

Estimating Down Woody Materials in the Eastern U.S. From FIA Data



David C. Chojnacky and Stephen P. Prisley

Virginia Tech, Department of Forestry, Blacksburg, VA, U.S.A.

Introduction

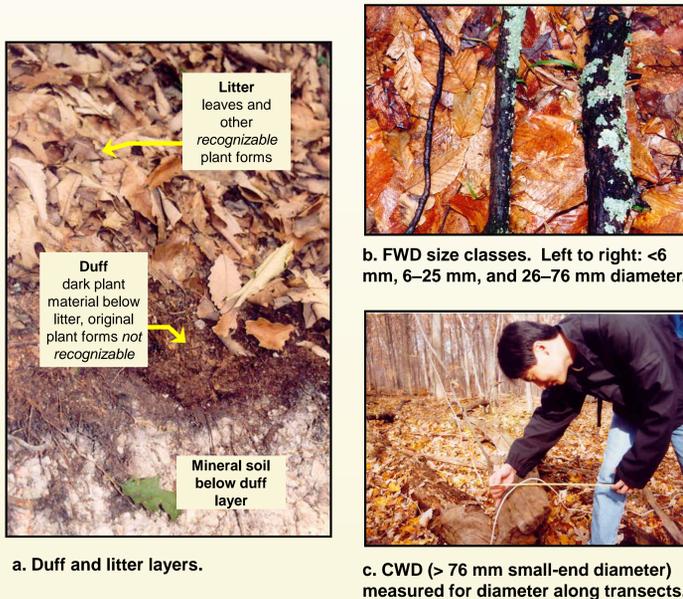
Down woody materials (DWM; Figure 1) include

- soil organic layers of duff and litter
- dead and down fine and coarse woody detritus (FWD, CWD)
 - CWD is >76 mm diameter
 - FWD has 3 diameter-size classes: <6, 6–25, and 26–76 mm
- live and dead understory vegetation

DWM are important for carbon storage in the forest floor, organism habitat, and decomposing materials critical for nutrient cycling. They are key components of fire fuels. Accurate estimates of DWM are important for assessments of fire risk, fuel loading, etc.

The USDA Forest Service, Forest Inventory and Analysis (FIA) Program samples DWM on a subsample of plots covering all U.S. forests regardless of ownership, but these data are not very useful in their raw form as posted in the FIA database (FIADB 3.0; FIA 2008). Therefore, we used FIA field (P2 plots) and DWM sample data (P3 subsamples on 1/16th of P2 plots) to model mass and carbon of DWM components in eastern U.S. forests based on available FIA and auxiliary climate variables.

Our objective is to produce methods for calculating dry-weight mass and carbon for CWD, FWD, duff, litter, and understory vegetation using models based on P2 variables. These models can then be used with FIA plots in the eastern United States where DWM are not measured.



References

- Brown, J.K. 1974. Handbook for inventorying downed woody material. GTR INT-16. U.S. Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station, Ogden, UT, 34 pp.
- Chojnacky, D.C.; Mickler, R.A.; Heath, L.S.; Woodall, C.W. 2004. Estimates of down woody materials in eastern U. S. forests. Environmental Management 33: (Supplement 1): S44-S55
- Chojnacky, D.C.; Amacher, M.C.; Gavazzi, M.J. [in press 2009]. Separating duff and litter for improved mass and carbon estimates. Southern Journal of Applied Forestry.
- Cleland, D.T., Freeof, J.A.; Keys, J.E., Jr.; Nowacki, G.J.; Carpenter, C.; McNaab, W.H. 2007. Ecological subregions: Sections and subsections of the conterminous United States. [1:3,500,000] [CD-ROM]. Sloan, A.M., cartog. Gen.Tech. Report WO-76. Washington, DC: U.S. Department of Agriculture, Forest Service.
- FIA 2008. Download data for all states combined. FIA DataMart. FIADB version 3.0. <http://fiatools.fs.fed.us/fiadb-downloads/fiadb3.html>
- Woodall, C.W., and V.J. Monleon. 2008. Sample protocol, estimation, and analysis procedures for the down woody materials indicator of the FIA program. USDA For. Serv. Gen. Tech. Rep. NRS-22. 68 p.

Data Collection and Modeling Methods

FIA Data Compilation

- Downloaded all FIA DWM data for 1998–2007 (FIA 2008).
- Over 3,000 plots were available for analysis (Figure 2). We omitted western Texas mesquite and juniper woodlands and western plains pine and mixed conifer plots; data from these were different from those in the rest of the East and therefore more appropriately analyzed with other western U.S. FIA data.
- Calculated mass for DWM components, using Brown's (1974) transect methodology as updated by Woodall and Monleon (2008). However, we used duff and litter density factors from mid-Atlantic work we did (Chojnacky et al. in press) instead of Woodall and Monleon (2008) because the latter would have nearly doubled duff and litter estimates; these already seemed high for some northern states. Understory conversion factors were taken from our previous work (Chojnacky et al. 2004).



DWM also include understory shrubs and herbs.

Modeling

Previous work (Chojnacky et al. 2004):

- Initial models parameterized with 2001 and 2002 DWM data.
- Initial model results affected by many data issues including data inconsistency and inadequate database linkage to P2 data.

Current study (updating previous work):

- Full suite of FIA data available for all DWM plots; all P2 data now linked for easy access in FIADB 3.0 database to newly available P3 data (FIA 2008).
- Computed over 100 variable combinations for describing stand structure and species composition for live/dead trees of various size classes for oak, maple, pine, and other hardwood/conifer species groups from basal area, tree density, and quadratic mean diameter metrics. Also accounted for stand age and indicator variables such as recent cutting, public lands, physiographic site, forest type groups, plantation site, etc.
- Instead of modeling the entire eastern United States with a single model for each DWM component, used the additional data available to construct models that applied within ecoregion provinces (Cleland et al. 2007).
- Step-wise regression used to select approximately 5 variables to model mass prediction of each DWM component; models then used to estimate DWM for each P2 FIA plot.
- DWM accumulation process is difficult to model because it is not only regulated by inputs from live trees but also controlled by human removal actions, periodic disturbance events (fire, insect, disease, storms), and decay rates that respond to temperature and moisture.

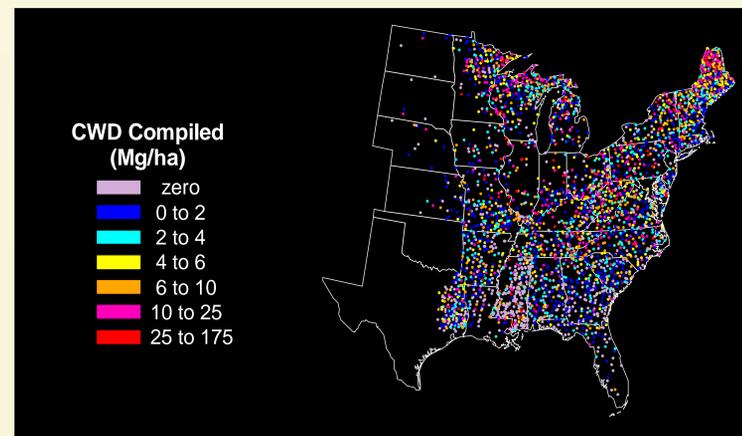


Figure 2. Compiled CWD data for 3,063 plots. The map shows much heterogeneity in plot-to-plot data with some trend of greater amounts in the north.

Results and Discussion—CWD Component

Modeling within Ecoregion Province (Figure 3)

- Only CWD modeling in progress to date.
- R² -statistics for the 11 province-scale models 0.12–0.80; median = 0.28.
- Further study of variable interactions may improve models.
- 25% of plots had no CWD; might need a 2-step process to estimate probability of CWD occurring on plot followed by estimate of CWD amount.
- Models appear useful for estimation of CWD at regional scales where predictions for groups of FIA plots would be averaged.

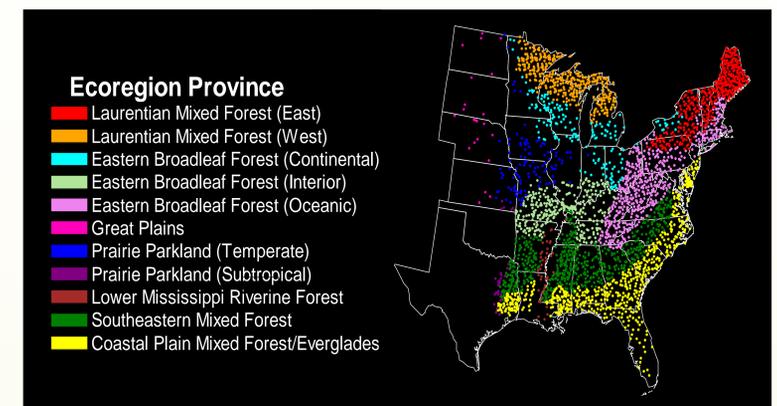
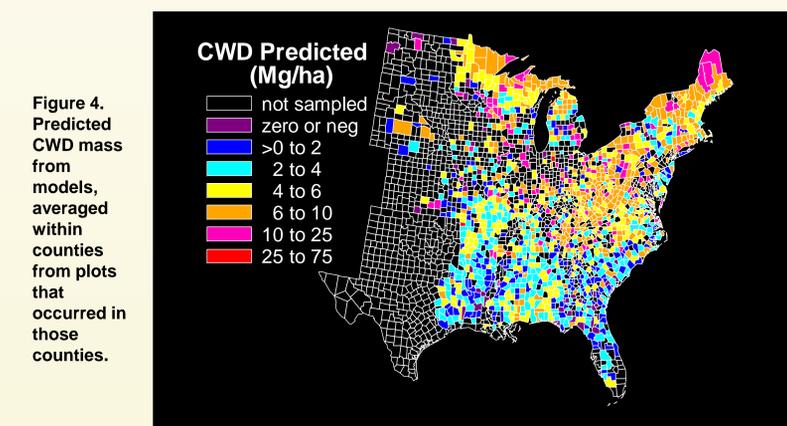


Figure 3. CWD plots within Ecoregion Provinces. Separate CWD models were fit within 11 Ecoregion Provinces in the eastern U.S.A. Sample sizes ranged from 22 plots in Great Plains to 575 in Outer Coastal Plain Mixed Forest.

Modeling results averaged by county (Figure 4)

- Results best suited for averaging across areas such as counties.
- Trends predicted by CWD model appear reasonable in terms of spatial pattern: no abrupt boundaries, more CWD in the north as would be expected from comparison to figure 2 compiled plot data.



Summary and Conclusions

- Estimates of down woody materials are vital for forest managers, given the importance of DWM for carbon storage, forest health, and fuel loads. But DWM estimates are difficult to obtain from FIA data—which is posted only as raw data measurements for only 1/16^h subsample of plots.
- We used FIA P2 field and P3 DWM subsampled data to model mass and carbon of DWM components in eastern U.S. forests based on available FIA and auxiliary climate variables.
- CWD component models appear useful for regional-scale CWD estimates.
- Preliminary results suggest we will be able to produce models for estimating dry-weight mass and carbon of DWM components. These models can then be used with eastern U.S. FIA plots where DWM are not measured.