Sagebrush & Juniper Sampling with High Resolution Aerial Photography
Exercise 8

Aerial photography was first used in 1858 when Gaspar Felix Tournachon captured photographic images of his village from a tethered balloon. Since the mid 20th century, aerial photography has been widely used for rangeland assessment and management to detect change in land cover and land use. Tree and shrub density, distribution and other ecosystem attributes are often visible in imagery, especially in higher resolution photographs.

Conventional black and white and later color aerial film photography was an essential component of vegetation and soil mapping from the end of the Second World War through the 1990s when high quality digital cameras began to replace film. The digital revolution has allowed us to collect aerial images very inexpensively compared to traditional film. Today we can capture thousands of sequential aerial images then quickly transfer them to a computer for storage. These images can be transferred over the internet or stored on media for future reference.   One of the difficulties inherent in the use of aerial photography has been the process of geo-referencing images. Geo-referencing images with a computer removes image displacement caused by terrain relief and camera tilt. These processed images retain the characteristics of a photograph with the geometric qualities of a map.

We assembled an aircraft/camera/computer/software system that roughly geo-references digital imagery. We employed a Canon® digital camera linked to a laptop computer system and powered from an aircraft's electrical system (Figure 1) to collect our aerial images. Various aircraft platforms, from ultra-lights, fixed-wing commercial models, blimps and helicopters have been used to carry the camera. Cameras are mounted so they point vertically downward and can be leveled in flight.
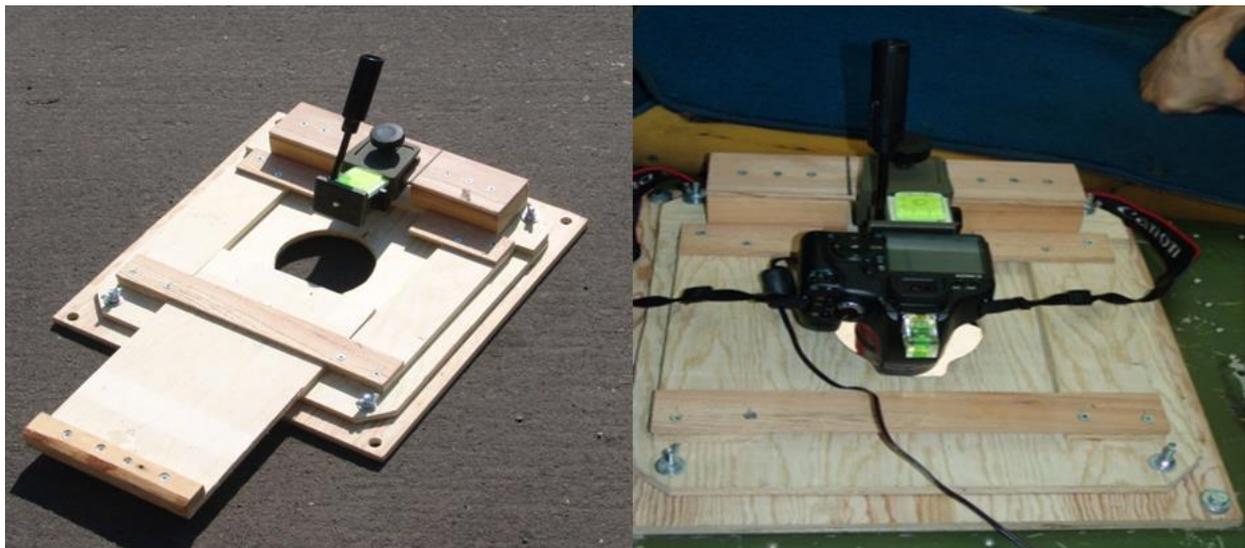

Figure 1. Camera mount and camera in a Cessna 182 aircraft. This setup is used for aerial photographic missions to monitor rangeland vegetation.

In our system, the camera transfers the image immediately after it is captured to the on-board computer. Everything is powered from the aircraft's electrical system through a 12 volt DC to 115 volt AC power inverter. Because they are independent of battery power and images are stored on a laptop, we can fly for a full day without interruption except for fuel and pilot fatigue.

Images can be acquired at an interval as fast as 1 photo every 5 seconds. Thus, the system collects 720 images per hour. Ground coverage of the images and the resolution (ground pixel size) is dependent on the height of the aircraft above the ground and lens settings on the camera. In digital imagery the lens settings are recorded in the header file of each image.

Figure 2. Images taken during the flight are transferred to the onboard computer. The pilot can see the images as they are acquired to get an idea of image quality and ground coverage.

The aircraft is positioned throughout the flight at 1 second intervals with continuous WAAS-enabled GPS. The GPS track log records the latitude, longitude, altitude, date, time, bearing, speed over ground, number of satellites used in the fix, and an estimate of the quality of the position data. Just before the flight we photograph the screen of a GPS or USNO Master Clock showing the date and time. This allows us to calculate the camera time offset from GPS time.

We programmed an Aerial Image Positioning Tool (software program) that:

1. Determines the offset of camera time to GPS time.
2. Searches the aircraft GPS track log and determines the aircraft/camera latitude, longitude, bearing, and altitude when each image was taken.
3. Our program then reads camera lens settings and uses it in conjunction with user inputted ground elevation to determine approximate corners for each image.
4. It then writes a KML file that puts the image in approximately the correct position on the ground.
5. A KML file is written that allows rotation and proper viewing in GIS software.
6. Either single images or batch images can be processed.

Images can be batch processed so that all the images collected on a flight can be automatically rough corrected. Once images are in approximately the right position, they can be re-rectified to match the data standards of the reference map or image, if desired. We have been referencing to the National Aerial Imaging Program (NAIP) 2009 imagery which is generally accurate to within 5 m.
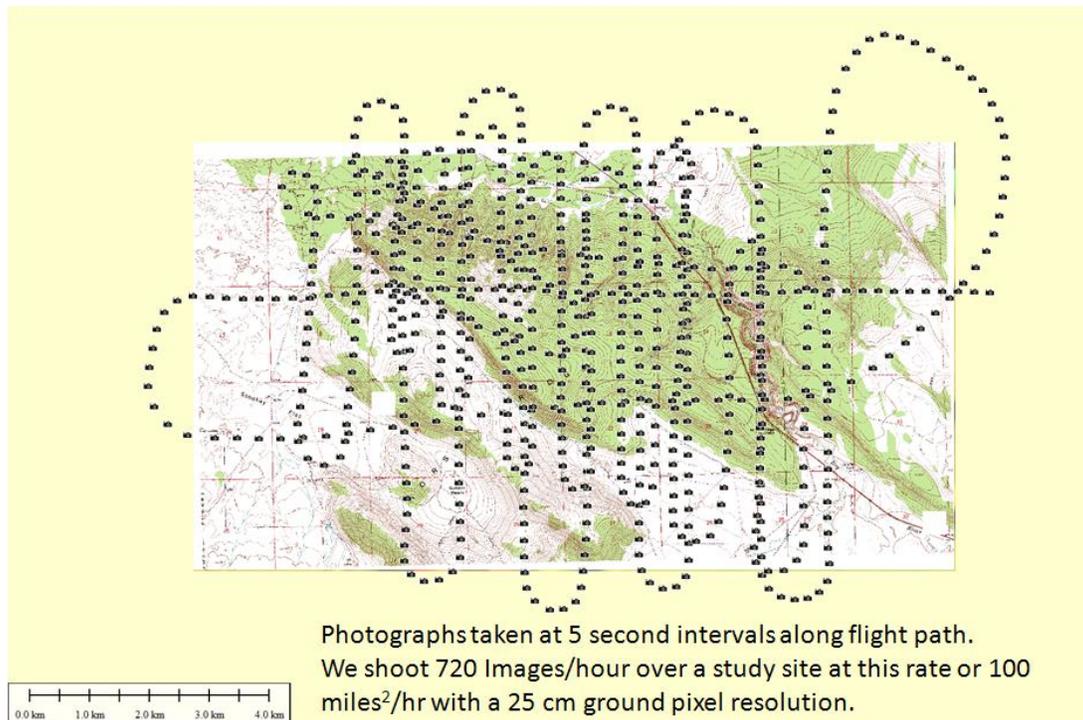

Photographs taken at 5 second intervals along flight path.
We shoot 720 Images/hour over a study site at this rate or 100 miles^2/hr with a 25 cm ground pixel resolution.

0.0 km 1.0 km 2.0 km 3.0 km 4.0 km

Figure 3. Positions of photographs lain on a 7 1/2 minute USGS topographic map. We use this layout to select images for closer examination.
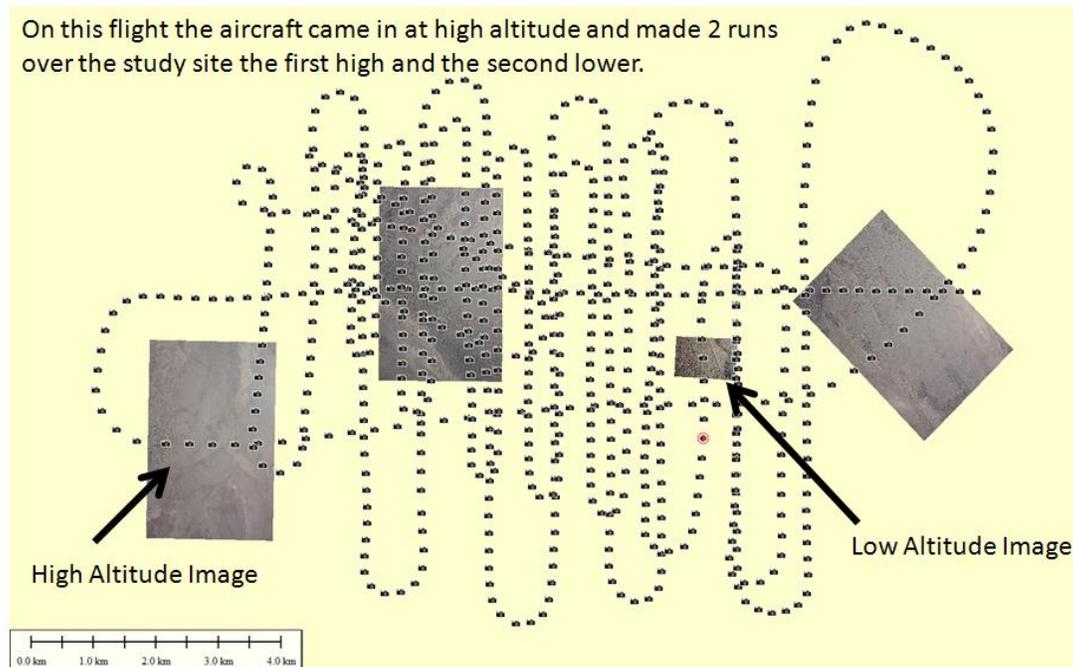
Figure 4. These four aerial images have been rotated and coarse scaled so they are in approximate position in a GIS.

In this laboratory we will examine one of our aerial images taken on 4 July 2010 of an area east of Bend, Oregon at a location called Horse Ridge. The image has a ground resolution (pixel size) of 25 cm and your map has a scale of 1 cm in the image = 5m on the ground. This area is a juniper/sagebrush community in which some of the juniper is quite old and others are relatively young.

When you examine this scaled air photo think about how you identify what is juniper. Photo interpreters use a number of "basic elements" to identify objects in an image. These elements are: size, shape, shadow, color, texture, pattern, and association.

This is how the aerial photograph lies on the topography of the study area. Does this image help you partition the vegetation into communities? North is toward the top of the image.
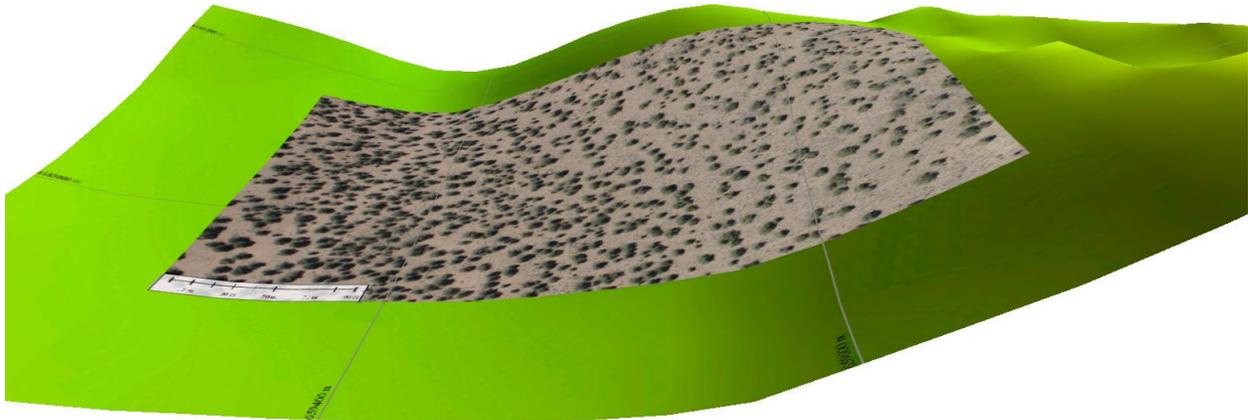
Figure 5. The high-resolution aerial photograph we are analyzing has been draped on a digital elevation model in this image. It shows the relative position and orientation of the catena with areas of hilltop, hillside and valley.

Assignment

Our tasks today are to answer the following:
1. What is the size of each of our square sample quadrats (transparencies) on our 1:500 digital orthophotographic map?
2. Can you stratify the vegetative communities on our map into homogenous units?
3. What is the juniper density and cover in each of our communities?
4. How large is an average juniper?
5. Do larger plants have a more irregular outline?
6. Do you think you could determine tree height from length of shadow in this image?

Build a sampling data sheet to be used for this laboratory. Then Make an outline drawing of the communities as you have defined them. Sample the communities you have defined for juniper density and cover using a quadrat with a size and shape of your choice. Also sample the communities for juniper cover using a line intercept method. Prepare a laboratory write-up that presents your findings in a logical, understandable format.