

TITLE: Multi-scale modeling and mapping coarse woody debris

LOCATION: North Central Region

DURATION: 2 years

FUNDING SOURCE: Fire Plan EM

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PROJECT OBJECTIVES:

1. Develop generalized plot-level and stand-level statistical/computer models to quantify coarse woody debris (CWD) using plot and site factors.
2. Develop a system of predictive models applicable for multiple spatial scales (from 1 ha up to approximately 100 ha in extent) and identify estimation/prediction accuracy associated with each spatial scale. (Note: See *Background* material below. For forest components such as CWD that are highly variable among plots, models predicting CWD on areas larger than a single plot or stand can perform better than models based on individual plots and often have other advantages.)
3. Evaluate the use of ensembles of models to predict CWD.
4. Apply the models in conjunction with FIA/FHM plots and other sources of data to map CWD for selected subregions in Missouri. Missouri sites serve as a prototype to calibrate and test a general approach suitable for eastern forests.
5. Compare data and predictions to values for other published CWD inventories in the Midwest.

JUSTIFICATION: Coarse woody debris is a key component in fuel loading and fire modeling as well as for wildlife habitat evaluation. The ability to use modeling to extend the utility of the limited amount of available coarse woody debris data will aid in the management of fire, fuels and wildlife habitat.

DESCRIPTION:**a. Background:**

FIA/FHM programs provide important data that have been used to map dead and down woody material for multi-state regions (McRoberts et al. 2004). The dead and down woody material maps generated based on FIA/FHM plots are too coarse to describe variation at small spatial scales because of the low sampling intensity (about 1 Phase 2 and Phase 3 plot per 2,500 and 40,000 ha, respectively). The resultant maps are, therefore, insufficient for regional resource management and planning to evaluate fire risk or wildlife habitat suitability (e.g., at the scale of a national forest or other sub-state region). Generally, dead and down woody material is relatively scarce and varies dramatically at small spatial scales such as plots/stands, even when the plots/stands are similar in many other respects (Shifley and Schlesinger 1994). This is due to the spatially stochastic nature of disturbance agents (Shifley et al. 2000) and the resultant tree mortality and decay process. Research on other rare components of the forest such as cavity trees have indicated rare forest components are predictable within a tolerable range of errors at relatively small spatial scales (e.g. 20 ha blocks) using stand and site factors, and the prediction/estimation error may be reduced significantly by employing an ensemble of related models rather individual component models (e.g., simple linear regression models) (Hensen and Salamon 1990, Breiman 1996, Lee 1999, Fan et al. 2004a, 2004b). The scale-dependent statistical/computer models and ensembles of predictive models can be developed by using boot-strapping techniques to combine groups of FHM plots and create virtual landscapes of various sizes where the CWD characteristics are known. These can be linked with other data sources such as remote sensed imagery, GIS layers, or other sources of existing data (e.g., Shifley and Brookshire 2000) to map dead and down woody material at finer scales than previously reported for the Midwest. Other sources of CWD data for the region (Spetich et al. 1999, Shifley et al. 1997) serve as an additional benchmark against which to compare findings from FHM data.

b. Methods:

1. Use classification and regression tree (CART) and other machine learning tools to identify the hierarchical relation of dead and down woody material to the associated stand/site factors based on FIA/FHM and intensive monitoring plots (phase 3 plots).
2. Construct a statistical/computer model (e.g., probability density model) to quantify and characterize change of dead and down woody material stratified by stand and site factors identified in step 1 above.
3. Use resampling (e.g., bootstrap), ensemble modeling, and computer simulation to aggregate model results across different spatial scales (one to many hectares) to construct scale-dependent models and ensembles and evaluate the effect of scales on prediction/estimation accuracy and statistical power.
4. Integrate intensive monitoring and FIA/FHM plots to map dead and down woody material based on models applied at scales larger than the individual plot. Initial applications will be in Missouri where CWD data are relatively abundant from multiple sources. The process is generic and should be applicable throughout the eastern United States.

c. Products:

1. An identified set of hierarchical stand and site factors and/or computed composite variables statistically associated with dead and down woody material. (year 1)
2. A set of statistical/computer models applicable for estimating CWD at multiple spatial scales. (year 1)
3. Dead and down woody material maps for Missouri based on models or ensembles applied at different scales. These also serve as prototypes for extension of the methods to other geographic regions. (year 2)

d. Schedule of Activities: (Based on elapsed time from date of award)

Year 1:

Month 1 to 6: Exploratory data analysis to identify down and dead woody material pattern and associated stand/site factors.

Month 7 to 10: Develop confirmatory statistical/computer models.

Month 11 to 12: Model evaluation and quantify prediction accuracy across scales

Year 2:

Month 1 to 6: GIS work and generate dead and down woody material maps at appropriate scales based on current FIA/FHM and intensive monitoring plots

Month 7 to 9 Simulate down and dead woody material change under management alternatives

e. Progress/Accomplishments: Not applicable, this is a new proposal.**COSTS:**

	Item	Requested FHM EM Funding	Other-Source Funding	Source
YEAR 1				
Administration	Salary and Benefits (Fan)	\$45,000	\$25,000	Contributed salary and benefits for P.I. and cooperators
	Travel	\$800	\$2,000	Contributed travel for P.I. and cooperators
Procurements	Contracting			
	Equipment			
	Supplies	\$ 300		
YEAR 2				
Administration	Salary and Benefits (Fan)	\$39,000	\$27,000	Contributed salary and benefits for P.I. and cooperators
	Travel	\$1,000	\$2,000	Contributed travel for P.I. and cooperators
Procurements	Contracting			
	Equipment			
	Supplies	\$500		
Total direct cost				
F & A	Overhead (19.2%)	\$16,627		
Total request		\$103,227		

Literature Cited

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