Field studies meet remote sensing to assess bird populations in Las Cocolobas private ecological reserve: Evaluating endemic vs native species in a secondary forest patch in Utuado, Puerto Rico.

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Introduction: Ornithology is a science of great historical trajectory. The study of birds has helped to develop numerous key concepts regarding the evolution, behavior, ecology and conservation (Boscolo et al., 2006). During its beginnings, ornithology was mainly concerned with the description and distribution of species, ornithologists today seek answers to very specific issues and often use birds as models to test their hypotheses or predictions based on theories. Most of the current biological theories are applied without differentiating between the different taxonomic groups, and therefore the number of scientists who identify themselves as ornithologists has reduced. The spectrum of tools and techniques used in ornithology is very broad, and is in constant innovation (Ralph et al., 1996).

A census is the determination of a population of some species or communities in an area. Census makes it possible to determine the size of the population and contribute to dictating and evaluating measures to improve the protection or management of the species. In practice, estimates of the population are made only once a year, due to the scarcity of resources and personnel to carry out the census (Van Horne, 1983). In general, four types of census methods are used to estimate the size of avian populations: point counts, line transect, intensive search, and plot mapping methods.

Puerto Rico hosts over 375 species of birds throughout the year. Some of these birds come to winter in the island, others stop to fuel up for further journeys, some have been accidentally introduced or have established in the island. From these 375 species, there are 17 endemic bird species in the Island. Most of these endemic birds live mostly in forested areas, though you might often find them all around the island. Forests are an ecological hotspot for many species of organisms. In them, 70% of all animals and plants can be found, with more than 13 million different species. 70% of all vascular plants, 30% of all bird species and 90% of invertebrates call forests their home. Rain forests are extremely diverse and may contain over 200 species of trees per acre.

In 1940, only 6% of Puerto Rico was covered in forests. In that decade, farming was one of Puerto Rico's primary source of income. Sugar, coffee, tobacco and cotton were the most common agricultural products being farmed on the island, and land was needed for production. This extreme deforestation was a result from big companies buying land and destroying forested areas. This agricultural boom lasted only a couple of decades, until industrialism took its place. Now, 32% of the Island is covered in forests and there has been an increment in "green-thinkers". Birdwatching, photography, science and the general community have played an important role in promoting ecological thinking and natural resource protection.

This study aims to evaluate if more native or endemic bird species live in the study site. Also, I wish to understand if the NDVI and SAVI analysis have a positive or negative relationship.

Materials and Methods:

The study area is a 27 acre ecological reserve called "Finca Ecologica Las Cocolobas" in the Angeles sector, municipality of Utuado(396.2 m above sea level) which belongs to my thesis mentor, Dr. Alberto Puente Rolon. Las Cocolobas farm is an ecological reserve that before its foundation, was a cultivated agricultural property and has become a secondary forest that has patches that received less human impact and so the proliferation of trees and their size is larger. The main goal of the reserve is to protect endemic species of animals and plants alike and to promote the wild and natural growth of both groups. Prof. Puente has a small patch of farm exclusively to grow cacao trees (over 200 trees), but he has ensured that this farming of cacao is ecologically sustainable and that it does not affect surrounding forested areas. This reserve is an important place to many endemic and native animals and plants. Endemic Anole, bird, plant and amphibian species can be found as well as native or established groups.

In both sites, 9 points were chosen (Fig. 1-2) at approximately at 200 meters from each other, to avoid overlapping (Silwa and Sherry, 1992). 3 replicates were made per site, to have a n=54. In each point, for a period of 5 minutes, a point count census was made, and all bird species that were heard or seen were accounted for.

NDVI and SAVI maps were created in the laboratory using ArcMap and following the directions learned in class. Birds were divided into endemic, native and migratory (for the purpose of this study, no other category was used). Graphs grouping all categories and each category individually were made. Lastly, an NDVI vs SAVI scattergram was made to assess the relationship between these two analyses.

Results:

As a result, from the census, the most common bird was the Bananaquit (BANA) (*Coreoba flaveola)* with 72 individuals. This was expected since this bird is very common in the island and tends to be a generalist. The other more common birds were the Puerto Rican Tody(PRTO) (*Todus mexicanus*) with 32 individuals, Adelaides Warbler(ADWA) (*Setophaga adelaidae*) with 32 individuals and the Scaly naped pigeon(SNPI) (*Patagioneas squamosa*) with 33 individuals. Analizing birds per category; in the Endemics, the most common birds were the PRTO, the ADWA the Puerto Rican Woodpecker (PRWO)(*Melanerpes portoricensis*) and the Puerto Rican vireo(PRVI)(*Vireo latimeri*)(Graph 1). Some of the less common species were the Green mango hummingbird (GRMA), the Puerto Rican Emerald hummingbird (PREM) and the Puerto Rican Lizard cuckoo (PRLC). (Graph 1).

The NDVI vs SAVI scattergram shows that there is a slight positive relationship between these analysis (Graph 3 and 4). Here, I graph the 9 study points (Graph 3) and the 9 gps points with 11 other random points (Graph 4) to observe if there is a change in the direction of the slope. It can be observed that in both graphs, the outcome is positive, nevertheless, it is quite scattered and with many outgroups.

Fig 1. GPS points in las Cocolobas

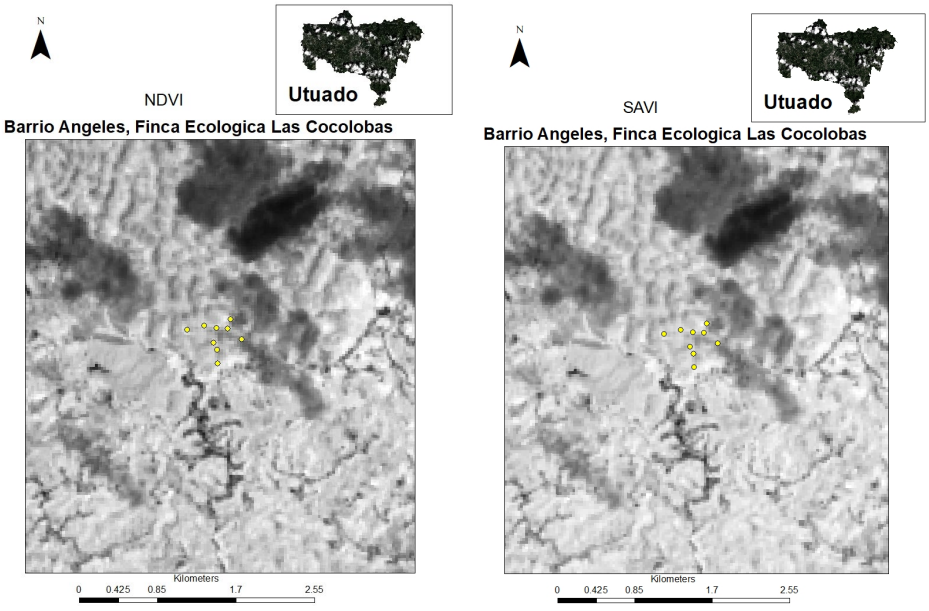
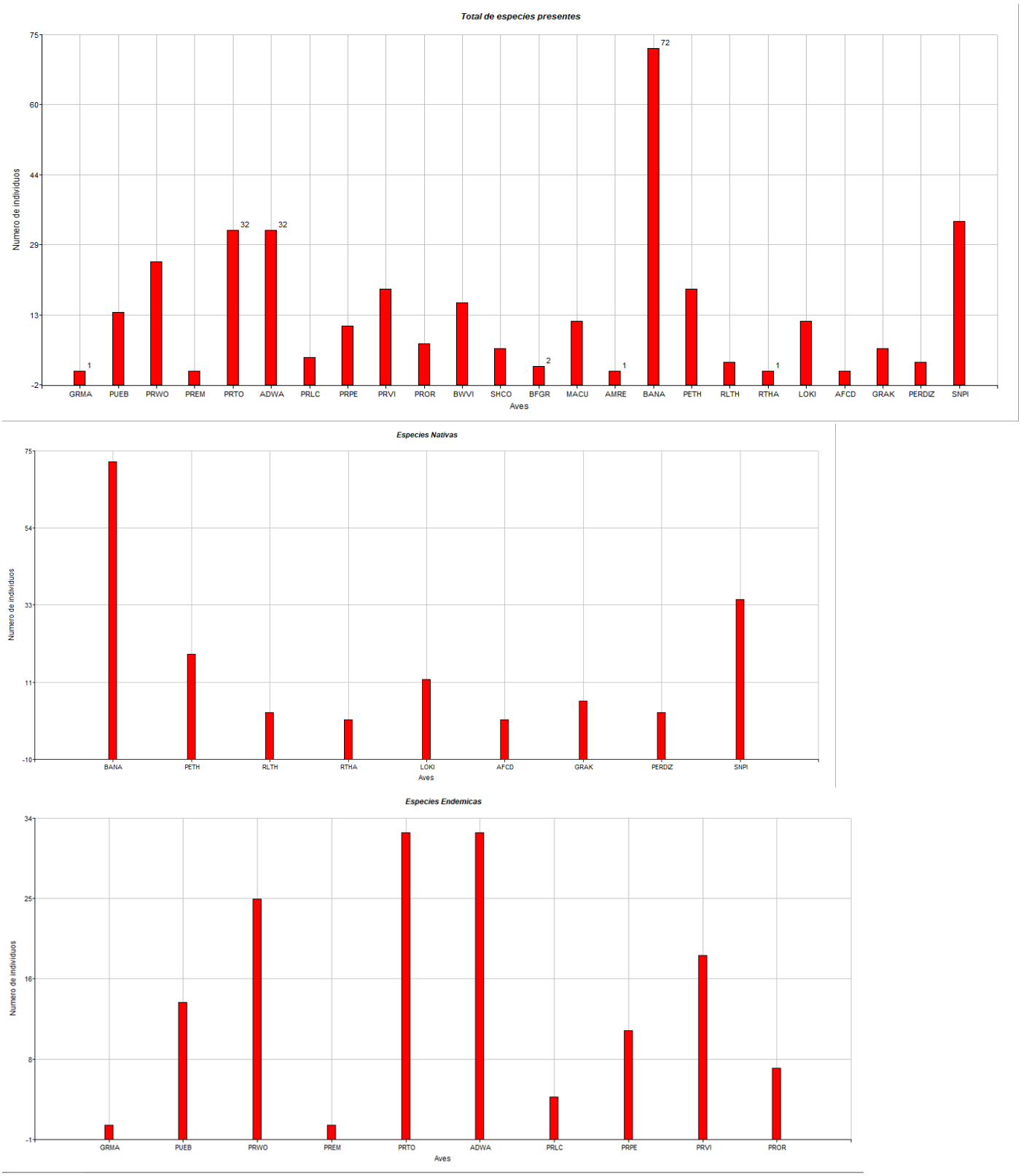
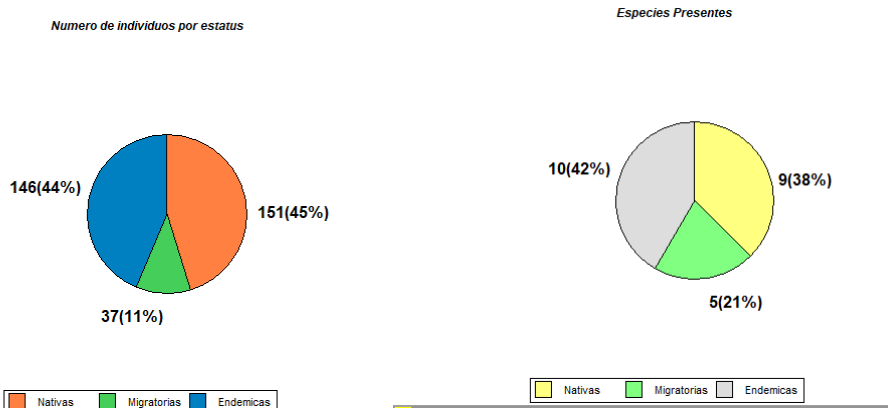


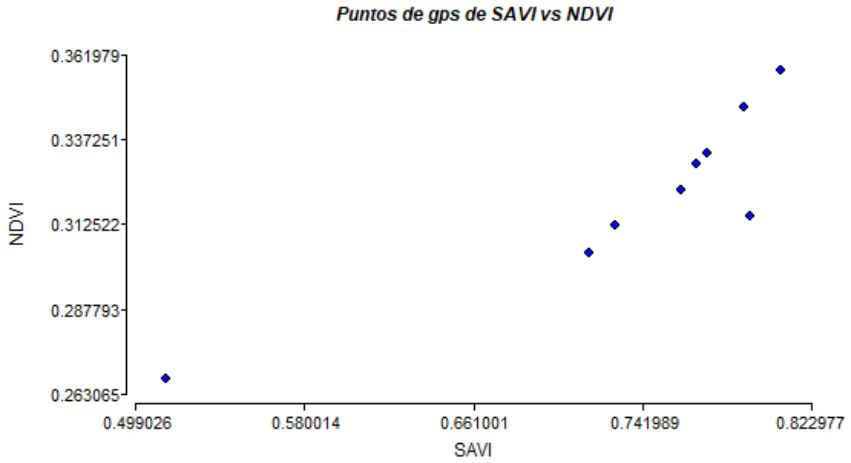
Fig 2. NDVI(left) and SAVI(right) analysis of Las Cocolobas



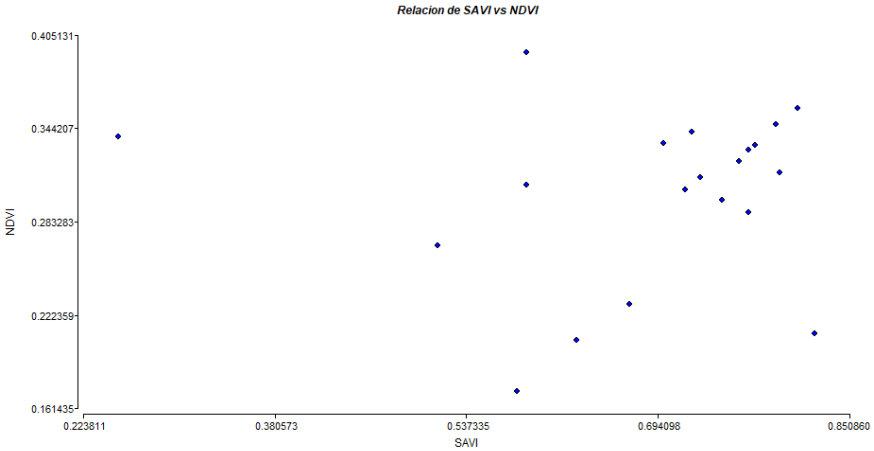
Graph1. Quantity of birds per category and as a whole



Graph 2. Percentage of the number of individuals in each category(left) and number of species present per category(right).



Graph 3. SAVI vs NDVI for the 9 gps points



Graph 4. SAVI vs NDVI for the 9 gps points plus 11 other random points

Conclusion: For this study, SAVI and NDVI have a positive relationship, though the scattergram should have been made with a smaller scale in the 20 points. Regarding endemic vs native species, there is no difference between the quantity of species per category nor the quantity of individuals per category. The proliferation of native species (more generalists and urbanized) may be a result of the passing of Hurricane Maria, which devastated all the forested areas of Puerto Rico. This created many open spaces

and destroyed forest canopy, a habitat that many endemic species use. Endemic species tend to be more specialized than native or migratory species and that is why they are the first to be affected when their living conditions get altered. Regarding migratory species, there was very little representation form this category because these species tend to stay in lower, more coastal areas surrounding the Island (remember that this forest is 396m above sea level). For further studies, more census points and repetitions must be made and to have a more accurate number of species and individuals, means must be taken. A matrix of forests can be made (altitudinal or forest category) and then the results can be compared to observe how birds behave in different conditions. Canopy cover can be taken and then compared to the SAVI and NDVI analysis to have more accurate data. Aerial images are a must since the study area is small enough for satellite images to be very pixeled when zoomed in. Drones can be used for these types of studies. Finally, telemetry, GPS data and more intense bird capturing techniques can be combined with remote sensing to have more thorough data regarding bird population status in the forested areas of Puerto Rico.

Bibliography:

Boscolo, D., Metzger, J. P., & Vielliard, J. M. (2006). Efficiency of playback for assessing the occurrence of five bird species in Brazilian Atlantic Forest fragments. *Annals of the Brazilian Academy of Sciences*, 629-644.

Ralph, C. J., Geupel, G. R., Pyle, P., Martin, T. E., & DeSante, D. F. (1993). Handbook of Field Methods for Monitoring Landbirds. *Director*, *144*(1), 1–41. https://doi.org/10.1016/j.biocon.2013.11.029

Horne, B. Van. (1983). Density as a Misleading Indicator of Habitat Quality. *The Journal of Wildlife Management*, *47*(4), 893. https://doi.org/10.2307/3808148

Raffaele, H. A. (1989). *A guide to the Birds of Puerto Rico and the Virgin Islands.* Princeton: Princeton University Press.

Silwa, A., Sherry, T. W.(1992). Surveying wintering warbler populations in Jamaica: point counts with and without broadcast vocalizations. Condor, 94: 924-936