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Natural Resource Stewardship and Science

Documenting Remnant Old Growth at New River Gorge National Park & Preserve

A Pre-Industrial Legacy Forest at the Burnwood Area

Natural Resource Report NPS/NERI/NRR—2023/2504

ON THIS PAGE
Old-growth forest at the Burnwood area of New River Gorge National Park & Preserve (11 November 2022).
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ON THE COVER
Scenes from the study site at the Burnwood area of New River Gorge National Park & Preserve. Clockwise from top left: Early morning fog near forest plot 2; the balding bark of a 200-year-old white oak (*Quercus alba*); rosey russula (*Russula rosacea*) growing on the forest floor; and the deeply fissured bark and large, gnarled upper branches of a more than 300-year-old blackgum (*Nyssa sylvatica*).
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Executive Summary

Old-growth forests were first recognized as a resource by the U.S. Forest Service in 1988 and, within a year, a task group in the Eastern Old-Growth Definition Project developed a generic definition:

> "Old-growth forests are ecosystems distinguished by old trees and related structural attributes. Old growth encompasses the later stages of stand development that typically differ from earlier stages in a variety of characteristics which may include tree size, accumulations of large dead woody material, number of canopy layers, species composition, and ecosystem function" (White and Lloyd, 1994).

Defining and identifying old growth continues to be a priory for scientists, land managers, and the public for reasons ranging from carbon storage (McGarvey et al., 2015; Keeton, 2018) and species conservation (Flebbe and Dolloff, 1995; Haney, 1999; Schowalter, 2017; DellaSala et al., 2022) to recreation and tourism (Che, 2006; Hall et al., 2011).

The primary objective of this study was to document a potential old-growth site at the Burnwood area of New River Gorge National Park & Preserve (Figure 1). We evaluated multiple old-growth criteria and forest characteristics, including species composition and stand structure, tree recruitment and shrub cover, tree age, and coarse woody debris (CWD) and microtopography.

Our results indicate a forest composed of multiple overstory tree species, including eastern hemlock (*Tsuga canadensis* (L.) Carrière), American beech (*Fagus grandifolia* Ehrh.), red maple (*Acer rubrum* L.), blackgum (*Nyssa sylvatica* Marsh.), and four oak (*Quercus*) species. Large-diameter trees (> 50 cm at breast height) occurred at a relatively high density (85.7 trees/ha), and 28 of 50 trees that were cored had an inner-ring year that pre-dated 1900. Fifteen of these trees established before 1800, while five had an inner-ring year in the 1670s. Understory vegetation was sparse with red maple dominating the 5–15 cm seedling height class, while only six saplings and four individual shrubs were observed in forest plots. Average CWD volume was 52.0 m^3/ha and we observed pit and mound microtopography within plots and across the study site.

This report provides the first detailed assessment of old growth at New River Gorge National Park & Preserve and in southern West Virginia in general. Large-diameter (> 50 cm DBH) tree density and CWD volume were within the range of values reported for eastern old-growth forests (McGee, 2018), while tree age surpassed 300 years in some cases. The forest, however, is not characterized by the "pristine" conditions often ascribed to old growth. Fire and then fire exclusion, invasive pests and pathogens, and climate change have and will continue to collectively shape the future of this pre-industrial legacy forest. The results of this report can be used to inform resource management objectives as well as interpretive programming at New River Gorge National Park & Preserve.

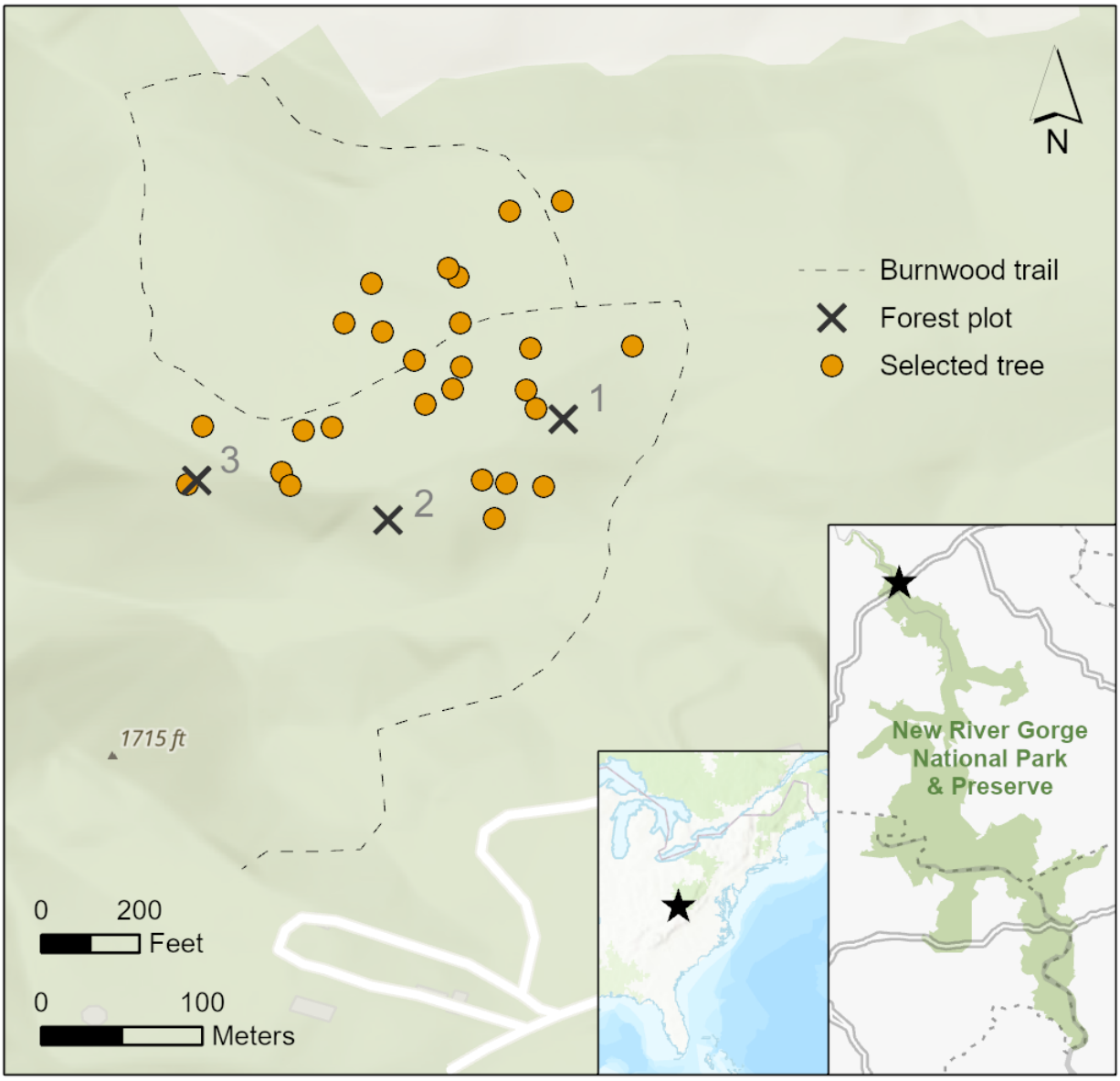


Figure 1. Locations of forest plots (1, 2, and 3) and trees selected for sampling based on the presence of old-growth morphological traits. Inset maps: Regional location of New River Gorge National Park & Preserve (left) and study site location within the Park (right).

Acknowledgments

We thank Chance Raso and Douglas Manning for their assistance in the field and invaluable enthusiasm for documenting old growth in New River Gorge National Park & Preserve. Kathleen Kull and Clay Gibbons provided additional assistance in the field and Rodney Tigaa coordinated the dying of blackgum tree core samples. Funding for travel to the study site was provided by Concord University.

The authors pose for a photo in front of an American beech with an 1829 inner-ring year at the Burnwood area of New River Gorge National Park & Preserve. From left to right: Ricardo Chinea-Pegler, Thomas Saladyga, Alexis Foster (documentarian), Joseph Duffer (in front), Mitchell Roush, Madison Cook, Haidyn DePinho, Madison Cornett, and Andrew Trump. Missing from the photo: Keiley Dudding (© CHANCE RASO).

Introduction

Old-growth forests were first recognized as a resource by the U.S. Forest Service in 1988 and, within a year, a task group in the Eastern Old-Growth Definition Project developed a generic definition:

> "Old-growth forests are ecosystems distinguished by old trees and related structural attributes. Old growth encompasses the later stages of stand development that typically differ from earlier stages in a variety of characteristics which may include tree size, accumulations of large dead woody material, number of canopy layers, species composition, and ecosystem function" (White and Lloyd, 1994).

Previous and subsequent definitions of "old growth," however, have variously been based on ecological data and economic policy (Hilbert and Wiensczyk, 2007), while public debates about the management or non-management of old-growth forests are often driven by social or cultural values (Spies, 2004). In some cases, these definitions prevent us from recognizing less obvious forest processes, such as interactions between species and resilience following disturbance (Frelich and Reich, 2003). Regardless, defining and identifying old growth continues to be a priority for scientists, land managers, and the public for reasons ranging from carbon storage (McGarvey et al., 2015; Keeton, 2018) and species conservation (Flebbe and Dolloff, 1995; Haney, 1999; Schowalter, 2017; DellaSalla et al., 2022) to recreation and tourism (Che, 2006; Hall et al., 2011).

In eastern North America, old-growth mixed mesophytic forests are characterized by "keystone structures" that enhance habitat and biological diversity at multiple spatial scales (Tews et al., 2004; McGee, 2018). These structures primarily include large-diameter living trees, standing dead trees (or "snags"), and rotting logs (or "coarse woody debris" (CWD)), as well as other features such as tree-fall canopy gaps that allow light to reach the forest floor and pit and mound microtopography that forms when a tree is uprooted and falls and is left to decompose. At the microscale, old-growth keystone structures and associated features create habitat islands for a variety of organisms that might not otherwise occur on the broader landscape, including multiple species of bryophytes, lichens, fungi, invertebrates, and an array of vascular plants (Martin, 1992; McGee, 2018).

Few examples of old-growth forest exist today in the Appalachian Mountains due to extensive logging between the 1870s and 1930s. In West Virginia, the Old Growth Forest Network (OGFN), a non-profit organization working to document and promote the conservation of old-growth forests across the United States, has recognized eleven remnant old-growth or mature forest tracts across the state (OGFN, 2023). One of these forests, the "Stone Cliff Old Growth" tract, is located within New River Gorge National Park & Preserve in southern West Virginia. Our objective in this report was to document a potentially older and more easily accessible forest located at the Burnwood area of the park. We evaluated multiple old-growth criteria and forest characteristics, including species composition and stand structure, tree recruitment and shrub cover, tree age, and CWD and microtopography. The results of this report will inform resource management objectives as well as interpretive programming at New River Gorge National Park & Preserve.

Methods

Study Area

New River Gorge National Park & Preserve includes approximately 85 km of the New River and nearly 30,000 ha of land area in Fayette, Raleigh, and Summers counties in southern West Virginia (Figure 1). The park is situated in the mixed mesophytic forest region and is distinguished by complex, dissected topography that harbors some of the highest levels of biodiversity in eastern North America. Plant communities include dry oak (*Quercus* spp.) and pine (*Pinus* spp.) forests on south-facing aspects and cliff edges, mesic and cove forests composed of maple (*Acer* spp.), American beech (*Fagus grandifolia* Ehrh.), tulip-poplar (*Liriodendron tulipifera* L.), and eastern hemlock (*Tsuga canadensis* (L.) Carrière), and riparian plant communities such as riverscour prairies and woodlands (Suiter and Evans, 1999; Vanderhorst et al., 2007). The climate is humid continental with an average annual temperature of 11.5°C and monthly temperatures ranging from 0.0°C in January to 21.9°C in July (1991–2020; NOAA, 2023). Average annual precipitation is 121.4 cm, with monthly totals ranging from 7.7 cm in October to 13.7 cm in July (1991–2020; NOAA, 2023).

The earliest evidence of human habitation in the lower New River region (present-day southern West Virginia) dates to the Archaic period (10,000–3,000 years BP) (NPS, 2023). More recently, the region was home to multiple Native American tribes, including the Shawnee, Delaware, Cherokee, Tutelo, Saponi, and Mingo prior to Euro-American contact in the 1600s (Peters and Carden, 1926). Permanent Euro-American settlements were first established in the region in the 1750s and it was not until 1790 that the James River Company completed the "Old State Road" that crossed the New River at Bowyer's Ferry in Fayette County (Unrau, 1996). When the James River and Kanawha Turnpike was complete in 1825, it provided a travel route around the New River Gorge (instead of through it) to present-day Charleston, West Virginia (Peters and Carden, 1926). The region was primarily agrarian until the completion of the Chesapeake and Ohio (C&O) railroad in 1873 ushered in an era of commercial coal mining and landscape-scale forest clearing for the burgeoning timber industry. Most areas inside present-day park boundaries were impacted by this activity between the 1870s and 1930s and, today, few forest stands are more than 100 years old (Saladyga et al., 2020).

The Burnwood area is located just west of U.S. 19 opposite the Canyon Rim Visitor Center at the northern end of the park (Figure 1). The area includes a maintenance yard, a group camping area and pavilions, and a loop trail that traverses our study site. The Laing family owned and lived on this parcel of land before it was acquired by the National Park Service in 1978 and, therefore, is less likely to have been disturbed by any of the industrial activities described above.

In August 2022, a permit (#NERI-2022-SCI-0013) was issued by the National Park Service to conduct this study including authorization to collect tree cores for analysis.

Field Methods

In August–September 2022, we established three 15-m radius (0.07 ha) forest plots at the study site in areas relatively less accessible for selective tree harvesting due to slope steepness or presence of rock outcrops (Figure 1). Vegetation and coarse woody debris (CWD) data collection methods are

based on those described by Perles and others (2015) and employed by the Eastern Rivers and Mountains Monitoring Network (ERMN).

At each plot center, we recorded the geographic coordinates (latitude/longitude) as well as elevation, slope, and aspect (Table 1). Within each 0.07-ha forest plot, we recorded the species, status (live/dead), presence of injury (e.g., fire scar, insect damage), and diameter of all trees ≥ 10 cm diameter at breast height (DBH) and noted pit and mound microtopography, if present (Figure 2). In four 2-m radius micro plots, we measured the diameter of saplings (DBH ≥ 1.0 cm but < 10.0 cm), tallied seedlings by species and size class (5–15 cm, 15–30 cm, 30–100 cm, 100–150 cm, and > 150 cm), and recorded percent cover and number of individuals of shrub species (Figure 2). CWD was measured using line intersect sampling (Van Wagner, 1964) along six 15-m transects (Figure 2). At each point of intersection, the diameter of CWD at least 7.5 cm in diameter and 1 m in length was measured and recorded.

Table 1. Burnwood forest plot coordinates and terrain characteristics.

Forest plot	Latitude	Longitude	Elevation (m)	Slope (%)	Aspect (°)
Plot 1	38°04'36" N	81°04'33" W	525	8	174
Plot 2	38°04'34" N	81°04'36" W	515	34	190
Plot 3	38°04'35" N	81°04'40" W	514	27	220

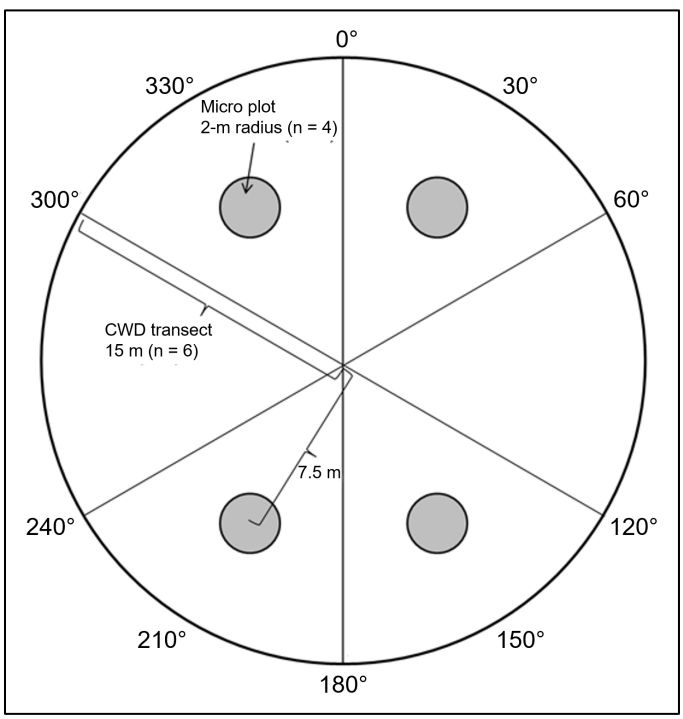


Figure 2. Forest plot design modified from Perles and others (2015). CWD = coarse woody debris.

To describe forest age structure, we collected two core samples from eight trees of any species located closest to the center of each 0.07-ha forest plot. We cored four trees in the 10–25 cm DBH class and four trees > 25 cm DBH to account for variation in diameter-age relationships. In addition, we selectively sampled trees outside forest plots that exhibited old-growth morphological traits, including a twisting trunk, balding or flaking bark, and large, gnarled upper branches (Pederson, 2010).

Forest plot field methods. Clockwise from top left: Measuring the diameter of a red maple; counting seedlings in a micro plot; collecting a core sample from an eastern hemlock; and measuring the diameter of coarse woody debris (CWD) (© ALEXIS FOSTER; THOMAS SALADYGA [upper left photo]).

Examples of trees selected for sampling outside of forest plots based on the presence of old-growth morphological traits, including a twisting trunk, balding or flaking bark, and large, gnarled upper branches. Clockwise from top left: Blackgum (1712 inner-ring year); sourwood (1896 inner-ring year); red maple (1847 inner-ring year); and American beech (1829 inner-ring year) (© THOMAS SALADYGA).

Forest Plot Data Analysis

We calculated importance value (IV; Curtis and McIntosh, 1951) and stem density for living trees with a DBH of at least 10 cm to describe forest composition and stand structure. Importance values, ranging from 0–100, were calculated for each species as the mean of relative frequency, relative basal area, and relative density. Stem density (trees/ha) was calculated by species (or genus, if

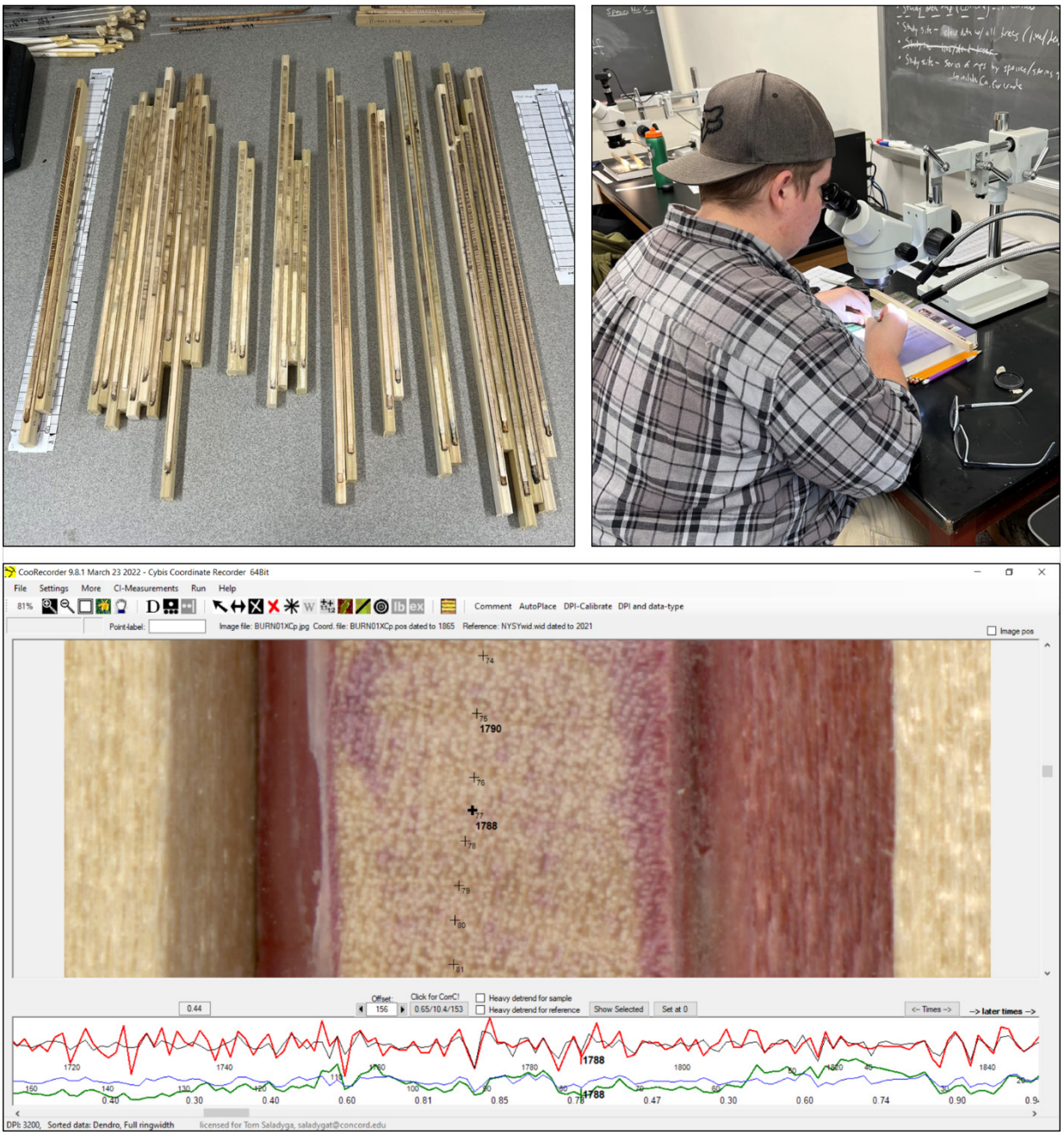
appropriate) for three diameter size classes, including 10–20 cm ("small-diameter"), 21–50 cm ("intermediate-diameter"), and > 50 cm ("large-diameter") trees. We also calculated seedling density by species and height class and summarized sapling counts and shrub cover by species to characterize tree recruitment and understory woody plant composition. In addition, we calculated average CWD volume (m^3/ha) for the site using CWD transect data and Huber's formula corrected for slope (Van Wagner, 1982; Marshall et al., 2000):

$$CWD = \frac{\pi^2 \sqrt{1 + \left(\frac{\%Slope}{100}\right)^2}}{8 * Slope_{length}} * \sum_{i}^{n} Diam_i^2$$

Laboratory Methods and Tree-Ring Analysis

Tree core samples were prepared and analyzed using standard dendrochronology methods (Speer, 2010). Samples were air-dried before mounting and surfacing with progressively finer sandpaper up to 1200 grit. Blackgum cores were dyed in a phloroglucinol solution and then placed in 50% hydrochloric acid (HCl) and sanded again to improve the visibility of annual rings under magnification (Patterson, 1959). Each sample was skeleton plotted and visually crossdated against a nearby reference chronology that we downloaded from the International Tree-Ring Data Bank (Cockrell et al., 2019; Saladyga et al., 2015; Saladyga and Stockton, 2019). We then used a large-format scanner (1200XL, Epson, Suwa, Japan) to capture a high-resolution (3200 dpi) image of each sample. Images were uploaded into the program CooRecorder 9.8.1 (Larsson, 2016) and annual rings were measured to the nearest 0.01 mm. We used the program CDendro 9.8.1 (Larsson, 2016) to statistically crossdate each measurement series and dating was quality checked using the XDateR application (Bunn, 2010).

Tree age is based on the innermost ring year as determined by the dating procedure described above. This approach provides a minimum age, as the actual germination year may be just a few years to multiple decades earlier than the reported inner-ring year depending on the height a tree was cored, whether or not initial rings were narrow (i.e., suppressed growth), or if a tree was hollow (Pederson, 2010). We reported the inner-ring year distribution for trees systematically sampled within forest plots and for trees selected for sampling based on the presence of old-growth morphological traits. In addition, we plotted the relationship between inner-ring year and DBH for all trees sampled. Attributes of trees that established before the year 1900 are summarized in tabular format and their locations have been mapped to inform park management and interpretive programming.



Tree core samples and analyses. Clockwise from top left: Mounted and sanded tree cores; visually crossdating a tree core sample under magnification; and a screen image of annual ring-width measurements in CooRecorder software (© ALEXIS FOSTER; THOMAS SALADYGA [screen image]).

Results and Discussion

Forest Composition and Stand Structure

We observed a total of 103 living and 13 standing dead trees within forest plots. Species composition was dominated by eastern hemlock, American beech, red maple (*Acer rubrum* L.), and oak species, including white (*Q. alba* L.), chestnut (*Q. montana* Willd.), northern red (*Q. rubra* L.), and black (*Q. velutina* Lam.) (Table 2). Less dominant species included blackgum (*Nyssa sylvatica* Marsh.) and sourwood (*Oxydendrum arboreum* (L.) DC.), while sweet birch (*Betula lenta* L.), mountain magnolia (*Magnolia fraseri* Walt.), and Virginia pine (*Pinus virginiana* Mill.) were present within two or fewer plots (Table 2). This diversity in tree species reflects slight differences in slope, aspect, and microsite conditions among forest plots across a relatively short distance (~200 m).

Table 2. Tree species observed in forest plots. Importance values are on a scale of 0–100 and were calculated as the mean of relative frequency, relative basal area, and relative density for living trees ≥ 10 cm diameter at breast height (DBH).

		Importance Value			
Tree species	**Common name**	**Plot 1 (n = 30)**	**Plot 2 (n = 36)**	**Plot 3 (n = 37)**	**Site average**
Acer rubrum	Red maple	9.0	7.4	14.2	10.2
Betula lenta	Sweet birch	0.0	1.6	0.0	0.5
Fagus grandifolia	American beech	22.3	9.5	4.8	12.2
Magnolia fraseri	Mountain magnolia	3.3	0.0	0.0	1.1
Nyssa sylvatica	Blackgum	4.7	3.9	8.3	5.6
Oxydendrum arboreum	Sourwood	18.7	1.3	7.8	9.2
Pinus virginiana	Virginia pine	0.0	3.1	10.3	4.5
Quercus alba	White oak	0.0	0.0	1.9	0.6
Quercus montana	Chestnut oak	5.1	7.7	4.3	5.7
Quercus rubra	Northern red oak	0.0	0.0	4.7	1.6
Quercus velutina	Black oak	0.0	6.0	3.6	3.2
Tsuga canadensis	Eastern hemlock	37.1	59.6	40.2	45.6

Total stem density by diameter size class was 171 small-diameter trees/ha (10–20 cm DBH), 233 intermediate-diameter trees/ha (21–50 cm DBH), and 86 large-diameter trees/ha (> 50 cm DBH) (Figure 3). Eastern hemlock and sourwood occurred in the highest densities in the small-diameter class, while the intermediate-diameter class was dominated by eastern hemlock. Five species occurred in the large-diameter class with stem density ranging from 5 trees/ha for red maple to 29 trees/ha for eastern hemlock (Figure 3). The density of large-diameter trees observed at the study site

falls within the range of values reported for eastern old-growth forests of various types (McGee, 2018). Large-diameter trees not only provide structural diversity to the forest landscape, but contribute substantially to global aboveground biomass and carbon storage (Lutz et al., 2018).

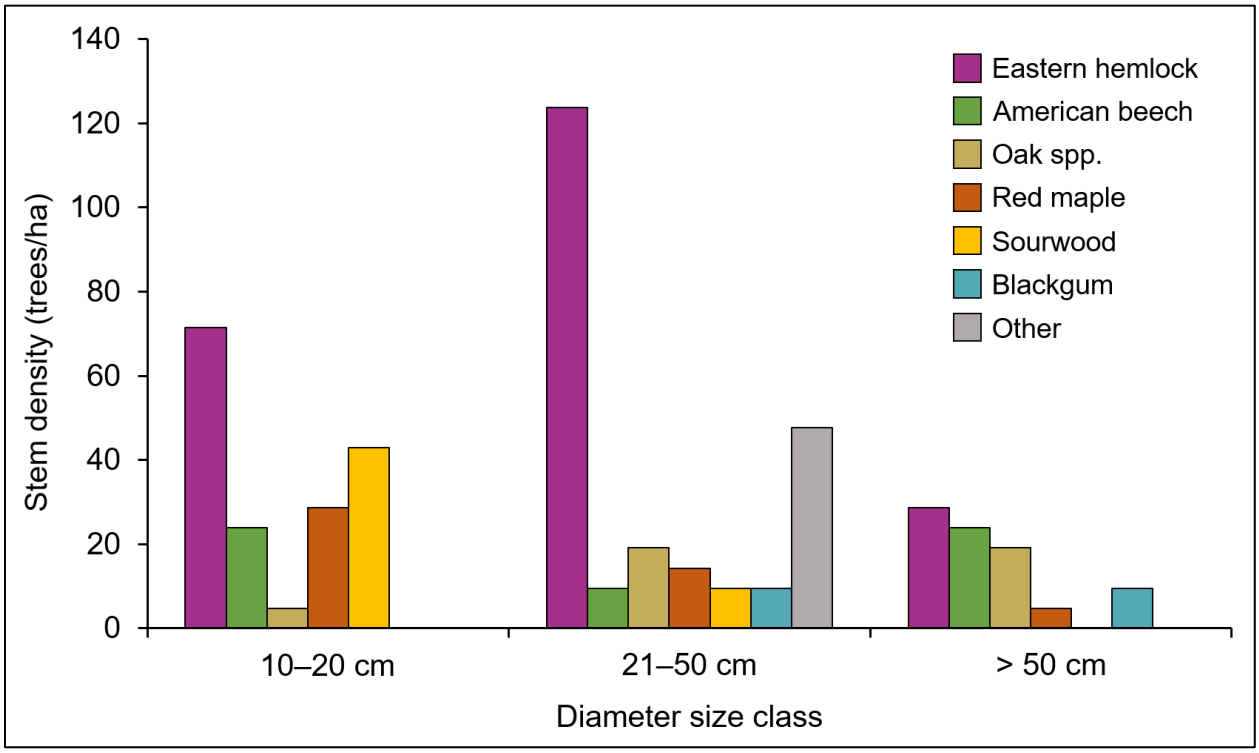


Figure 3. Stem density (trees/ha) by diameter size class (cm) for species observed within forest plots. Oak species include black oak, chestnut oak, northern red oak, and white oak. "Other" includes non-oak tree species with a site average importance value < 5.0, including mountain magnolia, sweet birch, and Virginia pine.

Seven trees within forest plots had an external fire scar (i.e., "cat face") and numerous others were observed across the study site. These scars provide evidence of past fires that may have promoted fire-tolerant or fire-dependent tree species (e.g., oak, pine, and hickory). Future forest composition will be influenced by multiple factors, including the continued exclusion of fire, an increasingly temperate and wet climate (Kutta and Hubbart, 2018), and by invasive organisms, namely hemlock woolly adelgid (*Adelges tsugae* Annand) (Limbu et al., 2018).

Tree Recruitment and Shrub Cover

We observed 10 different seedling species and 1 unidentified specimen within forest plots (Figure 4). Overall seedling density was relatively low and few seedlings were observed in height classes above 15 cm. Therefore, we summarized the data in two height classes: 5–15 cm and > 15 cm. Red maple and blackgum seedlings dominated the 5–15 cm height class, while seedling density in the taller height class was spread among eight species (Figure 4). Seedling species that we did not observe in the overstory included American holly (*Ilex opaca* Ait.) and black cherry (*Prunus serotina* Ehrh.). We observed only six saplings and four individual shrubs within forest plots. Saplings species

included sourwood, eastern hemlock, and American beech. Shrub species included mountain laurel (*Kalmia latifolia* L.), great laurel (*Rhododendron maximum* L.), and round-leaved greenbrier (*Smilax rotundifolia* L.). The sparse understory described here is indicative of low-light conditions due to an absence of recent disturbance and canopy gap formation which is further exacerbated by excessive deer herbivory (Perles et al., 2021). In addition, the relative profusion of shade-tolerant seedlings in the 5–15 cm height class (i.e., red maple and blackgum) and absence of oak reflects a regional trend observed in upland oak forests (Abrams, 1998; McEwan et al., 2011; Babl-Plauche et al., 2022).

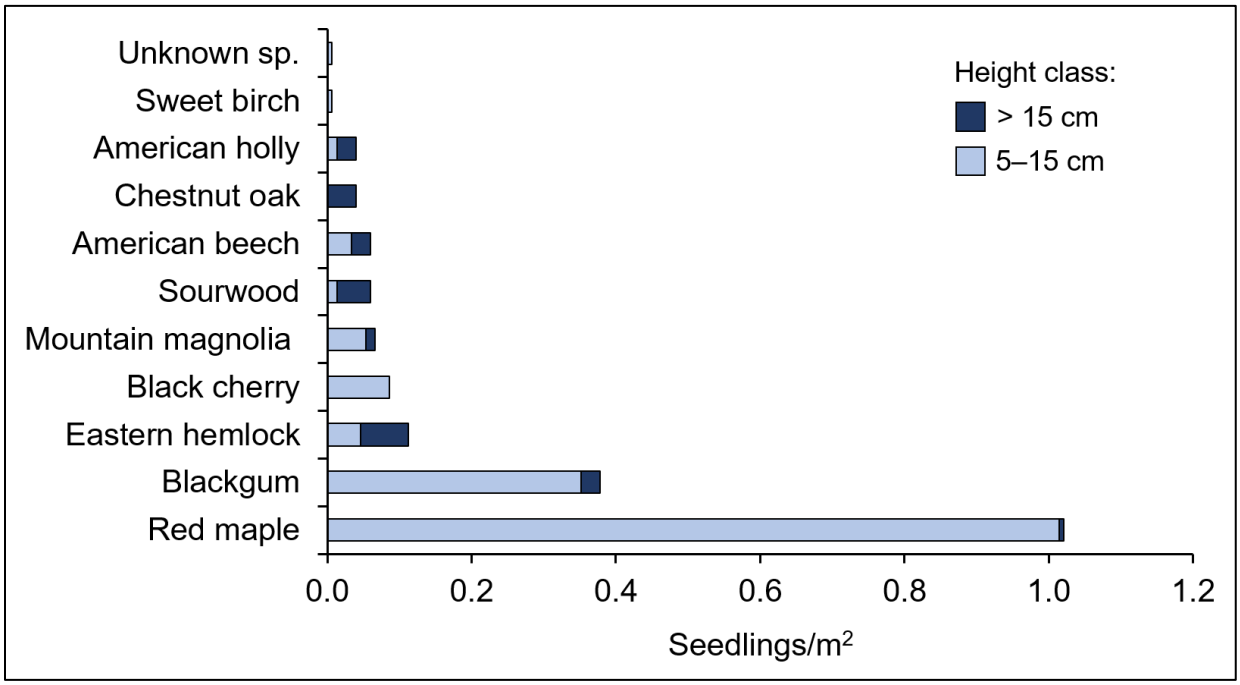


Figure 4. Seedling density by height class for species observed within forest plots.

Tree Age

We determined the minimum age of 24 trees sampled within forest plots and 26 trees that were selectively sampled across the study site (Table 3). In some cases, for blackgum, sourwood, and eastern hemlock, tree age was determined using a single core because an additional sample was either structurally compromised (e.g., rotten) or it could not be dated due to indistinguishable or suppressed growth rings. Systematic sampling revealed a pulse of establishment dominated by eastern hemlock in the early decades of the 20th century (Figure 5a) that may be linked to resources made available by the loss of American chestnut (*Castanea dentata* (Marsh.) Borkh.) in eastern forests (Dalgleish and Swihart, 2012). Trees selectively sampled across the study site established over a span of approximately 200 years between the late 17th century and late 19th century (Figure 5b). Oak establishment throughout this time period suggests suitable conditions for germination, including canopy gaps (Izbicki et al., 2020) and, presumably, minimal herbivory (Perles et al., 2021).

Table 3. Tree species sampled for age structure in forest plots and across the study site.

Tree species	Common name	Number of trees sampled within forest plots	Number of trees selectively sampled
Acer rubrum	Red maple	1	4
Carya tomentosa	Mockernut hickory	0	1
Fagus grandifolia	American beech	3	2
Nyssa sylvatica	Blackgum	2	6
Oxydendrum arboreum	Sourwood	3	1
Pinus virginiana	Virginia pine	1	0
Quercus alba	White oak	0	8
Quercus montana	Chestnut oak	2	3
Quercus velutina	Black oak	1	1
Tsuga canadensis	Eastern hemlock	11	0

In general, trees with a DBH > 60 cm were at least 150 years old (ca. 1870 or older) (Figure 6). This diameter-age relationship should be interpreted with caution, however, due to a variety of factors, including relatively low sample size, differential growth rates by species, and variation in microsite conditions (e.g., slope, soil depth, light) and disturbance history (Harper, 1977; Pederson, 2010).

Fourteen trees (5 species) were at least 250 years old at the time of sampling (Table 4). The ten oldest trees were either blackgum or chestnut oak and were all located south of the Burnwood trail loop on flat ground at the top of the slope or downslope in the vicinity of exposed bedrock (Figure 7). Blackgum, in particular, can persist in the understory in a suppressed state for decades and is one of the longest-lived tree species in eastern forests known to attain ages > 600 years (Burns and Honkala, 1990; Sperduto et al., 2000).

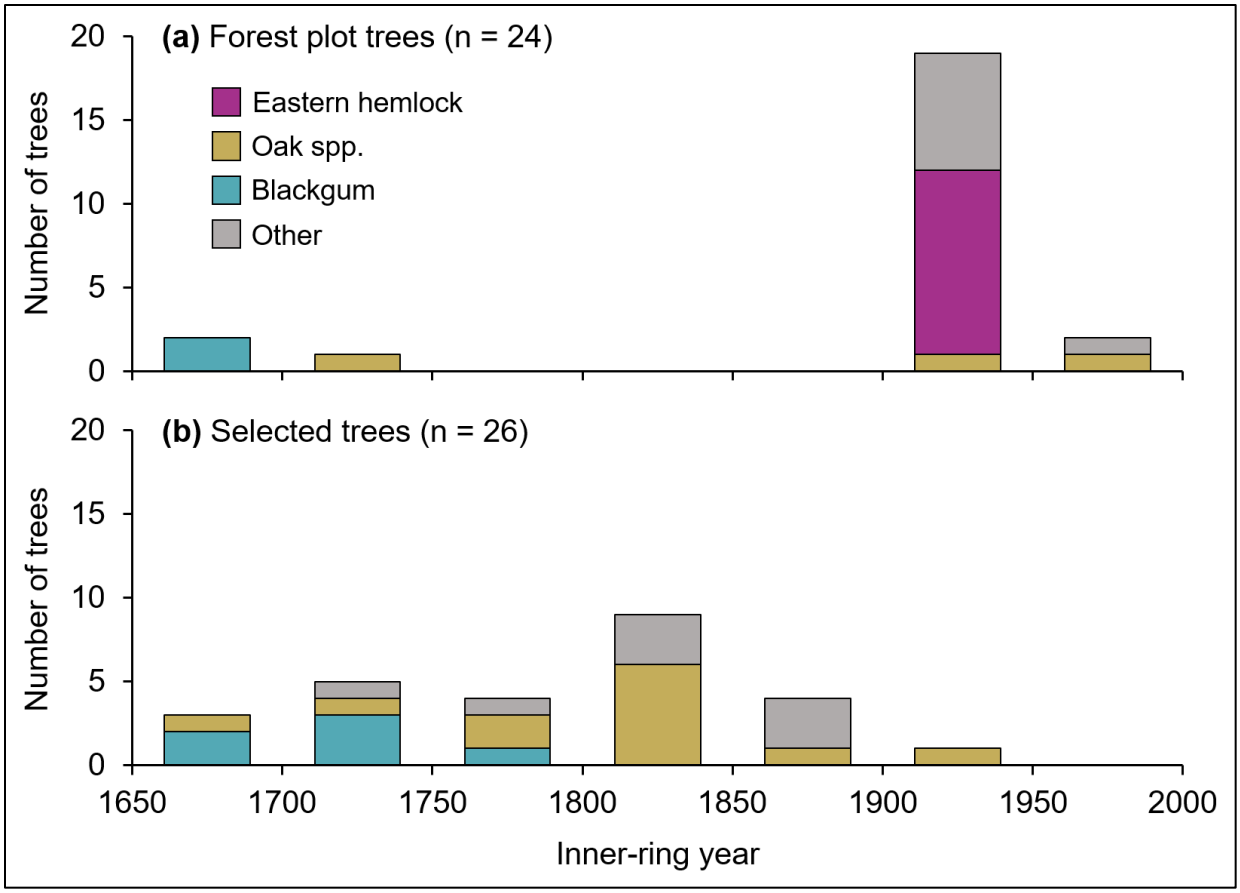


Figure 5. Inner-ring year distributions for **(a)** trees systematically sampled within forest plots and **(b)** trees selected for sampling based on the presence of old-growth morphological traits. In **(a)**, oak species include black oak (1) and chestnut oak (2). "Other" includes American beech (3), red maple (1), sourwood (3), and Virginia pine (1). In **(b)**, oak species include black oak (1), chestnut oak (3), and white oak (8). "Other" includes American beech (2), mockernut hickory (1), red maple (4), and sourwood (1).

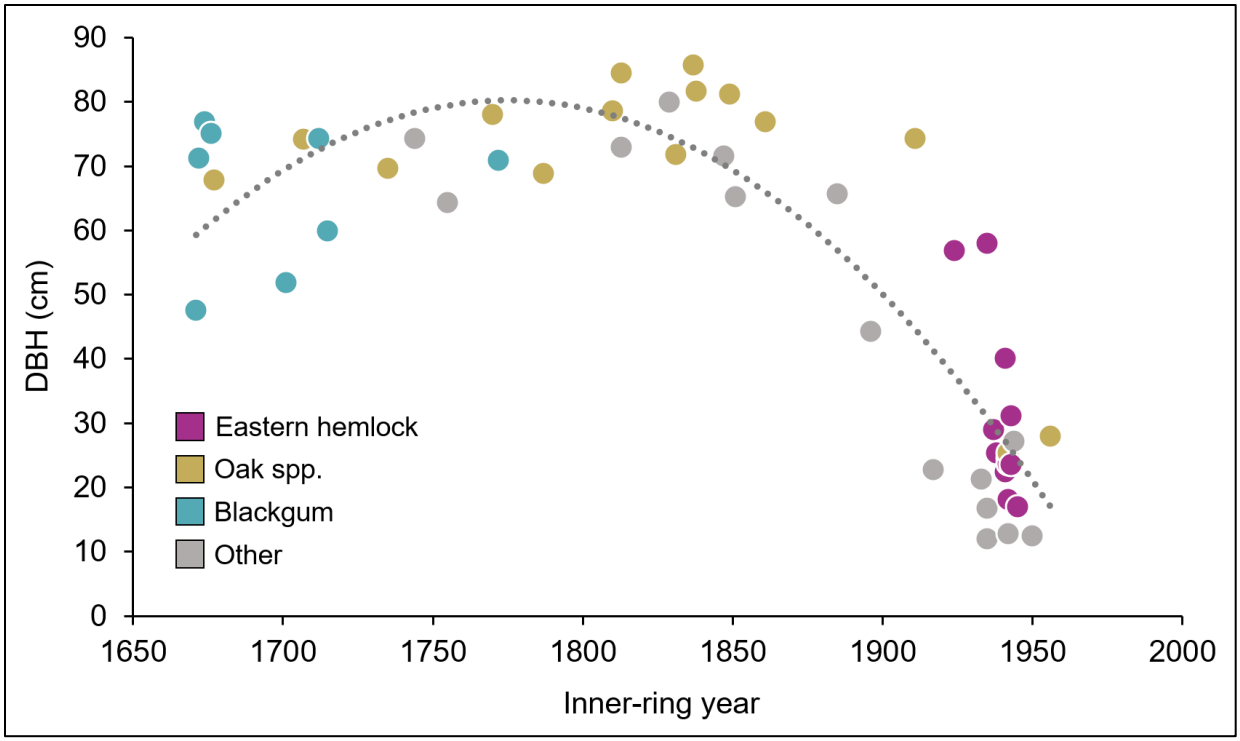


Figure 6. Relationship between inner-ring year and diameter at breast height (DBH) (n = 50). Oak species include black oak (2), chestnut oak (5), and white oak (8). "Other" includes American beech (5), mockernut hickory (1), red maple (5), sourwood (4), and Virginia pine (1). A second order polynomial trend line is shown for display purposes only.

Table 4. Inner-ring year, diameter at breast height (DBH), and sample date for trees established before 1900. All trees were living when sampled. Note that inner-ring year is minimum tree age. Actual germination year may be decade or more before the reported inner-ring year.

Tree species	Common name	Inner-ring year	DBH (cm)	Sample date
Oxydendrum arboreum	Sourwood	1896	44.2	6-Oct-2022
Acer rubrum	Red maple	1885	65.7	8-Oct-2022
Quercus montana	Chestnut oak	1861	76.9	15-Sep-2022
Acer rubrum	Red maple	1851	65.2	29-Sep-2022
Quercus alba	White oak	1849	81.2	8-Oct-2022
Acer rubrum	Red maple	1847	71.5	6-Oct-2022
Quercus alba	White oak	1838	81.6	27-Sep-2022
Quercus alba	White oak	1837	85.7	29-Sep-2022
Quercus alba	White oak	1831	71.8	24-Sep-2022
Fagus grandifolia	American beech	1829	79.9	27-Sep-2022
Carya tomentosa	Mockernut hickory	1813	72.9	6-Oct-2022

Table 4 (continued). Inner-ring year, diameter at breast height (DBH), and sample date for trees established before 1900. All trees were living when sampled. Note that inner-ring year is minimum tree age. Actual germination year may be decade or more before the reported inner-ring year.

Tree species	Common name	Inner-ring year	DBH (cm)	Sample date
Quercus alba	White oak	1813	84.4	24-Sep-2022
Quercus alba	White oak	1810	78.6	8-Oct-2022
Quercus alba	White oak	1787	68.8	8-Oct-2022
Nyssa sylvatica	Blackgum	1772	70.9	20-Sep-2022
Quercus alba	White oak	1770	78.0	8-Oct-2022
Fagus grandifolia	American beech	1755	64.3	6-Oct-2022
Acer rubrum	Red maple	1744	74.3	27-Sep-2022
Quercus montana	Chestnut oak	1735	69.6	6-Oct-2022
Nyssa sylvatica	Blackgum	1715	59.9	20-Sep-2022
Nyssa sylvatica	Blackgum	1712	74.3	9-Sep-2022
Quercus montana	Chestnut oak	1707	74.2	23-Sep-2022
Nyssa sylvatica	Blackgum	1701	51.8	23-Sep-2022
Quercus montana	Chestnut oak	1677	67.8	8-Oct-2022
Nyssa sylvatica	Blackgum	1676	75.1	9-Sep-2022
Nyssa sylvatica	Blackgum	1674	76.9	9-Sep-2022
Nyssa sylvatica	Blackgum	1672	71.2	23-Sep-2022
Nyssa sylvatica	Blackgum	1671	47.5	23-Sep-2022

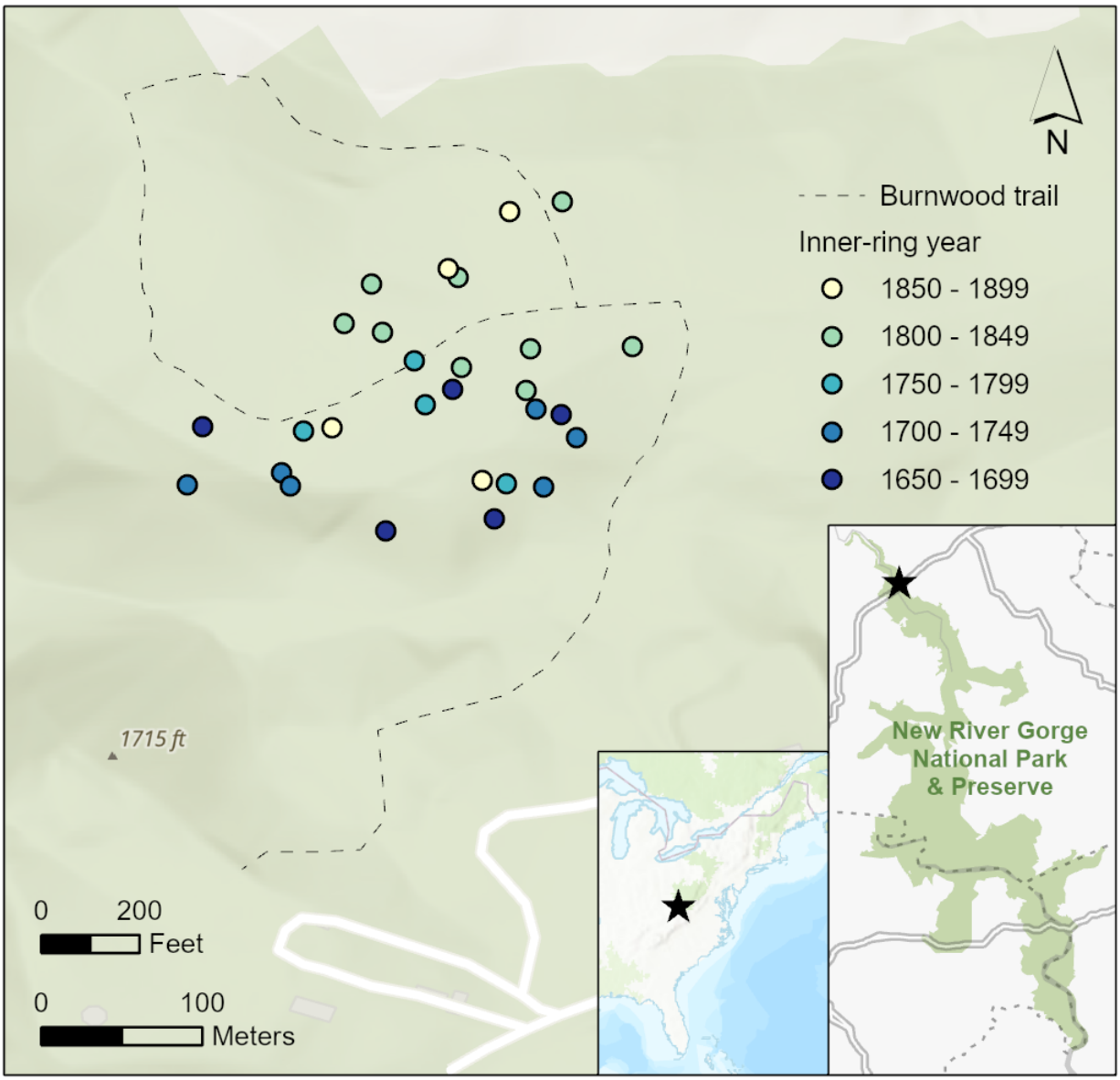
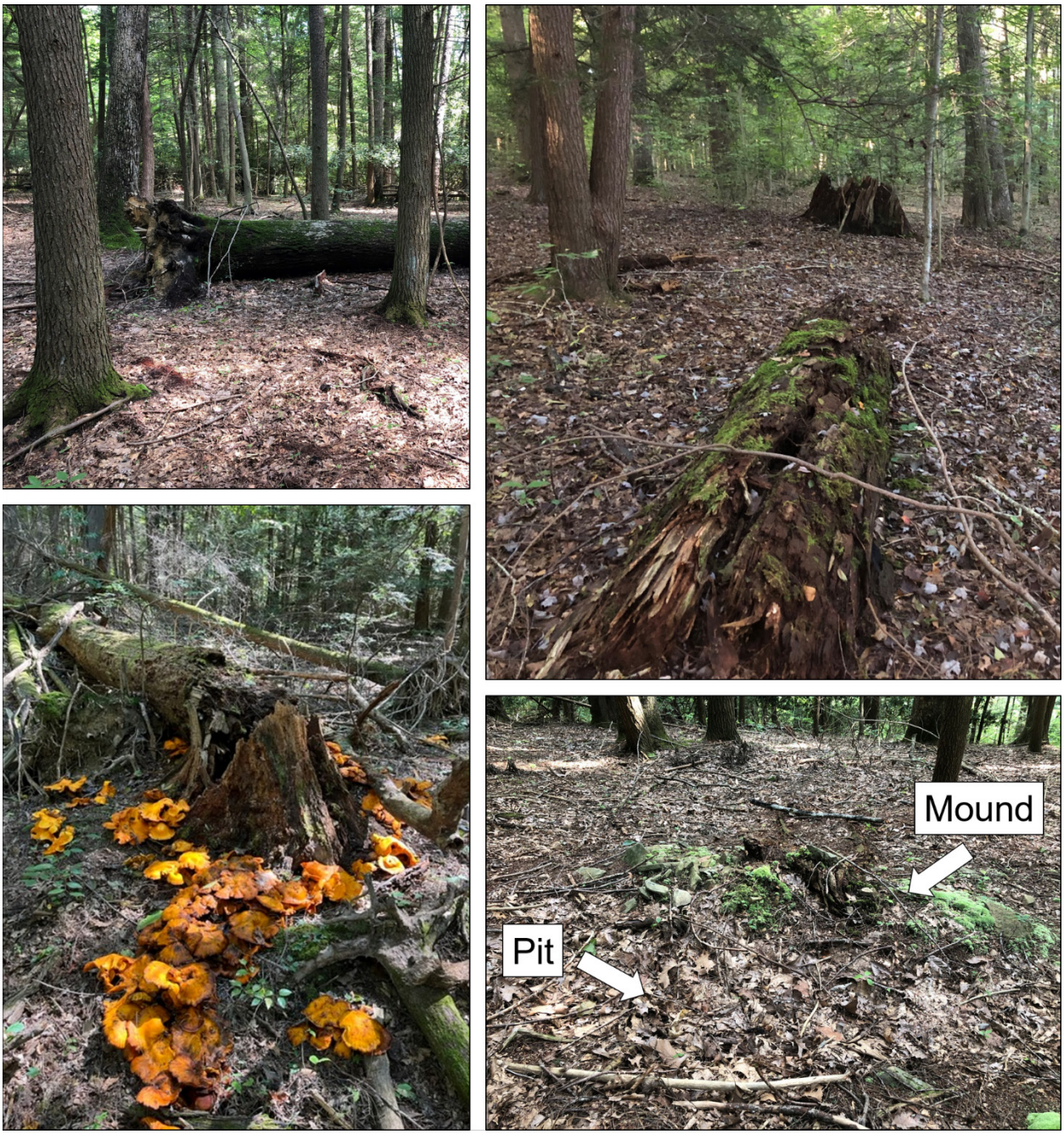


Figure 7. Locations of trees with an inner-ring year that pre-dates 1900. Inset maps: Regional location of New River Gorge National Park & Preserve (left) and study site location within the Park (right). Click here to view an interactive web map.

Coarse Woody Debris and Microtopography

Average CWD volume (52.0 m^3/ha) was within the range of values reported for eastern old-growth forests of various types (McGee, 2018) and slightly less than the 66.3 m^3/ha observed at an old-growth site in nearby eastern Kentucky (Muller and Liu, 1991), although this study included only CWD > 20 cm diameter. In addition to logs, multiple large-diameter stumps, possibly American chestnut, were observed outside forest plots. Otherwise, there was no evidence of selective cutting or timber harvesting in general at the site. We also observed multiple pit and mound features within each forest plot as well as across the study site. This microtopography contributes to high pedodiversity (i.e., diversity in soil characteristics) in eastern old-growth forests (Scharenbroch and

Bockheim, 2007; Fahey, 2018) and encourages the development complex mycorrhizal associations and networks (Simard, 2018). Relationships between large-diameter CWD and mycorrhizal diversity are only recently being explored (Birch et al., 2023).



Coarse woody debris (CWD) and an example of a pit and mound feature observed at the study site (© THOMAS SALADYGA; RICARDO CHINEA-PEGLER [lower left photo]).

Conclusions

Our results provide evidence of a previously undocumented old-growth mixed mesophytic forest at New River Gorge National Park & Preserve. This report provides the first detailed assessment of old growth in the park and in southern West Virginia in general. Large-diameter (> 50 cm DBH) tree density and CWD volume were within the range of values reported for eastern old-growth forests (McGee, 2018), while tree age surpassed those estimated for the previously recognized Stone Cliff old-growth site also located within the park (OGFN, 2023). Additionally, the ubiquitous presence of pit and mound microtopography suggests belowground complexity that mirrors aboveground forest composition and stand structure. The forest, however, is not characterized by the "pristine" conditions often ascribed to old growth. Fire and then fire exclusion, invasive pests and pathogens, and climate change have and will continue to collectively shape the future of this pre-industrial legacy forest.

In summary, this report does not provide an exhaustive census of every "old" tree at the study site. Rather, it highlights the distinctive characteristics of a forest that was not lost to development or subjected to destructive land use practices. This is a rarity in the New River Gorge region and, as such, the Burnwood old-growth forest deserves recognition as an important natural heritage site and should be promoted as a resource for future research activities, educational programming, and recreation.

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