AN ASSESSMENT OF COARSE WOODY DEBRIS DYNAMICS IN AN URBAN FOREST

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Abstract—Determining the amount of coarse woody debris (CWD) in an urban forest is essential to developing management strategies to maintain ecosystem function while minimizing hazards to local residents. It is also an essential variable used for the assessment and monitoring of carbon dynamics and fire fuel loads in forests. Plots were established and CWD measured in Marshall Forest, an approximately 300 acre urban forest in Rome, GA, managed by the Nature Conservancy, to determine the amount and the spatial distribution of CWD. The volume of CWD is 863 ft^3/ac and has a carbon content of 9.1 tons/ac and varies in its distribution throughout the forest. This area contains a large amount of debris that, while serving local wildlife, could pose a hazard for wildfire that could spread to adjacent neighborhoods. Forest managers should be aware of CWD levels and take steps to mitigate hazards.

INTRODUCTION

Marshall Forest Preserve (MFP) is 120 ha of forested natural area in northwest Georgia dominated by old growth pine and oak. Old growth forest remnants are rare in the eastern United States and are stands with trees that are old for their species in forests with a high degree of complexity (Petruccelli and others 2014). MFP is in the city of Rome (34° 15' N, 85° 12' W) and is one of the only remaining old growth areas in city limits in eastern North America (DeSelm 1984). Commercial logging has not been reported in MFP (DeSelm 1984) however, we frequently encountered evidence of timber harvest, especially on the west side near Mount Alto. MFP was designated a National Natural Landmark by the United States government in 1966 and is currently managed by the Nature Conservancy.

MFP is dominated by shortleaf pine *(Pinus echinata)* and chestnut oak (*Quercus montana)*. In the understory, red maple (*Acer rubra)* and mockernut hickory *(Carya tomentosa)* are common, with occasional dogwood (*Cornus florida),* loblolly pine *(Pinus taeda),* and black cherry *(Prunus serotina*). There is also a small population of montane longleaf pine (*Pinus palustris*) within the forest, although none were encountered during this study.

There are no fires documented in MFP since 1920 (Petruccelli and others 2014), which is a potential cause for the lack of pine and oak regeneration, as shade tolerant species are currently common in the understory. Active suppression of fires is often implicated in the decline of pine and oak regeneration and the succession to red maple dominated understory (Abrams 1992, Nowacki and Abrams 2008). It is unlikely that fire can be used at MFP due to the highly urbanized surrounding areas.

STUDY SITE

MFP is in the southern portion of the Ridge and Valley physiographic province in the Appalachian Mountains, characterized by folded layers of sedimentary rock forming long parallel ridges of sandstone and limestone (DeSelm 1984). The study site is on Horseleg Mountain, a ridge underlain by Armuchee chert and Conasauga shale (DeSelm 1984). Soil is shallow, well-drained silty loam formed from shale (Web soil survey 2010) and elevations range from 200-300 m (656 – 984 feet). The study area has a humid continental climate with mild winters and hot summers. Mean monthly temperatures range from 5° C (41° F) in January to 25° C (77° F) in July. Mean annual precipitation is approximately 1100 mm (43 inches) evenly distributed throughout the year (PRISM 2015).

METHODS

We randomly generated 30 plots within the boundaries of MFP using ArcMap (fig. 1). We navigated to the plots using Global Positioning Systems (GPS) and established 24 foot (7.31 m) transects from each plot center at 30, 150, and 270° azimuths (fig. 2; Woodall and Williams 2005). We included CWD pieces in the sample if the centerline intersected any of the three 24 foot transects emanating from the center of each plot at azimuths of 30, 150, and 270° (fig 2). CWD includes dead and downed pieces or portions of pieces of wood that have

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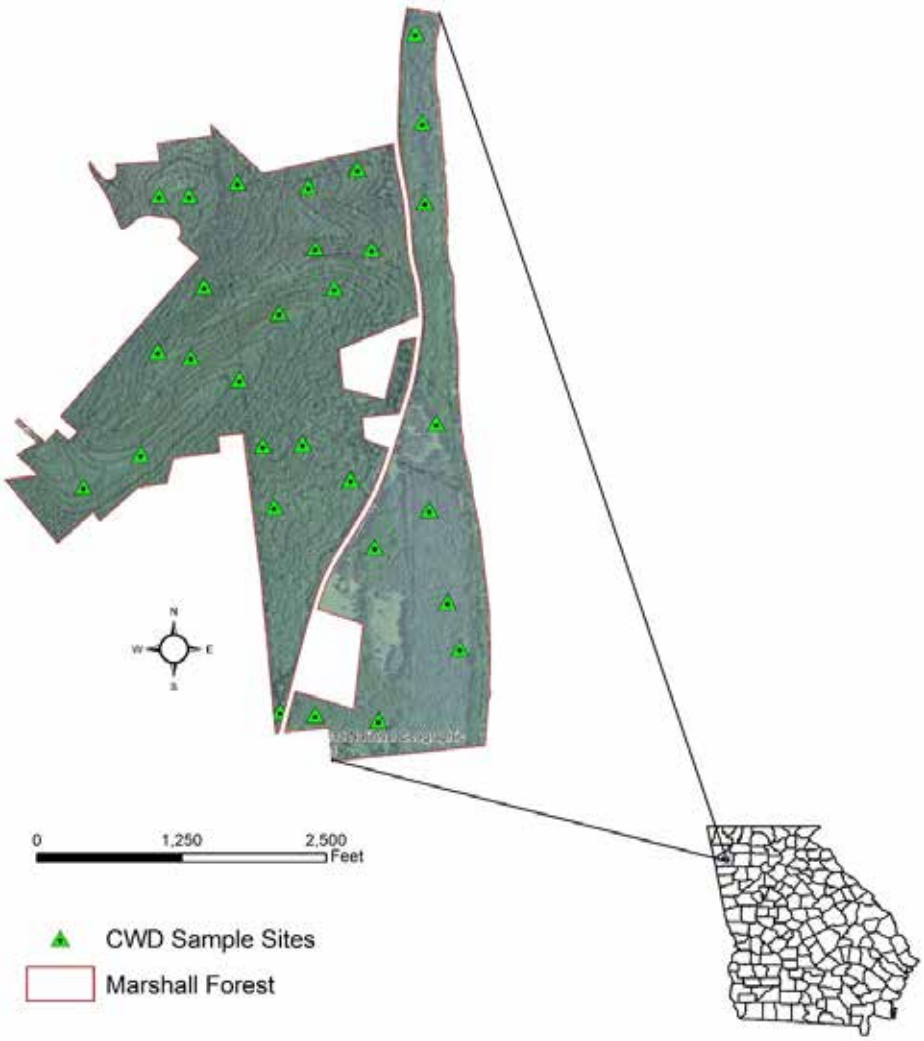

Figure 1—CWD sample locations in Marshall Forest Preserve, Rome, GA.

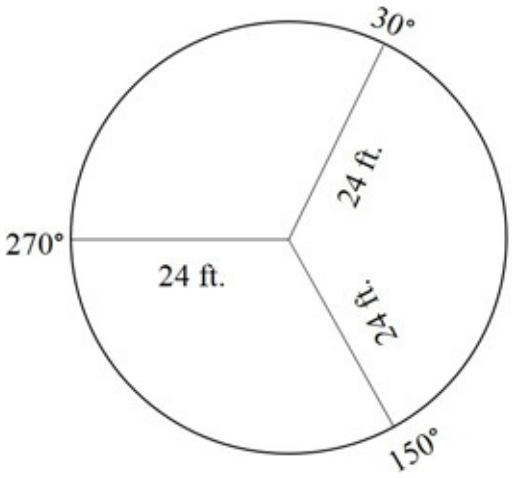

Figure 2—Example of a plot showing azimuths for each transect (after Woodall and Monleon 2008).

a diameter of at least 3 inches along a length of at least 3 feet and are in decay classes one to four (Woodall and Monleon 2008).

We rated the decay class according to a five-class scale (Sollins 1982) (table 1). For pieces in decay classes one through four we recorded the diameter at the point of transect intersection, large and small end diameter, species if possible (or pine or hardwood) decay class and length. We calculated volumes for each CWD piece using Smalian's formula (after Woodall and Monleon 2008). We calculated the estimated per acre (ft^3/ac) volume on each plot (Equation 1)

$$\overline{Y}_{CWD} = \frac{1}{k_c} \sum_{j=1}^{k_c} \overline{y}_j \ ,$$

where $\bar{y}_j$ = ft^3/ac volume on the jth transect and k_c= the number of transects per plot, and interpolated (via kriging) plot estimates for MFP.

RESULTS

MFP is dominated by shortleaf pine and chestnut oak with red maple abundant in the understory. Hardwood species comprised a majority of CWD sampled within MFP. There is very little CWD in decay class one, likely owing to time since the last major disturbance. Most CWD was in decay classes two and three for both pine and hardwood (fig. 3), although there was generally more pine in higher states of decay than hardwood.

The estimated CWD volume is 837 ft^3/ac, which represents a carbon content of 9.1 tons/ac. The distribution of CWD varies throughout the forest; however, the highest volumes are at the lower elevations along the north sections of MFP. This is the flood plain of the Coosa River, so it is reasonable that CWD washes up during flood events (fig. 4). Areas of increasing slope also have a high concentration of CWD as do areas along the MFP property boundary.

DISCUSSION

MFP is a disturbance-driven forest, with the most recent disturbances occurring in 1993 (ice/snow) and 2011 (wind) (Petruccelli and others 2014). The result of these disturbances is a high amount of CWD. Compared to Forest Inventory Analysis estimates, MFP has approximately four times the amount of CWD than the average for the State of Georgia (Woodall and Monleon 2008). Coupled with fire exclusion, disturbance has resulted in a significant amount of CWD in the MFP that could serve as a fuel source for wildfire. As the MFP is within the boundary of a city, prescribed fire is difficult to accomplish. Given that CWD falls within the 1,000+ hour fuel category, a wildfire would be catastrophic for the old-growth forest of MFP and negatively impact the city of Rome, GA. It is interesting that there was only one CWD piece in decay class one which points to the time elapsed since the last major disturbance. It would be informative to determine the decay rate of CWD by species within MFP. In terms of fire fuel modelling and monitoring, it would also be useful to obtain estimates for litter and duff within the forest. Future research within MFP will focus on these efforts with the goal of determining fire risk in MFP, which could be extended to other natural forests in the southeastern United States.

Table 1—Attributes of CWD pieces used to determine decay class (Woodall and Monleon 2008)

Decay class	Structural integrity	Texture of rotten portions	Color	Invading roots	Branches
1	Sound, freshly fallen	Intact	Original	Absent	Present, fine twigs are present
2	sound	Mostly intact	Original	Absent	Present, fine twigs are absent
3	Heartwood sound	Hard	Reddish brown	Sapwood	Branch stubs will not pull out
4	heartwood rotten	Soft, small blocky pieces	Reddish	Throughout	Branch stubs pull out
5	None	Soft; powdery when dry	Red brown	Throughout	Branch stubs and pitch pockets have usually rotted down

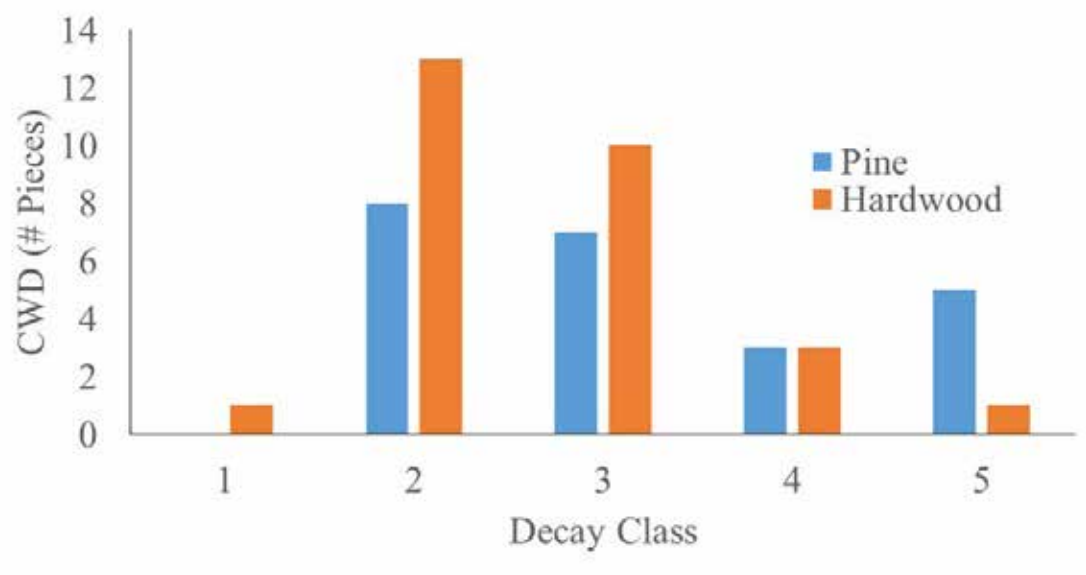

Figure 3—Distribution of CWD, for pine and hardwood, as a function of decay class.

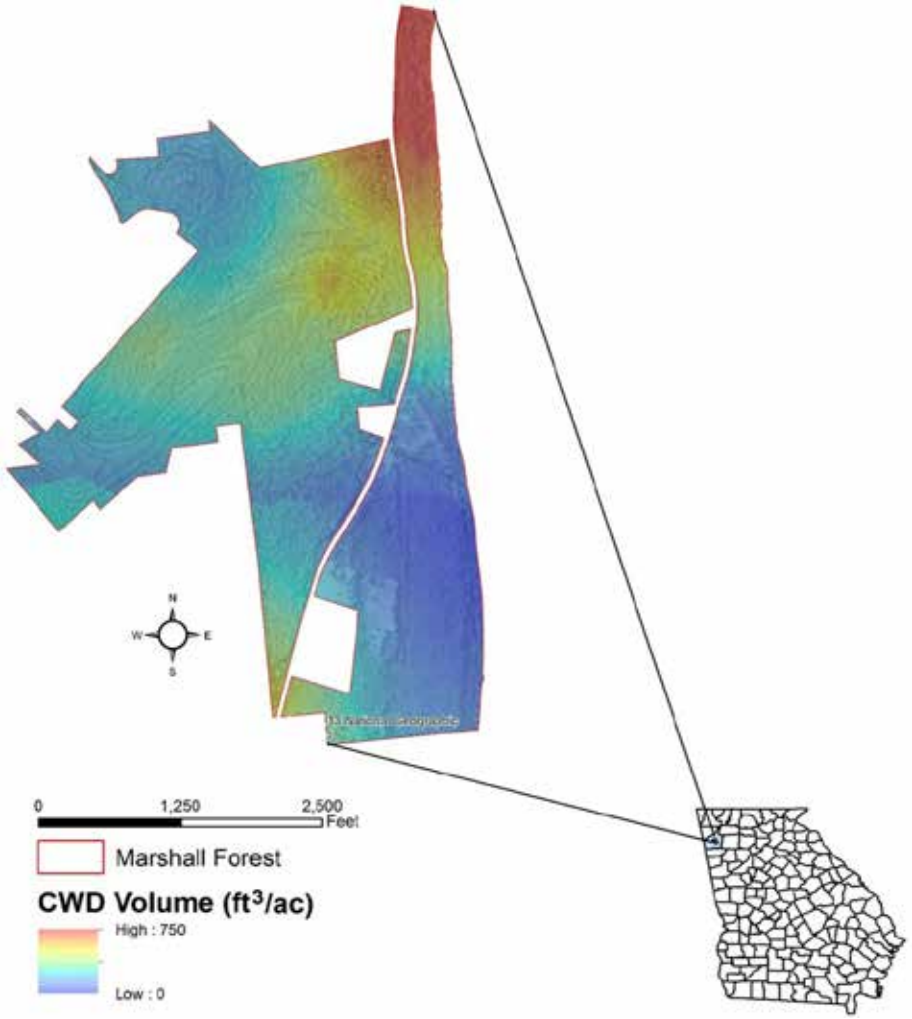

Figure 4—Spatial distribution of CWD (ft^3/ac) throughout Marshall Forest.

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