How microenvironment influences the Tree Swallow's Hatching Success at Beaverhill Bird Observatory, Alberta.

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Abstract

In northeastern North America, avian aerial insectivore (AAI) populations have suffered a steep decline in the last few decades. The causes of this decline are not well-understood, but research suggests that anthropogenically-induced habitat modification may be involved. Here we show the results of a study we conducted on the effects of habitat modification on hatching success in a population of tree swallows (Tachycineta bicolor) nesting at field sites located at the Beaverhill Bird Observatory in central Alberta. Our results show that tree swallows nesting in natural habitats laid larger clutches than tree swallows nesting in agricultural areas. Interestingly, however, we found no effect of site on overall tree swallow hatching success, suggesting that other factors could be contributing to the decline of this species.

Introduction

North American avian aerial insectivores (AAI), a guild of birds that forage predominantly on flying insects, are rapidly declining. The reasons for AAI decline are not well-understood, but several factors, including habitat quality, have been proposed as drivers of their decrease, with one of the most often cited causes being the loss of quality habitat, as natural sites are converted to agriculture (Smith et al. 2015).

Tree swallows (T*achycineta bicolor*) are cavity nesting AAI and readily nest in artificially constructed nest boxes (Ardia et al. 2006). Because they can be easily sampled from nest-boxes, tree swallows have been extensively studied and a lot of information is available about their breeding habits (Jones 2003). For example, we know that tree swallows lay between 1-8 eggs, but clutches of 4-7 eggs are most common, with mean clutch size typically being around 5.2 eggs/clutch (Wood 2015). We also know that approximately 3.5 nestlings usually hatch successfully from a clutch (Wood 2015), after an incubation period of 14 to 15 days (tree swallow Life History, All About Birds, Cornell Lab of Ornithology). During the spring and summer, tree swallows migrate from their overwintering grounds in the southern United States, Central America, and the West Indies, to breed in the United States and Canada (Gow et al. 2019). And It is here, across their breeding ranges in the northeastern part of North America, where tree swallows are suffering their steepest declines (Cox et al. 2020).

In this study, we explored the links between habitat quality and breeding success in a population of tree swallows breeding in central Alberta, Canada. To do so, we collected information on clutch size and hatching success, our measure of breeding success, from birds naturally occupying nest boxes at three sites, two located in natural habitats and one located in an agricultural area. These sites provide ideal locations to investigate whether the decline in breeding success of aerial insectivores is linked to habitat modification due to agricultural practices, as the central Alberta prairies are highly modified environments across tree swallows and other aerial insectivore breeding ranges. If land conversion to agriculture is contributing to aerial insectivore decline, we predict our agricultural site to produce smaller clutches and have lower hatching success compared to natural sites. Further, because previous studies found a link between proximity to water and tree swallow breeding success (Hussell and Quinney 1987; Nooker et al. 2005), we also predicted to find an effect of proximity to water, with sites closer to water having higher breeding success (i.e., producing larger clutches and having higher reproductive success) than sites further from the water.

Methods

Study Site

We conducted our study in and near the Beaverhill Natural Area (BNA) located near Tofield in central Alberta, Canada (53.39873° N, 112.53566° W) in nest boxes maintained by Beaverhill Bird Observatory (BBO), . The BBO is the second oldest bird migration monitoring observatory in Canada (Beaverhill Bird Observatory, 2023), and tree swallows have been monitored at their field sites since 1984. The BNA provides a suitable habitat for a variety of wildlife, including bats, butterflies, and owls. The BBO maintains three sites for monitoring tree swallows: the Road Grid, the Spiral Grid, and the New Grid. The Road Grid is set up along the roadside wire fence of Township Road 510, in the middle of agricultural fields. The Spiral Grid is located northwest of the BBO, near Beaverhill Lake; and the New Grid, installed in 2013, is located in the northeastern part of the BBO, along BBO Boulevard, and is the closest to the lake (Figure 1).

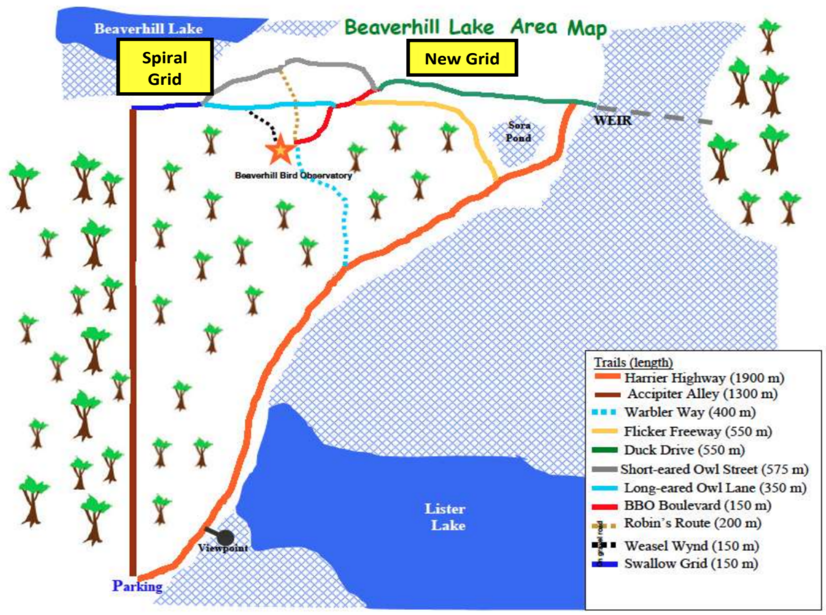

Figure 1. Map of the distribution of tree swallow grids . Figure from Beaverhill Bird Observatory tree swallow Internship Manual.

Data collection

We monitored tree swallow nest boxes at the three sites from laying, at the beginning of May, until fledging. During the nesting season, we checked the nest boxes at least twice/ week. Nest monitoring consisted of checking nest state and adult state. Nest state included recording whether a nest was inactive or active, and, if active, whether the nest was being built or had eggs or nestlings in it. We also recorded the number of eggs/ nest and number of nestlings/nest. We calculated clutch size as the total number of eggs laid. Adult state referred to the absence or presence of a parent at a nest, and whether the adult was flushed, remained in the nest, or the vicinity when we approached.

Data analysis

We used the statistical software R (RCore Team 2023) to analyze our data. We checked for the normal distribution of the data using the R package “P*erformance*”

(Lüdecke 2021). Because our data was not normally distributed. We used a generalized linear model (GLM) with a Poisson distribution for count data to explore the relationship between clutch size and site (Road Grid, Spiral Grid, and New Grid). We used a GLM with a binomial distribution for proportion data to test for differences in hatching success between sites. We used the R package "ggplot2" to make all our graphs (Wickham 2016).

Result

We collected data on clutch size from 42 nests at the Road Grid, 81 nests at the Spiral Grid, and 46 nests at the New Grid. Tree swallows nesting at the Road Grid laid clutches that were 6.9% smaller than clutches of birds nesting at the New Grid (Poisson GLM, $z = -2.115$; $P = 0.036$; Figure 2). However, tree swallows nesting at Road Grid did not differ in their clutch sizes from birds nesting at the Spiral Grid (Poisson GLM, $z = 0.799$; $P = 0.425$; Figure 2) nor did birds nesting at the New Grid differ from birds nesting at the Spiral Grid (Poisson GLM, $z = -1.629$; $P = 0.105$; Figure 2).

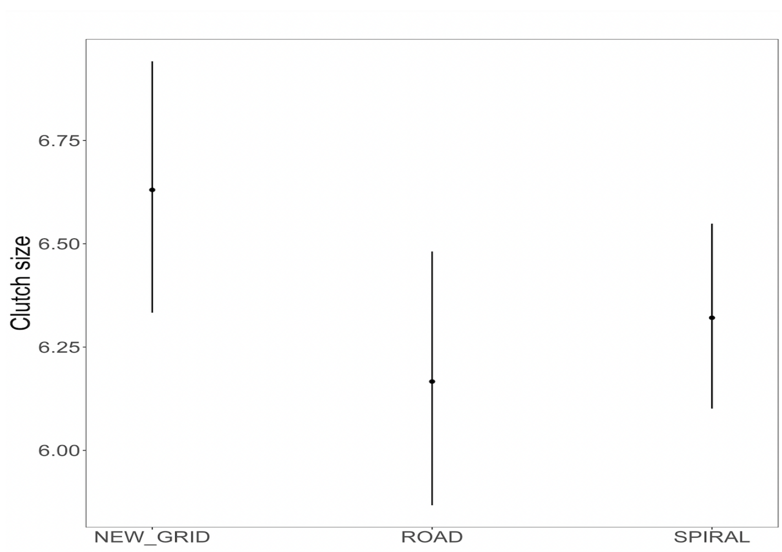

Figure 2. Mean clutch size (total # eggs in a clutch) differences between the New Grid, the Road Grid and the Spiral Grid.

We also found no difference in hatching success between the three sites with birds at the New Grid, Road Grid and Spiral Grid successfully hatching 87.5 %, 82.1% and 90.6% of eggs respectively (binomial GLM, Road Grid *vs.* New Grid: z = 0.910; P = 0.363; Road Grid vs. Spiral Grid: z = 0.367; P = 0.074; and New Grid *vs.* Spiral Grid: z = 0.773, P = 0.439).

Conclusion

Overall, we found a weak association between clutch size and site selection in our tree swallow population. While birds nesting at the Road Grid produced smaller clutches compared to birds nesting at the New Grid, we found this difference disappeared when we compared clutch sizes of birds nesting at the Road Grid with birds nesting at the Spiral Grid. In addition, we found no difference in hatching success between these sites overall. This suggests that agricultural activities and human disturbance may not be the main driving factor leading to a decline in this population. Besides, the population trends of aerial insectivores declined in the 1980's which caused the availability of AAI's food to decrease (Smith et al. 2015). Therefore, we suggest that food quality and quantity, particularly the availability of aquatic invertebrates may be more important in affecting this population.

One shortcoming of our study is that we predominantly focused on clutch size and hatching success. Future work should also include additional measures of reproductive success, such as fledging success, to get a better idea of the associations between site selection and fitness in this tree swallow population.

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