Influence of orientation on nest box occupation rates of House Wrens (*Troglodytes aedon*)

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Abstract

Nest box entrance direction is influential in nest site selection and can influence occupancy rate (Goodenough 2008). This study aimed to determine the state of the relationship between nest box entrance direction and occupation by House Wrens within the Beaverhill Natural Area. Ninety-nine artificial nest boxes, split between four grids, were checked once every two weeks from May until August, and data were collected regarding the development of the nests within. The nest box activity was recorded, including the presence and number of eggs and nestlings, the presence or absence of adult birds, and the success of each nest. The direction of each nest box was also measured via a compass. Historical data from 8 previous years was utilized to assess occupation rates of the nest boxes. Occupation and directional data were analyzed using Microsoft Excel, which provided a significant chi-squared result, indicating that the direction of the nest box entrance likely influences nest site preference in House Wrens. House Wrens preferred south-facing boxes and used east-facing boxes less than expected.

Introduction

House Wrens (*Troglodytes aedon*) are cavity-nesting passerines typically found in open woodlands on the edge of deciduous forests (Johnson 2020). Occupying the most extensive latitudinal range of any native passerine found in the western hemisphere, House Wrens make an excellent subject of study due to their expansive land coverage and tolerance of different habitat types (Johnson 2020).

Unable to forge their own nesting sites, secondary cavity-nesters, such as House Wrens, rely on excavators or other natural processes to craft the holes in which they build their homes (Martin et al. 2003). However, the number of suitable cavities can be limited by several factors,

including reduced presence of excavator species or anthropogenic activities in the area, therefore removing habitat options for the cavity-nesting species (Robles et al. 2011). Artificial nest boxes allow for increased availability of cavities to improve population size and breeding success of cavity-nesting birds.

Along with the quantity of nesting cavities, quality can be considered when evaluating secondary cavity-nesting birds' use (Lõmus and Remm 2004). Even in cavity-rich environments, nest box traits such as entrance direction have proven crucial for nest box selection (Goodenough 2008). Direction may be an essential factor due to temperature and weather conditions; for instance, previous research suggests boxes facing away from wind and rain are selected more frequently. Nest boxes facing east might also be preferable due to the rising sun, which allows the box to warm up faster in the morning (Zhang et al., 2021). The purpose of this study is to determine the relationship between nest box entrance orientation and nest site selection in House Wrens within the Beaverhill Natural Area.

Site Description and Methods

This study was completed from May until August 2024 at the Beaverhill Bird Observatory (BBO). Located on the south shores of Beaverhill Lake, within the Beaverhill Natural Area (BNA), the study site covers richly biodiverse wetlands and aspen-balsam poplar woods (Alberta Parks 2024). The Beaverhill Lake area is internationally regarded as an Important Bird Area, with over 270 species reported, making it an ideal location for bird monitoring and research (BBO 2024). Four grids, A, B, C, and D, contain 99 House Wren nest boxes. The nest boxes are organized in a five-by-five orientation, except grid B, which is three-by-eight. All the nest boxes in each grid were checked once every week or two weeks (Cicon et

al., 2024). During each survey, development within the nest boxes was evaluated, including nesting status, egg count, adult presence or absence, nestling number, and nestling age. The same approach was followed for other species discovered to have nested in the boxes, including Tree Swallows. To reduce the potential for premature fledging, after the House Wren nestlings were determined to be over seven days old and the Tree Swallow nestlings ten days old, the nest box was not checked until fledging was predicted to be complete - approximately 27 days. All data collected in the field were recorded through Google Sheets for future use (Google 2023).

Measurements of orientation were taken from the entrance of the nest box using a compass. Historical data from 2015 to the present, excluding 2016 as this data is missing, was used to determine occupation rates of the nest boxes. Data were sorted via Microsoft Excel (Microsoft Corporation 2010) based on the direction of the box entrance; the occupation frequency was determined for each box. A chi-squared analysis was completed to determine if a relationship was present between nest box occupancy and the direction the entrance of the nest box is facing.

Results

Breeding parameters

In 2024, of the 99 boxes spread throughout Beaverhill Natural Area, 44 remained unoccupied by secondary cavity-nesting passerines, 12 of which had some nesting material that was abandoned and no presence of eggs, and eight were occupied by other species, primarily the Northern flying squirrel. Within the 55 occupied boxes, House Wrens built successful nests in three. Tree Swallows had a dominating presence this summer as they built nests in 52 boxes (Figure 1). The House Wrens produced 19 eggs total with an average clutch size of 6.3. The

earliest sightings of House Wren nestlings were recorded on June 25, 2024. The latest date that new nestlings were observed was July 2, 2024. Brood size and exact nestling age could not be determined due to a loss of data.

Chi-squared analysis

The chi-squared analysis of House Wrens' occupancy frequency and direction for 8 years produced a significant chi-squared value ($X^2 = 14.87$, P=<0.001). The results are significant because the observed chi-squared statistic is greater than the critical value (7.81, P= 0.05), indicating a difference in occupancy depending on the direction of the nest box entrance. The same for 8 years applies to the Tree Swallows' nest box direction analysis, with a significant chi-squared value ($X^2 = 22.77$, P= <0.001). The occupancy frequencies calculated as observed and expected values differed for all directions (Figure 2).

Discussion

Given that the observed values recorded differ from the expected values for each direction, the significance of the chi-squared values indicated significant variation in the occupancy rate between North, East, South, and West with south-facing boxes preferred and east avoided over other directions. Further, it can be deduced that the direction of the nest box entrance is an influential predictor of occupancy and may contribute to nestbox selection by the secondary cavity-nesting passerines that inhabit the evaluated grids. These findings have practical implications concerning nest box management, as increased knowledge can be applied to the design and placement of artificial nest boxes to maximize occupancy and better support avian species. Specific displays of directional preference have also been noted in other species;

for instance, it was found that Eastern Bluebirds in Georgia presented occupancy much greater in nest boxes that faced northeast over any other direction (Navara and Anderson 2011). Those authors suggested that preference for box orientation may vary with latitude. Temperature in Georgia will be hotter than in Alberta, thus southern birds may prefer to avoid direct sunshine whereas in Alberta birds prefer added warmth in our colder climate.

Chi-squared analysis was chosen as the statistical test since the number of available nest boxes facing each direction was unequal (North:13, East: 32, South:52, West:2). A lesser variance between each category would likely provide more significant and distinguishable results. Another aspect influential to the chi-squared analysis was the greater population of Tree Swallows occupying the nest boxes within the study area. The low number of successful House Wren nests in 2024 makes it difficult to draw conclusions about the nest box preference in that year. Historical data were used for statistical analysis to overcome this and provide more relevant results. Over time, the number of occupied nest boxes and subsequent successful nests of House Wrens has declined greatly. On the other hand, Tree Swallow nestbox occupancy has greatly increased as these birds have taken over many of the artificial nest boxes within the House Wren grids in recent years. The rise in the number of Tree Swallows may be due to the advantageous interspecific competition, including territorial defense and opportunistic claim of the nest boxes depending on the arrival date (Wiebe 2016, Leffelaar and Robertson 1985). However, further research can be done to assess the population change of Tree Swallows in Alberta, specifically in the BNA.

Several external factors may also be responsible for nest box preference and the difference in occupancy per direction, including climate, predation risk, available resources, and anthropogenic influences. Therefore, it is difficult to concur that direction is the sole factor

contributing to whether or not House Wrens occupy an artificial nest box. However, direction likely plays a role as many direction-dependent characteristics may change the habitability of the nestbox, including temperature. Nestbox microclimate can change depending on the direction in which the box is facing in association with the sun; subsequently, previous research by Ardia et al., (2006), determined that Tree Swallows displayed a preference for specific nestbox orientations only when these boxes were also actively affected by ambient temperature.

Conclusion

Understanding nesting preference can help provide greater insight into the parameters required for successful breeding and maintaining stable populations of House Wrens. Analysis of the nest boxes placed within the Beaverhill Natural Area revealed that nest box orientation may play a role in nest box selection by House Wrens. Additionally, analysis of the other species nesting in the area reflected a similar significant result for Tree Swallow nest preference. Further research could be completed regarding which direction is preferred by different species and other parameters associated with direction, such as sun exposure, nest box microclimate, and vegetation height.

Figures

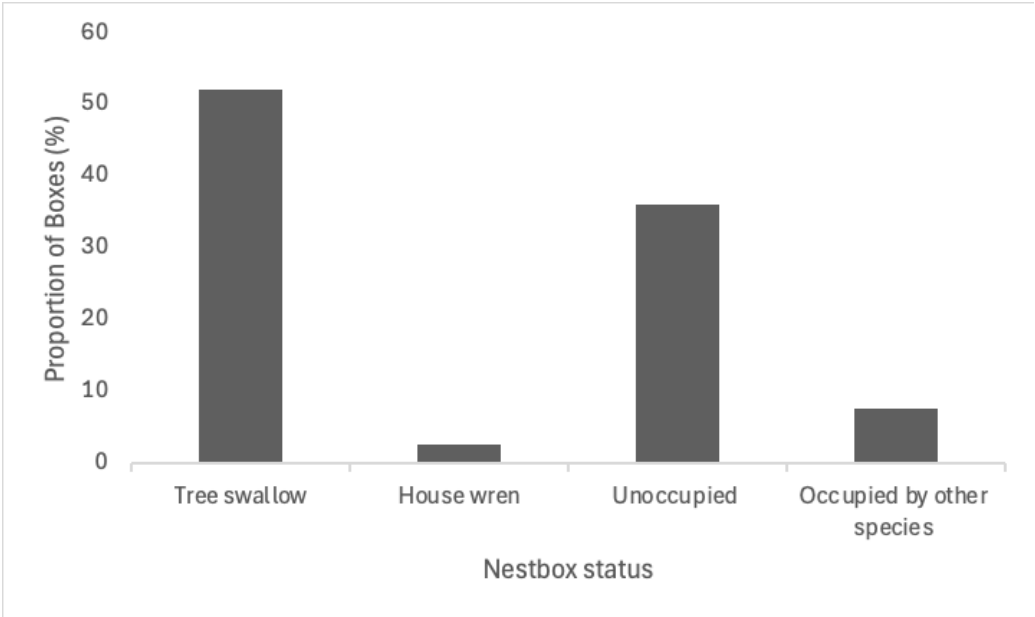

Figure 1. House Wren nestbox occupancy status in Beaverhill Natural Area, summer 2024. House Wrens occupied only three nestboxes (3.03%), Tree Swallows (52.52%), other species (8.08%), and the rest were unoccupied completely (36.3%).

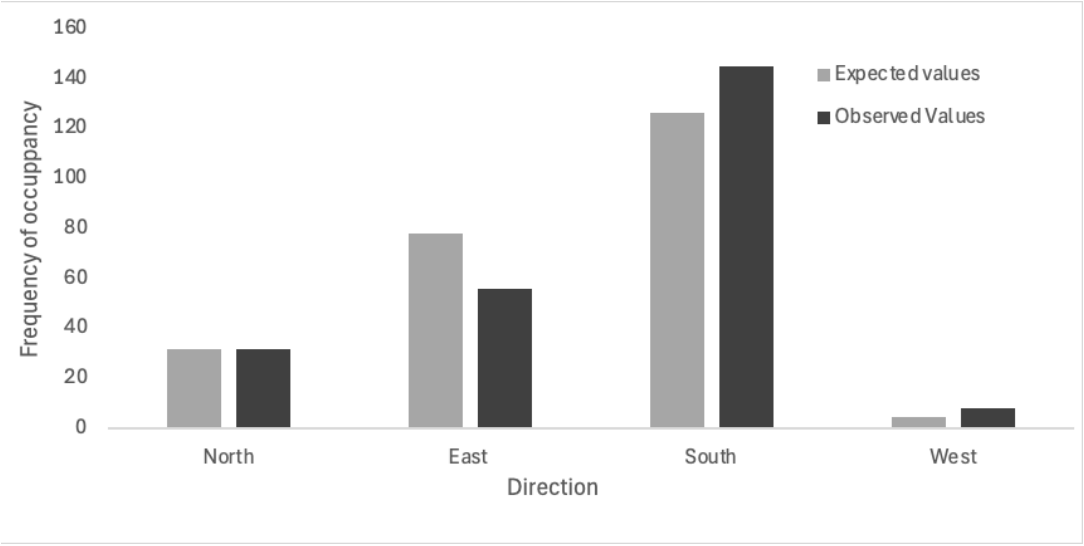

Figure 2. Observed and expected occupancy frequency of nest boxes by House Wrens over eight years in the House Wren grids within BNA. The observed values for North, East, South, and West (Observed: N = 32, E = 56, S = 145, W = 8) differed from the expected values within each directional category (Expected: N = 31.64, E = 77.898, S = 126.59, W = 4.87). Yielding a significant chi-squared value ($X^2 = 14.88$, P= <0.001).

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