

Mission Creek Fuel Data Description and Metadata

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The following report describes fuel data from the Mission Creek site of the Fire and Fire Surrogates Study (FFS). The data described are contained in the 'mission_master_widest.csv' file. Additional sample protocols are listed in the 'protocol_mission_creek_2020.doc' file.

The Mission Creek site was one of original 13 sites of the FFS, a nationwide coordinated distributed experiment designed to study the effects of the following forestry treatments: control, thin, burn, and thin plus burn (McIver and Weatherspoon 2010). The four treatments were implemented in 2001-2006 at the Mission Creek site, over three replicate units of roughly ten hectares each for each treatment (Agee and Lehmkuhl 2009). In 2012, a low severity wildfire burned through four of the replicate units: two control, one thin, and one burn (Rossman et al. 2020). See protocol document for more details.

The fuel data used in analysis includes two sample periods, called here 'pretreatment' and 'longterm.' Pretreatment data were collected in 2000, and collection was led by James Agee of the University of Washington (Agee and Lolley 2006, Agee and Lehmkuhl 2009). Longterm data were collected in 2019 and 2020, and collection was led by Don Radcliffe and Brian Harvey of the University of Washington. Immediate post treatment response data were also collected, and results are documented in Agee and Lolley (2006), but at the time of writing this report these data have not been relocated in raw form.

The goal of the current analyses is to analyze whether treatments affected fuel loading in the long term (greater than one decade following treatment, in our dataset 13-18 years following final treatment), and whether pretreatment differences in replicate units affected the long-term response. The fuel components that will be analyzed are detailed in the text below. Surface fuel data were collected and summarized using Brown's transects (Brown 1971), with two transects per plot. More details of the Mission Creek Brown's transects are outlined in Agee and Lolley (2006) and the attached protocol document. Tree attributes were collected and summarized from fixed area radius plots, the details of which are described in the attached protocol document.

All longterm data were double-checked after entry, and each column was graphed to check for outliers. Additional data files/scripts are available upon request. All data, metadata, and analyses are saved and version controlled on Don's github page (don-radcliffe). The repository

is currently private, but will be made public once a publication is produced from the longterm Mission Creek data.

The following table lists metadata for response variables used in the SEFS 502 final report. Note that for fire modelling variables, I've presented the 'moderate' fire weather and fuel conditions, which were determined from 80th percentile conditions using procedures described briefly below and in more detail in the report. In the 'mission_master_wide'.csv, these variables are also available using 'mild', 60th percentile, and 'severe', 97th percentile, conditions. Additionally, basal area and density mortality variables are available with a 'null' model, in which a four foot surface flame-length was applied to every plot in the dataset.

Response Variable Metadata

variable	units	explanation
plot	categorical	Sample plot the raw data were collected from, combined into the unitname_plotnumber format because plot numbers duplicated across different replicate units.
period	categorical	Sample period. 'pretreatment' was collected 1-6 years before treatment, in the year 2000. 'longterm' was collected 14-19 years after treatment, in 2019 & 2020.
basal_area	meters_squared_per_hectare	Basal area calculated from raw plot data (tree diameters). Potential range 0-infinity.
density	trees_per_hectare	Tree density calculated from raw plot data. Potential range 0-infinity.
qmd	centimeters	Quadratic mean diameter of trees on a plot. Potential range 0-infinity.
one_hour	megagrams_per_hectare	One hour fuels; surface woody fuels between 0 and 0.64 centimeters in diameter. Potential range 0-infinity.
ten_hour	megagrams_per_hectare	Ten hour fuels, surface woody fuels between 0.64 and 2.5 centimeters in diameter. Potential range 0-infinity.
hundred_hour	megagrams_per_hectare	Hundred hour fuels, surface woody fuels between 2.5 and 7.6 centimeters in diameter. Potential range 0-infinity.
thousand_sound	megagrams_per_hectare	Thousand hour fuels in decay classes 1-3, surface woody fuels greater than 7.6 centimeters in diameter. Potential range 0-infinity.
thousand_rotten	megagrams_per_hectare	Thousand hour fuels in decay classes 4-5, surface woody fuels greater than 7.6 centimeters in diameter. Potential range 0-infinity.
fuel_height	centimeters	Maximum height of dead woody fuel, averaged over multiple sample locations in plot. Potential range 0-200.
litter	megagrams_per_hectare	Biomass of forest litter layer, measured and summarized using the protocol of Brown, J.K. 1974. Potential range 0-infinity.
duff	megagrams_per_hectare	Biomass of duff layer (partially decomposed organic material of which parent source is unrecognizable). Potential range 0-infinity.
shrub	megagrams_per_hectare	Biomass of shrub layer, sampled and summarized using the protocol of (Burgan and Rothermel 1984). Potential range 0-infinity.

herb	megagrams_per_hectare	Biomass of herb layer, sampled and summarized using the protocol of (Burgan and Rothermel 1984). Potential range 0-infinity.
canopy_base_height	meters	Canopy base height, estimated from stand structural data using FVS-FFE program version 3431 (Reinhardt and Crookston 2003). Potential range 0-infinity.
canopy_bulk_density	megagrams_per_hectare	Canopy bulk density, estimated from stand structural data using FVS-FFE program version 3431. Potential range 0-infinity.
surface_flame	meters	Surface flame height, estimated from fuel data using FVS-FFE program version 3431, with 80% percentile weather and fuel moisture parameters for June 15 – September 15 of 2002-2017, determined from Fire Family Plus (Bradshaw and McCormick 2000). Potential range 0-infinity.
total_flame	meters	Total flame height including surface and crown fire, estimated from fuel data using FVS-FFE program version 3431, with 80% percentile weather and fuel moisture parameters for June 15 – September 15 of 2002-2017, determined from Fire Family Plus. Potential range 0-infinity.
torching_index	kilometers_per_hour	20 foot windspeed that is expected to ignite the crown layer, estimated from fuel and stand structure data using FVS-FFE program version 3431, with 80% percentile weather and fuel moisture parameters for June 15 – September 15 of 2002-2017, determined from Fire Family Plus. Potential range 0-infinity.
torching_probability	percent	Probability of ‘finding a small area’ that will torch under the fire weather and fuel moisture conditions given. , estimated from fuel and stand structure data using FVS-FFE program version 3431, with 80% percentile weather and fuel moisture parameters for June 15 – September 15 of 2002-2017, determined from Fire Family Plus. Potential range 0-100.
crowning_index	kilometers_per_hour	20 foot windspeed that is expected to maintain an active crown fire, estimated from fuel and stand structure data using FVS-FFE program version 3431, with 80% percentile weather and fuel moisture parameters for June 15 – September 15 of 2002-2017, determined from Fire Family Plus. Potential range 0-infinity.
density_mortality	Percent	Percentage of tree stems that would die in a simulated wildfire, estimated using FOFEM version 6.7 (Reinhardt et al. 1997) with stand structural data and FVS-FFE 3431 modelled surface flame. Potential range 0-100.
basal_area_mortality	Percent	Percentage of basal area that would die in a simulated wildfire, estimated using FOFEM version 6.7 (Reinhardt et al. 1997) with stand structural data and FVS-FFE 3431 modelled surface flame. Potential range 0-100.

The following predictor variables were not used in 502 analyses, but I’ve included metadata on them here, because they are contained within the mission_master_widest.csv data.

Predictor variable metadata

column	units	explanation
plot	categorical	Sample plot the raw data were collected from, combined into the unitname_plotnumber format because plot numbers duplicated across different replicate units.
elevation	meters	Elevation derived from a 10m resolution Digital Elevation Model. Potential range 0-infinity.
slope_percent	percent	Slope angle derived from a 10m resolution Digital Elevation Model. Potential range 0-infinity.
transformed_aspect	cosine	Aspect transformed using the equation $(\cos(45^\circ - \text{aspect}) + 1)$. Equation from (Beers et al. 1966). Potential range 0-2.
treatment	experimental_treatment	One of four experimental treatments: control, burn, thin, or thin plus burn. Also 'wildfire' for control units hit by a subsequent low severity wildfire. See protocol for more detail.
unit	replicate_unit	One of 8 individual replicate units, each approximately 10 hectares in size, each with an experimental treatment applied. See protocol for more detail.
topographic_wetness_index	index	Topographic wetness index calculated from a 10 meter digital elevation model using the RSAGA package in R. Potential range 0-10.
heat load index	index	Heat load index calculated from 10-meter digital elevation model using the spatialEco package in R. Potential range 0-1.
rlnbr	index	Relativized normalized burn index, calculated without offsets using growing season image composites analysis in Google Earth Engine (Gorelick et al. 2017) with code from (Parks et al. 2018), updated in 2021 to resolve a mistake found in the original code. Potential range -infinity-infinity.
thinning_intensity	index	Average of relativized change in basal area and relativized change in live canopy cover from pretreatment to longterm sample periods, with relativization by maximum. Potential range 0-1.

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