Using Low-Cost Drones to Map Habitat Change in Bahamian National Parks

Uso de Drones de Bajo Coste para Cartografiar el Cambio de Hábitats en los Parques Nacionales de Las Bahamas

Utilisation de Drones à Faible Coût pour Cartographier les Changements D'habitats dans les Parcs Nationaux des Bahamas

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EXTENDED ABSTRACT

Habitat monitoring of national parks in The Bahamas can be challenging, as they can be large, remote, and difficult to navigate. With threats to natural environments and endemic species like development and climate change, and with The Bahamas being a fisheries-reliant county, habitat monitoring is more important now than ever. However, conservation can be quite limited in resources, in terms of personnel, capacity, and funding. To help with management of its parks, the Bahamas National Trust (BNT) has adopted a small fleet of drones and used them to collect aerial imagery of a few national parks within the system (Bahamas National Trust, 2023). An alternative to satellite or LiDAR imagery, drones provide high-quality images that can be used for surveillance and monitoring by remote sensing. The imagery is often of a much higher resolution than freely available aerial or satellite imagery like Google Earth or Landsat and can be collected rapidly and with minimal human input. Additionally, purchasing a low-cost drone is much cheaper than having to pay for high-resolution remote sensing imagery (Pin Koh & Wich, 2012; Lowe, Adnan, Hamylton, Carvalho, & Woodroffe, 2019; Schaefer, et al., 2020). The aim of this project was to explore if using low-cost drones was an effective way to collect aerial imagery for monitoring, remote sensing, and national park management in Bahamian national parks.

The project used two low-cost drones: a 3DR Solo and DJI Mavic 2 Pro, both valued at less than $1,500 USD. The study area for this project was two BNT-managed national parks. The first, Lucayan National Park (LNP, est. 1982) in Grand Bahama, is a multi-ecosystem park of 1938 acres (only ~36 acres were captured) and the second is the Retreat (est. 1985) in New Providence, an l 11-acre terrestrial park. Imagery was collected via automated flight missions between 2018 to 2023 and transformed into orthomosaics via image processing software and manual georeferencing or ArcGIS Pro's OrthoMapping capabilities. Once finished, image classification was used to turn the orthomosaics into habitat maps. Both unsupervised and supervised classifications were used so that the two methods could be compared. Twelve habitat maps were produced for the project: three for each park for each year of imagery. The resulting supervised habitat classification maps were used to perform a change detection analysis for each park, which analyzed habitats changed between two study periods.

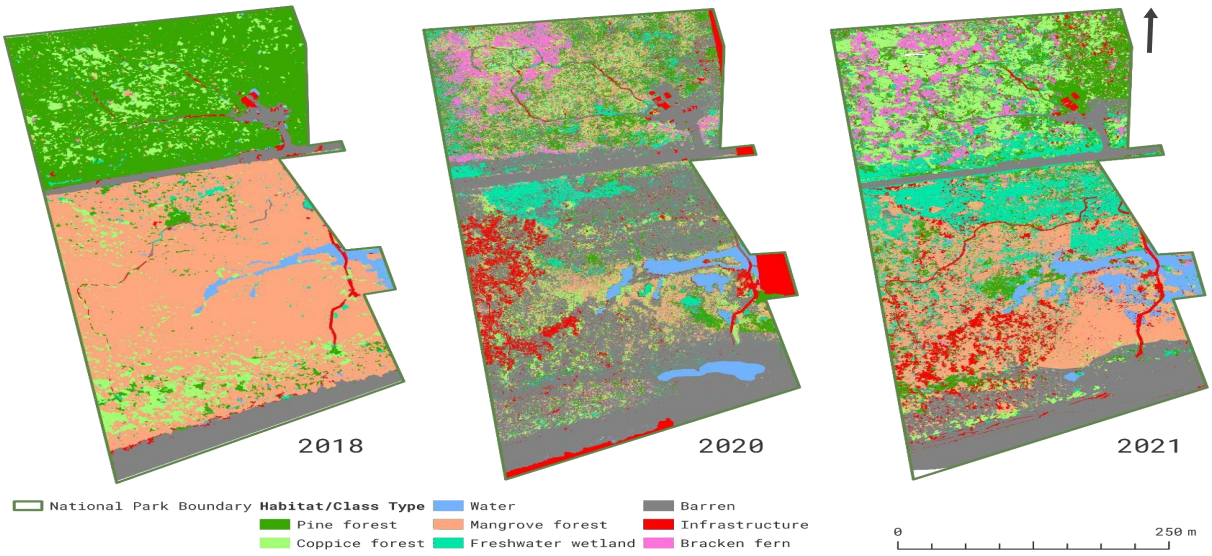

Figure 1. Results of supervised classification (habitat maps) of Lucayan National Park in 2018, 2020, and 2021. The impacts of Hurricane Dorian in 2019 are clearly demonstrated in the 2020 result.

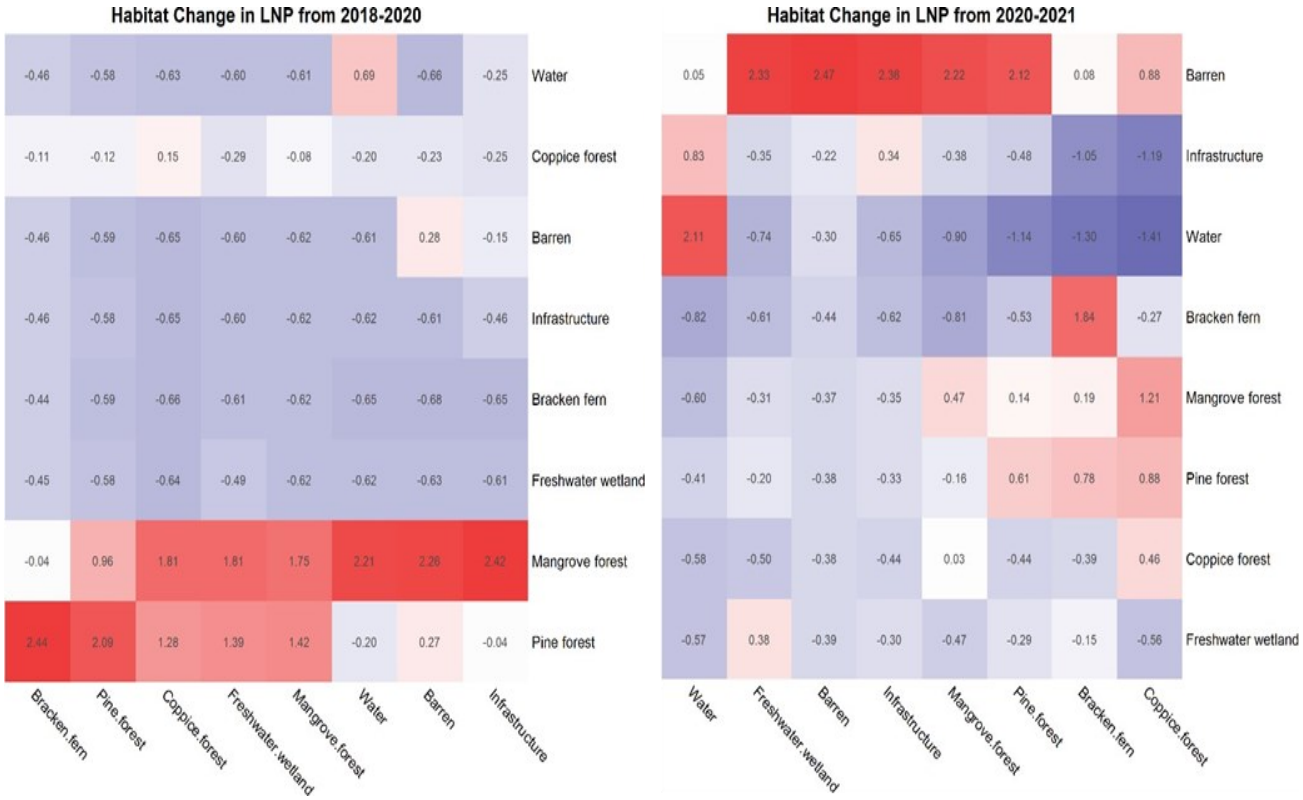

Figure 1. Heatmap representations of the change detection analysis for LNP for the two study periods. Former years (2018, 2020) are on the Y-axis and current years (2020, 2021) are on the X-axis.

The orthomosaics were used successfully in creating habitat maps for both LNP and the Retreat, with the parks assigned eight and three habitat classes respectively (Figure 2). The unsupervised classification as also relatively successful but was more inaccurate in differentiating actual habitats. From the results of the habitat classification, statistics for each park were quantified through additional analysis. This included the area of specific habitats classified by the software for each park and measuring how much habitat changed between study periods. Additional statistical analyses were performed using R and RStudio and was especially important for representing the change detection analysis for Lucayan National Park, which proved difficult to visualize as a geographic map. Instead, a heatmap of change detection between habitats was created which was more visually appealing and digestible.

Overall, the drone-derived imagery produced high-quality orthomosaics where the ground-sampling distance (GSD, or real-distance per pixel) ended up between 30 cm and 5 cm, varying between drone cameras, but a vast improvement over Landsat's 30 m resolution. The methodology used is very easy to follow and much of it is automated through drone flight mission software and the habitat mapping process, meaning that it is easily replicated. The most significant result of this project was how well the drone maps detected habitat change, particularly the defoliation of vegetation by Hurricane Dorian in 2019 and subsequent recovery within the boundaries of Lucayan National Park. Some challenges faced during this project included long processing times and demanding hardware requirements for the geoprocessing steps, misclassifications of habitats by the GIS' algorithm, and differences in image quality between drone cameras. Limitations of using low-cost drones include limited personnel capacity to operate drones, battery life, and ability to only cover small portions of parks at a time. Additionally, something that needed to happen for drone maps but could not was verification of the results by ground truthing. That said, training for drone use is ongoing and planned into the future at the BNT, and improved specifications like battery life and flight time of newer models mitigate the challenges of only being able to map smaller areas. The BNT should continue to use drones to assist its mission in protecting and managing its national parks. By embracing newer technologies like drones and GIS, comprehensive maps of national parks can be created relatively easily, although ground truthing of the maps is necessary.

KEYWORDS: drones, remote sensing, habitat classification, Bahamas, national park

LITERATURE CITED

Bahamas National Trust. (2023). National Park Drone Imagery & Orthomosaics for The Retreat and Lucayan National Park. Nassau, The Bahamas: Bahamas National Trust.

Lowe, M. K., Adnan, F. A., Hamylton, S. M., Carvalho, R. C., & Woodroffe, C. D. (2019). Assessing reef-island shoreline change using UAV-derived orthomosaics and digital surface models. *Drones, 3*(2), 44.

Pin Koh, L., & Wich, S. A. (2012). Dawn of drone ecology: low-cost autonomous aerial vehicles for conservation. *Tropical Conservation Science, 5*(2), 121-132.

Schaefer, M., Teeuw, R., Day, S., Zekkos, D., Weber, P., Meredith, T., & van Westen, C. J. (2020). Low-cost UAV surveys of hurricane damage in Dominica: automated processing with co-registration of pre-hurricane imagery for change analysis. *Natural Hazards, 101*(2020), 755-784.

Ventura, D., Bonifazi, A., Gravina, M. F., Belluscio, A., & Ardizzone, G. (2018). Mapping and classification of ecologically sensitive marine habitats using unmanned aerial vehicle (UAV) imagery and object-based image analysis (OBIA). *Remote Sensing, 10*(9), 755-784.