

Field Survey, Dendroecological Analysis, and Baseline Land Use History
for Identified Vegetation (Canopy and Sub-Canopy Trees)
at Totopotomoy Creek Battlefield/Rural Plains

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DESCRIPTION OF RICHMOND NATIONAL BATTLEFIELD PARK AND PARK UNIT

As one of the leading Civil War landscapes in the National Park Service, Richmond National Battlefield Park consists of eleven battlefield sites associated with the 1862 “Seven Days’ Battles” that concluded the first Union attempts to overtake Richmond, and those of the 1864 Overland Campaign. Newly acquired by the NPS in 2005, Totopotomoy Creek Battlefield/Rural Plains is comprised of 124 acres which include battle earthworks and one of the earliest residential structures in Hanover County, dating to circa 1726. Until recently, “Rural Plains” landholdings were utilized as a local nursery specializing in English boxwood. The property has been in agricultural use since before the Civil War; however, the extent and composition of historic landscape patterns (domestic use, fields, pastures, woodlots, etc) has not been determined.

GOAL AND TASKS OF THE PROPOSED PROJECT

The goal of this project is to produce a baseline land use history for Rural Plains/Totopotomoy Creek Battlefield through the use of field reconnaissance, selective tree dating, and ecological analysis based on age, distribution, and population dynamics of canopy and sub-canopy vegetation. The specific questions to be addressed for this baseline history include: age and condition of identified specimen trees within the presumed domestic landscape associated with the historic structure and its immediate environs; age and condition of identified trees sited along the road trace now functioning as a trail; limits of historic agriculture as indicated by tree stands (areas formerly under cultivation); dates and effects of significant environmental events (disturbances, weather phenomena, succession); other limited areas of interest identified through initial field reconnaissance with Principal Investigator.

This goal will be accomplished through completion of the following tasks.

1. Conduct field reconnaissance survey of Rural Plains/Totopotomoy Creek Battlefield in conjunction with Park staff; identify potentially historic specimen trees, wooded areas of interest, and field hedgerows for dating. Photographs of existing conditions for all vegetation should be recorded during fieldwork.
2. Develop historic timeline for specimen trees, wooded areas (historic woodlots, former fields), and field hedgerows based on analysis of field data.
3. Produce report that provides a baseline land use history as indicated by field and lab analysis of tree material, and documented with existing conditions photographs and base map of trees, woodlots, hedgerows, and other areas of interest addressed in the land use history. Map will indicate potential boundaries for historic fields suggested by field reconnaissance and tree dating research.

Methods

The Rural Plains site was divided into eight sections for the purpose of this study. These are: 1. The main house, 2. Northwest Point woods, 3. Northwest Woods, 4. West-central woods, 5. East-central woods, 6. Southwest woods, 7. Southeast woods, and 8. South woods. The location and boundary of each of these areas are indicated on the 2006 aerial photo in Figure 1. From April 9 to 11, a detailed reconnaissance was conducted of the entire site and a total of 26 trees were selected and cored for age with an increment borer. Seven of these trees were located around the main house, whereas the remaining 19 trees were located in the forested areas to the south. The trees cores were brought back to my lab at Penn State University where they were glued to a wooden block, sanded and examined under a microscope for the number of tree rings (i.e., tree age). Because the trees were cored at breast height (1.4 m), approximately 4 years need to be added to each core age to approximate total age of the tree. This is the time a typical tree would need to grow this tall. Photographs were taken in each of the study locations to document the condition of the site and tree composition and structure.

Results

Aerial photographs of the Rural Plains sites were taken in 1937, 1953 and 2006 (Figures 1-3). The 1937 aerial photo was taken in December 1936. Therefore, the deciduous hardwood trees were leafless at that time and probably gave the appearance of the forests being more open than they actually were. Alternatively, very dark areas of the forest in the 1937 aerial were probably dominated by pine. The 1953 photo was taken during the growing season making it much more difficult to distinguish pines from hardwoods. Nonetheless, these photos indicate dramatic changes in the landscape cover (forest versus agriculture) during this time period. In 1937, approximately 40% of Rural Plains was forested and the remaining 60% was in agriculture. By 1953, this pattern reversed itself with approximately 60% of Rural Plains being forested and 40% in agriculture. Most notably, three large fields in the south-central and southeast parts of Rural Plains were converted from agriculture to what appear to be young pine (probably loblolly pine; *Pinus taeda*) plantations or forests. Alternatively, in the southwest part of Rural Plains, a small field in a mostly forested area in 1937 became a larger open field in 1953. By 2006, the forested areas increased by another 5-10% as some agricultural areas in the northern, central and southwest portions were converted to woodlands. In contrast, however, one forested area in the west central portion of Rural Plains in 1953 was converted to an agricultural field by 2006. More specific changes in land-use and cover will be described for each woodlot in Rural Plains below.

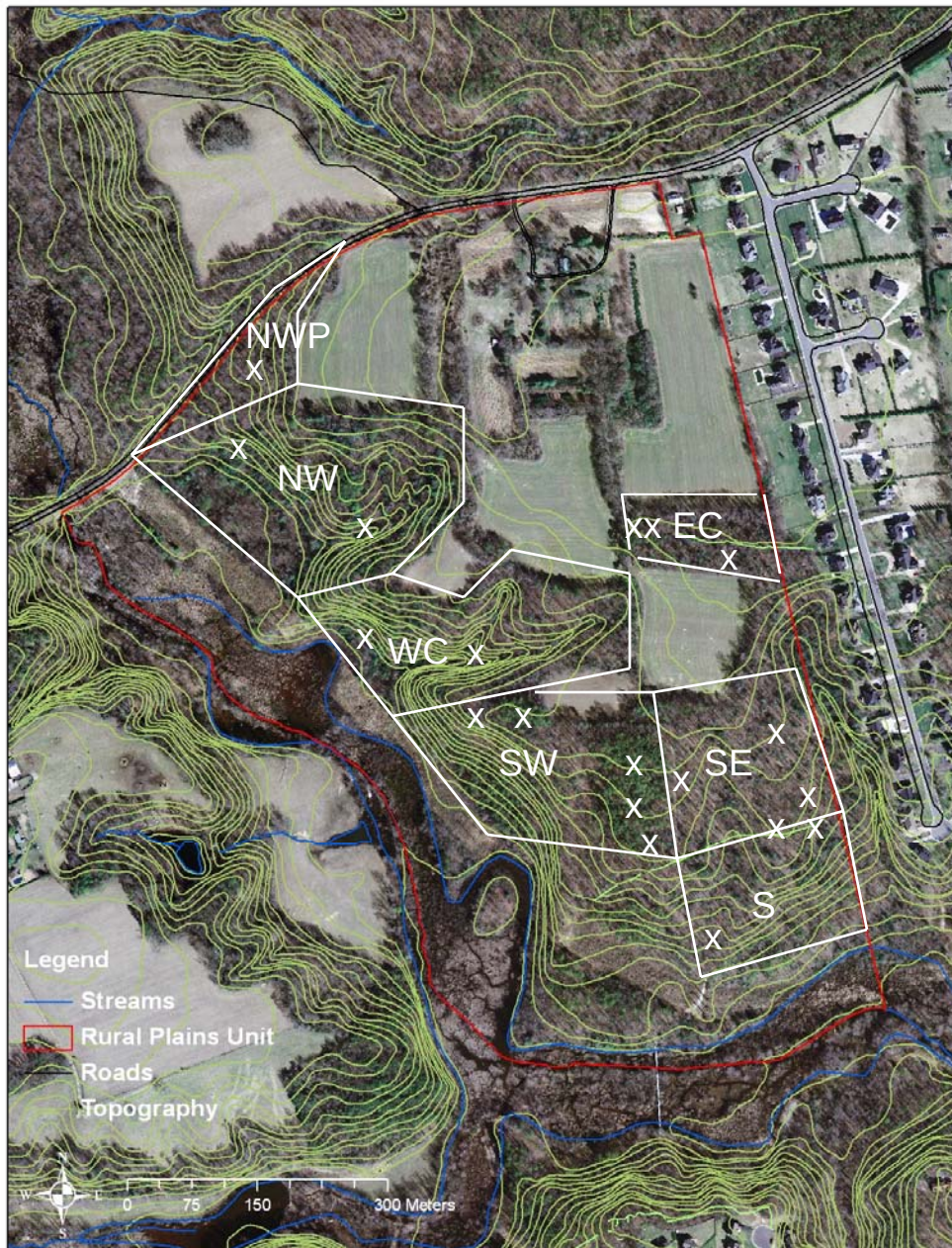


Fig. 1. Aerial photo of Rural Plains taken in 2006. The seven labeled polygons represent the seven woodlots in which the forest survey was conducted. NWP= northwest point; NW= northwest; WC= west-central; EC= east-central; SW= southwest; SE= southeast; S= south. The X's in each woodlot represent the location of trees measured for size and age.



Figure 2. Aerial photo of Rural Plains taken in 1953.



Figure 3. Aerial photo of Rural Plains taken in 1937.

Tree surrounding the main house

In the immediate area of the main house, seven trees were cored for age and measure for diameter at breast height (Fig. 4). There include a holly (*Ilex opaca*), elm (*Ulmus*; probably *U. americana*), black walnut (*Juglans nigra*), hackberry (*Celtis occidentalis*), sycamore (*Platanus occidentalis*), Chinese chestnut (*Castanea*) and pecan (*Carya illinoensis*; see Pics for examples). All the trees are large in size and range from 52 to 95.5 cm, although the multiple stem Chinese chestnut is especially large at 190 cm.

Because of their large size, I was not able to reach the pith for five of the seven trees. Thus, the ages presented in Table 1 underestimate their total age by about 20%. In the case of the Chinese chestnut, I cored one main stem above the lower trunk and it was rotten. Therefore, the total age of this tree exceeds the core age (65 years) by much more than 20%. The oldest trees around the main house are the elm at 154 and the holly at 127 years; these are the two trees in which the pith was reached. Because these trees were cored at breast height (1.2 m or 4.5 feet), about 5 years should be added to their age to get the date they were planted. The five other tree cores contained 42 to 93 years.



Fig. 4. A 2006, aerial photo of the main house at Rural Plains and the species and location of the trees that were measured for diameter and age.

Table 1. Tree diameter (at breast height; dbh) and age in 2008 for seven trees located around the main house at Rural Plains, Virginia.

Species	DBH (cms)	Total Age	Pith present
Hackberry	87	42	no
Pecan	85	48	no
Walnut	86.5	59	no
Sycamore	95.5	93	no
Elm	83	154	yes
Chinese Chestnut	190	65	no
Holly	52	127	yes



Pics of tree by main house. Photos of Chinese chestnut (top panel), sycamore (bottom left) and hackberry (bottom right) measured for size and age by the main house.

Northwest Point Woods

West of the main house and bordering Studley Road to the north is a triangular-shaped woodlot I labeled as northwest point woods. The area was not fully wooded in 1937 (Fig. 2), but was so in 1953 (Fig. 3). Thus, trees become established on an abandoned field sometime after 1937. The wood as it exists today is dominated by tulip poplar and a few oak trees, with understory trees of red maple (*Acer rubrum*), black cherry (*Prunus serotina*), beech (*Fagus grandifolia*) and hackberry (see Pics). A representative tulip poplar (*Liriodendron tulipifera*) I aged was 34 years old at dbh, for a total age of about 38 years. This indicates that the forest at Northwest Point originated approximately in 1970. Thus, the forest that was present in 1953 was apparently cut around 1970, after which the tulip poplar grew rapidly.



Pic. Tulip poplar dominated overstory at northwest point woods.

Table 2. Trees measured age and diameter in various woodlots throughout Rural Plains VA in 2008.

Rural Plains Woodlands

Species	Location	DBH (cms)	Total Age	Pith present
Tulip Poplar	NW point	56	34	yes
Willow Oak	NW woods	56.5	49	yes
White Oak	NW woods	60	98	yes
White Oak	West Central	42	92	yes
White Oak	West Central	41	94	yes
Tulip Poplar	East Central	48	47	yes
Loblolly Pine	East Central	41	44	yes
So. Red Oak	East Central	86.5	44	no
Loblolly Pine #1	SW Woods	34	44	yes
Loblolly Pine #2	SW Woods	33.5	41	yes
White Oak	SW Woods	45	73	yes
White Oak	SW Woods	43	84	yes
Loblolly Pine	SW Woods	36	49	yes
White Oak	SE Woods	42	77	yes
Sweetgum	SE Woods	34	75	yes
Sweetgum	SE Woods	46.5	118	yes
So. Red Oak	South Woods	42	66	yes
White Oak	South Woods	34	60	yes
Beech	South Woods	71	122	no

Northwest woods

Just south of northwest point woods an area designated as northwest woods. The northeast quarter of the woods is dominated by overstory loblolly pine, tulip poplar, black cherry and holly with a brushy understory, including the invasive shrubs Japanese honeysuckle (*Lonicera japonica*) and greenbriar (*Smilax*). This area appeared to be a continuous forest in 1937, but an L-shaped opening or field existed there in the 1953 aerial photos. In 1937, the western portion of the woods was more densely forested, including what appears to be a substantial amount of overstory pine. By 1953, however, the eastern portion of the western half appeared to be a much more sparsely populated forest. Outside of the northeast quarter, the wood is presently dominated by mixed oak (white oak (*Quercus alba*), southern red oak (*Q. falcata*) and willow oak (*Q. phellos*)), tulip poplar, beech, holly and loblolly pine. The understory is more open in the central

and western portions, being less brushy than the northeast quarter. I aged a 49 year old willow oak in the northwest part of the woods and a 98 year old white oak in the south-central part where the landscape is dissected by a ravine that flows to the wetlands/utility right-of-way to the west (see Pics). Thus, this area was mostly forested for the last century.



Pic. Willow oak (left panel) located in the northwest part and white oak (right panel) cored for age in the south central part of northwest woods.

West-central woods

To the south and east of northwest woods is west-central woods. There are agricultural fields surrounding most of this woods to the north, east, and to a lesser extent the south. The larger agricultural field to the east (across the main dirt road) was present in the 1937 and 1953 aerial photos, but the smaller field to the northwest was not present at those dates. After 1953, a portion of the northwest and west-central woods was cleared and used for agriculture. In contrast, the field to the south and east of this wood decreased in size from 1953 to 2006 as the forest increased in the eastern half of that field. In 1937, the east half of the west-central woods appeared to be fairly open (probably due to being hardwood dominated and photographed in a dormant, leafless condition), while the western half was denser, probably dominated by loblolly pine. Presently, there is a substantial amount of pine in the western half of the woods. By 1953, most of the woods were densely forested, although it is difficult to distinguish pines from hardwoods in that

aerial photo. The most prominent landscape feature of the west-central woods is two ravine systems that converge into one near the southern and western borders (see Pics). The forest is presently dominated by mature white oak, southern red oak, hickory, tulip poplar, beech, loblolly pine and holly. The beech is mainly located in or near the ravines where cooler and more mesic conditions prevail. The understory is open and sparsely vegetated. Two white oaks were cored for age in the woods, one in the central portion and one on the western edge near the wetlands/utility right-of-way. These trees are 92 and 94 years old, suggesting that that west-central wood established about 100 years ago, possibly after the last major logging event. The 94 year old white oak had suppressed growth for a decade starting in 1936 and for 15 years starting in 1952, after which growth increased. The 92 year old white oak had suppressed growth for an 18 year period starting in 1960. The exact cause(s) of the suppression is not known.



Pic. Ravine system and dissected topography (top panel) and mature white oak (bottom panel) in west-central woods.

East-central woods

This is a small wooded area in the east-central part of Rural Plains that lies east of the main dirt road (that bisects the site from north to south) and adjoins the eastern boundary of the park. In 1937 and 1953, this area appeared to exist as three parallel strips of forest oriented east to west with two narrow, open strips in between. The two outside strips of woods appear to be hedgerows for the agricultural fields that lie to the north and south. The middle strip contains Civil War earthworks in the form of a long trench and

mound of earth that extends a short distance beyond the eastern boundary of the park. By 2006, the east-central woods matured into a more continuous forest. In 2008, the forest was dominated by loblolly pine, tulip poplar, sweetgum (*Liquidambar styraciflua*), southern red oak and hickory (see Pics). A very large but rotten southern red oak stands in the northwest part of the woods. Several large southern red oaks grow along the agricultural fields at the southern boundary. Three trees were cored for age in this woods, including a 44 year old loblolly pine in the west-central portion, a 47 year old tulip poplar about 5 m west of the loblolly pine near the earthworks, and a large, 44 year old southern red oak further west and along the southern edge of the forest. This indicates that the present forest became established in the late 1950's or early 1960's. It appears that tulip poplar and loblolly pine established after abandonment of the middle opening present in 1953 aerial photo. The fact that the southern red oak cored here is about the same age as the pine and poplar is intriguing because its location was wooded in 1937 and 1953. It is possible that the area was logged around 1960.



Pics of east-central woods with loblolly pine and mixed-hardwoods (left panel) and large southern red oak (right panel).



Pics of east-central woods continued- southern border with several large southern red oak (bottom right); the one on the right was cored for age.

Southwest woods

This woods is immediately south of the west-central woods. In 1937, the northeast quarter and eastern third of the area were in agriculture, while the western and south-central portions were forested. By 1953, the eastern third of the woods was converted from agriculture to a young pine plantation; most of the northeast quarter remained in agriculture. However, a small opening in the middle of the west half of the forest in 1937 expanded to a larger opening by 1953. At present, the most of the wood is densely forested, except for the remaining agricultural field that borders the west-central woods to the north. Presently, loblolly pine dominates much of the tract except the central and southern portions which are dominated by a mixed-oak, tulip poplar, and hickory overstory, with oak, hickory, sweetgum, red maple and holly in the understory (see pics).

Five trees in this wood were measured for diameter and age, including two loblolly pine (41 and 44 years old) in the eastern section, an 84 year old white oak and 49 year old loblolly pine in the northwest quarter, and a 73 year old white oak in the southeast corner. A large and apparently very old white oak in the southern part of the woods was rotten and could not be aged. The age of the pines in the east part of the stand suggest they became established in the early or mid 1960's. However, the 1953 aerial photo indicated a young pine forest existed at that time. Therefore, one of three things may have happened. The first is that some pines became established later than many of

the other trees in the stand; 2) they spend many years in a suppressed condition prior to reaching breast height (the height at which they were cored); or 3) the stand present in the 1953 photo was cut in the 1960's and a new crop of pine trees became established at that time. Explanation 3 may be the most likely scenario. The ages of the white oak (73-84 years at dbh) in this woods is consistent with others at Rural Plains, but well below the maximum longevity for the species at 300-400 years.



Pics of southwest woods. Loblolly pine established after 1937 in the eastern portion (left panel) and white oak used for coring in the northwest quarter (right panel).



Pics of southwest woods *continued*. Large white oak in the south (bottom panel).

Southeast woods

The southeast wood is bordered to the northeast by more woods and to the northwest by an agricultural field. All three of these entities date back to 1937 and 1953. In 1937, it appears that the eastern half of the wood was more pine dominated, while the western half was more hardwood dominated. Along the southern edge of this woods, where it borders with the south woods, is a trench and mound earthworks created during the Civil War. The earthwork continues to the west across the main dirt road and runs along the southern border of the southwest woods. Presently, the forest is dense, contains a full range of tree diameter and canopy classes, and is dominated by southern red oak, white oak, tulip poplar, hickory, sweetgum and lesser amounts of beech (see Pics). Three trees were cored in this wood; a 75 year old sweetgum in the northeast quarter, a 77 year old white oak in the southeast quarter next to the earthworks, and a 118 year old sweetgum in the west-central portion. These ages support the information in the aerial photos that this area was forests prior to 1937. The 77 year old white oak experienced suppression in growth for a five year period starting in 1939 and a 17 year period starting in 1961. These suppressed periods were followed by increased growth.



Pics of southeast woods. Forest interior with large southern red oak (left panel) and Civil War earthworks in the form of a trench and mound (right panel).

South woods

To the immediate south of the southeast woods, on the other side of the Civil War earthworks, is the south wood. Its southern border extends to the utility right-of-way near the southeast corner of Rural Plains. In 1937, the south and east third of this area was an agriculture field that ran from the southwest to the northeast. At that time, a dense band of what appears to be pine grew along the north border of that field. In contrast, the central part of the forest was dominated by hardwoods in 1937. By 1953, this agricultural field and the larger one to the immediate west were converted to a young pine forest or plantation, while the rest of the area remained forested. Presently, the stand is dominated by southern red oak, white oak, tulip poplar, hickory, loblolly pine with some beech trees and holly (see Pics). A 66 year old southern red oak and a 60 year old white oak along the earthworks in the north and a large, 122+ year old beech in the southwest quarter were cored for tree ages. I did not reach the pith on the large beech. The ages of trees here and in southeast wood suggest that those growing near the earthworks are younger than the mature trees present in the forest. Thus, the earthworks create a unique micro-topography (trench and mound) known as a *land-use legacy* and were re-colonized by certain tree species after the Civil War in a spatial and temporal manner that differs from the less disturbed portions of the forest.



Pics of south woods. White oak and holly (left panel) and large beech cored for age (right panel).

Summary

Rural Plains contains, for the most part, of high quality woodlands of mixed hardwood and loblolly pine typical of the southeastern Coastal Plain. Trees growing around the main house were probably planted, including two species not native to Virginia- pecan and Chinese chestnut. Indeed, the elm and holly growing there were among the oldest trees of any at Rural Plains. The size of the trees at Rural Plains is impressive, despite the relatively young ages, and suggests that soils are good quality and highly conducive to tree growth. This can be expected on an area used extensively for agriculture. Nonetheless, I was somewhat surprised by the fairly young ages of many of the trees I cored, especially those that were chosen to represent what I thought were the oldest trees in each of the woods. Moreover, not all of the Rural Plains property is suitable for agriculture (e.g., the ravines in the west side). Most hardwood species represented in the natural woods at Rural Plains can live at least 200-300 years. The oldest tree I cored in the woodlots was a 118 year old sweetgum and a 122+ year old beech (pith not reached). Even loblolly pine can live 150-175 years on most Coastal Plain sites. The oldest loblolly pine I cored was only 49 years at breast height.

This raises the question why older trees are not present at the site? The most likely answer is that the forests were cut intensively and regularly for timber production and were converted periodically to agriculture or pine plantations. This high turnover of forests has actually promoted a young and healthy population of trees and the perpetuation of light-demanding oak, hickory and loblolly pine that now dominate the site. Other forests with these species in the mid-Atlantic and southeast regions that had fewer disturbances (fire and cutting) during the 20th century are being replaced by more shade tolerant, later successional species such as red maple, beech and holly. These species are present at Rural Plains, but presently are not in dominant position. However, this may change over time.

Future research on the forests at Rural Plains should focus on several aspects:

1. Conduct more detailed vegetation analysis of composition, structure and regeneration of the various woodlots.
2. Monitor the presence and location of exotic and native invasive plant species.
3. Develop a management plan for the natural forests at Rural Plains to promote long-term forest health and maintain the native tree species and keep invasive species to a minimum.
4. Conduct a hazard tree evaluation of Rural Plain focusing on trees around the main house and other locations where the public will be allowed to visit.
5. Research the *land-use legacy* impact of earthworks on the composition, structure, and ages of forests and soil structure and chemistry in and around the earthworks versus the forests and soils at some distance away.

Without proper management, the forests at Rural Plains will eventually lose their present composition and structure. It will experience increased red maple, beech and holly recruitment through the natural process of succession and the increase of invasive understory species such as Japanese honeysuckle and greenbriar. Over time, the earthworks will likely lose their integrity from soil erosion and forest growth and their role as a land-use legacy in the present-day forest will eventually wane. Action on the part of the National Park Service should be taken to preserve the cultural and natural heritage of the trees and woodlands at Rural Plains.

