Optimizing UAV Flight Methods and Evaluating Potential Uses of High-Resolution Imagery in the Estimation of Vegetation Cover

RECON
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Poster by Alex Fromer, Frank McDermott, and Mike Nieto, Poster Design by Vince Martinez | reconenvironmental.com

We would like to thank the U.S. Army Corps of Engineers, Los Angeles District for allowing us to perform this study in conjunction with one of their projects

1. INTRODUCTION

The use of drone technology in surveying has expanded exponentially. Translating these new drone capabilities to biological applications is an ongoing challenge. There is an opportunity to use drone technology to increase our field effectiveness, especially in remote and hard to reach locations. This can be done by increase the efficiency of various tasks by reducing the amount of time required to complete them, increasing the accuracy of a survey, quickly obtaining current field condition information, and using numerous other applications.

2. OBJECTIVE

To optimize drone flight effort and to evaluate potential uses of high-resolution aerial imagery, particularly in estimating vegetation cover.

3. METHODS

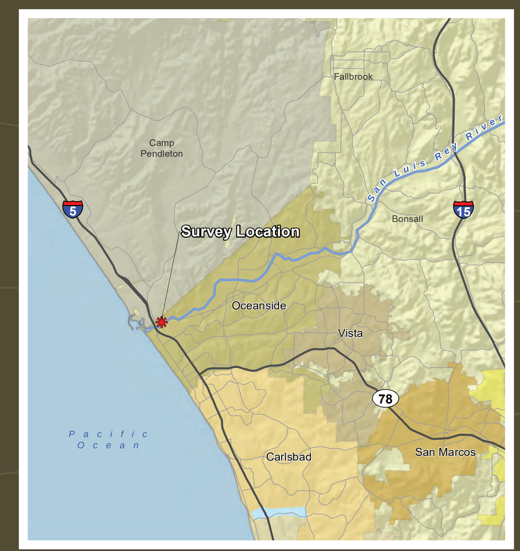
RECON Environmental has obtained a Part 107 Airman Certificate from the FAA, which allows us to legally fly unmanned aerial vehicles (UAV), more commonly referred to as drones, for commercial purposes. We selected the DJI Inspire 1 UAV platform for its high-resolution 3-axis gimbal-mounted RGB camera, increased battery life, relatively low purchase price, and ability for it to be configured to carry thermal and multi-spectral sensors to fit different project objectives. For this study we chose to use the camera that was provided with the UAV at the time of purchase.

Test flights were flown in conjunction with the San Luis Rey River project located in western Oceanside, California. In order to assess the progress of active restoration areas within the San Luis Rey River, quantitative monitoring has been conducted annually. Quantitative monitoring consists of comparing relevé data between adjacent control plots and plots within the restored habitat. Numerous relevé locations are spread throughout the western reach of the San Luis Rey River channel and this particular relevé was chosen based on a combination of ease of access, vegetation composition, and total vegetation cover. Relevé methodology followed that of the California Native Plant Society's (CNPS) Relevé Protocol (CNPS 2007). For this particular comparison, only total vascular vegetation cover within the relevé plot was used. The relevé for the comparison plot was completed on July 27, 2017 by RECON biologists Alex Fromer and Kevin Israel.

The study area is located close to Oceanside Municipal Airport, which required RECON to get permission from the control tower before commencing flight operations. We informed them of our flight times, altitude, and specific location and provided them with the cell phone number of our UAV pilot in command in case of emergency. One single grid (2D) and one double grid (3D) mission were flown on August 25, 2017 at altitudes of 50, 75, and 100 feet above ground level (AGL) for a total of 6 individual flights. Per industry guidelines, the 2D flights were flown using 80% front and 70% side overlaps while 85% front and 80% side overlaps were used for the 3D flights. Both flight methods were employed to determine if either led to better results. The automated flight pattern and other UAV settings were controlled using Pix4Dcapture running on an iPad Mini 4. Once back in the office the images were processed using Pix4Dmapper professional drone-based photogrammetry software, which stitched the individual raw images together into one georeferenced orthomosaic per flight. The resulting orthomosaics were then brought into ArcGIS Pro to perform the image segmentation and classification process. Finally, the resulting raster data were analyzed and overall percent cover was determined for each of the 6 flights.

In order to more easily compare the potential efficiency of the various drone flight methods for field use an efficiency index was created for each flight. This allows for a quick, quantitative value to be applied to and compared between flights to help optimize time spent in the field.

The efficiency index was created by finding the absolute value of the difference in percent cover between the digitally estimated cover and the field-observed cover, multiplied by how many minutes the drone required for its flight ([Diff. from obs]. x field-min/acre). Values closer to "1" signify higher efficiency.



Location Map

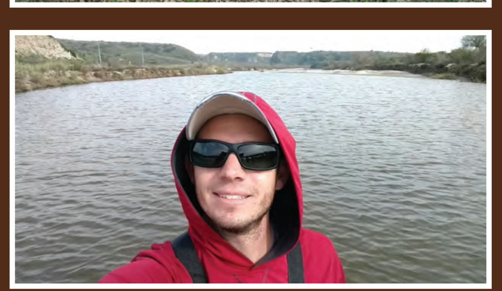
UAV in the Field

Frank McDermott Controlling UAV in Flight

4. RESULTS

Two flights were conducted to gather two-dimensional (2D) and three-dimensional (3D) imagery at three different heights for a total of six flights for the single relevé plot. Flight heights were 50, 75, and 100 feet. At 50 feet, digitally estimated vegetation cover was determined to be approximately 40% using 2D imagery, and 32% using 3D imagery. At 75 feet, the digitally estimated cover was nearly identical at approximately 32%. At 100 feet, again the digitally estimated cover was nearly identical at approximately 32% for 2D and 31% for 3D (Table 1). The visually assessed field estimate for this plot using the CNPS method was 20% total living vegetation cover.

Photo Points

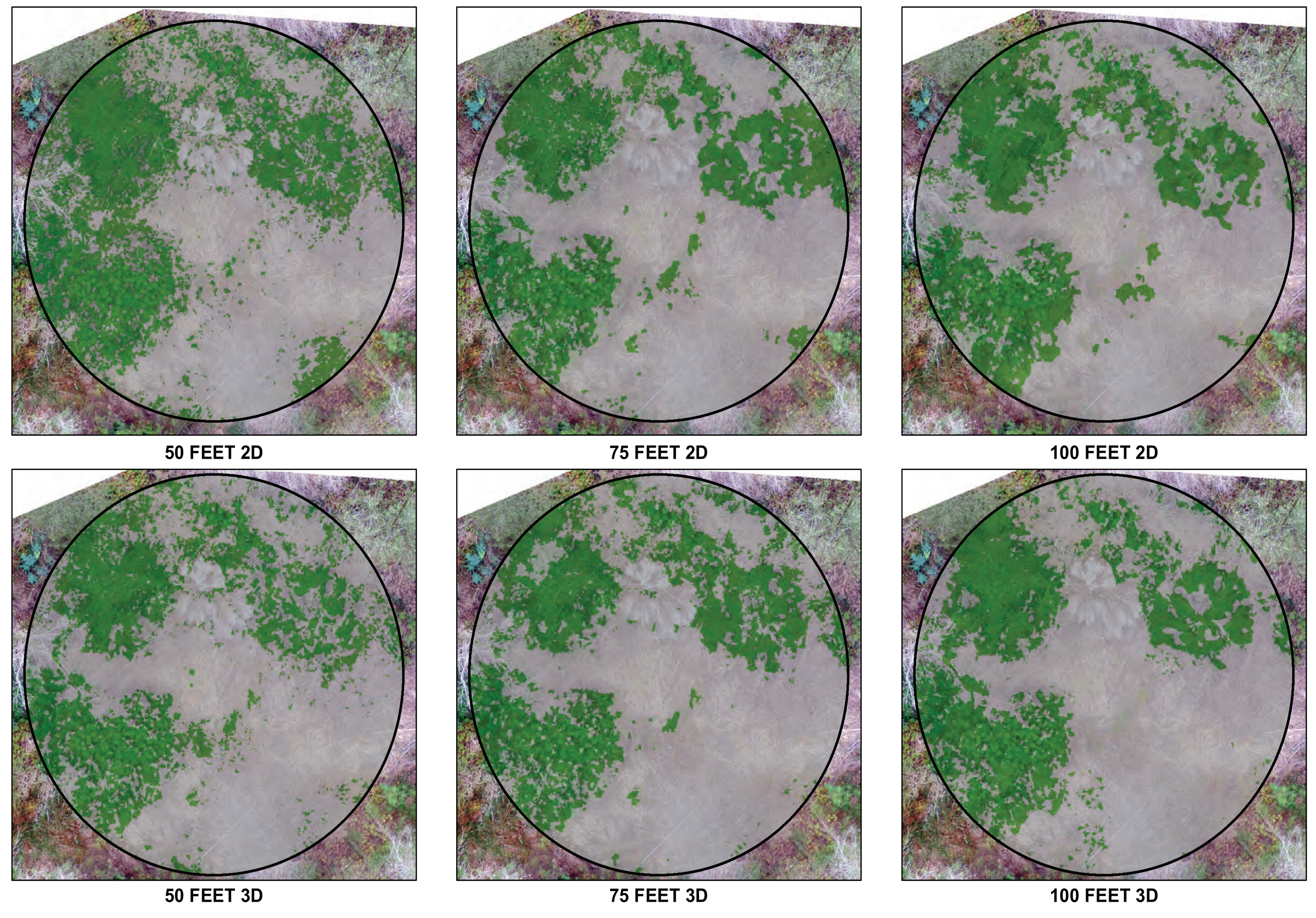


Alex Fromer in the Field

Table 1
Drone Flight Data Collection Efficiency

Height	2D/3D	Digital Cover Estimate	Difference from Observed	Flight time (min./acre)	Efficiency index
50	2D	40.03%	20.03%	1.2	0.76
50	3D	32.41%	12.41%	6.6	0.18
75	2D	32.19%	12.19%	0.9	0.89
75	3D	32.02%	12.02%	4.2	0.50
100	2D	32.43%	12.43%	0.6	0.93
100	3D	31.86%	11.86%	3.0	0.64

Image Classification



5. CONCLUSION

Three-dimensional aerial mapping was less efficient at capturing similar data than two-dimensional aerial imagery. This is due to the increased flight times associated with 3D mapping without a corresponding increase in accuracy.

At the three different heights flown, there appeared to be no decrease in precision. The drop in resolution associated with the increased flight elevation did not significantly change the results of the digitally estimated vegetation cover. More flights will need to be flown at higher elevations to determine what the upper limit of efficiency would be for estimating vegetation cover. In order to directly compare the accuracy of the digitally estimated vegetation cover to that of experienced field biologists, a greater sample size of relevé plots would be required.

Based on our testing experience and data, we feel that more flights would need to be conducted at a wider range of elevations and at more relevé locations, to genuinely assess the effectiveness of using drones to evaluate vegetation cover. However, using available supplemental technology such as lens filters and multi spectral sensors, we feel that drones have promising potential in various biological applications. With the use of these additional tools and greater experience leading to optimizing flight method, accurately estimating vegetation cover through the use of drones may be a highly efficient option.