Testing the use of Unmanned Aerial Systems (UAS, or *drones*) for vegetation assessment near the Carrizo Plains Ecological Reserve, April 2015

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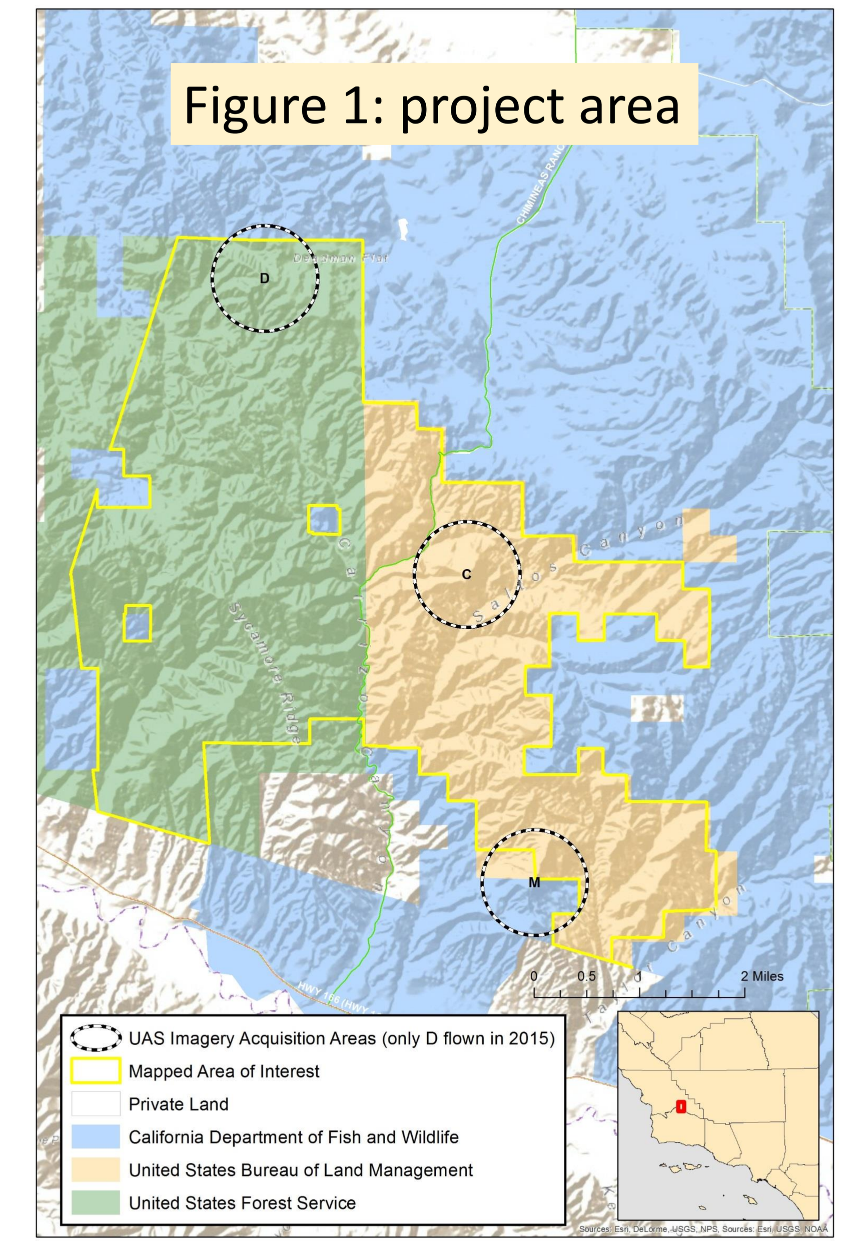
Figure 2: T-hawk UAS returning from a windy flight above Saltos Canyon.

Introduction: *We wanted to evaluate UAS as a replacement for time-intensive field data collection in difficult terrain.* In 2013, CDFW's Vegetation Classification and Mapping Program (VegCAMP) mapped vegetation in the area shown in Figure 1, which encompasses elk habitat on BLM and FS land adjacent to the Carrizo Plain NM and CDFW's Carrizo Plain ER. Mapping was based on a combination of interpretation of aerial photography and field reconnaissance performed in 2013. In 2015, CDFW partnered with USFWS and USGS to fly a UAS to test whether it is feasible and efficient to substitute UAS-acquired imagery for fieldwork in the assessment of map accuracy, and to generally assess the quality of the imagery for the purposes of vegetation mapping.

Methods: Using viewshed analysis tools in ArcGIS to find test areas with direct line-of-sight as required for UAS operation, three one-mile diameter areas, shown on Figure 1, were selected for UAS imagery acquisition. In the spring of 2014, field crews were sent throughout the entire mapping area to collect vegetation assessments of mapped polygons using an accuracy assessment protocol, with extra surveys concentrated in the 3 chosen areas. In the spring of 2015, USGS staff used a UAS RQ-16A T-Hawk platform with a COTS Ricoh GR (16 megapixel) camera to acquire imagery at 400 feet above ground level. Digital orthoimagery was created using photogrammetry within Agisoft Photoscan software. A VegCAMP staff member who had not been involved in the mapping or field effort used the UAS imagery to determine the relative cover of dominant plant species per the survey protocol. The efficiency of the ground-based field effort was compared with the drone effort by tracking the hours spent by CDFW and USGS staff on the project.

Wind and terrain issues reduced the efficiency and extent of UAS imagery acquisition. The week of April 13th, 2015 was a particularly windy one in the whole region. On April 14th, an attempt was made to fly Area C, which, because of the terrain, would have required setting up the ground control twice (it was not possible to get the heavy equipment close enough to the high point). In the end only a very small portion of the area was flown before USGS staff determined it was too windy to continue flying (see Fig. 2). April 15th was still windy; imagery was acquired for most of Area D, but Area M could not be flown. This meant that comparisons could only be made on less than 1/3 the area planned, yielding 30 stands to compare field-based and drone imagery-based vegetation assessment.



Result 1: *UAS acquired imagery was much higher resolution and showed vegetation color better than the imagery used in mapping.* On the morning of April 15th, CDFW took GPS points and photographs within area D to test whether the imagery was capable of displaying small shrubs and herbaceous differences. The imagery acquired by the T-Hawk allowed for detection of small (1 m or less) patches of green herbaceous vegetation and shrubs. See figures 3-6 for visual comparison.

Figure 3: UAS-acquired imagery showing a patch of *Isocoma*. The resolution of the UAS-acquired imagery is 0.0321316 meters (1.27 inches), and the color of the shrubs is clearly visible.

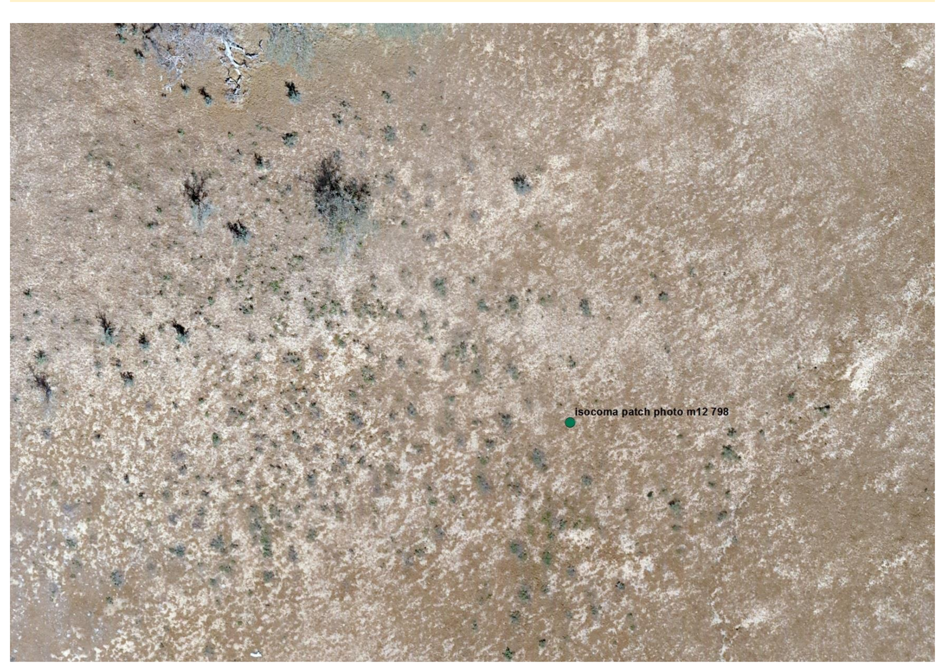


Figure 4. The base imagery used to produce the vegetation map was aerial imagery from 2007 with 0.3048 m (one foot) resolution.

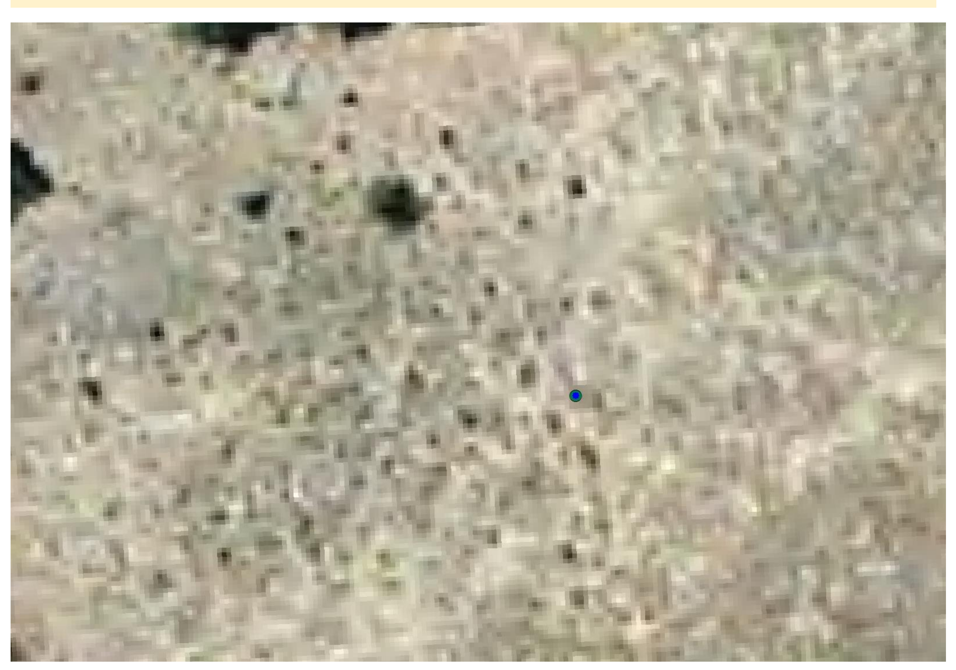


Figure 5. High resolution imagery was also flown in the same month as the drone imagery (April, 2015), and was available in Google Earth.

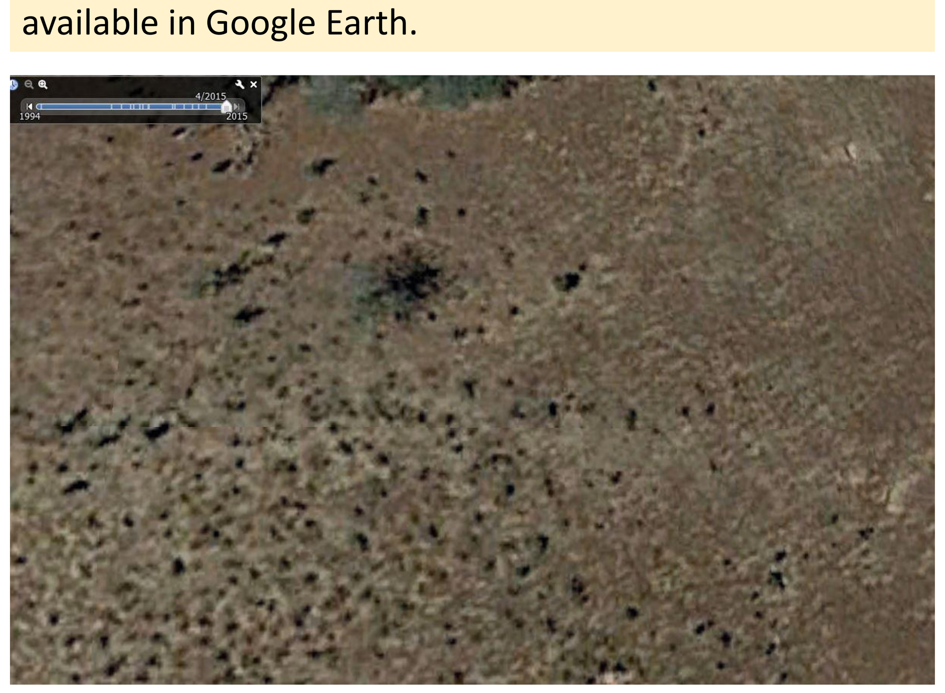
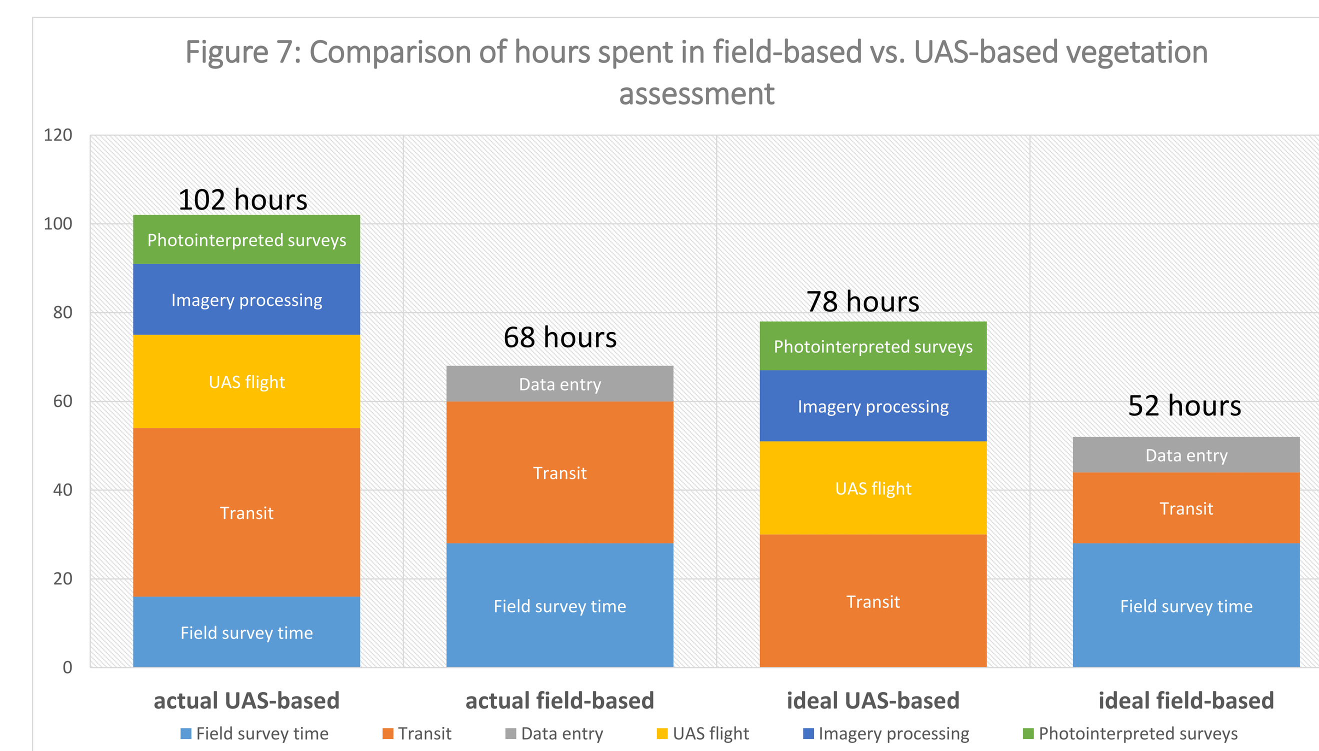


Figure 6. One of the authors in the stand. The green dot in Figure 3 shows where she was standing.

Result 2: *Use of UAS-based vegetation assessment saved no time.* The hours used by USGS and CDFW staff were compared for both the field-based (2014) and drone-based (2015) efforts. After the initial comparison, potentially unnecessary hours were eliminated from both efforts for a theoretical "ideal" comparison. For the field-based effort the extra hours of transporting a second crew were eliminated. For the UAS-based effort, field survey time was eliminated, assuming field surveying could be done in conjunction with a UAS mission, and time spent deploying georeferencing targets would not be necessary with a UAS that had onboard global positioning available. Figure 7 shows that in either case, field-based assessment required less staff time.



Result 3: *The original photointerpretation and the assessments done with the UAS-acquired imagery seemed similar in accuracy, assuming the field-based assessments were correct.* Because of the low number of samples, this shouldn't be considered a statistically valid comparison, but in a fuzzy score comparison with the field based assessments, the mapped vegetation type and the type chosen using the UAS imagery received scores of 75% and 77%, respectively. Additionally, on 13 polygons, the assessment done with the UAS imagery allowed for assignment of the stand to the association level, which is a finer distinction than made in the mapping classification.

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Conclusions and next steps: *UAS imagery allows vegetation assessment, but still requires field effort for calibration of photosignatures to get accurate vegetation data.* Originally, we thought that a UAS would be more efficient in steep terrain than a field crew, but maintaining line-of-sight in steep terrain required setting up more base stations, which is time-intensive. VegCAMP staff may pursue another test of UAS technology in the future, focusing on wetlands where field crew access may be limited by water and where line-of-sight is easier to maintain. Advances in the technology will make it easier to acquire imagery than it was for us in this project, but it is unclear at this point how VegCAMP can incorporate UAS into our regular work.