fire and fuel specialists in these areas felt that the fire behavior under these conditions could only be described by slash models, but these situations are relatively rare.

Canopy Base Height and Bulk Density—Examples of the relationships developed during the canopy fuels regression tree analysis are shown in figures 5 and 6. Figures 5 and 6 indicate CBD estimates above 0.4 and CBH estimates above approximately 6 meters are probably not reliable. In general there are not enough plots with large values of CBD or CBH to make a reliable and stable regression tree above these values.

There is an inverse relationship between canopy cover and bulk density in some mapping zones but only in areas of extremely high CC. This non-linear relationship typically only occurs in stands with relatively high CH. This follows the pattern observed in the plot level estimates of CBD and CC (fig. 3). Figure 3 clearly shows two distinct relationships between CBD and CC; one for tall trees and one for short trees.

In comparison to CBD, CBH is more difficult to interpret, map and identify using field based reconnaissance. This is because CBH is more abstract and is not a definitively measurable feature of a stand. Thus, few techniques exist that can be used to asses the true accuracy of these estimates in LANDFIRE data. This is one primary reason for creating the expert system derived CBH estimates. Examples of these expert system estimates are shown in table 2.

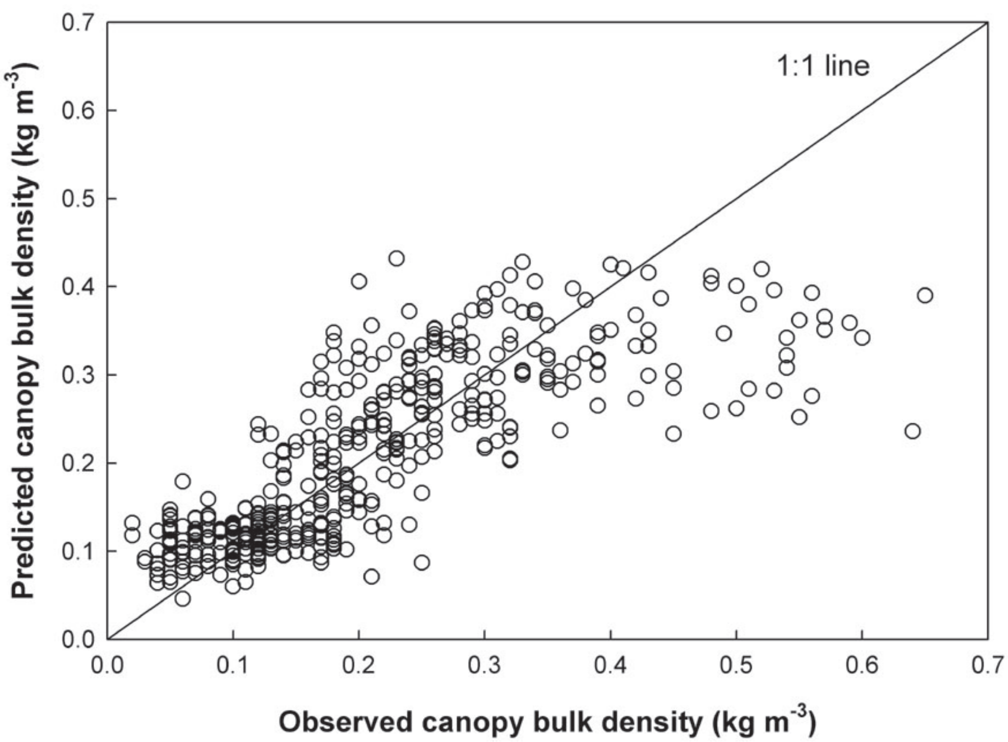

Figure 5—Predicted and observed canopy bulk density (kg m^{-3}) resulting from a regression tree analysis for Mapping Zone 12. Note the asymptotic feature beginning at approximately 0.4 kg m^{-3}.

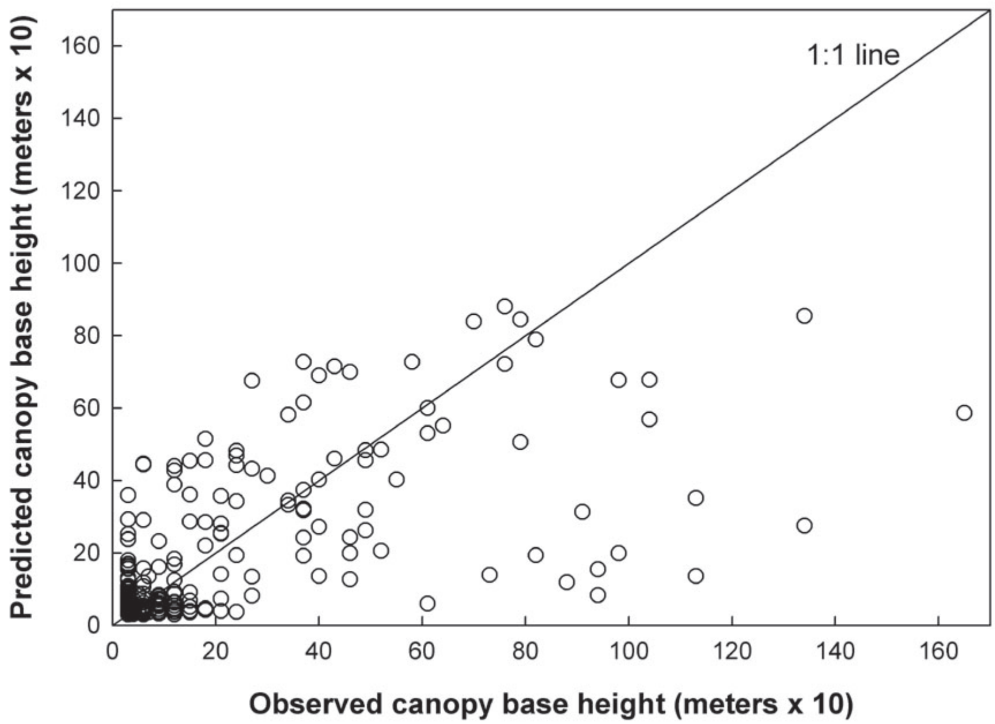

Figure 6—Predicted and observed canopy base height (m) resulting from a regression tree analysis for Mapping Zone 23. Predictions above approximately 6.0 meters are unreliable.

Table 2—Canopy base heights computed using an analytical spreadsheet informed through an expert system. Note that each fuelbed has both Anderson (1982) (FBFM13) and Scott and Burgan (2005) (FBFM40) fuel models. The environmental criteria for this analysis are as follows: fine dead fuel moistures (1,10 and 100 hr time lag fuels) are 4,5 and 6% moisture content respectively; 20 ft. wind speed was estimated as 20 mph.

EVT	Cover	Ht	ESP[1]	FBFM13	FBFM40	CBH13[2]	CBH40[3]
	(%)	*(m)*				- - - - - - *(m)*	- - - - - -
Northern Rocky Mountain Ponderosa Pine Woodland and Savannah							
	≥50	≥ 5	Any	9	TU5	0.29	.71
	< 50	≥ 5	Any	2	TU3	0.075	2.33
	Any	< 5	Any	6	GS2	N/A	N/A
Rocky Mountain Subalpine Mesic Spruce-Fir Forest and Woodland							
	≥ 50	≥ 5	Any	10	TU5	0.34	1
	30 - 49	≥ 5	Any	8	TU1	0.25	0.23
	< 30	< 5	Any	5	SH4	N/A	N/A

[1] ESP is Environmental Site Potential.
[2] Canopy base heights formulated using the Anderson (1982) fuel model.
[3] Canopy base heights formulated using the Scott and Burgan (2005) fuel model.

Use and Limitations of LANDFIRE Fuels Data

The LANDFIRE fuels data layers can be used for applications at varying scales, including project level planning (for example, < 5000 acres), particularly when higher resolution data are lacking. These data are particularly well suited for comparative analyses within and between regions. Thus, it is the responsibility of the user to determine the appropriate scale and usefulness of LANDFIRE fuels data. These fuels layers span all ownerships, a trait not likely to be found in other fuels data sets. These layers are expected to form the baseline data for interagency planning, while local datasets, which cost more and take longer to produce can be used in place of, or in addition to, LANDFIRE data. However, because of their objective and comprehensive nature LANDFIRE data can be used efficiently for such activities as strategic fuels reduction plans, tactical fire behavior assessment and estimating fire effects. These fuels data are the first of their kind because they will seamlessly cover the nation. Any project with this scope will have tradeoffs between quantity and quality. As a result, there is a need for further research for improving the quality of these layers and for assessing their true efficacy. To meet this need we recommend cohesive, scientific, interagency assessments of LANDFIRE fuels data.

Summary

This paper provides a general overview of the LANDFIRE fuels mapping procedures and highlights their interdependency on multiple data sources including other LANDFIRE layers. Fire behavior fuel models are linked with vegetation type and structural attributes based on rulesets devised by local fire and fuel experts. In turn, the spatial expression of these rulesets is evaluated and critiqued in a series of local calibration efforts. Canopy fuels are mapped using predictive landscape modeling by relating a multitude of predictor variables to CBH and CBD in regression trees. These regression trees are subsequently applied across the landscape. Given the nebulous nature of CBH and the dependence on this variable by fire behavior processors, we have devised a strategy to map canopy base height across the landscape using an expert system approach. At national and regional scales LANDFIRE will provide valuable insight for modelers, fire scientists and managers. Finally, we recognize the need for cohesive efforts to assess the efficacy of all LANDFIRE fuels data and hope to initiate this process in the future.

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