I confirm that the following report and associated code is my own work, except where clearly indicated.

Comparative Analysis of Bird Counts in the UK: A Deep Dive into Starlings and House Sparrows.

ABSTRACT

Using data from the British Trust for Ornithology's Garden Bird Feeding Survey over 40 years, this study explored the difference in House Sparrows and Starlings counts between rural and (sub)urban areas in the UK. T-tests, permutation tests and linear regressions were conducted. Results revealed no significant difference for House Sparrows, but a substantial disparity for Starlings, though with notable temporal changes. The result shed light on potential impacts of urbanization on bird communities, hence contributing to the preservation of biodiversity within urbanized settings.

Introduction

The dataset, identified by the 'site' and 'year' columns, encompasses a mix of spatial, temporal, and environmental variables. Drawing insights from the dataset, this research aims to elucidate the relationship between urbanization and bird populations. This long-term observation of local bird richness is pivotal in comprehending shifts in biodiversity over time, thereby providing insights for effective nature management practices [Hernández]. The research focuses on the question: **'Is there a significant difference in the average count of House Sparrows and Starlings between rural and (sub)urban areas?'**

Methods

The diagram outlines approaches in the research, from data visualization to parametric and non-parametric tests [Figure 6].

During preliminary data analysis, no missing values were detected. However, boxplot outlier checks for both Starlings and House Sparrows revealed a substantial number of outliers, suggesting instances of particularly high bird counts [Figure 1].

Using ggplot for in-depth data visualization, data was categorized yearly to determine average bird counts for both species. Both species revealed declining trends, with periodic oscillations [Figure 2-1]. Examining the two Species separately: House Sparrows in (sub)urban regions initially had higher counts but later fell under their rural counterparts [Figure 2-2]. Conversely, Starlings counts are consistently higher in suburban [Figure 2-3].

A lack of obvious linear relationships between bird counts and temperature variations was observed and recorded in the R code Appendix 1. Given these patterns and the downward trajectories, the ensuing Discussion section will delve deeper into the possible influences of factors such as habitat transitions, food supply, and human interventions.

To test the null hypothesis that there is no significant difference in the means of bird counts between rural and (sub)urban areas, 'compute_p_value_ttest' function was used to perform a two-sample independent t-test on the bird species columns.

Further analysis indicates that the t-test outcomes should be considered cautiously due to breaches in the assumptions of the parametric test. The function 'plot_distrbution_rural' offers a visual representation of the bird species distribution in both habitats using histograms. Both species in both areas displayed noticeable positive skewness, pointing to deviations from a standard normal distribution [Figure 3]. The evident positive outliers in the boxplots further underscore a possible breach of the normality assumption of t-test [Figure 1]. Another potential violation is the assumption of homogeneity of variance. This was further assessed using Levene's Test for both House Sparrows and Starlings detailed in R code Appendix 2.

Given these concerns, we proceed with a non-parametric permutation test.

The 'diff_in_means' function was used to compute the observed difference in means for House Sparrows and Starlings

counts. The ‘compute_p_value’ function conducts the permutation test with input dataset, a column name, and the number of permutations (default 1000). By shuffling the ’subrur’ labels (rural and suburban) of the data multiple times, this function simulates a distribution of the differences in means under null hypothesis of no difference in bird counts between the two areas. The function outputs a list containing the p-value, the observed difference, and an array of simulated differences. Finally, the ‘plot_permutation_test’ function visualizes the permutation test results with a histogram of simulated differences and overlays a red dashed line to indicate the observed difference [Figure 4].

For a more in-depth examination of the temporal variation in spatial differences for Starlings, a linear regression model was applied separately to data from (sub)urban and rural areas.

Results

House Sparrows: The observed difference in means for House Sparrows is 0.376. The House Sparrows showed no significant difference in counts between rural and (sub)urban areas, which is confirmed by both the t-test (p-value = 0.187) and the permutation test (p-value = 0.182). Despite a decline over time, the fluctuations between the average (sub)urban counts and rural locale counts do not showcase a consistent pattern.

Starlings: The results for Starlings differed from that of the House Sparrows. The observed difference in means for Starlings is 2.59. The t-test yielded a significant p-value near 0, which was reaffirmed by the permutation test’s p-value of 0. Both tests conclusively indicated a significant difference in Starlings counts between rural and (sub)urban areas. Further analysis suggests that such differences may change over time. The findings indicated a more pronounced decline in the (sub)urban areas with a slope of -0.33, compared to the rural areas with a slope of -0.22 [Figure 5]. This suggests a steeper decrease in Starlings populations over the years in (sub)urban regions relative to their rural counterparts.

Discussion

The study’s results provide insights into the potential effects of urbanization on the populations of House Sparrows and Starlings in the UK. While House Sparrows showed no significant difference in counts between rural and (sub)urban areas, Starlings revealed a noticeable disparity, with higher counts in (sub)urban regions. Two factors might contribute to these observations:

Food Availability: Urban and (sub)urban areas often provide consistent food sources, such as garbage. One explanation suggested is that Starlings an omnivores, which prefer urban settings with more abundant food compared with Sparrows as seed eaters [Birdfact]. A linear regression analysis on Starlings counts over the years, revealed that the Starlings undergo sharper decline in (sub)urban areas, suggesting that the rapid urbanization over the years might be affecting their food abundance, leading to a more pronounced decline in the area.

Habitat Alteration: The decline in both bird species’ counts, more pronounced in (sub)urban settings for Starlings, indicates that urbanization impacts their habitats. The British Trust for Ornithology indicates that the alterations in agricultural practices and land utilization might be influencing bird populations [British Trust for Ornithology].

The study highlights the differential effects of urbanization on House Sparrows and Starlings. These findings underscore the need for species-specific conservation efforts in urban environments and further research on external effect.

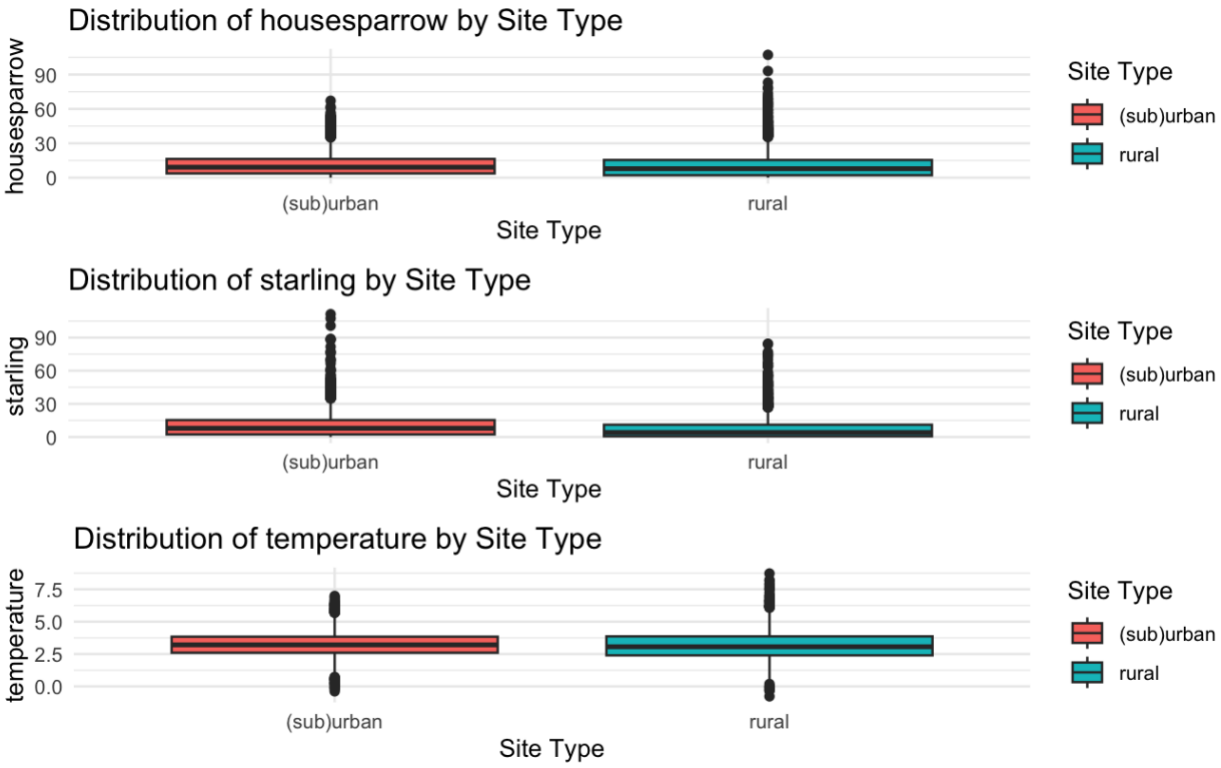

Figure 1

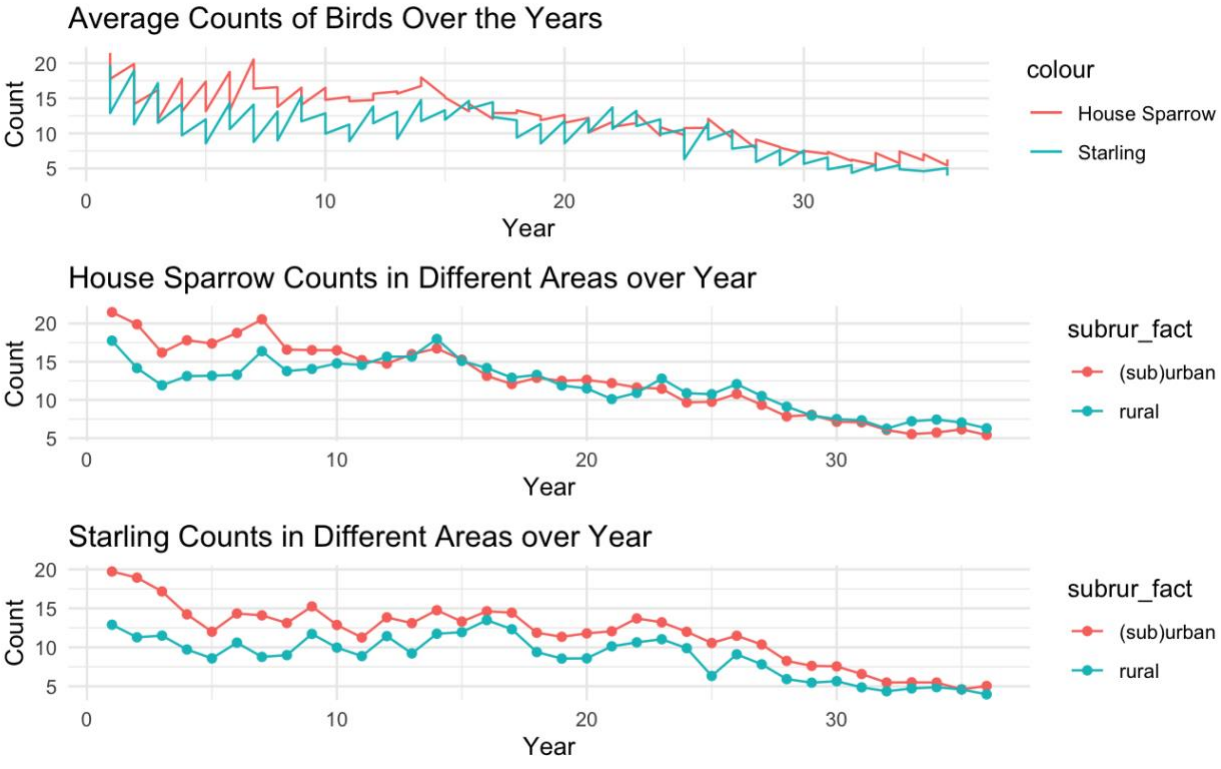

Figure 2

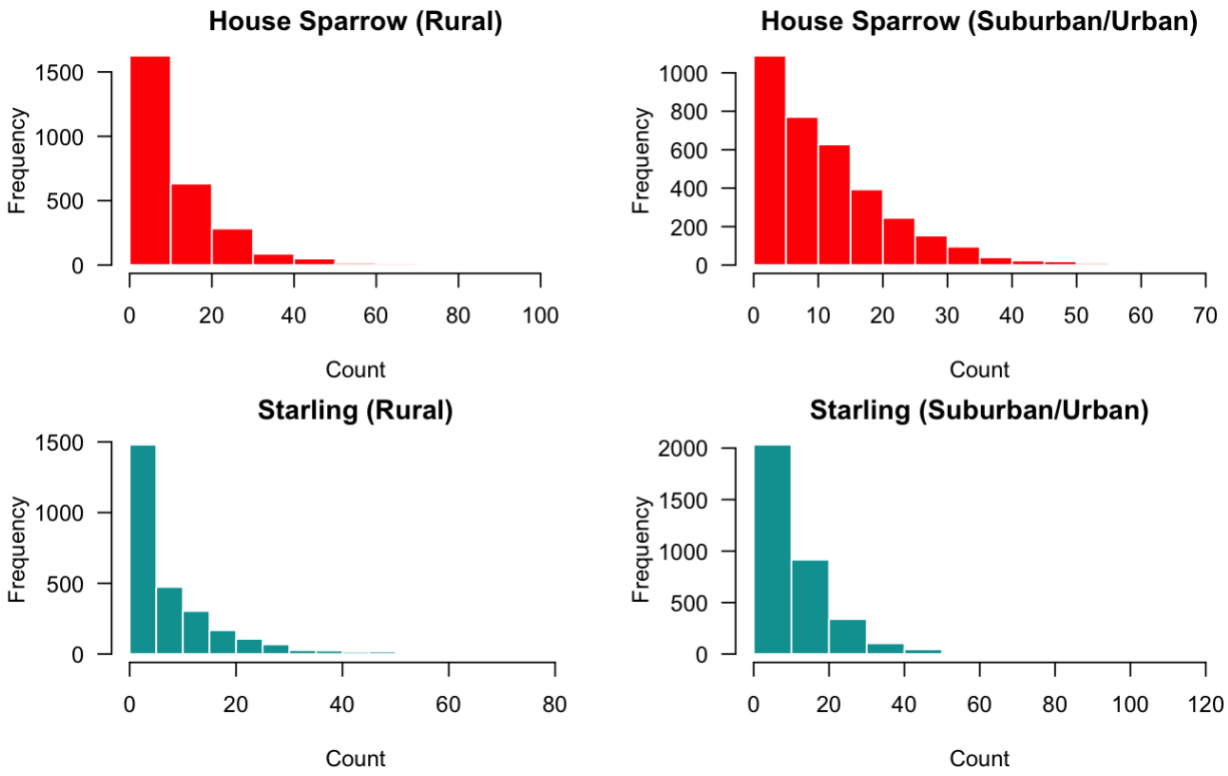

Figure 3

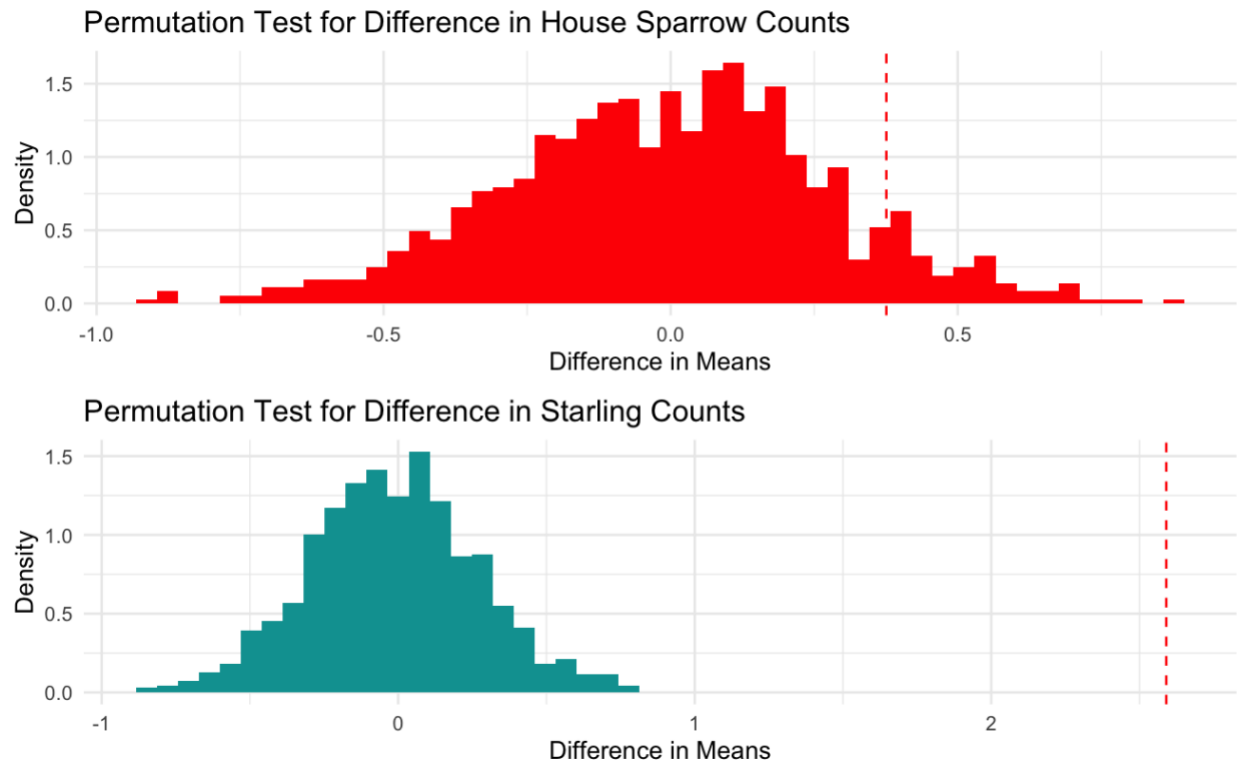

Figure 4

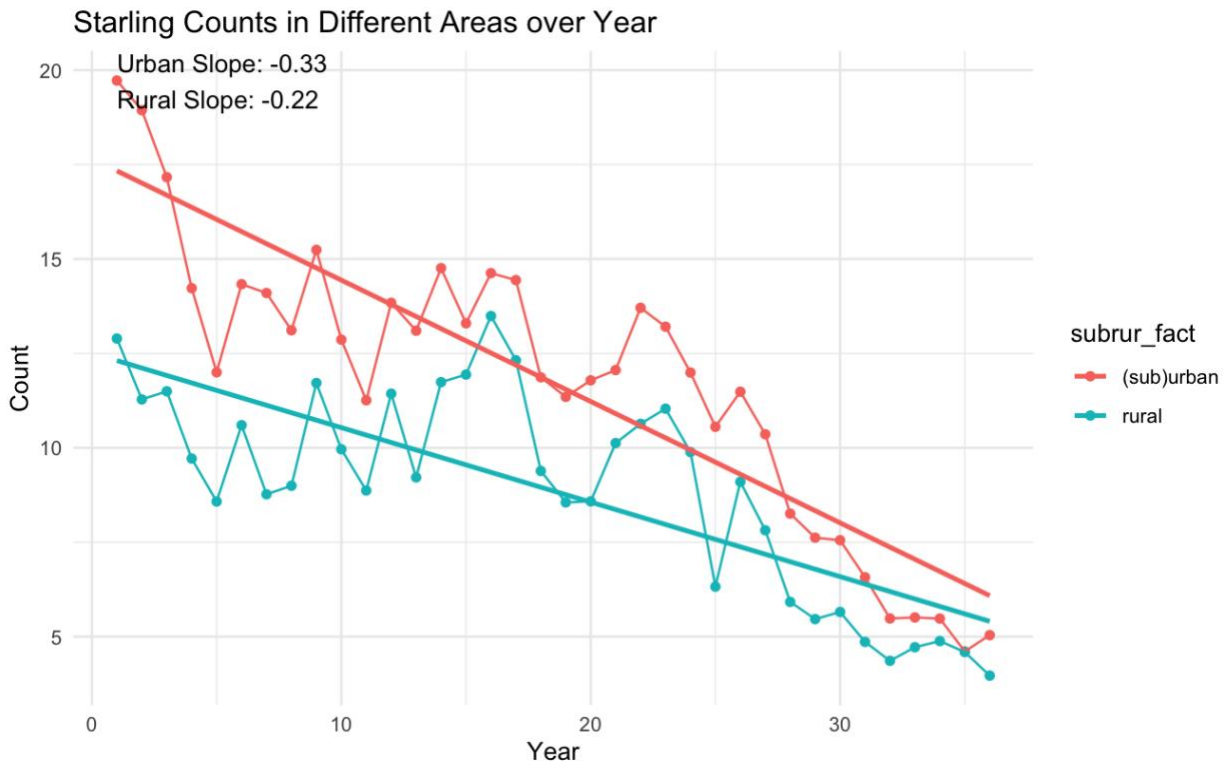

Figure 5

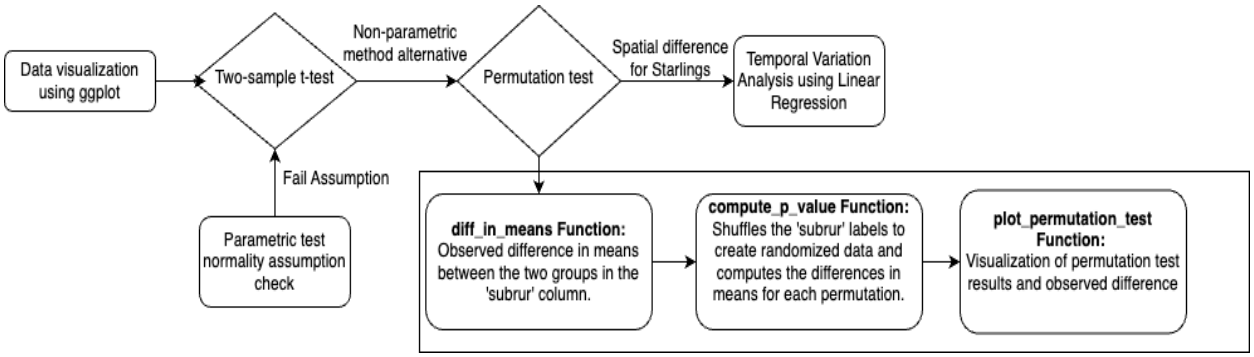

Figure 6

References

1. British Trust for Ornithology. (n.d.). Garden Bird Feeding Survey. https://www.bto.org/our-science/projects/gbfs.

2. Hernández-Navarro, A.J., Robledano, F., Jiménez-Franco, M.V., et al. (2023). Long-term trends of local bird populations based on monitoring schemes: are they suitable for justifying management measures? J Ornithol. https://doi.org/10.1007/s10336-023-02114-3

3. Birdfact. (n.d.). What Do Starlings Eat? (Complete Guide). https://birdfact.com/birds/starling/what-do-starlings-eat1.