

Measuring mulch fuelbed loads

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- 1) Layout a 150 foot transect.
- 2) At every 3 feet, place a 9 ft² (3 x 3 ft) square quadrat.
- 3) Measure mulch depth at each corner and in the center of the quadrat.
 - a. Often the mulch material is mixed with needles and duff. To measure mulch depth place ruler into mulch until it reaches the mineral soil surface.
 - b. Measure the depth from mineral soil to the top of the 1 or 10 hour fuel size particle.
 - c. Average the 5 mulch depth measurements.
- 4) Repeat depth measurements within a quadrat at each interval along transect.
- 5) Calculate average transect mulch depth.
- 6) Use the appropriate forest type equation to determine total mulch (1hr+10hr+litter+duff) loading for the transect (Table 1).
- 7) To determine the contribution of each fuel type (1hr, 10hr, litter, and duff), multiply the proportion value provided for each fuel size class to the total mulch loading (Table 2)
- 8) To measure the 100 hr and 1000 hr fuels, we recommend following Brown's transect protocols.

Table 1: Equations to predict mulch fuelbed in tons per acre. Mulch fuelbed is defined as litter + duff+ 1hr +10hr fuels.

Ecosystem	Equation for Mulch Fuel bed mass (tons / acre)	r ²
Lodgepole	$-1.721 + 17.04 * \text{average_depth_inches}$	0.84
Mixed conifer	$-7.435 + 20.48 * \text{average_depth_inches}$	0.58
Ponderosa	$-1.142 + 16.22 * \text{average_depth_inches}$	0.86
Pinyon pine	$-0.469 + 18.02 * \text{average_depth_inches}$	0.90

Table 2: To determine proportion of each fuel type

Ecosystem	Litter	Duff	1-hr	10-hr
Lodgepole	0.18	0.20	0.29	0.33
Mixed conifer	0.29	0.20	0.25	0.26
Ponderosa	0.27	0.27	0.16	0.36
Pinyon pine	0.26	0.15	0.23	0.36

Determining the expected average depth of mulch based on tree biomass treated

Often, one would like to know how much mulch they will generate based on the amount of tree biomass that is to be treated. To address this issue, we developed a relationship between tree biomass treated (predicted by the Forest Vegetation Simulator) to the amount of mulch fuelbed biomass (litter + duff + 1hr + 10 hr).

Regardless of forest type, use the following equation:

$$\text{Mulch fuel bed (tons per acre)} = 0.478 + 0.796 * \text{tree biomass treated}; r^2 = 0.67$$

Tree Biomass treated (tons/acre)	Mulch fuel bed [litter + duff+1hr + 10hr] (tons/acre)
10	8.4
20	16.4
30	24.3
40	32.3
50	40.3

So what's the average mulch depth you can expect?

Average mulch depth = mulch fuelbed mass ÷ Mulch fuelbed bulk density

Ecosystem	Mulch fuelbed bulk density (lbs/ft ³)
Lodgepole pine	8.54
Mixed Conifer	8.62
Ponderosa pine	8.65
Pinyon pine / Juniper	9.35

For example,

If 20 tons/acre of tree biomass is treated, about **16.4 tons/acre** of **mulch** will be deposited on the forest floor.

Ponderosa pine mulch fuelbed bulk density = **8.65 lbs/ft³**

Average mulch depth = mulch fuelbed mass ÷ Mulch fuelbed bulk density

= **16.4 tons/acre ÷ 8.65 lbs/ft³**

Note: (need to convert tons/acre to lbs/ft²)

= **0.7530 lbs/ft² ÷ 8.65 lbs/ft³ = 0.087 ft = 1.0 inch**

So the average depth across the entire acre is 1.0 inch. Keep in mind that some areas might be deeper than 1 inch and other areas shallower than 1 inch (since this is an average).

Since the lodgepole pine, mixed conifer, and ponderosa pine have similar fuelbed bulk densities, you can use the table below for estimates of average mulch depth.

Lodgepole pine, Mixed Conifer and Ponderosa pine

Tree Biomass treated (tons/acre)	Mulch fuel bed [litter + duff+1hr + 10hr] (tons/acre)	Approximate Average depth (inch)
10	8.4	0.5
20	16.4	1.0
30	24.3	1.6
40	32.3	2.1
50	40.3	2.6

Pinyon pine / Juniper had a slightly different fuelbed bulk density, so use the following table for estimated fuelbed depth based on tree biomass treated.

Pinyon pine / Juniper

Tree Biomass treated (tons/acre)	Mulch fuel bed [litter + duff+1hr + 10hr] (tons/acre)	Average depth (inch)
10	8.4	0.5
20	16.4	1.0
30	24.3	1.4
40	32.3	1.9
50	40.3	2.4