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## **Final Report for Joint Fire Science**

**Project title:** Archival of post-mountain pine beetle fuels and fire behavior data of south-central Oregon.

**JFSP Project ID number:** 12-4-01-8

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**Project Title:** Archival of post-mountain pine beetle fuels and fire behavior data of south-central Oregon.

**Abstract:**

We archived data from a recently completed a 3 year project funded by the Joint Fire Science Program titled “Temporal Dynamics of Ground, Surface, Ladder, and Crown Fuels and Their Potential Effects on Fire Behavior, Following *Dendroctonus ponderosae* epidemics in the *Pinus contorta* Zone of South-Central Oregon.” Additional funding for data archival provided our project additional support to document and create the appropriate metadata, and ensure data is appropriately archived into repositories such as the Forest Service Research Data Archive (FSRDA) and at Oregon State University. This project resulted in datasets containing surface and crown fuel loadings and structural measures following mountain pine beetle epidemics in south-central Oregon, as well as point-based fire behavior inputs that we used for BehavePlus 5.0 analysis. The documentation and archiving of fuels data from south-central Oregon will be extremely useful to managers on both the Deschutes and Fremont-Winema National Forests. Datasets of the temporal dynamics of post-mountain pine beetle fuels and fire behavior data from our study may be useful for future research comparisons with results from previous and current studies across western North America, as well as future meta-analyses of post-mountain pine beetle fuels, fire behavior, and forest succession.

Therefore, documentation and archival of information obtained through our current project is relevant to many future activities both locally and across multiple research and management communities.

**Background and Purpose**

We have recently completed a 3 year project funded by the Joint Fire Science Program titled “Temporal Dynamics of Ground, Surface, Ladder, and Crown Fuels and Their Potential Effects on Fire Behavior, Following *Dendroctonus ponderosae* epidemics in the *Pinus contorta* Zone of South-Central Oregon.” The purpose of this data archival project was to document and create the appropriate metadata, and ensure the project data is appropriately archived into repositories such as the Forest Service Research Data Archive (FSRDA) and at Oregon State University.

**Study Description and Location**

This project was completed at Oregon State University.

**Project Data Management for JFSP project (Project ID 09-1-06-17) titled ‘Temporal Dynamics of Ground, Surface, Ladder, and Crown Fuels and Their**

## **Potential Effects on Fire Behavior, Following *Dendroctonus ponderosae* Epidemics in the *Pinus contorta* Zone of South-Central Oregon'**

### *1. Data types*

To understand changes in fuel structure and fire behavior over time following mountain pine beetle (MPB) epidemics we have collected fuels data across a chronosequence of time since MPB epidemic initiation. Plots were selected using previously collected Aerial Detection Survey (ADS) and Plant Association Group (PAG) GIS spatial data. Once plot centers were established and GPS locations were recorded, we measured the following variables. On an 8.92 m radius plot we collected variables regarding live and dead tree (> 5 cm DBH) structure (e.g., height, DBH) and canopy structure (e.g., canopy base height, dwarf mistletoe rating). Using 4 - 25 m transects we used Brown's line intercept method to collect data on 1, 10, 100, and 1,000 hour fuels, as well as litter, duff, and overall fuel depth. The first 8.92 m of these transects was also used to determine overstory (taller than 1.37 m) canopy cover (%) for upper, middle, and lower canopy using line intercept methodology.

Photographs of fuel structure (surface/ladder) were also taken along each of the four fuel transects. An additional photograph was taken of the canopy above plot center. On four 3.2 m radius subplots all tree regeneration (< 5 cm DBH) and shrubs were measured for height and either basal diameter or crown dimensions (some shrub species) to determine biomass. Within each of these subplots a 2x2 meter subplot was used to measure % ground cover of fuels types and vegetation (herbaceous and shrubby) % cover. In the center of each of these subplots, canopy cover was collected using a convex spherical densiometer.

### *2. Quality Assurance*

During data collection, data was proofed initially following the completion of each plot. This was done to assure no data points were missing and the data that was collected for certain measures (e.g., % vegetation cover) was logical. If errors were found, data collection was re-checked and corrections were made. Once data was collected, all data was entered by hand into Microsoft Excel spreadsheets. This was done twice by independent data entry technicians. These separate data entries were then cross-referenced in both SAS9.2, and in Microsoft Excel using separate cross-checking methods. Data entry errors were corrected by referencing original datasheets from the field. Following cross-reference procedures, the distribution of each variable within the dataset was graphed and inspected for outliers or anomalies.

### *3. Data Access*

There is no sensitive data associated with this project. We are making the data public immediately, as we hope it could be helpful in managing fire on the Deschutes and Freemont-Winema National Forests.

#### *4. Storage and Backup*

Data is currently being stored on Oregon State University College of Forestry (COF) servers, and external USB drives that are stored off-site for additional protection. In addition, COF servers are backed up nightly and back-up tapes are readily available to restore data following loss of original data. Data has been transferred to Forest Service Research Data Archive (FSRDA) with the intention of being made immediately accessible to the public.

### **Long-Term Data Management**

#### *1. Metadata*

We plan used the metadata language used by the Forest Science Data Bank (FSDB; <http://andrewsforest.oregonstate.edu/lter/data/metadata.cfm?topnav=115>) metadata guide which is consistent with both the Ecological Metadata Language (EML) and the Federal Geographic Data Committee (FGDC) Biological Data Profile. We used the program Metavist to create metadata following these guidelines. Images were documented with a title, description, photographer, date, and are geo-referenced.

#### *2. Data Repository*

We used the JFSP recommended repository Forest Service Research Data Archive (FSRDA), and the data archive at Oregon State University for long-term storage of this data.

#### *3. Data Access*

We have archived our data in FSRDA. Our research datasets and documentation will be “open access” to encourage re-use of the data, or for use of the data in active fire management.

### **Data Archival for JFSP project (Project ID 09-1-06-17) titled ‘Temporal Dynamics of Ground, Surface, Ladder, and Crown Fuels and Their Potential Effects on Fire Behavior, Following *Dendroctonus ponderosae* epidemics in the *Pinus contorta* Zone of South-Central Oregon’**

#### *1. Description of Datasets*

Plot-level fuels and stand structure datasets

(See Table 1 for information on all variables and scale and resolution of each dataset)

a) PLOT DATA – Includes attributes that describe plot locations (UTM coordinates), identification of personnel measuring and recording data, and plot level descriptors (e.g., aspect, slope, ladder fuel types and continuity, general plot scale comments).

- b) PHOTOS – Includes both a spreadsheet that links photograph identification number to the plot and transect that photograph is associated with, and digital files of the photographs themselves.
- c) TREE DATA – Includes attributes of live and dead trees greater than or equal to 5.0 cm diameter at breast height (DBH). Tree level measurements include species, crown class, vigor rating, DBH, height, height to crown base, decay class (if dead) and dwarf mistletoe rating (if live).
- d) CANOPY – Includes attributes that describe live and dead (i.e. red or brown) canopy cover using a line intercept method. Canopy measurements include intercepts and total canopy cover by canopy layer (i.e. Upper, Mid, Lower).
- e) SURFACE FUELS (FINE and COARSE) – Includes attributes from Brown’s line transect method for 1, 10, 100, and 1,000 hour fuels. Fine fuel attributes include piece counts for 1, 10, and 100 hour fuels. Coarse fuel attributes include piece diameter, species, decay class, and count for 1,000 hour fuels.
- f) LITTER/DUFF/FUEL DEPTH –Includes attributes of litter, duff, and particle intercept (litter – 100 hour depth of fuel using a line intercept method) depths.
- g) GROUND COVER – Includes attributes of percent ground cover estimates of bare soil or rock, wood, litter, tree bole, total vegetation, and dead shrub.
- h) HERBACEOUS VEGETATION– Includes attributes of species, species code, and percent cover for all herbaceous, shrub, and tree species.
- i) SHRUBS – Includes attributes to estimate shrub density and biomass by species. Shrub measurements include species, species code, varying measurements to estimate shrub biomass (e.g., basal diameters, crown dimensions), estimate type, and stem count.
- j) SEEDLINGS/SAPLINGS – Includes attributes of species, species code, height, basal diameter, and # of stems of tree saplings (<5.0 cm DBH) and seedlings (<40 cm in height).
- k) DENSIOMETER – Includes attributes of point estimates of canopy cover from a spherical densiometer method.

#### Fire behavior modeling input datasets

(See Table 2 for information on all variables and scale and resolution of each dataset)

- a) FUEL MOISTURE/WIND – Includes attributes of dead fuel moisture of extinction, live and dead fuel heat content, 1, 10, and 100 hour fuel moisture, live herbaceous moisture, live woody moisture, foliar moisture, 20 foot wind speed and wind adjustment factor used in BehavePlus fire behavior modeling runs for various wind and fuel moisture scenarios.
- b) CANOPY FUELS – Includes plot-level attributes of canopy bulk density, canopy base height, available canopy fuel, total canopy weight, stand height, canopy cover, live basal area and stand density. The variables were estimated from measured stand structure and fuels variables using the program FuelCalc and were used in fire behavior modeling runs in BehavePlus.
- c) SURFACE FUELS – Includes means, medians, standard deviations, 25<sup>th</sup> and 75<sup>th</sup> percentiles of plot-level surface fuel loading attributes by time since beetle (years) and

stage (categorical grouping of years). Surface fuel attributes include 1, 10, 100, and 1000 hour fuel loadings, litter, duff, and live woody loadings, fuel bed depth, live vegetation mass, overstory cover, live and dead basal area, canopy bulk density, and canopy base height. The variables were estimated from measured stand structure and fuels variables using biomass equations and were used in fire behavior modeling runs in BehavePlus.

### **Quality Assurance Procedures**

During data collection, data was initially proofed following the completion of each plot. This was done to assure no data points were missing and the data that was collected for certain measures (e.g., % vegetation cover) was logical. If errors were found, data collection was re-checked and corrections were made. Once data was collected, all data was entered by hand into Microsoft Excel spreadsheets. This was done twice by independent data entry technicians. These separate data entries were then cross-referenced in both SAS9.2, and in Microsoft Excel using separate cross-checking methods. Data entry errors were corrected by referencing original datasheets from the field. Following cross-reference procedures, the distribution of each variable within the dataset was graphed and inspected for outliers or anomalies.

### **Management Implications**

To date, our dataset is the only source of information regarding fuel loading following MPB epidemics in south-central Oregon. This provides valuable contributions to future scientific endeavors by providing a comparison dataset to the many datasets being collected in the Intermountain west, particularly the Northern Rocky Mountains and British Columbia. In addition, meta-analyses of forest structure of lodgepole pine forests post-mountain pine beetle will become very important in furthering our understanding of fuel succession and developing/implementing both fire behavior and MPB modeling approaches in the future.

We feel that this data may be useful to forest fire managers who are managing a fire in the lodgepole pine type of the Deschutes and Fremont-Winema National Forests. The value of this dataset for future management applications such as fuels reduction planning, specifically to the managers in south-central Oregon, is unparalleled. Given the support of both the Deschutes and Fremont-Winema National Forest Supervisors (see attached original support letter) to acquire this type of data, this dataset will provide extremely relevant information regarding future projects in zones of past and current MPB epidemics.

### **Relationship to Other Findings**

This is a data archival project and relationship to other findings is not applicable.

### **Future Work Needed**

Future work is always needed to have better or more extensive data, but this is a data archival project in which we fully archived our datasets.

### **Deliverables**

The deliverables for this project include the metadata, the database, and associated photographs of all plot locations from our original post-mountain pine beetle fuels and fire behavior study. See Tables 1 and 2 for specific attributes contained in the datasets.

**Table 1.** List of attributes associated with the different datasets collected in the field, their spatial scale and resolution, and whether they are numerical or categorical variables. All datasets have variables indicating Site and Plot identification.

<b>Data Set</b>	<b>Attribute(s)</b>	<b>Scale</b>	<b>Type</b>	<b>Resolution</b>
PLOT DATA	UTM Coordinates	Point	Numerical	1 m
	Aspect (°)	Point	Numerical	1°
	Slope (%)	0.025 ha	Numerical	1%
	Physiographic Code	NA	Categorical	NA
	Fuel Continuity (Y/N)	0.0625 ha	Categorical	NA
	Ladder Fuel Type	0.0625 ha	Categorical	NA
	MM/DD/YYYY	NA	Numerical	NA
	Personnel	NA	Categorical	NA
Comments	NA	Categorical	NA	
PHOTOS	Transect	NA	Categorical	NA
	PHOTO-ID	NA	Categorical	NA
	Comments	NA	Numerical	NA
TREE DATA	Species	Tree	Categorical	NA
	Status	Tree	Categorical	NA
	Vigor Rating (Healthy, Unhealthy, Dying)	Tree	Categorical	NA
	Crown Class (Dominant, Co-dominant, Intermediate, Suppressed)	Tree	Categorical	NA
	DBH (cm)	Tree	Numerical	0.1 cm
	Height (m)	Tree	Numerical	0.1 m
	Height to Crown Base (m)	Tree	Numerical	0.1 m
	Dwarf Mistletoe Rating (Upper, Middle, Lower crown thirds)	Tree	Categorical	NA
	Decay Class (1-5)	Tree	Categorical	NA
Crown Status (Green, Red, Brown, Needleless)	Tree	Categorical	NA	
Comments	NA	Categorical	NA	
CANOPY	Canopy Layer (Lower, Middle, Upper)	100 m trans.	Categorical	NA
	Transect	NA	Categorical	NA
	Start of canopy along transect (m)	100 m trans.	Numerical	0.01 m
	End of canopy along transect (m)	100 m trans.	Numerical	0.01 m
	Crown Status (Green, Red, Brown)	100 m trans.	Categorical	NA
Comments	NA	Categorical	NA	
SURFACE FUELS-FINE	Transect	NA	Categorical	NA
	Fuel Class (1, 10, 100 hour)	Piece	Categorical	NA
	Fine fuel type (down wood, dead shrub, low branches)	Piece	Categorical	NA
	Piece count	100 m trans.	Numerical	1
	Comments	NA	Categorical	NA
SURFACE FUELS-COARSE	Transect	NA	Categorical	NA
	Fuel Class (1000 hour)	Piece	Categorical	NA
	Species	Piece	Categorical	NA
	Piece count	100 m trans.	Numerical	1
	Decay Class (1-5)	Piece	Categorical	NA
	Diameter (cm)	Piece	Numerical	0.1 cm
Comments	NA	Categorical	NA	

Table 1 (continued).

<b>Data Set</b>	<b>Attribute(s)</b>	<b>Scale</b>	<b>Type</b>	<b>Resolution</b>
LITTER/DUFF/FUEL DEPTH	Transect Type (Litter, Duff, Fuel Intercept) Depth (cm) at 10 cm from plot center along transect Depth (cm) at 20 cm from plot center along transect Comments	NA NA Point Point NA	Categorical Categorical Numerical Numerical Categorical	NA NA 0.1 cm 0.1 cm NA
GROUND COVER	Subplot (NE, SE, SW, NW) Bare cover (%) Wood cover (%) Tree bole cover (%) Litter cover (%) Live vegetation cover (%) Dead shrub cover (%) Comments	NA 2 m <sup>2</sup> 2 m <sup>2</sup> 2 m <sup>2</sup> 2 m <sup>2</sup> 2 m <sup>2</sup> 2 m <sup>2</sup> NA	Categorical Numerical Numerical Numerical Numerical Numerical Numerical Categorical	NA 0.1% 0.1% 0.1% 0.1% 0.1% 0.1% NA
HERBACEOUS VEGETATION	Subplot (NE, SE, SW, NW) Species Species code Type (cover, count) Cover estimate by species (%) Comments	NA Herb Herb Herb 2 m <sup>2</sup> NA	Categorical Categorical Categorical Categorical Numerical Categorical	NA NA NA NA 0.1% NA
SHRUBS	Subplot (NE, SE, SW, NW) Species Species code Type (cover, count) Basal diameter (mm) Crown length (cm) Crown width (cm) Average maximum height (cm) Shrub stem count by species Comments	NA Shrub Shrub Shrub Stem Shrub Shrub Shrub 32.15 m <sup>2</sup> NA	Categorical Categorical Categorical Categorical Numerical Numerical Numerical Numerical Numerical Categorical	NA NA NA NA 1 mm 1 cm 1 cm 1 cm 1 NA
SEEDLINGS/SAPLINGS	Subplot (NE, SE, SW, NW) Species Species code Basal diameter (mm) Height (cm) Stem count by species and size Comments	NA Shrub Shrub Seedling/Sapling Seedling/Sapling 32.15 m <sup>2</sup> NA	Categorical Categorical Categorical Numerical Numerical Numerical Categorical	NA NA NA 1 mm 1 cm 1 NA
DENSIOMETER	Subplot (NE, SE, SW, NW) Azimuth (N, E, S, W) Canopy cover as estimated with densitometer (0-17) Comments	NA NA Point NA	Categorical Categorical Numerical Categorical	NA NA 1 NA

**Table 2.** List of attributes associated with the different datasets created as fire behavior modeling inputs for use in the program BehavePlus, their spatial scale and resolution, and whether they are numerical or categorical variables. For surface fuels, the data file contains a separate attribute for the mean, median, standard deviation, 25<sup>th</sup> and 75<sup>th</sup> percentile of each attribute listed below.

<b>Data Set</b>	<b>Attribute(s)</b>	<b>Scale</b>	<b>Type</b>	<b>Resolution</b>
FUEL MOISTURE/WIND	Fuel Scenario (Dry, Moderate)	NA	Categorical	NA
	Wind Scenario (High, Low)	NA	Categorical	NA
	Dead fuel moisture of extinction (%)	Point	Numerical	1%
	Dead fuel heat content (kJ/kg)	Point	Numerical	0.001 kJ/kg
	Live fuel heat content (kJ/kg)	Point	Numerical	0.001 kJ/kg
	1 hour fuel moisture (%)	Point	Numerical	1%
	10 hour fuel moisture (%)	Point	Numerical	1%
	100 hour fuel moisture (%)	Point	Numerical	1%
	Live herbaceous moisture (%)	Point	Numerical	1%
	Live woody moisture (%)	Point	Numerical	1%
	Foliar moisture (%)	Point	Numerical	1%
	20 foot wind speed (km/h)	Point	Numerical	0.01 km/h
	Wind adjustment factor	Point	Numerical	0.1
CANOPY FUELS	Year of the beginning of previous MPB epidemic (years)	NA	Numerical	1 year
	Productivity category of site (low, moderate, high)	NA	Categorical	NA
	Plot replicate (1, 2, 3, 4)	NA	Categorical	NA
	Canopy bulk density, calculated in FuelCalc (kg/m <sup>3</sup> )	0.025 ha	Numerical	0.01 kg/m <sup>3</sup>
	Available canopy fuel, calculated in FuelCalc (kg/m <sup>2</sup> )	0.025 ha	Numerical	0.01 kg/m <sup>2</sup>
	Total canopy weight, calculated in FuelCalc (kg/m <sup>2</sup> )	0.025 ha	Numerical	0.01 kg/m <sup>2</sup>
	Canopy base height, calculated in FuelCalc (m)	0.025 ha	Numerical	0.1 m
	Stand height, calculated in FuelCalc (m)	0.025 ha	Numerical	0.1 m
	Canopy cover, calculated in FuelCalc (%)	0.025 ha	Numerical	0.01 %
	Live basal area, calculated in FuelCalc (m <sup>2</sup> /ha)	1 ha	Numerical	0.01 m <sup>2</sup> /acre
Live stand density, calculated in FuelCalc (tph)	1 ha	Numerical	1 tph	
SURFACE FUELS	Time since beginning of previous MPB epidemic (years)	NA	Numerical	1 year
	1 hour fuel loading (Mg/ha)	Point	Numerical	0.1 Mg/ha
	10 hour fuel loading (Mg/ha)	Point	Numerical	0.1 Mg/ha
	100 hour fuel loading (Mg/ha)	Point	Numerical	0.1 Mg/ha
	Coarse fuel loading (Mg/ha)	Point	Numerical	0.1 Mg/ha
	Litter loading (Mg/ha)	Point	Numerical	0.1 Mg/ha
	Duff loading (Mg/ha)	Point	Numerical	0.1 Mg/ha
	Live woody fuel loading (Mg/ha)	Point	Numerical	0.1 Mg/ha
	Fuel bed depth (m)	Point	Numerical	0.01 m
	Live vegetation loading (Mg/ha)	Point	Numerical	0.1 Mg/ha
	Overstory cover (%)	Point	Numerical	1%
	Live basal area (m <sup>2</sup> /ha)	Point	Numerical	0.1 m <sup>2</sup> /ha
	Dead basal area (m <sup>2</sup> /ha)	Point	Numerical	0.1 m <sup>2</sup> /ha
	Canopy bulk density (kg/m <sup>3</sup> )	Point	Numerical	0.01 kg/m <sup>3</sup>
Canopy base height (m)	Point	Numerical	0.1 m	