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Data Exploration and Preparation for Analysis

**Multi-Parametric Assessment of Avian Biodiversity and Anthropogenic Disturbance for
Conservation Prioritization in Belize.**

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Abstract: Multi-Parametric Assessment of Avian Biodiversity and Anthropogenic Disturbance for Conservation Prioritization in Belize

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Ecological Principles/ Methods, SNHU

Background: Anthropogenic climate change and rising

levels have accelerated global warming, causing severe disruptions to Belizean ecosystems through sea-level rise and habitat fragmentation. To mitigate these impacts, identifying high-value land for protected status is a critical conservation priority for maintaining medicinal biodiversity and preventing zoonotic disease spillover.

Objective: This study evaluated four candidate land parcels—Belmopan, Cockscomb Basin, Gallon Jug, and Punta Gorda—to determine the optimal site for acquisition based on ecological health and long-term sustainability.

Methods: Avian populations served as primary biological indicators. Biodiversity was quantified using taxonomic richness (s), the Shannon-Wiener index (H), dominance (D), and equitability (J). These metrics were integrated with geospatial land-use data to assess anthropogenic pressure, including agricultural encroachment and soil stability risks.

Results: Preliminary analysis excluded Belmopan and Gallon Jug due to insufficient taxonomic richness ($S < 100$). While Punta Gorda exhibited the highest immediate biodiversity ($S = 240$; $H = 5.446$; $J = 0.9936$), it faced extreme anthropogenic pressure with 50% land conversion for agriculture. Conversely, Cockscomb Basin demonstrated robust biodiversity ($S = 240$, $H = 4.411$); with significantly lower agricultural impact (30%) and superior habitat complexity, including lowland lake and pine forest ecosystems. Statistical differentiation in dominance (D) values—0.00443 for Punta Gorda versus 0.05034 for Cockscomb Basin—suggested more resilient population clusters in the latter despite lower evenness.

Conclusion: Cockscomb Basin was identified as the superior conservation candidate due to its higher ecological integrity and lower risk of future degradation. This study underscores the necessity of combining point-in-time biodiversity indices with longitudinal land-use data and chemical monitoring, such as soil pH and contamination tracking, to ensure sustainable environmental preservation.

INTRODUCTION

Every region of the planet is impacted by climate change. The increase in temperature brought on by rising levels of carbon dioxide and other greenhouse gases is referred to as global warming. Scientists have been able to develop explanations for an increase in natural disasters such as storms, flooding, coral bleaching, and more due to climate change and global warming. Such catastrophic disasters are common in Belize, a Central American nation. Belize is under Mexico and west of the Caribbean Sea. Here, increasing sea levels and increased surface temperatures are putting coral reefs at risk of bleaching.

According to UNESCO, if we keep producing greenhouse gases, the coral reefs in all 29 World Heritage sites with reefs might vanish by the end of this century if we carry on with business as usual (Fabro, 2021). These coastal areas are essential to the region's overall biodiversity and sustain a diverse range of habitats. A team of conservation experts evaluated four parcels of land in Belize to determine which one to purchase in an attempt to protect it. Scientists evaluated the vegetation and bird populations in the Belmopan, Cockscomb Basin, Gallon Jug, and Punta Gorda areas (as well as within a 15-mile radius). Because they respond quickly to changes in their surroundings, bird populations can be used as markers of an ecosystem's health. Birds contribute to the upkeep of habitats and food crops by pollination, eating dangerous pests, and dispersing seeds (NPS, 2022).

Scientists and bird conservationists were able to determine which piece of property was most desirable for preservation because to the research that was done.

METHODS

Data on bird populations were collected using the Mackinnon list technique. In order to generate a species accumulation curve, all species that were heard or seen were grouped into sequential lists of the same length. The species that were not on any of the earlier lists were then added. The aggregate number of species is defined by O'Dea, Watson, and Whittaker (2004). A line graph was used to enter data from this list into a species accumulation graph.

The research study endeavor focuses on the intentional selection of a Belizean area of land for conservation because I work for a global bird conservation organization. The four pieces of land in question have different geographical and ecological characteristics and are currently earmarked for comparative study. The number of bird species present, overall biodiversity, and the inherent richness of the vegetation are some of the criteria we will use to assess these places.

GIS mapping techniques were used in a survey to assist identify the vegetation present in each location. Using GIS mapping, scientists were able to determine the land use and vegetation in each surveyed parcel. Agricultural uses, mangroves, coastal forests, lowland or submontane pine forests, urbanization, water, wetland, lowland savanna, and submontane broadleaf forest were the categories used to categorize the main vegetation or land cover. These Following that, the categories were separated into parcels for each specialized and generalist region (15 miles radius).

Methods(Materials)

I determined the number and presence of each species of bird in each location with the aid of the bird data spreadsheet, especially the 15-mile circle tabs. To determine which site could benefit the most from conservation, the species were categorized into events with more than ten individuals.

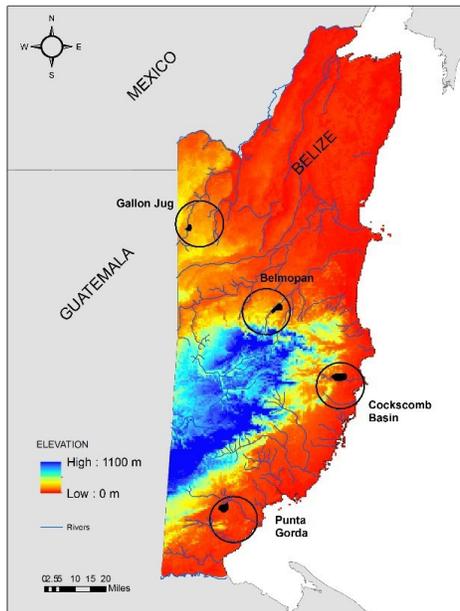
- Gallon Jug: 96 total species, 7 species with a 10 or greater individual count leaving 89 species that could benefit from greater conservation efforts.
- Cockscomb Basin: 240 species, 45 species with a 10 or greater individual count leaving 195 species that could benefit.
- Belmopan: 97 total species, 41 species with a 10 or greater individual count leaving 56 species that could benefit.
- Punta Gorda: 240 total species, 42 species with a 10 or greater individual count leaving 198 species that could benefit.

The vegetation assessments provided a picture of the geographical variety of each site as well as a split of the parcel that was being considered for acquisition. By categorizing the regional charts by land usage, it was feasible to determine if land use and diversity were closely associated. *Gallon Jug's three land uses are lowland broadleaf forests, which comprise 97% of the regional land use. The remaining 3% is made up of agricultural usage and wetlands. Nine land uses comprise the Cockscomb Basin: lowland pine, lowland savanna, lowland broadleaf forest (53 percent), lowland savanna (35 percent), mangrove and coastal forest, and wetland areas.

Although Belmopan has seven different land uses, 75% of it is lowland broadleaf forest. Lowland savanna, urban areas, lowland pine woods, submontane broadleaf forests, and agricultural use comprise the remaining areas. 25%. * Although Punta Gorda has seven distinct land uses, lowland broadleaf forest and agriculture occupy 96% of the area. The remaining 4% of land uses are urban, marsh, lake, lowland pine forest, and coastal and mangrove forest. The Cockscomb Basin has nine different land uses and was home to 240 species of birds, indicating a relationship between the number of bird species

found in each area and places with a more even distribution of land and multiple land uses supporting more species.

The map and information below identify the region and specific parcel for each survey.



1) Gallon Jug

- a. Furthest north of all survey sites, nearest to the Guatemalan border
- b. 17.561 °N, 89.044 °W

2) Belmopan

- a. Near center of Belize, northwest of Cockscomb Basin parcel site
- b. 17.146 °N, 88.729 °W

3) Cockscomb Basin

- a. Furthest east of all survey sites, nearest the Caribbean Sea
- b. 16.797 °N, 88.379 °W

4) Punta Gorda

- a. Situated in the south of Belize, furthest south of all parcel sites
- b. 16.165 °N, 88.883 °W

For each parcel site, diversity indices were measured via PAST software using the values below:

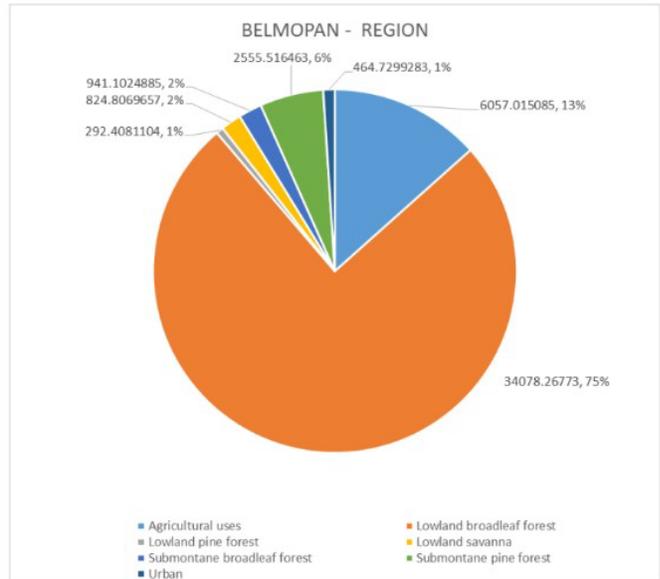
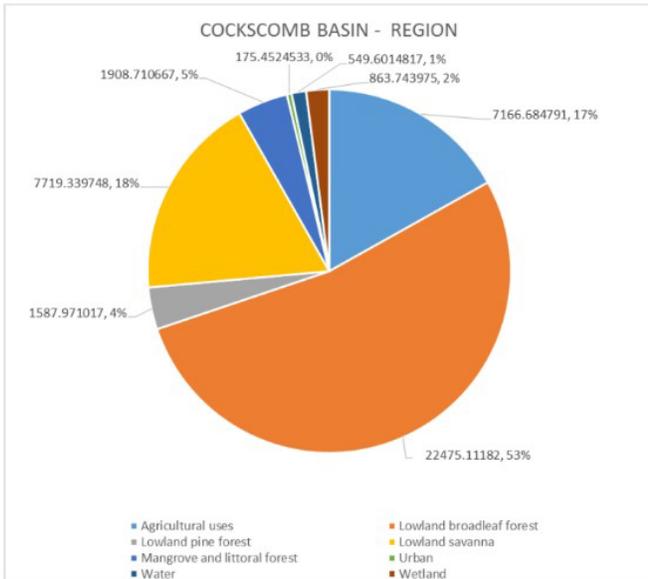
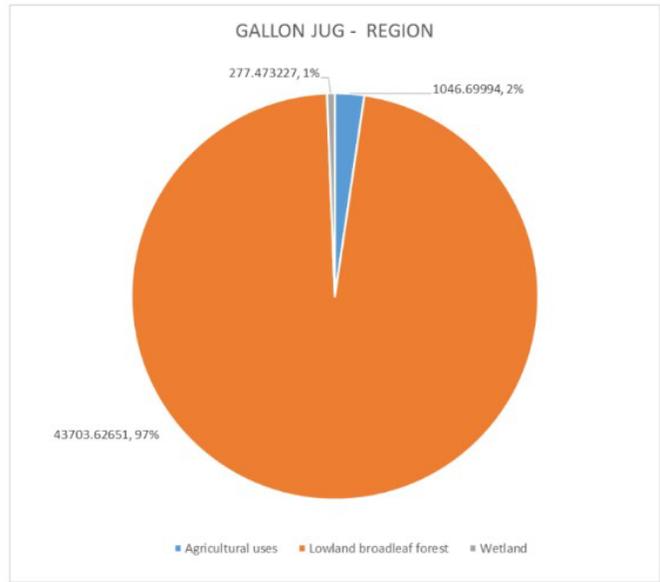
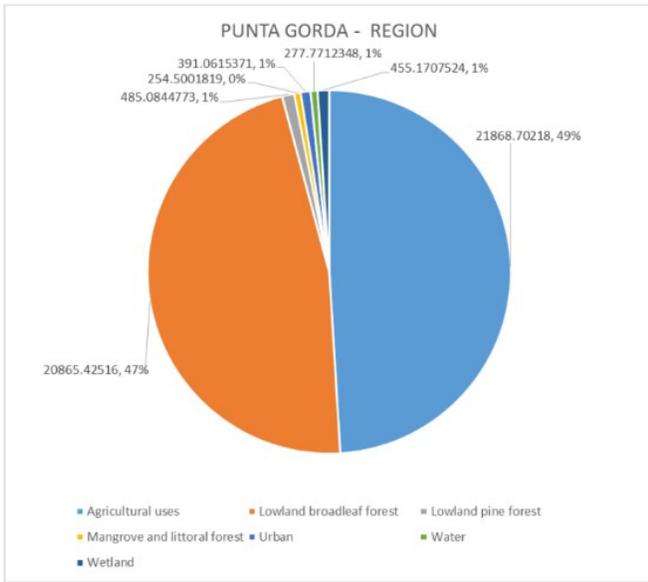
1. Each taxa (species) of bird was recorded (S) and each individual bird was tallied
2. Simpson's index (D) was calculated to measure dominance of a given species ($D = 1$ represents total dominance)
3. The Shannon Index (H) was used to measure certainty of diversity ($H = 0$ represents an area where only one species is present)
4. Equitability (J) measures the evenness each species is to one another ($J = 1$ represents highest level of evenness)

In order to facilitate rapid evaluation, these species were counted in a single day while investigating the grasslands and trails of each parcel.

RESULTS

The pie charts below show the vegetation inside each particular piece of land and within each region (15 miles radius). The Gallon Jug, Belmopan, Cockscomb Basin, and Punta Gorda regions all have lowland broadleaf forests and some type of agricultural use, among other land uses, according to the researchers that studied each location. By further breaking down the earth and focusing only on the vegetation within the parcels, the two main categories are lowland broadleaf forest and agricultural use of the land and vegetation on each parcel.

The vegetation investigation indicated that potentially the area was not sufficiently diversified, even though Punta Gorda contains 12 more feathered species than Cockscomb Basin and had an equivalent number of species recognized in the reasonable variety files. For horticulturists, Punta Gorda is a favorite destination. Belmopan has a lot of flora, but it is not spread out evenly throughout the area, and it has a lot fewer distinct bird varieties than the other regions. Gallon Jug contains a diversity of marsh broadleaf forests, but it is not large enough. Because of the widely dispersed and significantly enhanced vegetation, as well as its quantity, I think the Cockscomb Basin should be acquired for the protection/preservation zone.



A Diversity Indices chart was created and is shown below. The data could be further analyzed by scientists and our bird conservation group. Punta Gorda and Cockscomb Basin have 240 taxa (S), whereas Belmopan and Gallon Jug have 97 and 96, respectively, within their respective zones.

There were 3080 persons in the Cockscomb Basin overall, whereas the Gallon Jug had 1740. Gallon Jug's near level of equitability (J) is 0.8049, Punta Gorda's is at least 0.99, and Belmopan's is 0.6591.

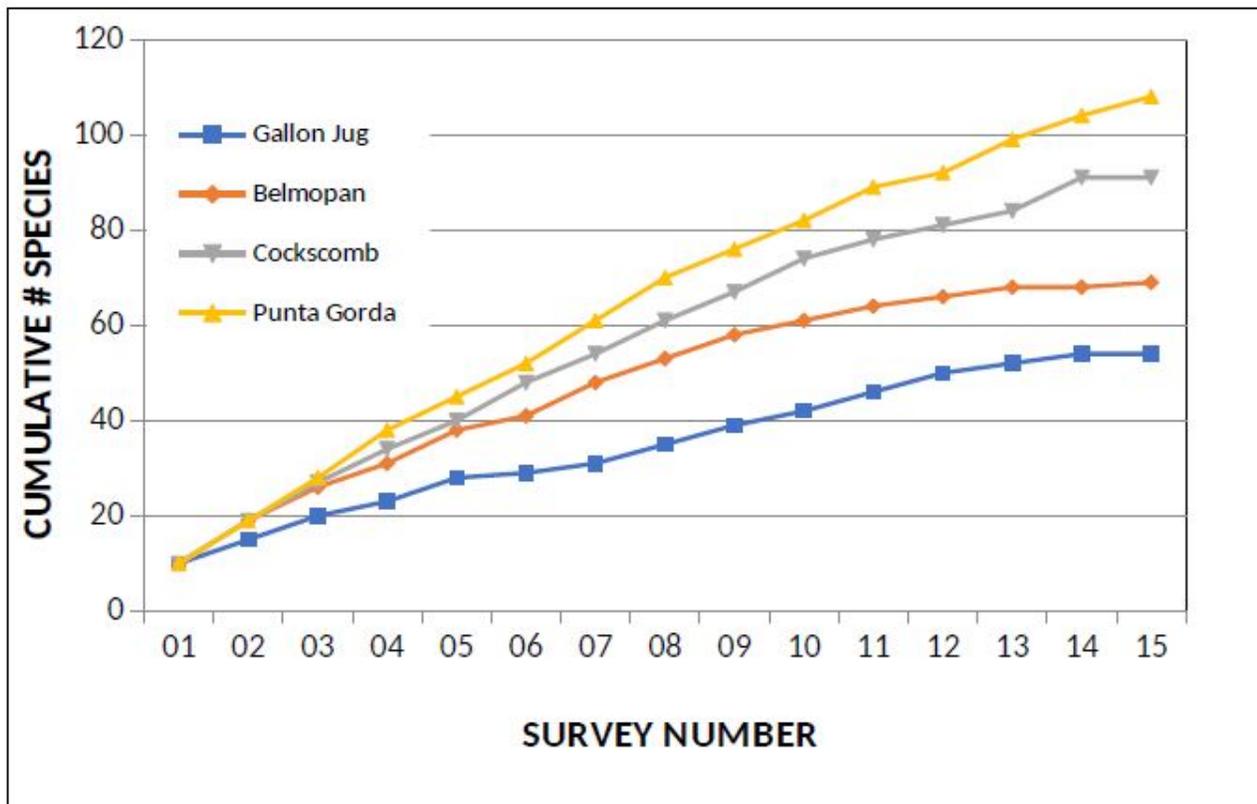
Gallon Jug has a diversity level of 3.008, Belmopan and Cockscomb Basin are close to each other at 4.411 and 4.535, and Punta Gorda has a variety level of 5.446 according to the Shannon index (H).

	Punta Gorda	Cockscomb Basin	Belmopan	Gallon Jug
Taxa (S)	240	240	97	96
Individuals	1855	3080	1802	1740
Dominance (D)	0.00443	0.05034	0.01101	0.10690
Shannon (H)	5.446	4.411	4.535	3.008
Equitability (J)	0.9936	0.8049	0.9913	0.6591

The collected MacKinnon lists were used to produce the species accumulation graph below. Using a 10-species list, all species that had not been previously heard or seen (recorded) on a previous list were added to the total number of species.

I have determined that Punta Gorda or Cockscomb Basin should be the location of the bird preservation area after analyzing the variety indexes and the Mackinnon List data. The vegetation studies may include the most valuable information. In contrast to Punta Gorda, it appears that there is a lot more vegetation in the Cockscomb Basin. Punta Gorda possesses and there are few swamp broadleaf forests and a lot of area that is solely used for farming. The Cockscomb Basin is rich in marsh grassland, swamp pine forests, and water. Although there were somewhat *less birds* in the Cockscomb Basin according to the Mackinnon List survey, the region is progressively growing.

Scientists visually classified Punta Gorda as having the highest cumulative number of bird species using the data chart above and the line graph below.



The Cockscomb Basin is the most suitable district to use as a protection/preservation zone, according to the facts presented. However, as was already said, the standard point count data was only collected for a single day, therefore it is not enough to draw any conclusions. The Mackinnon List data was collected from 15 distinct fields rather than concentrating on just one. There is also a dedicated Mackinnon List review that has found additional information on bird species. This study found that whereas the area

above Cockscomb Basin has 96 different bird species, the Punta Gorda area has 108 different flying creature species, most notably birds. Belmopan has only 69 birds, whereas Gallon Jug has only 54.

DISCUSSION

An early analysis of the data was able to quickly exclude Belmopan and Gallon Jug as eligible conservation parcels because their taxonomic (S) values were both less than 100. Punta Gorda has the highest taxa (S) of 240 and the highest Shannon index (H) of 5.446 out of the four parcels.

Furthermore, the Cockscomb Basin is given equal consideration due to its robust Shannon index (H) of 4.411 and 240 taxa (S). According to the Diversity Indices chart, dominance (D) and equitability (J) are the only areas where the two parcels disagree. The dominance (D) of 1855 individuals in Punta Gorda is 0.00443, but the dominance (D) of 3080 individuals in Cockscomb Basin is 0.05034. Punta Gorda and Cockscomb Basin have respective equitability (J) values of 0.9936 and 0.8049. This data indicates that Punta Gorda has a greater richness and evenness of bird species, but a more thorough perspective needs to be recognized.

Belize's low-lying terrain and climate change-induced sea level rise make it vulnerable to natural calamities including storms, flooding, coral bleaching, and more. Scientists and conservationists had to consider all anthropogenic disturbance in order to determine which parcel would have the most conservation value. Researchers evaluated the types of vegetation present in each parcel and the amount of land used for farming in the surrounding area. Upon closer inspection, Punta Gorda's vegetation is diverse.

Records show that the Lowland broadleaf woods occupies the remaining portion of the property, with approximately 50% of the area being used for agriculture. Similarly, the Cockscomb Basin region is quite diverse, with land use decreasing as it gets closer to its allotment; however, only around 30% of it is used for agriculture, with the majority being lowland broadleaf woods, lowland lake, and pine forest. The richness of animal species across vast taxa usually suffers significant reductions as a result of cattle grazing and the alterations it causes to the soil and plants (Saab, Petit, 1992). To ascertain if Punta Gorda uses its agricultural land for livestock or crops, however, there is not enough information available.

For some purposes, it is safe to suggest partial use. Thus, scientists and the worldwide bird To preserve the ecosystem, a conservation group delegation has proposed purchasing the Cockscomb Basin region. Another survey in Belize identified 46 species in the two types of pastures, with 15 species found in grazed pastures and 39 in abandoned pastures (Saab, Petit, 1992).

Further research will be necessary to determine whether the parcel is used for commercial, livestock, crop, or a combination of these types of agriculture. As farm sizes increased, avian variety declined by 15%, according to a recent UBC study that looked at how extensive industrial farming affected biodiversity (University of British Columbia, 2022). It will be essential to maintain the soil's PH levels and land cover. be monitored for changes or contamination. Although there are currently fewer species in the Cockscomb Basin than in Punta Gorda, vegetation data shows that Punta Gorda's land has not been sufficiently protected to support the amount of species it currently has. Since 1977, Belize has maintained 34,131 hectares of national forest reserves. DE-reserved land has been made available for cultivation after being removed from reserve status (Brokaw et al., 1998). To preserve the taxonomy (S) and the inhabitants of the Cockscomb Basin, the piece will be protected to preserve the area as The time has come.

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