

National Park Service  
U.S. Department of the Interior

Northeast Region  
Philadelphia, Pennsylvania



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## **Vegetation Classification and Mapping at Friendship Hill National Historic Site**

Technical Report NPS/NER/NRTR--2006/041



**ON THE COVER**

Tuliptree – Beech – Maple Forest in Friendship Hill National Historic Site.

Photograph by: Ephraim Zimmerman.

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U.S. Department of the Interior  
National Park Service  
Northeast Region  
Philadelphia, Pennsylvania

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## Executive Summary

Vegetation classification and mapping was conducted at Friendship Hill National Historic Site, creating a current digital geospatial vegetation database for the park. Seven vegetation associations, Northern Red Oak – Mixed Hardwood Forest, Tuliptree – Beech – Maple Forest, Sycamore Floodplain Forest, Early Successional Forest, Conifer Plantation, Successional Old Field, and Mixed Forb Marsh, that occur within the park were identified and described in detail.

The most abundant vegetation type in Friendship Hill National Historic Site is Tuliptree – Beech – Maple Forest. This vegetation type is similar to the natural vegetation of the region (Mixed Mesophytic Forest); however, the predominance of tuliptree (*Liriodendron tulipifera*) reflects the relatively recent disturbances. Northern Red Oak – Mixed Hardwood Forest is relatively limited in extent in Friendship Hill National Historic Site. This type occurs only on steep slopes where harvesting the trees was difficult, and in pockets of forest in which the oaks were not timbered. The Sycamore Floodplain Forest is the prominent vegetation type on the floodplain terraces adjacent to the Monongahela River. The Conifer Plantation association is the least abundant association in the park. These small patches of conifers are remnants of the pine plantations that once covered the Friendship Hill estate.

The Early Successional Forest and Successional Old Field associations occur in abandoned agricultural areas on which woody species have colonized. These associations illustrate the process of natural succession from open field to forest. The management of these former agricultural fields should be a priority for the park. The Successional Old Field association contains particularly high abundances of invasive plant species that threaten and impede the succession to a native forest type. The Mixed Forb Marsh association occurs in small patches along Ice Pond Run that drains from south to north through the center of the park. This variable vegetation type is heavily influenced by acid mine drainage and associated remediation efforts.

The lack of current management in the Successional Old Fields is promoting the establishment and spread of invasive species such as multiflora rose (*Rosa multiflora*), morrow's honeysuckle (*Lonicera morrowii*), and autumn olive (*Elaeagnus umbellata*). The park should develop a management plan for old fields to address the control of invasive species, the development of desired target vegetation structure and composition, and management actions to achieve the desired target conditions. If the desired target condition is a native forest type, Northern Red Oak – Mixed Hardwood Forest or Tuliptree – Beech – Maple should be considered for selection.

Since the time Albert Gallatin acquired the Friendship Hill estate over 200 years ago, the forest has been timbered and replanted numerous times, and the land has been mined for coal and cultivated for row crops, hay, orchards, tree nurseries, and Christmas trees (Roddy and Hammons 1986). The effects of these land uses can be seen on the land today, and their influences on the vegetation classification and the vegetation map are discussed throughout the report.

A map showing the locations of vegetation associations in the park was created, following the USGS/NPS Vegetation Mapping Program protocols (The Nature Conservancy and Environmental Systems Research Institute 1994a, b, c). These vegetation associations were also

crosswalked to the Terrestrial and Palustrine Plant Communities of Pennsylvania (Fike 1999) and the National Vegetation Classification System in order to provide a regional and global context for the park's vegetation. A dichotomous field key was developed for these vegetation associations to assist with field recognition and classification. This project documents the vegetation associations of Friendship Hill National Historic Site based on 2003 aerial photography and 2004 field sampling, and completes one of 12 basic inventory data sets for the park.

Keywords: vegetation association, vegetation classification, vegetation mapping, Friendship Hill National Historic Site

## Introduction

### General Background

One of the goals of the National Park Service's Inventory and Monitoring Program is to provide the information and expertise needed by park managers for effective, long-term management of the natural resources held in trust (National Park Service 2003). The program recommends that 12 basic natural resource inventories be developed for each park that contains significant natural resources. These inventories provide crucial baseline information needed for proper park natural and cultural resource stewardship. A map of each park's vegetation based on aerial photography less than five years old is one of the 12 inventories recommended by the program (National Park Service 2003). To ensure that vegetation mapping is standardized across the National Park Service (NPS), The Nature Conservancy, in conjunction with NatureServe, the Federal Geographic Data Committee, and the Ecological Society of America Vegetation Subcommittee, developed a protocol for creating vegetation maps in national parks. This protocol was adopted by the United States Geological Survey (USGS)/NPS Vegetation Mapping Program as the standard (The Nature Conservancy and Environmental Systems Research Institute 1994a, b, c) and has been implemented at Friendship Hill National Historic Site by the Pennsylvania Natural Heritage Program.

The goal of the mapping effort at Friendship Hill National Historic Site was to produce an up-to-date digital geospatial vegetation database for the park and to provide a plant species list, a dichotomous key for vegetation associations, and descriptions of the vegetation associations in the park. Baseline information on plant community composition and rarity is critical to developing desired conditions and park management goals relating to native plant communities, nonnative plant and insect species, and effects of deer browse and other disturbances. The identification and description of plant communities also provide habitat information important to understanding associated organisms, including animals, protozoans, bacteria, and fungi. A map of vegetation communities may allow inferences about the location and abundance of species that are characteristic of each community.

This report also describes the park's vegetation in the context of a national and regional vegetation classification. The Nature Conservancy, in conjunction with NatureServe, the Federal Geographic Data Committee, and the Ecological Society of America Vegetation Subcommittee, developed the National Vegetation Classification System (NVCS) in order to standardize vegetation classification and facilitate the comparison of vegetation types throughout the United States and internationally. The NVCS is a systematic approach to classifying existing natural vegetation using physiognomics and floristics. This classification system has a hierarchical structure (Grossman et al. 1998).

The basic unit of vegetation classification in the NVCS is the association. An association is defined as a plant community type that is relatively homogeneous in composition and structure and occurs in a uniform habitat. For example, Northern Red Oak - Sugar Maple - Tuliptree Forest is a common association in the Allegheny Plateau and Appalachian Mountain regions of the United States, typically found on mesic, well-drained sites. Associations are also assigned global rarity ranks that indicate their conservation status and relative risk of extirpation

(Grossman et al. 1998). Associations from the NVCS are often equivalent to communities in state-specific vegetation classifications such as the Terrestrial and Palustrine Plant Communities of Pennsylvania (Fike 1999). Therefore, NVCS associations can be crosswalked with communities in these state classifications.

Several associations that share one or more dominant or characteristic species can be grouped to form an alliance. Alliances are generally more wide-ranging geographically than associations, covering multiple habitats and having broader species composition. For example, the Northern Red Oak - Sugar Maple - Tuliptree Forest association mentioned previously is grouped with other similar northern red oak-dominated forest associations into the Northern Red Oak - (Sugar Maple) Forest Alliance. An association with unique species composition or environmental niche can be assigned to its own alliance, such that the alliance only contains one association instead of multiple associations.

One level above alliance is the formation, representing vegetation types that share a common vegetation structure and leaf phenology within broadly defined environmental factors (Grossman et al. 1998). For example, Lowland or submontane cold-deciduous forest is a common formation that encompasses numerous forest types in the northeastern and midwestern United States, including the Northern Red Oak - (Sugar Maple) Forest Alliance mentioned above.

#### Park-specific Information

Friendship Hill National Historic Site is a 280 ha (693 ac) national park unit that encompasses the country estate of Albert Gallatin. Gallatin served as a U.S. Senator and a U.S. Congressman before being appointed Secretary of the Treasury under presidents Thomas Jefferson and James Madison. His estate was designated as a National Historic Site in 1978. The historic site offers tours of Gallatin's house, as well as nature trails for hiking, cross-country skiing, and wildlife viewing.

A shapefile of the park's boundary was obtained from the North Carolina State University's Center for Earth Observation in fall 2003. All maps in this report used that shapefile to depict the park's boundary.

## Project Area

### Location and Regional Setting

Friendship Hill National Historic Site is situated on the banks of the Monongahela River in southwestern Pennsylvania, approximately three miles north of Point Marion, on PA Route 166 (Figure 1). It is located in Fayette County on the Masontown, PA 1:24,000 USGS topographic quad map. This area of the county occurs within the Pittsburgh Low Plateau section of the Appalachian Plateau physiographic province, a mature plateau where many steep-sided stream valleys cut down from the uplands to the large rivers that flow through this section (Schultz 1999).

The Pittsburgh Low Plateau generally is composed of rolling uplands and rounded hills. The predominant natural vegetation in the environs of Friendship Hill National Historic Site is Mixed Mesophytic Forest, typically dominated by sugar maple (*Acer saccharum*), yellow buckeye (*Aesculus flava*), American beech (*Fagus grandifolia*), tuliptree (*Liriodendron tulipifera*), white oak (*Quercus alba*), northern red oak (*Quercus rubra*), and American basswood (*Tilia americana*). This forest type typically occurs on rich mesic soils on gentle slopes or valley bottoms. This Mixed Mesophytic Forest is more common in adjacent West Virginia and can contain some elements of the Beech / Maple Forest common in the Midwest (Cuff et al. 1989). However, the extent of remaining forest cover is now limited in this part of Fayette County. The rich, deep soils that eroded off the lower slopes of the ridges and were deposited by streams have made this section of the county a prime agricultural area. The clearing of land for agriculture and land development has dramatically decreased the amount of forest cover (Wagner and Coxe 2000).

### Park Environmental Attributes and Site History

Many environmental factors, such as geology, topography, soils, and hydrology, affect the types and distribution of vegetation within Friendship Hill National Historic Site. The bedrock geology within the majority of Friendship Hill National Historic Site is Casselman Formation, a marine-derived sediment of Pennsylvania age that is composed of shale and siltstone, with limited amounts of sandstone, limestone, and coal. The higher elevations of the park occur over the Monongahela Group, a sedimentary sequence of Pennsylvania age, dominated by limestone, mudstone, shale, siltstone, and coal (Schultz 1999). Though coal makes up only a small part of the Monogahela Group, portions of the Friendship Hill estate and the lands adjacent to the park's current southeastern border have been mined for coal. From the mid-1940s to the mid-1950s, extensive underground mining and strip mining of the Pittsburgh coal seam occurred in and around the estate. Strip mining operations continued in the area until the late 1970s (Roddy and Hammons 1986). Although these mines are no longer in operation, their legacy persists in the form of acid mine drainage.

Elevation within the park ranges from approximately 235–350 m (780–1,140 ft). In the higher elevation sections of Friendship Hill National Historic Site, Monongahela silt loam, Cavode silt loam, Allegheny fine sandy loam, Westmoreland channery silt loam, and Guernsey silt loam

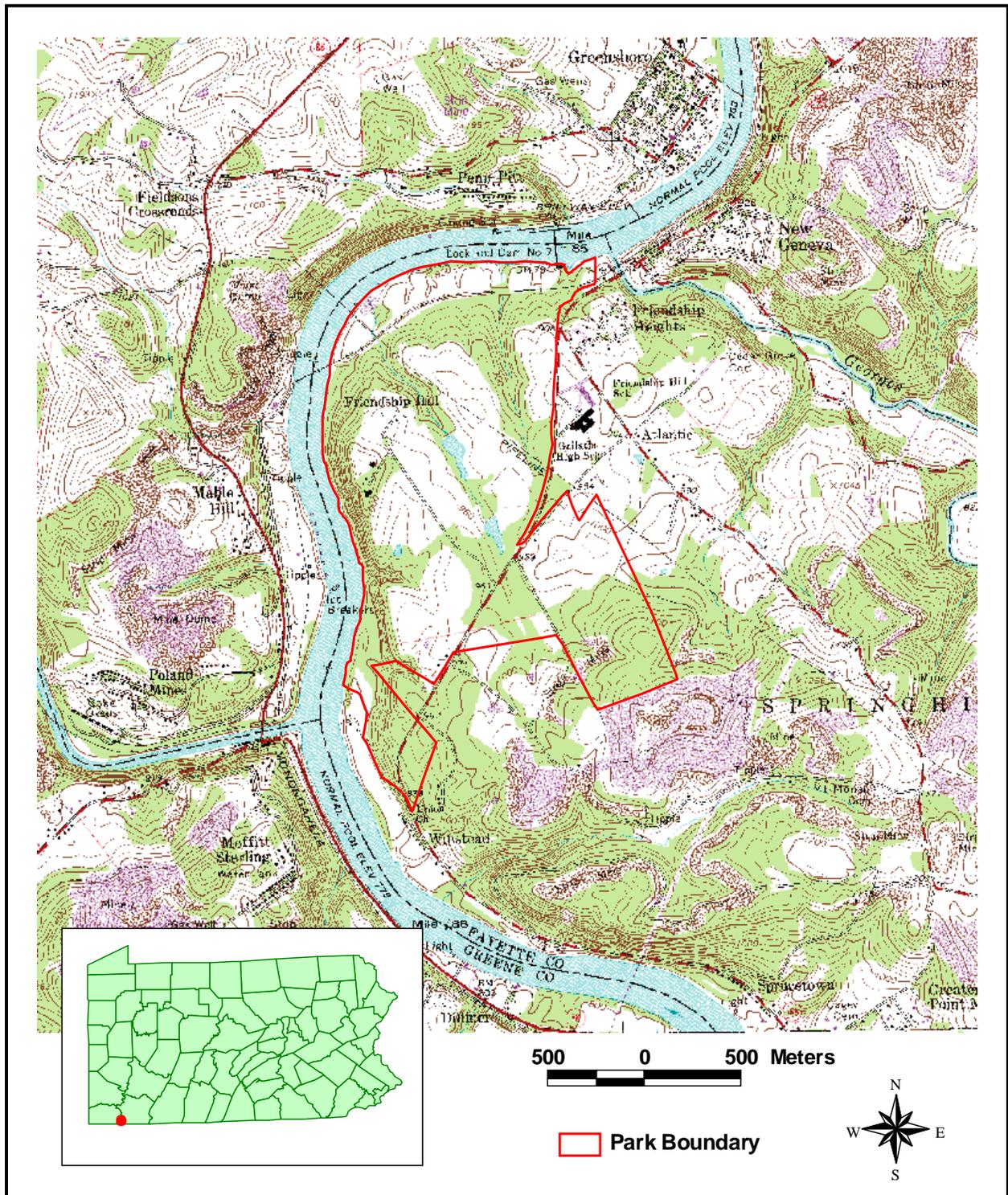


Figure 1. Location of Friendship Hill National Historic Site, Fayette County, Pennsylvania, on the Masontown, PA 1:24,000 USGS topographic quad map.

are common, somewhat poorly-drained to well-drained soils associated with upland fields and forest. The upland stream corridors draining toward the Monongahela River typically contain Tyler silt loam, a somewhat poorly-drained soil associated with depressional areas of stream terraces. Gilpin very stony silt loam occurs on the steep banks that lead down to the floodplain of the Monogahela River, on which Philo silt loam is the predominant soil (Kopas 1991).

The Monogahela River forms the western and northern border of the park and has historically been used as an important transportation route. Thus, the floodplain of the river in the Friendship Hill estate has supported boat landings and portions of a lock and dam. In 1911, a right-of-way along the banks of the Monongahela River was sold to the Monongahela Valley Railroad to build a rail line. After its construction, sparks and burning cinders from passing trains occasionally set fires to the Friendship Hill estate (Roddy and Hammons 1986).

Within Friendship Hill National Historic Site, one prominent stream, Ice Pond Run, flows north through the park to the Monogahela River. Ice Pond Run is not a natural stream; it exists solely because of drainage from a deep mine. In the late 1950s two ponds were constructed along Ice Pond Run. The upper pond collected and diverted the acidic water, while the lower pond was used for agricultural purposes. From 1988 to 1991, the upper pond was used by the U.S. Bureau of Mines and the National Park Service to test the ability of constructed wetlands to mitigate acid mine drainage. Three other small streams, Dublin Run, Rhododendron Run, and South Run, drain from the park property into the Monogahela River (Roddy and Hammons 1986).

Albert Gallatin bought the land that is now Friendship Hill National Historic Site in 1786 when most of the property was still in virgin forest, with large trees and little groundcover. Gallatin began clearing the forest to make land available for pasture, row crops, and orchards. By 1895, the Friendship Hill estate consisted of 128 ha (317 ac) that had been cleared for agriculture and 494 ha (200 ac) that remained wooded (Roddy and Hammons 1986).

During the 1920s, at least 110 additional hectares (280 ac) were timbered in the Friendship Hill estate. Some of the mature trees that were harvested had an average age of 260 years and a diameter at breast height (dbh) of up to 150 cm (60 in). Nearly 100,000 trees, including eastern white pine (*Pinus strobus*), red pine (*Pinus resinosa*), Japanese red pine (*Pinus densiflora*), Scotch pine (*Pinus sylvestris*), Austrian pine (*Pinus nigra*), European larch (*Larix decidua*), Japanese larch (*Larix kaempferi*), eastern hemlock (*Tsuga canadensis*), Norway spruce (*Picea abies*), balsam fir (*Abies balsamea*), and Douglas fir (*Pseudotsuga menziesii*), were ordered from nurseries to replant some of the cleared land (Roddy and Hammons 1986). In the 1930s, part of the Friendship Hill estate was used as a nursery, selling over 50 varieties of trees. The clearing and planting of forests continued at Friendship Hill through the 1940s and 1950s. Logging continued in both mature forests and second-growth forests. Part of the estate was also used to run a dairy, as well as to grow row crops and Christmas trees. The effects of these many land uses can be seen in the vegetation types today.



## Materials and Methods

### Planning and Scoping

Several steps were taken to prepare for the mapping and classification of vegetation at Friendship Hill National Historic Site. A planning and review meeting was held on June 19, 2003 with ecologists from the Pennsylvania Natural Heritage Program (both the Pennsylvania Science Office of The Nature Conservancy and the Western Pennsylvania Conservancy), National Park Service staff, and NatureServe staff. The project timeline, access issues, park resource management needs, current vegetation management, vegetation types of special interest, and applicable previous research conducted at the park were discussed. In addition, reconnaissance of the park's vegetation types was conducted to estimate the number and distribution of vegetation associations in the park.

### Preliminary Data Collection and Review of Existing Information

Previous studies conducted at Friendship Hill National Historic Site were obtained from the park's natural resource manager and reviewed for information pertinent to the park's vegetation. These reports included previous vegetation mapping conducted by the Western Pennsylvania Conservancy and the National Park Service, and inventories of birds and mammals (Roddy and Hammons 1986; Downs and Abrams 1990; Western Pennsylvania Conservancy 2003; Yahner and Ross 2004). The Fayette County Natural Heritage Inventory (Wagner and Coxe 2002) was also reviewed.

### Aerial Photography Acquisition and Processing

Color infrared, stereo pair 1:6,000 scale aerial photography for a digital orthophoto mosaic of Friendship Hill National Historic Site was acquired from an overflight on April 13, 2003, during leaf-off conditions, by Kucera International. Some of the photography was overexposed and, at the request of the National Park Service (NPS), Kucera International scanned the photos at 1200 dpi and color balanced and adjusted them. The NPS accepted these scanned images and sent them to North Carolina State University (NCSU) along with the original air photos. Upon receipt at NCSU, both the air photos and image files were counted to make sure that none were missing and placed in the air photo archive maintained at NCSU for the NPS Northeast Region Inventory & Monitoring Program. The airborne GPS/IMU files, the camera calibration certificate provided by Kucera International, and the hardcopy flight report for the photography that crosswalks the airborne GPS/IMU data to the photo frame numbers are also stored in the air photo archive.

The mosaic was produced from 18 color infrared air photos scanned at 1200 dpi with 24-bit color depth. The scanned images of the air photos were imported into ERDAS Imagine (.img) format where a photo block was created using airborne GPS and IMU data that Kucera International supplied with the aerial photography. The photo block was manipulated until it could be triangulated with a root mean square error of less than 1. At this point, single frame orthophotos (one for each air photo) were generated within Imagine and exported to Imagine .lan format. Then the .lan files were imported into ER Mapper's native (.ers) format, and an ER Mapper algorithm was created which contains the color balancing information and the cutlines created

for the final mosaic. In ER Mapper a band interleaved by line (.bil) image and header file of the final mosaic was generated, the .bil image was imported into Imagine .img format, and, finally, the .img image was compressed using MrSID software with a 20:1 compression ratio.

A metadata record for the mosaic was prepared according to current Federal Geographic Data Committee standards (FGDC 1998a). Metadata were produced in notepad and parsed using the USGS metadata compiler program (MP) to locate errors and omissions (USGS 2004). After all errors and omissions were corrected, MP was used to generate final TXT, HTML, and XML versions of each metadata record which are stored in the air photo archive. Key information for the Friendship Hill National Historic Site mosaic is summarized in Table 1.

### Photointerpretation

After receiving the digital orthophoto mosaic from North Carolina State University, ecologists at the Pennsylvania Natural Heritage Program developed a formation-level vegetation map. Vegetation formations are the most general level in the NVCS and classify vegetation by structure and leaf phenology. A general level of classification that broadly differentiates between vegetation types is very useful for vegetation mapping, especially because vegetation structure and leaf phenology can be easily identified through aerial photograph interpretation. This concept of broad formation-level vegetation types was borrowed from the NVCS in order to guide the vegetation mapping process. A map of vegetation types, differentiated by vegetation structure and leaf phenology, was developed as a guide over which the vegetation sampling efforts would be distributed. This map was attributed with formation-level names from the NVCS, solely as a guide. This map does not intend to identify specific NVCS formations for specific polygons, since each polygon's formation will be determined after the vegetation association classification and mapping according to the hierarchy of the NVCS.

The formation-level map was created through aerial photograph interpretation. Aerial photograph interpretation is the act of examining aerial photographs in order to identifying objects, in this case vegetation types (Avery 1978). The diapositive photographs (color infrared, stereo pair, hard copy photographs) were examined through a stereoscope, which provides the viewer with a three-dimensional view of the photographs. The digital orthophoto mosaic was also examined onscreen in ArcView 3.2 (Environmental Systems Research Institute, Inc., 1992–2000). In addition, digital topographic quad maps were examined in ArcView 3.2. Using information gathered from the diapositives, the mosaic, and the topographic maps, polygons representing different vegetation types and land uses were identified. These polygons were digitized onscreen using ArcView 3.2. Polygons that represented vegetation were attributed with formation-level vegetation types from the National Vegetation Classification System. Polygons that represented other land uses, such as buildings and roads, were attributed with names modified from the Anderson level II categories (Anderson et al. 1976). To determine which formation-level vegetation types or modified Anderson level II categories should be assigned to each polygon, an aerial photography interpretation key (Appendix A) was used.

Table 1. Summary of key information for Friendship Hill National Historic Site mosaic.

Title of metadata record:	Friendship Hill National Historic Site Color Infrared Orthorectified Photomosaic (ERDAS Imagine IMG and Mr.SID formats)
Publication date of mosaic (from metadata):	September 15, 2004
Date aerial photography was acquired:	April 13, 2003 (leaf-off)
Vendor that provided aerial photography:	Kucera International
Scale of photography:	1:6,000
Type of photography:	Color infrared, stereo pairs, leaf-off conditions
Number of air photos delivered:	18
Archive location of air photos, airborne GPS/IMU files, camera calibration certificate, and hard copy flight report:	North Carolina State University, Center for Earth Observation
Scanning specifications:	1200 dpi, 24-bit color depth
Horizontal positional accuracy of mosaic:	1.453 meters, meets Class 1 National Map Accuracy Standard
Number of ground control points upon which estimated accuracy is based:	34
Method of calculating positional accuracy:	Root Mean Square Error (RMSE)
Archive location of mosaic and metadata:	North Carolina State University, Center for Earth Observation
Format(s) of archived mosaic:	.img (uncompressed); MrSID (20:1 compression)

The resulting map (Figure 2) identified 102 map polygons, each labeled with one of 13 different attributes (Table 2). Of these polygons, 15 represent built-up land, ponds, the river, or transportation corridors. The remaining polygons were each attributed with one of nine formation-level vegetation types. The number of total mapped hectares listed in Table 2 is larger than the size of the park because the mapped polygons extend beyond the park boundary. This formation-level vegetation map was used to guide vegetation plot sampling in the park.

### Field Data Collection and Classification

All vegetation plot sampling followed the USGS/NPS Vegetation Mapping Program protocols (The Nature Conservancy and Environmental Systems Research Institute 1994b). The protocol recommends that each vegetation association should have been sampled at least three times in order to capture the naturally occurring variation within the park. If each of the formation-level vegetation types listed in Table 2 represented only one association in Friendship Hill National Historic Site, the minimum number of plots needed would have been 25. This assumed that areas labeled with modified Anderson level II categories would not be sampled, and that for formations with less than three polygons, only one plot would be placed in each polygon. However, it is more likely that some formations represent multiple associations. Alternatively, a few of the formation-level vegetation types assigned to the map may actually represent a single association. This occurs because of significant variation in vegetation structure and leaf phenology caused by past land use, natural resource management, and environmental setting. This is contrary to the hierarchical nature of the NVCS, and illustrates why the formation-level map does not accurately reflect each polygon's NVCS formation. Regardless, the formation-level map is a useful guide to determine the intensity, distribution, and location of vegetation sampling.

Based on the formation-level map, our initial reconnaissance of Friendship Hill National Historic Site, and previous vegetation mapping efforts at this and other parks, we concluded that approximately 30 plots would be sufficient to capture the range of vegetation types. Polygons labeled Conical-crowned temperate evergreen forest were not sampled because they represented extremely small remnants of conifer plantations, a vegetation type adequately sampled at other nearby parks. Many of the Medium-tall sod temperate or subpolar grassland polygons were also excluded from sampling because they represented frequently mowed grasslands in which the plants could not be identified.

### Field Survey

Within each polygon selected for sampling, a plot was established in an area that was most representative of the existing vegetation association (Mueller-Dombois and Ellenberg 1974). All vegetation data were collected following NatureServe's accepted natural heritage sampling protocols (Strakosch-Walz 2000), with 20-m x 20-m (66 ft x 66 ft) plots in forests and woodlands, 10-m x 10-m (33 ft x 33 ft) plots in shrublands, and 5-m x 5-m (16 ft x 16 ft) plots in herbaceous vegetation. The plot sampling data form used in this project is shown in Appendix B. Abbreviated instructions for completing this form and definitions of the fields can be found in the NBS/NPS Vegetation Mapping Program: Field Methods for Vegetation Mapping manual (The Nature Conservancy and Environmental Systems Research Institute 1994b). The

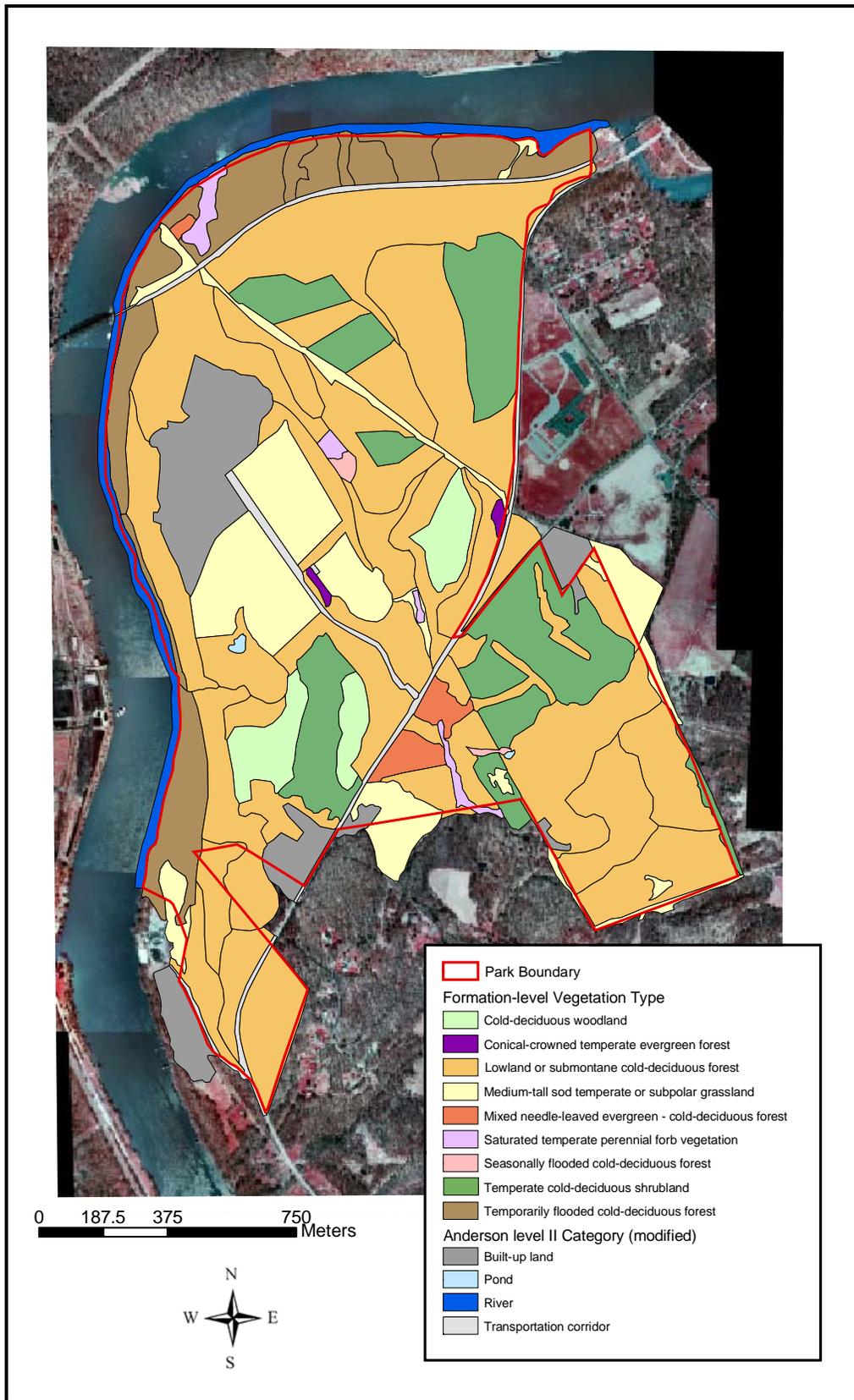


Figure 2. Formation-level vegetation types and Anderson level II categories (modified) for Friendship Hill National Historic Site.

Table 2. Number of polygons, total mapped hectares, mapped hectares within the park boundary, and number of plots sampled for formation-level vegetation types and Anderson level II categories (modified) at Friendship Hill National Historic Site.

	Number of Polygons	Total Mapped Hectares	Mapped Hectares within Park Boundary	Number of Plots Sampled
Formation-Level Vegetation Type				
Cold-deciduous woodland	3	10.05	10.05	2
Conical-crowned temperate evergreen forest	2	0.56	0.52	0
Lowland or submontane cold-deciduous forest	36	153.97	147.73	12
Medium-tall sod temperate or subpolar grassland	15	33.58	26.82	3
Mixed needle-leaved evergreen - cold-deciduous forest	3	3.57	3.57	3
Saturated temperate perennial forb vegetation	4	2.56	2.33	4
Seasonally flooded cold-deciduous forest	2	0.62	0.62	2
Temperate cold-deciduous shrubland	9	38.16	36.94	3
Temporarily flooded cold-deciduous forest	13	29.50	28.19	3
Anderson Level II Category (modified)				
Built-up land	6	21.86	16.58	0
Pond	2	0.24	0.24	0
River	2	9.32	1.32	0
Transportation corridor	5	7.42	5.42	0
Total	102	311.41	280.33	32

vegetation was visually divided into eight strata: emergent trees (variable height), tree canopy (variable height), tree subcanopy (>5 m [16 ft] in height), tall shrub (2–5 m [6–16 ft]), short shrub (<2 m [6 ft]), herbaceous, non-vascular, and vines. The percent cover was estimated for each species in each stratum using modified Braun – Blanquet cover classes (Strakosch-Walz 2000). Specimens of species that were not identifiable in the field were collected for later identification. In addition to floristic information, the following environmental variables were recorded at each plot: slope, aspect, topographic position, hydrologic regime, soil stoniness, average soil texture, and soil drainage. Any unvegetated area of the plot was characterized by the exposed substrate. Notes were taken on the plot representativeness of the surrounding vegetation and any other significant environmental information, such as landscape context, herbivory, stand health, recent disturbance, or evidence of historic disturbance. The vegetation profile and topographic position were sketched in cross-section to represent the location and setting of the plot. A digital photograph of each plot was also taken. The location of each plot was recorded with a Trimble GeoXM global positioning system (GPS) unit, with the datum set to North American 1983 (Conus) and the coordinate system set to Universal Trans-Mercator (UTM) zone 17.

Plot sampling was conducted in June and July 2004. In total, 32 plots were sampled throughout Friendship Hill National Historic Site (Figure 3). All vegetation types were sampled over a range of environmental variables. Two additional plots were added to the original sampling strategy, one each in a Saturated temperate perennial forb vegetation polygon and a Medium-tall sod temperate or subpolar grassland polygon in order to sufficiently capture the variation in species composition and environmental setting.

### Vegetation Classification and Characterization

Data from the 32 vegetation plots were entered into the NatureServe PLOTS 2.0 Database System on a Microsoft Access platform during August 2004. In the PLOTS 2.0 database, species were assigned standardized codes based on The PLANTS Database, Version 3.5, developed by the Natural Resource Conservation Service in cooperation with the Biota of North America Program (2006). For this report, some common names listed in The PLANTS Database, Version 3.5, were changed to reflect the common names typically used by ecologists and resource managers in this region. The common and scientific names of plants observed during the vegetation plot sampling are listed in Appendix C. Some tree and shrub seedlings and immature herbaceous plants could only be identified to the genus level and are therefore listed in the appendix as such. Environmental variables and species' percent cover data were exported from the PLOTS database into Excel in order to be manipulated into a format compatible with PC-ORD version 4.0 Multivariate Analysis software (McCune and Mefford 1999).

The vegetation plot data were analyzed using several multivariate statistical techniques available in the PC-ORD software. Different techniques were employed to provide multiple lines of evidence from which to interpret the results. For a detailed discussion of the statistical techniques used in this study, refer to McCune and Grace (2002). To classify the plot data into vegetation associations, a two-way indicator species analysis (TWINSPAN) was performed using the percent cover of species data. TWINSPAN successively divides the plots into groups

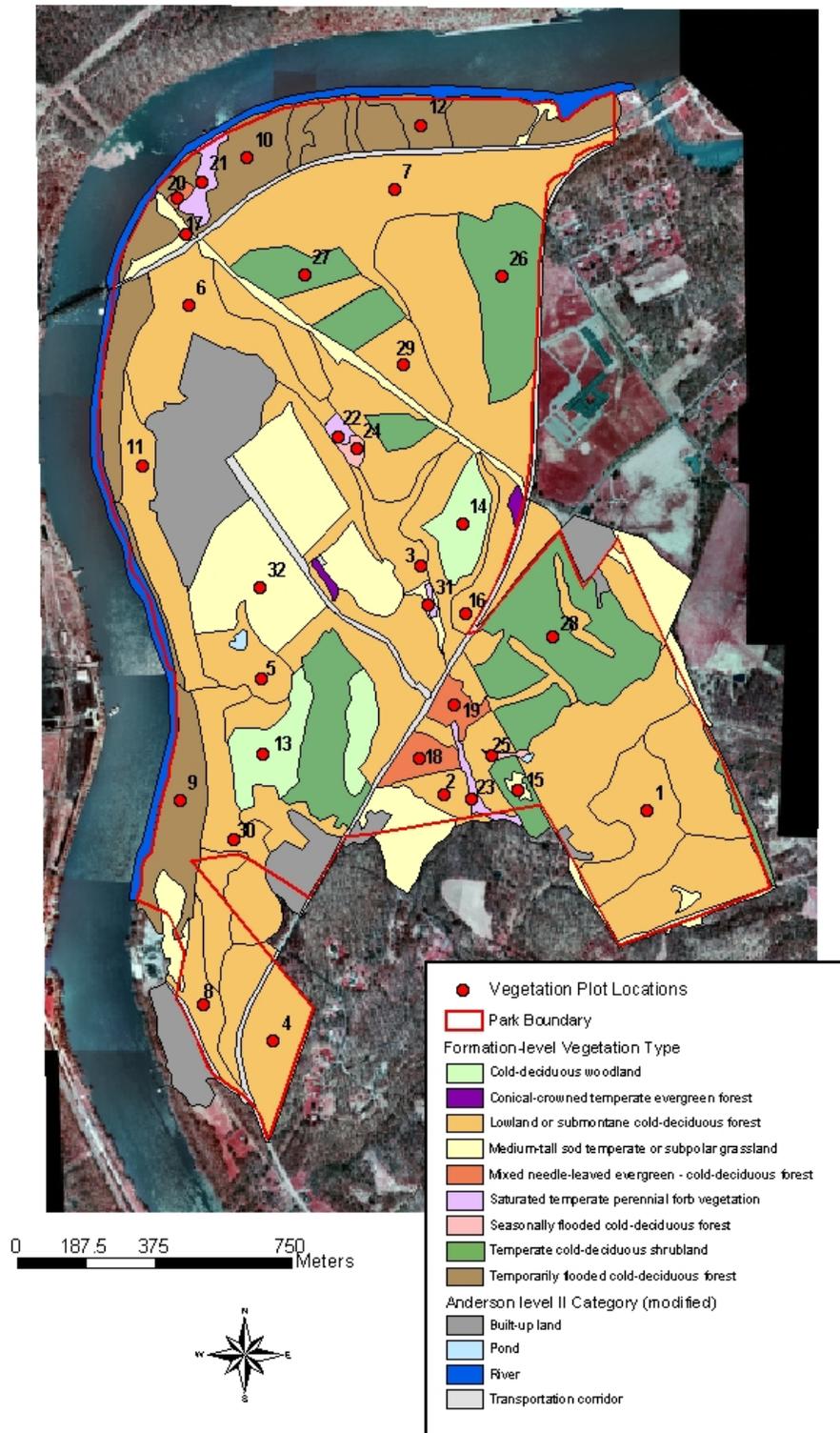


Figure 3. Locations of the 32 vegetation plots sampled in Friendship Hill National Historic Site for vegetation classification and mapping.

that are similar in species composition (Hill and Gauch 1979). A non-metric multidimensional ordination analysis (NMS) was also performed using both the percent cover of species and the environmental variables from the plots. NMS is an ordination technique well suited to non-normal data sets (Kruskal and Wish 1978). In this analysis, Sorensen distance measure, a random starting configuration, and a stability criterion of 0.005 were employed. Forty runs were performed with the real data, with a maximum of 400 iterations.

Based on these analyses, park-specific local vegetation associations were identified and described in detail. These vegetation associations were then crosswalked to the Terrestrial and Palustrine Plant Communities of Pennsylvania (Fike 1999) and the National Vegetation Classification System (NVCS) (NatureServe 2006). The NVCS was developed by ecologists of the Natural Heritage Program network and The Nature Conservancy after many years of literature review, data collection, and data analysis. This collaborative effort culminated in the publication of *International Classification of Ecological Communities: Terrestrial Vegetation of the United States* (Grossman et al. 1998). The International Classification of Ecological Communities, now known as the International Vegetation Classification, of which the NVCS is a subset, has been revised and refined since 1998, and is now managed by NatureServe in continued collaboration with the network of Natural Heritage Programs. The classification is housed in the Biotics database and is updated regularly (NatureServe 2006). The upper levels of the NVCS were adopted as a standard by the Federal Geographic Data Committee to support the production of uniform statistics on vegetation at the national level (Federal Geographic Data Committee 1996). The USGS/NPS Vegetation Mapping Program adopted the alliance level, and where possible, the association level, as the mapping unit for national parks.

Based on the aforementioned analyses, the park-specific local vegetation associations were qualitatively compared to existing associations in the National Vegetation Classification System by searching for alliances sharing similar dominant species, as well as physiognomy and environmental setting. Total floristic composition was used to determine the appropriate association within the alliance. Global information on the associations from the NVCS was then appended to the local descriptions to provide resource managers with a broader context for the vegetation in the park.

Each vegetation association was assigned a common name based on the Terrestrial and Palustrine Plant Communities of Pennsylvania (Fike 1999). If no appropriate name existed in Fike (1999), the National Vegetation Classification System common name was used. A park-specific common name was created for successional and cultural vegetation types not easily handled by Fike (1999) or the NVCS.

A park-specific dichotomous key was created for the vegetation associations to guide accuracy assessment and for use by park natural resource managers and others (Appendix D). A dichotomous key is a tool for identifying unknown entities, in this case, vegetation associations. It is structured by a series of couplets, two statements that describe different, mutually exclusive characteristics of the associations. Choosing the statement that best fits the association in question leads the user to the correct association. The dichotomous key should be used in conjunction with the detailed vegetation association descriptions to confirm that the association selected with the key is appropriate.

## Vegetation Map Preparation

Following the vegetation data analysis, the formation-level vegetation map was further edited and refined to develop an association-level vegetation map. Using ArcView 3.2, polygon boundaries were revised onscreen based on the plot data and additional field observations. Each polygon was attributed with the name of a vegetation association based on plot data, field observations, classification analyses, aerial photography signatures, and topographic maps. An aerial photograph interpretation key for the vegetation associations and Anderson level II categories (modified) is located in Appendix A. After the vegetation association map was completed, the thematic accuracy of this map was assessed.

## Accuracy Assessment

Two sources of potential error in the vegetation map include: 1) horizontal positional accuracy, in which a location on the photomosaic does not accurately align with the same location on the ground due to errors in orthorectification or triangulation; and 2) thematic accuracy, in which the vegetation type assigned to a particular location on the map does not correctly represent the vegetation at the same location in the park due to mapping error. The USGS/NPS Vegetation Mapping Program protocols (The Nature Conservancy and Environmental Systems Research Institute 1994c) were followed to assess the positional and thematic accuracy of the Friendship Hill National Historic Site vegetation map.

### Positional Accuracy Assessment

Well-defined positional accuracy ground control points, spaced throughout all quadrants of the mosaic, were placed on the final mosaic in ArcMap. Ground control points and zoomed-in screenshots of each point were plotted on hard copy maps with the mosaic as a background. These maps and plots were used to locate the ground control points in the field. For each plotted ground control point, field staff noted any alterations to the locations in the field, and then recorded the field coordinates with a Trimble Pro XR/XRS or GeoXT. Mapped ground control points that were physically inaccessible were also noted. The field crew correctly located and collected accuracy assessment data at 37 ground control points. The coordinate data were collected with real time GPS and post processed with differential correction using Pathfinder Office software. Prior to calculating accuracy, three ground control points, identified as outliers with SAS's JMP program, were removed. For each of the remaining 34 points, the field-collected "true" or "reference" GPS coordinates were compared to the coordinates obtained from the mosaic viewed in ArcMap. Both pairs of coordinates for each point were entered into a spreadsheet in order to calculate horizontal accuracy (in meters). Horizontal positional accuracy of the mosaic should meet Class 1 National Map Accuracy Standards (FGDC 1998b). Figure 4 shows the distribution of these 34 ground control points within the park and surrounding area.

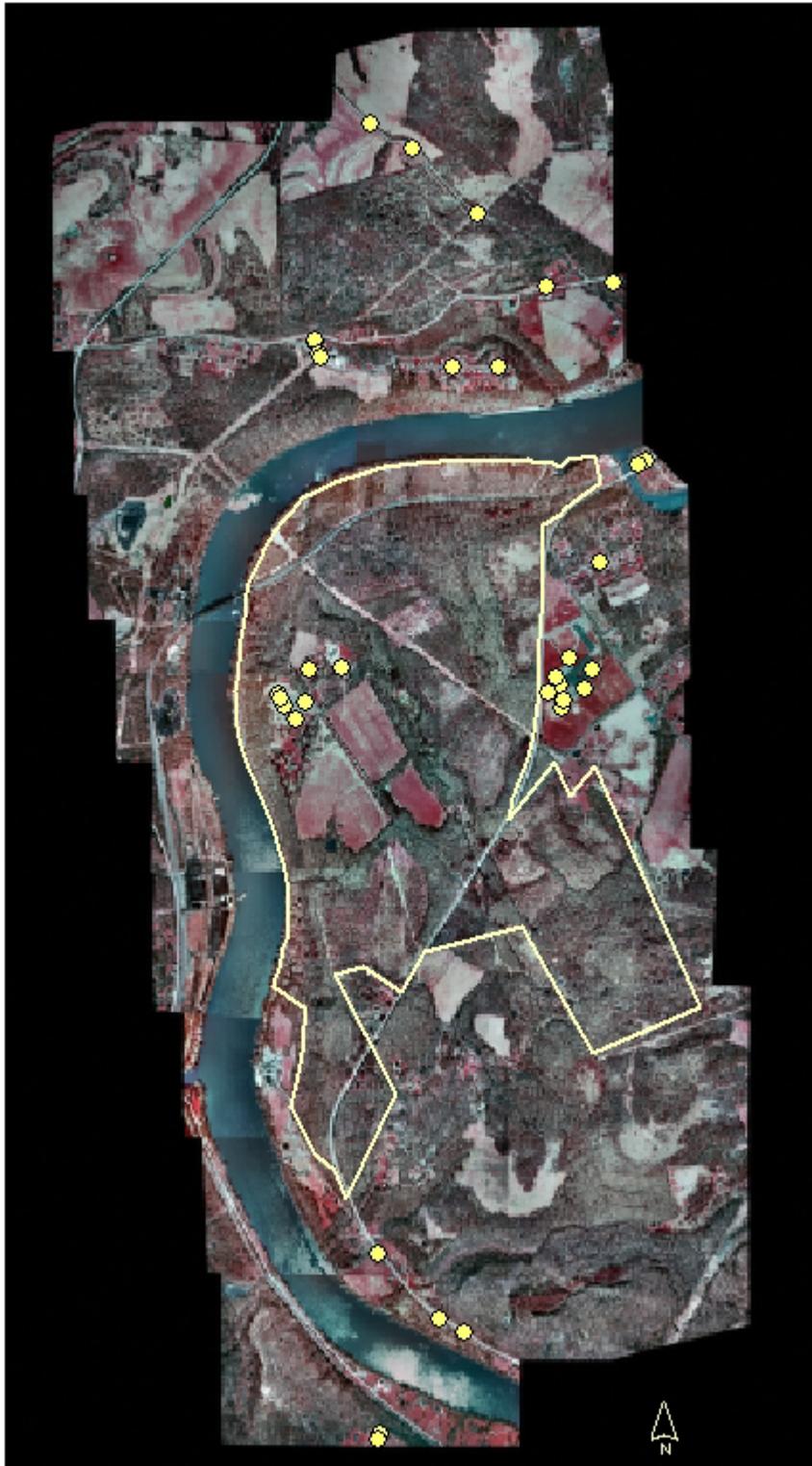


Figure 4. Ground control points (n=34) used to calculate horizontal positional accuracy of the Friendship Hill National Historic Site mosaic.

## Thematic Accuracy Assessment

The thematic accuracy of the vegetation map was assessed by the Pennsylvania Natural Heritage Program. A stratified random sampling approach was used, distributing the sampling effort across seven vegetation associations. Polygons labeled with modified Anderson level II categories were not included in the thematic accuracy assessment sampling. The number of samples per association varied according to the rarity of the vegetation type, both in terms of number of polygons and polygon size. The following rules were used to determine the number of points assigned to each association (The Nature Conservancy and Environmental Systems Research Institute 1994c):

- Scenario A: The class is abundant. It covers more than 50 hectares of the total area and consists of at least 30 polygons. In this case, it is recommended that 30 polygons be selected at random from the set of the association's polygons. One sampling point will be assigned to each of the 30 selected polygons.
- Scenario B: The association is relatively abundant. It covers more than 50 hectares of the total area but consists of fewer than 30 polygons. In this case, it is recommended that 20 polygons be selected at random from the set of the association's polygons, and that one sampling point be assigned to each of the 20 selected polygons. If the association contains less than 20 polygons, some polygons will contain multiple sampling points. The number of sampling points assigned to each polygon is determined by the relative area of that polygon compared with the other polygon in that association.
- Scenario C: The association is relatively rare. It covers less than 50 hectares of the total area but consists of more than 30 polygons. In this case, it is recommended that 20 polygons be selected at random from the set of the association's polygons. One sampling point will be assigned to each of the 20 selected polygons.
- Scenario D: The class is rare. It has 5 – 30 polygons and covers less than 50 hectares of the area. In this case, it is recommended that five polygons be selected at random from the set of the association's polygons. One sampling point will be assigned to each of the five selected polygons.
- Scenario E: The association is very rare. It has fewer than five polygons and occupies less than 50 hectares of the total area. In this case, it is recommended that one sampling point be assigned to each polygon.

Scenarios B, D, and E were used in the sampling design. Scenarios A and C were not used for this sampling design because no association met the criteria of those scenarios. The distribution of sampling points among vegetation associations was adjusted slightly from that recommended by the protocol to fit park-specific conditions. In general, the adjustments tended to weight the area covered by an association more heavily than the number of polygons contained in that association. Table 3 shows the allocation of the 47 accuracy assessment points among the vegetation associations.

Table 3. Thematic accuracy assessment (AA) sampling strategy for Friendship Hill National Historic Site.

Vegetation Association	Number of Polygons	Mapped Hectares within Park Boundary	Number of AA points Recommended by Protocol <sup>1</sup>	Number of AA points Sampled
Conifer Plantation	2	0.56	2	2
Early Successional Hardwood Forest	8	20.68	5	7
Mixed Forb Marsh	7	3.63	5	4
Northern Red Oak - Mixed Hardwood Forest	8	35.80	5	8
Successional Old Field	13	51.76	5	6
Sycamore Floodplain Forest	4	31.16	4	5
Tuliptree - Beech - Maple Forest	11	97.40	20	15
Total	53	240.99	46	47

<sup>1</sup>The Nature Conservancy and Environmental Systems Research Institute. 1994 (c). NBS/NPS Vegetation Mapping Program: Accuracy Assessment Procedures. 71pp. Report to the National Biological Survey and the National Park Service. Arlington, VA and Redlands, CA. <http://biology.usgs.gov/npsveg/standards.html>. Last accessed 17 March 2005.

In order to randomly determine the location of these sampling points in the polygons, the random number generator function in Microsoft Excel was used to create 900 sets of random x and y coordinates that fell within the boundaries of Friendship Hill National Historic Site. These coordinates were imported into ArcView 3.2 and overlaid onto the vegetation map. The first pair of coordinates listed in the table of coordinates to fall within a polygon at least 50 m (164 ft) from the polygon boundary was selected. All other points that fell within that polygon were deleted. This procedure was carried out until all 47 points were assigned (Figure 5).

Each accuracy assessment point was then located in the field using a Trimble Geo XM GPS unit during May and June 2005. The vegetation association at that location was then determined using the dichotomous key and the detailed vegetation descriptions. The minimum area of observation around the sampling point was a circle with a radius of 50 m (164 ft). The accuracy assessment data form used in this study is shown in Appendix E. Data from the 47 accuracy assessment points were then entered into the NatureServe PLOTS 2.0 Database System on a Microsoft Access platform during the fall of 2005. In the PLOTS database, species were assigned standardized codes based on The PLANTS Database, Version 3.5 (United States Department of Agriculture, National Resources Conservation Service 2006). For this report, some common names listed in The PLANTS Database were changed to reflect the common names typically used by ecologists and resource managers in this region. The common and scientific names of plants observed during thematic accuracy assessment sampling are listed in Appendix C. Some tree and shrub seedlings and immature herbaceous plants could only be identified to the genus level and are therefore listed in the appendix as such.

The thematic accuracy was then tabulated using a contingency matrix that compared the mapped vegetation communities with the actual vegetation communities observed in the field. Overall percent accuracy and the Kappa index were calculated (The Nature Conservancy and Environmental Systems Research Institute 1994c). Overall percent accuracy was calculated by dividing the number of correctly classified accuracy assessment points by the total number of accuracy assessment points. The Kappa index is the preferred method of reporting overall thematic accuracy because it takes into account that a certain number of correct classifications will occur by chance (Foody 1992). The USGS/NPS vegetation mapping protocol requires that the Kappa index of vegetation associations maps exceed 80% (The Nature Conservancy and Environmental Systems Research Institute 1994c).

Errors of omission and errors of commission were also calculated for each vegetation association. Both of these errors are calculated by dividing the number of correctly classified points in one association by the total number of points sampled in that association. Errors of omission indicate the probability that an accuracy assessment point classification will be correct and are calculated by mapped vegetation association. Errors of commission indicate the probability that a mapped vegetation association actually represents the vegetation on the ground. This error is calculated by observed vegetation association. The errors of omission and errors of commission for mapped vegetation associations should exceed 80%, according to the USGS/NPS Vegetation Mapping Protocol (The Nature Conservancy and Environmental Systems Research Institute 1994c).



Figure 5. Locations of the 47 thematic accuracy assessment sampling points in Friendship Hill National Historic Site.



## Results

### Vegetation Classification and Characterization

The vegetation associations of Friendship Hill National Historic Site were classified using TWINSpan and NMS analyses. The results of these two analyses were evaluated and compared to the Terrestrial and Palustrine Plant Communities of Pennsylvania (Fike 1999), vegetation classifications at nearby national parks, and the ecologists' field experiences at Friendship Hill National Historic Site. Based on this evaluation, the dendrogram of the TWINSpan results was interpreted (Figure 6). The evaluation determined that six of the 32 vegetation sampling plots were misclassified in the original dendrogram output. Mixed Forb Marsh, an association that includes wide variations in species composition, did not group well in this analysis and contained three of the six misclassified plots.

The NMS analysis recommended a three-dimensional ordination (Figure 7). For each axis,  $p = 0.0196$  in which  $p$  is equal to the proportion of randomized runs in which the stress is less than or equal to the observed stress. Stress in NMS analysis is calculated based on the distances between data points in the ordination space as compared to the same distances in higher-dimensionality space (McCune and Grace 2002). The cumulative  $r^2$  for the three axes was 0.641. Table 4 lists several environmental and physiognomic variables that showed strong correlations with the axes. As would be expected from these correlations, the palustrine associations tend to occur in the lower portion of the diagram while terrestrial associations occur in the upper portion of the diagram. Forests tend to fall to the upper right side of the ordination, whereas woodlands and shrublands occur in the upper left section of the diagram. Associations dominated by graminoids and herbs fell in the lower left section of the ordination (Figure 7). Figure 7 shows the ordination diagram with the plots grouped into vegetation associations as determined by the evaluation. Axes 1 and 3 were chosen for display in Figure 7 because they reported higher  $r$  values than axis 2 (Table 4) and because they provided the clearest visual depiction of the groups.

Based on these analyses and the evaluation of the results, it was determined that the vegetation at Friendship Hill National Historic Site can be described by seven vegetation associations: Northern Red Oak – Mixed Hardwood Forest, Tuliptree – Beech – Maple Forest, Sycamore Floodplain Forest, Early Successional Hardwood Forest, Conifer Plantation, Successional Old Field, and Mixed Forb Marsh. One modified Anderson level II category, Grassland, was also sampled and therefore is shown in the diagrams of the results (Figures 6 and 7). The Conifer Plantation association was observed in Friendship Hill National Historic Site, but was not sampled there because adequate data on this type had been collected at several other nearby national parks. In addition, the examples of the Conifer Plantation association in Friendship Hill National Historic Site are extremely small in size since they are remnants of previously larger plantations.

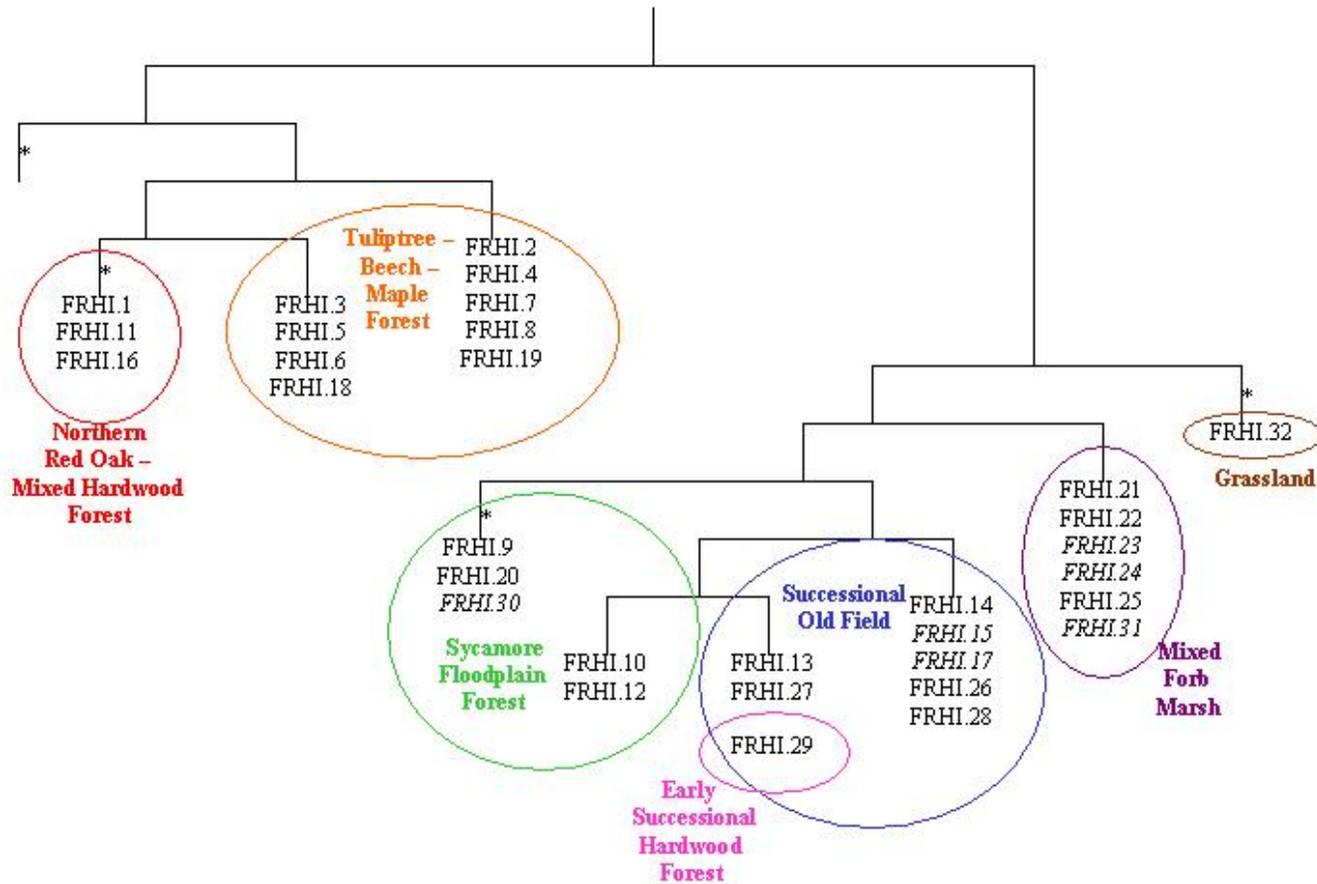


Figure 6. Dendrogram interpreted from the two-way indicator species analysis (TWINSPAN) results, showing vegetation associations and one modified Anderson level II category (Grassland) in Friendship Hill National Historic Site. No vegetation plots were sampled in the Conifer Plantation association, therefore, it is not represented in this diagram. The plots that were determined through the results evaluation to be misclassified by the analysis are labeled in italics and are shown correctly classified. The branches of the dendrogram in which the misclassified plots were originally incorrectly located are marked with asterisks (\*).

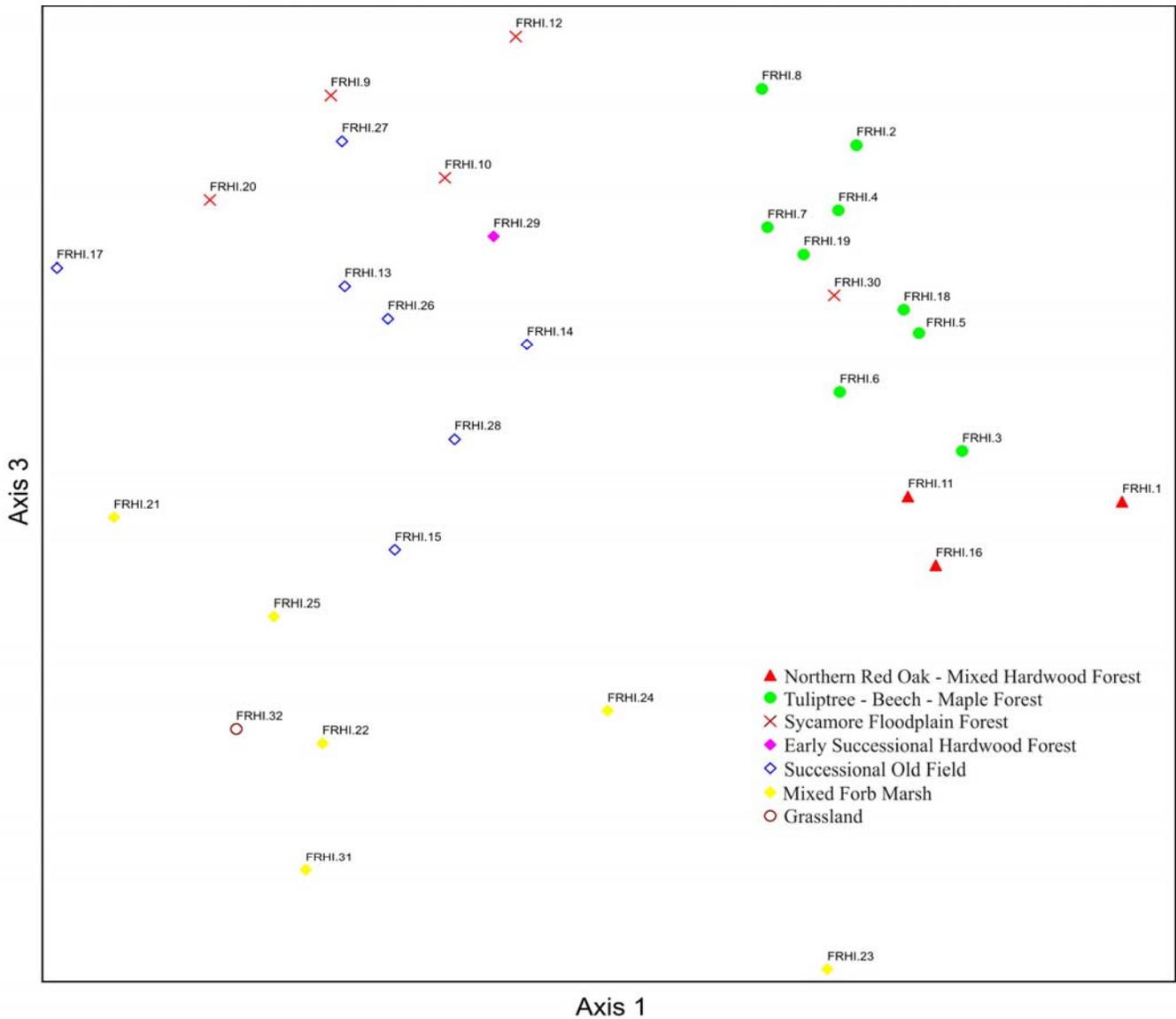


Figure 7. Ordination diagram from the non-metric multidimensional ordination analysis (NMS) showing vegetation associations and one modified Anderson level II category (Grassland) in Friendship Hill National Historic Site. No vegetation plots were sampled in the Conifer Plantation association, therefore, it is not represented in this diagram.

Table 4. Correlations (r values) between measured variables and the three axes calculated in the non-metric multidimensional ordination analysis (NMS).

Measured Variable	Axis 1	Axis 2	Axis 3
Percent cover of emergent trees	0.699	-0.020	0.358
Percent cover of tree canopy	0.683	0.066	0.573
Percent cover of subcanopy	0.422	-0.199	0.568
Percent cover of tall shrubs	0.335	0.054	0.550
Percent cover of herbaceous layer	-0.953	-0.109	-0.109
Unvegetated surface in plot			
Percent cover of litter	0.679	0.054	0.272
Percent cover of wood	0.565	0.160	0.579
Percent cover of water	-0.295	0.148	-0.500

## Vegetation Association Descriptions

Detailed local descriptions for seven vegetation associations were written based on the plot data, photographs of each plot, and the ecologists' field experiences at Friendship Hill National Historic Site and other nearby national parks. These vegetation associations were then crosswalked to the Terrestrial and Palustrine Plant Communities of Pennsylvania (Fike 1999) and the National Vegetation Classification System (NVCS). Detailed local and global descriptions of the vegetation associations are presented. Except for the Conifer Plantation association, representative photographs of each vegetation association are provided after each description. An index of these photos is located in Appendix F. A bibliography for the sources cited in the global vegetation descriptions from the NVCS is provided in Appendix G. A list of the 256 plants found during the vegetation plot sampling and thematic accuracy assessment sampling is located in Appendix C.

A dichotomous key was also developed for these seven vegetation associations (Appendix D). The dichotomous key should be used in conjunction with the detailed vegetation association descriptions to confirm that the association selected with the key is appropriate. This key and the detailed vegetation association descriptions were used in the thematic accuracy assessment and may be used by park resource managers and others to identify vegetation associations in the park.



**Common Name (Park-specific): Northern Red Oak – Mixed Hardwood Forest**

**SYNONYMS**

**NVC English Name:** Northern Red Oak - Sugar Maple - Tuliptree Forest

**NVC Scientific Name:** *Quercus rubra* - *Acer saccharum* - *Liriodendron tulipifera* Forest

**NVC Identifier:** C EGL006125

**LOCAL INFORMATION**

**Environmental Description:** This forest type is found occasionally throughout Friendship Hill National Historic Site on mid to upper slopes and higher topographic positions. This type typically occurs on well-drained soils such as Monongahela silt loam, Allegheny fine sandy loam, and Gilpin very stony silt loam. These stands occur on steep slopes where harvesting trees is more difficult or in patches of forest from which the oaks were not recently harvested.

**Vegetation Description:** Characteristic canopy composition for this forest type includes one or two oak species (*Quercus* spp.) that are at least codominant with a variety of other hardwood species. Typical oak species are northern red oak (*Quercus rubra*), white oak (*Quercus alba*), and black oak (*Quercus velutina*). The most common hardwood associate is red maple (*Acer rubrum*). Other common hardwood species found in the canopy are sugar maple (*Acer saccharum*), pignut hickory (*Carya glabra*), shagbark hickory (*Carya ovata*), tuliptree (*Liriodendron tulipifera*), American beech (*Fagus grandifolia*), chestnut oak (*Quercus prinus*), white ash (*Fraxinus americana*), sassafras (*Sassafras albidum*), and blackgum (*Nyssa sylvatica*). The height of the trees in the canopy ranges from 20 to 30 m, and the canopy cover is generally greater than 80% of the area. Subcanopy trees range from 9 to 16 m in height and typically cover 20–40% of the area. Common subcanopy trees include red maple, sugar maple, flowering dogwood (*Cornus florida*), and other hardwoods listed above. A moderately dense tall-shrub layer (2–5 m in height; 30–40% cover) is also typical of this forest type and is composed of saplings of the canopy trees listed above. In addition, hophornbeam (*Ostrya virginiana*) and northern arrow-wood (*Viburnum recognitum*) can be common tall shrubs in this forest type. The short-shrub layer (<2 m in height) can be sparse or moderately dense (15–40% cover) and is primarily composed of seedlings of the canopy trees species and tall-shrub species. Ericaceous species such as Blue Ridge blueberry (*Vaccinium pallidum*) and deerberry (*Vaccinium stamineum*) can be common, along with non-ericaceous species such as Allegheny blackberry (*Rubus allegheniensis*) and northern spicebush (*Lindera benzoin*). The herbaceous layer is often sparse and includes flattened oatgrass (*Danthonia compressa*), white wood aster (*Eurybia divaricata*), Carolina horsenettle (*Solanum carolinense*), mayapple (*Podophyllum peltatum*), feathery false lily of the valley (*Maianthemum racemosum* ssp. *racemosum*), New York fern (*Thelypteris noveboracensis*), panicgrass (*Panicum* sp.), sedges (*Carex pensylvanica*, *Carex digitalis*, *Carex communis*, *Carex rosea*, *Carex swanii*), white rattlesnakeroot (*Prenanthes alba*), sessile-leaf bellwort (*Uvularia sessilifolia*), Indian-pipe (*Monotropa uniflora*), eastern hay-scented fern (*Dennstaedtia punctilobula*), jewelweed (*Impatiens* sp.), partridgeberry (*Mitchella repens*), calico aster (*Symphotrichum lateriflorum* var. *lateriflorum*), common cinquefoil (*Potentilla simplex*), common woodrush (*Luzula multiflora*), and jumpseed (*Polygonum virginianum*). Vines such as greenbrier (*Smilax rotundifolia*, *Smilax glauca*), Virginia creeper (*Parthenocissus quinquefolia*), eastern poison-ivy (*Toxicodendron radicans*), and summer grape (*Vitis aestivalis*) can be sparsely distributed through the forest. This forest type is susceptible to

invasion by Japanese stilt grass (*Microstegium vimineum*) and Japanese honeysuckle (*Lonicera japonica*).

**Most Abundant Species:**

<u>Stratum</u>	<u>Lifeform</u>	<u>Species</u>
Tree canopy	Broad-leaved deciduous tree	<i>Quercus alba</i> , <i>Quercus rubra</i> , <i>Quercus velutina</i>
Tree subcanopy	Broad-leaved deciduous tree	<i>Acer rubrum</i> , <i>Acer saccharum</i>
Tall shrub/sapling	Broad-leaved deciduous shrub	<i>Ostrya virginiana</i> , <i>Viburnum recognitum</i>
Short shrub/sapling	Broad-leaved deciduous shrub	<i>Vaccinium pallidum</i> , <i>Vaccinium stamineum</i>
Herb (field)	Vine/Liana	<i>Parthenocissus quinquefolia</i> , <i>Smilax glauca</i> , <i>Smilax rotundifolia</i>
Herb (field)	Forb	<i>Danthonia compressa</i> , <i>Eurybia divaricata</i> , <i>Podophyllum peltatum</i> , <i>Solanum carolinense</i>

**Characteristic Species:** *Acer rubrum*, *Betula lenta*, *Quercus alba*, *Quercus rubra*, *Quercus velutina*.

**Other Noteworthy Species:** Information not available.

**Subnational Distribution with Crosswalk Data:**

<u>State</u>	<u>State Rank</u>	<u>Confidence</u>	<u>State Name</u>	<u>Reference</u>
PA	S5	1	Red oak - mixed hardwood forest	Fike 1999

**Local Range:** Mid to upper slopes, higher topographic positions, and well-drained soils in Friendship Hill National Historic Site.

**Classification Comments:** The composition of this forest may overlap with that of Tuliptree - Beech - Maple Forest. However, oaks cover at least 50% of the canopy in this forest type, with tuliptree as an associate (typically <25% cover). Also, northern spicebush is an associate shrub in this forest type, not a clear dominant in the tall- or short-shrub layers as it is in Tuliptree - Beech - Maple Forest.

**Other Comments:** Information not available.

**Local Description Authors:** S. J. Perles (PNHP).

**Plots:** FRHI.1, FRHI.11, FRHI.16.

**Friendship Hill National Historic Site Inventory Notes:** Information not available.

**GLOBAL INFORMATION**

**NVC CLASSIFICATION**

Physiognomic Class	Forest (I)
Physiognomic Subclass	Deciduous forest (I.B.)
Physiognomic Group	Cold-deciduous forest (I.B.2.)
Physiognomic Subgroup	Natural/Semi-natural cold-deciduous forest (I.B.2.N.)
Formation	Lowland or submontane cold-deciduous forest (I.B.2.N.a.)
Alliance	<i>Quercus rubra</i> - ( <i>Acer saccharum</i> ) Forest Alliance (A.251)
Alliance (English name)	Northern Red Oak - (Sugar Maple) Forest Alliance
Association	<i>Quercus rubra</i> - <i>Acer saccharum</i> - <i>Liriodendron tulipifera</i> Forest
Association (English name)	Northern Red Oak - Sugar Maple - Tuliptree Forest

**Ecological System(s):** Laurentian-Acadian Pine-Hemlock-Hardwood Forest (CES201.563).  
Appalachian (Hemlock)-Northern Hardwood Forest (CES202.593).

#### **GLOBAL DESCRIPTION**

**Concept Summary:** This red oak - sugar maple community is found primarily in the Allegheny Plateau and Appalachian Mountain regions of the United States, as well as on the northern Piedmont north to the Hudson Valley, with possible extensions east and west of those areas. It is typically found in coves, on moist north- and east-facing slopes and on well-drained flats. Soils are slightly acidic and of intermediate fertility. Stands contain a closed-canopy tree layer. *Acer saccharum*, *Liriodendron tulipifera*, *Quercus alba*, and *Quercus rubra* are the leading dominant or characteristic species. *Acer rubrum*, *Carya ovata*, *Carya alba*, *Carya glabra*, *Nyssa sylvatica*, *Quercus coccinea*, *Quercus prinus*, and *Quercus velutina* are possible associates. A wide variety of more mesic associates, such as *Betula alleghaniensis*, *Betula lenta*, *Fagus grandifolia*, *Magnolia acuminata*, and *Fraxinus americana*, occur in some areas. In addition to *Acer saccharum* reproduction, some understory species may include *Carpinus caroliniana*, *Cercis canadensis*, and *Ostrya virginiana*. Shrub and vine species include *Amelanchier laevis*, *Amelanchier arborea*, *Cornus* spp., *Hamamelis virginiana*, *Lindera benzoin*, *Viburnum acerifolium*, *Viburnum recognitum*, and *Vitis riparia*. Ericaceous shrubs, such as *Kalmia latifolia*, *Vaccinium angustifolium*, and *Vaccinium pallidum*, may also be present. The ground layer species are highly variable, but include *Caulophyllum thalictroides*, *Ageratina altissima*, *Dennstaedtia punctilobula*, *Podophyllum peltatum*, *Maianthemum racemosum*, *Medeola virginiana*, *Thelypteris noveboracensis*, *Dryopteris marginalis*, *Actaea* spp., and *Uvularia sessilifolia*.

**Environmental Description:** Stands are typically found in coves, on moist north- and east-facing slopes, and on well-drained flats. Soils are slightly acid and of intermediate fertility (Anderson 1982, Reschke 1990, Fike 1999).

**Vegetation Description:** Stands of this red oak - sugar maple forest contain a closed-canopy tree layer. *Acer saccharum*, *Liriodendron tulipifera*, *Quercus alba*, and *Quercus rubra* are the leading dominants. *Acer rubrum*, *Carya ovata*, *Carya alba*, *Nyssa sylvatica*, and *Quercus velutina* are possible associates. *Liriodendron* dominance may indicate a past disturbance history, and *Carya* spp. may share dominance in some stands. There is evidence (Fleming 1999) that *Castanea dentata* may have been important in these stands prior to its demise. A wide variety of more mesic associates, such as *Betula alleghaniensis*, *Betula lenta*, *Fagus grandifolia*, and *Fraxinus americana*, could occur but are negligible in dominance. In addition to *Acer saccharum* reproduction, some understory species may include *Carpinus caroliniana*, *Cercis canadensis*, and *Ostrya virginiana*. Shrub and vine species include *Amelanchier laevis*, *Amelanchier arborea*, *Cornus* spp., *Hamamelis virginiana*, *Lindera benzoin*, *Viburnum acerifolium*, *Viburnum recognitum*, and *Vitis riparia*. Ericaceous shrubs, such as *Kalmia latifolia*, *Vaccinium angustifolium*, and *Vaccinium pallidum*, may also be present. The ground layer species are highly variable, but include *Caulophyllum thalictroides*, *Dennstaedtia punctilobula*, *Podophyllum peltatum*, *Maianthemum racemosum*, *Medeola virginiana*, *Thelypteris noveboracensis*, and *Uvularia sessilifolia*.

**Most Abundant Species:**

<u>Stratum</u>	<u>Lifeform</u>	<u>Species</u>
Tree canopy	Broad-leaved deciduous tree	<i>Acer saccharum</i>
Tree subcanopy	Broad-leaved deciduous tree	<i>Acer saccharum</i>
Tree canopy	Broad-leaved deciduous tree	<i>Quercus alba, Quercus rubra</i>
Tree subcanopy	Broad-leaved deciduous tree	<i>Acer rubrum</i>
Tall Shrub/sapling	Broad-leaved deciduous shrub	<i>Viburnum acerifolium</i>
Short shrub/sapling	Broad-leaved deciduous shrub	<i>Vaccinium angustifolium, Vaccinium pallidum, Viburnum acerifolium</i>
Herb (field)	Forb	<i>Podophyllum peltatum</i>
Herb (field)	Fern or fern ally	<i>Dennstaedtia punctilobula</i>

**Characteristic Species:** *Acer saccharum, Carpinus caroliniana, Caulophyllum thalictroides, Liriodendron tulipifera.*

**Other Noteworthy Species:** Information not available.

**USFWS Wetland System:** Not applicable.

**DISTRIBUTION**

**Range:** This red oak - sugar maple community is found primarily in the Allegheny Plateau and Appalachian Mountain regions of the United States, with possible extensions east and west of those areas, ranging from southeastern New York and New Jersey, and west to Pennsylvania, West Virginia, and southeast Ohio.

**States/Provinces:** CT, NJ, NY, OH, PA, WV?

**Federal Lands:** NPS (Allegheny Portage Railroad, Delaware Water Gap, Fort Necessity, Friendship Hill).

**CONSERVATION STATUS**

**Rank:** GNR (31-Dec-1997).

**Reasons:** Information not available.

**CLASSIFICATION INFORMATION**

**Status:** Standard.

**Confidence:** 2 – Moderate.

**Comments:** According to Anderson (1982), in Ohio, where this community is found in the southeastern unglaciated plateau region, it is differentiated from the oak-maple type, *Quercus alba - Quercus rubra - Quercus prinus - Acer saccharum / Liriodendron tulipifera* Forest (CEGL002059), and the Appalachian oak forest type, *Quercus prinus - Quercus (alba, coccinea, velutina) / Viburnum acerifolium - (Kalmia latifolia)* Forest (CEGL005023), by the substantial presence (over 20% canopy or basal area) of *Liriodendron tulipifera* and insignificant amounts of *Fagus grandifolia* or other mesic tree species. This type concept may overlap considerably with that of the oak-maple type, *Quercus alba - Quercus rubra - Quercus prinus - Acer saccharum / Liriodendron tulipifera* Forest (CEGL002059). Braun (1950, e.g., p. 140) reports stands similar to this type in the Shawnee Hills and Mammoth Cave area of Kentucky, as well as other Interior Low Plateau sites. In New York, this type is reported primarily from the southeastern part of the state (Reschke 1990).

### Similar Associations:

- *Acer saccharum* - *Quercus rubra* - *Carya (glabra, ovata)* / *Ageratina altissima* - *Bromus pubescens* Forest (CEGL008517)--for similar vegetation in Virginia.
- *Fagus grandifolia* - *Quercus alba* - *Quercus rubra* Forest (CEGL006377).
- *Quercus alba* - (*Quercus rubra*, *Acer saccharum*, *Fagus grandifolia*) / *Aesculus flava* Forest (CEGL007233)--is a related type to the south and west.
- *Quercus alba* - *Quercus rubra* - *Quercus prinus* - *Acer saccharum* / *Lindera benzoin* Forest (CEGL002059).
- *Quercus prinus* - *Quercus (alba, coccinea, velutina)* / *Viburnum acerifolium* - (*Kalmia latifolia*) Forest (CEGL005023).
- *Quercus rubra* - *Acer saccharum* - *Tilia americana* var. *heterophylla* - *Aesculus flava* - (*Cladrastis kentukea*) Forest (CEGL007698).
- *Quercus rubra* - *Tsuga canadensis* - *Liriodendron tulipifera* / *Hamamelis virginiana* Forest (CEGL006566).

### Related Concepts:

- Dry-Mesic Inland Mixed Oak Forest, mixed oak-hardwood type (Breden 1989) ?

### SOURCES

**Description Authors:** D. Faber-Langendoen, mod. E. Largay.

**References:** Anderson 1982, Braun 1950, Breden 1989, Breden et al. 2001, Eastern Ecology Working Group n.d., Fike 1999, Fleming 1999, Lundgren 2001, Metzler and Barrett 2001, Reschke 1990.



Figure 8. Northern Red Oak – Mixed Hardwood Forest in Friendship Hill National Historic Site (plot FRHI.1). July 2004. NAD 1983 / UTM easting 592784, northing 4402615.



Figure 9. Northern Red Oak – Mixed Hardwood Forest in Friendship Hill National Historic Site (plot FRHI.16). July 2004. NAD 1983 / UTM easting 592289, northing 4403158.

## Common Name (Park-specific): Tuliptree - Beech - Maple Forest

### SYNONYMS

NVC English Name: American Beech - Sweet Birch - Tuliptree - Sugar Maple Forest

NVC Scientific Name: *Fagus grandifolia* - *Betula lenta* - *Liriodendron tulipifera* – *Acer saccharum* Forest

NVC Identifier: CEGLO06296

### LOCAL INFORMATION

**Environmental Description:** This forest type occurs in a variety of topographic positions in Friendship Hill National Historic Site. This community typically occurs on well-drained soils, such as Monongahela silt loam, Allegheny fine sandy loam, and Gilpin very stony silt loam. The plant composition of Tuliptree - Beech - Maple Forests is a result of past land use, such as logging and agriculture. As a result, this forest type often exhibits a weedy character. For example, several stands of Tuliptree - Beech - Maple Forest have developed in former pine plantations that have been harvested. Invasive nonnative plants are often abundant.

**Vegetation Description:** The most consistent tree species in this variable forest type are tuliptree (*Liriodendron tulipifera*), red maple (*Acer rubrum*), and American beech (*Fagus grandifolia*). In successional, disturbed, or degraded areas, tuliptree may occur in nearly pure stands or as scattered emergent trees over a dense maple subcanopy. The most common species of the many possible associates include sugar maple (*Acer saccharum*), black maple (*Acer nigrum*), black birch (*Betula lenta*), white pine (*Pinus strobus*), black cherry (*Prunus serotina*), northern red oak (*Quercus rubra*), bitternut hickory (*Carya cordiformis*), white ash (*Fraxinus americana*), cucumber-tree (*Magnolia acuminata*), sycamore (*Platanus occidentalis*), and elm (*Ulmus americana*, *Ulmus rubra*). The height of the trees in the canopy ranges from 25 to 35 m, and the canopy cover is generally greater than 80% of the area. The diameter at breast height of canopy trees typically ranges from 40 to 70 cm. The subcanopy is moderately dense (20–60% cover) and ranges in height from 10 to 20 m. Maples and tuliptree typically dominate this layer, along with blackgum (*Nyssa sylvatica*), shagbark hickory (*Carya ovata*), and other hardwood species found in the canopy. Stands of this forest type have also developed in former conifer plantations that have been harvested. Therefore, occasional Norway spruce (*Picea abies*), Scotch pine (*Pinus sylvestris*), eastern white pine (*Pinus strobus*), or red pine (*Pinus resinosa*) may occur in patches in certain areas of the park. The most common and diagnostic shrub in this forest type is northern spicebush (*Lindera benzoin*), occurring in both the tall- and short-shrub layers. Other tall shrubs (2–5 m in height) form a sparse to moderately dense layer that includes species from the canopy and subcanopy as well as flowering dogwood (*Cornus florida*), hophornbeam (*Ostrya virginiana*), hawthorn (*Crataegus* sp.), and alternateleaf dogwood (*Cornus alternifolia*). Common short shrubs (<2 m in height) are northern spicebush, seedlings of present hardwood trees, pawpaw (*Asimina triloba*), and Allegheny blackberry (*Rubus allegheniensis*). The herbaceous layer is often weedy, dominated by hay-scented fern (*Dennstaedtia punctilobula*), vines, and invasive species. Native associates can vary greatly depending on the topographic position and soil moisture. The most common associates include New York fern (*Thelypteris noveboracensis*), jumpseed (*Polygonum virginianum*), white snakeroot (*Ageratina altissima* var. *altissima*), black snakeroot (*Sanicula canadensis*), white wood aster (*Eurybia divaricata*), broadleaf enchanter's nightshade (*Circaea lutetiana*), Christmas fern (*Polystichum acrostichoides*), Canadian violet (*Viola canadensis*), feathery false lily of the valley

(*Maianthemum racemosum* ssp. *racemosum*), mayapple (*Podophyllum peltatum*), lady's-thumb (*Polygonum persicaria*), rough bedstraw (*Galium asprellum*), jewelweed (*Impatiens* sp.), common blue violet (*Viola sororia*), spinulose woodfern (*Dryopteris carthusiana*), sensitive fern (*Onoclea sensibilis*), clearweed (*Pilea pumila*), white rattlesnakeroot (*Prenanthes alba*), and grove bluegrass (*Poa alsodes*). Vines such as catbrier (*Smilax rotundifolia*, *Smilax glauca*), Virginia creeper (*Parthenocissus quinquefolia*), eastern poison-ivy (*Toxicodendron radicans*), and grape (*Vitis aestivalis*, *Vitis riparia*) are typical and vary from sparsely distributed through the forest to moderately dense. Invasive species such as multiflora rose (*Rosa multiflora*), Japanese barberry (*Berberis thunbergii*), and Japanese honeysuckle (*Lonicera japonica*) can be abundant.

**Most Abundant Species:**

<u>Stratum</u>	<u>Lifeform</u>	<u>Species</u>
Tree canopy	Broad-leaved deciduous tree	<i>Acer rubrum</i> , <i>Acer saccharum</i> , <i>Fagus grandifolia</i> , <i>Liriodendron tulipifera</i>
Tree subcanopy	Broad-leaved deciduous tree	<i>Acer rubrum</i> , <i>Acer saccharum</i> , <i>Liriodendron tulipifera</i>
Tall Shrub/sapling	Broad-leaved deciduous shrub	<i>Lindera benzoin</i>
Short Shrub/sapling	Broad-leaved deciduous shrub	<i>Lindera benzoin</i>
Herb (field)	Vine/Liana	<i>Parthenocissus quinquefolia</i> , <i>Smilax glauca</i> , <i>Smilax rotundifolia</i>
Herb (field)	Forb	<i>Polygonum virginianum</i>
Herb (field)	Fern or fern ally	<i>Dennstaedtia punctilobula</i> , <i>Thelypteris noveboracensis</i>

**Characteristic Species:** *Acer rubrum*, *Liriodendron tulipifera*.

**Other Noteworthy Species:** Information not available.

**Subnational Distribution with Crosswalk Data:**

<u>State</u>	<u>State Rank</u>	<u>Confidence</u>	<u>State Name</u>	<u>Reference</u>
PA	S4	2	Tuliptree - beech - maple forest	Fike 1999

**Local Range:** Well-drained soils in Friendship Hill National Historic Site.

**Classification Comments:** The composition of this forest may overlap with that of Northern Red Oak - Mixed Hardwood Forest. However, oaks cover <50% of the canopy (typically <25%) in Tuliptree - Beech - Maple Forest, whereas tuliptree and maple are clear dominant. Also, northern spicebush is a diagnostic shrub in the tall- or short-shrub layers in this forest type. Tuliptree - Beech - Maple Forest is also similar to Early-Successional Hardwood Forest found in Friendship Hill National Historic Site. Tuliptree - Beech - Maple Forest generally contains older, more established trees, often with American beech as a codominant. Early-Successional Hardwood Forest contains primarily saplings and young trees, with black cherry, boxelder, and other early successional species as prominent associates.

**Other Comments:** Information not available.

**Local Description Authors:** S. J. Perles (PNHP).

**Plots:** FRHI.2, FRHI.3, FRHI.4, FRHI.5, FRHI.6, FRHI.7, FRHI.8, FRHI.18, FRHI.19.

**Friendship Hill National Historic Site Inventory Notes:** Information not available.

## GLOBAL INFORMATION

### NVC CLASSIFICATION

Physiognomic Class	Forest (I)
Physiognomic Subclass	Deciduous forest (I.B.)
Physiognomic Group	Cold-deciduous forest (I.B.2.)
Physiognomic Subgroup	Natural/Semi-natural cold-deciduous forest (I.B.2.N.)
Formation	Lowland or submontane cold-deciduous forest (I.B.2.N.a.)
Alliance	<i>Fagus grandifolia</i> - <i>Acer saccharum</i> - ( <i>Liriodendron tulipifera</i> ) Forest Alliance (A.227)
Alliance (English name)	American Beech - Sugar Maple - (Tuliptree) Forest Alliance
Association	<i>Fagus grandifolia</i> - <i>Betula lenta</i> - <i>Liriodendron tulipifera</i> - <i>Acer saccharum</i> Forest
Association (English name)	American Beech - Sweet Birch - Tuliptree - Sugar Maple Forest
<b>Ecological System(s):</b>	Northeastern Interior Dry-Mesic Oak Forest (CES202.592)

### GLOBAL DESCRIPTION

**Concept Summary:** This mid- to lower-slope deciduous forest of the mid-Atlantic region occurs on deep soils that are not strongly acidic. The tree canopy is characterized by a mixture of *Liriodendron tulipifera*, *Fagus grandifolia*, *Acer saccharum*, *Betula lenta*, and other associated species, including *Acer rubrum*, *Nyssa sylvatica*, and *Carya alba*. The subcanopy is characterized by *Carpinus caroliniana*, *Cornus florida*, and *Ostrya virginiana*. *Magnolia acuminata* may occur in the western portion of the range. Common species of the shrub layer include *Hamamelis virginiana* and *Lindera benzoin*. The herbaceous layer is characterized by *Podophyllum peltatum*, *Sanguinaria canadensis*, *Botrychium virginianum*, *Dicentra cucullaria*, *Dicentra canadensis*, *Allium tricoccum*, and *Claytonia virginica*.

**Environmental Description:** This vegetation occurs on middle to lower slopes on moderately deep soils that are not extremely acidic.

**Vegetation Description:** The tree canopy is characterized by a mixture of *Liriodendron tulipifera*, *Fagus grandifolia*, *Acer saccharum*, *Betula lenta*, and other associated species, including *Acer rubrum*, *Nyssa sylvatica*, and *Carya alba*. The subcanopy is characterized by *Carpinus caroliniana*, *Cornus florida*, and *Ostrya virginiana*. Common species of the shrub layer include *Hamamelis virginiana* and *Lindera benzoin*. The herbaceous layer is characterized by *Podophyllum peltatum*, *Sanguinaria canadensis*, *Botrychium virginianum*, *Dicentra cucullaria*, *Dicentra canadensis*, *Allium tricoccum*, and *Claytonia virginica*.

### Most Abundant Species:

<u>Stratum</u>	<u>Lifeform</u>	<u>Species</u>
Tree canopy	Broad-leaved deciduous tree	<i>Acer saccharum</i> , <i>Fagus grandifolia</i> , <i>Liriodendron tulipifera</i>
Tree subcanopy	Broad-leaved deciduous tree	<i>Carpinus caroliniana</i> , <i>Cornus florida</i> , <i>Ostrya virginiana</i>
Shrub/sapling (tall & short)	Broad-leaved deciduous shrub	<i>Hamamelis virginiana</i> , <i>Lindera benzoin</i>
Herb (field)	Forb	<i>Podophyllum peltatum</i>
Herb (field)	Fern or fern ally	<i>Botrychium virginianum</i>

**Characteristic Species:** *Acer saccharum*, *Allium tricoccum*, *Betula lenta*, *Botrychium virginianum*, *Carpinus caroliniana*, *Claytonia virginica*, *Cornus florida*, *Dicentra cucullaria*, *Fagus grandifolia*, *Liriodendron tulipifera*, *Ostrya virginiana*, *Podophyllum peltatum*, *Sanguinaria canadensis*.

**Other Noteworthy Species:** Information not available.

**USFWS Wetland System:** Not applicable.

#### DISTRIBUTION

**Range:** This vegetation is currently described primarily from Pennsylvania and is also documented in New Jersey. It may occur in Maryland.

**States/Provinces:** MD?, NJ, PA

**Federal Lands:** NPS (Allegheny Portage Railroad, Delaware Water Gap, Friendship Hill, Morristown).

#### CONSERVATION STATUS

**Rank:** GNR (6-Dec-2004).

**Reasons:** More information is required to determine the range and rank of this vegetation type.

#### CLASSIFICATION INFORMATION

**Status:** Standard.

**Confidence:** 3 – Weak.

**Comments:** This description is based on the tuliptree - beech - maple forest of Fike (1999). More information is required to determine the range of this type.

#### Similar Associations:

- *Fagus grandifolia* - *Acer saccharum* - *Liriodendron tulipifera* Unglaciated Forest (CEGL002411)--also contains *Liquidambar styraciflua*, *Asimina triloba*, *Carya cordiformis*, and *Betula lenta* is absent.
- *Fagus grandifolia* - *Acer saccharum* Glaciated Midwest Forest (CEGL005013)--has a shrub layer characterized by *Diervilla lonicera*, *Euonymus obovatus*, *Lonicera canadensis*, and *Betula lenta* is absent.
- *Fagus grandifolia* - *Betula lenta* - *Quercus (alba, rubra)* / *Carpinus caroliniana* Forest (CEGL006921)--lacks *Acer saccharum*, and *Quercus* spp. are more important.

**Related Concepts:** Information not available.

#### SOURCES

**Description Authors:** J. Fike and L. A. Sneddon, mod. E. Largay.

**References:** Eastern Ecology Working Group n.d., Fike 1999, Podnieszinski et al. 2006.



Figure 10. Tuliptree – Beech – Maple Forest in Friendship Hill National Historic Site (plot FRHI.2). July 2004. NAD 1983 / UTM easting 592230, northing 4402658.



Figure 11. Tuliptree – Beech – Maple Forest in Friendship Hill National Historic Site (plot FRHI.7). July 2004. NAD 1983 / UTM easting 592095, northing 4404320.



## **Common Name (Park-specific): Sycamore Floodplain Forest**

### **SYNONYMS**

**NVC English Name:** Sycamore - Boxelder - Black Walnut / Common Pawpaw / Virginia Bluebells Forest

**NVC Scientific Name:** *Platanus occidentalis* - *Acer negundo* - *Juglans nigra* / *Asimina triloba* / *Mertensia virginica* Forest

**NVC Identifier:** C EGL004073

### **LOCAL INFORMATION**

**Environmental Description:** This community type occurs along the low terrace floodplain of the Monongahela River on the northern and western boundary of Friendship Hill National Historic Site. The forest occurs on Philo silt loam, a moderately well-drained soil typical of floodplains. This community receives periodic or seasonal flooding during high water events. Historically, the river was one of the main transportation conduits to Friendship Hill and the riverbanks and floodplains served as boat landings. The majority of the floodplain was cleared until 1975 and was also used for growing row crops, pasture, and raising pigs. Evidence of this land-use history is abundant, and therefore the current composition of the floodplain forest appears weedy and disturbed. Invasive nonnative plants are often abundant.

**Vegetation Description:** The most characteristic canopy tree species of this forest type is sycamore (*Platanus occidentalis*). Other canopy associates are species typical of floodplain communities, such as boxelder (*Acer negundo*), common hackberry (*Celtis occidentalis*), white ash (*Fraxinus americana*), tuliptree (*Liriodendron tulipifera*), willow (*Salix* spp.), American elm (*Ulmus americana*), and sugar maple (*Acer saccharum*), or early successional species, such as black cherry (*Prunus serotina*) and black locust (*Robinia pseudoacacia*). The canopy is typically open (40–60% cover), and canopy trees extend from 12 to 30 m in height. The subcanopy covers up to 60% and is dominated by the species listed above and pawpaw (*Asimina triloba*). The tall-shrub layer (2–5 m in height) varies from sparse to dense (25–80% cover). Common tall shrubs include species found in the canopy and subcanopy, as well as northern spicebush (*Lindera benzoin*), eastern redbud (*Cercis canadensis*), and white ash. The same species can also be found in the short-shrub layer (<2 m in height; 10–40% cover). The herbaceous layer is typically dense and often dominated by the nonnative invasive Japanese stilt grass (*Microstegium vimineum*). Typical native species include Canadian clearweed (*Pilea pumila*), wingstem (*Verbesina alternifolia*), small-spike false nettle (*Boehmeria cylindrica*), white cutgrass (*Leersia virginica*), white snakeroot (*Ageratina altissima* var. *altissima*), marsh-pepper knotweed (*Polygonum hydropiper*), riverbank wild rye (*Elymus riparius*), grove bluegrass (*Poa alsodes*), jumpseed (*Polygonum virginianum*), and rice cutgrass (*Leersia oryzoides*). Vines such as Virginia creeper (*Parthenocissus quinquefolia*) and summer grape (*Vitis aestivalis*) can be scattered throughout this forest type. Other invasive species such as multiflora rose (*Rosa multiflora*), Japanese barberry (*Berberis thunbergii*), Japanese honeysuckle (*Lonicera japonica*), Morrow's honeysuckle (*Lonicera morrowii*), and oriental lady's-thumb (*Polygonum caespitosum*) can also be present.

**Most Abundant Species:**

<u>Stratum</u>	<u>Lifeform</u>	<u>Species</u>
Tree canopy	Broad-leaved deciduous tree	<i>Acer negundo</i> , <i>Platanus occidentalis</i> , <i>Prunus serotina</i>
Tree subcanopy	Broad-leaved deciduous tree	<i>Acer negundo</i> , <i>Platanus occidentalis</i>
Tall shrub/sapling	Broad-leaved deciduous shrub	<i>Acer negundo</i> , <i>Asimina triloba</i> , <i>Lindera benzoin</i>
Short shrub/sapling	Broad-leaved deciduous shrub	<i>Acer negundo</i> , <i>Asimina triloba</i> , <i>Lindera benzoin</i>
Herb (field)	Vine/Liana	<i>Parthenocissus quinquefolia</i> , <i>Vitis aestivalis</i>
Herb (field)	Forb	<i>Boehmeria cylindrica</i> , <i>Pilea pumila</i> , <i>Polygonum hydropiper</i> , <i>Verbesina alternifolia</i>
Herb (field)	Graminoid	<i>Elymus riparius</i> , <i>Leersia oryzoides</i> , <i>Leersia virginica</i>

**Characteristic Species:** *Acer negundo*, *Asimina triloba*, *Celtis occidentalis*, *Leersia oryzoides*, *Leersia virginica*, *Platanus occidentalis*, *Ulmus americana*.

**Other Noteworthy Species:** Information not available.

**Subnational Distribution with Crosswalk Data:**

<u>State</u>	<u>State Rank</u>	<u>Confidence</u>	<u>State Name</u>	<u>Reference</u>
PA	S3	3	Sycamore – (river birch) – boxelder floodplain forest	Fike 1999

**Local Range:** The floodplain of the Monongahela River in Friendship Hill National Historic Site.

**Classification Comments:** Although the floodplain is very disturbed and supports predominantly younger trees, the examples at Friendship Hill are relatively representative of the global type.

**Other Comments:** Information not available.

**Local Description Authors:** S. J. Perles (PNHP).

**Plots:** FRHI.9, FRHI.10, FRHI.12, FRHI.20, FRHI.30.

**Friendship Hill National Historic Site Inventory Notes:** Information not available.

**GLOBAL INFORMATION****NVC CLASSIFICATION**

Physiognomic Class	Forest (I)
Physiognomic Subclass	Deciduous forest (I.B.)
Physiognomic Group	Cold-deciduous forest (I.B.2.)
Physiognomic Subgroup	Natural/Semi-natural cold-deciduous forest (I.B.2.N.)
Formation	Temporarily flooded cold-deciduous forest (I.B.2.N.d.)
Alliance	<i>Platanus occidentalis</i> - ( <i>Fraxinus pennsylvanica</i> , <i>Celtis laevigata</i> , <i>Acer saccharinum</i> ) Temporarily Flooded Forest Alliance (A.288)
Alliance (English name)	Sycamore - (Green Ash, Sugarberry, Silver Maple) Temporarily Flooded Forest Alliance

Association	<i>Platanus occidentalis</i> - <i>Acer negundo</i> - <i>Juglans nigra</i> / <i>Asimina triloba</i> / <i>Mertensia virginica</i> Forest
Association (English name)	Sycamore - Boxelder - Black Walnut / Common Pawpaw / Virginia Bluebells Forest
<b>Ecological System(s):</b>	Information not available.

#### GLOBAL DESCRIPTION

**Concept Summary:** This association occupies the higher elevations of floodplains, floodplain berms, and low terraces of major Mid-Atlantic rivers (e.g., Potomac, Shenandoah, Monocacy, James), and as main floodplain vegetation on medium-sized rivers, draining areas of nutrient-rich substrates (e.g., Antietam Creek, Bull Run). Soil texture is variable, ranging from silty-clay loams to loams over much of the range, and samples collected from plots had very high base status. This vegetation type is a closed forest with mixed overstory dominance by *Platanus occidentalis*, *Juglans nigra*, *Carya cordiformis*, *Celtis occidentalis*, *Ulmus americana*, and, locally, *Fraxinus pennsylvanica*, *Liriodendron tulipifera*, and *Quercus shumardii*. *Acer saccharinum* is codominant in a minority of stands but absent or unimportant in many others. *Acer negundo* is strongly dominant in the subcanopy. *Asimina triloba* and/or *Lindera benzoin* dominate moderately dense to dense shrub layers. Herb layers are rich in spring ephemerals and other nutrient-demanding species, including *Mertensia virginica*, *Asarum canadense*, *Chaerophyllum procumbens*, *Hydrophyllum canadense*, *Viola striata*, *Phlox divaricata*, *Podophyllum peltatum*, *Erythronium americanum*, *Dicentra canadensis*, *Sanicula odorata*, *Packera aurea*, *Claytonia virginica*, *Festuca subverticillata*, *Carex jamesii*, *Carex grisea*, *Floerkea proserpinacoides*, *Osmorhiza longistylis*, and *Ranunculus abortivus*. Invasive exotics, especially *Alliaria petiolata*, *Veronica hederifolia*, *Duchesnea indica*, *Urtica dioica* ssp. *dioica*, *Microstegium vimineum*, and *Glechoma hederacea*, are usually abundant. This type was defined to cover rich large-stream floodplain forests of the Mid-Atlantic Piedmont and Central Appalachians. It was split off from the more broadly defined *Platanus occidentalis* - *Acer saccharinum* - *Juglans nigra* - *Ulmus rubra* Forest (CEGL007334).

**Environmental Description:** This association occupies the higher elevations of floodplains, floodplain berms, and low terraces of major Mid-Atlantic rivers (Potomac, Shenandoah, Monocacy), and as main floodplain vegetation on medium-sized rivers, draining areas of nutrient-rich substrates (e.g., Antietam Creek, Bull Run). In the Potomac Gorge, average flood-return interval was from about 3 to 15 years. Soil texture is variable, ranging from silty-clay loams to loams over much of the range, but it can be sandy loams or sands along high-gradient reaches. Soil samples collected from plots have a mean pH of 7.0, high calcium content (mean = 2800 ppm), and 100% total base saturation.

**Vegetation Description:** This vegetation type is a closed forest with mixed overstory dominance by *Platanus occidentalis*, *Juglans nigra*, *Carya cordiformis*, *Celtis occidentalis*, *Ulmus americana*, and, locally, *Fraxinus pennsylvanica*, *Liriodendron tulipifera*, and *Quercus shumardii*. *Acer saccharinum* is codominant in a minority of stands but absent or unimportant in many others. *Acer negundo* is strongly dominant in the subcanopy. *Asimina triloba* (usually on sites with coarser soil textures) and /or *Lindera benzoin* (on finer-textured substrates) dominate moderately dense to dense shrub layers. Vines are common, with *Parthenocissus quinquefolia*, *Vitis vulpina*, and *Toxicodendron radicans* most frequent. Herb layers are rich in spring ephemerals and other nutrient-demanding species, including *Mertensia virginica*, *Asarum canadense*, *Chaerophyllum procumbens*, *Hydrophyllum canadense*, *Viola striata*, *Phlox divaricata*, *Podophyllum peltatum*, *Erythronium americanum*, *Dicentra canadensis*, *Sanicula*

*odorata*, *Packera aurea*, *Claytonia virginica*, *Festuca subverticillata*, *Carex jamesii*, *Carex grisea*, *Floerkea proserpinacoides*, *Osmorhiza longistylis*, and *Ranunculus abortivus*. Invasive exotics may be abundant and are represented by *Alliaria petiolata*, *Veronica hederifolia*, *Duchesnea indica*, *Urtica dioica* ssp. *dioica*, *Microstegium vimineum*, and *Glechoma hederacea*.

**Most Abundant Species:**

<u>Stratum</u>	<u>Lifeform</u>	<u>Species</u>
Tree canopy	Broad-leaved deciduous tree	<i>Carya cordiformis</i> , <i>Platanus occidentalis</i> , <i>Ulmus americana</i>
Tree subcanopy	Broad-leaved deciduous tree	<i>Acer negundo</i> , <i>Celtis occidentalis</i> , <i>Juglans nigra</i>
Tall shrub/sapling	Broad-leaved deciduous shrub	<i>Asimina triloba</i> , <i>Lindera benzoin</i>
Herb (field)	Vine/Liana	<i>Parthenocissus quinquefolia</i> , <i>Toxicodendron radicans</i> , <i>Vitis vulpina</i>
Herb (field)	Forb	<i>Mertensia virginica</i>

**Characteristic Species:** *Acer negundo*, *Asimina triloba*, *Juglans nigra*, *Mertensia virginica*, *Platanus occidentalis*, *Ulmus americana*.

**Other Noteworthy Species:** Information not available.

**USFWS Wetland System:** Not applicable.

**DISTRIBUTION**

**Range:** This community occurs on floodplains of large and medium-sized Mid-Atlantic rivers, including the Potomac, Shenandoah, James, Rappahannock, Monocacy, Clinch, and possibly others northward.

**States/Provinces:** MD, PA, VA, WV

**Federal Lands:** NPS (Antietam, C&O Canal, Eisenhower, Friendship Hill, George Washington Parkway, Gettysburg, Harpers Ferry, Manassas, Monocacy, National Capital-East); USFS (George Washington).

**CONSERVATION STATUS**

**Rank:** G4 (25-Jan-2005).

**Reasons:** The type is not rare but has a restricted geographic range, is confined to larger rivers in the Mid-Atlantic region, and is subject to continuing degradation by invasive species.

**CLASSIFICATION INFORMATION**

**Status:** Standard.

**Confidence:** 2 – Moderate.

**Comments:** This type was defined through analysis of 36 plot samples from Virginia and Maryland and through consultation with ecologists from those states and West Virginia. It possibly extends into Pennsylvania, but should be confirmed with ecologists in that state. It was decided to split this unit off from the more broadly defined USNVC unit *Platanus occidentalis* - *Acer saccharinum* - *Juglans nigra* - *Ulmus rubra* Forest (CEGL007334).

**Similar Associations:**

- *Acer saccharinum* - *Acer negundo* / *Ageratina altissima* - *Laportea canadensis* - (*Elymus virginicus*) Forest (CEGL006217).
- *Platanus occidentalis* - *Acer saccharinum* - *Juglans nigra* - *Ulmus rubra* Forest (CEGL007334)--covers rich floodplain forest west of the Appalachians.

### Related Concepts:

- *Platanus occidentalis* - *Acer negundo* - *Juglans nigra* / *Asimina triloba* / *Mertensia virginica* Forest (Fleming et al. 2004) =
- *Platanus occidentalis* - *Acer negundo* / *Asarum canadense* Forest (Thomson et al. 1999) =
- *Platanus occidentalis* - *Acer negundo* / *Asimina triloba* - *Lindera benzoin* / *Mertensia virginica* - *Asarum canadense* Forest (Fleming and Coulling 2001) =
- *Platanus occidentalis* - *Acer negundo* / *Asimina triloba* / *Asarum canadense* Forest (Lea 2000) =
- *Platanus occidentalis* - *Acer negundo* / *Asimina triloba* / *Carex jamesii* Forest (Lea 2000) =
- *Platanus occidentalis* - *Acer negundo* / *Asimina triloba* / *Mertensia virginica* Forest (Lea 2000) =
- *Platanus occidentalis* - *Acer negundo* / *Hydrophyllum canadense* - *Laportea canadensis* Forest (Lea 2000) =
- *Platanus occidentalis* - *Fraxinus pennsylvanica* Floodplain Forest (Vanderhorst 2000b) =
- Piedmont / Central Appalachian Rich Floodplain Forest (Fleming et al. 2004) =

### SOURCES

**Description Authors:** G. P. Fleming and K. D. Patterson.

**References:** Eastern Ecology Working Group n.d., Fleming and Coulling 2001, Fleming et al. 2004, Harrison 2004, Lea 2000, Lea 2003, Thomson et al. 1999, VDNH 2003, Vanderhorst 2000b.



Figure 12. Sycamore Floodplain Forest in Friendship Hill National Historic Site (plot FRHI.10). July 2004. NAD 1983 / UTM easting 591690, northing 4404407.



Figure 13. Sycamore Floodplain Forest in Friendship Hill National Historic Site (plot FRHI.20). July 2004. NAD 1983 / UTM easting 591449, northing 4404297.

## **Common Name (Park-specific): Early Successional Hardwood Forest**

### **SYNONYMS**

**NVC English Name:** Black Cherry - Tuliptree - Red Maple - White Ash Forest

**NVC Scientific Name:** *Prunus serotina* - *Liriodendron tulipifera* - *Acer rubrum* - *Fraxinus americana* Forest

**NVC Identifier:** C EGL006599

### **LOCAL INFORMATION**

**Environmental Description:** This community typically occurs in agricultural areas that have been abandoned for at least two decades. Without ongoing management, woody plants established in these abandoned agricultural areas, which then developed into dense young forests of early successional hardwoods. Early Successional Hardwood Forests are generally located adjacent to or surrounding Successional Old Fields in Friendship Hill National Historic Site.

This forest type typically occurs on level or slightly sloping uplands on Monongahela silt loam.

**Vegetation Description:** The species composition of Early Successional Hardwood Forest varies depending on the length of time since management ceased, the original species composition of the agricultural field, the local seed sources, soil moisture, and other disturbance factors. The common trees are species typical of early successional environments, such as tuliptree (*Liriodendron tulipifera*), black cherry (*Prunus serotina*), boxelder (*Acer negundo*), and red maple (*Acer rubrum*). Numerous other species may be present, including black locust (*Robinia pseudoacacia*), white ash (*Fraxinus americana*), sycamore (*Platanus occidentalis*), eastern white pine (*Pinus strobus*), American elm (*Ulmus americana*), and sweet birch (*Betula lenta*). Trees typically do not exceed 15 m in height or a diameter at breast height of 25 cm. Short and tall shrubs can form sparse to dense layers in this forest type. The shrub layers typically include species from the canopy as well as northern spicebush (*Lindera benzoin*), flowering dogwood (*Cornus florida*), multiflora rose (*Rosa multiflora*), Allegheny blackberry (*Rubus allegheniensis*), and black raspberry (*Rubus occidentalis*). The herbaceous layer is often dominated by weedy native species, vines, and invasive species such as Japanese stilt grass (*Microstegium vimineum*) and oriental lady's-thumb (*Polygonum caespitosum*). Native associates can vary greatly depending on past land use and soil moisture. The most common associates include Canadian clearweed (*Pilea pumila*), small-spike false nettle (*Boehmeria cylindrica*), poverty rush (*Juncus tenuis*), white snakeroot (*Ageratina altissima* var. *altissima*), jumpseed (*Polygonum virginianum*), eastern hay-scented fern (*Dennstaedtia punctilobula*), common yellow oxalis (*Oxalis stricta*), sensitive fern (*Onoclea sensibilis*), Kentucky bluegrass (*Poa pratensis*), New York fern (*Thelypteris noveboracensis*), and spotted lady's-thumb (*Polygonum persicaria*). Vines such as Virginia creeper (*Parthenocissus quinquefolia*), eastern poison-ivy (*Toxicodendron radicans*), and summer grape (*Vitis aestivalis*) are typical and vary from sparsely distributed through the forest to moderately dense. Multiflora rose, tree-of-heaven (*Ailanthus altissima*), Japanese stilt grass, oriental lady's-thumb, Japanese barberry (*Berberis thunbergii*), and Japanese honeysuckle (*Lonicera japonica*) are common invasive species that can be abundant in this forest type.

**Most Abundant Species:**

<u>Stratum</u>	<u>Lifeform</u>	<u>Species</u>
Tree canopy	Broad-leaved deciduous tree	<i>Acer negundo</i> , <i>Acer rubrum</i> , <i>Liriodendron tulipifera</i> , <i>Prunus serotina</i>
Tree subcanopy	Broad-leaved deciduous tree	<i>Acer negundo</i> , <i>Acer rubrum</i> , <i>Liriodendron tulipifera</i> , <i>Prunus serotina</i>
Tall shrub/sapling	Broad-leaved deciduous shrub	<i>Cornus florida</i> , <i>Lindera benzoin</i>
Short shrub/sapling	Broad-leaved deciduous shrub	<i>Rosa multiflora</i> , <i>Rubus allegheniensis</i> , <i>Rubus occidentalis</i>
Herb (field)	Vine/Liana	<i>Parthenocissus quinquefolia</i> , <i>Toxicodendron radicans</i>
Herb (field)	Forb	<i>Ageratina altissima</i> var. <i>altissima</i> , <i>Boehmeria cylindrica</i> , <i>Pilea pumila</i>
Herb (field)	Graminoid	<i>Juncus tenuis</i>

**Characteristic Species:** *Acer negundo*, *Acer rubrum*, *Microstegium vimineum*, *Polygonum cespitosum*, *Prunus serotina*.

**Other Noteworthy Species:** Information not available.

**Subnational Distribution with Crosswalk Data:**

<u>State</u>	<u>State Rank</u>	<u>Confidence</u>	<u>State Name</u>	<u>Reference</u>
PA	NA	NA	no crosswalk	Fike 1999

**Local Range:** Level or slightly sloping uplands, adjacent to or surrounding Successional Old Fields in Friendship Hill National Historic Site.

**Classification Comments:** Northeastern Modified Successional Forest in Friendship Hill typically develops from Successional Old Fields on which dense young forest has established over many years. There is not a hard definitive distinction between these two types; however, Successional Old Fields tend to be open fields, shrublands, or woodlands (with less than 60% cover of trees). Trees in the Successional Old Fields do not generally exceed 20 cm in diameter at breast height or 12 m in height. By contrast, Northeastern Modified Successional Forests have greater than 60% cover of trees, often with trees that exceed 20 cm in diameter at breast height or 12 m in height. Many of the Northeastern Modified Successional Forests in Friendship Hill will develop into Tuliptree - Beech - Maple Forest over time. Trees in Tuliptree - Beech - Maple Forest are more mature (25 to 35 m in height and diameter at breast height from 40 to 70 cm) and often include American beech and oak species. Trees in Northeastern Modified Successional Forest are typically younger (<15 m in height and diameter at breast height of <25 cm) and include weedy species such as black locust (*Robinia pseudoacacia*).

**Other Comments:** Information not available.

**Local Description Authors:** S. J. Perles (PNHP).

**Plots:** FRHI.27, FRHI.29.

**Friendship Hill National Historic Site Inventory Notes:** Information not available.

## GLOBAL INFORMATION

### NVC CLASSIFICATION

Physiognomic Class	Forest (I)
Physiognomic Subclass	Deciduous forest (I.B.)
Physiognomic Group	Cold-deciduous forest (I.B.2.)
Physiognomic Subgroup	Natural/Semi-natural cold-deciduous forest (I.B.2.N.)
Formation	Lowland or submontane cold-deciduous forest (I.B.2.N.a.)
Alliance	<i>Prunus serotina</i> - <i>Acer rubrum</i> - <i>Amelanchier canadensis</i> - <i>Quercus</i> spp. Forest Alliance (A.237)
Alliance (English name)	Black Cherry - Red Maple - Canada Serviceberry - Oak species Forest Alliance
Association	<i>Prunus serotina</i> - <i>Liriodendron tulipifera</i> - <i>Acer rubrum</i> - <i>Fraxinus americana</i> Forest
Association (English name)	Black Cherry - Tuliptree - Red Maple - White Ash Forest
Ecological System(s):	Central Appalachian Dry Oak-Pine Forest (CES202.591). Northeastern Interior Dry-Mesic Oak Forest (CES202.592).

### GLOBAL DESCRIPTION

**Concept Summary:** This early successional woody vegetation of the northeastern United States occurs on sites that have generally been cleared for agriculture. Environmental setting varies, but generally, sites are dry-mesic to mesic, with small seepage inclusions in some examples. Physiognomy of this vegetation is highly variable, ranging from closed forest, open forest, tall dense shrubland, to more open tall shrubland. Early successional woody species dominate the canopy in a widely variable mix, depending on geographic location. Tree species may include *Prunus serotina*, *Liriodendron tulipifera*, *Fraxinus americana*, and *Acer rubrum*. Other associates can include *Juglans nigra*, *Sassafras albidum*, *Betula populifolia*, *Juniperus virginiana*, *Acer negundo*, *Acer saccharinum*, *Ailanthus altissima*, *Ulmus americana*, *Quercus* spp., *Betula lenta*, *Amelanchier* spp., and *Robinia pseudoacacia*. Other woody species may contribute to the canopy or form a tall-shrub layer, including *Lindera benzoin* and *Carpinus caroliniana*. The low-shrub layer, if present, is usually characterized by the presence of *Rubus* spp. such as *Rubus flagellaris*, *Rubus allegheniensis*, *Rubus phoenicolasius*, or *Rubus hispidus*. This layer is often dominated by exotic species such as *Lonicera tatarica*, *Lonicera japonica*, *Rhamnus cathartica*, *Crataegus* spp., *Rosa multiflora*, and *Berberis thunbergii*. The herbaceous layer is variable, often containing grasses and forbs of both native and exotic origin.

**Environmental Description:** This vegetation occurs on sites that have been cleared for agriculture or otherwise heavily modified in the past. Generally sites are dry-mesic and may have small seepage inclusions in some examples.

**Vegetation Description:** Early successional woody species dominate the canopy in a widely variable mix, depending on geographic location. Tree species may include *Prunus serotina*, *Liriodendron tulipifera*, *Fraxinus americana*, and *Acer rubrum*. Other associates can include *Juglans nigra*, *Sassafras albidum*, *Betula populifolia*, *Juniperus virginiana*, *Acer negundo*, *Acer saccharinum*, *Ailanthus altissima*, *Ulmus americana*, *Quercus* spp., *Betula lenta*, *Amelanchier* spp. and *Robinia pseudoacacia*. Other woody species may contribute to the canopy or form a tall-shrub layer, including *Lindera benzoin* and *Carpinus caroliniana*. The low-shrub layer, if present, is usually characterized by the presence of *Rubus* spp. such as *Rubus flagellaris*, *Rubus allegheniensis*, *Rubus phoenicolasius*, or *Rubus hispidus*. This layer is often dominated by

exotic species such as *Lonicera tatarica*, *Lonicera japonica*, *Rhamnus cathartica*, *Crataegus* spp., *Rosa multiflora*, and *Berberis thunbergii*. The herbaceous layer is variable, often containing grasses and forbs of both native and exotic origin.

**Most Abundant Species:**

<u>Stratum</u>	<u>Lifeform</u>	<u>Species</u>
Tree canopy	Broad-leaved deciduous tree	<i>Acer rubrum</i> , <i>Fraxinus americana</i> , <i>Liriodendron tulipifera</i> , <i>Prunus serotina</i>
Tree subcanopy	Broad-leaved deciduous tree	<i>Acer rubrum</i>
Tall shrub/sapling	Broad-leaved deciduous tree	<i>Carpinus caroliniana</i>
Tall shrub/sapling	Broad-leaved deciduous shrub	<i>Lindera benzoin</i>

**Characteristic Species:** *Acer rubrum*, *Fraxinus americana*, *Liriodendron tulipifera*, *Prunus serotina*, *Robinia pseudoacacia*.

**Other Noteworthy Species:** Information not available.

**USFWS Wetland System:** Not applicable.

**DISTRIBUTION**

**Range:** This vegetation is currently described from Pennsylvania but is of broader distribution in the northeastern U.S.

**States/Provinces:** NJ, NY, PA

**Federal Lands:** NPS (Allegheny Portage Railroad, Delaware Water Gap, Fort Necessity, Friendship Hill, Gettysburg, Johnstown Flood, Morristown, Valley Forge).

**CONSERVATION STATUS**

**Rank:** GNA (ruderal) (29-Nov-2004).

**Reasons:** This vegetation is modified by human activity and not of conservation concern.

**CLASSIFICATION INFORMATION**

**Status:** Standard.

**Confidence:** 3 – Weak.

**Comments:** This vegetation is broadly defined and varies widely in composition across its range, presenting a classification challenge at the alliance level.

**Similar Associations:**

- *Robinia pseudoacacia* Forest (CEGL007279).

**Related Concepts:** Information not available.

**SOURCES**

**Description Authors:** L. A. Sneddon.

**References:** Eastern Ecology Working Group n.d., Fike 1999, Perles et al. 2006c, Podniesinski et al. 2006.



Figure 14. Early Successional Hardwood Forest in Friendship Hill National Historic Site (plot FRHI.29). July 2004. NAD 1983 / UTM easting 592117, northing 4403839.



Figure 15. Early Successional Hardwood Forest in Friendship Hill National Historic Site (plot FRHI.27). NAD 1983 / UTM easting 591849, northing 4404085.



## Common Name (Park-specific): Conifer Plantation

### SYNONYMS

NVC English Name: Pine species Planted Forest

NVC Scientific Name: *Pinus* spp. Planted Forest

NVC Identifier: CEGLO06313

### LOCAL INFORMATION

**Environmental Description:** While most of the planted conifers have been harvested from the park, a few small patches of the conifer plantations remain. These patches occur as extremely small stands less than 0.5 hectare in size. This forest type typically occurs on level or slightly sloping uplands on Monongahela silt loam.

**Vegetation Description:** These small forest stands are dominated by a canopy of Scotch pine (*Pinus sylvestris*), Norway spruce (*Picea abies*), eastern white pine (*Pinus strobus*), or red pine (*Pinus resinosa*) ranging in height from 20–26 m. The moderately dense subcanopy (15–20 m in height) contains a diversity of adventitious hardwoods such as sugar maple (*Acer saccharum*), sweet birch (*Betula lenta*), black cherry (*Prunus serotina*), red maple (*Acer rubrum*), yellow birch (*Betula alleghaniensis*), white ash (*Fraxinus americana*), and American beech (*Fagus grandifolia*). These same tree species can also be found in the sparse to moderately dense tall-shrub (2.5–7.5 m in height) and short-shrub (<2 m in height) layers. Hawthorn (*Crataegus* spp.) and northern spicebush (*Lindera benzoin*) are other commonly occurring shrubs. The herbaceous layer can be sparse to moderately dense and is dominated by New York fern (*Thelypteris noveboracensis*), asters (Asteraceae), Canada mayflower (*Maianthemum canadense*), Canadian white violet (*Viola canadensis*), ribbed sedge (*Carex virescens*), and wrinkleleaf goldenrod (*Solidago rugosa*). Other associate species include flattened oatgrass (*Danthonia compressa*), sweet vernalgrass (*Anthoxanthum odoratum*), eastern hay-scented fern (*Dennstaedtia punctilobula*), sarsaparilla (*Aralia nudicaulis*), intermediate woodfern (*Dryopteris intermedia*), and Jack in the pulpit (*Arisaema triphyllum*). This forest type is susceptible to invasion by garlic mustard (*Alliaria petiolata*), Morrow's honeysuckle (*Lonicera morrowii*), multiflora rose (*Rosa multiflora*), and Japanese barberry (*Berberis thunbergii*).

### Most Abundant Species:

<u>Stratum</u>	<u>Lifeform</u>	<u>Species</u>
Tree canopy	Needle-leaved tree	<i>Pinus strobus</i> , <i>Picea abies</i> , <i>Pinus sylvestris</i>
Tree subcanopy	Broad-leaved deciduous tree	<i>Acer saccharum</i> , <i>Betula lenta</i> , <i>Prunus serotina</i>
Tall shrub/sapling	Broad-leaved deciduous shrub	<i>Lindera benzoin</i>
Herb (field)	Forb	<i>Maianthemum canadense</i>
Herb (field)	Graminoid	<i>Carex virescens</i>
Herb (field)	Fern or fern ally	<i>Thelypteris noveboracensis</i>

**Characteristic Species:** *Pinus resinosa*, *Pinus strobus*, *Pinus sylvestris*.

**Other Noteworthy Species:** Information not available.

### Subnational Distribution with Crosswalk Data:

<u>State</u>	<u>State Rank</u>	<u>Confidence</u>	<u>State Name</u>	<u>Reference</u>
PA	NA	NA	no crosswalk	Fike 1999

**Local Range:** Level or slightly sloping uplands in Friendship Hill National Historic Site.

**Classification Comments:** This description is based on descriptions of these conifer plantations in Roddy and Hammons (1986) and on stands of remnant conifer plantations sampled at Johnstown Flood National Memorial that are similar to those at Friendship Hill National Historic Site.

**Other Comments:** None.

**Local Description Authors:** S. J. Perles (PNHP).

**Plots:** FRHI\_AA.18, FRHI\_AA.40.

**Friendship Hill National Historic Site Inventory Notes:** Information not available.

## GLOBAL INFORMATION

### NVC CLASSIFICATION

Physiognomic Class	Forest (I)
Physiognomic Subclass	Evergreen forest (I.A.)
Physiognomic Group	Temperate or subpolar needle-leaved evergreen forest (I.A.8.)
Physiognomic Subgroup	Planted/Cultivated temperate or subpolar needle-leaved evergreen forest (I.A.8.C.)
Formation	Planted/cultivated temperate or subpolar needle-leaved evergreen forest (I.A.8.C.x.)
Alliance	<i>Pinus strobus</i> Planted Forest Alliance (A.98)
Alliance (English name)	Eastern White Pine Planted Forest Alliance
Association	<i>Pinus</i> spp. Planted Forest
Association (English name)	Pine species Planted Forest
<b>Ecological System(s):</b>	Information not available.

### GLOBAL DESCRIPTION

**Concept Summary:** These plantations consist of mature *Pinus strobus* or *Pinus sylvestris*, with other conifers sometimes present in smaller amounts, planted in post-agricultural fields and pastures. Associated canopy conifers include *Pinus resinosa*, *Picea abies*, or *Larix decidua*. The understory varies widely in its degree of development and may be virtually absent. Northern hardwoods typically dominate the sapling and seedling layers, and cover is proportional to the degree of canopy break-up or opening that has occurred. Common hardwoods include *Prunus serotina*, *Acer rubrum*, and *Fraxinus americana*. A tall-shrub layer may be present; common species (aside from smaller individuals of the hardwood saplings) include *Crataegus* spp., *Hamamelis virginiana*, and *Lindera benzoin*. Common short shrubs include *Viburnum recognitum*, *Vaccinium pallidum*, *Rubus hispidus*, and *Rubus flagellaris*. The species composition and abundance of the herbaceous layer vary widely due to variation in canopy tree species composition, stand stocking, and soil drainage. Herbaceous species include *Ageratina altissima*, *Dryopteris intermedia*, *Dryopteris carthusiana*, *Oxalis stricta*, *Potentilla simplex*, *Mitchella repens*, *Galium aparine*, *Galium asprellum*, *Brachyelytrum erectum*, and *Lycopodium digitatum*. Graminoid and forb species associated with disturbed areas, such as *Agrostis stolonifera*, *Dichanthelium clandestinum*, *Dennstaedtia punctilobula*, and *Hypericum perforatum*, are often dominant in these communities. Vines such as *Toxicodendron radicans*, *Smilax glauca*, *Smilax rotundifolia*, *Vitis* spp., and *Parthenocissus quinquefolia* may be present, but not abundant, in these plantations. Disturbance from the silvicultural treatments and landscape fragmentation leave these communities prone to invasion by exotic species, including *Lonicera tatarica*, *Berberis vulgaris*, and *Rosa multiflora*, which are locally abundant in places.

**Environmental Description:** These mature plantations are planted in post-agricultural fields and pastures.

**Vegetation Description:** These plantations consist of mature *Pinus strobus* or *Pinus sylvestris*, with other conifers sometimes present in smaller amounts, planted in post-agricultural fields and pastures. Associated canopy conifers include *Pinus resinosa*, *Picea abies*, or *Larix decidua*. The understory varies widely in its degree of development and may be virtually absent. Northern hardwoods typically dominate the sapling and seedling layers, and cover is proportional to the degree of canopy break-up or opening that has occurred. Common hardwoods include *Prunus serotina*, *Acer rubrum*, and *Fraxinus americana*. A tall-shrub layer may be present; common species (aside from smaller individuals of the hardwood saplings) include *Crataegus* spp., *Hamamelis virginiana*, and *Lindera benzoin*. Common short shrubs include *Viburnum recognitum*, *Vaccinium pallidum*, *Rubus hispidus*, and *Rubus flagellaris*. The species composition and abundance of the herbaceous layer vary widely due to variation in canopy tree species composition, stand stocking, and soil drainage. Herbaceous species include *Ageratina altissima*, *Dryopteris intermedia*, *Dryopteris carthusiana*, *Oxalis stricta*, *Potentilla simplex*, *Mitchella repens*, *Galium aparine*, *Galium asprellum*, *Brachyelytrum erectum*, and *Lycopodium digitatum*. Graminoid and forb species associated with disturbed areas, such as *Agrostis stolonifera*, *Dichanthelium clandestinum*, *Dennstaedtia punctilobula*, and *Hypericum perforatum*, are often dominant in these communities. Vines such as *Toxicodendron radicans*, *Smilax glauca*, *Smilax rotundifolia*, *Vitis* spp., and *Parthenocissus quinquefolia* may be present, but not abundant, in these plantations. Disturbance from the silvicultural treatments and landscape fragmentation leave these communities prone to invasion by exotic species, including *Lonicera tatarica*, *Berberis vulgaris*, and *Rosa multiflora*, which are locally abundant in places.

**Most Abundant Species:**

<u>Stratum</u>	<u>Lifeform</u>	<u>Species</u>
Tree canopy	Needle-leaved tree	<i>Pinus strobus</i> , <i>Pinus sylvestris</i>

**Characteristic Species:** *Pinus strobus*, *Pinus sylvestris*.

**Other Noteworthy Species:** Information not available.

**USFWS Wetland System:** Not applicable.

**DISTRIBUTION**

**Range:** Information not available.

**States/Provinces:** PA, VT

**Federal Lands:** NPS (Allegheny Portage Railroad, Delaware Water Gap, Fort Necessity, Friendship Hill, Johnstown Flood, Marsh-Billings-Rockefeller).

**CONSERVATION STATUS**

**Rank:** GNA (modified/managed) (1-Dec-2004).

**Reasons:** Information not available.

**CLASSIFICATION INFORMATION**

**Status:** Standard.

**Confidence:** 3 – Weak.

**Comments:** This type is intended for plantations of mixed pines or pine mixed with other nonnative planted conifers.

**Similar Associations:**

- *Pinus strobus* Planted Forest (CEGL007178)--monotypic white pine.

**Related Concepts:** Information not available.

**SOURCES**

**Description Authors:** S. C. Gawler.

**References:** Eastern Ecology Working Group n.d., Perles et al. 2006a, Perles et al. 2006b, Podniesinski et al. 2006.

**Common Name (Park-specific): Successional Old Field**

**SYNONYMS**

**NVC English Name:** Orchard Grass - Sheep-sorrel Herbaceous Vegetation

**NVC Scientific Name:** *Dactylis glomerata* - *Rumex acetosella* Herbaceous Vegetation

**NVC Identifier:** CEGLO06107

**LOCAL INFORMATION**

**Environmental Description:** This community occurs in fields that are no longer being actively maintained as open by the National Park Service. These fields typically occur on level or slightly sloping uplands on Monongahela silt loam. Without mowing, brushcutting, grazing, or burning, open fields dominated by grasses and forbs undergo natural succession to shrubland and then to woodland and forest. Woody plants typically first establish on the outer edges of the fields and spread throughout the field. Consequently, there is a wide range of variation in the vegetation structure and composition of this community. Many of the old-field sites at Friendship Hill National Historic Site contain some patches of open grass- and forb-dominated fields surrounded by sparse to dense shrublands and young woodlands. Invasive nonnative plants are often abundant.

**Vegetation Description:** The composition of these old fields varies greatly depending on the length of time since management ceased, the original species composition of the open field, the local seed sources, soil moisture, and other disturbance factors. Portions of the fields that remain open and dominated by grasses and forbs typically contain orchard grass (*Dactylis glomerata*), harvest-lice (*Agrimonia parviflora*), common velvet grass (*Holcus lanatus*), poverty rush (*Juncus tenuis*), wrinkleleaf goldenrod (*Solidago rugosa*), bluegrass (*Poa* sp.), tall fescue (*Lolium arundinaceum*), Kentucky bluegrass (*Poa pratensis*), ground-ivy (*Glechoma hederacea*), calico aster (*Symphotrichum lateriflorum* var. *lateriflorum*), jumpseed (*Polygonum virginianum*), white avens (*Geum canadense*), common yellow oxalis (*Oxalis stricta*), rough bedstraw (*Galium asprellum*), red clover (*Trifolium pratense*), Carolina horsenettle (*Solanum carolinense*), spotted lady's-thumb (*Polygonum persicaria*), panicgrass (*Panicum* spp.), sweet vernalgrass (*Anthoxanthum odoratum*), flat-top goldentop (*Euthamia graminifolia*), and American milletgrass (*Milium effusum*). In places with higher soil moisture, hydrophilic species such as Canadian clearweed (*Pilea pumila*), small-spike false nettle (*Boehmeria cylindrica*), sensitive fern (*Onoclea sensibilis*), wingstem (*Verbesina alternifolia*), common rush (*Juncus effusus*), and arrowleaf tearthumb (*Polygonum sagittatum*) are common. Many other grass and forb species may be present. Short and tall shrubs can cover 25–80% of the field, often forming dense thickets or thick clumps of shrubs. The most common shrubs are the invasive species multiflora rose (*Rosa multiflora*) and autumn olive (*Elaeagnus umbellata*), however, Allegheny blackberry (*Rubus allegheniensis*), pawpaw (*Asimina triloba*), and seedling and saplings of numerous hardwood tree species can also be abundant. Hardwood trees that have established in the old field are typically 7 to 15 m in height and form open woodlands or patches of young forest (25–60% cover). Boxelder (*Acer negundo*), black cherry (*Prunus serotina*), white ash (*Fraxinus americana*), tuliptree (*Liriodendron tulipifera*), sycamore (*Platanus occidentalis*), American elm (*Ulmus americana*), and pin oak (*Quercus palustris*) are common species, however, numerous other species can be present. Vines such as eastern poison-ivy (*Toxicodendron radicans*), grape (*Vitis aestivalis*, *Vitis riparia*), and Virginia creeper (*Parthenocissus quinquefolia*) can also be abundant (15–50% cover). Due to the successional nature of the old fields, multiflora rose,

Japanese honeysuckle (*Lonicera japonica*), Japanese stilt grass (*Microstegium vimineum*), autumn olive, and oriental lady's-thumb (*Polygonum caespitosum*) are common nonnative invasive species that thrive in these environments.

**Most Abundant Species:**

<u>Stratum</u>	<u>Lifeform</u>	<u>Species</u>
Tree canopy	Broad-leaved deciduous tree	<i>Acer negundo</i> , <i>Fraxinus americana</i> , <i>Liriodendron tulipifera</i> , <i>Prunus serotina</i>
Tall shrub/sapling	Broad-leaved deciduous shrub	<i>Asimina triloba</i> , <i>Elaeagnus umbellata</i>
Short shrub/sapling	Broad-leaved deciduous shrub	<i>Rosa multiflora</i> , <i>Rubus allegheniensis</i>
Herb (field)	Forb	<i>Agrimonia parviflora</i> , <i>Solidago rugosa</i>
Herb (field)	Graminoid	<i>Dactylis glomerata</i> , <i>Holcus lanatus</i>

**Characteristic Species:** *Acer negundo*, *Agrimonia parviflora*, *Dactylis glomerata*, *Fraxinus americana*, *Holcus lanatus*, *Juncus tenuis*, *Prunus serotina*, *Rosa multiflora*, *Rubus allegheniensis*, *Solidago rugosa*.

**Other Noteworthy Species:** Information not available.

**Subnational Distribution with Crosswalk Data:**

<u>State</u>	<u>State Rank</u>	<u>Confidence</u>	<u>State Name</u>	<u>Reference</u>
PA	NA	NA	no crosswalk	Fike 1999

**Local Range:** Level or slightly sloping uplands in Friendship Hill National Historic Site.

**Classification Comments:** Despite the diversity of vegetation structure and species composition observed in this community, successional old fields are a coherent and common vegetation type at Friendship Hill National Historic Site. Early Successional Hardwood Forests in Friendship Hill typically develop from Successional Old Fields on which dense young forest has established over many years. There is not a hard definitive distinction between these two types; however, Successional Old Fields tend to be open fields, shrublands, or woodlands (with less than 60% cover of trees). Trees in the Successional Old Fields do not generally exceed 20 cm in diameter at breast height or 12 m in height. By contrast, Early Successional Hardwood Forests have greater than 60% cover of trees, often with trees that exceed 20 cm in diameter at breast height or 12 m in height.

**Other Comments:** Information not available.

**Local Description Authors:** S. J. Perles (PNHP).

**Plots:** FRHI.13, FRHI.14, FRHI.15, FRHI.17, FRHI.26, FRHI.28.

**Friendship Hill National Historic Site Inventory Notes:** Information not available.

**GLOBAL INFORMATION**

**NVC CLASSIFICATION**

Physiognomic Class	Herbaceous Vegetation (V)
Physiognomic Subclass	Perennial graminoid vegetation (V.A.)
Physiognomic Group	Temperate or subpolar grassland (V.A.5.)
Physiognomic Subgroup	Natural/Semi-natural temperate or subpolar grassland (V.A.5.N.)
Formation	Medium-tall sod temperate or subpolar grassland (V.A.5.N.c.)
Alliance	<i>Dactylis glomerata</i> - <i>Rumex acetosella</i> Herbaceous Alliance (A.1190)
Alliance (English name)	Orchard Grass - Common Sheep Sorrel Herbaceous Alliance Association <i>Dactylis glomerata</i> - <i>Phleum pratense</i> - <i>Festuca</i> spp. - <i>Solidago</i> spp. Herbaceous Vegetation

Association (English name) Orchard Grass - Timothy - Fescue species - Goldenrod species  
Herbaceous Vegetation

**Ecological System(s):** Information not available.

### GLOBAL DESCRIPTION

**Concept Summary:** This broadly defined vegetation type includes pastures and post-agricultural fields and is largely composed of nonnative grasses and herbs (generally of European origin) in the early stages of succession. The fields are typically mowed at least annually. Physiognomically, these grasslands are generally comprised of mid-height (1–3 feet tall) grasses and forbs, with occasional scattered shrubs. Species composition varies from site to site, depending on land-use history and perhaps soil type, but, in general, this vegetation is quite wide-ranging in northeastern and midwestern states and at higher elevations (610–1220 m [2000–4000 ft]) in the southeastern states. Dominant grasses vary from site to site but generally feature the nominal species. Other graminoid associates may include *Agrostis stolonifera*, *Agrostis hyemalis*, *Elymus repens*, *Bromus inermis*, *Bromus tectorum*, *Lolium perenne*, *Poa pratensis*, *Poa compressa*, *Schizachyrium scoparium* (not in abundance), and *Anthoxanthum odoratum*. Forbs scattered among the grasses are varied but include *Hieracium* spp., *Oxalis stricta*, *Achillea millefolium*, *Asclepias syriaca*, *Solidago rugosa*, *Solidago nemoralis*, *Solidago juncea*, *Solidago canadensis*, *Solidago altissima*, *Euthamia graminifolia*, *Cerastium arvense*, *Oenothera biennis*, *Potentilla simplex*, *Symphyotrichum lateriflorum*, *Symphyotrichum novae-angliae*, *Symphyotrichum lanceolatum*, *Daucus carota*, *Ambrosia artemisiifolia*, *Vicia cracca*, *Trifolium* spp., and many others.

**Environmental Description:** This association occurs on pastures and land that has been tilled.

**Vegetation Description:** In addition to *Dactylis glomerata* and *Rumex acetosella* these grassy fields are characterized by *Symphyotrichum* spp. (including *Symphyotrichum lateriflorum* and *Symphyotrichum novae-angliae*), *Rudbeckia hirta*, *Pteridium aquilinum*, *Chenopodium album*, *Asclepias syriaca*, *Andropogon virginicus*, *Schizachyrium scoparium*, *Phytolacca americana*, *Phleum pratense*, *Poa pratensis*, *Poa compressa*, *Elymus repens*, *Bromus inermis*, *Solidago* spp. (including *Solidago rugosa*, *Solidago nemoralis*, *Solidago juncea*, *Solidago canadensis*, *Solidago altissima*), *Euthamia graminifolia*, *Oenothera biennis*, *Potentilla simplex*, *Daucus carota*, *Ambrosia artemisiifolia*, *Hieracium* spp., *Taraxacum officinale*, *Vicia cracca*, *Trifolium* spp., and many others.

### Most Abundant Species:

<u>Stratum</u>	<u>Lifeform</u>	<u>Species</u>
Herb (field)	Forb	<i>Rumex acetosella</i>
Herb (field)	Graminoid	<i>Dactylis glomerata</i>

**Characteristic Species:** *Dactylis glomerata*, *Rumex acetosella*.

**Other Noteworthy Species:** Information not available.

**USFWS Wetland System:** Not applicable.

### DISTRIBUTION

**Range:** This vegetation is quite wide-ranging in northeastern and midwestern states and possibly occurs at higher elevations in the southeastern states.

**States/Provinces:** CT, DE, KY, MA, MD, ME, NH, NJ, NY, PA, RI, TN, VA, VT, WV

**Federal Lands:** NPS (Allegheny Portage Railroad, Cape Cod, Delaware Water Gap, Fire Island, Fort Necessity, Friendship Hill, Gettysburg, Johnstown Flood, Marsh-Billings-Rockefeller, Minute Man, Morristown, Saint-Gaudens, Valley Forge, Weir Farm); USFWS (Assabet River, Great Meadows, Oxbow).

### CONSERVATION STATUS

**Rank:** GNA (modified/managed) (8-Dec-2005).

**Reasons:** This vegetation type includes pasture and post-agricultural fields and is largely composed of nonnative grasses and herbs (generally of European origin).

### CLASSIFICATION INFORMATION

**Status:** Standard.

**Confidence:** 3 – Weak.

**Comments:** Information not available.

### Similar Associations:

- *Lolium (arundinaceum, pratense)* Herbaceous Vegetation (CEGL004048).
- *Phleum pratense - Bromus pubescens - Helonium autumnale* Herbaceous Vegetation (CEGL004018).
- *Schizachyrium scoparium - Solidago* spp. Herbaceous Vegetation (CEGL006333).

**Related Concepts:** Information not available.

### SOURCES

**Description Authors:** Eastern Ecology Group.

**References:** Clark 1986, Dowhan and Rozsa 1989, Eastern Ecology Working Group n.d., Edinger et al. 2002, Keever 1979, Newbold et al. 1988, Perles et al. 2006a, Perles et al. 2006b, Perles et al. 2006c, Podniesinski et al. 2006, Sneddon et al. 1995, TDNH unpubl. data.



Figure 16. Successional Old Field in Friendship Hill National Historic Site (plot FRHI.15). July 2004. NAD 1983 / UTM easting 592433, northing 4402671.



Figure 17. Successional Old Field in Friendship Hill National Historic Site (plot FRHI.28). July 2004. NAD 1983 / UTM easting 592528, northing 4403091.



## Common Name (Park-specific): Mixed Forb Marsh

### SYNONYMS

NVC English Name: (Swamp Smartweed, Dotted Smartweed) - (Catchfly Cutgrass, White Cutgrass) Herbaceous Vegetation

NVC Scientific Name: *Polygonum (hydropiperoides, punctatum)* - *Leersia (lenticularis, virginica)* Herbaceous Vegetation

NVC Identifier: C EGL004290

### LOCAL INFORMATION

**Environmental Description:** This variable community occurs in small patches along a stream that drains from south to north through the center of Friendship Hill National Historic Site. Most of the small palustrine herbaceous openings along the stream have been heavily modified due to acid mine drainage remediation. These palustrine areas are predominantly associated with Tyler silt loam, a somewhat poorly drained soil common in depressions and near stream channels. Invasive nonnative plants are often abundant.

**Vegetation Description:** This highly variable community is dominated by hydrophilic graminoids and forbs, however, species dominance can vary greatly between patches. Rice cutgrass (*Leersia oryzoides*), woolgrass (*Scirpus cyperinus*), reed canarygrass (*Phalaris arundinacea*), and broadleaf cattail (*Typha latifolia*) can be locally dominant. Other abundant species include arrowleaf tearthumb (*Polygonum sagittatum*), wingstem (*Verbesina alternifolia*), small-spike false nettle (*Boehmeria cylindrica*), creeping bentgrass (*Agrostis stolonifera*), swamp smartweed (*Polygonum hydropiperoides*), broadleaf arrowhead (*Sagittaria latifolia*), wrinkleleaf goldenrod (*Solidago rugosa*), marsh-pepper knotweed (*Polygonum hydropiper*), fringed sedge (*Carex crinita*), cinnamon fern (*Osmunda cinnamomea*), and softstem bulrush (*Schoenoplectus tabernaemontani*). Species typical of old fields, such as orchard grass (*Dactylis glomerata*), deertongue grass (*Dichanthelium clandestinum*), panicgrass (*Panicum* spp.), common velvet grass (*Holcus lanatus*), poverty rush (*Juncus tenuis*), and rough bedstraw (*Galium asprellum*) can also be common. Peatmosses (*Sphagnum* spp.) can be locally abundant in some examples of this community. Although mixed forb marshes are typically open with <5% cover of woody species, shrubs and trees extend up to 10 m in height and can cover up to 60% of the wetland in some cases. Woody species typical of this community are sweet birch (*Betula lenta*), red maple (*Acer rubrum*), pin oak (*Quercus palustris*), tuliptree (*Liriodendron tulipifera*), boxelder (*Acer negundo*), and black willow (*Salix nigra*). Several of these wetlands contain the invasive species Japanese stilt grass (*Microstegium vimineum*) and oriental lady's-thumb (*Polygonum caespitosum*). This community is also susceptible to invasion by purple loosestrife (*Lythrum salicaria*) and common reed (*Phragmites australis*), although none was observed in Friendship Hill during this study.

#### Most Abundant Species:

<u>Stratum</u>	<u>Lifeform</u>	<u>Species</u>
Herb (field)	Forb	<i>Polygonum sagittatum</i>
Herb (field)	Graminoid	<i>Leersia oryzoides</i> , <i>Phalaris arundinacea</i> , <i>Scirpus cyperinus</i> , <i>Typha latifolia</i>

**Characteristic Species:** *Boehmeria cylindrica*, *Leersia oryzoides*, *Polygonum sagittatum*, *Scirpus cyperinus*, *Typha latifolia*, *Verbesina alternifolia*.

**Other Noteworthy Species:** Information not available.

**Subnational Distribution with Crosswalk Data:**

<u>State</u>	<u>State Rank</u>	<u>Confidence</u>	<u>State Name</u>	<u>Reference</u>
PA	S4	2	Mixed forb marsh	Fike 1999

**Local Range:** Along a small stream draining from the south to the north through the middle of Friendship Hill National Historic Site.

**Classification Comments:** If these small-patch wetlands were larger, more numerous, or less disturbed, they probably could be classified into multiple, more discreet palustrine types. However, given the highly disturbed nature of these wetlands and their size and distribution, it seemed appropriate to lump them into one general palustrine type.

**Other Comments:** Information not available.

**Local Description Authors:** S. J. Perles (PNHP).

**Plots:** FRHI.21, FHRI.22, FRHI.24, FRHI.25, FRHI.31.

**Friendship Hill National Historic Site Inventory Notes:** Information not available.

### GLOBAL INFORMATION

#### NVC CLASSIFICATION

Physiognomic Class	Herbaceous Vegetation (V)
Physiognomic Subclass	Perennial forb vegetation (V.B.)
Physiognomic Group	Temperate or subpolar perennial forb vegetation (V.B.2.)
Physiognomic Subgroup	Natural/Semi-natural temperate or subpolar perennial forb vegetation (V.B.2.N.)
Formation	Seasonally flooded temperate perennial forb vegetation (V.B.2.N.h.)
Alliance	<i>Polygonum</i> spp. (section Persicaria) Seasonally Flooded Herbaceous Alliance (A.1881)
Alliance (English name)	Smartweed species Seasonally Flooded Herbaceous Alliance
Association	<i>Polygonum (hydropiperoides, punctatum) - Leersia (lenticularis, virginica)</i> Herbaceous Vegetation
Association (English name)	(Swamp Smartweed, Dotted Smartweed) - (Catchfly Cutgrass, White Cutgrass) Herbaceous Vegetation
<b>Ecological System(s):</b>	East Gulf Coastal Plain Small Stream and River Floodplain Forest (CES203.559). East Gulf Coastal Plain Northern Depression Pondshore (CES203.558). South-Central Interior Small Stream and Riparian (CES202.706).

#### GLOBAL DESCRIPTION

**Concept Summary:** This association incorporates vegetation of beaver ponds and other semipermanent impoundments in the Piedmont, South Atlantic Coastal Plain, Upper East Gulf Coastal Plain, scattered localities in the Blue Ridge, and possibly other adjacent provinces. Stands of this vegetation are dominated by some combination of *Polygonum punctatum*, *Polygonum hydropiperoides*, *Leersia lenticularis*, and/or *Leersia virginica*. Other herbaceous species present include *Saururus cernuus*, *Proserpinaca* sp., *Bidens aristosa*, and *Xanthium strumarium*. Scattered individuals of *Cephalanthus occidentalis* and *Acer saccharinum* may be

present. A Piedmont North Carolina example contains *Impatiens capensis*, *Boehmeria cylindrica*, and the exotic *Murdannia keisak*.

**Environmental Description:** This association incorporates vegetation of beaver ponds and other semipermanent impoundments.

**Vegetation Description:** Stands of this vegetation are dominated by some combination of *Polygonum punctatum*, *Polygonum hydropiperoides*, *Leersia lenticularis*, and/or *Leersia virginica*. Other herbaceous species which may be present include *Polygonum densiflorum*, *Saururus cernuus*, *Proserpinaca* sp., *Sparganium americanum*, *Typha latifolia*, *Scirpus cyperinus*, *Lobelia cardinalis*, *Onoclea sensibilis*, *Penthorum sedoides*, *Boehmeria cylindrica*, *Sambucus canadensis*, *Bidens aristosa*, and *Xanthium strumarium*. Scattered individuals of *Cephalanthus occidentalis* and *Acer saccharinum* or other woody plants may be present. Examples which have become dried-out (through drought and/or beaver dam failure) may exhibit greater dominance by *Leersia* rather than *Polygonum*. The combination of *Polygonum punctatum* - *Leersia virginica* was first noted, but the combination of *Polygonum hydropiperoides* and *Leersia lenticularis* has also been observed in the Oconee National Forest.

**Most Abundant Species:**

<u>Stratum</u>	<u>Lifeform</u>	<u>Species</u>
Herb (field)	Forb	<i>Polygonum hydropiperoides</i> , <i>Polygonum punctatum</i>
Herb (field)	Graminoid	<i>Leersia lenticularis</i> , <i>Leersia virginica</i>

**Characteristic Species:** *Leersia lenticularis*, *Leersia virginica*, *Polygonum hydropiperoides*, *Polygonum punctatum*.

**Other Noteworthy Species:** Information not available.

**USFWS Wetland System:** Palustrine.

**DISTRIBUTION**

**Range:** This association is found in the Coastal Plain and Interior from Tennessee and Alabama to the Carolinas. The full extent of its distribution is not known.

**States/Provinces:** AL, GA, KY?, NC, NJ, PA, SC, TN

**Federal Lands:** DOD (Fort Benning); NPS (Friendship Hill, Great Smoky Mountains, Morristown, Shiloh); USFS (Bankhead, Daniel Boone?, Oconee, Talladega?).

**CONSERVATION STATUS**

**Rank:** G4? (21-Dec-2000).

**Reasons:** This association is found in the Coastal Plain and Interior from Tennessee and Alabama to the Carolinas. The full extent of its distribution is not known. This is not a rare community type, but it is threatened by filling of wetlands.

**CLASSIFICATION INFORMATION**

**Status:** Standard.

**Confidence:** 2 – Moderate.

**Comments:** Documented from a beaver pond in the floodplain of Owl Creek, Shiloh National Battlefield, Tennessee, on soils of the Collins silt loam; also documented on Bailey Island in the ACE Basin (C. Aulbach-Smith pers. comm.). Also seen in the Bankhead National Forest, Alabama, and the Oconee National Forest, Georgia.

**Similar Associations:** Information not available.

**Related Concepts:** Information not available.

## SOURCES

**Description Authors:** M. Andreu and M. Tukman.

**References:** Aulbach-Smith pers. comm., Gallyoun et al. 1996, NatureServe Ecology - Southeastern U.S. unpubl. data, Schotz pers. comm., Southeastern Ecology Working Group n.d., TDNH unpubl. data.



Figure 18. Mixed Forb Marsh in Friendship Hill National Historic Site (plot FRHI.21). July 2004. NAD 1983 / UTM easting 591567, northing 4404342.



Figure 19. Mixed Forb Marsh in Friendship Hill National Historic Site (plot FRHI.23). July 2004. NAD 1983 / UTM easting 592305, northing 4402648.

## Vegetation Map Production

In order to produce an association-level vegetation map, the formation-level vegetation map was edited and refined onscreen in ArcView 3.2. Based on the vegetation data analysis, each polygon was assigned one of the seven vegetation association types. The vegetation types were assigned using information from plot data, field observations, aerial photography signatures, and topographic maps. Polygon boundaries were also revised based on these four information sources. Seven polygons were labeled as a mosaic of Early Successional Hardwood Forest and Successional Old Field associations because both types were present in the polygons and clear boundaries between the two associations could not be delineated.

Polygons that were attributed with modified Anderson level II categories retained their attributes. Eleven polygons originally labeled as Medium-tall sod temperate or subpolar grassland were attributed to the modified Anderson level II category Grassland. These grasslands are actively maintained by the National Park Service and adjacent landowners as hayfields, lawns, and utility rights-of-way. An aerial photograph interpretation key for the vegetation associations and Anderson level II categories (modified) is located in Appendix A.

The thematic accuracy of this vegetation-association map was then assessed. Based on the accuracy assessment sampling points, the association-level map was revised again to correct errors and create more accurate vegetation association polygon boundaries. In this final revision, accuracy assessment data, plot data, field observations, aerial photography signatures, and topographic maps were used to revise polygon boundaries and attributes. The resulting final vegetation association map is shown in Figure 20 and a summary of the vegetation associations' distribution and abundance is provided in Table 5. The number of total mapped hectares listed in Table 5 is larger than the number of hectares in the park because the mapped polygons extend beyond the park boundary. Metadata for the vegetation association shapefile, the plot location shapefile, the accuracy assessment sampling point location shapefile, and the digital photomosaic were prepared according to Federal Geographic Data Committee standards and have been provided as a deliverable along with this report.

## Accuracy Assessment

### Positional Accuracy

The final horizontal positional accuracy for the mosaic is 1.453 meters and meets Class 1 National Map Accuracy Standards (FGDC 1998b; Minnesota Governor's Council on Geographic Information and Minnesota Land Management Information Center 1999). A copy of the spreadsheet that contains the x and y coordinates for each ground control point and the root mean square error accuracy calculation formula is included in the air photo archive.

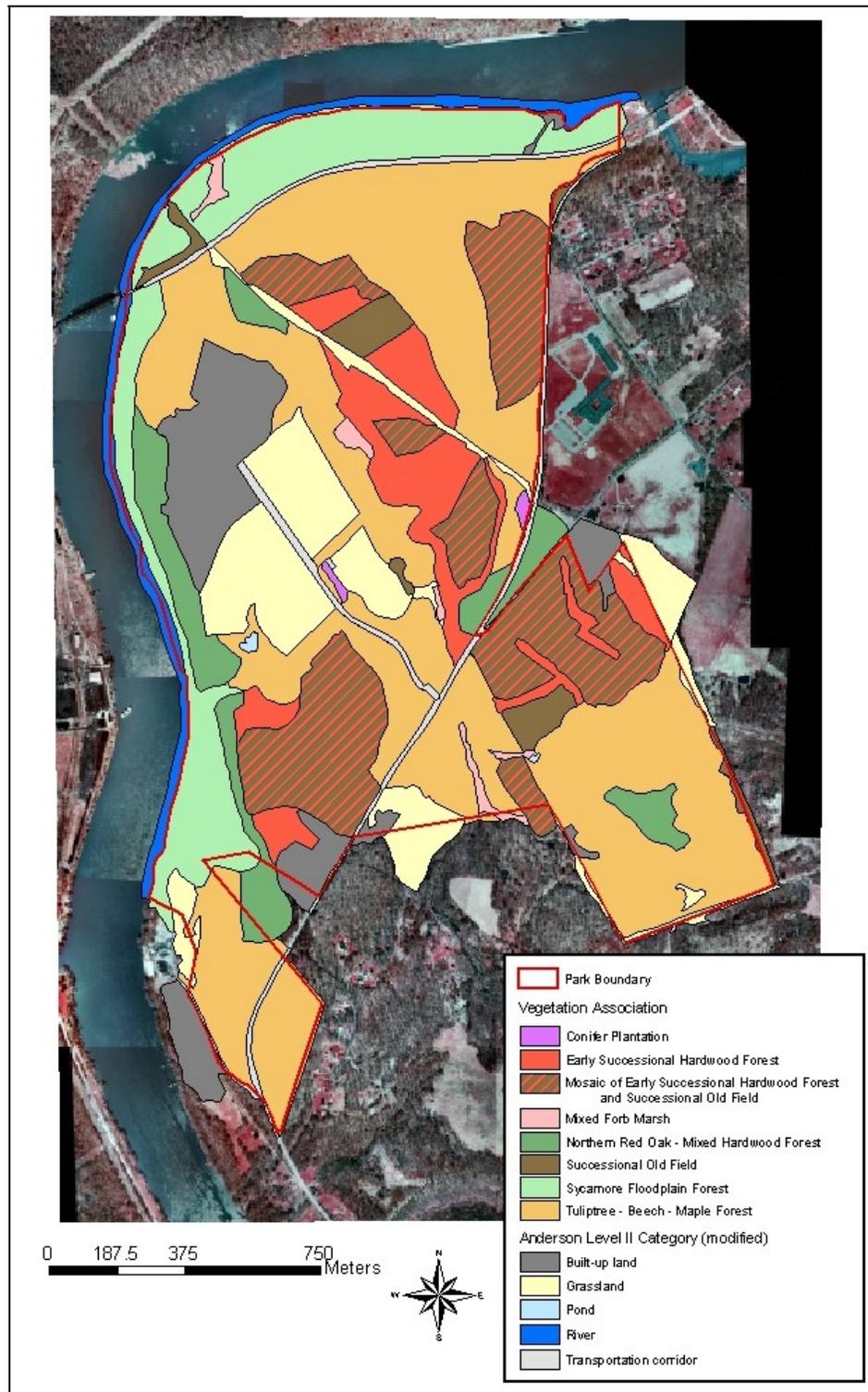


Figure 20. Vegetation associations and Anderson Level II categories (modified) of Friendship Hill National Historic Site.

Table 5. Number of polygons, total mapped hectares, and mapped hectares within the park boundary for vegetation associations and Anderson level II categories (modified) at Friendship Hill National Historic Site.

	Number of Polygons	Total Mapped Hectares	Mapped Hectares Within Park Boundary
Vegetation Association			
Conifer Plantation	2	0.56	0.52
Early Successional Hardwood Forest	9	21.95	21.92
Mixed Forb Marsh	5	2.25	2.07
Northern Red Oak - Mixed Hardwood Forest	6	16.96	13.09
Successional Old Field	5	6.68	5.88
Sycamore Floodplain Forest	4	33.53	31.73
Tuliptree - Beech - Maple Forest	10	113.31	111.47
Mosaic of Early Successional Hardwood Forest and Successional Old Field	7	45.38	44.80
Anderson Level II Category (modified)			
Built-up land	7	22.47	17.01
Grassland	11	31.69	24.93
Pond	2	0.24	0.24
River	2	9.33	1.32
Transportation corridor	5	7.25	5.35
Total	78	311.59	280.31

### Thematic Accuracy

Based on the contingency matrix (Table 6), the Kappa index for the vegetation association map was  $78.8\% \pm 10.9\%$ , with the overall percent accuracy calculated as 83.0%. The errors of commission for five of the seven vegetation associations exceeded the USGS/NPS vegetation mapping protocol requirement of 80% (Table 6). The exceptions were Northern Red Oak – Mixed Hardwood Forest (75.0%) and Tuliptree – Beech – Maple Forest (77.8%) which fell just below the protocol requirement. The errors of omission for five of the seven vegetation associations also exceeded the USGS/NPS vegetation mapping protocol requirement of 80%. Northern Red Oak – Mixed Hardwood Forest (37.5%) and Mixed Forb Marsh (50.0%) did not meet the protocol requirements. The very low error of omission for Northern Red Oak – Mixed Hardwood Forest was caused by the over estimation of oak distribution in the draft association-level map. The low error of omission for Mixed Forb Marsh was caused by one inaccurate polygon boundary and one aerial photointerpretation error.

### Project Deliverables

Final products of the vegetation mapping project are shown in Table 7. All products have been delivered to the National Park Service by the Pennsylvania Science Office of The Nature Conservancy with this report.

Table 6. Contingency matrix and calculated errors for the thematic accuracy assessment of the vegetation association map of Friendship Hill National Historic Site.

Accuracy Assessment Observation	Mapped Vegetation Association							Total	Error of Comission (% correct)
	Conifer Plantation	Early Successional Hardwood Forest	Mixed Forb Marsh	Northern Red Oak - Mixed Hardwood Forest	Successional Old Field	Sycamore Floodplain Forest	Tuliptree - Beech - Maple Forest		
Conifer Plantation	2							2	100.0%
Early Successional Hardwood Forest		7		1				8	87.5%
Mixed Forb Marsh			2					2	100.0%
Northern Red Oak - Mixed Hardwood Forest				3			1	4	75.0%
Successional Old Field					6			6	100.0%
Sycamore Floodplain Forest			1			5		6	83.3%
Tuliptree - Beech - Maple Forest				4			14	18	77.8%
Developed Land			1					1	N/A
Total	2	7	4	8	6	5	15	47	
Error of Omission (% correct)	100.0%	100.0%	50.0%	37.5%	100.0%	100.0%	93.3%		

Total Points Correct 39

Overall Accuracy 83.0%

Kappa Index 78.8%

90% confidence interval for Kappa Index 10.9%

Table 7. Summary of products resulting from the Friendship Hill National Historic Site vegetation classification and mapping project.

Product	FGCD-complaint spatial metadata
Aerial photos, including flight line map and photoindex	Yes
Photomosaic as paper copy and in digital format	Yes
Annotated field forms with vegetation plot sampling data	Not applicable
Vegetation plot sampling data in the PLOTS 2.0 database	Not applicable
Differentially corrected GPS locations of vegetation plots	Yes
Annotated field forms with thematic accuracy assessment data	Not applicable
Thematic accuracy assessment data in the PLOTS 2.0 database	Not applicable
Differentially corrected GPS locations of thematic accuracy assessment sampling points	Yes
Digital photos representative of all vegetation types	Not applicable
Final map of vegetation associations as paper copy and in digital format	Yes
Final report as paper copy and in digital format	Not applicable



## Discussion

### Vegetation Classification and Characterization

This study of Friendship Hill National Historic Site identified seven vegetation associations: Northern Red Oak – Mixed Hardwood Forest, Tuliptree – Beech – Maple Forest, Sycamore Floodplain Forest, Early Successional Forest, Conifer Plantation, Successional Old Field, and Mixed Forb Marsh. These vegetation types reflect the varied land use history, ongoing management, and varied environmental settings of the park.

Since the time Albert Gallatin acquired Friendship Hill, over 200 years ago, the estate has undergone many changes. The forests have been timbered and replanted numerous times, and the land has been mined for coal and cultivated for row crops, hay, orchards, tree nurseries, and Christmas trees (Roddy and Hammons 1986). The effects of these land uses can be seen on the land today and are reflected in the vegetation classification and the vegetation map.

The most abundant vegetation type in Friendship Hill National Historic Site is Tuliptree – Beech – Maple Forest which covers 111 ha (274 ac) of the park. Tuliptree (*Liriodendron tulipifera*) is a common pioneer species and therefore reflects that much of the park was cleared or maintained as open relatively recently. Downs and Abrams (1990) reported that the establishment of the tuliptree, American beech (*Fagus grandifolia*), and red maple (*Acer rubrum*) that are now dominant in one forest stand in Friendship Hill National Historic Site coincided with the selective logging of that stand in the 1930s and 1940s. The Tuliptree – Beech – Maple Forest also contains small remnant patches of the conifer plantations that were once abundant on the property. These small inclusions of a few conifer trees remain as reminders of the intensive land management that is part of the property's history. Tuliptree is a component of the naturally occurring Mixed Mesophytic Forest, the typical dominant type in this area (Cuff 1989). The abundance of tuliptree, as opposed to other species, such as sugar maple (*Acer saccharum*), yellow buckeye (*Aesculus flava*), and American beech, which are often associated with Mixed Mesophytic Forest, is noteworthy, however, and indicates this area was substantially altered since establishment of the Gallatin estate.

The Northern Red Oak – Mixed Hardwood Forest type is relatively limited in extent within Friendship Hill National Historic Site (13 ha [32 ac]). It occurs only on steep slopes where harvesting trees was difficult, and in pockets of forest in which the oaks were not extensively timbered. While these patches of Northern Red Oak – Mixed Hardwood Forest are relatively small and scattered, they represent what are probably the highest quality forest stands on the property. The size of the dominant trees, primarily slow-growing white oaks (*Quercus alba*) and northern red oaks (*Quercus rubra*), suggests that these trees are considerably older than surrounding red maple and tuliptree that are now dominant in the Tuliptree – Beech – Maple Forest (Downs and Abrams 1990). While the exact logging history of the Northern Red Oak – Mixed Hardwood Forest stands is unclear, these areas were probably not cleared for pastures or agriculture. The occurrence and abundance of invasive plant species is dramatically less than in other vegetation types in the park (Zimmerman and Yoder 2005).

The Sycamore Floodplain Forest is the primary vegetation type on the terraces adjacent to the Monongahela River and covers 32 ha (77 ac). Stands of this forest type were composed of younger trees interspersed with patches of relatively open canopy. A vegetation study of the park conducted in 1983 mapped the majority of the floodplain area as Thickets (Roddy and Hammons 1986). The Thickets were described as “heavy growth of young trees” with similar species composition to the Sycamore Floodplain Forest described here. Until 1975, the floodplain area was planted in corn and housed a pig raising operation, thus the young trees were only 7–9 years old in the 1983 study (Roddy and Hammons 1986). Roddy and Hammons (1986) also mapped a Riparian Community on the floodplain that encompasses the more mature stands of Sycamore Floodplain Forest that existed in the 1980’s. The results of this study, which identified all areas along the floodplain as Sycamore Floodplain Forest, indicate that Roddy and Hammons’ “thickets,” or stands of successional riparian forest have developed substantially in the past 20 years and exhibit characteristics of natural forest communities along the Monongahela River. The Fayette County Natural Heritage Inventory identifies two plants of special concern, blue mistflower (*Conoclinium coelestinum*) and Indian woodoats (*Chasmanthium latifolium*), that occur in the Sycamore Floodplain Forest on the slopes and shores of the Monongahela River within Friendship Hill National Historic Site (Wagner and Coxe 2000).

The Conifer Plantation association is the least abundant association in the park, covering only 0.52 ha (1.3 ac) between two polygons. These small patches of conifers are remnants of the pine plantations that once covered the Friendship Hill estate (Roddy and Hammons 1986). The majority of these plantations were harvested for timber or cleared for agriculture. A few coniferous trees from these plantations that were not harvested remain scattered throughout the park. These trees have become inclusions in the Tuliptree – Beech – Maple Forest that regenerated after the plantations were removed. For example, the polygons that encompassed plots FRHI.18 and FRHI.19 were originally mapped as Mixed needle-leaved evergreen – cold-deciduous forest in the formation-level map because of the presence of the coniferous and deciduous trees. However, plot sampling revealed that the forest was actually Tuliptree – Beech – Maple Forest with scattered remnant conifers from the plantations.

The Early Successional Forest and Successional Old Field associations occur in abandoned agricultural areas on which woody species have colonized. These associations illustrate the process of natural succession from open field to forest. Without ongoing management, woody plants established in these abandoned agricultural areas, which then developed into shrublands. The shrublands then grew to dense young forests of early successional hardwoods. The species composition of this young forest type is somewhat similar to that of Tuliptree – Beech – Maple Forest and thus represents an intermediate between the succession from Successional Old Field to Tuliptree – Beech – Maple Forest.

The Mixed Forb Marsh association occurs in small patches along Ice Pond Run that drains from south to north through the center of the park. This variable vegetation type is heavily influenced by acid mine drainage and the associated remediation efforts. One polygon mapped as Mixed Forb Marsh contains three constructed remediation wetlands, another polygon contains a wetland established in an abandoned farm pond. The Mixed Forb Marsh is a palustrine vegetation type that can be crosswalked to the Cowardin classification system used for the National Wetland

Inventory mapping efforts (Cowardin et al. 1979). Using the Cowardin classification system, Mixed Forb Marsh is best classified as Palustrine, Emergent, Persistent (PEM1).

The Grassland type, considered a modified Anderson level II category, differs from the Successional Old Field association in that lands classified as Grassland are actively managed. These fields are mowed, hayed, or maintained as open. The largest examples of this type within the park are the hayfields near the Gallatin house that are managed under a special use permit as part of the cultural landscape. Other examples of this type are a right-of-way that runs southeast to northwest through the park and the frequently mowed grasslands on properties immediately adjacent to the park boundary.

### Vegetation Map Production

The final vegetation map for Friendship Hill National Historic Site includes seven vegetation associations and five modified Anderson level II categories. This map is based on aerial photography that was flown in April 2003. Since that time, the vegetation in the park continues to change. Continued natural succession in the Successional Old Field and Early Successional Hardwood Forest associations will influence the mapped vegetation. Management of invasive species and woody plants would also alter the vegetation. Despite these continual changes, the vegetation map produced by this project provides crucial baseline data for park resource managers.

It is important to note that the vegetation formations listed in the attribute table of the final vegetation association shapefile were determined by the hierarchical nature of the NVCS. Based on the NVCS, each polygon was attributed with the appropriate formation for the polygon's NVCS association. The original formation-level map created during this study was developed solely to guide vegetation sampling and was not intended to identify specific NVCS formations for specific polygons. The information on each polygon's vegetation structure, leaf phenology, and hydrologic regime that was contained in the original formation-level vegetation map has been retained in the "Veg\_Strc" field of the final vegetation association shapefile.

### Recommendations for Future Projects

Invasive exotic plant species are the main threat to the native vegetation at Friendship Hill National Historic Site, particularly in the abandoned agricultural fields, on forest edges, and along trails and roads. The most common and problematic species include multiflora rose (*Rosa multiflora*), found in nearly all community types, Japanese honeysuckle (*Lonicera japonica*), and Japanese stilt grass (*Microstegium vimineum*). Tree of heaven (*Ailanthus altissima*), though not widely distributed across Friendship Hill National Historic Site, is a problem where it is found, predominantly in Tuliptree – Beech – Maple Forest where it forms dense colonies, displacing native understory trees. Japanese knotweed (*Polygonum cuspidatum*) was extremely abundant in parts of the Monongahela River floodplain, often dominating the understory. However, it is rare to absent over the remainder of the park.

The Successional Old Field association contains particularly high abundances of invasive shrub species (Zimmerman and Yoder 2005). Morrow's honeysuckle (*Lonicera morrowii*), autumn olive (*Elaeagnus umbellata*) and multiflora rose are the most problematic exotic species in this

association, although Japanese honeysuckle and Japanese stilt grass may also be common. These species may threaten and impede the succession to a native forest type without proper management. Therefore, the management of these former agricultural fields should be a priority for the park. The park should develop a management plan, specifically tailored to these areas in the park that addresses the control of invasive species, designates desired target vegetation structure and composition, and outlines management actions to achieve the desired target conditions. The development and implementation of a management plan specifically for the Successional Old Field type would facilitate the control of these invasive species and the restoration of natural vegetation associations.

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Appendix A. Aerial photograph interpretation keys to formation- and association-level vegetation types and Anderson level II categories (modified) at Friendship Hill National Historic Site.



**AERIAL PHOTOGRAPH INTERPRETATION KEY TO FORMATION-LEVEL  
VEGETATION TYPES AND ANDERSON LEVEL II CATEGORIES (MODIFIED) AT  
FRIENDSHIP HILL NATIONAL HISTORIC SITE  
for April 2003 Color Infrared Aerial Photography**

1. Individual tree crowns visible as gray, black, or pink signatures of varying architecture. Trees cover greater than 25% of area.

2. Signatures of at least 25% of the trees are pink and conical, indicating evergreen trees.

3. Evergreen tree crowns cover greater than 75% of the area, creating a near continuous pink canopy of conical crowns.

**Conical-crowned temperate evergreen forest**

3. Evergreen tree crowns cover 25–75% of the canopy and are interspersed with light to dark gray deciduous tree crowns.

**Mixed needle-leaved evergreen - cold-deciduous forest**

2. Signatures of trees are light to dark gray or black, indicating cold-deciduous trees. Less than 25% of the trees are pink and conical.

4. Tree crowns cover greater than 60% of the area, creating a near continuous canopy.

5. Forest occurs immediately adjacent to the dark blue gray signature of the river. Shading of forest is more pink than gray or blue.

**Temporarily flooded cold-deciduous forest**

5. Forest does not occur immediately adjacent to the dark blue gray signature of the river. Shading of forest is more gray or blue than pink.

**Lowland or submontane cold-deciduous forest**

4. Tree crowns cover 60% or less of the area, such that individual trees or clumps of trees are visible in a matrix of white to light gray herbaceous vegetation. Gray shrubs may also be present.

6. Individual gray or black tree crowns form an open canopy over light pink or gray herbaceous vegetation. Rounded gray clumps of shrubs may also be present. Dark curvilinear drainage features are not present

**Cold-deciduous woodland**

6. Individual gray or black tree crowns form an open canopy over bright white or pink herbaceous vegetation. Dark curvilinear drainage features are present.

**Seasonally flooded cold-deciduous forest**

1. Individual tree crowns cover less than 25% of the area.
7. Signature is primarily white to medium gray, ranging from uniform to mottled. Buildings, structures, parking lots, and roads are absent. Signature is not uniform dark blue gray with occasional white speckles, indicating open water.
8. Shrubs cover greater than 25% of the area, appearing as round gray circles, scattered or in clumps within a matrix of white to light gray herbaceous vegetation. Areas of dense shrub cover will have a bumpy gray signature.

**Temperate cold-deciduous shrubland**

8. Shrubs cover 25% or less of the area. Signature is almost entirely white to light gray herbaceous vegetation, ranging from uniform to mottled.
9. Signature tends to be bright to light pink with occasional linear mow lines.

**Medium-tall sod temperate or subpolar grassland**

9. Signature is white with speckled or dappled gray sections that indicate saturated soil and hummocky herbaceous vegetation. Dark gray linear drainage features may be present.

**Saturated temperate perennial forb vegetation**

7. Either, buildings, structures, parking lots and roads are present, often surrounded by frequently mowed turf grass that has a light to bright pink signature. Or, signature is uniform dark blue gray with occasional white speckles, indicating open water.

10. Buildings, structures, parking lots and roads are present, often surrounded by frequently mowed turf grass that has a light to bright pink signature.

11. Buildings, structures, and parking lots, often surrounded by frequently mowed turf grass that has a light, bright pink signature.

**Built-up land**

11. Roads and highways have a linear uniform light gray to blue-gray signature often with visible lane lines and automobiles.

**Transportation corridor**

10. Signature is dark blue gray with occasional white speckles, indicating open water.

12. Large linear dark blue gray feature with occasional white speckles that runs along the northern and western borders of the park.

**River**

12. Small, somewhat circular dark blue gray features isolated within other vegetation types.

**Pond**

**AERIAL PHOTOGRAPH INTERPRETATION KEY TO VEGETATION  
ASSOCIATIONS AND ANDERSON LEVEL II CATEGORIES (MODIFIED) AT  
FRIENDSHIP HILL NATIONAL HISTORIC SITE  
for April 2003 Color Infrared Aerial Photography**

1. Individual tree crowns visible as gray, black, or pink signatures of varying architecture. Trees cover greater than 25% of area.
2. Tree signatures are pink and conical, indicating evergreen trees. Evergreen trees occur in small patches of near continuous pink canopy of conical crowns.

**Conifer Plantation**

2. Tree signatures are light to dark gray or black, indicating cold-deciduous trees. (The associations in couplet 5 below may be indistinguishable from each other on the aerial photography. Field verification may be necessary for positive identification.)
3. Trees have somewhat consistent mature height and regular spacing. Individual tree architecture can be identified. Groundstory varies from bright white to mottled brown and pink.
4. Forest occurs immediately adjacent to the dark blue gray signature of the river. Shading of forest is more pink than gray or blue. Canopy structure can be variable.

**Sycamore Floodplain Forest**

4. Forest does not occur immediately adjacent to the dark blue gray signature of the river. Shading of forest is more gray or blue than pink.
5. Tree crowns are light gray to light brown, symmetrical, fine-branched, and tall. Often emergent crowns are visible above a varied subcanopy. This is the most common forest type in the park. (This association type may be indistinguishable from Northern Red Oak – Mixed Hardwood Forest on aerial photography.)

**Tuliptree – Beech – Maple Forest**

5. Tree crowns are dark gray with open asymmetrical canopies and coarse craggy branches. Forest occurs on steep slopes and in patches throughout the park. (This association type may be indistinguishable from Tuliptree – Beech – Maple Forest on aerial photography.)

**Northern Red Oak – Mixed Hardwood Forest**

3. Forest has dense bumpy gray signature of young trees, with occasional small, interspersed patches of white to light gray open herbaceous vegetation.

**Early Successional Hardwood Forest**

1. Individual tree crowns cover less than 25% of the area.
6. Signature is predominantly white, light gray or pink herbaceous vegetation, ranging from uniform to mottled. Shrubs, appearing as round gray circles, may be present or absent, scattered or in clumps within the white to light gray matrix of herbaceous vegetation. Buildings, structures, parking lots, roads, and open water are absent.
7. White to light gray herbaceous vegetation signature contains gray to black speckled or textured areas that indicate saturated or inundated soil. Gray to black linear drainage features are prominent or common.

**Mixed Forb Marsh**

7. Signature is bright or light pink, white, or light gray. Gray to black speckled or textured areas that indicate saturated or inundated soil and gray to black linear drainage are absent. Individual tree crowns and shrubs may be present or absent, scattered or in clumps. Areas of dense shrub cover will have a bumpy gray signature.
8. Signature tends to be bright to light pink with occasional linear mow lines. Shrubs and trees are absent.

**Grassland**

8. Signature tends to be light gray, white, or light pink with shrubs appearing as round gray circles, scattered or in clumps. Areas of dense shrub cover will have a bumpy gray signature. Scattered tree crowns may also be visible

**Successional Old Field**

6. Either, buildings, structures, parking lots and roads are present, often surrounded by frequently mowed turf grass that has a light to bright pink signature. Or, signature is uniform dark blue gray with occasional white speckles, indicating open water.
9. Buildings, structures, parking lots and roads are present, often surrounded by frequently mowed turf grass that has a light to bright pink signature.
10. Buildings, structures, and parking lots, often surrounded by frequently mowed turf grass that has a light, bright pink signature.

**Built-up land**

10. Roads and highways have a linear uniform light gray to blue-gray signature often with visible lane lines and automobiles.

**Transportation corridor**

9. Signature is dark blue gray with occasional white speckles, indicating open water.

11. Large linear dark blue gray feature with occasional white speckles that runs along the northern and western borders of the park.

**River**

11. Small, somewhat circular dark blue gray features isolated within other vegetation types.

**Pond**



Appendix B. Vegetation plot sampling form.



NPS 6 Parks Vegetation Mapping Project

**A. General Information**

Plot Number: _____	Park Name: _____
Survey date: _____	Surveyors: _____
Easting: _____ E	Northing: _____ N
EPE/APE: _____	DOP: _____
Map datum: _____	Zone: _____

**B. Environmental Description**

Representative sketch of stand and landscape position          Picture No.: _____		Slope: _____ Aspect: _____ Elevation: _____  Stoniness: <input type="checkbox"/> Stone free <0.1% <input type="checkbox"/> Moderately stony 0.1-1% <input type="checkbox"/> Stony 3-15% <input type="checkbox"/> Very stony 15-50% <input type="checkbox"/> Exceedingly stony 50-90% <input type="checkbox"/> Stone piles >90%																																																						
Topographic position: <input type="checkbox"/> Interfluvial (ridgetop) <input type="checkbox"/> Low slope <input type="checkbox"/> High slope <input type="checkbox"/> Toe slope <input type="checkbox"/> High level <input type="checkbox"/> Low level <input type="checkbox"/> Midslope <input type="checkbox"/> Channel wall <input type="checkbox"/> Backslope <input type="checkbox"/> Channel bed <input type="checkbox"/> Step in slope <input type="checkbox"/> Basin Floor <input type="checkbox"/> Other: _____	Hydrologic regime: <input type="checkbox"/> Permanently flooded <input type="checkbox"/> Semi-permanently flooded <input type="checkbox"/> Seasonally flooded <input type="checkbox"/> Intermittently flooded <input type="checkbox"/> Temporarily flooded <input type="checkbox"/> Artificially flooded <input type="checkbox"/> Saturated (wet, but never flooded)	Average soil texture: <input type="checkbox"/> sand <input type="checkbox"/> clay loam <input type="checkbox"/> sandy loam <input type="checkbox"/> clay <input type="checkbox"/> loam <input type="checkbox"/> peat <input type="checkbox"/> silt loam <input type="checkbox"/> muck <input type="checkbox"/> other: _____																																																						
Soil drainage: <input type="checkbox"/> Rapidly drained <input type="checkbox"/> Well drained <input type="checkbox"/> Moderately well drained <input type="checkbox"/> Somewhat poorly drained <input type="checkbox"/> Poorly Drained <input type="checkbox"/> Very poorly drained	Soil profile description: note depth, texture, and color of each horizon. Note significant changes such as depth to mottling, depth to water table, root penetration depth <table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th style="width: 10%;">Horizon</th> <th style="width: 10%;">Depth</th> <th style="width: 20%;">Texture</th> <th style="width: 10%;">Color</th> <th style="width: 5%;">pH</th> <th style="width: 45%;">Comments</th> </tr> </thead> <tbody> <tr><td> </td><td> </td><td> </td><td> </td><td> </td><td> </td></tr> </tbody> </table>		Horizon	Depth	Texture	Color	pH	Comments																																																
Horizon	Depth	Texture	Color	pH	Comments																																																			
Unvegetated surface: <input type="checkbox"/> % Bedrock <input type="checkbox"/> % Litter, duff <input type="checkbox"/> % Large rocks (> 10 cm) <input type="checkbox"/> % Wood (> 1 cm) <input type="checkbox"/> % Small rocks (0.2-10 cm) <input type="checkbox"/> % Water <input type="checkbox"/> % Sand (0.1-2 mm) <input type="checkbox"/> % Bare soil <input type="checkbox"/> % Other: _____	Plot representativeness: Note homogeneity of vegetation in plot versus rest of community          Environmental Comments: Note surrounding vegetation, landscape context, herbivory, stand health, recent/historic anthropogenic evidence, etc.																																																							



Appendix C. Plants observed in Friendship Hill National Historic Site during vegetation plot and thematic accuracy assessment sampling.



**Plants Observed in Friendship Hill National Historic Site  
During Vegetation Plot and Thematic Accuracy Assessment Sampling**

Nomenclature follows The PLANTS Database, Version 3.5, developed by the Natural Resource Conservation Service in cooperation with the Biota of North America Program (United States Department of Agriculture, National Resources Conservation Service 2006). For this report, some common names listed in The PLANTS Database were changed to reflect the common names typically used by ecologists and resource managers in this region.

Family	Scientific Name	Common Name
Aceraceae	<i>Acer negundo</i>	boxelder
	<i>Acer nigrum</i>	black maple
	<i>Acer rubrum</i>	red maple
	<i>Acer saccharinum</i>	silver maple
	<i>Acer saccharum</i>	sugar maple
Alismataceae	<i>Sagittaria latifolia</i>	broadleaf arrowhead
Anacardiaceae	<i>Toxicodendron radicans</i>	eastern poison ivy
Annonaceae	<i>Asimina triloba</i>	pawpaw
Apiaceae	<i>Cryptotaenia canadensis</i>	Canadian honewort
	<i>Daucus carota</i>	Queen Anne's lace
	<i>Osmorhiza claytonii</i>	Clayton's sweetroot
	<i>Sanicula canadensis</i>	Canadian blacksnakeroot
	<i>Sanicula trifoliata</i>	largefruit blacksnakeroot
Apocynaceae	<i>Apocynum androsaemifolium</i>	spreading dogbane
Araceae	<i>Arisaema triphyllum</i>	Jack in the pulpit
Asclepiadaceae	<i>Asclepias incarnata</i>	swamp milkweed
	<i>Asclepias syriaca</i>	common milkweed
Aspleniaceae	<i>Asplenium platyneuron</i>	ebony spleenwort
Asteraceae	<i>Ageratina altissima</i> var. <i>altissima</i>	white snakeroot
	<i>Ambrosia artemisiifolia</i>	annual ragweed
	<i>Bidens</i> sp.	beggarticks
	<i>Erigeron pulchellus</i>	robin's plantain
	<i>Erigeron strigosus</i>	prairie fleabane
	<i>Eupatorium fistulosum</i>	trumpetweed
	<i>Eupatorium perfoliatum</i>	common boneset
	<i>Eurybia divaricata</i>	white wood aster
	<i>Eurybia macrophylla</i>	bigleaf aster
	<i>Euthamia graminifolia</i>	flat-top goldentop
	<i>Helianthus tuberosus</i>	Jerusalem artichoke
	<i>Leucanthemum vulgare</i>	oxeye daisy
	<i>Packera aurea</i>	golden ragwort
	<i>Prenanthes alba</i>	white rattlesnakeroot
	<i>Rudbeckia laciniata</i>	cutleaf coneflower
	<i>Solidago caesia</i>	wreath goldenrod
<i>Solidago canadensis</i>	Canada goldenrod	
<i>Solidago canadensis</i> var. <i>scabra</i>	Canada goldenrod	

Family	Scientific Name	Common Name
Asteraceae (cont.)	<i>Solidago rugosa</i>	wrinkleleaf goldenrod
	<i>Symphyotrichum lateriflorum</i> var. <i>lateriflorum</i>	calico aster
	<i>Symphyotrichum prenanthoides</i>	crookedstem aster
	<i>Symphyotrichum puniceum</i> var. <i>puniceum</i>	purplestem aster
	<i>Symphyotrichum shortii</i>	Short's aster
	<i>Taraxacum officinale</i>	common dandelion
	<i>Verbesina alternifolia</i>	wingstem
	<i>Vernonia gigantea</i>	giant ironweed
Balsaminaceae	<i>Impatiens capensis</i>	jewelweed
Berberidaceae	<i>Berberis thunbergii</i>	Japanese barberry
	<i>Podophyllum peltatum</i>	mayapple
Betulaceae	<i>Betula lenta</i>	sweet birch
	<i>Carpinus caroliniana</i>	American hornbeam
	<i>Ostrya virginiana</i>	hophornbeam
Bignoniaceae	<i>Catalpa speciosa</i>	northern catalpa
Boraginaceae	<i>Hackelia virginiana</i>	beggarslice
Brassicaceae	<i>Alliaria petiolata</i>	garlic mustard
	<i>Cardamine concatenata</i>	cutleaf toothwort
	<i>Cardamine diphylla</i>	crinkleroot
Campanulaceae	<i>Lobelia inflata</i>	Indian-tobacco
	<i>Lobelia spicata</i>	palespike lobelia
Caprifoliaceae	<i>Lonicera japonica</i>	Japanese honeysuckle
	<i>Lonicera morrowii</i>	Morrow's honeysuckle
	<i>Sambucus nigra</i> ssp. <i>canadensis</i>	common elderberry
	<i>Sambucus racemosa</i> var. <i>racemosa</i>	red elderberry
	<i>Viburnum acerifolium</i>	mapleleaf viburnum
	<i>Viburnum dentatum</i> var. <i>lucidum</i>	southern arrowwood
Caryophyllaceae	<i>Viburnum prunifolium</i>	blackhaw
	<i>Cerastium</i> sp.	mouse-ear chickweed
	<i>Stellaria media</i>	common chickweed
Clusiaceae	<i>Hypericum mutilum</i>	dwarf St. John's wort
	<i>Hypericum punctatum</i>	spotted St. John's wort
Convolvulaceae	<i>Calystegia sepium</i>	hedge false bindweed
	<i>Ipomoea lacunosa</i>	whitestar
Cornaceae	<i>Cornus alternifolia</i>	alternateteaf dogwood
	<i>Cornus florida</i>	flowering dogwood
Cyperaceae	<i>Carex albursina</i>	white bear sedge
	<i>Carex annectens</i>	yellowfruit sedge
	<i>Carex appalachica</i>	Appalachian sedge
	<i>Carex blanda</i>	eastern woodland sedge
	<i>Carex communis</i>	fibrousroot sedge
	<i>Carex crinita</i>	fringed sedge
	<i>Carex digitalis</i>	slender woodland sedge
	<i>Carex laevivaginata</i>	smoothsheath sedge
	<i>Carex laxiflora</i>	broad looseflower sedge
	<i>Carex lurida</i>	shallow sedge

Family	Scientific Name	Common Name
Cyperaceae (cont.)	<i>Carex pensylvanica</i>	Pennsylvania sedge
	<i>Carex platyphylla</i>	broadleaf sedge
	<i>Carex rosea</i>	rosy sedge
	<i>Carex scoparia</i>	broom sedge
	<i>Carex swanii</i>	Swan's sedge
	<i>Cyperus strigosus</i>	strawcolored flatsedge
	<i>Schoenoplectus tabernaemontani</i>	softstem bulrush
	<i>Scirpus cyperinus</i>	woolgrass
	<i>Scirpus expansus</i>	woodland bulrush
Dennstaedtiaceae	<i>Dennstaedtia punctilobula</i>	eastern hayscented fern
Dioscoreaceae	<i>Dioscorea quaternata</i>	fourleaf yam
Dryopteridaceae	<i>Athyrium filix-femina</i>	common ladyfern
	<i>Dryopteris carthusiana</i>	spinulose woodfern
	<i>Dryopteris intermedia</i>	intermediate woodfern
	<i>Onoclea sensibilis</i>	sensitive fern
	<i>Polystichum acrostichoides</i>	Christmas fern
Elaeagnaceae	<i>Elaeagnus umbellata</i>	autumn olive
Ericaceae	<i>Gaultheria procumbens</i>	eastern teaberry
	<i>Gaylussacia baccata</i>	black huckleberry
	<i>Vaccinium pallidum</i>	Blue Ridge blueberry
	<i>Vaccinium stamineum</i>	deerberry
Fabaceae	<i>Amphicarpaea bracteata</i>	American hogpeanut
	<i>Apios americana</i>	groundnut
	<i>Cercis canadensis</i>	eastern redbud
	<i>Desmodium rotundifolium</i>	prostrate ticktrefoil
	<i>Robinia pseudoacacia</i>	black locust
	<i>Trifolium hybridum</i>	alsike clover
	<i>Trifolium pratense</i>	red clover
	<i>Trifolium repens</i>	white clover
	<i>Castanea dentata</i>	American chestnut
	Fagaceae	<i>Fagus grandifolia</i>
<i>Quercus alba</i>		white oak
<i>Quercus muehlenbergii</i>		chinkapin oak
<i>Quercus palustris</i>		pin oak
<i>Quercus prinus</i>		chestnut oak
<i>Quercus rubra</i>		northern red oak
	<i>Quercus velutina</i>	black oak
Hamamelidaceae	<i>Hamamelis virginiana</i>	American witchhazel
Hippocastanaceae	<i>Aesculus flava</i>	yellow buckeye
Hydrangeaceae	<i>Hydrangea</i> sp.	hydrangea
Hydrophyllaceae	<i>Hydrophyllum canadense</i>	bluntleaf waterleaf
	<i>Hydrophyllum virginianum</i>	Shawnee salad
Iridaceae	<i>Sisyrinchium</i> sp.	blue-eyed grass
Juglandaceae	<i>Carya cordiformis</i>	bitternut hickory
	<i>Carya glabra</i>	pignut hickory
	<i>Carya ovalis</i>	red hickory

Family	Scientific Name	Common Name
Juglandaceae (cont.)	<i>Carya ovata</i>	shagbark hickory
	<i>Juglans nigra</i>	black walnut
Juncaceae	<i>Juncus effusus</i>	common rush
	<i>Juncus tenuis</i>	poverty rush
	<i>Luzula multiflora</i>	common woodrush
Lamiaceae	<i>Clinopodium vulgare</i>	wild basil
	<i>Glechoma hederacea</i>	ground ivy
	<i>Lycopus uniflorus</i>	northern bugleweed
	<i>Lycopus virginicus</i>	Virginia water horehound
	<i>Pycnanthemum incanum</i>	hoary mountainmint
	<i>Pycnanthemum muticum</i>	clustered mountainmint
	<i>Pycnanthemum tenuifolium</i>	narrowleaf mountainmint
Lauraceae	<i>Lindera benzoin</i>	northern spicebush
	<i>Sassafras albidum</i>	sassafras
Liliaceae	<i>Allium</i> sp.	onion
	<i>Maianthemum canadense</i>	Canada mayflower
	<i>Maianthemum racemosum</i> ssp. <i>racemosum</i>	feathery false lily of the valley
	<i>Medeola virginiana</i>	Indian cucumber
	<i>Polygonatum pubescens</i>	hairy Solomon's seal
	<i>Uvularia sessilifolia</i>	sessileleaf bellwort
Magnoliaceae	<i>Liriodendron tulipifera</i>	tuliptree
	<i>Magnolia acuminata</i>	cucumber-tree
Monotropaceae	<i>Monotropa uniflora</i>	Indianpipe
Moraceae	<i>Morus alba</i>	white mulberry
Nyssaceae	<i>Nyssa sylvatica</i>	blackgum
Oleaceae	<i>Fraxinus americana</i>	white ash
Onagraceae	<i>Circaea lutetiana</i>	broadleaf enchanter's nightshade
	<i>Oenothera perennis</i>	little evening-primrose
Ophioglossaceae	<i>Botrychium dissectum</i>	cutleaf grapefern
	<i>Botrychium virginianum</i>	rattlesnake fern
	<i>Ophioglossum</i> sp.	adderstongue
Orchidaceae	<i>Goodyera pubescens</i>	downy rattlesnake plantain
	<i>Liparis liliifolia</i>	brown widelip orchid
Orobanchaceae	<i>Epifagus virginiana</i>	beechnuts
Osmundaceae	<i>Osmunda cinnamomea</i>	cinnamon fern
	<i>Osmunda claytoniana</i>	interrupted fern
Oxalidaceae	<i>Oxalis grandis</i>	great yellow woodsorrel
	<i>Oxalis stricta</i>	common yellow oxalis
Pinaceae	<i>Picea abies</i>	Norway spruce
	<i>Pinus resinosa</i>	red pine
	<i>Pinus strobus</i>	eastern white pine
	<i>Pinus sylvestris</i>	Scotch pine
Plantaginaceae	<i>Plantago lanceolata</i>	narrowleaf plantain
Platanaceae	<i>Platanus occidentalis</i>	sycamore
Poaceae	<i>Agrostis capillaris</i>	colonial bentgrass
	<i>Agrostis gigantea</i>	redtop

Family	Scientific Name	Common Name
Poaceae (cont.)	<i>Agrostis stolonifera</i>	creeping bentgrass
	<i>Anthoxanthum odoratum</i>	sweet vernalgrass
	<i>Cinna latifolia</i>	drooping woodreed
	<i>Dactylis glomerata</i>	orchard grass
	<i>Danthonia compressa</i>	flattened oatgrass
	<i>Dichanthelium clandestinum</i>	deertongue grass
	<i>Elymus riparius</i>	riverbank wildrye
	<i>Holcus lanatus</i>	common velvetgrass
	<i>Leersia oryzoides</i>	rice cutgrass
	<i>Leersia virginica</i>	whitegrass
	<i>Lolium arundinaceum</i>	tall fescue
	<i>Lolium perenne</i>	perennial ryegrass
	<i>Microstegium vimineum</i>	Japanese stilt grass
	<i>Milium effusum</i>	American milletgrass
	<i>Panicum</i> sp.	panicgrass
	<i>Paspalum laeve</i>	field paspalum
	<i>Phalaris arundinacea</i>	reed canarygrass
	<i>Phleum pratense</i>	timothy
	<i>Poa alsodes</i>	grove bluegrass
	<i>Poa compressa</i>	Canada bluegrass
<i>Poa pratensis</i>	Kentucky bluegrass	
Polygonaceae	<i>Polygonum caespitosum</i>	oriental ladysthumb
	<i>Polygonum hydropiper</i>	marshpepper knotweed
	<i>Polygonum hydropiperoides</i>	swamp smartweed
	<i>Polygonum persicaria</i>	spotted ladysthumb
	<i>Polygonum sagittatum</i>	arrowleaf tearthumb
	<i>Polygonum virginianum</i>	jumpseed
	<i>Rumex crispus</i>	curly dock
Primulaceae	<i>Rumex obtusifolius</i>	bitter dock
	<i>Polypodium virginianum</i>	rock polypody
Pyrolaceae	<i>Lysimachia ciliata</i>	fringed loosestrife
	<i>Lysimachia quadrifolia</i>	whorled yellow loosestrife
Pyrolaceae	<i>Chimaphila maculata</i>	striped prince's pine
Ranunculaceae	<i>Cimicifuga racemosa</i>	black bugbane
	<i>Clematis virginiana</i>	devil's darning needles
	<i>Ranunculus abortivus</i>	littleleaf buttercup
Rosaceae	<i>Agrimonia gryposepala</i>	tall hairy agrimony
	<i>Agrimonia parviflora</i>	harvestlice
	<i>Amelanchier arborea</i>	common serviceberry
	<i>Crataegus flabellata</i>	fanleaf hawthorn
	<i>Fragaria virginiana</i>	Virginia strawberry
	<i>Geum canadense</i>	white avens
	<i>Potentilla simplex</i>	common cinquefoil
	<i>Prunus serotina</i>	black cherry
	<i>Rosa multiflora</i>	multiflora rose
	<i>Rubus allegheniensis</i>	Allegheny blackberry

Family	Scientific Name	Common Name
Rosaceae (cont.)	<i>Rubus flagellaris</i>	northern dewberry
	<i>Rubus hispidus</i>	bristly dewberry
	<i>Rubus occidentalis</i>	black raspberry
Rubiaceae	<i>Galium asprellum</i>	rough bedstraw
	<i>Galium circaezans</i>	licorice bedstraw
	<i>Galium lanceolatum</i>	lanceleaf wild licorice
	<i>Galium triflorum</i>	fragrant bedstraw
	<i>Mitchella repens</i>	partridgeberry
Salicaceae	<i>Populus grandidentata</i>	bigtooth aspen
	<i>Salix nigra</i>	black willow
Scrophulariaceae	<i>Chelone glabra</i>	white turtlehead
	<i>Veronica officinalis</i>	common gypsyweed
Simaroubaceae	<i>Ailanthus altissima</i>	tree of heaven
Smilacaceae	<i>Smilax glauca</i>	cat greenbrier
	<i>Smilax rotundifolia</i>	roundleaf greenbrier
	<i>Smilax tamnoides</i>	bristly greenbrier
Solanaceae	<i>Physalis heterophylla</i>	clammy groundcherry
	<i>Solanum carolinense</i>	Carolina horsenettle
Sphagnaceae	<i>Sphagnum</i> sp.	sphagnum
Thelypteridaceae	<i>Thelypteris noveboracensis</i>	New York fern
Typhaceae	<i>Typha latifolia</i>	broadleaf cattail
Ulmaceae	<i>Celtis occidentalis</i>	common hackberry
	<i>Ulmus americana</i>	American elm
	<i>Ulmus rubra</i>	slippery elm
Urticaceae	<i>Boehmeria cylindrica</i>	smallspike false nettle
	<i>Pilea pumila</i>	Canadian clearweed
	<i>Urtica dioica</i>	stinging nettle
Verbenaceae	<i>Verbena hastata</i>	swamp verbena
Violaceae	<i>Viola canadensis</i>	Canadian white violet
	<i>Viola cucullata</i>	marsh blue violet
	<i>Viola pubescens</i>	downy yellow violet
	<i>Viola sororia</i>	common blue violet
	<i>Viola striata</i>	striped cream violet
Vitaceae	<i>Parthenocissus quinquefolia</i>	Virginia creeper
	<i>Vitis aestivalis</i>	summer grape
	<i>Vitis riparia</i>	riverbank grape

Appendix D. Dichotomous field key to the vegetation associations of Friendship Hill National Historic Site.



**KEY TO VEGETATION ASSOCIATIONS AT  
FRIENDSHIP HILL NATIONAL HISTORIC SITE**

1. HERBACEOUS & SHRUB VEGETATION: TREE COVER LESS THAN 25%

2. Herbaceous layer dominated by hydrophilic species, including rice cut grass (*Leersia oryzoides*), woolgrass (*Scirpus cyperinus*), reed canarygrass (*Phalaris arundinacea*), and/or broadleaf cattail (*Typha latifolia*). Vegetation usually surrounds small streams or drainages. Soil is saturated for at least part of the growing season.

**Mixed Forb Marsh**

2. Herbaceous layer dominated by a mix of grasses and herbs, predominantly terrestrial species. Common species include: orchard grass (*Dactylis glomerata*), harvestlice (*Agrimonia parviflora*), velvet grass (*Holcus lanatus*), poverty rush (*Juncus tenuis*), rough goldenrod (*Solidago rugosa*), bluegrass (*Poa* sp.), tall fescue (*Lolium arundinacea*), and Kentucky bluegrass (*Poa pratensis*). Short and tall shrubs can cover 25–80% of the field, forming dense thickets or thick clumps of shrubs. Common shrubs include multiflora rose (*Rosa multiflora*), autumn olive (*Elaeagnus umbellata*), common blackberry (*Rubus allegheniensis*), and pawpaw (*Asimina triloba*). Seedling and saplings of numerous hardwood tree species can also be abundant.

**Successional Old Field**

1. FOREST & WOODLAND, TREE COVER GREATER THAN 25%

3. Trees almost exclusively evergreen, including eastern white pine (*Pinus strobus*) Scotch pine (*Pinus sylvestris*), red pine (*Pinus resinosa*), and/or Norway spruce (*Picea abies*). Occurs in very small isolated stands.

**Conifer Plantation**

3. Deciduous trees are dominant, although evergreen trees may be associates.

4. Trees cover between 25–60%. Trees predominantly <12m in height and <20cm in diameter. Scattered tree canopy contains boxelder (*Acer negundo*), black cherry (*Prunus serotina*), white ash (*Fraxinus americana*), tuliptree (*Liriodendron tulipifera*), sycamore (*Platanus occidentalis*), American elm (*Ulmus americana*), and pin oak (*Quercus palustris*). Shrub and herbaceous layers are as described above in couplet 2.

**Successional Old Field**

4. Tree cover greater than 60%
5. Trees are typically younger (12–15 meters in height and diameter at breast height of 20–25 centimeters) and include early successional and weedy species such as tuliptree (*Liriodendron tulipifera*), black cherry (*Prunus serotina*), boxelder (*Acer negundo*), red maple (*Acer rubrum*), and black locust (*Robinia pseudoacacia*).

**Early Successional Hardwood Forest**

5. Forest canopy trees are middle aged to mature (25 to 35 meters in height and diameter at breast height from 25 to 70 centimeters).
6. Forest is dominated by sycamore (*Platanus occidentalis*) with boxelder (*Acer negundo*), black cherry (*Prunus serotina*), willow (*Salix* spp.) and pawpaw (*Asimina triloba*) as associates. Forest occurs on floodplain on the Monongahela River.

**Sycamore Floodplain Forest**

6. Forest is dominated by oaks (*Quercus* spp.) and/or tuliptree (*Liriodendron tulipifera*). Forest does not occur in floodplain setting.
7. Oaks (*Quercus* spp.) have higher relative cover in the canopy and subcanopy combined than tuliptree (*Liriodendron tulipifera*). Forest is dominated by northern red oak (*Quercus rubra*), white oak (*Quercus alba*), and/or black oak (*Quercus velutina*), composing at least 50% of the canopy. Hickories (*Carya* spp.) are common associates. Tuliptree typically covers less than 25% of the canopy, however they may cover up to 50%.

**Northern Red Oak – Mixed Hardwood Forest**

7. Tuliptree (*Liriodendron tulipifera*) has higher relative cover in the canopy and subcanopy combined than oaks (*Quercus* spp.). Forest is dominated by tuliptree and/or maple (*Acer rubrum*, *Acer saccharum*), with American beech (*Fagus grandifolia*) as an associate. Oaks typically compose less than 25% of the canopy, however they may cover up to 50%. Northern spicebush (*Lindera benzoin*) is abundant in the tall or short shrub layers.

**Tuliptree – Beech – Maple Forest**

Appendix E. Accuracy assessment data form.



# Accuracy Assessment Form for USGS-NPS Vegetation Mapping Program

Plot Number \_\_\_\_\_ Park \_\_\_\_\_ Date \_\_\_\_\_ Observers \_\_\_\_\_

Easting: \_\_\_\_\_ E Northing \_\_\_\_\_ N EPE/APE: \_\_\_\_\_ DOP: \_\_\_\_\_ Map datum: \_\_\_\_\_ Zone: \_\_\_\_\_

Topographic Description: \_\_\_\_\_ Elevation: \_\_\_\_\_ Aspect: \_\_\_\_\_ Canopy Closure: \_\_\_\_\_

Vegetation Association at Point: \_\_\_\_\_

Veg Assoc 1 2/in 50 m of point: \_\_\_\_\_

Veg Assoc 2 w/in 50 m of point: \_\_\_\_\_

Major Species by Strata: \_\_\_\_\_

Rationale for Classification: \_\_\_\_\_

Comments: \_\_\_\_\_

Plot Number \_\_\_\_\_ Park \_\_\_\_\_ Date \_\_\_\_\_ Observers \_\_\_\_\_

Easting: \_\_\_\_\_ E Northing \_\_\_\_\_ N EPE/APE: \_\_\_\_\_ DOP: \_\_\_\_\_ Map datum: \_\_\_\_\_ Zone: \_\_\_\_\_

Topographic Description: \_\_\_\_\_ Elevation: \_\_\_\_\_ Aspect: \_\_\_\_\_ Canopy Closure: \_\_\_\_\_

Vegetation Association at Point: \_\_\_\_\_

Veg Assoc 1 2/in 50 m of point: \_\_\_\_\_

Veg Assoc 2 w/in 50 m of point: \_\_\_\_\_

Major Species by Strata: \_\_\_\_\_

Rationale for Classification: \_\_\_\_\_

Comments: \_\_\_\_\_



Appendix F. Index of representative photographs of vegetation classification sampling plots in Friendship Hill National Historic Site.



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Appendix G. Bibliography for global vegetation descriptions from the National Vegetation Classification System.



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