The Long-Term Stability of Bird Populations in Monteverde

By: Mekhi Hernandez Project Advisors: Peter Freeman, Debra Hamilton

Background

From 1940 to the 1980s, almost half of Costa Rica's abundant natural forests had been cut down to make room for cattle ranching and agriculture, which had a massive effect on wildlife populations.

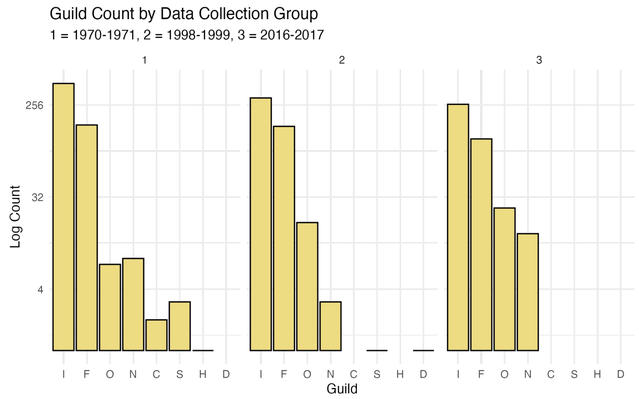
Since then, reforestation efforts have led to restoration of two-thirds of the clear-cut land, but have these efforts allowed the populations present at the start of the reforestation efforts to persist? Do wildlife with different roles in the ecosystem still have the same proportional size as they have in the past?

Data

To answer these questions, the Monteverde Institute shared a dataset of bird information that contained 1504 observations of 80 unique bird species collected over three main periods: 1970-1971, 1998-1999, and 2016-2017. We focus on four main variables:

- **Date of Capture:** The date when a bird was recorded
- **Species:** The bird's species name according to the SCP foundation
- **Guild:** The environmental role regarding the diet of the recorded species
- **Preferred Habitat:** The preferred habitat type of the bird species

Analysis and Modeling



Most Common Guilds:

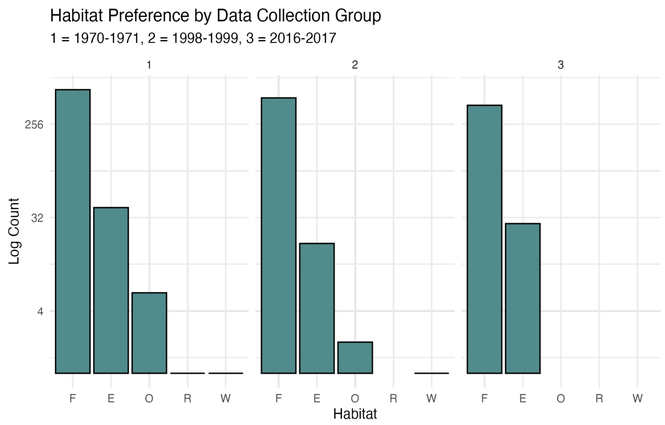
1. Insectivore
2. Frugivore (Fruit eater)
3. Omnivore
4. Nectarivore

Statistically significant differences between time periods using chi-square test of homogeneity (p-value: 0.0005) and simulation using poisson distribution (p-value 0.0074)

Most Common Habitat Preferences:

1. Forest
2. Edge
3. Open

Differences not statistically significant using chi-square test of homogeneity (p-value 0.085)



Occupancy Modeling

Occupancy modeling accounts for imperfect and unequal measurements across days or locations

- We account for exposure (duration of recording on a given day) to scale a modified logistic regression model
- Is there a significant difference in observations over time and by guild, accounting for inconsistent observation periods?

Predicted / Actual	Bird Not Present	Bird Present
Bird Not Detected	180	16
Bird Detected	26	126

Final Model:

- First collection group excluded due to missing recording times
- 87.93% prediction accuracy
- Date and guild both are significantly correlated with observation likelihood given exposure

Over 20 years, the odds ratio increases by:

- 17 percent for frugivores
- 11 percent for omnivores

Results

- There have been small yet significant changes in the bird populations within Monteverde's forests
- Using occupancy modeling, we determined that omnivores and frugivores are slightly more frequently observed over time
- Overall population makeups have remained relatively static

Future Steps

- Occupancy modeling by site
  - Deeper insights into movement of species and guilds
  - Include elevation as an additional variable
- Dive deeper into specific species changes

References

- Shaffer, T. L. (2004). A Unified Approach to Analyzing Nest Success. *The Auk*, 121(2), 526–540. https://doi.org/10.2307/4090416
- Donovan, T., Hines, J., & MacKenzie, D. (2024). occupancyTuts: Occupancy modelling tutorials with RPresence. *Methods in Ecology and Evolution*, 15, 477–483. https://doi.org/10.1111/2041-210X.14285