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Big Data Analysis

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Changes in Bird Abundance on Block Island Over Time

**Introduction**

The Block Island Banding Station (BIBS) on Block Island, RI has been banding birds every spring and fall since 1967. This data presents an opportunity to begin to understand changes in bird abundance and species diversity on Block Island over the last five decades. Though further research is needed to understand the mechanisms behind these changes, this preliminary analysis can help set the stage for future research projects utilizing this dataset.

**Methods**

Data from the Block Island Banding Station is available publicly from the United States Geological Survey Bird Banding Lab, and includes data about the species, age, sex, and morphological measurements of each bird that is captured at the station. The number of nets, called mist-nets, and the number of hours that the station is open each day have changed over the last 56-years, and these differences can affect the numbers of birds that are captured each day. As a result, I have accounted for effort in my analysis by dividing the number of captures by the number of net hours. Net hours are calculated by multiplying the number of nets open each day by the number of hours those nets were open. I only have access to net hour data from 1967-2016, so all analysis that accounts for effort will only fall within that time period. Additionally, some data is currently missing from the database (1967, 2004) but will be remedied for future analysis. All analysis was performed using the tidyverse and lubridate packages in R Studio. Effort was accounted for in all analysis. Linear models were run on the individual species time series analysis but left out of the total captures analysis because the trend was not linear. I did not run linear models on the total yearly captures data (Fig. 1) because the data was far from linear. However, I did decide to run linear models on the individual species analysis using the interaction between year and species as the predictor (Fig. 3). Though there was also a lot of variation in the individual species linear models, I thought it would be helpful to get a preliminary idea of the directionality and significance of the trends. Paired two-sample t-tests were used to compare the mean captures per 100 net hours of the 1970s (1970-1980) and 2010s (2010-2020) for the four most common species on Block Island.

**Results**

Total bird captures per 100 net hours decreased by 77% in only a four-year period between 1974 and 1978 (Fig. 1). After this crash, bird captures never recovered in the subsequent 38 years. Between 1978 and 2016, the highest number of bird captures per 100 hours was 65 birds per 100 net hours, reported in 2005. For every year of bird banding since 1968, the bird captures per 100 net hours of each of the six most commonly caught species at BIBS decreased by approximately 0.16 birds per 100 net hours (Fig. 3, p < 0.05). The declines in the number of species caught per 100 net hours closely mirrored the patterns seen in Figure 1 (Fig. 2). The interaction between year and species significantly accounted for 38% of the variation seen within the banding data (R-squared = 0.38, p < 0.05). The effect of banding year was significantly different for each species of bird included in the model (p <0.05). Gray Catbirds, Myrtle Warblers, and Red-eyed Vireos all decreased significantly from the 1970s to the 2010s (Fig. 4, GRCA p < 0.05, t = 16.1, df = 76, MYWA p < 0.05, t = 12.1, df = 76, REVI p < 0.05, t = 10.4, df = 76). Myrtle Warblers had the steepest decrease with a mean difference of 21 birds per 100 net hours across the two decades. Golden-crowned Kinglets were caught more often in the 2010s than the 1970s, with an average difference of 1.6 birds per 100 net hours. Though this difference was far lower than those seen in the other three species, it was statistically significant (GCKI p < 0.05, t = -3.03, df = 69).

**Discussion**

This preliminary analysis indicates that bird captures at the Block Island Banding Station on Block Island, RI have dropped significantly over the last five decades. This drop is most pronounced in the late 1970s, where bird captures dropped nearly 80% in only a four-year period. Species diversity (number of birds captured per 100 net hours of effort) showed a strikingly similar pattern to total bird captures, indicating that both fewer bird specieswere captured over time and fewer individuals of each species were captured over time. Bird captures on the island have never returned to the captures of the 1970s, even though the BIBS has operated more nets and stayed open for more hours on average each day. From 1980 to present, there are smaller booms and busts in the data, but the range of captures stays relatively consistent until 2010 when the capture rate began to decline once more. Further analysis will be required to determine the cause of these declines and exactly which species were most affected. I hope to include model variables such as diet, migratory strategy, land use, and meteorological variables such as wind profit and temperature to better understand the patterns that are evident in the data.

Myrtle Warblers declined significantly over the 48-year period, with a nearly 99% decrease between the highest capture rate of 58 birds per 100 net hours in 1971 and the lowest rate of 0.3 birds per 100 net hours in 2016. Myrtle Warblers, Red-eyed Vireos, and Gray Catbirds all declined significantly over the study period. These species followed a similar pattern as the overall bird capture rate, with a sharp drop in captures the late 1970s, though Gray Catbirds had much greater variation during the subsequent decades. White-throated Sparrows and Hermit Thrushes have decreased slightly but have remained largely stable over time. Golden-crowned Kinglets have increased slightly but significantly, which is evident in both Figure 3 and Figure 4. The combination of year and species accounted for 38% of the variation in our data, but as previously mentioned, it will be important to incorporate weather, life history strategies, and land use to more fully understand why some species are declining so sharply and others are stable or increasing.

Chart, histogram

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**Figure 1.** Changes in the fall season total birds per 100 net hours over time on Block Island, RI between 1968 and 2016 (excluding 2004). Total birds per 100 net hours decreased from 122 to 28 between 1974 and 1978, a 77% decrease. Total birds per 100 net hours was calculated by dividing the number of birds caught each fall by the total number of net hours for that season. All data comes from September, October, and November. Data was provided by BIBS and the USGS BBL.

Chart

Description automatically generated

**Figure 2.** The number of bird species (species diversity) captured per 100 net hours over time on Block Island, RI between 1968 and 2016 (excluding 2004). Number of bird species per 100 net hours was calculated by dividing the number of bird species caught each fall by the total number of net hours for that season. All data comes from September, October, and November. Data was provided by BIBS and the USGS BBL.

Chart, histogram

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**Figure 3.** Changes in abundance (birds per 100 net hours) of the six most common BIBS species over time (1968-2016, excluding 2004). The interaction between year and species had a significant relationship with birds per 100 net hours and accounted for 38% of the variation in the data (R-squared = 0.38, p = 2.2e-16). Birds per 100 net hours was calculated by dividing the number of birds caught each fall by the total number of net hours for that season. All data comes from September, October, and November. Data was provided by BIBS and the USGS BBL.

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**Figure 4.** A comparison of birds per 100 net hours of the four most common BIBS species between the 1970s (1970-1980) and 2010s (2010-2020). All four species differed significantly between decades (p < 0.05). GCKI means Golden-crowned Kinglet, GRCA means Gray Catbird, MYWA means Myrtle Warbler, and REVI means Red-eyed Vireo. Red represents the 1970s (1970-1980) while blue represents the 2010s (2010-2020). All data comes from September, October, and November. Data was provided by BIBS and the USGS BBL.

**References**

Kamm, M. D., T. L. Lloyd-Evans, M. Handmaker, and J. M. Reed. 2019. A half-century of changes in migratory landbird numbers along coastal Massachusetts. PLOS ONE 14:1-18.