Plant Species Identification via Drone Images in an Arid Shrubland

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Introduction

Desert shrubland protected rangelands (<250 mm annual rainfall) are often hundreds to tens of thousands of square kilometers in size (IUCN & UNEP, 2015). Vegetation is sparse, spatially heterogeneous, and low in biodiversity. Vegetation monitoring of these habitats by satellite or manned aircraft is prohibitively expensive due to the scale. Ground based monitoring is very labor intensive due to large and distant sample sizes. Consequently, most conservation reserves on the Arabian Peninsula are monitored too infrequently to properly inform management. The aim of this study was to assess whether low altitude aerial photography via drone stratified sampling could provide a feasible alternative to ground based monitoring.

Plant biodiversity is more important than total biomass as a long-term indicator of herbivory (Holechek, Pieper, & Herbel, 2010), particularly in shrublands where much of the plant biomass is unavailable to managed herbivore populations either proximally or nutritionally. For measuring biodiversity, the sparseness and low species count of this habitat is a distinct advantage. The total number of plant species that have been recorded at the Dubai Desert Conservation Reserve, a protected area of 225 km^2, is just 45, of which 13 are ephemeral (Khafaga, 2009). Measures of biomass would be significantly more useful if they were estimated for taxonomic groups, since they could then be related to herbivore preferences. Therefore, an assessment of plant identification accuracy is the logical first step.

Materials and Methods

Between 30 and 44 individual plants for each of 17 abundant species were numbered and identified by the resident botanist, and then photographed from above at 10, 30 and 100m (ground sampling distances, GSDs, of 2, 6 and 20 mm) using a DJI s1000 multirotor drone with a Sony NEX7 24MP camera. Twelve less common species were also photographed opportunistically. This represented a complete sample of species bearing green vegetation within the Dubai Desert Conservation Reserve at the time of study (Mar-Apr 2015). Images were selected and cropped to include one sample of each labeled plant at each GSD and assigned a randomized filename such that each image contained between one and 54 labeled plants. Two botanists who were familiar with the region, but not the specific location, then classified each image to species, genus, and plant group (tree, shrub, herb, grass, sedge).

Results and Discussion

Larger species (trees and large shrubs) and higher resolution images both resulted in increased accuracy (Figure 1), as could be predicted. At the highest resolution of 2 mm GSD, all plant groups were classified to genus with 70% accuracy or more. Some results were strongly affected by repeated misclassification of one species for another. Misclassification of established *Lycium shawii* shrubs with juvenile *Acacia tortilis* trees by one of the botanists at the 6 and 20 mm GSD resulted in a 20% difference in accuracy for the large shrub categories between the two botanists. A botanist familiar with the plant communities at sampling locations would therefore be able to classify perennial species from photos with greater accuracy.

Surprisingly, almost 40% of the annuals, biennials and dwarf shrubs were classified to species level from 20 mm GSD images, despite this representing the smallest plants and poorest image resolution. Many fixed-wing drones that are marketed for routine survey work claim 20mm as their most detailed setting. These results indicate that a rough estimate of plant biodiversity could be obtained even at this resolution.

The results obtained were only possible because of the sparsity and extremely low plant biodiversity that exists in this arid shrubland habitat. Further accuracy is likely achievable if infrared imagery is added.

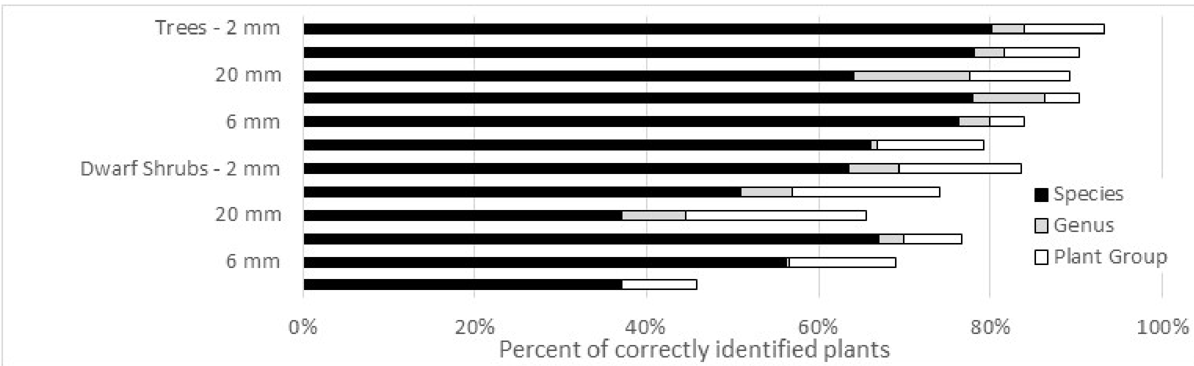

Figure 1. Accuracy of classifying plant species from RGB aerial images taken vertically at 2, 6 and 20 mm ground sampling distance.

Conclusion and Implications

Plant species identification by drone is less accurate than ground-based assessment at any resolution, but it does provide several other benefits, including

- Collection of data from large sample areas (e.g.; 2 / 50 ha at 2 / 20 mm GSD) in a short period of time. More data could therefore be collected during seasons of peak growth or reproduction.
- Remote assessment of data. Image analysis is not location dependent, though it is far preferable for the botanist to be familiar with the study site

Our study indicates that it would be feasible in this habitat to establish a database of all perennial plants within predefined sample areas, and thus aerially collect biomass estimates (e.g.; cover, height, normalized difference vegetation index) periodically for georeferenced perennial species. Non-perennial species could be identified with sufficient accuracy to estimate changes in species richness and biomass of taxonomic groups that are of importance to herbivore classes.

References

Khafaga, T.A., 2009. Report to Emirates Airlines titled 'A comparative study of vegetation structure and regeneration between two monitoring surveys in Dubai Desert Conservation Reserve', Dubai, UAE. http://ddcr.org/en/downloads/full/vegetaton-survey-2009.html

Holechek, J.L., R.D. Pieper and C.H. Herbel. 2010. Range Management: Principles and Practices (6th Ed.). Boston: Prentice Hall.

IUCN, UNEP., 2015. The World Database on Protected Areas (WDPA). Cambridge, UK: UNEP-WCMC.