Understanding Endemic Bog Ecosystems using UAV Technology, Remote Sensing and GIS on the Alakaʻi Plateau in Kauai, HI

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Introduction

The purpose of this project was to evaluate the use of an unmanned aerial vehicles (UAVs) to evaluate a remote bog ecosystems on the Alaka'i Swamp Trail in Kauai, HI. Vegetation coverage and bare ground are important factors in understanding sustainability and the ecology of many ecosystems (Breckenridge et al., 2011). Data from remote-sensing instruments mounted on manned aircrafts don't capture data at a spatial resolution sufficient to formulate ecological investigations (Anderson and Gaston, 2013). Modern technology has led researchers to use lightweight UAVs, offering high resolution aerial imagery at reasonable costs. UAVs enable ecologists the opportunity for scale-appropriate measurements of ecological phenomena in ecosystems, such as the bogs explored in Kauai, HI. An attempt to understand the ecology of these remote areas is investigated.

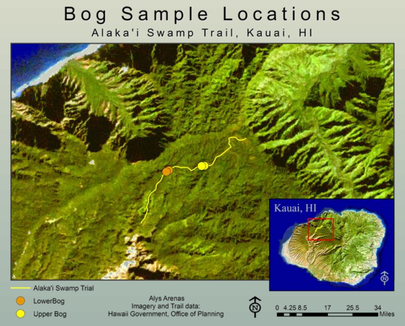

Figure 1. Study site: Alaka'i Swamp Trail and location of 2 bogs sites surveyed

Data and Data Sources

Data was collected on March 27th and March 28, 2014 on two remote Bog ecosystems along the Alakaʻi Swamp Trail on the Alakaʻi Plateau in Kauai, Hawaii. Using a DJI Phantom 2 UAV. Imagery was captured using a Pentax Optio WG-2 16-megapixel camera (RGB) and a GoPro camera with a modified lens (NIR). Point data was collected using a GeoXH Trimble 2005 series GPS. Imagery for the Field site location Map was obtained from USGS, LandSat at 15m NAD 1983 State Plane Zone 4 FIPS Hawaii (Table 1).

Table 1. *List of data and data sources used in the project*

Dataset	Source
RGB Orthophotographs	Personal Data Collection
NIR Orthophotographs	Personal Data Collection
Field Site Location	Hawaii Government, Office of Planning
Bog Point Data	GeoXH Trimble 2005 series
Vegetation Analysis	ERDAS

Methodology

The study was performed on two relatively flat bogs on the Alkal'i Plateau in Kauai, HI in attempt to analyze vegetation using near inferred (NIR) and RGB aerial imagery with the aid of low cost UAV technology. Study sites were distinguished as Upper Bog and Lower Bog and aerial imagery was captured on March 27 and March 28, 2014 (Figure 1).

Aerial imagery was post processed and mosaicked using Agisoft Photoscan Professional 1.0.2 software. Mosaicked images were exported locally as tiff files and as point cloud files. Tiff files were uploaded into ERDAS in attempt to understand vegetation present in these ecosystems. The point cloud data files were used in ArcMap 10.1 to run surface interpolations in order to create a continuous surface and other statistical analysis such as DEMs, contour lines, and hillshade analysis (Figure 2).

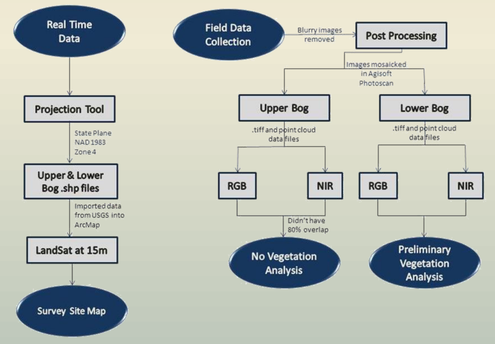

Figure 2. *Spatial Model representing brief summary of methods for project*

Project Timeline

Table 2. *Summary of Project Timeline. For detailed timeline, refer to Applied Thesis Project.*

Time Frame	Steps to Desired Goals
March 25th- 28th	Field Data Collection
Saturday April 12th	Image data files downloaded from SD cards
Month of May	Photos were organized for Agisoft Photoscan
Saturday June 14	**Project Question & Data Sources Due**
Saturday June 21st	**Methodology and Timeline Due**
June 22nd – June 25th	Project Proposal and PP Presentation
Wednesday June 25th	**Project Proposal Due**
June 26th – July 11th	▪ Post processing
Saturday Jul 12th- 14th	▪ Started Stitching NIR Image data files ▪ Cancelled Process → New Project (14th)
July 14- August 9th	Mosaic Lower and Upper Bog Data (NIR) on Agisoft Photoscan & Post processing
Thursday July 17th	**Data Sources and Methods Section Due**
Thursday July 24th	**Literature Review Due**
August 5-13th	**Cartographic Output, Poster, Conclusion and Abstract Due**
Friday August 15th	**Final Applied Thesis Project Due**

Results

Red, Green Blue (RGB) and Near Infrared (NIR) Orthophotographs for the Upper and Lower bog were generated using Agisoft Photoscan software (Figures 3-5). Due to an insufficient overlap between the RGB and NIR Lower Bog Orthophotos, an accurate vegetation analysis could not be completed. A preliminary Vegetation Analysis was generated for the Upper Bog spatial data (Figures 6-7).

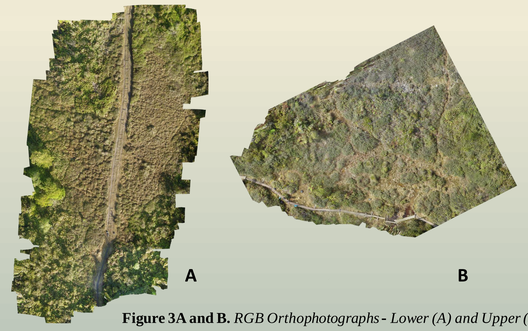

Figure 3A and B. *RGB Orthophotographs - Lower (A) and Upper (B) Bogs*

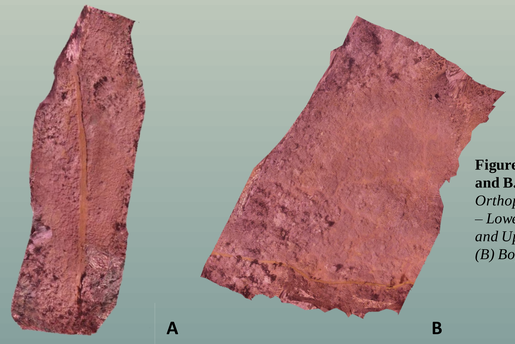

Figure 4A and B. *NIR Orthophotos – Lower (A) and Upper (B) Bogs*

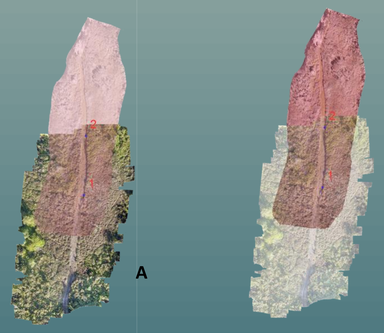

Figure 5A and B. *Lower Bog Orthophoto overlap showing insufficient coverage to run vegetation analysis. (A) NIR image over RGB (B) RGB over NIR*

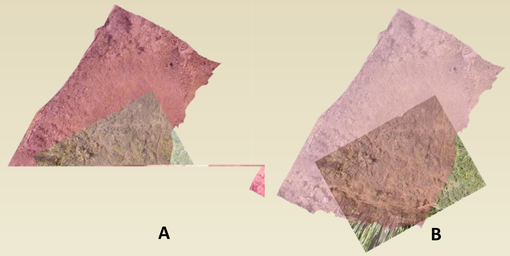

Figure 6A and B. *Upper Bog Orthophoto overlap showing sufficient coverage to run vegetation analysis. (A) NIR image over RGB (B) RGB over NIR*

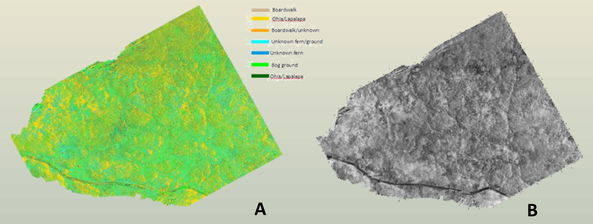

Figure 7A and B. (A)Upper Bog Unsupervised classification – preliminary vegetation analysis. (B) Upper Bog NDVI Analysis.

Discussion

The availability of low cost UAV technology to collect large scale aerial imagery to process data into meaningful ecosystem analysis has increased the use of using this type of imagery to monitor ecosystems. However, in order to provide reliable and accurate information for researchers, its essential to understand the statistical implications when designing and implementing UAV technology image studies (Karl et al., 2012), as was the case for this study. Consideration of image scale and sample design limitations is required prior to undertaking a bog ecosystem survey. These results provides a framework for understanding bog systems. Potential sources of error include poor image capture and flight design execution, inability to set ground control points for georeferencing and accounting for post-processing time.

Conclusion

This research project investigated the applicability and the limitations of using low cost UAV imagery to contribute to data used in evaluation and study of bog ecosystems in Kauai, Hawaii. This project demonstrated that high-resolution imagery capture can be used to directly study the ecology of a bog as a non-destructive alternative to ground surveys. However reliable results are dependent on proper site sampling and project planning.

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