscula*). Less commonly observed species, though still present in the province, include the Bobolink (*Dolichonyx oryzivorus*), Western Meadowlark (*Sturnella neglecta*), Bullock's Oriole (*Icterus bullockii*), Baltimore Oriole (*Icterus galbula*), and the Rusty Blackbird (*Euphagus carolinus*) (Birds of the World, 2020).

This study aimed to examine whether the presence of Icterids and *S. vulgaris* was correlated with the nesting success of *Tachycineta bicolor* in the Beaverhill Natural Area. In the Natural Area, artificial nest boxes exist as three separate grids: The Spiral Grid and New Grid, both located north of the Beaverhill Bird Observatory Laboratory, and the Road Grid, which is geographically separated. The Spiral Grid and New Grids are situated in a mixed habitat of grassland, shrubland and forest edge. In contrast, the Road Grid runs along Township Road 510 between the entrance to the observatory and Range Road 183A, with a short stretch of boxes on Range Road 183. Its surrounding habitat is primarily composed of agricultural fields, marshy roadside edges and sparse shrub and tree cover. The spatial variation between grids made it possible to observe differences in the nesting behaviours of *T. bicolor,* as well as interspecies presence. The concentration of Icterids and European Starlings provided a unique opportunity to evaluate the impact of increased interspecific presence on *T. bicolor* nesting success.

I hypothesized that the Road Grid, due to its limited resources and space, would result in lower productivity for Tree Swallow (*T. bicolor*) nesting, in both number of successful nests (at least 1 young fledged) and clutch size per box, when compared to the New Grid and Spiral Grid. The prediction was that the presence of residing Icterids and European Starlings in the Road Grid would be directly correlated to a lower success rate in young produced, possibly due to the intensified competition that arises in habitats with limited resources. This research was done not only to better understand the dynamics between *T. bicolor* and Blackbirds, but also to further understand the factors that humans need to consider prior to a nest box installation.

## Methods

*Study site*

Positioned within the Central Aspen Parkland ecoregion, the Beaverhill Bird Observatory (53°22'50.1"N, 112°31'37.4"W) lies within the Beaverhill Natural Area, south of Beaverhill Lake in Beaver County, Alberta. Within the natural area, there is an abundance of flora and fauna and a variety of macro- and microhabitats. The nest box grids differed geographically and in area: the Spiral Grid consisted of 90 boxes, the New Grid of 50, and the Road Grid of 68.

*Data Collection*

Nest boxes were monitored weekly starting May 13th, 2025. Nest construction stages were classified as follows: **Partially built** (some grass or feathers present), **Fully built** (a complete nest with nesting material but lacking a distinct cup), or **Lined** (a fully built nest with a well-defined cup, indicating readiness for egg-laying). Nests with insufficient material were labeled as **Inactive**, though they continued to be monitored weekly for any development.

For each nest box, adult Tree Swallow presence was categorized as **Absent**, **In**

**Vicinity** (an adult was perched on the box or actively dive-bombing), **Flushed** (an adult exited the nest upon human approach), or **Remaining** (an adult continued brooding despite human presence). Eggs were recorded as either **Warm** or **Cold**, along with the number observed. Once eggs hatched, nestling age and number were monitored until Day 12. After that point, boxes were left undisturbed until Day 30 to minimize the risk of premature fledging.

The primary reproductive metric was determined to be clutch size, that is the largest number of eggs counted at any point previous to hatching. Nestling number was calculated the same way. Nestling age was determined using resources provided by the Beaverhill Bird Observatory staff, and nesting success was determined by the absence or presence of fecal material. That being, if feces present, they successfully fledged at least one young. If absent, they failed.

In parallel, the presence of Icterids and European Starlings was recorded across all three grids, almost weekly. Species and number of individuals were the two metrics recorded. Observations were not box-specific but instead noted any individuals present within approximately a 10-meter radius of any nest box. The presence or absence of these birds was the main metric used to categorize grids for statistical analysis.

## Results

*Nest Occupancy*

Weekly checks were conducted on 208 nest boxes throughout the summer. Most boxes housed *Tachycineta bicolor*, while a small number were occupied by *Troglodytes aedon* or *Peromyscus sonoriensis*. Boxes that never housed Tree Swallows were classified as **Inactive**, and those that housed swallows but were later taken over by other species were classified as **Failed**. Of the 208 boxes, 8 remained Inactive for the entire season, leaving 200 boxes that housed Tree Swallows at some point. Inactive boxes were not counted for the statistical analysis.

The New Grid proved to be the most successful location for Tree Swallows. Despite having fewer boxes (n = 50), it showed 98.0% occupancy, with only one box going unused. This box was one of four broken boxes that was replaced in June 2025. The Road Grid had 2 inactive boxes (97.1% occupancy), while the Spiral Grid had 5 inactive boxes (94.4% occupancy; Table 1).

***Table 1***. Nest box occupancy of *Tachycineta bicolor* in three different grids within the Beaverhill Lake Natural Area during the 2025 breeding season.

| Grid | # of Boxes | Boxes Occupied by *T. bicolor* | % of Grid Occupancy |
|---|---|---|---|
| New | 50 | 49 | 98.0 |
| Road | 68 | 66 | 97.1 |
| Spiral | 90 | 85 | 94.4 |

*Statistical Analysis Metrics*

Among occupied boxes, the New Grid was also the most productive: 43 of 49 boxes successfully fledged at least one young (87.8% success). The Spiral Grid fledged 68 of 85 occupied boxes (77.6%), while the Road Grid had the lowest success, with only 46 of 66 occupied boxes fledging young (69.7%; Table 2).

Average clutch size per box and Icterid abundance were also analyzed. The Road Grid was the only location with consistent Icterid presence. Although —

Icterids were observed eight times at the Spiral Grid over the summer, but this number was too low to classify the Spiral Grid as having present resident Icterids. At the Spiral Grid, Brewer's Blackbirds (*Euphagus cyanocephalus*) were observed on two occasions, both which triggered mobbing behavior by Tree Swallows, a response never observed at the Road Grid. The other six Icterids at the Spiral Grid were Baltimore Orioles (*Icterus galbula*), which only flew overhead and rarely perched near nest boxes.

***Table 2.*** Averages in three different breeding grids of *Tachycineta bicolor* in the Beaverhill Natural area for: clutch size, Icterid abundance and nestlings hatched, per box. During the 2025 breeding season. As well as the success rate of at least one young fledged.

| Grid | Average Eggs/Nest | Average# of Icterid | % of Successful Nests |
|---|---|---|---|
| New | 5.3 | 0.0 | 87.8 |
| Road | 4.3 | 6.7 | 69.7 |
| Spiral | 4.5 | 0.0 | 78.8 |

The New Grid had the highest mean clutch size (5.3 eggs/nest), followed by the Spiral Grid (4.5 eggs/nest) and the Road Grid (4.3 eggs/nest). The Road Grid also had the greatest Icterid and Starling activity: over the season, 452 Icterid presences were recorded, primarily Brewer's Blackbirds and Red-winged Blackbirds (*Agelaius phoeniceus*), 236 and 128 sightings respectively. Each box averaged 6.7 Icterid visits per week, though some boxes were likely affected more than others. By contrast, the New Grid, located deeper in the Natural Area on a grassland with fewer perching sites, had no Icterid activity, making it a strong reference site for absence–presence comparisons.

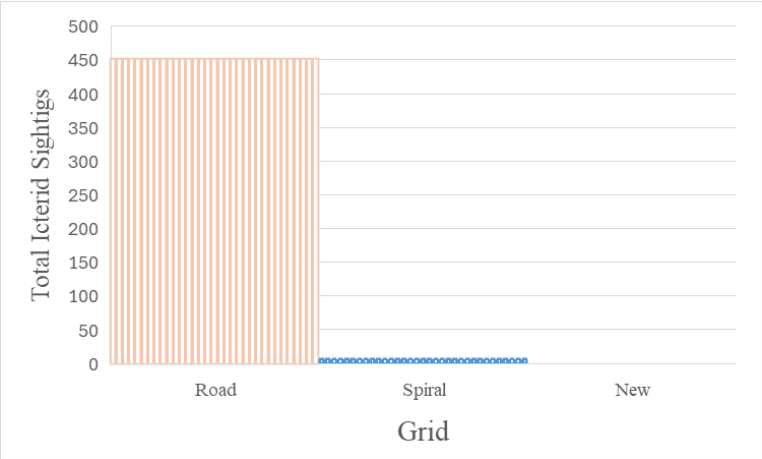


***Figure 1.*** Differences in Icterid and *Sturnus vulgaris* abundance between the three *Tachycineta bicolor* grids within the Beaverhill Natural Area. Data collected from May to August 2025.

The New and Spiral Grids had little to no consistent Icterid activity, therefore, they were combined into a single category representing absence of Icterids. The Road Grid was treated as the category representing presence of Icterids. These two groups, Icterids absent vs. Icterids present, were then used to test whether Icterid presence was correlated with clutch size and nesting success.

*Statistical Analysis*

The effect of Icterid presence on clutch size was tested using a one-way ANOVA. Results showed no significance ($df = 1$, $F = 1.882$, $p = 0.172$; Figure 2).

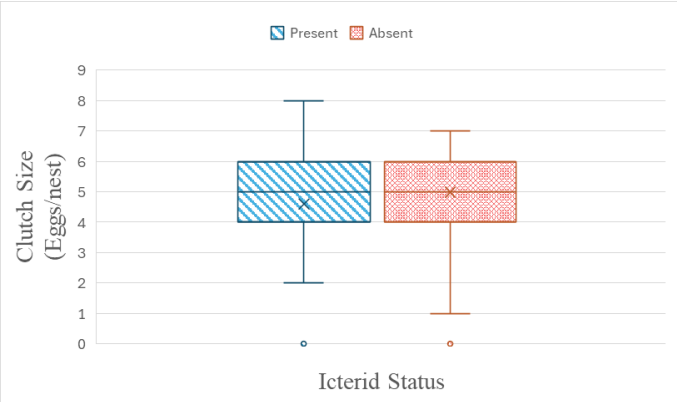


***Figure 2.*** Clutch size (eggs/nest) differences between grids with or without the presence of Icterids. New and Spiral Grid were combined to represent absence. The Road grid was representative of the present Icterids. Data collected from Beaverhill Lake Natural Area in 2025.

Icterid presence was then tested to understand whether it influenced nesting success (fledging at least one young). A one-way ANOVA rejected the null hypothesis, showing a significant correlation of Icterid presence on nest outcome ($df = 1$, $F = 4.377$, $p = 0.038$).

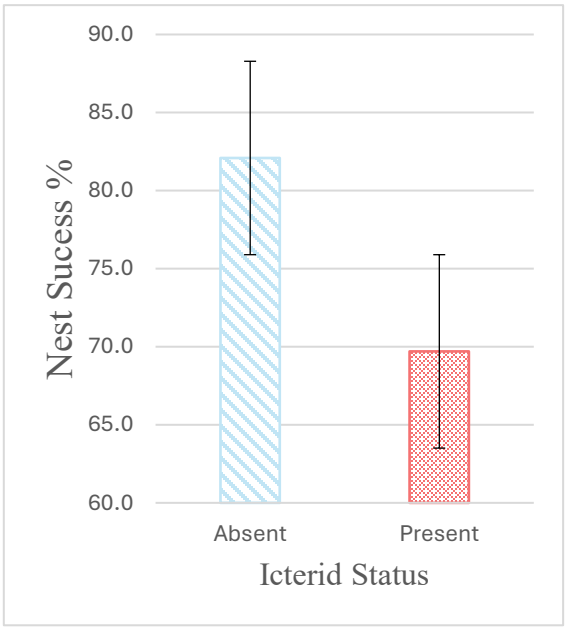


***Figure 3.*** Significant differences in nesting success (%) between grids with or without the presence of Icterids. New and Spiral Grid were combined to represent absence. The Road grid was representative of the present Icterids. Data collected from Beaverhill Lake Natural Area in 2025.

However, because Icterid presence occurred almost exclusively on the Road Grid, this effect is likely confounded with grid identity. Thus, while the ANOVA detected a statistical relationship, the descriptive data suggests that differences in clutch size and nesting success are more plausibly explained by the combined influence of Icterids and grid-level factors, rather than Icterid presence alone.

*Additional Observations*

During nest box checks, several other species were observed nesting within the grids. Although these observations were not a metric or focus of this study, they are noteworthy for future research. In the Spiral Grid, a high density of Northern House Wrens (*Troglodytes aedon*) attempted to nest, particularly after the Tree Swallows (*Tachycineta* bicolor) had vacated boxes. On one occasion, a Mallard (*Anas platyrhynchos*) hen was seen nesting on the ground in the middle of the grid, which was ultimately predated. In the Road Grid, multiple Brewer's Blackbird (*Euphagus cyanocephalus*) nests were recorded. The observatory also confirmed Loggerhead Shrikes (*Lanius ludovicianus*), a Wilson's Snipe (*Gallinago delicata*), and a Marbled Godwit (*Limosa fedoa*) nesting adjacent to the nest boxes. Additionally, one batch of five Mountain Bluebird (*Sialia currucoides*) eggs was recorded in a Road Grid box; these were replaced by Tree Swallow eggs by the following week, and no adult Mountain Bluebirds were ever observed afterwards.

## Discussion

The results indicate that Tree Swallow reproductive success at Beaverhill Lake differs notably between grids, with the New Grid achieving the highest occupancy and fledging rates, while the Road Grid showed the lowest. These patterns appear to reflect differences in habitat structure and resource availability. Dunn and Hannon (1992) reported that the Spiral Grid had more insects available to swallows than on the Road grid during the egg laying stage but no difference during the nestling stage. The New and Spiral Grids, located within more natural habitat of grassland and forest edge, provide Tree Swallows with more security, space and resources. This dispersal of resources possibly reduces direct competition and allows multiple species to coexist with minimal interference, and as previously noted, it appears that the lack of interspecific conflicts might potentially trigger a more territorial and protective response in Tree Swallows when an intruder is near.

In contrast, the Road Grid occupies an agricultural landscape with limited nesting and perching resources. High Icterid and European Starling activity in this grid suggests that competition might intensify under these constrained conditions, potentially contributing to lower clutch sizes and fledging success. However, it is important to note that Icterid presence is not an isolated variable. Other factors including human activity, vehicle disturbance, proximity to the road, farming operations, the agricultural environment itself, and the presence of other cavity-nesting or ground-nesting birds such as shrikes, godwits, blackbirds, and sparrows likely influence Tree Swallow reproductive outcomes. These combined pressures may exacerbate the impact of interspecific competition and make it difficult to attribute effects solely to Icterids.

Although the ANOVA did not detect a significant correlation of Icterid presence on clutch size, descriptive patterns suggest that post-laying outcomes, such as nestling survival, are particularly sensitive to interspecific competition in resource-limited habitats, independent of the presence of other species. Occasional mobbing behavior observed at the Spiral Grid demonstrates that Tree Swallows actively respond to Icterid intrusions, but low competitor density in natural habitats is likely to minimize impacts on reproductive success.

At the Road Grid, Tree Swallows appeared relatively tolerant of Icterids, no direct physical conflict between species was ever observed (unlike the Spiral Grid). This pattern suggests that the effect of Icterids on Tree Swallows may be indirect. It is also possible that prolonged exposure to Icterids leads swallows to become habituated or overly comfortable, reducing their nest-defending behaviors. As a result, they may be less vigilant against other intruders or competing species in the area, potentially lowering their long-term reproductive success even when Icterids themselves are not being aggressive.

Overall, my study highlights that habitat context plays a critical role in shaping interspecific dynamics. Natural habitats with abundant resources support higher Tree Swallow productivity by reducing competition (Norris, et al. 2018, Dunn and Hannon 1992), while agricultural landscapes are more likely to concentrate birds around limited resources, intensifying interactions and reducing reproductive success. Management of nest boxes should therefore consider habitat quality, resource availability,

and the broader ecological community, not just the presence of competitors, to optimize Tree Swallow reproductive outcomes. Future research could experimentally assess how habitat complexity, human disturbance, that being vehicles and agriculture at the Road Grid, and interspecific interactions jointly influence nesting success for *T. bicolor* in man-made habitats.

## Conclusion

This study demonstrates that habitat context undeniably influences Tree Swallow reproductive success at Beaverhill Lake. Nest boxes in natural habitats with abundant resources, such as the New and Spiral Grids, supported higher occupancy, larger clutch sizes, and greater fledging success compared to boxes in the agriculturally dominated Road Grid. Increased interspecific activity, particularly by Icterids and European Starlings, coincided with reduced productivity in the Road Grid, but these effects are likely compounded by habitat limitations, human disturbance, and the presence of other competing species. Additionally, Tree Swallows may become habituated to the presence of Icterids, potentially reducing their vigilance toward other intruders and further impacting reproductive outcomes.

Overall, these findings highlight the importance of considering both habitat quality and ecological community dynamics when managing nesting resources for Tree Swallows.

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 Icterids observed in my study could have habitat preferences that overlap with the Road Tree Swallows that have lower productivity for unrelated reasons.

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