0. Equipment Checklist

1. Micasense camera and peripherals
2. Tau camera, its associated USB and video cables
3. USB video converter
4. BNC female to RNC male converter
5. At least 3 USB battery packs
6. 2 USB-C cables and extras
7. Raspberry pi
8. Calibration panel for Micasense
9. USB Monitor
10. USB mouse/keyboard
11. Computer for running flight software
12. Computer for checking cameras/data
13. Inverter/car that can be used with inverter
14. Drone and associated items
15. Two each of SD cards formatted for the raspberry pi and the Micasense, kept separately
16. SD card USB adapter
17. Tape measure
18. Several shears
19. Airtight ziploc bags
20. Several coolers
21. Aerial markers/GCPs
22. Alignment objects
23. PVC pipe and fittings for plot establishment
24. 1’ PVC pipe segments for field sample stratification
25. Gloves
26. Sharpies
27. Duct tape
28. Lens cleaner
29. USB router in case it is needed for the flight control laptop

30. Survey-grade GPS

1. Site Establishment

The study area consisted of 60 plots on each side of a road, in 6 rows/side of ten plots each. The rows were spaced 2 meters apart, and then a tape measure was used to place a plot every two meters. When bare ground or very poor drainage (such as a ditch) was encountered, this plot location was skipped. The plots were delineated by 1m square PVC frames with posts sticking out of the west corner. When establishing the plots, the frame was constructed within the grass to avoid crushing the grass. In plot establishment and in collecting field data, stepping inside the plot was avoided. Each plot was labeled with a number according to a consistent numbering scheme (plots 1-60 were "tall grass," which had an average height of about 1 m and plots 61-120 were "short grass," which had an average height of .3m.)

The workspace for setting up the drone, with a table, laptops, etc was established at the north end of the test site. The calibration panel for the micasense was set up near this site. Some good things to have on hand for emergencies include extra USB battery packs, an extra laptop, and an inverter.

The overall location of the test site was delineated with wooden aerial placards marked with the cardinal direction. Objects to aid in image alignment were scattered around the area (pool noodles and bi-colored metal objects). Sixteen ground control points made of steel sheets with black "x's" drawn on them were also scattered throughout the study area. Throughout the rest of this process, the locations for these GCPs were being recorded using the GPS unit.

The below steps were repeated once for the morning flight and once in the afternoon.

2. Camera testing/setup

The following checklist was performed before each flight:

a. Check the micasense and ensure that it has an empty, properly formatted SD card.

i. An SD card with a write speed of at least 100MB/s should be used, ideally 32+GB, or images will be skipped in recording.

ii. The status of the SD card can be viewed in the Micasense web app, which is accessible by connecting to the camera's wifi network and navigating to the IP address listed on the camera.

b. Check/set the Tau

i. Using the windows software that comes with the camera (link below) and a windows computer, establish the correct exposure settings for the field. In this study, the minimum amount of contrast was used. The settings can be tested using any camera app on the computer.

https://www.dropbox.com/s/mu6yfcomvcbbtdy/CameraControllerSetup.msi?dl=0

ii. The lens of the Tau should be cleaned with lens wipes.

iii. The focus should be set to infinity.

c. Attach both the Tau and the Micasense to the drone

i. Drone setup up to this point is as per AFSL procedures

ii. The micasense is connected to its own power source, and the Tau is connected via 2 USB ports to the raspberry pi, which also has a separate power source. All of these things must be attached to the drone, an area that could be improved in the future. A simple diagram of the electronics is below.

3. Start Recording

i. A wireless USB keyboard and a USB monitor were used to start the Tau using ffmpeg from the raspberry pi terminal, using the command below:

```
ffmpeg -f v4l2 -r 25 -s 640x480 -i /dev/video0 out.avi
```

ii. The Micasense was initiated from the web app. The capture rate should be set to once per second (the fastest it goes).

4. Flight

This study used a DJI M600 drone and UGCS flight control software. The drone setup and flight safety procedures are standard AFSL procedures. The flight control

settings were as follows for both flights. At the start of the flight, the drone was flown over the calibrated reflectance panel.

a. Flight pattern: double-grid
b. Side-lap: 80%
c. Overlap: 85%
d. Height: 52 ft.
e. Speed: 3 m/s

Note: the overlap was calculated automatically by the software for the Micasense and did not reflect sufficient side-lap for the Tau. This issue should be resolved in future work.

5. Data Quality Check

a. When the drone landed, it was brought over to the table so that the raspberry pi could be reconnected to the monitor and keyboard to end the video recording. The video was then viewed on the USB monitor to ensure successful recording and data quality.
b. Then, the drone and peripherals were unplugged/powered off.
c. The SD card was removed from the Micasense and plugged into a laptop for a quality check and to remove the images and put them on the computer in an appropriate folder.

6. Field Sample Collection

a. Within 2 hours after the flight, the field samples were recorded. This was accomplished by randomly generating the list of plots to be collected after each flight and then assigning a subset of these plots to each person. The bags were also partially prelabeled for efficiency.
b. Each plot was destructively sampled and placed into three bags:
    i. Live: Scotch Broom, bracken fern, and uncured grasses were collected separately and placed in this bag regardless of height. (These were not very abundant.)

ii. Top: Using a 1’ PVC pipe, every remaining piece of vegetation above this height was placed into this bag.

iii. Bottom: The rest of the vegetation was collected in this bag, except mosses, roots, and grass very covered in soil.

c. Each bag was carefully sealed, labeled with the plot, grass type, initials of the collector, sample type, and time and date collected, and placed in a cooler to minimize moisture loss.

d. If a piece of vegetation was only partially included in the plot, the collector included whatever parts of the plant were “visually” in the plot. For example, if grass had roots outside the plot but the upper portion fell within, it would be cut off at the point it entered the plot and bagged.

7. Field Sample Processing

The field samples were taken back to the USFS lab in Seattle, where they were weighed, dried for 48+ hours in a convection oven at 70 degrees C, and weighed again to calculate fuel moisture.