COLORADO FOREST RESTORATION INSTITUTE

Colorado State University

Field Data Collection Protocol for Evaluating Fire Mitigation Effectiveness

2015 Simple Plot Protocol

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CFRI-1601

Sampling Objective:

This Fuels Assessment Protocol is designed to collect comprehensive data for ground, surface, herbaceous, shrub, and tree fuels in order to determine changes in fuel abundance and distribution as a result of management actions in forest of Colorado. The following protocol was designed to provide suitable data for analysis with the Fuels Characteristic Classification System (within the Fuel and Fire Tools analysis package) in order to quantify fuel condition and fire hazard potential, but this protocol ultimately is a general fuels sampling method and can be used for any objective where fuel loading is needed.

Sampling Design and Intensity Recommendations:

The most accurate and straightforward method for quantifying changes in fuels as a result of management actions is to quantify fuels at the same location before and after treatment. When conducting pre-post fuel loading comparisons, permanently marked plot locations are highly desirable and greatly increase ease of finding plot locations and comparability of multiple measurements over time. Sample plots located randomly throughout the area of interest provides a robust study design and is generally recommended over a gridded plot system.

How many plots do you need? Appropriate sampling intensity will depend on monitoring objectives and level of confidence needed in results. If you are gathering information to determine standard fuel model for fire behavior modeling, only a few plots may be needed. However, if you want to determine differences in fire hazard over a large area before and after treatment, much more intensive sampling is required. Exactly how many plots you need to get a reliable answer depends on local site variability, which cannot be predicted remotely. However, when using our fuels assessment protocol in Colorado, typically a minimum of roughly 10 to 15 plots is adequate to evaluate differences pre and post treatment with relatively high confidence. CFRI's philosophy is to sample an area using this protocol with a crew of 3 trained individuals for 2-3 full days no matter how many plots are measured. Typically we will complete around 15 plots in that time. If sampling goes fast that usually indicates more samples are needed to account for higher variability, so 2-3 days is still appropriate.

Plot Layout

1. Randomly locate the plot origin within the desired sample area. Use GIS technology if available, or a random number table with numbers 0-359 can be used to choose a random direction and then a random distance to walk.
2. From the plot origin, chose a random direction (0-359) for the plot transect orientation.

3. Stretch out a measuring tape 25 feet in each direction along the randomly chosen direction to establish the transect, being carful to place the tape as close to the soil surface as possible. Before proceeding, be sure that the edge of the plot is at least 30 feet from a treatment boundary.
4. Each of the three 1m² sampling frames are placed to the left of the 50 foot transect as depicted below. The frames begin at 0ft, 25ft, and 47ft on transect. To avoid trampling vegetation and woody fuels, walk on the right side of the transect as much as possible.

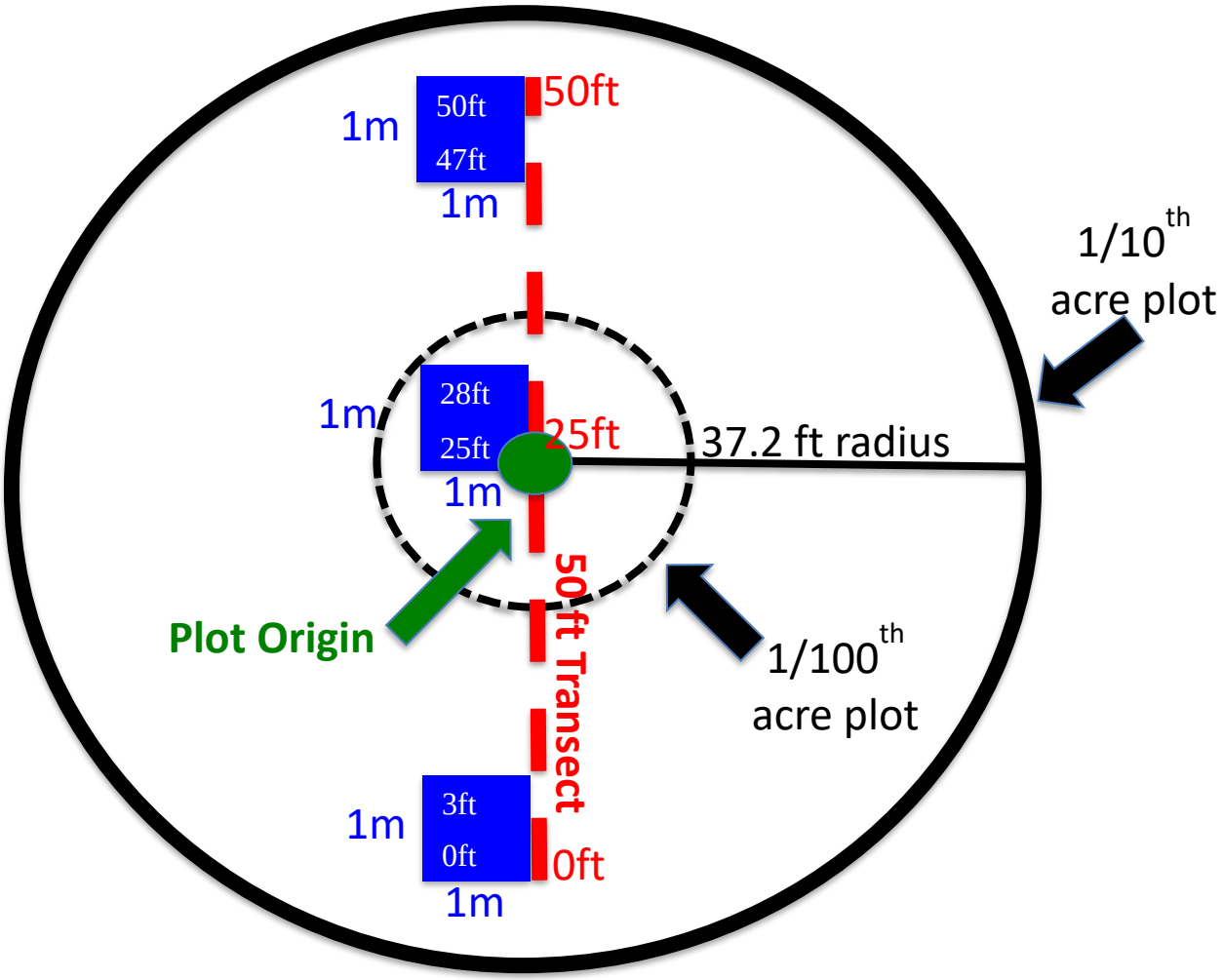

Figure 1. Diagram of the CFRI Rapid Fuels Assessment sample plot. Diagram not to scale.

Origin Sample Point

1. **Location**
   a. Using a GPS, record the location and elevation at the origin point. To locate plots post treatment, it's strongly recommended to leave a monument (pinflag, rebar, etc.) at the origin and 0 ft mark of the 50 ft transect. Flagging a tree near the plot origin that is likely to remain post treatment (e.g. the largest tree, old snags, etc.) can also assist with plot relocation.
   b. Using a compass, record hillslope azimuth (degrees, 0-359) within the 1/10th acre plot.

c. Using a clinometer, record the slope to the nearest percent within the 1/10th acre plot.

2. **Photo's**
   a. Standing at the plot origin (25 ft on transect), take 4 photo's. Photo's will be used to describe fuel conditions and to help locate plots post treatment. Suggested photo sequence:
      1. Along the transect looking in the direction of 50 ft towards the ground (capturing 25-35 ft on the transect and the $1m^2$ sampling frame).
      2. Along the transect looking in the direction of 50 ft out at eye level.
      3. Along the transect looking in the direction of 50 ft towards the upper tree canopy.
      4. Along the 50 ft transect looking in the direction of 0 ft out at eye level.
3. **Tree Overstory**
   a. Record the basal area prism or angle gauge size and units.
   b. Standing at the plot origin, use a basal area prism or angle gauge to record the basal area of the variable radius plot for all live and dead tree's taller than 4.5ft (Diameter at Breast Height, DBH) with a DBH ≥ 5.0 inches. If a tree is a 'hit' and included in the basal area count, mark that tree for further measurement.
   c. For each hit tree included in the basal area count, record:
      1. Tree species.
      2. Live or dead.
      3. Diameter at breast height (to nearest 1/10th in).
      4. Tree height (to the nearest ft).
      5. Lowest height of continuous live vegetation (crown base height) (live trees and class 1a snags only, to the nearest ft).
         a. Tree species, live/dead, and DBH are quick easy measurements and need to be done on all trees to for data anaylsis. Measuring tree height and CBH can be more time intensive. In order to obtain an average tree height and CBH for the plot, measuring height on the first 5 live trees and the first 5 dead trees in the plot rather than measuring every single tree height will typically give reasonable averages for the stand and save significant time.
   d. For standing dead trees taller than DBH (snags) that are included in basal area count, also record decay class on a scale of 1-3.
      1. Decay class 1a *with needles* = recently dead trees, top intact, needles/foliage and fine branches present. Record CBH for trees with needles.
      2. Decay class 1b *without needles*= recently dead trees, top intact, fine branches present.
      3. Decay class 2 = snags have coarse branches and bark present, but fine branches and foliage have fallen off.
      4. Decay class 3= snags are rotten, bark not present. Very few if any branches remain.
   e. Saplings: Often variable radius plots measured with a prism or angle gauge are not very effective at capturing smaller trees. However, fuel reduction treatments frequently are aimed specifically at removing these small trees, which can serve as

ladder fuels. If there are significant amounts of small trees in your stand, or quantifying the removal of these trees in the monitoring is of special interest, consider counting all trees taller than 4.5 ft that are <5" DBH in one fixed radius 1/100th acre (11.78 ft radius) subplot centered on the plot origin. Record a count of trees by species, average tree height, and CBH. For finer scale estimates, tally by species in DBH size classes 0.1-2.4 inches, 2.5-4.9 inches. For saplings, often an ocular estimate of tree height and CBH for all trees is quicker and just as accurate as measuring the height of every single sapling tree using a hypsometer or digital device. If more detailed data is desired, measure the exact DBH, height, and CBH for each tree. Tree seedlings (<4.5 ft tall) are measured in 1m^2 Sample Frames.

1m^2 Sample Frame

In each of the three 1m^2 sampling frames located along the transect, measure the following:

1. **Groundcover**
    a. Using the ocular estimate method, at the soil surface measure ground cover to the nearest 1% within the 1m^2 sample frame. This includes small wood all as one category (1hr/10hr/100hr fuel), litter, duff, and rock/bare soil. If stumps or live tree trunks occur in the frame, record them separately as woody basal. Each category should be measured separately and total ground cover can exceed 100% with overlap of categories (e.g. 80% litter, 65% duff, 20% rock/bare soil, etc. in the same plot).
        a. When estimating ground cover, exclude live vegetation from estimates. Basal clumps of large bunchgrasses and moss should be classified as litter.
2. **Depth of Litter, Duff, and Small Woody Fuels**
    a. At the 4 corners of each quadrat along the transect, measure the depth of litter and duff to the nearest 0.25 inch. Also measure the depth of 1hr/10hr/100hr fuels lumped as one category. If you record a cover of small woody fuels in the plot, the depth must be >0. Since woody fuels tend to have small cover, measuring depth of woody fuels at the 4 corners of the quadrat often results no measurements and an average depth of 0 inches. To avoid this, often it is best to measure the depth of these small woody fuels *where they occur* in the quadrat and not at the 4 corners.
3. **Tree Seedlings**
    a. For any trees less than 4.5 feet tall (below DBH) that are rooted within the frame, record the species and number of individuals by height class.
        i. Height Classes: 1 = 0"-4"; 2 = 4.1"-18"; 3 = 18.1"-30"; 4 = 30.1"-54".
4. **Herbaceous Vegetation Cover and Height**
    a. Using the ocular estimate method, measure vegetation canopy cover to the nearest 1% within the 1m^2 frame. A closed fist equals approximately 1% cover as a rough guide.
        1. Record Total Herbaceous Cover of all non-woody vegetation that is rooted in the 1m^2 frame.
        2. Estimate average total maximum height of all herbaceous vegetation at the highest point of each plant that is rooted within the 1m^2 frame to the nearest 1.0 inch.
        3. Record cover for the 3 most common herbaceous species rooted in each 1m^2

sample frame. Identify plants to species when possible. The goal is to identify dominant plants in the plot (roughly the 3 most abundant species). If you can't identify to species, record as graminoid (grasses and grass like plants) or forbs (herbs). It is important to note succulent plants (e.g. cactus, yucca, etc.) that are less reactive in a fire than grasses or other forbs.

5. **Herbaceous Biomass**
    a. Label an appropriate size paper bag with date, "Herb", and plot number.
    b. Clip all herbaceous material at the soil surface (current year's growth and senesced/dead material that is attached to plants) for each plant *rooted* within the frame and place in labeled paper bag.
    c. All herbaceous material should then be oven dried to constant mass and weighed to attain dry weight of herbaceous material (loading in tons/acre).
        i. Clipping herbaceous biomass can be time intensive. For a rapid assessment, we recommend collecting biomass at only one quadrat (e.g. at 25 ft).

6. **Woody Fuels**

"The Photoload Sampling Technique: Estimating Surface Fuel Loadings From Downward Looking Photographs of Synthetic Fuelbeds." Robert E. Keane and Laura Dickinson. USFS General Technical Report RMRS-GTR-190, pages 15-17. April, 2007.
http://www.fs.fed.us/rm/pubs/rmrs_gtr190.pdf

    a. Using the Photoload technique, estimate fuel loading for 1 hr, 10 hr, and 100 hr fuels in tons/acre within the frame. The photos on pages 15-17 are intended as guides and not absolute choices. Estimate as close to the picture as possible or chose an intermediate loading between pictures if appropriate. A go-no-go gauge can be used to help classify fuels in the frame.
        ii. 1 hr fuels (0 to 0.24 inch)
        iii. 10 hr fuels (0.25 to 0.99 inch)
        iv. 100 hr fuels (1.00 to 2.99 inches)

50 foot Transect

1. **Shrubs**
    a. Record cover of any shrubs along the 50 ft transect.
        1. Using the line intercept method, record the amount of line covered by each shrub by species to the nearest 1.0 inch. Record only the top shrub layer.
        2. For shrubs with sparse leaves, clump the shrub and record the continuous cover of shrub if any part of the live shrub intersects the tape. If a gap of more than 6 inches exists between shrubs or within the canopy of a large single shrub, record that as a break and separate shrubs.
    b. For each clump of shrubs, record the average shrub height to the nearest 1.0 inch at the highest point of each plant within each clump (or several times as appropriate for large clumps). A yard stick is handy to estimate heights.
2. **Tree Cover**
    a. Using the densitometer scope, at every foot along the 50ft transect record cover of any live tree taller than 4.5 ft (DHB). Stand directly over each point along the tape, look straight up through the densitometer scope and record when tree (foliage or trunk) is encountered. For each hit, record the tree species. Each transect will have 50 potential hits.

1/10th Acre Plot (37.2 ft radius)

1. **1000 hr fuels** (larger than 3 in diameter)
    a. Measure the end diameters, the length, and species of every log larger than 3 inches diameter within the 1/10th acre plot to the nearest 0.1 inches.
        1. If diameter drops below 3 inches on the log, stop measuring at that point.
        2. When a log travels outside of the 1/10th acre plot boundary, stop measuring the log at the plot boundary.
        3. If the center point of the log is below the duff, stop measuring at that point.
    b. Record if the fuel is rotten or sound. Consider pieces rotten when the piece at the intersection is obviously punky or can be easily kicked apart.

Record if the full, half, or quarter of the 1/10th acre plot was measured for 1000hr fuels. Measuring 1000hr fuels can be one of the most time intensive aspects of fuels measurements. If 1000hr fuels are excessive and relatively evenly distributed throughout the plot, we recommend only sampling ½ of the plot. When 1000hr loading is extreme, only ¼ of the plot can be measured. If measuring ½ of the plot, measure to the left of the transect tape. If measuring ¼ plot, measure from 25ft to 50ft on the left of the transect tape. Be sure to record on the datasheet the area sampled for 1000hr fuels.

Gear List

Data sheets
Random number table (0-359)
Photo load guides for 1hr, 10hr, and 100hr fuels (pages 15-17).

> "The Photoload Sampling Technique: Estimating Surface Fuel Loadings From Downward Looking Photographs of Synthetic Fuelbeds." By Robert E. Keane and Laura Dickinson. USFS General Technical Report RMRS-GTR-190, pages 15-17. April, 2007. http://www.fs.fed.us/rm/pubs/rmrs_gtr190.pdf

Tatum/Clipboard
Pencils, Sharpie
GPS and Batteries
Camera and Batteries
Hypsometer and Batteries (to estimate tree height, optional)
Compass
Clinometer
100 ft tape with 1 inch markings
Diameter tape and/or calipers
$1m^2$ frame
Basal area prism or angle gauge
Yard stick for plant heights
Ruler for litter/duff depths
Paper bags (for plant biomass)
Grass clippers/shears
Go no go gauge (for woody fuel class size measurement, optional)
Densitometer (for tree cover)

Angle Gauge

Densitometer

This is an example fire potential summary report based on field data analyzed with Fuels Condition Class System (FCCS) software. Reports will be generated with both pre and post treatment measurements to compare change in fuels condition resulting from treatment. For more info about FCCS or to download to program for free: http://www.fs.fed.us/pnw/fera/fccs/index.shtml

Calculator results for fuelbed: /Applications/FCCS22/fuelbeds/user_fuelbeds/PIPO standard.xml: 2.2.2 : 10/20/2013

Select type of report

(•) Potential ( ) Surface Fire Behavior ( ) General ( ) Strata & Categories ( ) Input ( ) Carbon

Potentials Report

Author:
Date: Oct 20 2013 - 03:47 PM
Fuelbed name: Interior Douglas-fir -- interior ponderosa pine / gambel oak forest
Fuelbed number: 34
File name: /Applications/FCCS22/fuelbeds/user_fuelbeds/PIPO standard.xml
Data quality ranking:
Original FBPS fuel model (13)*: 9
Standard fuel model (40)*: TL3
Description: This fuelbed represents mixed Douglas-fir and ponderosa pine conifer forests of the Southwest. Fire exclusion has created hazardous fuel conditions.

Fire Potential Ratings (0-9)		
Surface Fire Behavior Potential	**3**	Summary surface fire behavior potential, calculated as the maximum of spread potential and flame length potential scaled to an index between 0-9.
Reaction potential	4.5	Approximates the potential reaction intensity (energy released per unit area and time).
Spread potential	3.1	Proportional to the no-wind rate of spread in surface fuel (distance per unit time).
Flame length potential	3.0	Proportional to fireline intensity or flame length.
Crown Fire Potential	**2**	Weighted average of crown fire subpotentials.
Crown fire initiation potential	2.8	Potential for fire to reach canopy layer.
Crown-to-crown transmissivity potential	5.8	Potential for fire to carry through a canopy.
Crown fire spreading potential.	1.0	Relative index of crown fire rate of spread.
Available Fuel Potential	**4**	Sum of fuel loadings in all combustion phases scaled to an index between 0-9.
Flame available fuel potential	1.4	Sum of fuel loadings available for the flaming phase of combustion (in units of 10 tons/acre).
Smoldering available fuel potential	0.7	Sum of fuel loadings available for the smoldering phase of combustion (in units of 10 tons/acre).
Residual available fuel potential	1.6	Sum of fuel loadings available for the residual smoldering phase of combustion (in units of 10 tons/acre).
FCCS Fire Potential Code	**324**	Three-digit code representing the surface fire behavior, crown fire, and available fuel potentials.

*Based on dry fuel conditions (D2L2 moisture scenario)

FCCS v 2.2

Format Output

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