

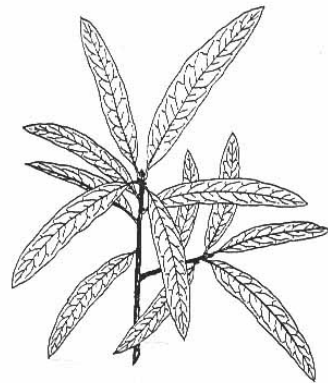
National Park Service
U.S. Department of the Interior

Northeast Region
Philadelphia, Pennsylvania



A Synthesis of Natural Resource Information for George Washington Birthplace National Monument

Technical Report NPS/NER/NRTR—2007/077



ON THE COVER

Sunset photographs at George Washington Birthplace National Monument

Photograph by: James Laray, National Park Service

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Technical Report NPS/NER/NRTR—2007/077

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

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Abstract

The Synthesis of Natural Resource Information for George Washington Birthplace National Monument reviews information available through August 2006. In this document the current conditions at the Birthplace are described based on reports, inventories, past analyses, and discussions or document reviews held during the period from September 2005 through December 2006. Evaluation of conditions at the Birthplace leads to assessment of threats and vulnerabilities and identification of gaps in information. The document concludes with a variety of recommendations. General and specific status of each resource is the main focus and organizing principle for the document. A report card of resource status and trends is provided. Status of the base geology at the park is *good*, but *significant concern* is expressed about the soil at the park because of shoreline erosion along the Potomac River. Paleontology resources at the park prompt *caution* because of the erosive forces that reveal and dislodge specimens, and then collection of these specimens by visitors. Surface water quality prompts *caution* as well, as indicated by signs posted against consumption of shellfish in Popes Creek and along the Potomac shoreline. *Significant concern* exists about the diminishing extent of wetlands, especially islands in Popes Creek, but wetland functions are rated *good*. Landscape plant resources are rated *good* because detailed plans exist and are being implemented for their care. *Caution* exists concerning natural areas primarily because of exotic species intrusions, but also because of changes in wetland species composition. Forest status is *unknown* because insufficiently detailed inventory data exist to know forest health and habitat conditions. The status of all animal populations is rated *good*, based on inventories mostly conducted within the last few years. Both federally listed and state listed species at the park have a status of *good* with no apparent trends. *Caution* is warranted concerning air quality, night light, and surrounding views, all because of changing conditions around the park and downward trends regarding these resources. Noise issues prompt *concern*. The main conclusion is that the National Park Service, in planning for the future at the Birthplace, must decide how the park will fulfill its mission amid changing conditions that surround it now and could impact it ever more significantly in the future.

Executive Summary

George Washington Birthplace National Monument is located in Westmoreland County on the Northern Neck of rural and tidal Virginia about 45 miles east of Fredericksburg on State Highway 3 and about 80 miles southeast of Washington, D.C. The park is fairly flat, typical of the North American Coastal Plain. Park-owned and managed lands comprise 550 acres. Preserving and interpreting the history and resources associated with George Washington, the historical monument attempts to portray conditions of an 18th century tobacco farm by maintaining period-representative farm buildings, tree groves, livestock, gardens and fields. Most land at the site has been either a working farm or historical landmark since the 18th century. The Washington family burial ground is also located within the park.

Land use history at the park can be divided into five phases during the last 1100 years: Late Woodland Period, Brooks Patent, Popes Creek Plantation, Wakefield Plantation, and Park status. Implications of each stage are potentially important, but the results of the last three phases principally affect current decisions about resource management and impact predictions at the Birthplace. Substantial evidence of paleo-archeological remains has been observed at the park although the precise extent of this resource has not been determined.

The Natural Resources Conservation Service (formerly, the U.S. Soil Conservation Service) classified the majority of the park's land as 'non-tidal wetlands' or 'prior converted wetlands' with Leaf, Lenoir, or Bibb/Levy soil types. Four non-hydric park soils include Rumford fine sandy loam, Tetotum loam, Montross, and Nansemond. Freshwater ponds, creeks, a number of springs, areas of tidal marshes, and freshwater wetlands constitute the water resources at the Birthplace, but the park extracts groundwater as the public drinking water supply.

Park habitats include beaches and dune habitats, marshes and estuaries, open grasslands, closed canopy forests, memorial cultural landscapes, and developed lands. Three acres of developed lands include the visitor center, staff residences, and parking areas. Memorial cultural landscape structures include open areas for penned stock. Twelve vegetation classes have been identified, and species have been inventoried several times. A small area of very old trees has been studied but general characteristics of the forest remain to be examined. Two plant species significantly important at the state level were discovered in the inventories done, but questions concerning present status of both species remain. Two globally rare plant communities have been noted. Faunal communities present reflect the diverse habitats within the boundary but lack large predator species and the natural balance of other species populations that such predation enables. Some populations have been studied more completely than others. Exotic and pest faunal species are not problems noted at the park but some invasive plants need attention.

Air quality at the park reflects its position within the urbanizing Middle Atlantic region and the heavy dependence of residents on personal vehicles for transportation. Similarly, viewshed and lightscape issues result from the rapidly developing rural-urban interface and the tendency for affluent city dwellers in the region to seek locations for recreation and leisure.

Introduction

Project Description

The mission of the National Park Service (NPS) at George Washington Birthplace National Monument (herein after referred to as the park or the Birthplace) is to preserve and interpret the history and resources associated with George Washington. As a historical monument, the Birthplace attempts to portray the conditions of an 18th century tobacco farm by maintaining period farm buildings, tree groves, livestock, gardens, and fields. Most of the land has been either a working farm or historical landmark since the 18th century. Archaeological structures, commemorative edifices and the cultural landscape are conserved and employed to preserve the memory of George Washington.

The Northeast Regional Office of the National Park Service is working with the Superintendent of George Washington Birthplace National Monument to develop a General Management Plan and Environmental Impact Statement for the park. To meet NPS planning standards, existing cultural and natural resource information about the area needs to be summarized and assessed prior to starting the formal planning process.

This report synthesizes currently available natural resource data as well as information about the current status of, significant threats to, and gaps in knowledge about the natural resources at the park. Information from this report can be used to describe existing conditions in the “Affected Environment” section of an environmental impact statement.

Study Area

George Washington Birthplace National Monument is located in Westmoreland County on the Northern Neck of rural and tidal Virginia about 45 miles east of Fredericksburg on State Highway 3 and about 80 miles south of Washington, D.C. (see Figure 1). “Northern Neck” is a term commonly used to refer to the peninsula jutting into the Chesapeake Bay and bounded by the Potomac River on the north and the Rappahannock River on the south. The park is fairly flat and typical of the Coastal Plain. Park-owned and managed lands comprise about 550 acres bounded on the north by the Potomac River; Popes Creek estuary to the east and south; and Bridges Creek and other private lands to the south and west. The boundary of this property is shown in Figure 2.

In 2002 Congress approved a plan to revise the boundary of the Birthplace to include an additional area of 111 acres, which lies in between two separate areas of park land. However, this property was recently sold to private interests and it appears the new owners plan to build private residences on their respective tracts (George Washington Birthplace National Monument, R. Morawe, Chief, Natural and Cultural Resources Management, pers. comm., 2006). The authorized boundary created by the 2002 legislation is shown in Figure 3.

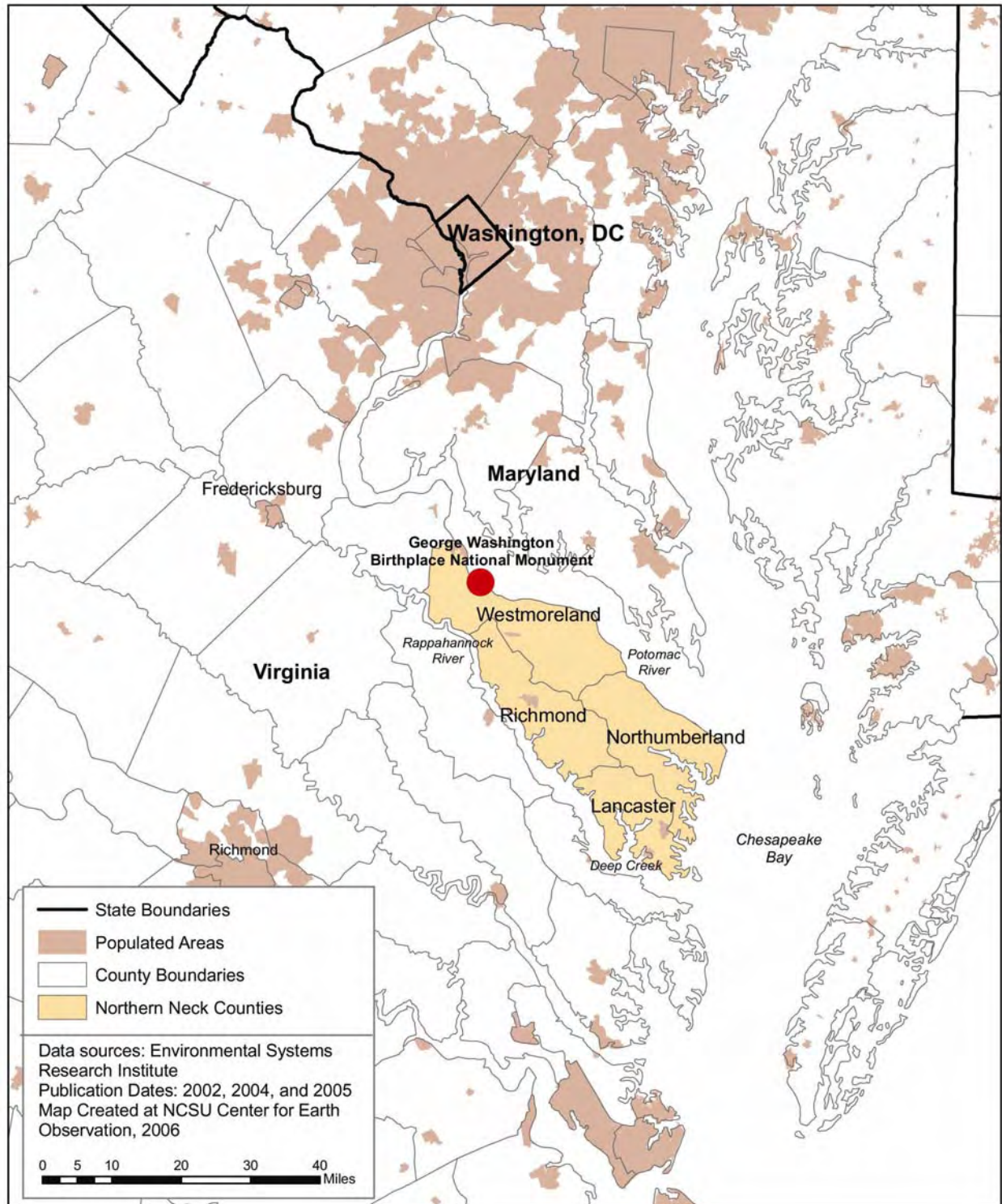


Figure 1. Location of George Washington Birthplace National Monument.



Figure 2. Boundary of federal property at George Washington Birthplace National Monument (GEWA) shown on 2002 aerial photography (NCSU-CEO 2002a).



Figure 3. Authorized boundary for George Washington Birthplace National Monument (GEWA) shown on 2002 aerial photography (NCSU-CEO 2002a).

The climate in the area of the park is humid maritime. On typical summer days, temperatures range from 90-95°F and thunderstorms are frequent. Winter weather varies from mild and rainy to snowy and icy, with temperatures that range from 15-40°F. Spring and fall temperatures are typically 50-60°F. Average yearly precipitation is 40 inches, of which 55% falls between April and September. The average mid-afternoon relative humidity is 50%.

Typical natural resources and habitats within the park include a complex association of cultural landscapes integrated with natural resources and ecosystems, with a goal of reflecting a colonial era plantation in a frontier brackish and tidal environment. The park maintains a degree of integrity of natural resources and thriving ecosystems indicative of the Chesapeake Bay region and reflecting a shadow of the conditions prevalent in the 17th and 18th centuries while facing the management challenges and threats of modern times. The park manages a unique assemblage of forest types, fresh water and brackish water swamps and marshes, grasslands and meadows, freshwater streams and ponds, and brackish water tidal estuaries with an impressive diversity of faunal and floral species for such a small land base. The park also preserves and manages paleontological resources dating to the Miocene Epoch, fossils of Calvert, Maryland fame. (George Washington Birthplace National Monument, R. Morawe, Chief, Natural and Cultural Resources Management, pers. comm., February 2007)

The park is a component of the Chesapeake Bay Program (CBP) with natural resources that, according to Ellsworth (2003), “have remained relatively pristine due to efforts focused on the preservation of the historical setting at this location and limited development along the park boundary. While the park is a small component of the CBP, it provides scientific and interpretive opportunities to exemplify proactive resource management practices.” Ellsworth also noted that the Popes Creek watershed, which is partially protected by the park, provides a benchmark for assessing CBP restoration activities in other watersheds.

Methods

Literature Review and Synthesis Process

A comprehensive literature search was performed to identify existing publications, reports, studies, and spatial data, and other relevant information for this synthesis. In addition to using library bibliographic search tools, the literature search included websites maintained by the NPS, the U.S. Geological Survey (USGS), the Virginia Institute of Marine Science (VIMS), the Virginia Department of Conservation and Recreation, Division of Natural Heritage (VADCR-DNH), and the Virginia Department of Game and Inland Fisheries (VADGIF); other online information sources such as NatureBIB and NPSpecies; the Chesapeake Bay Program staff and website; and faculty and staff at the North Carolina State University Center for Earth Observation.

During the development of this report a number of biological inventories were completed at the park and results were made available by the NPS Northeast Coastal and Barrier Network (NCBN) Inventory and Monitoring Program. In some cases final reports were not available; however, draft data were provided to aid in the development of this document.

After the initial literature review, a start-up meeting was held on December 7-8, 2005 at the Birthplace and was attended by NPS staff and members of the research team at North Carolina State University. The purpose of this meeting was to report on progress, review initial data sources, discuss important issues facing the park, and visit the site.

A thorough review of all the data sources was conducted after the start-up meeting and a basic outline of the synthesis report was created. The structure decided upon for the synthesis report is meant to facilitate the efficient preparation of future planning documents, specifically the General Management Plan/Environmental Impact Statement.

In general, all documentary material was examined so topical coverage would be as complete as possible, but so duplication of the same material from different sources was avoided. Much of the material included in this synthesis is not peer reviewed, published literature. In fact, a major portion of the material comes from internal NPS reports and commissioned studies that address the information needs for planning purposes. Whenever discrepancies between sources were encountered, the synthesis authors sought to corroborate material from other sources or consult topical experts to resolve questions. In some cases, resolution did not occur until the review process when comments came back to the authors.

The resulting document begins with a chapter that details the land use history of the park from prehistoric times to the present. The following chapter breaks down the resources of the park into general types: physical resources (geological, paleontological, and water), biotic (flora and fauna), and special topics (viewshed, air quality, lightscape, and soundscape). The structure of this chapter, which deals with general status and conditions, generally holds through all subsequent chapters. In these chapters the resource types are analyzed, threats are identified, information gaps are highlighted, and recommendations are made. A result of this structure is that material from any given report may appear in segments scattered throughout chapters of the document. When, for instance, an NPS report described conditions, discussed the problems

created by these conditions, and went on to offer recommendations to address the problematic conditions, it would by necessity be parsed into segments and inserted in three different chapters.

On April 14, 2006, a draft of the Land Use History chapter, along with a full treatment (status, analysis, threats, information gaps, and recommendations) of the Geological Resources and Water Resources sections, was sent to the NPS for review. A draft of all the resource chapters in the synthesis report was then sent to the NPS on June 6, 2006. Revisions and additions were made to the report and another draft was sent to the NPS on July 17, 2006, in anticipation of the Natural Resources Roundtable that was held at the Birthplace on July 27. The roundtable was a valuable source of information and provided an opportunity for many people (NPS natural resource specialists, staff of state and federal agencies, as well as private citizens) to review the synthesis report and provide feedback. This feedback has been incorporated into the current document.

Although generation of information concerning the Birthplace will continue, for instance with completion of several faunal species studies previously in draft form, a review cut-off date of August 2006 was used, with a few exceptions. Thus, for the most part, new studies released, newspaper articles, or other NPS publications after August 31 will not be referenced in this document. (The most notable exceptions are the species data obtained in December 2006 from the NPS Biodiversity Database that are included in Appendixes C, D, G, I, and J.) Any pertinent information not found in this document may, however, be of value in the NPS planning process or useful in preparation of an environmental impact statement. Omission of any material from this current synthesis document does not imply any value judgment about the missing material nor an intention to ignore information that could further understanding of conditions at the Birthplace.

The Common Era (CE) / Before Common Era (BCE) system of dating notation is used in this report. The Common Era is the period of measured time beginning with the year 1 on the Gregorian calendar.

Spatial Data

A separate document cataloging spatial data relevant to the park was developed as a sub-task of this project. The document, “A Catalog of Spatial Data for George Washington Birthplace National Monument” (Devine et al. 2006) is meant to provide additional support to future planning efforts at the park. The data catalog provides easy access to geo-referenced, digital datasets and imagery that can be used to create maps portraying historic or current conditions of the park and surrounding regions. It includes datasets covering not only the park, but also Westmoreland County, the seven-county region surrounding the park that comprises the General Management Plan study area, the Commonwealth of Virginia, the Chesapeake Bay watershed, and, in a few cases, the continental United States. The data catalog is contained on a set of two DVDs which has been provided to the park.

Land Use History

Eastern North America's vegetation changes can be traced back at least to the last ice age 18,000 years ago. The Wisconsin Glacier was then at its southern limit in what is now New York. There, a relatively narrow band of tundra was located at the glacier's margins, transitioning to a wide band of boreal forest extending south to what is now the Carolinas. As the glacier retreated northward, so did the boreal forest, with its southern boundary in New England by 10,000 years ago. At that time, the forests in the Middle Atlantic region were conifer mixed with deciduous trees. About 5,000 years ago, in the same region, forest types were oak (*Quercus* spp.)-chestnut (*Castanea dentate*) and oak-hickory (*Carya* spp.)-southern pine (*Pinus* spp.), much like those today, except that the chestnut is no longer a canopy component. The Northern Neck has long been a naturally forested area, although human activity has had a great influence on the vegetation. The following summary of human activity, much of it based on the work of Wilson (1984) and Gilmore et al. (2001), describes these influences.

From prehistory to the arrival of European settlers, the Northern Neck was occupied by American Indians. During their early use of this region they were hunter-gatherers who were nomadic in their search for good hunting, but dependent on simple forms of transportation, such as foot or canoe. Agriculture became important to their economy around 500 Before the Common Era (BCE), resulting in homes, villages, and the clearing of land for agriculture. Hunting and fishing remained important food sources; evidence of this are the middens, shallow shell-lined seafood roasting pits along the river, which have been dated from 6800 BCE to 400 Common Era (CE). With the more permanent living arrangements came more political structure. Capt. John Smith recorded various Indian settlements and tribal connections in Powhatan's Confederation, based on his 1607-1609 explorations of the Chesapeake Bay.

An environmental history of the Birthplace was conducted between 1999 and 2000 by Lisa Kealhofer, a research associate with Colonial Williamsburg's Department of Archaeological Research (Gilmore et al. 2001). In order to investigate the park's historic and prehistoric landscapes, Kealhofer and Colonial Williamsburg's Department of Archaeological Research (DAR) staff archaeologist Andrew Edwards used a Vibracorer to retrieve an intact 627 cm sediment core (VC-1) from Dancing Marsh. The core was intensively studied to date and analyze sediments. A detailed geological description, or profile, of the core was completed before it was disturbed by sampling. ¹⁴Carbon and ²¹⁰Pb dating were used to determine the age of the sediments within the core. However, issues with the ²¹⁰Pb dating indicate that dates for the upper layers may be inaccurate, and more radiocarbon dating may be required to resolve the rate and pattern of change over the last 150 years (Gilmore et al. 2001).

Dr. John Jones from Texas A&M completed the pollen analysis of the samples retrieved from VC-1 (Gilmore et al. 2001). Jones identified three pollen zones: 610-305 cm (3000-650 BCE), 305-100 cm (650 BCE-1000 CE), and above 100 cm (1000 CE-present). The uppermost zone includes taxa from a group palynologists call "Cheno-ams," which are often indicative of human disturbance. This zone reveals substantial disturbance at the park (both Cheno-ams and Compositae, as well as domesticated grain pollen) and forest clearance over the last 1000 years (decline in *Carya*, *Quercus*), significantly predating British colonization. There were relatively few pollen samples from the upper 100 cm of the core. However, there was a sharp change

between 50 to 20 cm (e.g., low in oaks), which may indicate intensified clearance in the colonial period (Gilmore et al. 2001).

Both of the lower zones reveal a marine or brackish water environment at the park, surrounded by typical deciduous woodland taxa in the upper ravines and slopes. The lower zone (3000-650 BCE) includes more Chenopods taxa that, in this case, are probably indicative of the development of salt marsh. Given the lack of other weedy disturbance indicators, Jones suggests that the earlier phase is one of salt marsh development – which would inferentially suggest that the middle zone (650 BCE-1000 CE) is more brackish/fresh water (Gilmore et al. 2001).

Phytolith processing and analysis of samples from the core were completed at the DAR lab. A phytolith is a rigid microscopic body, usually silicon, which occurs within many plants. Phytoliths are generally well preserved in soil, and can be used to reconstruct the plants present at a given time and place. Phytolith analysis indicates that beginning around 3000 BCE the area of the park was forested, including oaks, Magnoliaceae, and pines. For the next 4000 years the forest fluctuated cyclically, with shifting patterns of known and unknown arboreal forms. Between 1000 and 1500 CE, the forest declined, weeds of various sorts increased, and disturbances were increasingly common. The pattern of disturbance changed (different weeds and trees) over the transition to the colonial period. Interestingly, between 1800 and 1920, reforestation is documented by a dramatic increase in oaks and other arboreal taxa. Diversity also increased in these samples providing evidence of the expansion of exotic flora in horticulture and agriculture (Gilmore et al. 2001).

Phytolith analysis of the grasses appears to reveal periodic expansion of the marsh. These shifts appear to be cyclical as Cloridoids and Arundinoids (possibly cordgrass and Phragmites) increase at 1100 BCE, 0 BCE, and 900 CE. Panicoid increases seem to correlate with periods of cultural disturbance (possibly maize agriculture) (Gilmore et al. 2001).

The long-term environmental sequence in VC-1 potentially provides an interesting record of periods of sea level change (estuarine/salt marsh expansion) and upland land use if dating issues are resolved. The environment is best understood when the pollen and phytolith data are considered together. The pollen data demonstrate deforestation occurring beginning ca. 1000 CE, while the phytolith data show some local reforestation in the last 200 years. Unidentified types in the phytolith data are usually Dicot types, and often arboreal; in this case the pollen data indicate that they are most likely taxa associated with cultural disturbance and/or fresh water marsh expansion. The record also reveals sharp changes in the marsh (1270 CE and 650 BCE), as one unidentified pollen type dominates the phytolith record. The periods of fresh water marsh expansion also seem to include evidence of cultural disturbance indicators, particularly in more recent samples, and it may be that land use fluctuated as sea levels stabilized and destabilized in the area of the park (Gilmore et al. 2001). Additional cores have been taken from Popes Creek and the Potomac River by Wayne Newell of the USGS (George Washington Birthplace National Monument, R. Morawe, Chief, Natural and Cultural Resources Management, pers. comm., 2006). Palynology studies of these cores may further an understanding of the environmental history of the park, though it is unclear if funding will become available for this purpose.

The last 1100 years of land use history at the Birthplace can be divided into five phases: Late Woodland Period, Brooks Patent, Popes Creek Plantation, Wakefield Plantation, and Park status (see Table 1).

Late Woodland Period (Pre-1650)

The Late Woodland Period is characterized by village life and domestication of plants. This period does not occur uniformly in time over the southeast, and in the Northern Neck region it generally occurred between 500 and 1500 CE. During this period, the Powhatans of the Northern Neck were swidden agriculturalists cultivating corn, beans, squash, and perhaps plants domesticated locally. Woodland burning to maintain hunting grounds was also widely practiced across Coastal Plain and Piedmont landscapes (Frost 1998). Cultural and economic interaction among tribes intensified during this time, which undoubtedly led to the clearing of substantial areas of Coastal Plain (Gilmore et al. 2001).

More specific to the park, evidence from examination of the VC-1 core indicates that these land uses were likely prevalent within the current boundaries. Both phytolith and pollen sampling indicate substantial disturbance and forest clearing within the park well before the arrival of British colonists. Pollen analysis also confirms cultivation of domesticated grains within the park (Gilmore et al. 2001).

The Cultural Landscape Inventory (NPS 2005a) for the Birthplace gives a similar description of the park area during this period stating that:

Between 200 CE and 1650, the Algonquins utilized land along the three water bodies—Popes Creek, Bridges Creek, and the Potomac River—for the harvesting of oysters. At some point during the Late Woodland period, ca. 1300, portions of this landscape were most likely adapted for agricultural use by the Algonquins, leading to a slow but steady deforestation of the areas containing prime agricultural soils.

Later, many of these cleared areas were taken over by colonial settlers (Gilmore et al. 2001).

Brooks Patent (1650-1720)

European settlers arrived in the area about 1640, coming not from the Jamestown area, but from across the river in Maryland. These were the first “come-heres”, the traditional Northern Neck term for outsiders. The newcomers were Protestants leaving Catholic Maryland, and their first settlements were in the Coan River area, about 30 miles down river from the Birthplace. Rapid development followed, with many settlers arriving and establishing plantations; clearing of forest for agriculture was a major activity, with tobacco the main crop.

During the 1650’s, a large tract of land that included the current park was patented by Henry Brooks, who quickly established three house sites. In the following years Brooks began to divide up his 1020 acre patent by selling parts of it and deeding or willing other tracts to family members. John Washington acquired one of these tracts and established a family burial ground near his homesite in 1665 (NPS 2005a).

Table 1. Summary of land use history at George Washington Birthplace National Monument.

Period	Classification	Description	Activity
pre-1650	Late Woodland Period	Powhatan Native Americans settled in villages and depended on domesticated crops (e.g., corn, squash, and beans).	Forests cleared for crops
ca 1650-1720	Brooks Patent	Farming neighborhoods relied on subsistence farming and tobacco for cash. Little class distinction among settlers.	Tobacco planting begins
ca 1720-1780	Popes Creek Plantation	Formation of large plantations, gentry power, and class distinctions.	Deforestation continues with use of slave labor; depletion of land due to tobacco farming
ca 1780-1858	Wakefield Plantation	Decline of tobacco and an increase of other crops. Wakefield was known for production of corn, wheat, and barley.	Crop rotations are introduced; plowing of fields begins, increasing erosion; animal dung and lime are used to improve soil fertility
1858-1882	Public Property - Park status	Conveyed by William Lewis Washington to the Commonwealth of Virginia.	Agriculture becomes less intense, some fields revert to forest
1882-1930	Public Property	Conveyed by the Commonwealth of Virginia to the U.S. government in 1882.	Construction of the commemorative landscape begins
1930-present	Public Property	Established as George Washington Birthplace National Monument in 1930.	Land is modified for visitor use and interpretation; colonial farm is established

During this period, common crops were corn for subsistence and tobacco for cash. The hill-and-hoe technique, where crops were planted in mounds of soil, was adopted from the indigenous population (Mann 2005). This technique allowed for planting between stumps in freshly cleared land and did not require special skill or equipment. A small gentry class began to form, but society mostly consisted of small landowners, many servants, and landless freedmen. Most of the settlers were grouped in loosely organized neighborhood networks.

The Northern Neck was designated Northumberland County in 1648, and other counties were sub-divided from Northumberland in the following years. Westmoreland County was created in 1653. The Indians were pushed further west and were no longer a factor in the Northern Neck. Labor for tobacco growing was provided by indentured white servants until African slaves were brought into the area about 1700.

Popes Creek Plantation (1720-1780)

During the 1700's, families that controlled politics and economics included the Washingtons, Lees, and Carters. In 1717 Augustine Washington I acquired 200 acres of the Brooks Patent property along Popes Creek, south of the area called Dancing Marsh. The Washington family built their home there in 1718, the Lee family built nearby Stratford Hall around 1730, and the Carters built two homes in the 1730's. Their prosperity depended on tobacco grown on the "virgin" land of the Coastal Plain, cultivated by slave labor, and sold to England.

By the end of the 1720's, Augustine Washington I had acquired the entire original Brooks Patent, which came to be known as the Popes Creek Plantation. On February 22, 1732 Augustine and Mary Ball Washington gave birth to George, their first son together. George Washington was born in the family home near the shore of Popes Creek. In 1734 Augustine expanded his holdings further with the purchase of several small islands at the mouth of Popes Creek, but in 1735 the Washington family moved away from the area to Mount Vernon. After Augustine Washington's death in 1743 the property was passed on to Augustine Washington, Jr. who continued to work the land (Gilmore et al. 2001).

This period saw the continued development of agricultural land in the park area. Additional forests were cleared, new fields were cultivated, and old fields with exhausted soils were abandoned to meadow. Around the middle of the century drainage ditches were dug on the Popes Creek Plantation, further increasing suitable farmland (NPS 2005a). By the end of this period the vast Popes Creek Plantation reflected the Washington family's status within the newly formed aristocracy.

Wakefield Plantation (1780-1858)

Augustine Washington, Jr. died in 1764 and the Popes Creek Plantation was passed to his son William Augustine Washington. William was only seven years old at the time and did not take formal possession of the property until 10 years later. During William's tenure the property came to be known as Wakefield Plantation. This name change was symbolic of other changes occurring at the time. During this period Wakefield Plantation moved away from tobacco and began concentrating on grain crops (Gilmore et al. 2001).

Crop rotation and plowing were used to improve productivity. Plowing also increased erosion which may have resulted in significant infilling of the Bridges Creek and Popes Creek estuaries, declining fisheries, and formation of marsh islands (George Washington Birthplace National Monument, R. Moräwe, Chief, Natural and Cultural Resources Management, pers. comm., 2006). In 1803, Wakefield Plantation was known for producing corn, wheat, and barley (Gilmore et al. 2001). These crops required special skills and equipment, available only to larger landowners who had access to capital.

After the house on Popes Creek burned, the Wakefield Plantation seat was moved far up Bridges Creek and the land around the ruins on Popes Creek was rented. The tenant built a frame dwelling, maintained other buildings on the property, and cleared two fields for corn (Gilmore et al. 2001).

During the War of 1812 the British fleet was active in the Chesapeake Bay and moved up the Potomac in 1814 en route to Washington. The British sent troops ashore to destroy homes and other buildings. After the war, access to water transportation did provide some help to the evolving economy of the Northern Neck. The steamboat came to the Northern Neck in 1815, eventually establishing passenger service and more rapid trade routes to markets from Baltimore to Norfolk, which benefited farmers producing the new grain crops.

Park Status (1858-present)

The first move toward creating a park occurred in June 1815 when the schooner *Lady of the Lake* dropped anchor offshore of Westmoreland County and dispatched a small landing party with the intent of erecting a memorial to George Washington. This landing party was led by George Washington Parke Custis, adopted grandson of George and Martha Washington. On shore, the small party met a few fishermen and local gentlemen who joined them upon learning of their intent. They proceeded up to the remaining foundation and fireplace of a house thought to be George Washington's birthplace, and on this spot erected a memorial (Wiencek 2003). In 1858, William Lewis Washington conveyed the site of the Washington family house and burial ground to the Commonwealth of Virginia. This memorial became a cherished relic and most visitors left with chips of the memorial so, by 1870, the entire stone marker was gone (Wiencek 2003). In 1882, Virginia Governor William E. Jameson conveyed the property to the United States government.

The 1920's saw the beginnings of private and public efforts to resuscitate both the Lee family home, Stratford Plantation, and the Washington home on Popes Creek. The Wakefield National Memorial Association (WNMA) was formed in 1924 for the purpose of building a replica of George Washington's birth home, restoring the family burial ground, and making the site a national attraction. By early 1926, the WNMA had raised enough money to purchase 70 acres surrounding the existing government property and 50 feet of land circling the family burial ground (Bruggeman 2005). On January 23, 1930, the federal property was transferred from the War Department to the Department of the Interior, and designated the George Washington Birthplace National Monument.

On June 7, 1926, President Herbert Hoover signed a bill granting the WNMA permission to construct a "replica" of Washington's birth home, which was completed in the summer of 1931.

Bricks for the Memorial House were produced on site in kilns located 600-1000 feet west of the house and above usable clay deposits. In 1931, the WMNA also completed work on the family burial ground, which included restoration of the burial vault using original bricks. This activity included construction of a wall surrounding the burial ground using bricks left over from construction of the Memorial House. After completion of these initial projects, on June 22, 1931, the land holdings of the WMNA and approximately 265 acres held by John D. Rockefeller, Jr. were transferred to the NPS. This transaction brought the total acreage of the Birthplace to 394.47 acres (Bruggeman 2005).

The years of 1932 to 1940 saw completion of a number of construction projects at the Birthplace. The Log House Tea Room was built at Duck Hall in 1932 and was intended to accommodate overnight visitors. A road and traffic circle were built to provide access to the Log House and a 400 foot long wooden footbridge was constructed across Dancing Marsh from the Log House to the picnic grounds. Tables, drinking fountains, fireplaces, and a boat pier were all installed in the picnic area. Two residences and a tennis court were also constructed west of Dancing Marsh (Bruggeman 2005).

The core historic area also saw several new developments during this period. A utility building was constructed where the kilns once were, and a horse barn was built near the Memorial House to accommodate three horses donated by John D. Rockefeller, Jr. Paved roads, parking areas, and a network of clay and gravel nature trails were completed, and a historic crop demonstration area was established along the entrance road. Plum and cherry tree orchards were planted on the north side of the Memorial House and period-correct fencing was erected between the core historic area and the crop demonstration area. The construction that occurred during these years formed much of what exists at the park today (Bruggeman 2005).

In the years following this initial period of development, several other projects were completed. A water tower and septic system were finished in 1975 and a new Visitor Center was constructed along Popes Creek in 1976. The Visitor Center was accompanied by a new trail system leading to the core historic area. The trail consisted of about 1800 feet of crushed oyster shells and several hundred feet of brick and stabilized turf (Bruggeman 2005).

From the 1930's until the late 1960's, a large part of the land within the park was leased to the former owners, the Latane family, to grow crops and raise livestock. Barbed wire and split rail fences were constructed to facilitate sheep and cattle grazing, and crops were managed on a three year rotation. In the early 1960's, the Latanes were raising crops on 173 acres until the special use permits for these purposes ended in 1968 (Bruggeman 2005).

The NPS has been involved in considerable farming activity at the Birthplace. In 1969, the NPS constructed the Morgan Horse Farm between the family burial ground and the staff residences. This ranch included a barn, four paddocks, a clay training ring, and six pasture sheds. The objective of the horse farm was to supply horses to mounted rangers at other parks. However, the project was not economically viable and came to an end in the mid-1970's. In 1992, livestock and crops were part of a living farm at the park that included one acre of corn, a quarter acre of tobacco, twelve acres of hay, ten cows, four hogs, nine sheep, six hens, and two horses (Bruggeman 2005). Period breeds that are raised at the park today include Devon cattle, Ossabaw Island Hogs, and Hog Island Sheep. Heirloom varieties of vegetables were also planted

in the gardens in the late 1990's (George Washington Birthplace National Monument, R. Moräwe, Chief, Natural and Cultural Resources Management, pers. comm., 2006).

Over the years, surrounding properties were acquired and added to the park in an attempt to protect the peaceful and historic setting of the Birthplace. Significant acquisitions include the purchase of 62.3 acres in 1972 from Catherine Shouse and 12 acres in 1995 from the Horner family (Bruggeman 2005).

Current Land Use

Currently the NPS maintains the Birthplace as an 18th Century farm with alterations to manage visitor impacts. This focus results in land being used for grazing and raising feed but no land is cultivated for crops besides animal feed. No timber harvesting has been reported from forested areas of the park.

Habitats at the park include about 280 acres of open grasslands, 220 acres of forests, 25 acres of marshes and estuaries, 18 acres of memorial cultural landscapes, 5 acres of beaches and dunes, and 3 acres of developed lands. The developed lands include the visitor center, staff residences, and parking areas. The memorial cultural landscapes include other structures and areas for penned stock. The park property is divided in half by 115 acres of private land that was sold in 2006. The current owners of the property plan to build homes and have begun some clearing, planting, and septic system installation.

The fenced fields to the west of the historic core and east of the granite monument are used to pasture cattle. Large, open areas to the east of Bridges Creek Road are maintained in hay fields by the NPS. These areas are bush-hogged or hayed twice yearly (Bellavia et al. 1996).

Natural Resources

Physical Resources

Physical resources are the base upon and in which biotic communities become established. Soil and water, as affected by underlying geology and the terrain it constitutes, provide the physical environment for biological processes to evolve life forms characteristic of a specific location. Physical features of the park are shown in Figure 4. Although formal paleontological studies have not been conducted at the park, opportunistic and nearby discoveries described in this section provide evidence that further investigation is warranted.

Geology, Paleontology, Relief and Soils

Westmoreland County is entirely within the Atlantic Coastal Plain and consists of three general types of topography: neckland, upland, and cliffs. The neckland is nearly level and ranges in elevation from 10 to 50 feet above sea level. It borders most of the waterways and extends into the lower portions of the upland. The dividing line between neckland and upland is mainly marked by a distinct slope or scarp that starts at an elevation of about 50 feet and rises to about 100 feet. Cliffs are found along the Rappahannock and Potomac rivers, with the steepest found in Westmoreland State Park (Nicholson et al. 1981). The Birthplace comprises primarily neckland topography, with a section of 10 to 15 foot cliffs bordering the Potomac River.

Geology: The Atlantic Coastal Plain physiographic region consists of sediments that, in this part of Virginia, deepen from a feather-edge at the Fall Line to a depth of over 1,500 feet near the mouth of the Potomac River, and to over 5,000 feet at the Atlantic Ocean (Belval et al. 1997). The environment in which sediments are deposited ultimately affects both the resulting geology and the associated hydrology, including the capacity for sediments to conduct water (hydraulic conductivity), the chemical composition of the formations, and the dissolved constituents of the groundwater in contact with the formations.

The formations underlying the Birthplace were described by Thornberry-Ehrlich (2005) in the *George Washington Birthplace National Monument Geological Resource Management Issues Scoping Summary*:

At depth, the Lower Cretaceous Potomac Formation underlies most of the area. This formation is comprised of feldspathic quartz sand and sandstone, silty channel-bar deposits, and lignitic sandy silt and clay layers. Atop the Potomac Formation is the upper Paleocene Aquia Formation of glauconitic sands, silts, clays, and containing some scant fossil layers. Nanjemoy Formation deposits from the lower Eocene overlie the Aquia Formation and are exposed in ravines. These are glauconitic sands, clays, silts, and mixed layers. Miocene age deposits of the Chesapeake Group overlie the Aquia and Nanjemoy Formations in the park area. This includes the prominent Calvert Formation of marine sands, silts, and clays that contains abundant fossils such as shark teeth. An unconformity separates the Calvert Formation from the Eastover Formation (not exposed near the park), which grades upwards into the younger marine, intertidal, and fluvial deposits of Pliocene age.

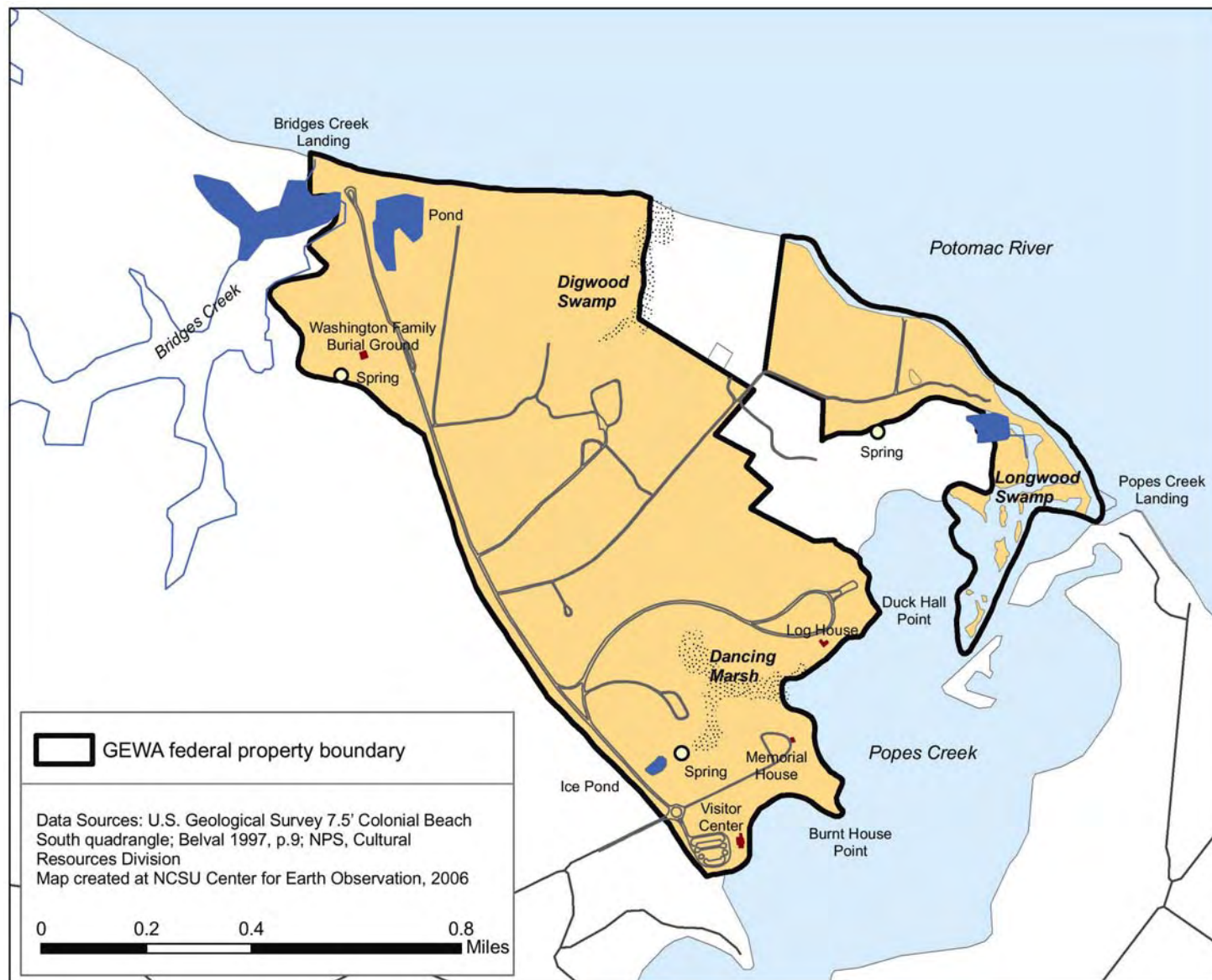


Figure 4. Physical features of George Washington Birthplace National Monument (GEWA).

Younger deposits include the Yorktown Formation and Pliocene sands and gravels. The Yorktown Formation is a maximum of 25 m (82 ft) thick and contains quartz and feldspar sands mixed with lesser clays and silts. The upper Pliocene Bacons Castle Formation includes gravelly sand and sandy-silty-clayey upper layers. These are often found in high-level terrace areas. The more recent deposits at the park include various Quaternary age units.

A correlation of Quaternary map units by the USGS described the park as underlain by Marsh deposits and the Sedgfield and Lynnhaven members (late Pleistocene) of the Tabb Formation. All of these units are classified as Estuarine Environments (Newell et al. 2002).

The ancestral Potomac River and Chesapeake Bay have had a great influence on the surficial landforms in this area. Generally, Atlantic Coastal Plain sediments are unconsolidated interbedded gravel, sand, silts, and clays. The terraces were deeply incised by streams as seas receded. These high (relative to current sea level), flat terraces continue to be vulnerable to erosion along the banks of the Potomac River, as well as along the smaller creeks that lead to the Potomac River. These unconsolidated sediments are undercut in response to flooding, wave action, and/or direct precipitation and erosion (Belval et al. 1997).

Meng and Harsh (1988) documented the overall hydrogeologic framework, or framework of aquifers, confining units, and the depositional environment for the entire Virginia coastal plain. Within the park, the base geologic unit of the shallow aquifer system, defined as less than 100 feet deep, is the Nanjemoy Formation of Eocene Age. Sediments of the Nanjemoy Formation were deposited in a protected marine shelf, in water that ranged from 30 to 230 feet deep, resulting in sediments that consist of glauconitic (indicating deposition in a marine environment) fine-grained sand and clays with abundant bivalve fossils and glauconitic silty sand. During a Pleistocene glacial period, fluvial erosion incised deep (greater than 80 feet) paleochannels into the Nanjemoy Formation, which filled with undifferentiated Pleistocene sediments during the subsequent interglacial period as sea levels rose. The undifferentiated Pleistocene sediments first were deposited in a high-energy environment that changed gradually to a low-energy marsh environment during the course of transgression. This resulted in deposition of coarse-grained sand and pebbles that fine upward into fine- to medium-grained sand, clay, and peat, and then into clay with abundant wood fragments. These Pleistocene channel deposits differ greatly from the fine-grained sand and clay of the surrounding Nanjemoy Formation, and their morphology results in local channel-like aquifers with a greater capacity to transmit water than the Nanjemoy Formation (Belval et al. 1997).

Directly above the Nanjemoy Formation and below the surficial sediments is the Tabb Formation. This formation was deposited in a fluvial-estuarine setting during a later Pleistocene marine transgression. The formation consists of fine- to coarse-grained sand and pebbles that fine upward into silt and clay. The Tabb Formation was not deposited on some of the higher, previously formed terraces since the ocean was at a lower relative elevation when this formation was created; instead, only lower land areas were inundated and deposited with the swamp and marsh mud, sand, and peat that became the Tabb Formation (Belval et al. 1997).

Sediment deposition at the mouth of Popes Creek has formed ecologically important delta marshes. The marshes were studied in 2000 when the USGS performed analyses of sediment cores extracted along a continuum in Popes Creek using a Hoverprobe watercraft (Newell et al.

2000). Core analysis indicated the oldest observed sediment along the shoreline of the park picnic area was deposited approximately 4000 BCE as valley flood plain alluvium and channel gravel. The scenario for sediment dated 2000 BCE was described as a tidewater flooding distribution of estuarine sediments along a gentle landward gradient with a fluvial delta reaching Burnt House Point. Two thousand years ago oysters occurred along with wood and peat as tidewater inundated the valley to Canal Swamp Delta. Significant coastal erosion associated with the undercutting of shoreline bluffs, as well as indications of corn agriculture and Algonquin Confederacy social structure are found in sediment dating to 1000 CE. Core measurements dating to 1650 CE indicate sea level rise and coastal erosion have resulted in a 122 meter loss of shoreline along the Potomac River from that time to the present date (Ellsworth 2003). Shoreline erosion will be addressed more fully in later sections of this report. Due to the land use history available for the park, there is potential for relating changes in land use to changes in geological and other natural processes. This aspect of the park, along with its accessibility to researchers, has contributed to a heightened interest in further research at the park in order to establish a baseline for monitoring long-term trends (Newell and Moräwe 2006). Furthermore, the geological processes occurring in Popes Creek can be viewed as a microcosm of the Chesapeake Bay. By continuing research into the history of sediment transport and storage, erosion, and other processes at the park, scientists hope to deepen their understanding of the entire Chesapeake Bay system (Newell and Moräwe 2006).

Finally, it should be noted that during the last glacial maximum, the ocean was as much as 400 feet below current mean sea level (Dickinson 2000). Thus, tidal and estuarine conditions now evidenced along the lower Potomac shoreline have developed as glacial melt progressed within the last several thousand years of the Holocene.

Paleontology: The following section is extracted from Kenworthy and Santucci (2003), and has been updated with information from personal communications with Kenworthy and Santucci and Moräwe (NPS, George Washington Memorial Parkway, V. Santucci, Chief Ranger, pers. comm., 2006; George Washington Birthplace National Monument, R. Moräwe, Chief, Natural and Cultural Resources Management, pers. comm., 2006).

No formal paleontological inventories have been undertaken at the park. Paleontological scoping sessions have likewise not been completed for the park. While the park has not made formal inventories and collections, extensive paleontological resources are known from the park. Rijk Moräwe has consulted with Dave Bohaska et al. of the Smithsonian Institution and has begun a natural history collection, which includes paleontological resources in the park's museum. Paleontological resource locality documentation and condition assessment for Government Performance and Results Act reporting was initiated in July 2006 (NPS, George Washington Memorial Parkway, V. Santucci, Chief Ranger, pers. comm., 2006).

The Calvert Formation is the main fossiliferous deposit within the park and has been known as a major source of fossil material since the original descriptions by George Burbank Shattuck in 1902 and 1904. Stratigraphically, the Calvert Formation is part of the Chesapeake Group. The fossil biota of the Chesapeake Group is very significant because it offers a rare opportunity to directly compare biochronologies based on mollusks, diatoms, foraminiferans, marine mammals, and terrestrial mammals (Wright and Eshelman 1987). Likewise, the extensive exposures and abundance of fossils within the Chesapeake Group

combine to make the stratigraphic sequence which includes the Calvert Formation the best record of Miocene marine life available from eastern North America (Gottfried et al. 1994). While there are limited exposures of the Calvert Formation within the boundaries of the park, large quantities of fossils from this formation wash onto the beaches within the park and are popularly collected by visitors (George Washington Birthplace National Monument, R. Moräwe, Chief, Natural and Cultural Resources Management, pers. comm., 2006).

Sharks teeth are common throughout the Calvert Formation and, in turn, are the most common fossil found on the beaches of the park (George Washington Birthplace National Monument, R. Moräwe, Chief, Natural and Cultural Resources Management, pers. comm., 2003). In addition to being quite abundant, species represented are quite varied. The most frequently discovered sharks teeth include specimens from *Galeocerdo contortus* (tiger shark), *Hemipristis serra* (requiem, or snaggletooth, shark), *Isurus desorii* (mackerel shark), *Sphyrma prisca* (hammerhead shark), and *Odontaspis elegans* (sand shark), all of which are now extinct (McLennan 1971). While these are reported for the Calvert Cliffs area in Maryland, the presence of teeth from *Hemipristis serra* and *Isurus desorii* has been noted at the park (George Washington Birthplace National Monument, R. Moräwe, Chief, Natural and Cultural Resources Management, written communication, 1999). In addition, teeth from sand, mako, silky, and white sharks have been found at the park (George Washington Birthplace National Monument, R. Moräwe, Chief, Natural and Cultural Resources Management, pers. comm., 2003). Large hand-sized specimens of *Carcharodon* (the giant white shark) have been recovered from the park's beaches (George Washington Birthplace National Monument, R. Moräwe, Chief, Natural and Cultural Resources Management, written communication, 1999) and are part of the museum's new natural resource museum collection. Fieldwork by Dave Bohaska of the Smithsonian Institution in January of 1989 uncovered a broken *Carcharodon* tooth while excavating a partial porpoise skull (see marine mammal section below) near the park (Bohaska field notes, 1989). Bohaska (field notes, 1989) also reports finding teeth of *Galeocerdo contortus* and *Hemipristis serra*, along with two unidentified specimens, during other marine mammal excavations. According to another Smithsonian Institution paleontologist, teeth of *Otodus obliquus* (mackerel shark) have been found within the park, but they may be fossils reworked from older Paleogene sediments (Robert Purdy, personal communication, 2006).

Fossilized remains of turtles and rays are also described from the Calvert Formation in Maryland, and similar fossils may be discovered in Virginia (McLennan 1971). In fact, Bohaska (field notes, 1989) reports finding leatherback tortoise shell fragments during his 1989 excavations near the park.

Among the largest fossils found in exposures of the Calvert Formation near the Birthplace are those of marine mammals such as whales, sea cows, and dolphins (George Washington Birthplace National Monument, R. Moräwe, Chief, Natural and Cultural Resources Management, pers. comm., 2003). The Smithsonian Institution's National Museum of Natural History has a number of cetacean (whale and dolphin) specimens collected from the area immediately surrounding the park. Fragmentary bones of marine mammals frequently wash up on the beaches at the park.

Dave Bohaska (personal communication, 2003) has collected material from a number of sites near the Birthplace. In 1989, Bohaska's field crew excavated a long-beaked porpoise skull found on a beach located on private property northwest of the park. Additional excavations 30 meters (100 feet) downstream yielded another partial porpoise skull along with ribs and vertebrae. *Cetothere* whale material was collected approximately 457 meters (1,500 feet) upriver from the beach parking lot at the Birthplace, about 366 meters (1,200 feet) below the porpoise material. Skeletal remains collected from the *Cetothere* include mandible, ribs, and vertebrae (Bohaska 1989). In 1996, Bohaska returned to the the park area to collect a partial sirenian skeleton later identified as *Metaxytherium* (dugong). The specimen was originally discovered by the Richmond Gem and Mineral Society about 235 meters (770 feet) upstream from range station #17, near Bridges Creek Landing, just outside the Birthplace boundary (Bohaska 1996). The excavation yielded several vertebrae and ribs, now in the Smithsonian's collection. Additional material, including a small porpoise mandible was found upriver. In 1977 a large jaw fragment and teeth of *Orycterocetus crocodilinus* (sperm whale) was discovered and excavated 1.6 kilometers (one mile) west of the park boundary (USNM 183078 specimen notes) (USNM numbers listed are catalog numbers). A maxillary fragment of a sperm whale was discovered in 1975 at Church Point, west of the Birthplace. Myrick (1979) studied *Rhabdosteidae* (dolphins), including specimens found in the Calvert Formation near Church Point.

Fossils of land animals have also been found in the Calvert Formation. Tapirs, mastodons, rhinoceros, horses, bear dogs, and seals have been found occasionally from Calvert Cliffs, Maryland (McLennan 1973), many of which are represented from deposits near the park. While it may seem odd to find land animal fossils in a marine unit, streams probably transported the material from terrestrial environments, where the creatures lived, to the sea after death. In Virginia, *Amphicyon* (bear dog) skull material, including a jaw fragment with tooth, was excavated in 1970 from the cliffs at "Wakefield", most likely just outside of the park (USNM 26405 specimen notes). This material is significant because it is very rare to find skull bones of predators such as *Amphicyon* in the Calvert Formation (D. Bohaska, personal communication, 2003). A peccary dentary identified as "*Cynorca proterva*" was discovered near Church Point in Westmoreland County (USNM 214942 specimen notes) a few miles northwest of the park and mentioned by Wright and Eshelman (1987). The distal end of a left tibia (leg bone) of a tayassuid (peccary) was collected in 1978 above the beach at "Wakefield" (USNM 321259 specimen notes). These discoveries, all accessioned into the Smithsonian collections, indicate that additional land animal fossils could be found in the the park area.

An extensive variety of mollusks, mostly gastropods and pelecypods, are found throughout the Calvert Formation and may wash up on the beaches of the Birthplace. As an example of the abundance of mollusks, 408 species of Mollusca are reported from Calvert Cliffs, Maryland (McLennan 1973). *Chesapecten coccymelus*, *Crassatella melinus*, and *Ecphora tricostata* are typical of the formation in Virginia, although they probably represent a very small fraction of molluscan diversity (Mixon et al. 1989).

Well-preserved foraminifera are also reported from the Calvert Formation throughout the coastal plain of Virginia including the genera *Siphogenerina* and *Uvigerina* (Teifke 1973).

Diatoms are very common as well, evidenced by the diatomaceous clay-silt layers described by Mixon et al. (1989).

Extensive collections of Calvert Formation material in the area around the Birthplace have been made by the Smithsonian Institution's National Museum of Natural History. Approximately 800 cataloged specimens at the museum come from Calvert Formation exposures in Westmoreland County, Virginia (M. Brett-Surman, CBN Paleontology Inventory & Monitoring 23 written communication, 2003). The American Museum of Natural History has a baleen whale collected near the park (D. Bohaska, personal communication, 2003).

Fossil sharks teeth have been discovered in association with an archeological site and shell midden within the park (George Washington Birthplace National Monument, R. Moräwe, Chief, Natural and Cultural Resources Management, pers. comm., 2003). The site is associated with prehistoric components dating to the Middle (500 BCE – 900 CE) and Late (900 – 1600 CE) Woodland periods and contains remains of multiple occupations (Harwood 2002). Native Americans may have utilized the sharp fossils as tools to remove meat from shellfish.

While the Calvert Formation is more fossiliferous, the Sedgefield Member of the Upper Pleistocene Tabb Formation is exposed throughout the park (Mixon et al. 1989). Fossils have been discovered in the Sedgefield Member, and may be found in the park. The coral *Astrangia* has been discovered in the Sedgefield Member as well as the mollusk genera *Mercenaria*, *Anadara*, *Polynices*, and *Ensis* (Mixon et al. 1989). Mixon and others also note the occurrence of *Crassostrea* (a type of oyster) biostromes. These biostromes are laterally extensive carbonate deposits that may be reef-like structures or sheets of transported material. In addition, channel fill deposits, found locally in the Sedgefield Member, have yielded peat deposits with *in situ* tree stumps (Mixon et al. 1989).

Relief: The park is low neckland with a maximum elevation of 25 feet above mean sea level. The Potomac River shoreline is a mixture of beach and low cliffs. High erosion rates are associated with storm events such as Hurricane Isabel. In this particular storm, a section of 8 to 15 feet high cliffs that were about a quarter of a mile in length were severely eroded, up to 50 feet in places. Several tidal islands exist along the mouth of the Popes Creek estuary. As a whole, the park is essentially flat (Figure 4).

Soils: Nicholson et al. (1981) identified the soils type found throughout the park as the Lumbee-Leaf-Lenoir association (see Appendix A for description). Within this association, the majority of the park's land is classified as 'non-tidal wetlands' or 'prior converted wetlands' with Lumbee, Leaf, and Bibb/Levey soils. Much of the park's shoreline is composed of Bohicket silty clay loam, which is continually saturated due to flooding twice a day (Ellsworth 2003). There are five non-hydric soils within the park: Rumford fine sandy loam, State fine sandy loam, Tetotum loam, Montross silt loam, and Nansemond fine sandy loam.

The soils on the low terraces along the Potomac River were deposited in a low energy environment. Therefore, they include fine particles such as silts and clays, which cause water to pond rather than drain. During colonial times, drainage ditches were dug on low terraces along

the Potomac River, including the area that is now the Birthplace, to drain excess water from the fields for farming. The drainage ditches continue to serve as a means of keeping the fields arable today (Belval et al. 1997).

Nicholson et al. (1981) provides further description of park soils indicating that “the combination of more than 40 inches of annual rainfall and an average air temperature of 50 degrees or more causes removal of plant nutrients from the soil and oxidation of the organic matter in the surface layer of the soils. In farmed areas, the soils are frozen only for short periods and to a shallow depth each winter, and in wooded areas they are rarely frozen. Consequently, weathering and translocation of leachable materials are accelerated.”

Most park soils that are used for agriculture will respond well to fertilizer and, due to the medium to strong acidity, periodic application of lime is needed to maintain fertility (Nicholson et al. 1981). According to the soil survey, the best farming uses are pasture and hay cropping. The Natural Resources Conservation Service (formerly, the U.S. Soil Conservation Service) classified 168.18 acres within the Birthplace as prime farmland. The map units within the park that meet the requirements for prime farmland are Nansemond fine sandy loam, Rumford fine sandy loam (0-6 percent slopes), State fine sandy loam (0-6 percent slopes), Tetotum loam (0-6 percent slopes) (Nicholson et al. 1981).

The soil survey map of the park is presented in Figure 5. This map depicts 13 different soil series for the park and one nonsoil type called water. Four of the soil mapping units are hydric. A summary of the soil mapping units found within and adjacent to the park is presented in Table 2.

Water Resources

The Birthplace includes a diverse array of water resources, including freshwater ponds, streams, groundwater, several springs, tidal marshes, and freshwater wetlands. The park taps groundwater as the public drinking water supply (Belval et al. 1997).

Near the Birthplace, the Potomac River is over five miles wide and has a 2.5 to 3 foot tidal range. Depending on the season, the river is commonly characterized as “fresh-to-brackish”, ranging from a salinity of less than 0.5 parts per thousand (ppt)(low oligohaline) to 17 ppt (mesohaline) as a result of the connection with the Atlantic Ocean through the Chesapeake Bay.

Streams: Popes Creek and Bridges Creek form the east and west boundaries of the Birthplace. A small, unnamed creek that originates in, and runs through, the park, emptying into Digwood Swamp, separates these two sub-basins. The northern boundary of the Birthplace is the Potomac River. The combined drainage basin of Popes Creek, Bridges Creek, and the unnamed creek is approximately 13,500 acres of which the Birthplace comprises less than 5 percent (Figure 6). Popes Creek has been cited by the USGS as a desirable research site because of its perceived water quality in contrast to comparable watersheds in the Chesapeake region. Nancy Simon of the USGS identified Popes Creek as an “irreplaceable reference watershed for scientific research on the Chesapeake Bay” (U. S. Geological Survey, N. Simon, Research Chemist, pers. comm., 2006). The principal characteristics creating this interest are the lack of a large population, intense animal or grain agriculture, or sewage treatment plant in the watershed.

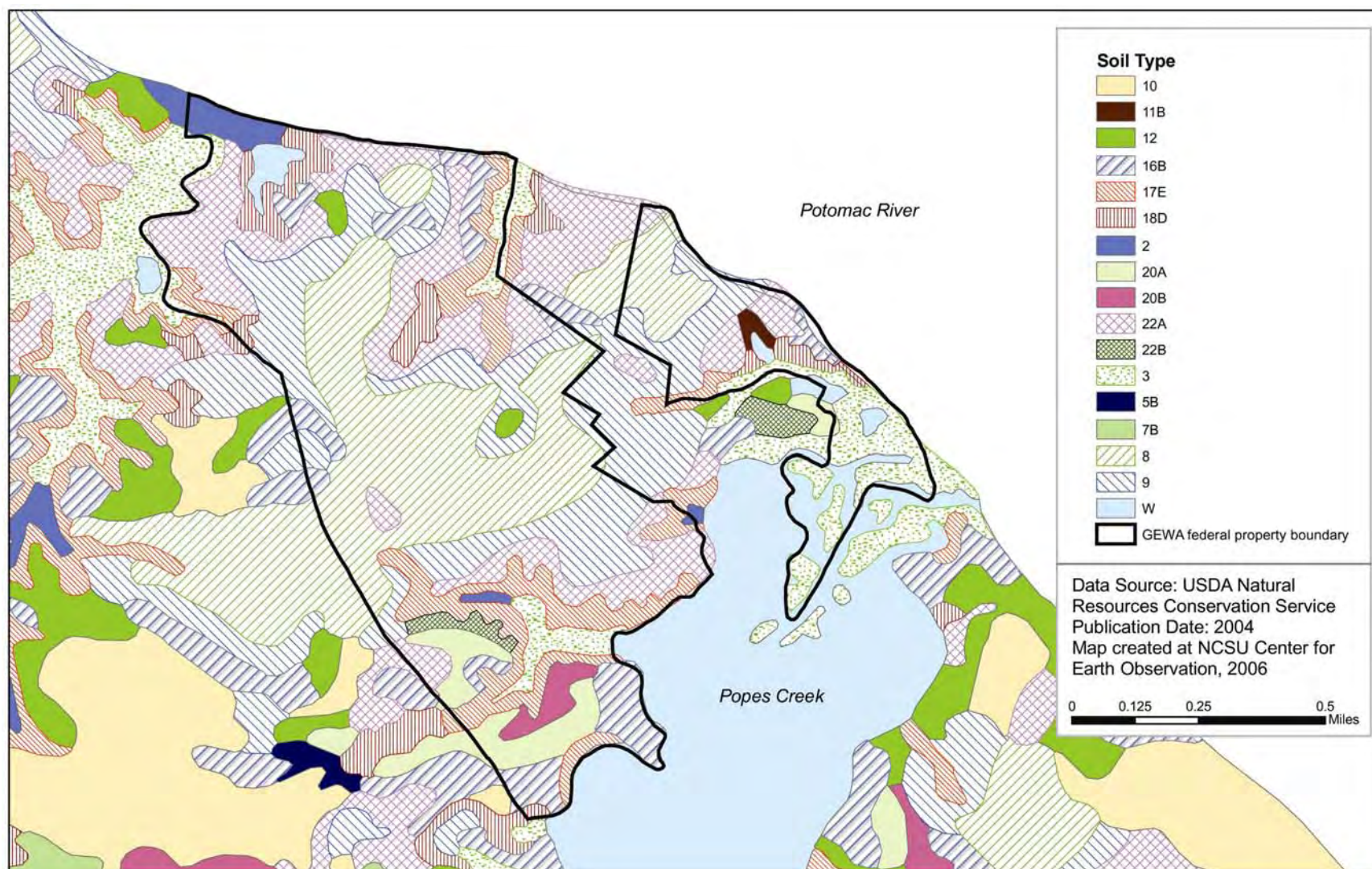


Figure 5. Soil survey of George Washington Birthplace National Monument (GEWA). Soil codes are defined in Table 2.

Table 2. Soil survey information (Nicholson et al. 1981; Sustainable Science, LLC 2006).

Map Symbol	Mapping Unit	Site Position	Hydric Soil	Area (acres) within the park
2	Bibb and Levy soils	Bottom of slopes	Yes	7.58
3	Bohicket silty clay loam	Tidal marsh areas	Yes	33.08
5B	Catpoint loamy sand	-- ^a	No	-- ^a
7B	Kempsville loam	-- ^a	No	-- ^a
8	Leaf silt loam	Higher elevation agricultural fields and forested areas	Yes	131.15
9	Lenoir silt loam	Higher elevation agricultural fields and forested areas	Yes	106.94
10	Lumbee loam	-- ^a	Yes	-- ^a
11B	Montross silt loam, 2 to 6 percent slopes	In valley bottom	No	2.05
12	Nansemond fine sandy loam	Portions of the agricultural fields	No	3.74
16B	Rumford fine sandy loam, 0 to 6 percent slopes	Along upper portion of hill slopes	No	36.29
17E	Rumford soils, 15 to 50 percent slopes	Majority of hill slopes	No	54.66
18D	Rumford and Tetotum soils, 6 to 15 percent slopes	Along hill slopes	No	20.80
20A	State fine sandy loam, 0 to 2 percent slopes	Portions of agricultural fields	No	19.70
20B	State fine sandy loam, 2 to 6 percent slopes	Portions of agricultural fields	No	6.67
22A	Tetotum loam, 0 to 2 percent slopes	Portions of agricultural fields	No	97.75
22B	Tetotum loam, 2 to 6 percent slopes	Portions of agricultural fields	No	4.03
W	Water	Water bodies	No	19.72

^aThis soil type occurs adjacent to, but not within the park.

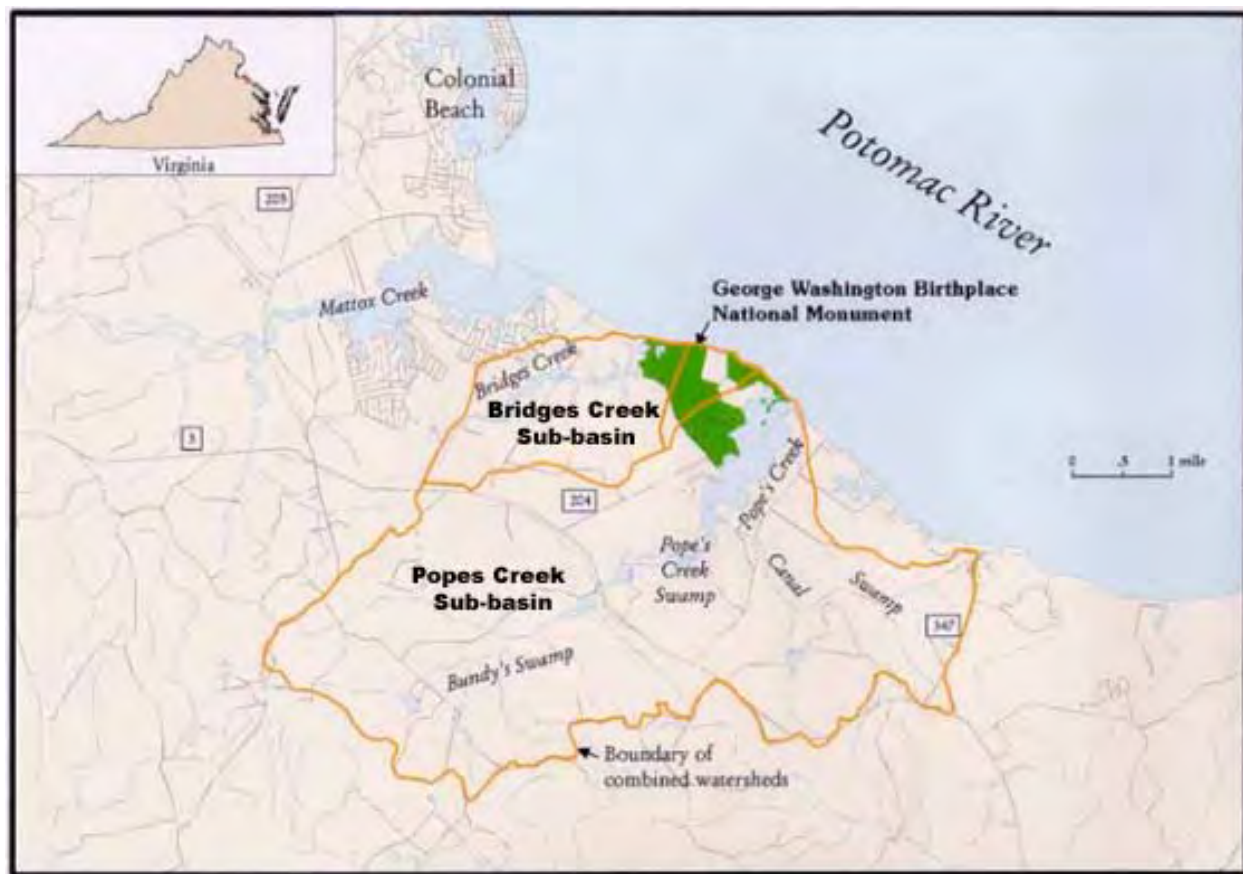


Figure 6. Location of George Washington Birthplace National Monument within three-basin watershed area (Belval 1997, p. 18).

The Popes Creek sub-basin is approximately 11,300 acres. Throughout this sub-basin, the poorly drained soils result in extensive wetlands around the creek. In the area of the Birthplace, the creek widens into a brackish estuary about 0.5 mi wide and 1.25 mi long. In this area the estimated average depth is 3-5 ft with a deeper main channel. The mouth of the creek narrows near the Potomac River and is partially blocked by an interior delta of small, partially shrub-covered islands (Belval et al. 1997).

The Bridges Creek sub-basin is approximately 1,960 acres, about one-fifth the size of the Popes Creek sub-basin. In the upper part of the watershed, Bridges Creek feeds into a pond formed where a road crosses the creek. Aerial photos from the 1950s to the 1990s show the gradual silting up of the lower half of Bridges Creek after the construction of this road. This has created an extensive marsh with only a small area of open water. The confluence of Bridges Creek and the Potomac River shifts, depending on flow and deposition from each stream (Belval et al. 1997).

The unnamed creek originates within the Birthplace boundary and flows north into Digwood Swamp, Longwood Swamp, and then into the Potomac River. This creek runs adjacent to a private farm located within the Birthplace and the park maintenance area, and so is not accessible by road. This sub-basin is approximately 1,100 acres, about one tenth the area of the Popes Creek sub-basin (Belval 1997).

Various ditches dug in the 17th and 18th centuries to drain excess water and allow farming of fields or maintenance of pastures still drain to these streams, though ditch maintenance has declined with reduction of agricultural activity since creation of the Birthplace.

Freshwater Ponds: Three freshwater ponds lie totally within the Birthplace. One pond, known as Ice Pond, probably was created in the early-to-mid 1700's by impounding the creek that runs through the Birthplace to Dancing Marsh. Another pond was created upstream of Ice Pond, and just outside the park boundary, when a road was improved in the mid-1800s. This pond is no longer maintained, and has become a small wetland that feeds into Ice Pond. The earthen dam downstream of Ice Pond was refurbished during the 1930's after not having been maintained for at least 20 years (Belval et al. 1997). A second freshwater pond within the park is located near Bridges Creek Landing and was possibly formed when a tidal inlet was impounded in the late 1800's (Belval et al. 1997). The third freshwater pond is located in the northeastern portion of the park, and was possibly formed when a dam was put in place to create a road, although the use of the pond and its age are unknown (Belval et al. 1997). Figure 4 depicts the locations of the ponds and other water features within the park.

Groundwater and Natural Springs: The primary Coastal Plain aquifers used for water supply in the Northern Neck are the Middle Potomac Aquifer, which occurs at a depth of about 300 feet near the Birthplace, and the Aquia Aquifer, which occurs at about 150 feet. These aquifers are within formations that were deposited in an environment subjected to little erosion, and therefore are a source of water over a much wider geographic area than shallower aquifers. The effects of pumping on the deep aquifer are difficult to assess because few data points to monitor water level and water quality exist (Belval et al. 1997).

The shallow aquifer system at the Birthplace likely can be divided from surface downward into four hydrogeologic units: the Columbia aquifer, the upper confining unit, the upper confined aquifer, and the Nanjemoy-Marlboro confining unit.

In some areas, the upper confining unit and the upper confined aquifer are not present and the Columbia aquifer directly overlies the Nanjemoy-Marlboro confining unit. This contact may provide a means of water exchange between the Columbia aquifer and the Nanjemoy-Marlboro confining unit, which effectively combine to form a thick aquifer. The Columbia Aquifer correlates with the Holocene deposits and Tabb Formation, and its water-bearing characteristics are highly variable as a result of the range of depositional environments in which the formations were created. Thin layers of clay or coarse-grained paleochannel deposits can strongly affect the rates and direction of flow in the Columbia aquifer. Generally, the Tabb Formation has its most permeable sediments at its base, and the least permeable sediments near land surface (Belval et al. 1997).

The upper confining unit correlates with the upper, fine-grained, undifferentiated Pleistocene deposits. This unit consists of plastic clay, silty sand, and clayey sand, gray in color and containing abundant organic material, including wood fragments. The upper confined aquifer correlates with the lower, coarse-grained part of the undifferentiated Pleistocene deposits, and consists of interbedded sand and clay grading downward into sand and pebbles. Because this unit was deposited in paleochannels, it probably is not present over the entire area.

Groundwater level is monitored by the USGS in two wells at the Birthplace. A 471 foot observation well was drilled into the middle Potomac Aquifer in 1974. The Potomac aquifer extends beneath the Potomac River into Maryland and is used as a water source throughout the Maryland and Virginia Coastal Plain. Monitoring of this well indicates a consistent decline in water levels. A total loss of approximately 24 feet of depth occurred over the data collection period from 1978 to 2001. Data from this well also revealed an annual water level cycle, wherein the aquifer level tends to rise in summer months and then decrease markedly during the winter (Belval et al. 1997). A shallow (26 foot) dug, unused water well was also monitored by the USGS from 1977 to 2001, and showed similar annual variation in water levels. However, there was no water level decline in this aquifer during the monitoring period. These data likely reflect the seasonal pattern of water level, possibly due to evapotranspiration, and very local effects of pumping (Belval et al. 1997).

Three freshwater springs have been documented near or within the park, each near the base of a scarp (Figure 4). Springs occur where there is some intersection of an aquifer with the surface, discharging groundwater into the surface water system. One of the documented springs was near the John Washington house site, southeast of the confluence of Bridges Creek and the Potomac River; a second lies outside the Birthplace boundary near Longwood Swamp; and a third, near Popes Creek, was reported to have “silted up”. This term may indicate erosion from the slope above or that the spring failed to produce a useful amount of water. A fourth, undocumented, spring exists between Ice Pond and Dancing Marsh and was used by the NPS for watering livestock (Belval et al. 1997).

Wetlands: Sustainable Science, LLC (2006) recently completed the *Wetland Inventory and Mapping Project* for the park. This study inventoried the 551 acres of federally owned property

at the park, but did not include the private property that divides the park. The maps generated by that study are presented here in Figures 7, 8, and 9. Figure 7 depicts the mapped wetland and stream systems of the park overlain on spring of 2002 orthorectified black and white aerial photography with the wetland data points also provided. Figure 8 depicts the same wetland mapping as Figure 7, without the wetland data points, overlain on the 1998 USGS Colonial Beach South quadrangle. Figure 9 compares the currently mapped wetlands and deepwater habitats with the National Wetlands Inventory mapping results.

In 2005 Sustainable Science, LLC conducted a review of National Wetlands Inventory (NWI) data, which were generated by interpreting aerial photography, and conducted actual field delineations to obtain the data discussed in this section. These field studies determined that the park includes 84.23 acres (15.5 % of the total park) in wetlands (Sustainable Science, LLC 2006). This finding was 18.08 acres less than the 102.43 acres mapped by the National Wetlands Inventory (NWI). The differences are attributed to more forested Palustrine wetlands (PFO) and scrub/shrub Palustrine wetlands (PSS) being mapped by NWI. However, the field study mapped Riverine systems that were not noted in the NWI data. Colonial ditches form one of the Riverine systems and have been identified with flow direction determined. A total of 14 different wetland types were classified during the field study as compared to 24 different types according to NWI.

Functionally, the park's wetlands are average to excellent in their capacity for sediment stabilization, water quality enhancement, wildlife habitat and fisheries habitat (Sustainable Science, LLC 2006). The Popes Creek marsh complex had below average functional ability for the above categories and for shoreline bank erosion control.

National Wetlands Inventory: Eighteen different Palustrine wetland classes were mapped on park property by NWI. The remaining mapped wetland systems are noted as six different Estuarine types. No Riverine systems occur on NWI documents. Tables 3 and 4 provide the NWI wetland mapping information, descriptions and associated acreage for Palustrine and Estuarine wetland systems, respectively.

Sustainable Science, LLC Wetland Delineation: Fourteen different Palustrine, Estuarine, and Riverine systems were identified within the park. Tables 5, 6, and 7 provide the United States Fish and Wildlife Service (USFWS) wetland types, acreages of each delineated site, and whether the wetlands are jurisdictional wetlands, other wetland types (e.g., unvegetated or nonsoil wetlands) or "other waters of the United States."

Combining all Estuarine, Palustrine and Riverine park wetland categories, the total acreage is 84.35 acres or approximately 15.5% of the total study area of 550 acres.



Figure 7. Current wetlands and US water boundaries including wetland data points in George Washington Birthplace National Monument (Sustainable Science, LLC 2006, plate 3).

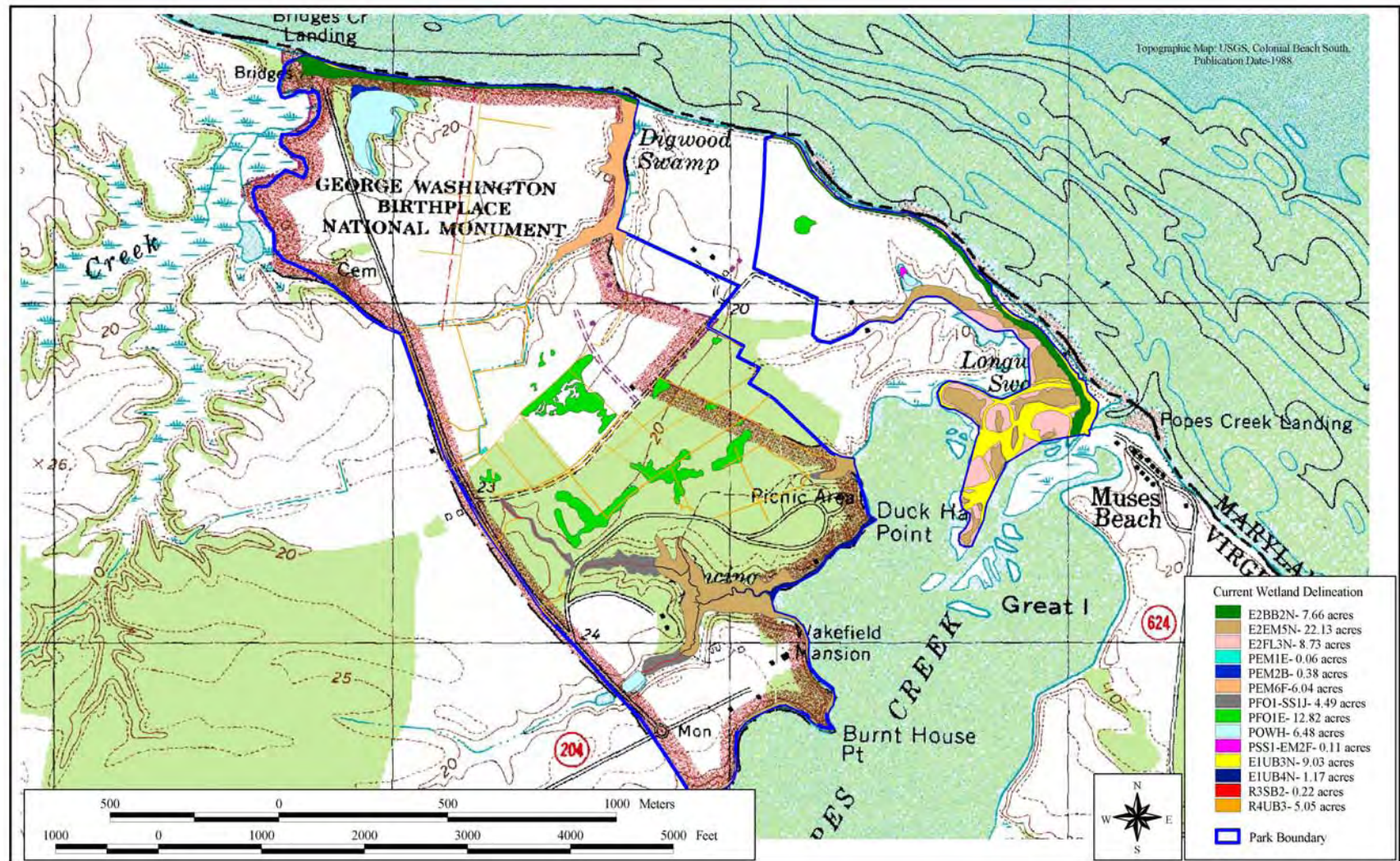


Figure 8. Current wetlands and US water boundaries in George Washington Birthplace National Monument (Sustainable Science, LLC 2006, plate 4).

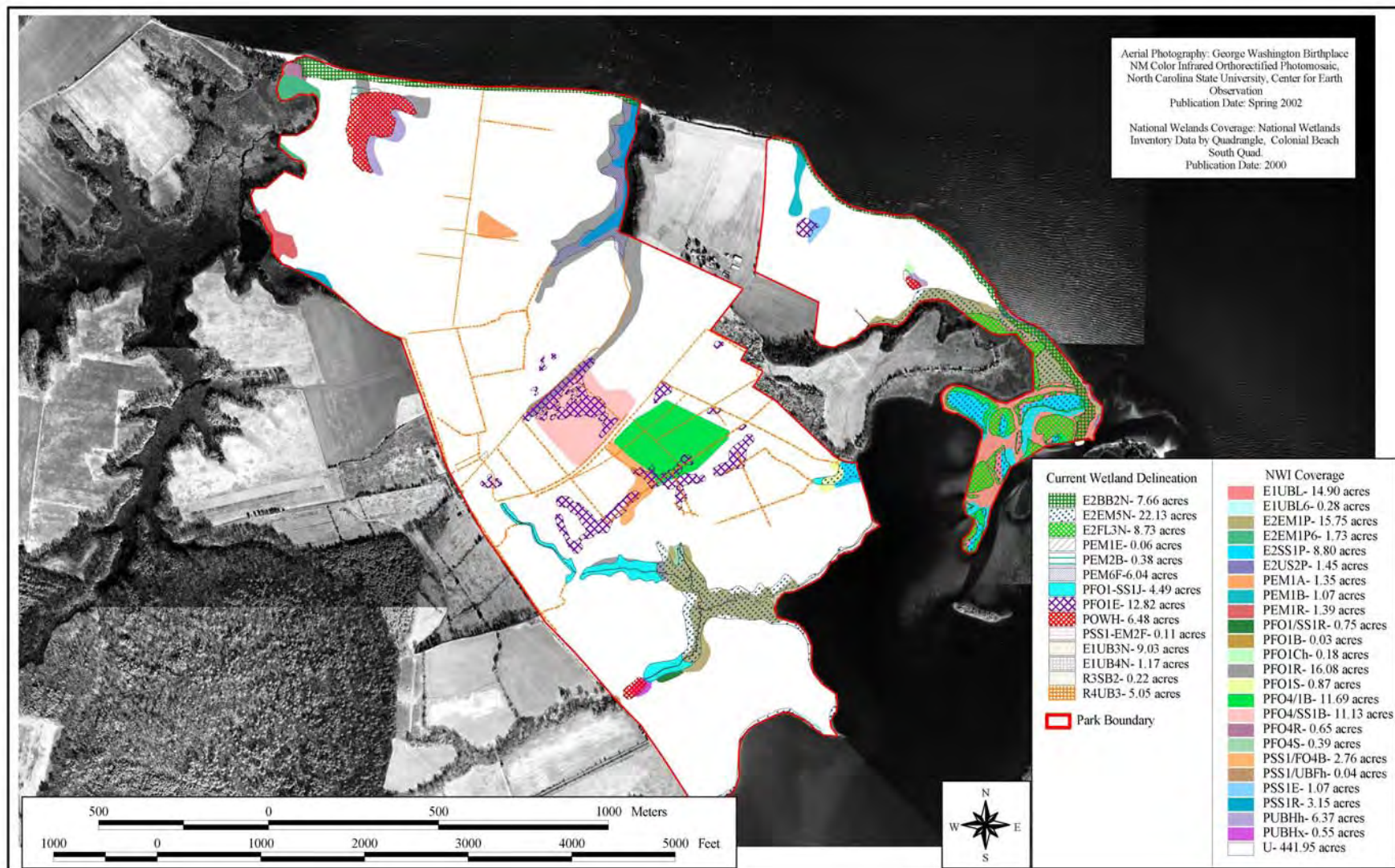


Figure 9. Field mapped wetlands and National Wetlands Inventory wetlands in George Washington Birthplace National Monument (Sustainable Science, LLC 2006, plate 5).

Table 3. Acres of Palustrine wetland systems within George Washington Birthplace National Monument (GEWA) mapped by the National Wetlands Inventory (reported by Sustainable Science, LLC 2006).

USFWS Symbol	USFWS Wetland Classification	Area (acres) within GEWA
PEM1A	Temporary, persistent, emergent palustrine ecosystem	1.35
PEM1B	Saturated, persistent, emergent palustrine ecosystem	1.07
PEM1R	Seasonal tidal, persistent, emergent palustrine ecosystem	1.39
PFO1/SS1R	Seasonal tidal, broad-leaved deciduous scrub/shrub, broad-leaved deciduous forested palustrine ecosystem	0.75
PFO1B	Saturated, broad-leaved deciduous, forested palustrine ecosystem	0.03
PFO1Ch	Diked/Impounded, seasonal, broad-leaved deciduous, forested palustrine ecosystem	0.18
PFO1R	Seasonal tidal, broad-leaved deciduous, forested palustrine ecosystem	16.08
PFO1S	Temporary tidal, broad-leaved deciduous, forested palustrine ecosystem	0.87
PFO4/1B	Saturated, needle-leaved evergreen, broad-leaved deciduous, forested palustrine ecosystem	11.69
PFO4/SS1B	Saturated, broad-leaved deciduous scrub/shrub, needle-leaved evergreen forested, palustrine ecosystem	11.13
PFO4R	Seasonal tidal, needle-leaved evergreen, forested palustrine ecosystem	0.65
PFO4S	Temporary tidal, needle-leaved evergreen, forested palustrine ecosystem	0.39
PSS1/FO4B	Saturated, needle-leaved evergreen forested, broad-leaved deciduous scrub/shrub, palustrine ecosystem	2.76
PSS1/UBFh	Diked/impounded, semipermanent, unconsolidated bottom, broad-leaved deciduous scrub/shrub palustrine ecosystem	0.04
PSS1E	Seasonal saturated, broad-leaved deciduous, scrub/shrub, palustrine ecosystem	1.07
PSS1R	Seasonal tidal, broad-leaved deciduous, scrub/shrub, palustrine ecosystem	3.15
PUBHh	Diked/impounded, permanent, unconsolidated bottom, palustrine ecosystem	6.37
PUBHx	Excavated, permanent, unconsolidated bottom, palustrine ecosystem	0.55
Total		59.52

Table 4. Acres of Estuarine wetland systems within George Washington Birthplace National Monument (GEWA) mapped by the National Wetlands Inventory (reported by Sustainable Science, LLC 2006).

USFWS		Area (acres) within GEWA
Symbol	USFWS Wetland Classification	
1UBL	Subtidal, unconsolidated bottom, subtidal estuarine ecosystem	14.90
E1UBL6	Oligohaline, subtidal, unconsolidated bottom, subtidal estuarine ecosystem	0.28
E2EM1P	Irregular, persistent, emergent, intertidal estuarine ecosystem	15.75
E2EM1P6	Oligohaline, irregular, persistent, emergent, intertidal estuarine ecosystem	1.73
E2SS1P	Irregular, broad-leaved, deciduous, scrub/shrub, intertidal estuarine ecosystem	8.80
E2US2P	Irregular, unconsolidated shore, intertidal estuarine ecosystem	1.45
Total		42.91

Table 5. Currently mapped Palustrine wetland systems within George Washington Birthplace National Monument (GEWA) (reported by Sustainable Science, LLC 2006).

USFWS Symbol	Area (acres) within GEWA	USFWS Wetland Classification	Jurisdictional Wetland	Other USFWS Unvegetated or Non-soil Wetland	Other Waters of the United States
PEM1E	0.06	Seasonal saturated, persistent, emergent, palustrine ecosystem	Yes	No	No
PEM2B	0.38	Saturated, nonpersistent, emergent palustrine ecosystem	Yes	No	No
PEM6F	6.04	Semipermanent, broad-leaved persistent, emergent, palustrine ecosystem	Yes	No	No
PFO1/SS1J	4.49	Intermittently flooded, broad-leaved deciduous, scrub/shrub & broad-leaved deciduous forested, palustrine ecosystem	Yes	No	No
PFO1E	12.82	Seasonal saturated, broad-leaved deciduous, palustrine ecosystem	Yes	No	No
POWH	6.48	Permanent, open water, palustrine ecosystem	No	Yes	Yes
PSS1/EM2F	0.11	Semipermanent, nonpersistent, emergent & broad-leaved deciduous scrub/shrub palustrine ecosystem	Yes	No	No
Total	30.37				

Table 6. Currently mapped Estuarine wetland systems within George Washington Birthplace National Monument (GEWA) (reported by Sustainable Science, LLC 2006).

USFWS Symbol	Area (acres) within GEWA	USFWS Wetland Classification	Jurisdictional Wetland	Other USFWS Unvegetated or Non-soil Wetland	Other Waters of the United States
E1UB3N	9.03	Regular tidal, mud, unconsolidated bottom, riverine ecosystem	No	Yes	Yes
E1UB4N	1.17	Regular tidal, organic, unconsolidated bottom, riverine ecosystem	No	Yes	Yes
E2BB2N	7.66	Regular tidal, sand, beach/bar, intertidal estuarine ecosystem	No	Yes	No
E2EM5N	22.13	Regular tidal, narrow-leaved persistent, emergent intertidal estuarine ecosystem	Yes	No	No
E2FL3N	8.73	Regular tidal, mud flat, intertidal estuarine ecosystem	No	Yes	Yes
Total	48.71				

Table 7. Currently mapped Riverine systems within George Washington Birthplace National Monument (GEWA) (reported by Sustainable Science, LLC 2006).

USFWS Symbol	Area (acres) within GEWA	USFWS Wetland Classification	Jurisdictional Wetland	Other USFWS Unvegetated or Non-soil Wetland	Other Waters of the United States
R3SB2	0.22	Sand streambed, upper perennial riverine ecosystem	No	Yes	Yes
R4UB3	5.05	Mud unconsolidated bottom, intermittent riverine ecosystem	No	Yes	Yes
Total	5.27				

Results of the delineation by Sustainable Science, LLC (2006) are shown in Figures 7, 8, and 9. “When comparing the field mapped wetlands (hatched colors) with those shown on the NWI map (solid colors) in Figure 9 several differences are noted:

- Differences are apparent in the USFWS classifications between the NWI and the field mapped wetlands. Most of the classification differences relate to the water regime and plant structure modifiers.
- The PEM1A system in the western parcel and the PEM1B system in the eastern parcel were not observed during the field review.
- The wooded PFO systems identified during the field study were found to be smaller in area, more scattered and more irregular in shape than those mapped by NWI.
- The PSS systems were observed to form the floodplain areas and not extend up the slopes. In addition the eastern upgradient valley fork of Digwood Swamp was observed to be smaller than mapped by NWI.
- No Riverine types were mapped by NWI while the current study has identified two types within park boundaries, namely R3SB2 and R4UB3.

Table 8 provides a comparison of the park’s Estuarine, Palustrine, and Riverine ecosystems mapped by Sustainable Science, LLC and by the NWI. A review of Table 8 reveals that NWI mapped 18.08 acres more wetland than the Sustainable Science, LLC study. This result is mostly attributed to the difference between the forested and scrub/shrub Palustrine wetland areas noted in the two studies.

Loss of tidal marsh in the Popes Creek complex, over time, has been documented. In January 1995 the Virginia Institute of Marine Science (VIMS) prepared a report (Silberhorn 1995) that documented marsh area reduction, changes in configuration and plant community fluctuations. The data used for this determination included aerial imagery taken in 1985 and 1994 and field vegetation cover analysis using transects through the marsh complex. The VIMS study determined that 4.36 acres of marsh area were lost from 1985 to 1994 in the Popes Creek Marsh complex near the Potomac River inlet. Six small marsh islands comprising 0.39 acres were lost since 1985 with the largest island measuring 0.19 acres. In 1985, two other islands were 0.69 acres in total area, but in 1994 one was fragmented into two islands and the other reduced in size. Roughly half of the total area for these two islands was lost over the nine-year period. Beach overwash also contributed to some wetland loss (Silberhorn 1995). It is important to note that the VIMS study also included tidal marsh outside of the park’s boundaries.

The Sustainable Science, LLC study determined the historical extent of tidal marsh by delineating the apparent vegetated boundaries using 1937 georeferenced black & white aerial photography provided by NPS. The results were compared to the Sustainable Science, LLC field study to determine loss of vegetated marsh of the Popes Creek complex within the park boundaries. The current wetland mapping effort utilized ground truthed, higher resolution color infrared aerial photography. The regular tidal, narrow-leaved persistent, emergent intertidal estuarine ecological system (E2EM5N) represents the limits of vegetated tidal marsh.

The total area for the 1937 marsh was determined to be approximately 24 acres. Current tidal marsh area was measured at 9.5 acres. This difference amounts to nearly a 60% loss since 1937 of vegetated Popes Creek tidal marsh complex contained within the park boundaries.

Table 8. Comparison of the area of Estuarine, Palustrine, and Riverine wetland types mapped by Sustainable Science, LLC and the National Wetlands Inventory (NWI) within George Washington Birthplace National Monument (GEWA) (Sustainable Science, LLC 2006).

USFWS Wetland Type	Sustainable Science, LLC Wetland Study: Acres within GEWA	NWI Map: Acres within GEWA
Subtidal Estuarine (E1)	10.20	15.18
Intertidal Estuarine (E2)	38.52	27.73
Emergent Palustrine (PEM)	6.48	3.81
Emergent/Scrub/Shrub Palustrine (PEM/SS)	0.11	None
Scrub/Shrub Palustrine (PSS)	None	4.22
Scrub/Shrub/Unconsolidated Bottom Palustrine (PSS/UB)	None	0.04
Scrub/Shrub/Forested Palustrine (PFO/SS)	4.49	14.64
Forested Palustrine (PFO)	12.82	29.89
Open Water Palustrine (POW)	6.48	None
Unconsolidated Bottom Palustrine (PUB)	None	6.92
Upper Perennial Riverine (R3)	0.22	None
Intermittent Riverine (R4)	5.05	None
Total:	84.35	102.43

During the Sustainable Science, LLC study, the man-made ditches were located in the field using the 1936 George Washington Birthplace National Monument (“Wakefield”) Topographic Map, the 1937 aerial photograph, 2002 aerial photography (spring and fall), and sub-meter accurate Trimble GPS equipment. It appears that the main ditches were originally constructed along the property lines, typically as two parallel ditches. Side ditches were dug to drain wetter agricultural lands. All ditches located were classified as mud, unconsolidated bottom, intermittent riverine ecological system (R4UB3). Ditch flow direction is noted on Figure 7. Runoff flow from five ditches enters the park from the adjacent western agricultural fields. One ditch (north of the inflow ditches) flows from the park onto the adjacent parcel. Half of the northern agricultural field main ditch drains into the Potomac River over the bluff, causing erosion. Most of the remaining northern ditches flow into Digwood Swamp. The southern fields and wooded areas drain into the central forested area ditch network. Ditch maintenance in the wooded areas has not been performed for many decades. Trees and shrubs block the flow path creating linear disjointed riverine wetland features. It appears that blocked flow paths have caused the forested wetland features noted as PFO1E systems shown on Figures 7, 8, and 9 to enlarge over time. Flow through the forested ditches seems to be retained in the depressional forested wetland systems. The limited flow from the forested areas ultimately drains into Popes Creek.

Biotic Resources

Biotic communities include all flora and fauna. These communities are seldom sharply defined, especially when the landscape is transitional between two markedly different habitat types. At the Birthplace, the habitat ranges from tidal estuary to forested or cleared terrestrial upland.

Biotic communities and the species within them can be divided and categorized in varied ways, depending upon the systems of interest, the questions to be answered about their status, or the agencies and organizations asking the questions. Efforts to systematize nomenclature and frames of reference across agencies sometimes encounter obstacles and resistance. The results of different perspectives, varied approaches and entrenched ways of naming organisms and ecosystem components sometimes lead to confusion in assessing exactly what resources, be they creatures, plants or combinations that are viewed as systems, exist in the area of interest. The synthesis presented here will identify the range of information available using labels and names as published by various sources and leave decisions about preferred nomenclature or natural resource element labels to agency personnel who are responsible for the management of these resources.

The NPS Northeast Coastal and Barrier Network (NCBN) has identified ten significant ecosystem types within the park (Milstead et al. 2005). The question that should be raised here, however, is the omission of pine-dominated forest, which is the largest category of land cover besides open field, at the Birthplace. The ten ecosystem types identified by the NCBN are:

- Salt Marsh/Tidal Flats
- Coastal Grasslands
- Vernal Ponds
- Red Maple swamps
- Hardwood forests

- Riparian
- Beach
- Dunes
- Freshwater wetlands
- Estuaries

However, as a method of organizing the inventory and monitoring program for the eight park units which make up the NCBN, a broader, more general, classification system is used. This system recognizes five ecosystem types, all of which are found at the Birthplace (Stevens et al. 2005):

- Salt Marsh
- Estuary
- Beach
- Freshwater
- Upland

Following Fleming et al. (2006) the natural communities present at the park are:

- Coastal Plain Acidic Seepage Swamp
- Coastal Plain Dry Calcareous Forest
- Mesic Mixed Hardwood Forest
- Non-Riverine Saturated Forest
- Salt scrub
- Tidal Mesohaline and Polyhaline Marsh
- Tidal Oligohaline Marsh
- Upper Beaches and Overwash Flats

Descriptions of these communities can be found on “The Natural Communities of Virginia” website maintained by the VADCR (<http://www.dcr.virginia.gov/dnh/nctoc.htm>).

Flora

Information concerning the flora at the Birthplace has been accumulating for over 20 years. In 1985, Lam (1985) completed a vegetation inventory of the park as an unpublished report. That work was followed with an investigation by Dodge (2000). Abrams and Black (2000) used dendrochronological analysis to study one small area of the forest at the Birthplace. Later, exotic invasive vegetation was documented along with a strategic plan for management of these species (Åkerson and Moräwe 2000) (see discussion of flora in the “Threats and Vulnerabilities” section below). Vegetation types have been delineated to the formation level of the National Vegetation Classification System (USNVC) (Grossman et al 1998, NatureServe 2006). A map of vegetation alliances, discussed in more detail below, will be completed in 2007. In addition, various comments about plant communities and their status have been made in the context of studies about topics such as water quality and management recommendations by NPS staff. Level of detail, spatial relationships, and geographic extent differ in all of the studies used for this synthesis.

Figure 10 is a map of vegetation formations in the park and surrounding area and Table 9 shows the areal extent of vegetation formations in the undeveloped portions of the park (NCSU-CEO 2002b). Of the park's 550 acres, 292.5 acres (53%) support needle-leaved evergreen and mixed needle-leaved evergreen-deciduous forest. Only 15.0 acres (5%) of the 307.5 acres of forest and woodland at the park is classified as deciduous forest or woodland. Planted forest constitutes 43.6 acres (8% of park land but 14% of the forest). The remainder of the forest is naturally regenerated following either past land clearance and subsequent abandonment or harvest disturbance, both at varied historical points. The age of only a small portion of the forest is known (Abrams and Black 2000).

The VADCR-DNH is developing a map of vegetation alliances in the park based on vegetation photo signatures and extensive field reconnaissance. The map units will correspond to the USNVC. Final map products will be delivered to the NPS in 2007. A draft of this vegetation alliance map was obtained from VADCR-DNH and is presented in Figure 11 (VADCR-DNH, K. Patterson, Vegetation Ecologist, E-mail; FTP, April 2006). Acreages from this map are summarized in Table 10.

At the Birthplace the most influential period for forests spans the last two hundred years. Of course, not all the forests at the park have existed as forested sites that long, and they have all experienced varying degrees of disturbance during the period of influence.

The Abrams and Black (2000) study site focused on 5 ha of forested area at the Birthplace, or 4% of the forest. The study site was located between the mouth of Dancing Marsh and the Log House (see Figure 4) in an area since classified as Mixed Evergreen-Deciduous Forest formation and predominantly Loblolly Pine Forest alliance (George Washington Birthplace National Monument, R. Moräwe, Chief, Natural and Cultural Resources Management, phone conversation, February 2007). The very specific focus of the study presents interesting and illuminating information about the forest dynamics in that particular stand, but the study cannot be taken as representative of the entire forest. The forest site examined by Abrams and Black contains ten main tree species and is dominated by American holly (*Ilex opaca* Ait.), sweetgum (*Liquidambar styraciflua* L.), loblolly pine (*Pinus taeda*), southern red oak (*Quercus falcata* var *falcata* Michx.), and blackgum (*Nyssa sylvatica*). The stand is distinctly uneven-aged, and nearly all the trees established prior to 1900 are blackgum. This suggests selective cutting of more valuable trees in the late 1800s. Abrams and Black's results and conclusions concerning historic land cover contradict slightly the conclusions of OCULUS (1998). Abrams and Black conclude that forest succession began around 1810, as opposed to 1840 (OCULUS 1998) when the Washington family sold the property to John Gray.

The recruitment of fire sensitive species in the 19th century suggests that burning ceased at that time. Loblolly pine recruitment began in 1895, ending in 1935 and these trees are now over-mature. The resulting transition to later succession hardwood species will continue over next 50 years as the loblolly pines are reduced in number (Abrams and Black 2000).

Besides the forest, 24.8 acres of shrub land, 144.5 acres of grasslands, and 58.3 acres of tidal or flooded vegetation constitute natural areas of the Birthplace (see Table 11).

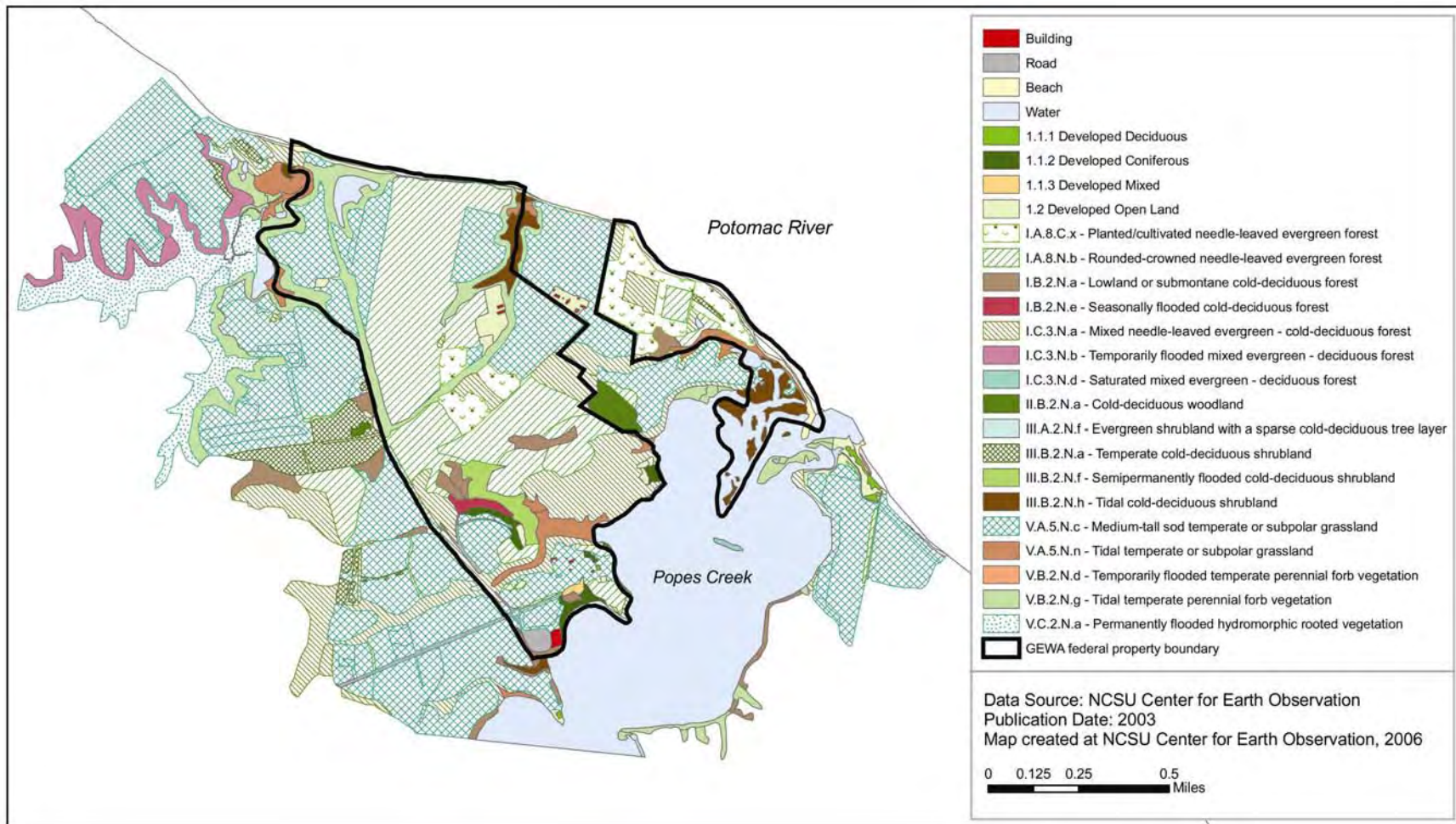


Figure 10. Vegetation formations in and around George Washington Birthplace National Monument.

Table 9. Vegetation formations of undeveloped areas at George Washington Birthplace National Monument (GEWA) mapped in 2003.

Vegetation Class Name (USNVC Classification Code)	Number of Acres within GEWA	Percent of Park
Needle-leaved evergreen (I.A.8.C.x & I.A.8.N.b)	220.9	40.2
Deciduous forest (I.B.2.N.a)	11.9	2.2
Seasonally flooded deciduous forest (I.B.2.N.e)	2.7	0.5
Mixed evergreen-deciduous forest (I.C.3.N.a)	71.6	13.0
Deciduous woodland (II.B.2.N.a)	0.4	0.1
Temperate deciduous shrubland (III.B.2.N.a)	0.8	0.2
Semi-permanently flooded deciduous shrubland (III.B.2.N.f)	9.5	1.7
Tidal deciduous shrubland (III.B.2.N.h)	14.5	2.6
Medium-tall grassland (V.A.5.N.c)	144.5	26.3
Tidal grassland (V.A.5.N.n)	16.6	3.0
Tidal perennial forb vegetation (V.B.2N.g)	41.6	7.6
Permanently flooded hydromorphic rooted vegetation (V.C.2.N.a)	0.1	0.02
Total	535.1	97.3

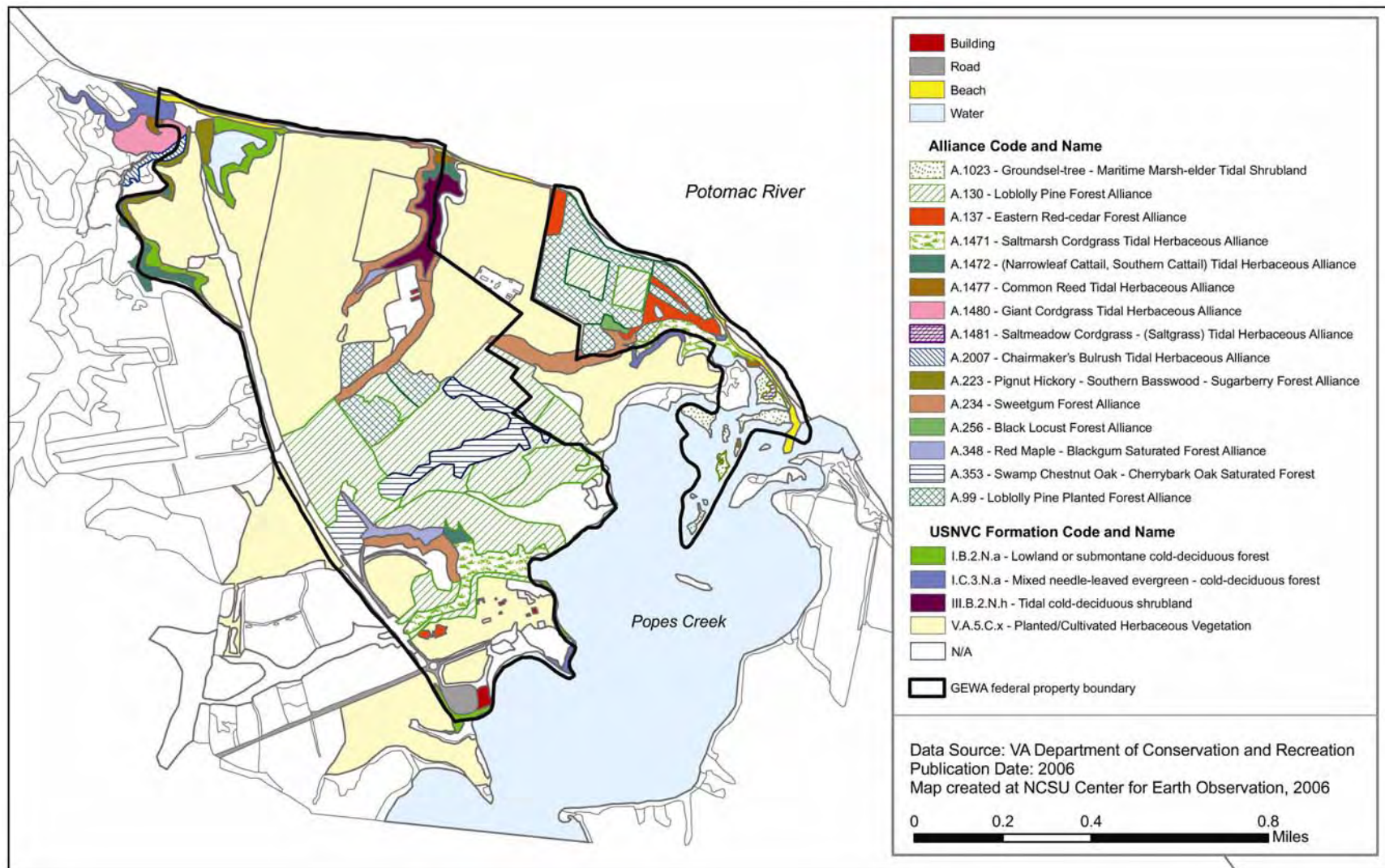


Figure 11. Vegetation alliances of George Washington Birthplace National Monument (draft).

Table 10. Vegetation alliances of George Washington Birthplace National Monument (GEWA) mapped in 2006 (draft).

Alliance Name (USNVC Classification Code)	Number of Acres within GEWA	Percent of park
Groundsel-tree - Maritime Marsh-elder Tidal Shrubland (A.1023)	6.9	1.3
Loblolly Pine Forest Alliance (A.130)	122.9	22.3
Eastern Red Cedar Forest Alliance (A.137)	7.4	1.3
Saltmarsh Cordgrass Tidal Herbaceous Alliance (A.1471)	14.7	2.7
(Narrowleaf Cattail, Southern Cattail) Tidal Herbaceous Alliance (A.1472)	6.6	1.2
Common Reed Tidal Herbaceous Alliance (A.1477)	1.8	0.3
Giant Cordgrass Tidal Herbaceous Alliance (A.1480)	5.9	1.1
Saltmeadow Cordgrass - (Saltgrass) Tidal Herbaceous Alliance (A.1481)	0.5	0.1
Chairmaker's Bulrush Tidal Herbaceous Alliance (A.2007)	2.2	0.4
Pignut Hickory - Southern Basswood - Sugarberry Forest Alliance (A.223)	4.8	0.9
Sweetgum Forest Alliance (A.234)	24.0	4.4
Black Locust Forest Alliance (A.256)	0.9	0.2
Red Maple - Blackgum Saturated Forest Alliance (A.348)	3.9	0.7
Swamp Chestnut Oak - Cherrybark Oak Saturated Forest (A.353)	18.0	3.3
Loblolly Pine Planted Forest Alliance (A.99)	43.4	7.9
Total	263.9	47.98

Table 11. Summary of habitat types at George Washington Birthplace National Monument (GEWA).

Habitat Type	Number of Acres within GEWA	Percentage of Park
Forest and Woodland	303.5	51
Shrubland	24.8	4
Grassland	144.5	25
Tidal or flooded vegetation	58.3	10

Between 1974 and 1994, three reports by the Virginia Institute of Marine Science (VIMS) documented and quantified vegetation and the changes occurring over time. As part of a Westmoreland County tidal marsh inventory survey, the percentage and acreage of freshwater and brackish-water wetlands were categorized and estimated by vegetation type (Mercer 1978). In a follow-up report, completed by a VIMS student as a Master's Thesis, Wilcox (1989) documented a decrease in the acreage of marsh within the Popes Creek complex, and an overall shift in wetland vegetation dominated by saltbush (*Iva frutescens*) to one dominated by grasses, such as *Spartina cynosuroides*, *S. alterniflora*, and *S. patens*. The percentage of saltbush reportedly decreased from 90 percent to 53 percent over that time period. Wilcox's study, using Cesium-137 as a tracer, also estimated an average accretion rate of 6.8 mm/yr. This rate is well above the estimate for relative sea level rise of approximately 2.6 mm/yr (Davis 1987 as cited in Wilcox 1989). Wilcox's analysis did not find a strong relation between relative elevation and species distribution. It did estimate a 50 percent loss of marsh acreage within Popes Creek between 1937 and 1985 by using changes documented in aerial photography. Suggested reasons for this loss included: the selective loss of areas dominated by saltbush, possibly due to different erosion rates and (or) root structures between plant types; tidal and wave effects on the morphology of marshes; the abundance of parasite plants; and plant community age structure (Belval et al. 1997). It has also been suggested that the Popes Creek system has become sediment starved since the formation of the park and the resulting decrease in farming activity (George Washington Birthplace National Monument, R. Moräwe, Chief, Natural and Cultural Resources Management, pers. comm., 2006 and Sustainable Science, LLC 2006). Historical farming practices in the area likely contributed large amounts of sediment to the Popes Creek system, which expanded tidal marsh areas. Improved and decreased farming activity reduced sediment amounts resulting in loss of marsh area over time. It is possible that marsh loss has been further exaggerated by relative sea level rise caused by isostatic rebound and depression of the Chesapeake Bay impact crater (George Washington Birthplace National Monument, R. Moräwe, Chief, Natural and Cultural Resources Management, pers. comm., 2006). (Information regarding the Chesapeake Bay impact crater is available at <http://woodshole.er.usgs.gov/epubs/bolide/>.)

Silberhorn and Shields (1995) updated some of the information from Wilcox's report and analyzed aerial photographs from 1936 to 1994 for changes in the Popes Creek marsh complex. They found further loss in marsh vegetation, due in part to the loss of several small islands, beach overwash, and sand deposition in marshes. Reinforcement of the Potomac River shoreline between 1985 and 1990, via groins and bulkheads, may have caused the observed widening of water channels in Longwood Swamp due to lost longshore sand movement. Silberhorn and Shields (1995) estimated that saltbush dominated or co-dominated 79 percent of the marsh system in 1994, an increase from the 53 percent reported in Wilcox's study.

Little information is available regarding grasslands and their management within the park. Examination of the plant species listed in NPSpecies (Appendix C) could provide insight about herbaceous species in these open fields.

A historic interpretive area of approximately 30 acres is managed to support boxwoods (*Buxus sempervirens*), fig (*figus* spp.) and rose (*rosa* spp.) bushes, hackberry (*Celtis* spp.) trees, ornamental and fruit trees, and red cedar (*Juniperus virginiana*), which are considered representative of the period that George Washington resided at what is now the park. A

hackberry tree and red cedar in the park date back 200 years and over 100 years, respectively (Ellsworth 2003). Considerable attention has been given to ornamentals and planted specimens within the interpretive landscape, with detailed plans for the maintenance of each species and timetables for overall actions. As these matters are not typically considered part of natural resource investigations, but rather horticultural efforts, this report includes that material by reference (Bellavia 1996) but does not review the material nor offer further consideration of its adequacy, issues, or make recommendations.

At the species level, two primary inventories exist for the park. The list Lam (1985) compiled includes 387 species of plants in 93 families. Beyond the names of the species encountered, we know little about the method of study and nothing about the locations of the plants indicated. Dodge (2000) also inventoried plants at the park as part of a larger study of the surrounding region. He submitted a list specific to the park that included 307 species. These two lists can be compared relatively easily because they used the same organizational scheme: genera and species grouped alphabetically by family. A comparison reveals that Lam includes 167 species that Dodge does not, and Dodge identified 83 species that Lam did not. Two hundred twenty-four of the same species were listed by both authors, though some of these are listed by different names that had to be reconciled. Reasons for the differences in the lists can only be speculative, though the 15 year interval between the studies may have resulted in many changes. However, any valid conclusions about the differences between the inventories would require a knowledgeable person's analysis of the species involved and the habitat conditions that might have changed over the intervening period.

The biggest difficulty with these inventories, however complete they might be, is that neither one gives more than fragmentary information about the locations of the plant species identified. Dodge (2000) does indicate where each species was first encountered, and provides information about relative abundance and whether it is native or introduced. However, the inventory does not group species in habitat or site types; nor does it characterize communities of plants. No cross reference between the species list and the vegetation maps (Figures 10 and 11) exists. Thus, it is not possible to determine where particular species might be encountered or impacted by planned changes to park areas.

Fauna

The Virginia Fish and Wildlife Information Service (VFWIS), a database of wildlife information that is updated monthly by the Virginia Department of Game and Inland Fisheries (VADGIF), was used to determine the species "known or likely to occur" within 3 miles of the Birthplace. The databases used by the VFWIS include Anadromous Fish Use Areas, Biota of Virginia, Breeding Bird Atlas, Breeding Bird Survey, Christmas Bird Count, Coldwater Stream Survey, Collections, and the Colonial Waterbird Database. VFWIS lists 198 species of birds, 42 species of mammals, 34 species of fish, 26 species of amphibians, 34 species of reptiles, 36 species of terrestrial insects, 5 tick species, 6 species of aquatic crustaceans, and 1 aquatic mollusk species in the area of the park (VADGIF 2006). It is important to emphasize that many of the species in this list are probable, not confirmed, in the general area of the park. It should also be noted, especially in the case of bird species, that the VFWIS list does not distinguish between species that may breed in the area and those that do not.

The federally listed (Threatened) bald eagle (*Haliaeetus leucocephalus*) and the state listed (Threatened) upland sandpiper (*Bartramia longicauda*) are both on the VFWIS list. The bald eagle has been identified nesting along Popes Creek, but there are no records of the upland sandpiper within the park.

Species that have been confirmed within the park include 14 amphibian and 19 reptile species (Appendix D), 51 Lepidoptera and 37 Odonata species (Appendixes E and F), 175 bird species (Appendix G), 17 mammal species (Appendix I), and four fish species (Appendix J). Twenty-four state or federal Species of Concern (not a legal status) are also on the VAFWIS lists (Table 12), 13 of which are documented in NPSpecies (2006). The exotic gypsy moth (*Lymantria dispar*) has been documented in the park (NPS 2000).

Amphibians and Reptiles: The most recent study of reptiles and amphibians was conducted between February 2001 and October 2002 and from March to August in 2003 (Mitchell 2005). Other than the Mitchell (2005) study, the only published literature on amphibians and reptiles found at the Birthplace is Eckerlin (1991). A comparison of these two studies is presented in Table 13.

The Eckerlin (1991) survey was conducted between March 1986 and April 1989. This survey primarily utilized intensive ground searches by daylight and, to a lesser extent, driving along roadways after dark, dipnetting of vernal ponds in the spring, and voice recognition of calls at night. Altogether, 30 species of reptiles and amphibians were identified in this survey.

The most commonly encountered amphibians in the Eckerlin (1991) study were the bullfrog, green frog, and southern leopard frog. Nine of the 12 amphibian species found in this study were frogs and toads. Salamanders were rarely encountered and only 3 of 12 expected species were found. The most commonly observed reptile species were the common snapping turtle, eastern box turtle, red-bellied turtle, eastern painted turtle, and the black rat snake. In total, 18 reptile species were found including six species of turtles, five species of lizards, and seven species of snakes.

The Mitchell inventory was hindered by the climatic conditions for 2002 in which precipitation was below the 30-year average for all months except April 2002. These conditions likely influenced the encounter probability and capture success. Water tables were not replenished and surface wetlands were not filled, which left many breeding sites unavailable to amphibians and reptiles in 2002 (Mitchell 2005). A map of the observation and capture locations from this survey is displayed in Figure 12.

Notwithstanding the climatic conditions, the species encountered during the Mitchell (2005) survey represent a robust list for all groups of amphibians and reptiles.

No state or federally listed species were found during this inventory. However, one fresh nest of the northern diamondback terrapin (*Malaclemys terrapin*) was found on a Potomac River beach (Mitchell 2005). This species is listed as a Federal Species of Concern due to recent population declines (VADGIF 2006).

Table 12. Species of concern that are known or likely to occur in the area of George Washington Birthplace National Monument (VADGIF 2006).

<i>Scientific Name</i>	Common Name	Status*	Documented in Park**
<i>Haliaeetus leucocephalus</i>	Bald eagle	FT ST	X
<i>Malaclemys terrapin terrapin</i>	Northern diamondback terrapin	FS	X
<i>Laterallus jamaicensis</i>	Black rail	FS	
<i>Acipenser oxyrhynchus</i>	Atlantic sturgeon	FS SS	
<i>Dendroica cerulea</i>	Cerulean warbler	FS	
<i>Bartramia longicauda</i>	Upland sandpiper	FT	
<i>Gallinula chloropus cachinnans</i>	Common moorhen	SS	
<i>Egretta caerulea caerulea</i>	Little blue heron	SS	
<i>Casmerodius albus</i>	Great egret	SS	X
<i>Egretta tricolor</i>	Tricolored heron	SS	
<i>Circus cyaneus</i>	Northern harrier	SS	X
<i>Nyctanassa violacea violacea</i>	Yellow-crowned night-heron	SS	
<i>Tyto alba pratincola</i>	Barn owl	SS	
<i>Sterna forsteri</i>	Forster's tern	SS	X
<i>Sterna antillarum</i>	Least tern	SS	
<i>Sterna caspia</i>	Caspian tern	SS	X
<i>Sitta canadensis</i>	Red-breasted nuthatch	SS	X
<i>Certhia americana</i>	Brown creeper	SS	X
<i>Cistothorus platensis</i>	Sedge wren	SS	
<i>Regulus satrapa</i>	Golden-crowned kinglet	SS	X
<i>Troglodytes troglodytes</i>	Winter wren	SS	X
<i>Catharus guttatus</i>	Hermit thrush	SS	X
<i>Dendroica magnolia</i>	Magnolia warbler	SS	X
<i>Lontra canadensis lataxina</i>	Northern river otter	SS	X
<i>Spiza americana</i>	Dickcissel	SS	
<i>Carpodacus purpureus</i>	Purple finch	SS	X

*FT=Federal Threatened, FS=Federal Species of Concern (not a legal status), ST=State Threatened, SS=State Species of Concern (not a legal status)

**X=Found in park (NPSpecies 2006)

Table 13. Comparison of expected reptile and amphibian species (Mitchell 2005), and species found by Eckerlin (1991) in 1986-1989 and by Mitchell (2005) in 2001-2003 in George Washington Birthplace National Monument.

	Number of Species Expected (Mitchell 2005)	Species Found by Eckerlin (1991)	Species Found by Mitchell (2005)	Species Found in Combined Inventories
Frogs	11	9	8	9
Salamanders	11	3	4	5
Turtles	7	6	7	7
Lizards	6	5	3	5
Snakes	15	7	6	10

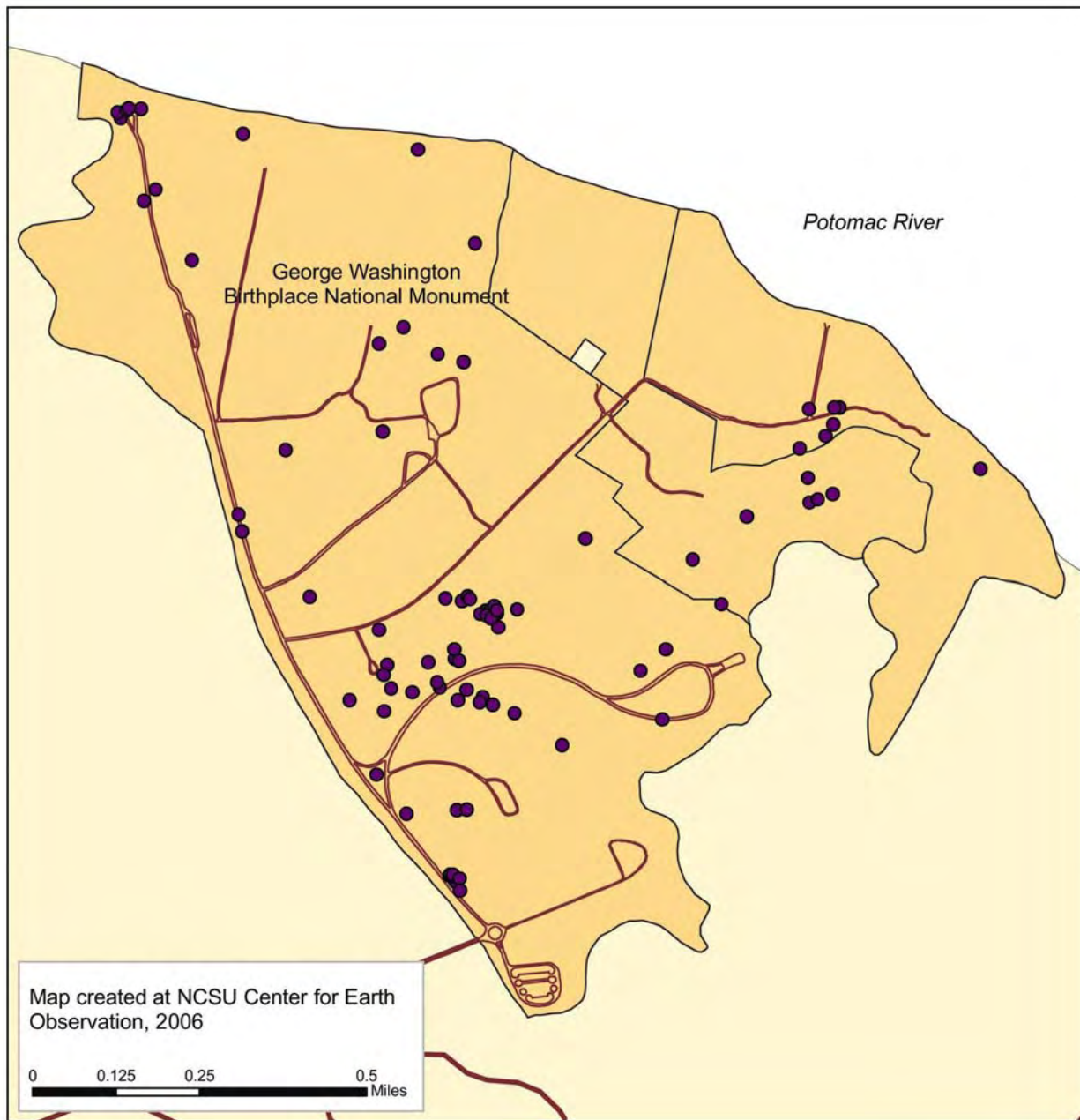


Figure 12. Reptile and amphibian observation and capture locations for 2001-2003 in George Washington Birthplace National Monument (Mitchell 2005).

Lepidoptera and Odonata: Surveys of Lepidoptera (butterfly and skipper only) and Odonata (dragonfly and damselfly) were conducted by VADCR-DNH during May-July of 2003 and April-September of 2004. To the best of the survey team's knowledge, no previously documented survey of Lepidoptera or Odonata for the park exists. All surveys were conducted during daylight hours and most were completed under excellent weather conditions (Chazal 2005). The results of this survey are summarized in Table 14 and a map of the observation and capture locations is shown in Figure 13.

Lepidoptera: Chazal (2005) reports the survey of Lepidoptera (butterfly and skipper only) identified 51 species within the park (Appendix E). This accounts for 76% (51 of 67) of the species Chazal determined were likely to occur in the Birthplace. The species accumulation curve for this inventory does not level off, indicating the potential for observing additional Lepidoptera species in the future. Before this survey, 38 Lepidoptera species were known from Westmoreland County and an additional 18 species had been documented in adjacent counties. This survey added 24 species to the county record.

Field habitat had the highest diversity with 37 Lepidoptera species and the highest total numbers observed (n=1763). The marsh habitats had the lowest diversity with 19 species, but the second highest total numbers. The forested habitats had the second lowest diversity and lowest total numbers (Chazal 2005).

There are no previously known records of rare, threatened, or endangered (RTE) Lepidoptera species in the park, Westmoreland County, or in the surrounding counties and none are tracked by the VADCR-DNH as RTE. However, the Aaron's Skipper (*Poanes aaroni*) is currently on the VADCR-DNH watchlist and one individual of this species was captured on June 5, 2003 in the Longwood Swamp area along the beach and salt scrub line. NatureServe (2005) ranks it as a G4 species, meaning it is common and apparently secure across its range and that conservation measures are not normally needed (Chazal 2005).

Odonata: The Odonata species survey identified 37 species of dragonflies and damselflies in the park (Appendix F). This amounts to 82% (37 of 45) of the species Chazal determined were likely to occur in the park. The last new species was identified on survey day 8 of the 13 survey days. After this date, the species accumulation curve levels off, indicating a low potential for additional Odonata species at the park. Prior to this study, 17 Odonata species had been documented in Westmoreland County. An additional 39 species had been documented in adjacent counties. This survey added 23 species to the county record.

The marsh habitat had the highest species diversity with 28 Odonata species observed. The forest habitat had the lowest species diversity with only 10 species observed (Chazal 2005).

There are no previously known records of RTE Odonata species in the park. There are records of tracked species in adjacent counties, but it is unlikely that any of these species would occur in the park because of the lack of appropriate habitat (Chazal 2005).

Table 14. Numbers of Lepidoptera and Odonata species found in 2003-2004 in George Washington Birthplace National Monument and the number of additional species that possibly or likely occur at the park (Chazal 2005).

Order	Species Found in 2003-2004	New County Records Found in 2003-2004	Possible Additional Species	Likely Additional Species
Lepidoptera	51	24	23	16
Odonata	37	23	22	8

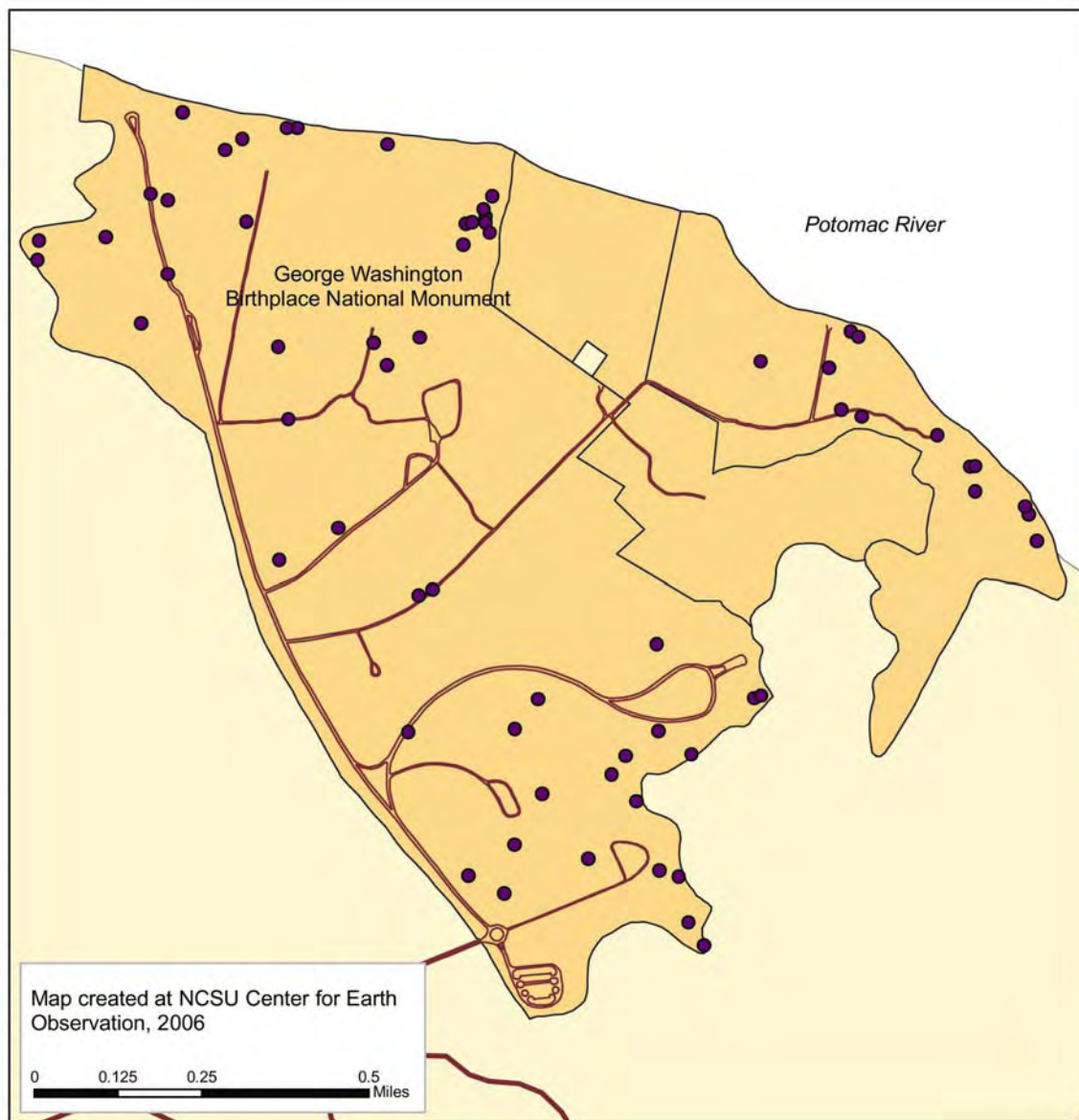


Figure 13. Lepidoptera and Odonata observation and capture locations for 2003-2004 in George Washington Birthplace National Monument (Chazal 2005).

Birds: A list of avian species documented at the park in the NPSpecies database is presented in Appendix H (NPS 2006). Dana Bradshaw at the College of William and Mary carried out an inventory of bird species in the park in 2003-2004. The final report for this inventory is not currently available (December 2006), however, a species list from the inventory is provided in Appendix I (Bradshaw In prep.). Neither of these lists distinguishes between breeding and non-breeding records. At this point, the existence of the bald eagle on both lists should be noted and the implications of this are discussed further in the “Federally Listed Threatened and Endangered Species” section below.

Mammals: Frostburg State University scientists conducted the most recent mammal survey (excluding bats) at the Birthplace between 2002 and 2003. The goal of this survey was to “confirm the existence of currently listed species and generate new records for species not detected in the park previously” (Barry and Dolbeare 2006). Painter and Eckerlin (1993) completed the only other mammal survey of the park. A comparison of the results from these studies is presented in Table 15.

Barry and Dolbeare (2006) utilized Sherman and Tomahawk live-traps for small mammals and medium-sized carnivores and pitfall trap arrays for shrews. Direct observation and remote cameras were also used to document individuals and sign. Sampling was conducted in grassland, mixed deciduous-coniferous forest, pine plantation, logged areas, and wetland habitat types.

Barry and Dolbeare (2006) documented 75% (15 of 22) of the mammal species previously known for the park. This survey also added seven new species to the park records for a documented total of 29 species. The seven new species added to the park records were the least shrew (*Cryptotis parva*), southeastern shrew (*Sorex longirostris*), eastern harvest mouse (*Reithrodontomys humulis*), domestic dog (*Canis familiaris*), red fox (*Vulpes vulpes*), river otter (*Lontra canadensis*), and long-tailed weasel (*Mustela frenata*). No threatened or endangered mammals have been documented at the park.

The most abundantly sampled species in this study was the white-footed mouse (*Peromyscus leucopus*) which was found in all five sampled habitats. Grasslands produced the highest species richness (5 species in 1002 trap nights) while logged areas had the least (3 species in 3,172 trap nights). White-tailed deer (*Odocoileus virginianus*) were frequently observed in the park in open fields near forest and within the pine plantation. Barry and Dolbeare (2006) state that the abundance of white-tailed deer within the park is likely due to the diversity of habitats that satisfy the concealment cover, thermal cover, and foraging needs of this species. Virginia opossums (*Didelphis virginiana*) and raccoons (*Procyon lotor*) were widely distributed within the park, occurring in all of the habitats sampled.

Barry and Dolbeare (2006) were unable to confirm the presence of the house mouse (*Mus musculus*), woodland vole (*Microtus pinetorum*), muskrat (*Ondatra zibethicus*), rat (*Rattus norvegicus*), and mink (*Mustela vison*), all of which were observed in the survey by Painter and Eckerlin (1993). Painter and Eckerlin (1993) also documented two bat species, the big brown bat (*Eptesicus fuscus*) and the silver-haired bat (*Lasionycteris noctivagans*).

Table 15. Mammals documented in George Washington Birthplace National Monument by Barry and Dolbeare (2006) and Painter and Eckerlin (1993).

<i>Scientific name</i>	Common name	Painter and Eckerlin (1993) ^a	Barry and Dolbeare (2006) ^a
<i>Odocoileus virginianus</i>	White-tailed Deer	F	F
<i>Canis familiaris</i>	Domestic Dog	N	X
<i>Urocyon cinereoargenteus</i>	Gray Fox	F	F
<i>Vulpes vulpes</i>	Red Fox	N	X
<i>Mephitis mephitis</i>	Striped Skunk	F	F
<i>Mustela vision</i>	Mink	F	N
<i>Procyon lotor</i>	Raccoon	F	F
<i>Eptesicus fuscus</i>	Big Brown Bat	F	NS
<i>Lasionycteris noctiyagans</i>	Silver-haired Bat	F	NS
<i>Didelphis virginiana</i>	Virginia Opossum	F	F
<i>Blarina brevicauda</i>	Northern Short-tailed Shrew	F	F
<i>Cryptotis parva</i>	Least Shrew	N	X
<i>Sorex longirostris</i>	Southeastern Shrew	N	X
<i>Scalopus aquaticus</i>	Eastern Mole	F	F
<i>Sylvilagus floridanus</i>	Eastern Cottontail	F	F
<i>Castor canadensis</i>	Beaver	F	F
<i>Microtus pennsylvanicus</i>	Meadow Vole	F	F
<i>Microtus pinetorum</i>	Pine Vole	F	N
<i>Mus musculus</i>	House Mouse	F	N
<i>Ondatra zibethicus</i>	Muskrat	F	N
<i>Oryzomys palustris</i>	Marsh Rice Rat	F	F
<i>Peromyscus leucopus</i>	White-footed Mouse	F	F
<i>Reithrodontomys humulis</i>	Eastern Harvest Mouse	N	X
<i>Rattus norvegicus</i>	Norway Rat	F	N
<i>Glaucomys volans</i>	Southern Flying Squirrel	F	F
<i>Marmota monax</i>	Woodchuck	F	F
<i>Sciurus carolinensis</i>	Gray Squirrel	F	F
<i>Lontra canadensis</i>	River Otter	N	X
<i>Mustela frenata</i>	Long-tailed Weasel	N	X

^aF=Found, N=Not found, X=New park record , NS=Not surveyed for

Aquatic Species: The park includes a diverse array of water-related resources: freshwater ponds, creeks, a number of springs, and extensive areas of tidal marshes and freshwater wetlands (Belval et al. 1997). In 2003 and 2004, the NPS and the U.S. Fish and Wildlife Service (USFWS) conducted an inventory of fish species within the park. Sampling methods included the use of fyke nets, trawls, seines, and angling gear (Atkinson 2005).

The lower section of Popes Creek was sampled extensively during late May and late August of 2004. Large numbers of fish were captured with fyke nets and hoop traps. Seine net hauls and angling also proved effective and provided contrasting results. Both the total number of species and the total number of individual fish captured were slightly higher during the May visit than the August visit. A total of 1,358 fish representing 24 species were recorded in May and 1,170 fish representing 18 species were captured during August. A combined total of 3,140 individual fish representing 30 species were captured. Four species were recorded from freshwater habitats within the park during 2003 that were not found in 2004. The total species count from these sampling efforts at the park is 34.

During 2004, white perch was the dominant fish species taken from the fyke net/hoop trap arrays and is the most dominant large fish species within the park's estuarine habitats. Large numbers of inland silversides (*Menidia beryllina*), Atlantic silversides (*Menidia menidia*) and mummichog (*Fundulus heteroclitus*) were taken from seine hauls around the delta islands in lower Popes Creek and around the bar habitat at the mouth of the creek. Angling yielded much larger numbers of striped bass (*Morone saxatilis*) and all of the channel catfish (*Ictalurus punctatus*) and bluefish (*Pomatomus saltatrix*) detected during the survey. The single white catfish (*Ameiurus catus*) recorded was also the result of angling. Three American eels (*Anguilla rostrata*) were captured along the edge of the main channel in lower Popes Creek.

All of the large catfish captured (some individuals approached 30 inches in length and nearly 10 pounds in weight), were channel catfish. Blue catfish (*Ictalurus furcatus*) are reputed to exist within the Potomac River, but none were captured.

Fish species captured during May but not in August included Atlantic menhaden (*Brevoortia tyrannus*), common carp (*Cyprinus carpio*), sheepshead minnow (*Cyprinodon variegatus*), naked goby (*Gobiosoma bosc*), and northern pipefish (*Syngnathus fuscus*). Menhaden and carp were captured in fyke nets and sheepshead minnows, naked goby and northern pipefish were captured in seine hauls. Conversely, fish species captured in August but not in May included Alewife (*Alosa pseudoharengus*), Atlantic needlefish (*Strongylura marina*), and bluefish.

All of the bay anchovies (*Anchoa mitchilli*) captured were taken with the otter trawl from channel habitats within Popes Creek. Sampling efforts within Bridge's Creek yielded the only black crappie (*Pomoxis nigromaculatus*) and eastern mosquitofish (*Gambusia holbrooki*) captured within the park (Atkinson 2005).

While there are currently no federal or state listed endangered or threatened species within the park there is some current concern about the status of American eel populations, which have been declining in the eastern United States (Atkinson 2005).

Little information exists regarding shellfish populations in the vicinity of the park. However, there is great concern throughout the Chesapeake Bay regarding low abundance levels of both blue crabs (*Callinectes sapidus*) and American oysters (*Crassostrea virginica*) (Chesapeake Bay Stock Assessment Committee 2005; Chesapeake Bay Program 2006). It is likely that populations in the vicinity of the park are at similarly low levels.

Rare and Protected Species

Rare and protected species are identified and categorized at both federal and state levels, with responsibility for protection and monitoring being shared by the U.S. Fish and Wildlife Service (USFWS) and the Natural Heritage Program of each state. The Natural Heritage Program in each state typically conducts inventories and maintains databases of element occurrences and population levels within the state. In addition to tracking rare and protected species, the Natural Heritage Program will also note rare plant communities.

Federally Listed Threatened and Endangered Species

The overwhelming majority of species federally listed as Threatened or Endangered in Virginia have never occurred near the Birthplace and would not find suitable habitat in the area. The bald eagle (*Haliaeetus leucocephalus*) has been observed at the Birthplace and will definitely need to be considered in planning efforts.

Two other federally listed species are discussed here because potential habitat exists at the Birthplace. Wherever suitable habitat exists, potential exists for the species to occur, so the USFWS typically requires formal consultation and habitat searches in order to arrive at a Biological Conclusion concerning the species' status and potential impacts from proposed actions. NPS staff will need to determine whether further investigation into the status of each of these species is needed during planning and environmental assessment processes.

Bald eagle (*Haliaeetus leucocephalus*); Listed as Threatened/Proposed for Delisting

Bald eagle nests have been documented within Birthplace boundaries. Furthermore, eagles have been documented along Bridges Creek. Jeffrey Cooper, Non-game Bird Coordinator with the Virginia Department of Game and Inland Fisheries, notes that this area is regarded as an "eagle concentration area" in winter. Moreover breeding activity has been monitored and nest site locations have been identified.

Typically bald eagles may be observed roosting in trees along the river while awaiting signs of their usual prey, which are usually fish feeding near the water surface. Bald eagles are wary of humans approaching roost sites on foot but do not appear to be affected by vehicular traffic in most locations. Boats, when they interfere with fish foraging activity, are known to be problematic.

Bald eagles require large, open crowned trees for roosting and nesting, mainly because their large wingspans demand a fairly spacious glide path to and away from the roost. Nesting pairs protect a fairly large area around their nest trees from encroachment by other predatory bird species.

Plans for accommodating habitat needs of bald eagles' roosting within and near the park should be specifically developed. Given the size of the park, much increase in the resident population number may not be likely; however, specific timber management practices in mature pine stands have been shown to create roosting habitat and lead to increases in eagle activity.

Northeastern beach tiger beetle (*Cicindela dorsalis dorsalis*); Listed as Threatened

The Recovery Plan for the northeastern beach tiger beetle (USFWS 1994) indicates that populations of the beetle occupy a number of shoreline sites along the lower Potomac and Chesapeake Bay in Virginia and Maryland. The Recovery Plan states that 55 sites in Virginia and 13 in Maryland have been identified, some with large populations, and suggests that further searches are warranted. The beetle's habitat is sand/dune and the beetle's special habit is burrowing in or using soil. The species' habitat occurs from about the fore-dune to the high tide line on ocean and bay beaches only. These facts suggest that beetles could occur at the Birthplace.

The northeastern beach tiger beetle is a whitish tiger beetle with variable dark maculation found only along salt water beaches. Larvae live in burrows in the sand. Adults actively hunt, but larvae sit and wait for passing prey. Adults are most active in July while immature beetles are present all year. Tiger beetle larvae seal off their burrow and hibernate in early fall. The life cycle takes two or three years. The species is not migratory, but some dispersal and colonization potential exists. According to Knisley and Schultz (1997) marked adults sometimes moved 10-15 miles.

Native populations of the northeastern beach tiger beetle apparently survive only on Martha's Vineyard, and in about 40 scattered places on Chesapeake Bay functioning as two or more meta-populations. Watersheds where the beetle has been found are listed as the following: Lower Potomac, Lower Chesapeake Bay, Great Wicomico-Piankatank, Lower Rappahannock, Lynnhaven-Poquoson, and Western Lower Delmarva. Chesapeake Bay was apparently a disjunct occurrence. The main historic range was from coastal Massachusetts to about northern Cape May County in New Jersey. Apparently the beetle was replaced from extreme southern New Jersey to coastal Texas by other subspecies.

No information has been encountered to suggest whether the Northeastern tiger beetle has ever been observed at the Birthplace, whether searches for the species have ever been conducted, or whether the park's beach habitat is considered suitable. Thus, the status of this species at the Birthplace will have to be addressed through further study during the General Management Plan process.

American burying beetle (*Nicrophorus americanus*); Listed as Endangered

All of the habitat types in which the American burying beetle has been found, except for chaparral, occur at the Birthplace. The species exhibits broad vegetation tolerances, though natural habitat may be mature forests. It is recorded from grassland, old field shrub land, and hardwood forests. Plant species include bayberry (*Myrica*), shadbush (*Amelanchier*), goldenrod (*Solidago*), and various non-native plants. Vegetation communities in which

Nicophorus americanus occurs range from large mowed and grazed fields to dense shrub thickets.

Soil characteristics are also important to the beetle's ability to bury carrion. Extremely dry, saturated, or loose sandy soils are unsuitable for these activities. Historic collections were made when forests had been cleared and the land was largely agricultural. Habitats associated with these collections were not clearly described.

Adults live primarily above ground. Eggs are laid in soil adjacent to a buried carcass. Adults bury vertebrate carcasses weighing between 80 and 100 grams which larvae then feed on. Adults are capable of burying carrion weighing up to 206 grams (Kozol, 1990; Kozol et al, 1988). Food resources depend upon carrion availability in a particular area. Beetles have been known to feed on carrion resources ranging from Ring-necked Pheasant chicks and American Woodcock to mammals such as the Hispid Cotton Rat. Elsewhere in their historic range, beetles were known to consume fish used as fertilizer in fields. Adults feed regurgitated carrion to larvae until larvae are capable of feeding directly from the carcass. Adults are classified as opportunistic scavengers, feeding on anything dead, but also catch and kill other insects (Raithel 1991).

It is unclear whether the species has ever been observed at the park or whether searches for the species have ever been conducted. Thus, the status of this species at the park will have to be addressed in the planning and impact assessment process.

Federal Species of Concern and State Listed Species

The USFWS and VADGIF together track species that are not formally listed as Endangered or Threatened but whose status bears close attention. Cross-checking the species inventories for the park reveals that 14 such species have been found at the Birthplace (Table 12). On this list, only the northern diamondback terrapin is listed as a Federal Species of Concern. The federally listed bald eagle has been discussed in the preceding section, "Federally Listed Threatened and Endangered Species."

Rare Plant Communities

Global and State Conservation Ranks are used by The Nature Conservancy, NatureServe, and the Virginia Natural Heritage Program to rank the conservation status of vegetation types found in Virginia. These rankings are defined in Tables 16 and 17. A question mark added to a rank expresses an uncertainty about the rank in the range of one either way on the 1-5 scale. For example, a rank of G2? indicates the rank is thought to be G2, but could be a G1 or G3.

In 2002, VADCR-DNH identified two globally rare vegetation communities at the Birthplace (Virginia Department of Conservation and Recreation, Division of Natural Heritage, K. Patterson, Vegetation Ecologist, E-mail; FTP, April 2006). They are the Coastal Plain Dry Calcareous Forest/Woodland and the Non-Riverine Wet Hardwood Forest. These rare communities have been mapped so they can be managed as sensitive eco-systems (Figure 14).

Table 16. Global conservation ranks.

Global Rank	Definition
G1	Critically imperiled throughout range.
G2	Imperiled throughout range.
G3	Rare or uncommon.
G4	Widespread, abundant, and apparently secure, but with cause for long-term concern.
G5	Demonstrably widespread, abundant, and secure.
GNR	Unranked; conservation status has not yet been assessed.
GNA	Not applicable because the community is not a suitable conservation target; usually assigned to ruderal, modified/disturbed, or managed vegetation.

Table 17. State conservation ranks.

State Rank	Definition
S1	Extremely rare, generally with five or fewer occurrences state-wide, and/or covering <50 ha (125 ac) in aggregate; or covering a larger aggregate area but highly threatened with destruction or modification.
S2	Very rare, generally with six to 20 occurrences state-wide, and or covering <250 ha (600 ac) in aggregate; or covering a larger aggregate area but threatened with destruction or modification.
S3	Rare to uncommon, generally with 21 to 100 occurrences state-wide; or with a larger number of occurrences subject to relatively high levels of threat; may be of relatively frequent occurrence in specific localities or geographic parts of the state.
S4	Common, at least in certain regions of the state, and apparently secure, but with cause for long-term concern.
S5	Very common and demonstrably secure.
SNR	Unranked; conservation status has not yet been assessed.
SNA	Not applicable because the community is not a suitable conservation target; usually assigned to ruderal, modified/disturbed, or managed vegetation.

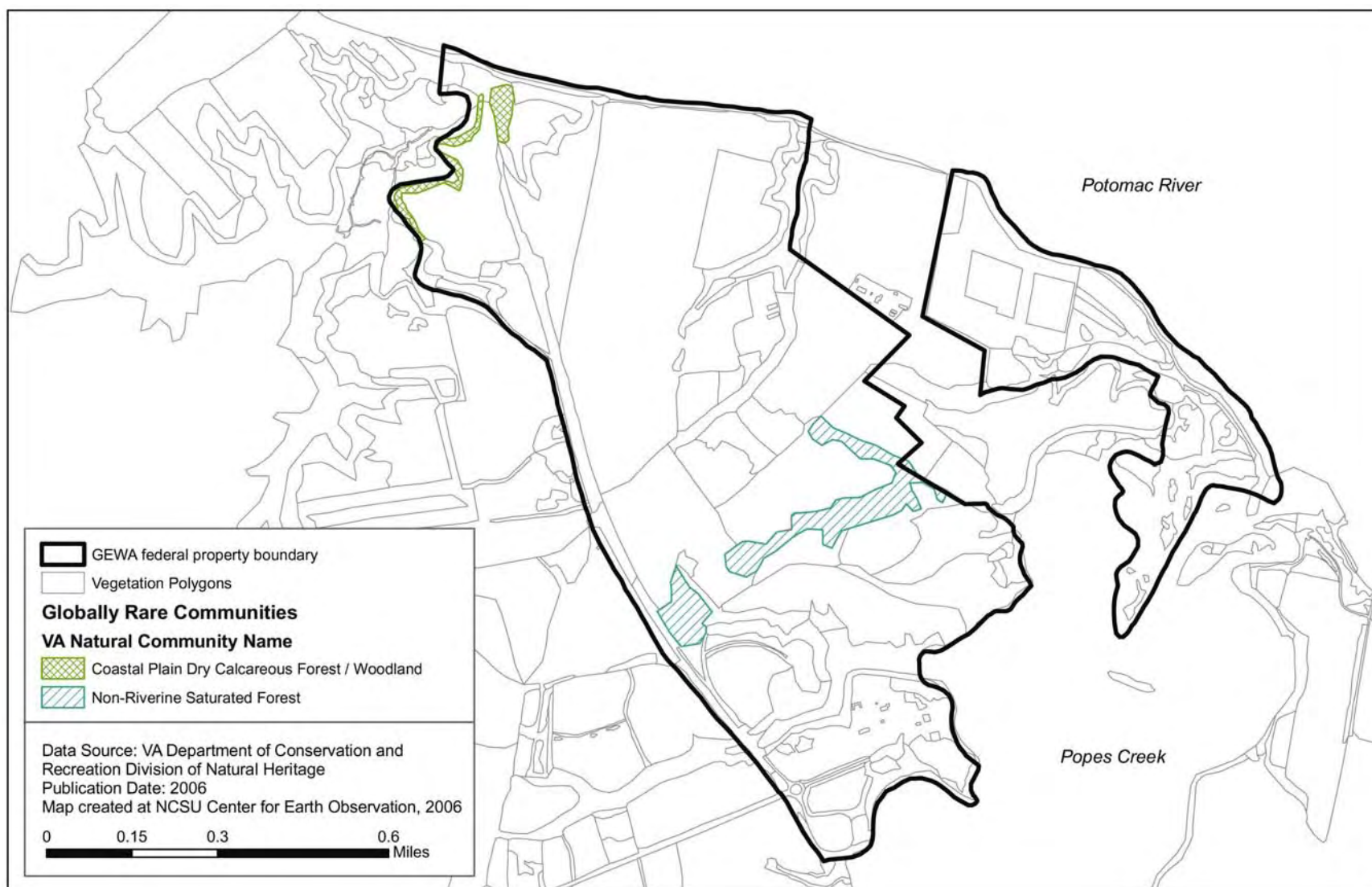


Figure 14. Locations of rare vegetation communities within George Washington Birthplace National Monument (GEWA).

The Coastal Plain Dry Calcareous Forest/Woodland natural community found at the park is classified as *Quercus muhlenbergii* / *Erigeron pulchellus* var. *pulchellus* – *Dichanthelium boscii* – (*Verbesina virginica* var. *virginica*) Forest (CEGL007748) in the U.S National Vegetation Classification (USNVC) (Grossman et al. 1998). The conservation ranks for this community are G2? and S1 (NatureServe 2006).

The occurrence of this community at the park consists of a narrow linear feature with marsh downslope and mowed field upslope. It is buffered on one side by a natural community. The community occurs in two patches of three and two acres respectively.

The Non-Riverine Wet Hardwood Forest natural community at the park has not been cross-walked to the USNVC, but is similar to *Quercus michauxii* – *Quercus pagoda* / *Clethra alnifolia* – *Leucothoe axillaris* Forest (CEGL007449) (Grossman et al. 1998). The conservation ranks for this community are G2 and S2 (NatureServe 2006).

Within the park, the canopy species of the Non-Riverine Wet Hardwood Forest include scattered *Quercus pagoda*, *Quercus palustris*, *Quercus falcata*, *Quercus phellos*, and *Quercus michauxii*. *Liquidambar styraciflua* is abundant in some areas. The stand has a tall canopy and well-developed subcanopy of *Ilex opaca*. There is no well developed shrub or herb layer. Ground strata is mostly devoid of herbs, although wet depressions in surrounding forest have local dominance of ferns (*Thelypteris noveboracensis*, *Dennstaedtia punctilobula*, *Woodwardia virginica*, *Osmunda regalis*). Hydrology has been altered and site contains historic berms and ditches. The area is surrounded by Loblolly Pine Plantation and grades into successional Loblolly-Sweetgum Forests. The occurrence is in two patches of 13.6 and 4.4 acres.

Special Topics

The following sections discuss the viewshed, air quality, lightscape, and soundscape in relation to the Birthplace. Although not traditionally enumerated as natural resources, these environmental elements have emerged in recent years as foci of concern in considering impacts related to management of natural resources. In the context of considering impacts to national parks these elements of the environment may assume special importance. Moreover, unlike biotic and physical resources within park boundaries, these elements are either not within complete control of park personnel, they may necessitate cooperation with people outside the park boundaries, or they are beyond anyone's immediate control. Thus, in this document, these elements are identified and treated as special topics.

Viewshed

A viewshed is the area observable from a particular point on the landscape. What is seen from that vantage point is commonly referred to as the view or, some would say "scenery." Concern for viewsheds surrounding national parks has become increasingly important as residential and commercial development on neighboring private land has encroached on once undisturbed or minimally developed landscapes. When many parks and monuments were established, surrounding landscapes often still reflected rural land uses consistent with their historic character. However, where private land is adjacent to a park, there is potential for development.

Some of the viewsheds at the park encompass only terrestrial environments of fields and forest. Some of these viewsheds include aquatic and terrestrial elements. All present views have potentially problematic elements that conflict with the historic purpose and mission of the park. For example, three communication towers are currently visible from Burnt House Point and views from the beach area include a power plant and the U.S. Highway 301 bridge crossing the Potomac River (George Washington Birthplace National Monument, R. Morawe, Chief, Natural and Cultural Resources Management, pers. comm., 2006). The power plant is the coal-burning Morgantown Generating Plant at the end of the U.S. Highway 301 bridge in Charles County, MD. Its two 700-foot tall smokestacks are visible not only from the park, but also from much of the Potomac River shoreline in Westmoreland and King George counties.

The view from the southern shore of the Potomac River includes development on the Maryland shore. Additionally, depending on the vantage point, an observer may also see upriver toward Colonial Beach and downriver toward Westmoreland State Park. Clearly, cluster developments or subdivisions on the far Potomac shore and upriver are inconsistent with the view that would have been observed historically by residents of the Birthplace site. Similarly, any development across Popes Creek is highly visible to park visitors. The distant jurisdiction of the Maryland shore probably precludes effective interaction between the park staff and local land use decision makers. The already concentrated development of Colonial Beach also probably limits the influence park personnel may have on land use decisions. The nature of structures and land use activities across Popes Creek, however, may be and probably should be a focus of NPS staff.

The most recent viewshed analysis of the park was completed by Doherty (1987) 20 years ago. The area has changed significantly since then so it is unclear how relevant that study is today. While the status of the park's viewshed is different today many of the threats discussed in that report are still pertinent and the recommendations made may still be useful. These issues will be discussed further in later chapters.

Air Quality

The NPS Air Resources Division (ARD) provided baseline values for the Birthplace as part of the 2002 Northeast Coastal and Barrier Network (NCBN) monitoring program. Upon completion of the initial data collection in 2002, no additional funding was provided to continue air quality monitoring at the park (NPS 2002a).

The park is currently designated a Class II air quality area, and is protected under the Clean Air Act, though less stringently than Class I areas (NPS 2002a). Only limited amounts of new emissions are allowed in Class II areas. Class I areas are defined as national parks over 6,000 acres, national wilderness areas and national memorial parks over 5,000 acres, and international parks. Generally, parks that do not meet these criteria are designated Class II areas.

There is no on-site ambient air quality monitoring at the park; however, there are monitors nearby. The air pollutants of significant concern for the NCBN are ozone and nitrogen deposition. The Birthplace is not currently designated an ozone non-attainment area, however, an ozone injury risk assessment indicates risk to vegetation in the park is high (NPS 2002a).

An air quality related value (AQRV) is a resource that may be adversely affected by a change in air quality. AQRVs include visibility and specific scenic, cultural, physical, biological, ecological, or recreational resources. Research has identified certain AQRVs as sensitive, such as lakes with low acid-buffering capacity and plant species that display injury symptoms at ambient ozone concentrations. AQRVs for the park are listed in Table 18. An “X” in the table indicates the AQRV is known to be, or likely to be, sensitive to air pollution. “Unknown” indicates there is not enough park-specific information available to determine if the resource is sensitive. The table is based on best available information relative to park resources (NPS 2002g).

Visibility: In 1985, in response to the mandates of the Clean Air Act, federal and regional/state organizations established the Interagency Monitoring of Protected Visual Environments (IMPROVE) program to protect visibility in Class I air quality areas. The objectives of the IMPROVE program are: to establish current visibility conditions in all Class I areas; to identify pollutants (particles and gases) and emission sources responsible for existing man-made visibility impairment; and to document long-term trends in visibility. In 1999, there were 30 official IMPROVE sites and 40 protocol sites. Because of recently enacted regulations that require improving visibility in Class I areas, the number of visibility monitors is increasing. Protocol sites are being upgraded to full IMPROVE sites and 80 new sites are being added to the IMPROVE network (NPS 2002a).

While the IMPROVE program has focused on Class I air quality areas, a great deal of visibility monitoring has been conducted in Class II areas. The IMPROVE site closest to the park (WASH1) is about 50 miles away at the National Mall in Washington, D.C., and has been operating since 1988.

Data from 1996-1998 indicated that, as with previous years, standard visual range is substantially less in the eastern than in the western United States. As for the sources of visibility impairment, 1996-1998 aerosol data from the National Mall are consistent with data from other eastern United States IMPROVE sites. These data show that, on an annual basis, visibility impairment is primarily due to sulfates (sources include coal combustion and oil refineries), then organics (sources include automobiles), then nitrates (sources include coal and natural gas combustion and automobiles), then light absorbing carbon (sources include wood burning), and then soil (from windblown dust) (NPS 2002a).

Wet Deposition: The National Atmospheric Deposition Program/National Trends Network (NADP/NTN) collects precipitation to monitor geographical and temporal long-term trends. The precipitation at each station is collected weekly according to strict clean-handling procedures. It is then sent to the Central Analytical Laboratory in Illinois where it is analyzed for hydrogen (acidity as pH), sulfate, nitrate, ammonium, chloride, and base cations (such as calcium, magnesium, potassium, and sodium). NADP/NTN’s excellent quality assurance programs ensure that the data remain accurate and precise. The distance to and location of these NADP/NTN sites is problematic, because in coastal areas, there can be substantial differences in wind patterns, and localized meteorology may significantly affect pollutant deposition. The NADP/NTN site in Wye, Maryland is the closest site to the park (about 70 miles to the northeast) and is probably representative of the Birthplace. This site (site #MD13) has been operating since 1983. Site data show a decrease in concentration and deposition of wet sulfate; a slight decrease

Table 18. Air quality related values at George Washington Birthplace National Monument (NPS 2002g).

Air Quality Related Value	Sensitivity to Air Pollution ^a
Visibility	X
Vegetation	X
Surface waters	Unknown
Soils	Unknown
Fish and wildlife	X ^b

^aX = Known or likely to be sensitive to air pollution.

^bState has issued fish consumption advisories in or near the park due to unsafe levels of one or more toxics.

in concentration of wet nitrate; and no overall trend in wet nitrate deposition, wet ammonium concentration, or wet ammonium deposition (NPS 2002a).

Dry Deposition: The Clean Air Status and Trends Network (CASTNet) is considered the nation's primary source for atmospheric data to estimate dry acidic deposition. Established in 1987, CASTNet now comprises over 70 monitoring stations across the United States. The majority of the monitoring stations are operated by EPA; however, approximately 20 stations are operated by the NPS in cooperation with EPA. Each CASTNet dry deposition station measures weekly average atmospheric concentrations of sulfate, nitrate, ammonium, sulfur dioxide, and nitric acid; hourly concentrations of ambient ozone; and meteorological conditions required for calculating dry deposition rates. Dry deposition rates are calculated using atmospheric concentrations, meteorological data, and information on land use, vegetation, and surface conditions. CASTNet complements the database compiled by NADP/NTN.

Because of the interdependence of wet and dry deposition, NADP/NTN wet deposition data are collected at or near all CASTNet sites. Together, these two long-term databases provide the necessary data to estimate trends and spatial patterns in total atmospheric deposition.

Because CASTNet uses different monitoring and reporting techniques than NADP/NTN, the dry deposition amounts are reported here as nitrogen and sulfur, rather than nitrate, ammonium, and sulfate. In addition, because CASTNet calculates dry deposition based on measured ambient concentrations and estimated deposition velocities, there is greater uncertainty in the reported values. Due to the small number of CASTNet sites nationwide, use of dry deposition isopleth maps is not advised at this time.

A CASTNet site has been operating about 50 miles to the northeast of the park at Blackwater NWR, Maryland (site #BWR139) since 1997. As with the NADP/NTN sites, distance to and direction from parks may limit the usefulness of the CASTNet data. However, data from the Blackwater NWR site are probably adequate for the Birthplace. Site data indicate a decrease in dry sulfur deposition, and no trend in dry nitrogen deposition. CASTNet estimates total nitrogen deposition at the site is composed of 39 percent dry deposition and 61 percent wet deposition, while total sulfur deposition is 42 percent dry and 58 percent wet.

Ozone: The nearest ozone monitoring site to the park is about 25 miles southwest in Caroline County, VA. While the park is not currently designated an ozone non-attainment area, this is probably due to the fact that ozone is not monitored within the county (NPS 2002a). High ozone concentrations occur in nearby counties and it is likely that levels within the park would exceed the EPA's human health-based 8-hour National Ambient Air Quality Standard. Designation of the park as an ozone non-attainment area may be beneficial to the park as this designation forces local and state air pollution control agencies to take measures to reduce ozone levels (NPS 2002a).

Lightscape

The issue of nighttime lighting in the vicinity of historic properties appears not to have been addressed. Given the fact that park visitation by the public is typically limited to hours after sunrise and before nightfall, ambient light levels from artificial sources proximal to the

Birthplace may not be a significant issue. Theoretically, of course, increases in visible lights along the Potomac waterfront, both across the river, upriver, and downriver of the park, create a condition degrading the historic experience one would have at the site at night. Practically speaking, however, this is not an issue that warrants extensive effort.

Soundscape

Unlike the matter of nighttime lighting, the matter of noise intrusion on visitors' experiences is a reality that needs to be considered. Noise produced by tests conducted at the Naval Surface Weapons Research Station upriver intrudes on the daytime visitor's experience of the park. The distinct boom heard when weapons are discharged during testing cannot be ignored and is definitely inconsistent with the perceived ambience of eighteenth century life on the lower Potomac River. Increasing personal watercraft usage in Popes Creek also has significant impacts on the soundscape within the park. Additional sound disturbance comes from nearby Kings Highway (VA Route 3). Traffic, trucks in particular, constantly drone east and west as Kings Highway is the main connector for this area and points south and north. (George Washington Birthplace National Monument, R. Morawe, Chief, Natural and Cultural Resources Management, pers. comm., 2006)

Analysis, Consolidation, and Synthesis

The preceding section documented the diverse range of natural resources occurring within the 550 acres of the park. These resources have evolved as the landscape has undergone transformations due to historic manipulation by settlers, farmers, preservationists, and site managers. In some areas of the park, processes of natural landscape change have been arrested, while in other areas of the park natural processes have persisted. Choices made by earlier decision makers present current decision makers with a variety of options, issues, and opportunities regarding how the natural elements of the landscape should be managed in light of the park's mission. As evidenced in the preceding section, these resources have been studied to varying extents, and a few need to be studied further before definitive answers can be reached concerning site planning.

The purpose of this section is to focus attention on key points raised by the previous sections and to establish the basis for considering threats and vulnerabilities, identifying gaps in knowledge, and laying out those recommendations possible at this stage of the NPS planning process.

Physical Resources

Situated along the lower Potomac River, a bit more than 50 miles from Washington, D.C., less than 100 miles from Baltimore and Richmond, and in the heart of the Tidewater Region, the Birthplace is on the edge of one of America's prime real estate markets. This position was historically significant during colonial times, but it is economically important today for very different reasons than during previous historic periods.

Geological Resources

The flat terrain at the Birthplace, except for the steep drop to the water level of the Potomac River along the northern boundary and Popes Creek, affected natural drainage, prompting ditching for agriculture early in the European era of site occupation. Soils on the site range from upland to inundated wetland, but the USDA Soil Conservation Service classified the majority of the park's land as 'non-tidal wetlands' or 'prior converted wetlands' with Leaf, Lenoir, or Bibb/Levy soil types. Such classification means that abandonment of effective drainage structures (ditches) could enable site reversion to wetlands.

The study performed by French (1985) suggests that simple erosion control measures, such as cliff bank terracing and vegetation development along beaches, will limit the threat to the park and its artifacts. Hardaway (1999) describes current methods for erosion control with the caveat that potential impacts to adjacent shorelines must be considered. Cliffs serve as sediment banks, which erode to provide sand for beaches, spits, and offshore bars. Erosion control structures may result in increased impinging wave heights, thereby increasing the potential for bottom scour and shoreline retreat (Hardaway 1999). Structurally stabilized shores also reduce or eliminate marsh migration and formation (Leatherman et al. 1995).

Scientists at the Virginia Institute of Marine Science modeled more complex strategies of shoreline stabilization at the park. The potential effectiveness of breakwaters, pocket beach

formation, and chevron rock structures was examined, but available funding for any of these measures was deemed inadequate (Thornberry-Ehrlich 2005).

The site itself has been influenced by fluctuations in river and tidal conditions, and the site's tidal shoreline has yielded a trove of ancient fossils. Erosion along the Potomac River has been reported at 1-3 feet per year (Miller 1987). Erosion from storm events has been reported as much as 50 feet (George Washington Birthplace National Monument, R. Moräwe, Chief, Natural and Cultural Resources Management, pers. comm., 2006).

Water Resources

Streams within the Birthplace boundary have not been described in detail, which may be a problem for planning some future activities. Usually the bank and streambed characteristics, flow rates, substrate material, sinuosity, vertical structure, etc. are noted in the technical section of an environmental assessment document. Given past alteration of site hydrology, including ditching for agricultural drainage, full examination of the streams would be useful for interpreting past and ongoing changes in the natural systems at the park.

Water quality in the Potomac River is of some concern, and inputs to Popes Creek merit careful monitoring, especially if further development in the watershed occurs. The lower groundwater aquifer is well confined and not readily susceptible to degradation. A USGS report describing groundwater assessments around the park area is currently in review (U. S. Geological Survey, Gary Spearin, pers. comm., 2006).

According to notes from a 2006 meeting about water quality in the vicinity of the park, the Virginia Department of Environmental Quality (VA DEQ) is currently developing bacterial Total Maximum Daily Load (TMDL) parameters for shellfish. By conducting public meetings to assemble interested parties and stakeholders, they intend to create a Technical Advisory Committee to review proposals and reports, initiate fieldwork analyses, and develop an implementation plan. A completion date for this process is currently (May 2006) unknown (George Washington Birthplace National Monument, R. Moräwe, Chief, Natural and Cultural Resources Management, written communication, 2006).

Surface Water Quality: Tributary creeks and streams originating in Virginia are monitored by VA DEQ for federal Clean Water Act compliance (VA DEQ 2002, as cited in James-Pirri 2004). Sampling at Station 1APOP000.38, located within the Popes Creek Estuary, was initiated in February 1997. Water quality parameters monitored at this station include turbidity, conductivity, dissolved oxygen, pH, total suspended solids, ammonia, nitrite, nitrate, nitrogen phosphorus, organic carbon, chloride, sulphate, sediment toxics, fecal coliform, and sediment particle size. Sampling at another VA DEQ station (1APOP003.92), located at the Route 3 bridge, was initiated in April 1996 and includes total suspended solids, nitrogen, ammonia, nitrite, nitrate, phosphorus, pathogens, turbidity, and hardness.

The Maryland-Virginia State border is the southern edge of the Potomac River, which affects water quality monitoring of the Potomac River. Maryland's basic statewide water monitoring activities are conducted principally by two agencies. Water monitoring programs within the Maryland Department of the Environment address regulatory issues (e.g., permit compliance and

modeling, evaluation of water quality standards, shellfish sanitation, Total Maximum Daily Loads). Programs within the Maryland Department of Natural Resources (MD DNR) address water quality and aquatic resource issues. Since 1984, the EPA Chesapeake Bay Program has funded Maryland's Water Quality Monitoring efforts in the main-stem bay. Two Potomac River stations within the vicinity of the park are maintained for federal Clean Water Act compliance, station XDC1706 at the US 301 bridge, and station MLE2.2 at Ragged Point. A full suite of dissolved organic and inorganic nutrients are monitored monthly at these stations, as well as pH, temperature, chlorophyll-*a*, salinity, and Secchi depth. Phytoplankton community structure is examined monthly at a site upstream of the park at Indian Head (over 50 km away). In addition, five fixed stations within 20 km of the Birthplace (none of which are directly adjacent to the park) are used for annual monitoring of benthic community structure and sediment organic matter in the Potomac River (Kopp et al. 2002).

The Alliance for Chesapeake Bay Citizen's Monitoring Program conducts weekly summertime monitoring for temperature, pH, salinity, and dissolved oxygen throughout the Chesapeake Bay. One station is located in Popes Creek at the Birthplace (initiated in 1991), another is approximately 6.5 km downstream in the Potomac River, and a third station is approximately 32 km upstream in the Potomac River (Kopp et al. 2002).

As part of the Mid-Atlantic Integrated Assessment, the EPA's Environmental Monitoring and Assessment Program monitors a variety of water quality parameters at stations in the Potomac River, one of which is adjacent to the park (James-Pirri 2004).

The National Park Service *Baseline Water Quality Data Inventory and Analysis* (1997) report compiled all available water-quality data for the Birthplace as part of a program to inventory, format, and analyze water-quality data of National Park units that have significant natural resources. The data for that document were retrieved from six different EPA databases: 1) the Storage and Retrieval (STORET) database management program; 2) River Reach File (RF3); 3) Industrial Facilities Discharge (IFD); 4) Drinking Water Supplies (DRINKS); 5) Water gages (GAGES); and 6) Water Impoundments (DAMS). Consistency and quality of the databases can be problematic, however, as is discussed further below.

Finally, a study by Simon et al. (2005) indicated that concentrations of available phosphorous in Popes Creek sediments were significantly lower than in Pocomoke River sediments, an implied result of the considerably lower amount of agricultural activity and absence of poultry production facilities in the Popes Creek watershed. Apparently, the USGS is interested in pursuing future research using the watershed as a control for comparative studies (U. S. Geological Survey, N. Simon, Research Chemist, pers. comm., 2006).

A large quantity of data exists for the Birthplace and surface water quality should be easily ascertainable. However, the availability and accessibility of these data varies and the quality of the sources is inconsistent.

The *Level One Water-Quality Inventory and Monitoring* study conducted in 1998-1999 (Lewis 2001) provides the most recent information available about park surface water quality (Appendix B). That document presents study data but does not summarize results or draw any conclusions, except to note potential threats to water quality around the park (see "Water Resources" in the

“Threats and Vulnerabilities” section below). The locations of the data collection sites used in that study are presented in Figure 15.

Prior to the Lewis (2001) study, the *Baseline Water Quality Data Inventory and Analysis* report (NPS 1997) indicates that “surface waters within the study area appear to have been impacted by urban development; however, the paucity of recent data at most water quality monitoring stations makes definitive statements difficult.” Most of the monitoring stations identified in this report represent either one-time or intensive single-year sampling efforts by the collecting agencies. Nine stations within the study area (including the one within the park boundary) yielded longer-term records consisting of multiple observations for several important water quality parameters (see Station Period of Record Tabulation in NPS 1997). The stations yielding the longest-term records within the study area, but outside of the park boundary, are: (1) End Of Rt. 1156 Below Colonial Beach Stp (GEWA 0040); (2) Monroe Bay, Monroe & Mattox Creeks Lettered Sta. (GEWA 0024); (3) Potomac R: Mattox Crk To Currioman Bay Numb. Sta (GEWA 0001); (4) Route 205 Bridge (Westmoreland County) (GEWA 0059); and (5) End Of Rt. 1164 Below Colonial Beach STP (GEWA 0049).

The *Baseline Water Quality Data Inventory and Analysis* (1997) utilized screening criteria consisting of published EPA water-quality criteria and instantaneous concentration values selected by the Water Resources Division (NPS 1997). Eleven groups of parameters exceeded screening criteria at least once within the study area. Dissolved oxygen, pH, chloride, cadmium, copper, and zinc exceeded their respective EPA criteria for the protection of freshwater aquatic life. Chloride, sulfate, cadmium, copper, and lead exceeded their respective EPA drinking water criteria. Bacteria concentrations (total coliform and fecal coliform) and turbidity exceeded the National Park Service’s Water Resources Division screening limits for freshwater bathing and aquatic life, respectively.

According to the *Baseline Water Quality Data Inventory and Analysis* report, “potential anthropogenic sources of contaminants include industrial and municipal wastewater discharges, and urban storm water runoff (NPS 1997).” However, this observation must be understood as generalized because the study area of that data accumulation report included 7,680 acres, an area extending 3 miles upstream and 1 mile downstream from the 550 acres of the park (see Figure 16). Only one of the 60 reporting sites included in the report was actually located inside the park boundary, and most of the sampling stations were in Monroe or Mattox Bays, upriver of the park and downriver from Colonial Beach and sources entering the Potomac upstream (see Figure 17). Results of the STORET retrieval for the study area yielded 20,998 observations for 181 separate parameters collected by the NPS, USGS, MD DNR, and the VA DEQ at 60 monitoring stations.

In summary, definite caveats have to be attached concerning use of the data accumulated in the *Baseline Water Quality Data Inventory and Analysis* (NPS 1997) report for the Birthplace. The authors of that report emphasize these caveats in their introduction by stating “observations that exceed water quality criteria may have occurred due to any number of natural or anthropogenic factors, as well as other reasons.” Moreover, at this point (2006) data reported in that baseline report are at least a decade old, and the data reported from the one site actually within the park boundary were collected from 1971 to 1983, making them over 20 years old.

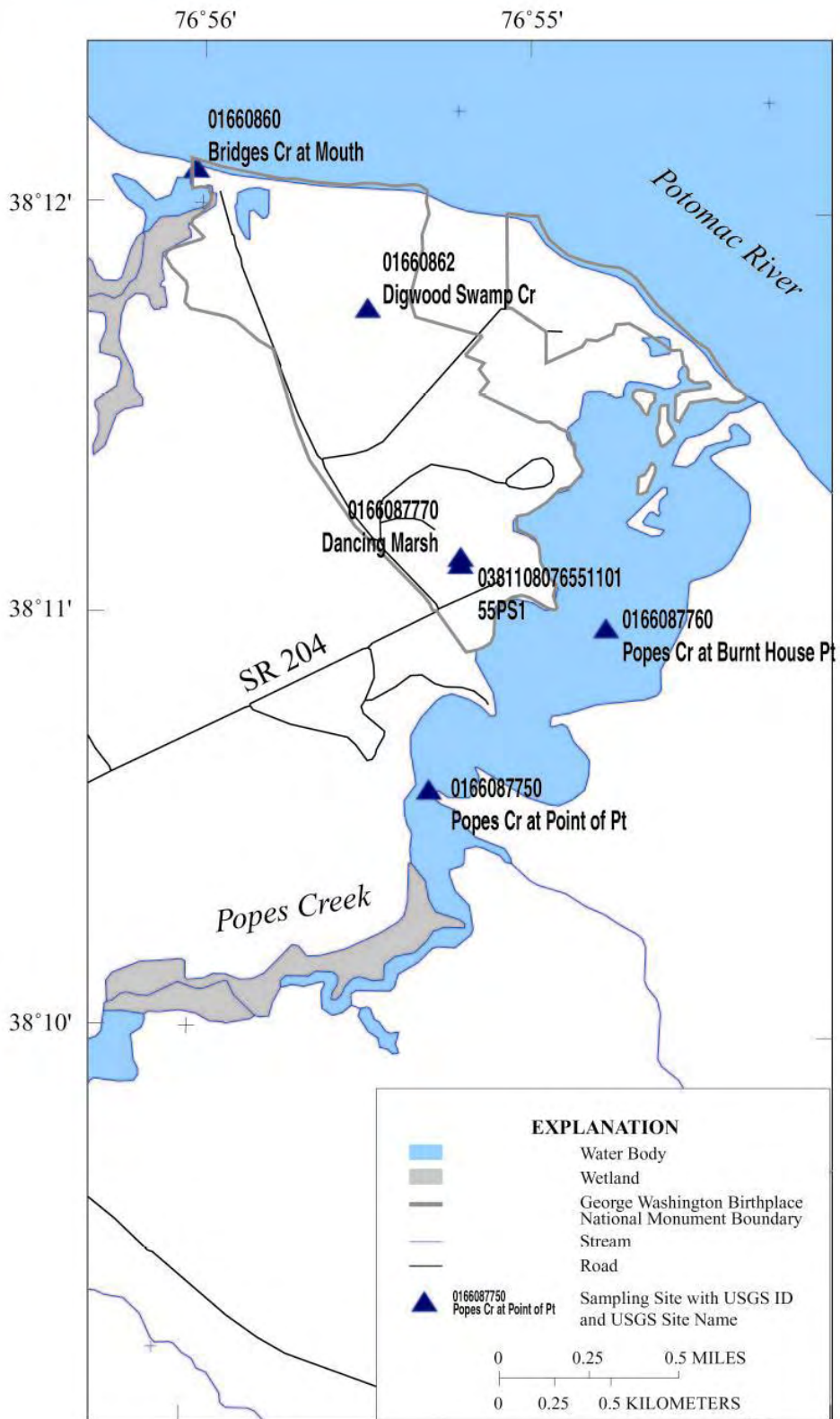


Figure 15. Locations of surface water quality data collection sites in and adjacent to George Washington Birthplace National Monument (Lewis 2001, p. 4).

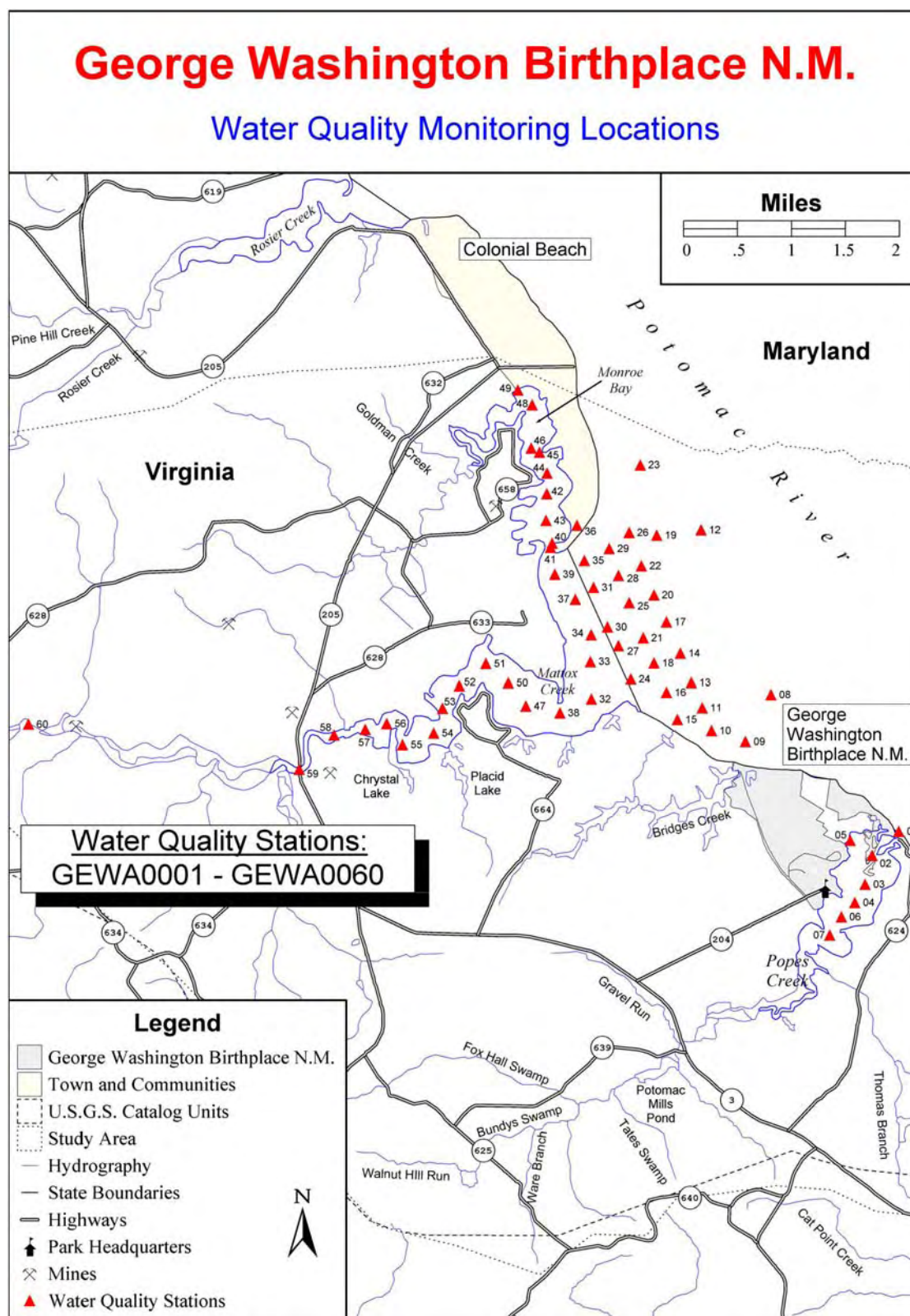


Figure 16. Water quality monitoring stations in George Washington Birthplace National Monument and the surrounding region (NPS 1997, p. 33).

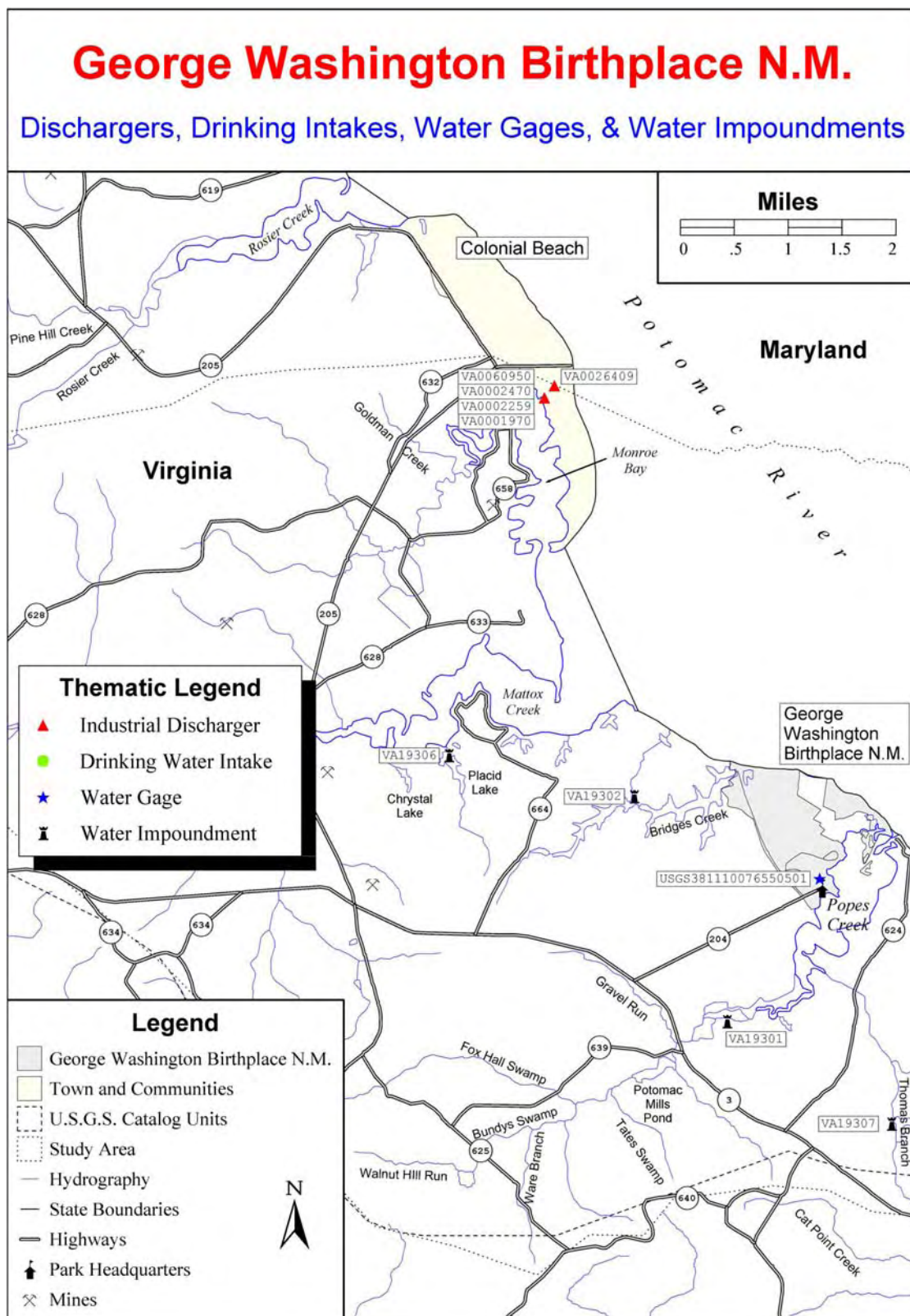


Figure 17. Discharges, drinking intakes, water gages, and water impoundments in George Washington Birthplace National Monument and the surrounding region (NPS 1997, p. 34).

Ellsworth (2003), referencing Belval et al. (1997), asserts that eutrophication and loss of submerged aquatic vegetation within waters of the park are likely associated with pollutants. Yet, Ellsworth (2003) also notes the relatively undisturbed conditions of the Popes Creek watershed and Simon (2005) indicates that it provides a baseline against which other tributaries of the Potomac River and Chesapeake Bay may be measured.

Most recently, however, signs posted on the beach at the park in December 2005 warned against consumption of shellfish from adjacent waters, suggesting a pollution problem. Apparently, the VA DEQ determined that Popes Creek should be closed to shell fishing indefinitely due to high levels of coliform bacteria and other contaminants. The largest contribution appears to come from natural causes (waterfowl) considered as “background”, but cattle and humans (failed septic systems) are also cited as significant contributors (George Washington Birthplace National Monument, R. Moräwe, Chief, Natural and Cultural Resources Management, written communication, 2006).

Apparent discrepancies among the observations concerning water quality at the park may be a matter of the scope of reporting and the focus within which the question of water quality at the park is considered. Thus, the data provided by Lewis (2001) stand as the most reliable gauge of known surface water quality inside the park and should be updated when more recent studies become available. The data tables from that report are therefore included in Appendix B of this document.

Wetlands: From the results of fieldwork, Sustainable Science, LLC (2006) believes “that the Palustrine systems represented possess all three criteria (hydrophytic vegetation, wetland hydrology and hydric soils) necessary to designate these areas as wetland areas by the 1987 COE criteria and also satisfy the USFWS criteria for wetland status. Though not technically wetlands by COE criteria, the Riverine systems do satisfy Cowardin et al. classification criteria, hence also are regulated under National Park Service guidelines. Therefore ... all of these ecosystems [are] subject to Section 404 (Clean Water Act of 1977) jurisdiction and also to NPS Director’s Order #77-1.”

Functional Wetland Assessment: A functional assessment was performed by Sustainable Science, LLC (2006) on wetland areas judged to represent the associated similar USFWS classes (Table 19). The locations of the wetland assessment areas (represented by wetland data points [WDP]) are shown on Figure 7. If the assessed wetland did not provide a function the associated assessment was not performed. For example, the PFO1E wetlands did not provide sufficient water to support fish hence the Fish functional assessment was not performed.

Several observations about the table’s data are noted by Sustainable Science, LLC (2006):

- **Shoreline Bank Erosion Control:** Most wetlands did not have a defined shoreline bank with the exception of the Estuarine E2EM5N Popes Creek island wetland systems. The resulting FCI score reflects the severe erosion and unstable bank face for this wetland complex. Since little shoreline erosion was noted between 1937 and 2002, the remaining E2EM5N systems (WDP-8, WDP-9 and WDP-15) were assessed in the marsh interior.

Table 19. Functional capacity indices for wetlands in George Washington Birthplace National Monument (Sustainable Science, LLC 2006).

Wetland Data Point ^a	USFWS Designation ^b	Functional Capacity Index						
		Shoreline Bank Erosion Control	Sediment Stabilization	Water Quality	Wildlife	Tidal Fish	Non-Tidal Stream/River Fish	Non-Tidal Pond/Lake Fish
WDP-1	PEM2B	NA	0.88	0.86	0.55	NA	NA	0.73
WDP-2	PEM6F	NA	1.00	0.94	0.49	NA	NA	0.45
WDP-5	PFO1E	NA	0.77	0.78	0.61	NA	NA	NA
WDP-7	PFO1E	NA	0.77	0.72	0.59	NA	NA	NA
WDP-8	E2EM5N	NA	1.00	1.00	0.55	0.87	NA	NA
WDP-9	E2EM5N	NA	1.00	1.00	0.63	0.94	NA	NA
WDP-10	PFO1/SS1J	NA	0.95	0.75	0.69	NA	0.73	NA
WDP-11	PFO1/SS1J	NA	0.90	0.66	0.70	NA	0.84	NA
WDP-12	E2EM5N	0.23	0.33	0.52	0.52	0.66	NA	NA
WDP-13	PFO1E	NA	0.79	0.83	0.37	NA	NA	NA
WDP-14	PSS1/EM2F	NA	0.83	0.87	0.50	NA	NA	0.55
WDP-15	E2EM5N	NA	1.00	1.00	0.41	0.99	NA	NA
Ice Pond	POWH	NA	0.60	0.70	NA	NA	NA	0.50

^aWetland data points are shown in Figure 7.

^bCodes are defined in Tables 3 and 4.

- **Sediment Stabilization:** In general all assessed wetlands had very good to excellent FCI scores in the ability to retain sediment. The PFO1E systems had somewhat lower scores ranging from 0.77 to 0.79 and is attributed to the vegetation root structure. The Popes Creek marsh island represented by WDP-12 had the lowest overall score due to severe disturbance caused by sea level rise and wave action that results in unstable slope conditions.
- **Water Quality:** In general, all the emergent marsh systems, except for the Popes Creek marsh island, exhibited high functional capacity to enhance water quality. The forest and scrub/shrub systems exhibited good to very good water quality enhancement capabilities. The lower score is mostly due to a less dense plant basal cover. Again the lowest score of 0.52 was for the Popes Creek marsh island assessment due primarily to the disturbance at site, small wetland width and continual erosive water contact causing slope instability.
- **Wildlife:** Wildlife habitat scores ranged from average to good for all assessed wetlands. Slightly higher scores were noted for the scrub/shrub and forested wetland systems due to more complex vertical and horizontal vegetation structure.
- **Tidal Fish:** All assessed tidal marshes, except for the Popes Creek marsh island, had very good to excellent scores for tidal fish habitat. The lower score reflected in WDP-12 is attributed to unstable shoreline, lack of rooted vascular aquatic beds and fish cover.
- **Non-Tidal Stream/River Fish:** Both assessed areas of WDP-10 and WDP-11 had very good scores for stream fish habitat. Pools and overhanging banks were not as optimal lowering the associated FCI scores.
- **Non-Tidal Pond/Lake Fish:** The pond fish habitat ranged from mostly average to a score of very good for WDP-1. The average scores were mostly due to fish passage obstruction and average vegetation overhang and fish attractors. Small open water area also lowered the Digwood Swamp score represented by WDP-2.

Sustainable Science, LLC (2006) judged that cultural values for the identified wetland systems are excellent due to the historical significance of the Birthplace. Research and scientific values were judged by Sustainable Science, LLC (2006) to be very good to excellent for the forested PFO1E wetland complex and the Popes Creek tidal marsh islands, although no indications were given as to how this judgment was made.

The fact that ditches that were once functional have ceased to drain effectively poses questions about future direction for land management. Clearly drainage of wetlands was an historical goal and a necessary condition for productive farming of some areas that have since reverted to forest. Areas drained prior to 1987 are labeled “prior converted” and can continue to be managed as non-wetland. Under the “No Net Loss” policy by which federal agencies operate, however, any action to drain wetlands would require careful consideration and probably mitigation. It is not likely that the NPS wants to drain any of the existing wetlands, but it should be apparent that lack of effective drainage substantially alters the working landscape from what would have been the condition at the time of historic focus. Interpretation of such landscape change could be an interesting educational topic.

Biotic Resources

Before discussing biotic resources at the park it is important to make a clarifying point. While some NPS reports have referred to “pristine conditions” at the park, use of terms such as *pristine*, even qualified with “relatively,” to describe natural resource conditions at the park can perhaps present a false impression. The natural landscape at this site has been impacted since the first colonists established residence here. Fields, forests, and the variety of structures are all certain artifacts of human activities or abandonment of activities since that earliest European influence. Moreover, evidence suggests that Indians were occupying this site prior to European settlement. The range of activities they conducted have not been precisely documented but modern scholarship indicates that landscape management practices of the indigenous peoples of North America depended profoundly upon periodic disturbance to maintain suitable habitats for food production (Mann 2005). Shellfish middens, where they occur, indicate the presence of the indigenous population, so it should therefore be assumed that prior to European influence, biotic communities were being manipulated to some extent to favor species desired by the inhabitants. So, while it is true that some areas of the park have developed more naturally than others, due to greater length of time since manipulation by humans, some degree of disturbance or effects of disturbance can be detected everywhere within the park boundary.

Moreover, given the mission at the Birthplace, protection of the natural resources should be considered to require management, hence manipulation, to foster desired visitor experiences: understanding the historic environmental context in which the Washington family made their living at this place.

Having said that, this synthesis must acknowledge that the planning process offers an opportunity to determine what practical management actions will create desired aesthetic impacts, while protecting natural elements of the landscape. Legally mandated requirements to protect certain species (such as eagles) cannot be ignored, including the obligation to protect habitats from actions that could jeopardize species’ persistence. Whether an active management regime to enhance eagle roosting and nesting habitat is undertaken depends on the priority placed on their welfare at this site. For instance, thinning dense, mature pine stands to create better habitat may run counter to usual NPS practice but is an option that should be considered in the general management plan. So consultation with experts at Virginia’s Department of Game and Inland Fisheries should be initiated during the planning process.

Flora

The plants of the park vary from those in highly manipulated to almost entirely naturally regenerated areas. A large amount of effort and detailed inventory work has been expended on the landscape specimens at the park, their need for care, and when that care should be administered. The document detailing that information is a large reference that defies easy summation or replication (Bellavia et al. 1996). The level of detail in that report reflects the importance of these features within the commemorative cultural landscape and a fundamental resource in the context of park purpose and significance. It also points to the highly manipulated condition of important portions within the Birthplace that the public most closely encounters.

The so-called natural vegetation communities at the park, being almost entirely the result of disturbance at some point in the past, exhibit a variety of developmental stages and responses to past management. Only a small area of the natural communities has been studied and characterized in detail (Abrams and Black 2000), though the plant composition of the park has been inventoried on at least two occasions (Lam 1985, Dodge 2000). These inventories have not been organized to identify plants existing in particular community types, so it is not possible to move from the species lists to understanding spatial distribution of plant communities at the park. Needle-leaved forest is the most common cover type, followed by medium-tall-grassland. In acreage both types far surpass deciduous forest, shrubland, and tidally influenced or flooded vegetation.

The two globally rare communities identified by VADCR-DNH should receive special attention during the planning process. Coastal Plain Dry Calcareous Forest/woodland is especially unique and therefore deserves further investigation to ascertain how it should be protected. While Non-Riverine Saturated Forest is less unique regionally, it represents a distinctive habitat type in the park and provides a protected example. In both cases, it is exceedingly important to determine how past and ongoing activities anywhere in the vicinity of these two sites have affected and will affect their persistence.

Perhaps the most significant plant species documented within the park are the pretty dodder (*Cuscuta indecora* Choisy) and the eastern bloodleaf (*Iresine rhizomatosa*). Pretty dodder was found by Dodge (2000) on an islet near the confluence of Popes Creek and the Potomac River. This plant is included in the Virginia Rare Vascular Plant List with a state status of “S2?” (Townsend 2006). The “?” indicates uncertainty of the “S2” status, which is defined as “very rare and imperiled with 6 to 20 occurrences or few remaining individuals in Virginia; or because of some factor(s) making it vulnerable to extirpation in Virginia.” The global rank for this species is G5. Pretty dodder was not observed by Lam. However, eastern bloodleaf was identified by Lam (1985) and not reported by Dodge (2000). Eastern bloodleaf is included in the Virginia Vascular Plant Watch List (State Rank=S3, Global Rank=G5) (Townsend 2006). As concerns have been raised about plant species composition changes observed in the aquatic related areas of the park, it is entirely possible that habitat for the pretty dodder no longer exists in this area. Plant community changes have resulted from altered substrates due to sedimentation and from exotic species introductions, both common threats to rare plants.

The Abrams and Black (2000) conclusion that, absent fire or other active disturbance, the forest will change markedly in character due to deciduous encroachment generally applies at the Birthplace. However, the limited information available supplies little guidance about the great majority of the forest acreage at the park. Neither species composition nor densities for the greater portion of the forest are known. Thus, little can be said about forest habitat quality for fauna, the risks of disease and insect infestations, and aesthetic considerations with regard to management in concert with the mission and stated goals for the park.

The hay fields and pasture areas within the park provide habitat for a variety of small mammal, bird, and insect species but are now not highly valued as wildlife habitat because of their past ubiquity in the landscape. As economic pressures convert such lands elsewhere into residential or commercial property, or as farm abandonment leads to old field succession into forested cover, the park’s open habitats may become more important in the overall habitat matrix.

Invasive species issues have been identified at the park, but these are treated in more substantial detail in the “Threats and Vulnerabilities” section below.

Fauna

Amphibians and Reptiles: Previous inventories at the park have indicated that the amphibian and reptile populations appear to be healthy in terms of individual appearance and stable in terms of population size. Overall diversity appears to be high, especially considering the history of human disturbance at the site (Eckerlin 1993).

Long-term preservation of the amphibian and reptile populations at the park will require the management and maintenance of a variety of landscape types (Mitchell 2005). Amphibians and reptiles function in a landscape context and a mix of habitat types is essential for their existence in the park. These animals rely more on the environment structure (shelter, temperature, relative humidity) provided by plant community environments, rather than individual plant species compositions. During their daily and seasonal movements, most amphibian and reptile species use multiple habitat types that are adjacent to one another and may travel one or more kilometers. Some habitats may be used by species only during movements from one primary habitat to another and other species can move among several habitat types in a single day or season (Mitchell 2005).

Effective amphibian conservation will require preserving several hundred meters of appropriate terrestrial habitat around the breeding pools or ponds in the park. Preservation of areas composed of terrestrial habitat with an imbedded complex of ephemeral or seasonal ponds is considered ideal (Mitchell 2005). Movement between breeding pools or ponds is important in maintaining viable amphibian populations. These populations require the ability to disperse across habitats and among breeding areas. Therefore, dispersal corridors should be included in any species management plan.

The presence of the northern diamondback terrapin, while not unexpected, is notable. This species has declined dramatically in the Chesapeake Bay and throughout much of its range in recent decades. Although its population status at the park and in the Potomac River is unknown, northern diamondback terrapins are uniquely adapted to estuarine habitats, and it is the only truly estuarine reptile in the world (Mitchell 2005). The discovery of this species in the tidal marsh raises several questions of management concern, including mortality from boat propellers and deterioration in environmental quality through pollutants. Further inventory work to determine park use by this species would assist in future management of the species within the park (Mitchell 2005).

Box turtles may be an excellent indicator of ecosystem condition and health (Mitchell 2005). During a recent study, it was found that nearly all box turtles captured in the Blacksburg, Virginia area had high levels of organochlorine pesticide in their systems. Because box turtles are so long-lived, they often accumulate chemicals from the environment. A good example is the development of aural (ear) abscesses as a result of vitamin A deficiency caused by organochlorine pesticide contamination (Holladay et al. 2001 cited in Mitchell 2005). During the 2002 inventory conducted at the Birthplace, no turtles with aural abscesses were found, suggesting that this may not currently be a problem at the park (Mitchell 2005).

Lepidoptera and Odonata: Overall, the species diversity of Lepidoptera at the park (51 species) is comparable to other surveys completed in Virginia, despite a lower diversity of Lepidopteran habitat types. In particular, Chazal (2005) indicates the variety of nectaries in a single habitat type, fields, as a major factor in the species diversity observed. Fewer nectar sources were found in forests and marshes, thus decreasing the diversity of habitats available to Lepidopteran species (Chazal 2005). It is unclear whether the Lepidoptera species observed are successfully completing their life cycles within the park or if individuals are from sources outside the park boundaries. The Odonata diversity at the park (37 species) is also comparable to other surveys in Virginia, especially considering the small amount and low diversity of suitable wetland/aquatic habitats available within the park. For example, there are no freshwater streams or creeks of substantial size that would encourage the presence of such species as members of the family Gomphidae or of the genus *Argia*.

Birds: The inventory of bird species suggests rich variety and little reason for concern under the prevailing habitat conditions. Recognizing that habitat changes surrounding the park can impact viability of some species within the park, it behooves the NPS to account for foraging and migratory patterns of all species as regional changes develop.

Planning for the bald eagle population at the park needs to be addressed. One option is to actively manage large old pine forest areas for eagle roosting and nesting habitat. Such management could involve thinning suppressed and lower canopy trees to accentuate the large crowns and large branched trees preferred by eagles. As a rule, coordination with the Virginia DGIF authorities concerning management for the bald eagle population in the park and vicinity should be the operative policy.

Mammals: Barry and Dolbeare (2006) state that the Birthplace “supports a predictable assemblage of mammals given the diversity of habitats present.” The white-footed mouse (*Peromyscus leucopus*), northern short-tailed shrew (*Blarina brevicauda*), Virginia opossum (*Didelphis virginiana*), raccoon (*Procyon lotor*), and white-tailed deer (*Odocoileus virginianus*) are common species which are widely distributed within the park. However, survey results indicate several species of interest that warrant further discussion.

The presence of two habitat specialists, the least shrew and the eastern harvest mouse, within the managed fields of the park suggests that current management practices are beneficial to grassland species (Barry and Dolbeare 2006). The least shrew was documented on the property despite the use of survey methods ill-suited to the capture of this species. Barry and Dolbeare (2006) suggest that, in future surveys, incorporating the careful use of pitfall traps in the fields would likely reveal a large population of least shrews and possibly document the pygmy shrew, which would be a new species for the park.

Several species have been found in low numbers at the park, including the southeastern shrew, marsh rice rat, southern flying squirrel, and long-tailed weasel. In addition, the woodland vole, muskrat, house mouse, Norway rat, and mink have existing records at the park but have not been recently confirmed. Special note should be made of these species when further inventory and monitoring is considered.

Barry and Dolbeare (2006) also make special note of the presence of river otters, three of which were seen in Popes Creek, indicating that this species is restricted to permanent watersheds within its range.

In the past, two exotic mammal species have been observed in the park. Domestic dogs were observed on the property in 2003 but it was uncertain whether they were part of a feral population or simply domestic animals from nearby residences (Barry and Dolbeare 2006). Another exotic species, the house mouse, was documented around the barns and outbuildings by Painter and Eckerlin (1993). While this species was not found within the park by Barry and Dolbeare (2006), they did observe that it was the most abundant species sampled in an adjacent agricultural field.

Aquatic species: Atkinson (2005) found that a sizable fishery exists at the Birthplace. Although there were no rare species observed during this survey, there is some concern among Atlantic coast states with regard to American eel populations due to recent declines throughout its range (Atkinson 2005). The Atlantic Sturgeon is another species of concern that is believed to use the waters near the park, although its presence has not been documented (VADGIF 2006). While significant fisheries resources have been documented at the park, the park's relatively small size precludes control of these resources which are part of the much larger Popes Creek and Potomac River aquatic systems (Atkinson 2005). It is most likely that any effects on these communities come from development, agriculture, or other disturbances outside of the park's boundaries (Atkinson 2005).

Special Topics

Special topic areas include the viewshed, air quality, lightscape, and soundscape, all of which share the characteristic that their conditions and effects on the park are largely beyond direct control of park and NPS personnel.

Air quality at the Birthplace reflects its position within the urbanizing Middle Atlantic region and the heavy dependence of residents on personal vehicles for transportation. Similarly, viewshed and lightscape issues result from the rapidly developing rural-urban interface and the tendency for affluent city dwellers in the region to seek locations where recreation and leisure can be spent proximal to water. Noise issues from traffic may also be rising locally, but an acute problem experienced at the park specifically relates to weapons testing over the Potomac River.

Of these four topics, the least important for planning consideration at this point would seem to be lightscape because visitor activity at the park is restricted to daylight hours. Lights visible at night from the site are therefore immaterial. Certainly this would change if evening and nighttime activities are planned in the future. Therefore, assessment of the impacts of nighttime light issues on such plans would need to occur during the planning and Environmental Impact Statement process.

Air quality, though of some concern, especially as it may impact visibility from the Potomac River shore line of the park, is one of the topic areas where little can be done by NPS to address the issue. Ground level ozone concentrations perhaps should be monitored and considered in landscape planting decisions.

The fate of adjacent properties should be of greatest concern in planning the future at the Birthplace. Views across Popes Creek and beyond the split rail fenced boundaries of the park are the most likely to affect visitor experiences. Potential impact from buildings on the Maryland shore and either upriver or downriver on the Virginia shore can be substantial.

These topic areas will increasingly cause future concern and therefore compel the NPS to remain engaged with all regional and local planning efforts in order to foster greater understanding and cooperation when potential effects on the Birthplace are noted.

Threats and Vulnerabilities

Physical Resources

Much change has occurred over the years in the Northern Neck, but much of the surrounding area still depends on a rural economy, with agriculture and logging as economic mainstays. Due to improvements in roads, more people who live in the Northern Neck now work outside of Westmoreland County at places like Fredericksburg, VA, the U.S. Navy installation at Dahlgren in King George County, and even Washington D.C. Also, due in part to improved water access and roads, recreation and retirement are significant economic factors. Thus, the character of the area could change dramatically in a very short time if presently observed trends continue. Population growth and increased services may increase pressure on the natural resources of the area and affect the historical setting of the park. Ellsworth (2003) suggests that “while ecosystem protection is provided by current park practices, stresses will be experienced due to development beyond the immediate control of park staff.”

Geological Resources

Shoreline erosion in this area has been dated to more than 1000 CE, and should be considered a natural process (Newell et al. 2000). Nevertheless, “shoreline erosion is one of the major concerns ... as loss of archeological resources and undesirable landscape change related to cliff erosion has occurred” (Ellsworth 2003). Thornberry-Ehrlich (2005) also notes that paleontological resources within the park are impacted by erosion processes. Large sections of shoreline cliff have been lost in recent years, especially during tropical storm events. High, flat terraces (up to 4.5 m vertical rise) along the shore of the Potomac River are vulnerable to mass loss generated by the undercutting of unconsolidated sediments associated with flooding, wave action, and erosion forces related to precipitation (Belval et al. 1997). In the long term, the cumulative effect of these processes may result in the loss of historically significant land. For instance, the site of Washington’s baptism at Church Point was reportedly lost to erosion some time before the establishment of the Birthplace (Thornberry-Ehrlich 2005).

Ellsworth (2003) provides further discussion of the erosional process within the park stating that:

“According to French (1985), cliff erosion at the park is primarily due to percolating water, which disperses through soil and gravel layers to an underlying clay layer resulting in lateral flow and subsequent mass wasting (i.e. loss of soil). Water flows along macropores associated with root channels, which exacerbate the erosion process by undermining root wads and directing water to the underlying clay layer. While French (1985) indicates wave action is not as great a threat as percolation due to the beach’s ability to buffer wave impact, the physical structure of the cliffs suggests wave action and lateral movement of sediment are also important components of the erosion process, particularly during large storm events (Hand, personal communication).”

In winter, erosion may be further increased due to freeze-thaw cycles within the soil (George Washington Birthplace National Monument, R. Moräwe, Chief, Natural and Cultural Resources Management, pers. comm., 2006). These cycles decrease soil-particle cohesion, which increases soil erodibility and the erosivity of subsequent runoff (Ferrick and Gatto 2004). In any event, the

continuation of these processes, while natural occurrences, poses a threat to the archaeological and paleontological resources of the site and may result in significant loss of park land.

In addition to significant natural impacts, fossils at the park are exposed to human impacts as well. Although collecting any fossil material on any NPS land is illegal, at the park this activity has historically occurred. Traditionally, fossil collecting on the beaches of the park has been a popular recreational activity due to the abundance and variety of fossils that can be found. The popularity of fossil collecting on park land may also be fueled by the constant “renewal” of material washing up on the beaches, coupled with the fact that the Birthplace provides the only free public access beach with fossils in the area. Collecting is allowed at Westmoreland State Park, although this activity is limited to “in plain view” fossils, and no digging is allowed. Likewise, public access beaches at Calvert Cliffs State Park in Maryland allow personal collecting, but no digging or excavating into the actual cliff face (Kenworthy and Santucci 2003).

Water Resources

Lewis (1999) states “potential threats to water-quality in the park include: (1) encroaching development (primarily outside of the immediate area of the park) and (2) agricultural activities.” He notes that their “data-collection sites and the parameters analyzed were selected based on the spatial distribution of land-use activities inside and immediately outside of the park’s boundaries and the nature of the potential threats to park water-quality.” (Lewis 2001).

The recent sale of the Muse property, interior to the park, indicates the potential for water quality issues to originate in close proximity to the park. Currently, this property is being cleared and prepared for septic system installation by the new owners. This may be a potential source of water quality problems such as nutrient runoff or groundwater contamination.

At a January 2006 meeting concerning water quality, Linda Crandall of Colonial Beach, a town located about 5 miles upriver from the park, stated that requests for new housing starts are increasing dramatically. There were about 450 requests in 2004 and 2005 compared with a “handful” per year in the past. She said the town expects population to double within the next three years. Moreover, Colonial Beach could include Monroe Bay, Placid Bay, Monroe Hall, and Oak Grove, all outlying areas where growth is already occurring. In addition, extension of planned sewer lines to these areas will remove current limits to development.

As growth continues in the surrounding area, threats posed to the park by VA Route 3 may increase as well. This is a fairly heavily traveled road that crosses Popes Creek about 2 miles southwest of the park. A traffic accident on this road could potentially contaminate Popes Creek, which flows from west of VA Route 3 to the park. In addition, the Virginia Department of Transportation has a maintenance facility in this area where fuel is stored, posing another threat to the creek. In spite of recently announced plans to close the facility and operate it as a staging area, fuel storage there is likely to continue. (George Washington Birthplace National Monument, R. Morawe, Chief, Natural and Cultural Resources Management, pers. comm., 2006).

Groundwater is protected somewhat by its isolation from the surface. The aquifer and geologic structure at the park indicate a need for awareness of possible routes of contamination to both the

surficial and deeper aquifer. Because the Columbia aquifer is unconfined, the direct route of recharge into the aquifer is through infiltration of rainfall at or near the Birthplace, and therefore surface conditions may affect the quality of that aquifer.

Past farming practices may have led to nutrient contamination of the groundwater from fertilizers or manure. Along with nutrients, there is a possibility that some hydrophilic pesticides also may have been transported into the groundwater. The effects of farming practices by generations of farmers may take tens to hundreds of years to move through the groundwater and discharge to the surface water (Belval et al. 1997). Current conditions may change, as the impacts of past practices are revealed in the hydrologic system.

Leaking septic systems may be another source of nutrients to the groundwater. Soils around the Birthplace do not readily percolate, so only a limited number of new septic systems have been installed in the county, and that has limited the development of homes and businesses. While regional sewage treatment facilities will protect groundwater from contamination through septic systems, they will allow for increased density of housing, which could have other negative effects on water quality in Westmoreland County. Treatment facilities for large municipalities along the Potomac River are also responsible for large discharges of untreated sewage during storm events or power outages. Such events are not uncommon and may be responsible for green tides and massive fish kills (George Washington Birthplace National Monument, R. Moräwe, Chief, Natural and Cultural Resources Management, pers. comm., 2006).

The indefinite closure of Popes Creek to shell fishing, due to high levels of coliform bacteria and other contaminants, indicates the reality of water quality problems at the Birthplace. VA DEQ officials have identified the largest natural contributor as the waterfowl population inhabiting the creek, and cite cattle and failed septic systems as additional causes. Given the limited flushing regime in Popes Creek, this pollution problem is seen as a fairly typical condition.

Application of bio-solids to upland fields does not appear to be contributory to water quality problems, despite concerns a number of individuals have raised about this activity. None of the tested areas have produced evidence suggesting this activity as a source. Tests have not included heavy metals, pharmaceuticals, etc. and the applied material is supposed to be heated to kill most viruses and bacteria, so questions about the practice may linger.

Wetlands

The wetlands report by Sustainable Science, LLC (2006) notes “the VIMS study results indicate that between 1985 and 1994 the total Popes Creek Marsh Island complex went from 27.23 acres to 22.87 acres. This 4.36 acre loss represents 16% marsh area reduction over the nine (9) year period. This trend correlates to nearly 0.5 acres of vegetated marsh lost each year. The Sustainable Science, LLC study indicates the Popes Creek marsh complex within the park’s boundaries was comprised of approximately 24 acres of vegetated marsh in 1937. The currently mapped vegetated marsh within the same area has revealed that only 9.4 acres remain. This, longer term, translates to a total loss of 14.6 acres or nearly 60%, equivalent to a loss rate of 0.2 acres per year. Should these trends continue, the Popes Creek vegetated marsh complex may entirely disappear in 19 to 47 years.”

Invasive species of common reed (*Phragmites australis*) dominate portions of the shoreline especially near the northwest pond and Digwood Swamp. The spread of the common reed within the park has been dramatic in recent years, and is threatening much of the native flora in these areas (George Washington Birthplace National Monument, R. Moräwe, Chief, Natural and Cultural Resources Management, pers. comm., 2006). Though this plant species is not considered valuable for wildlife habitat it does provide some protection from shoreline erosion. Other invasive species such as Japanese honeysuckle (*Lonicera japonica*), field garlic (*Allium vineale*) and tree-of-heaven (*Ailanthus altissima*) were noted during the field program to dominate the abandoned homesteads located on the eastern forest edge north of the Muse Farm Road and in the south central portion of the eastern park parcel. Besides the above described areas, dominant stands of invasive species were not noted during the field review.

As previously discussed, agricultural runoff does enter the park from the adjacent western parcel. Agricultural runoff may potentially convey nutrients and other agricultural chemicals depending upon the existing farm practices. Therefore, the pollution removal function of wetlands would be particularly important in this area.

Biotic Resources

Flora

Threats and vulnerabilities to vegetation at the park focus on three areas: (1) invasive plants, (2) loss or change of tidal wetland species, and (3) forest conditions. The invasive plants issue has been assessed in some detail, apparently due to NPS staff and overall federal land managers' increased sensitivity to this issue on public lands. Comments about changes in the species composition of tidal wetlands have appeared in several evaluative reports completed for the park. The status of the forested lands appears to be of less concern, if the lack of specific data and lack of comments about the forests are indicators. However, reason for concern about forest conditions may exist. Clearly the first of these three issues may easily intersect with the other two, as invasive species in wetlands may overcome the indigenous vegetation, or invasive tree species may alter forest composition over time. However, invasive tree species are most likely to prove problematic in areas not now densely forested or in areas radically disturbed and therefore ready to regenerate with available pioneer species.

In 1999, Åkerson and Moräwe of the NPS did field reconnaissance at the park to locate alien invasive species, and they listed 11 problematic plants (Table 20). Based on work done about the same time, Dodge (2000) reported that he identified 87 *introduced* species among the 307 that were either identified in the field or collected and later identified. The introduced plants represent 28 percent of the species Dodge found, which actually may not be that unusual for sites along the Eastern Seaboard that have been disturbed since Colonial times. Of these introduced species, Dodge stated 78 percent were common or occurred occasionally at the park (as opposed to being uncommon or rare). Dodge was not concentrating on, and therefore did not focus on, alien invasive species. He did not include 5 of the 11 species listed by Åkerson and Moräwe (2000), though the names of two species (*Festuca elatior* and *Verbascum phlomoides*) may be confused in one or the other of the reports. The absence of English ivy, Princess tree, and Multiflora rose from the Dodge list is worth noting because the Åkerson and Moräwe report suggests urgency for addressing these species is "High".

Table 20. Potentially problematic invasive exotic plant species at George Washington Birthplace National Monument and treatment priority (Åkerson and Moräwe 2000).

Common Name	Scientific Name	Park Location	Treatment Priority*
Autumn olive	<i>Elaeagnus umbellata</i>	Along Potomac and NE boundary	1
Chinese lespedeza	<i>Lespedeza cuneata</i>	Along Potomac and sandy bars	2
Common mullein	<i>Verbascum phlomoides</i>	Garden plot and elsewhere	4
English ivy	<i>Hedera helix</i>	Along Popes Creek and old bridge	3
Japanese honeysuckle	<i>Lonicera japonica</i>	Scattered in forest and edges several places	2
Multiflora rose	<i>Rosa multiflora</i>	Along Popes Creek Trail	2
Orchard grass	<i>Dactylis glomerata</i>	In fields along road to J. Washington site	1
Periwinkle	<i>Vinca minor</i>	Along Popes Creek bank and park houses	4
Phragmites	<i>Phragmites australis</i>	Along Potomac and Popes Creek Islands	2
Princess tree	<i>Paulownia tomentosa</i>	Road to J.Washington site and park housing	3
Tall fescue	<i>Festuca elatior</i>	Road to J. Washington site, beach and maintenance yard.	1

*1 = highest priority.

Examining data from the Dodge (2000) study does indicate areas at the park that seem problematic concerning alien species, as shown in Table 21. The maintenance area ranks first and is a concentrated area. The second highest ranked area actually combines all points cited by Dodge along the shoreline, beach, etc. The threat of invasive plants here intersects with the concerns noted by Ellsworth (2003), as raised by several studies of conditions in marshes around Popes Creek.

Concern about changes observed in marsh plants is likely to be part of the larger issue of sedimentation and water quality change in Popes Creek. Undoubtedly, plants in marshes are sensitive to qualities of substrates upon which they grow, the nutrient availability in the aquatic system bathing their roots, and perhaps even air quality and solar inputs in ambient conditions. The extent to which all the factors interact to foster change must be understood to explain, and thereafter address, the perceived problems.

Similarly, knowing the condition of forest stands remains prerequisite to identifying threats and determining vulnerabilities. We cannot know the extent to which the conditions that Abrams and Black (2000) identify for 5 ha of the forest apply in the total forest. We can speculate that the pine and mixed pine-deciduous forests are fairly old and therefore at some risk for southern pine bark beetle and other beetle attacks and heart rot. A widespread beetle attack that killed substantial numbers of old and overly dense younger trees would thereafter open the forest to invasion by exotic species mentioned above. Size of the openings created by tree deaths, proximity of the invasive species, and availability of deciduous sprouts and seeds, in addition to pine seedlings to occupy the new growing space, would determine the ensuing mix of forest trees. In any case, the forest would remain forest whether attacked by insects and altered or not. A substantial attack by insects would, however, eventually create conditions that threaten human visitor safety in any areas where pines died. Such dead trees could either force salvage actions, hazard reduction actions, or closure of stands to visitor use. While closure might be tolerable in some areas of the park not typically accessed by the public, in some areas it would probably not be desired.

Fauna

Amphibians and Reptiles: Mitchell (2005) has identified a number of threats to amphibian and reptile populations within the park, including mortality due to vehicular traffic, boat traffic, human disturbance or killing, subsidized predators, and habitat loss or alteration. Mortality due to vehicular or boat traffic is currently unknown; however, Mitchell suggests it may be high for some species. Removal of animals by humans for personal or the commercial pet trade also constitutes an unknown threat level as there are no data to evaluate this impact.

Scavenging/predatory mammals present a significant threat to reptile and amphibian populations at the park. Many of these species, known as subsidized predators, exist at higher population densities in areas of high human use due to garbage, discarded food, and structures that are used as shelter. Raccoons, in particular, are notorious for killing and eating adult turtles and eggs in nests. They also eat frogs and any other amphibian or reptile they can catch. Other animals that

Table 21. George Washington Birthplace National Monument problem sites for exotic species (Dodge 2000).

Problem Site (Dodge 2000)	Number of Exotic Species
Maintenance area and environs	21
Beach, beach swale, Potomac shore, Popes Creek	18
Muse Road and former home site	13
Burial ground and environs	12
Picnic area	10

qualify as subsidized predators include foxes, opossums, skunks, and crows (Mitchell 2005). All of these species have been documented at the park (Barry and Dolbeare 2006) and should be considered threats to the amphibian and reptile populations. However, classifying these species as subsidized predators suggests potential for reducing their impacts by minimizing human activities that benefit them.

Past studies have shown that opening areas to recreation can have impacts as significant as the complete loss of a turtle species population (Garber and Burger 1995). This was caused primarily by removal of turtles by humans and dogs. Similar problems may occur with box turtles, which are found within the park. This species is often picked up by human visitors and, if not removed, is relocated to another area. This relocation by park visitors results in loss of important reproductive individuals from populations. Therefore, areas of the park where box turtles concentrate should be evaluated before opening them to recreational activities (Mitchell 2005).

Ecotoxicology studies of herbicide and pesticide effects on amphibians have not been thorough and often use only a laboratory species not found in North America. However, it is believed that spraying herbicides and pesticides in and over terrestrial and wetland habitats could produce harmful results to amphibian populations, especially at the larval stage (Mitchell 2005).

Captive-raised or captive-bred amphibians and reptiles should not be released in the park under any circumstances. The potential for disease introduction is growing and every effort should be made to avoid contamination from exotics or native species from other areas. Captivity often induces stress and influences development of disease (Mitchell 2005).

Lepidoptera and Odonata: The marsh habitats in the park are fairly natural and intact systems with little impact or threats. If sea level rises in future years, the marshes may change from brackish to more salt influenced environments. This would negatively impact the Odonata directly by preventing successful breeding in these areas, and may impact Lepidoptera by changing the vegetation assemblages in the marshes. At this time, there are no management techniques to mitigate for this potential threat. Frequent mowing during the breeding season can have detrimental effects on Lepidoptera species either as a direct result of mowing, or as an indirect effect on nectar or host plant availability (Chazal 2005).

Negative effects of herbicides and pesticides are a more immediate potential threat to Lepidoptera and Odonata in the park. For example, many methods of gypsy moth control impact non-target species by compromising development of exoskeletons (VPISU 2006). Therefore, the most target-specific approach should be used when applying herbicides or pesticides. (VADCR-DNH, A. Chazal, Field Zoologist, written communication, December 2006)

Birds: The Bradshaw inventory report indicates a remarkable variety of birds at the park. This positive result underscores the fact that varied habitats exist, so changes in habitats can have both potential negative and positive effects on bird species, depending upon the particular habitat characteristics that change. Both natural and human induced changes in park habitat structure can favor or disfavor any species.

Mammals: Barry and Dolbeare (2006) state the importance of wetlands to a number of species found at the park and indicate that increased visitor use of areas around wetlands may adversely impact sensitive species such as the river otter.

Current management of the fields within the park appears to benefit small mammal species. However, alteration of management practices could be detrimental to these species which would, in turn, negatively impact large mammal species. Changes to field management practices may also encourage the expansion of the exotic house mouse, which appears to be abundant in adjacent fields (Barry and Dolbeare 2006).

The raccoon and white-tailed deer are abundant within the park and merit some concern as well. Raccoons can be a significant predator of many species of reptiles, amphibians, and birds and are also the primary reservoir of rabies in the Southeast. Barry and Dolbeare (2006) suggest that some activities at the park, such as picnicking and improper garbage disposal, may increase raccoon populations and their negative impacts. An overabundance of white-tailed deer may also have adverse impacts within the park. If the deer population grows large enough to affect understory cover, birds and other mammals may be impacted (Barry and Dolbeare 2006). Deer also serve as hosts to a number of parasites including the black-legged tick which is a vector of Lyme disease. In light of the abundance of the white-footed mouse, a competent host for tick larvae and nymphs, a large deer herd may increase health dangers to visitors and park staff (Barry and Dolbeare 2006).

Aquatic Species: The principal management issues that may impact water quality and/or fish populations within the aquatic systems at the park are potential effects from activities associated with development, agriculture, and other disturbances outside of the Birthplace. While it is generally acknowledged that every aquatic system within Atlantic Slope drainages has been somewhat degraded from pre-colonial conditions, the primary challenge will be to limit future degradations in an attempt to preserve and/or restore water quality and associated fish species assemblages.

Currently, surface water resources are impacted locally by land and water use within the three contributory sub-basins; by flooding, and erosion and deposition conditions with the Potomac River basin; and by tides, salinity, and regional basin conditions as tidal tributaries with the Chesapeake Bay watershed. Groundwater resources are affected on a local scale by water level and water quality in the shallow aquifer system and on a regional scale by changes in the water level and water quality within deeper aquifer systems. Additional impacts to water resources within the Birthplace include: local erosion and sedimentation as a result of agriculture or septic systems, and historic and current use of pesticides and herbicides (Belval et al. 1997). Broader-scale impacts may include problems with transporting of industrial and municipal waste, point-source discharges of waste, and hazardous material spills (Belval et al. 1997).

Ellsworth (2003) reports that eutrophication and loss of submerged aquatic vegetation within the waters of the park are likely associated with pollutants. Data are available to establish baseline water quality, which may be used to demonstrate future degradation for management purposes.

While a number of people (Ellsworth included) have raised concerns about land application of waste manure for agricultural purposes, the recent work by VA DEQ does not support this concern because no evidence links this application to the observed water quality problems.

The issue of water quality could emerge as a threat to water fowl populations in Popes Creek. As was noted above, closure of Popes Creek to shellfishing resulted from determinations that coliform bacteria and other contaminants were too high. The water fowl population was identified as the largest current contributor of pollutants. To address the matter, people in the community desiring shellfish harvesting could demand wildlife reductions to reduce bacterial contamination. If the goal is to reduce contaminants and raise water quality so shellfish can be harvested, then national standards for an export quality product would have to be met.

Rare and Protected Species

Rare and protected species that have been observed at the park include 14 species of fauna (see Table 12) including the bald eagle and two globally rare vegetation communities. In addition, the park has potential habitat for one federally listed threatened and one federally listed endangered species. Significant threats to the bald eagle and other rare species include residential development of land surrounding the park and increased recreational use of Popes Creek and the Potomac River. Within the park, however, the assumption is that these species and habitats are and will continue to be monitored and protected, consistent with the mission of the NPS.

Special Topics

Viewshed

The intent of the NPS is to maintain vistas that represent the experience of George Washington and his family. However, desirable views from the Birthplace are both currently impacted and in jeopardy of future disturbance.

Doherty (1987) identifies a number of threats to the park's views that are still relevant. The first of these is potential changes in the area's land use. Doherty identifies a number of land uses that were never components of plantation landscapes and should be viewed as threats to the Birthplace. These uses include non-farm residential developments, light or heavy industry, business or commercial use, marinas, campgrounds and other intensive recreational facilities, mobile homes, major above-ground utility lines, oil or gas drilling, and billboards or other large commercial advertising signs.

Changes in the density, sites, spacing, orientation, or design of built areas are also threats to the park's historic setting (Doherty 1987). Increases in housing density, new developments in visually prominent areas (e.g., waterfronts, wetlands, agricultural fields), use of incompatible accessories such as satellite dishes, or use of building materials other than wood and brick should be discouraged to preserve the view (Doherty 1987). Additional concerns include haze associated with air quality and near shore boating recreation (Ellsworth 2003).

Air Quality

For vegetation, the focus is on ozone sensitivity because 1) ozone is a regional pollutant and is, therefore, more likely to affect park resources than other gaseous pollutants like sulfur dioxide and nitrogen oxide, which quickly convert to other compounds, and 2) the literature on ozone sensitivity is more recent and more reliable than that for other pollutants. Park vascular plant lists contained in the April 2002 NPSpecies database were compared to the list of Very Ozone-Sensitive Plant Species contained in the NPS Synthesis information management system. The Synthesis lists were developed by an expert in the field of ozone effects on vegetation.

According to a SUM06 map generated by the University of Denver, all eight Northeast Coastal and Barrier Network parks have ozone concentrations, during some years, that are high enough to harm native vegetation (NPS 2002a). Given this, foliar injury surveys on sensitive species may be warranted. Black cherry (*Prunus serotina*) and common milkweed (*Asclepias syriaca*) are good candidates for foliar injury surveys because (1) ozone injury symptoms for these species are well described and (2) standardized survey protocols and training manuals have been developed (NPS 2002a). Both Lam (1985) and Dodge (2000) encountered *Prunus serotina* at the park, but only Lam reports finding *Asclepias syriaca* in the park.

Lightscape

The presence of artificial lights at night in the proximity of the park would be a problem if nighttime activities were to become a prevalent part of the Birthplace's typical activities.

Soundscape

Unlike lights visible at night, which are not an intrusion on the public's perception because the park is typically closed at night, the noise disturbances from several sources would impact the typical daytime visitor. The Naval Surface Warfare Center (Dahlgren) testing of weapons over the Potomac creates sporadic booming noises that are clearly audible throughout the park but especially noticeable along the river shoreline. Noise impacts from personal watercraft use in Popes Creek are expected to increase as the population of the area grows (George Washington Birthplace National Monument, R. Morawe, Chief, Natural and Cultural Resources Management, pers. comm., 2006).

Information Gaps

Recent inventory work at the Birthplace has closed most gaps in knowledge about resources at the park. Hence, the authors of this document find that a strong basis for planning exists in most areas of natural resources investigations. However, gaps that exist may pose difficulties in making certain decisions about what to do with specific resources.

This section itemizes needs for further information to provide a complete inventory or total understanding of the resources at the Birthplace. Overlap with statements in previous sections is likely when discussing the status of a resource noted the lack of certainty or detailed information. Essentially, however, this section is a list that corresponds with the Report Card.

Physical Resources

Geological Resources

(1) Preservation and successful management of resources at the park will benefit from documentation of temporal dynamics. While measurements of cliff erosion along the Potomac River have been conducted previously (French 1985 and Miller 1987), continued studies are needed to provide an ongoing assessment of shoreline degradation or aggradation. As recently as the summer of 2006 new, storm-caused erosion was noted by park staff. Tracking shoreline erosion will allow park staff to establish an appropriate timeline for documentation of archeologically important artifacts that may be exposed or buried by these processes.

(2) Only general relationships between nutrient loss from eroded soils and overall productivity can be deduced. If such analyses are truly needed, they appear not to be available in documents examined to produce this natural resource synthesis. Careful integration of all the pertinent historical and scientific data generated by the multiple and varied studies requires an interdisciplinary perspective attuned to the subtle implications of ecology in historical context, thus the expertise of an historical ecologist.

Water Resources

(1) Apparently no one has described the streams flowing into or from the park. Information concerning basic characteristics such as channel width, bank height, substrate material, and stream bed features (pools, riffles, etc.) has not been recorded. Their relationship to other landscape features such as riparian vegetation and adjacent or proximal wetlands needs to be better explained. The Popes Creek and Bridges Creek watersheds have not been delineated with digital data so analysis via GIS is not possible.

(2) Comments on the susceptibility of the aquifers to contamination appear to create some confusion. In one instance authors state that “the deepest aquifers from which water is withdrawn are susceptible to water-quality changes due to encroachment of waters higher in sodium chloride in the aquifer and groundwater level drops from regional usage” (Belval et al. 1997). But another source states that the lower groundwater aquifer is well confined and not readily susceptible to degradation. Clarification may be provided by a USGS report, which is

currently in review, describing groundwater assessments around the Birthplace area (U. S. Geological Survey, Gary Spearin, pers. comm., 2006).

(3) Two research initiatives have been suggested: examining localized surface water/groundwater chemical and physical interactions with the Virginia Coastal Plain, and determining sedimentation and erosion effects on wetlands, wildlife habitat, and other aspects of water resources in Westmoreland County. The slow rate of groundwater movement necessitates long-term and current changes to management practices, as changes may not be observed in the chemistry of the groundwater for many years.

Information concerning the contribution groundwater discharge provides to the surface water resources of the park is not known. However, it should be noted that groundwater contributions to coastal water conditions everywhere along the Atlantic Seaboard have not been investigated and are just beginning to attract scientists' attention.

(4) No information has been found to quantify or describe the amount or kind of recreational use in the aquatic areas surrounding the park, either in Popes Creek or portions of the Potomac River near the park boundary.

(5) Information concerning sub-aquatic vegetation is lacking.

(6) Finally, the current issue of contamination in Popes Creek suggests the need to investigate the sources, and DNA fingerprinting has been suggested as an analytical need.

Biotic Resources

Much work has been accomplished very recently in regard to the biota at the Birthplace. After longer use of these new data or during the planning process, gaps that are not identified below may emerge. Further investigation may be needed to determine the status of some of the rare and protected species that may occur at the park, as discussed in the "Natural Resources" section above. The status of the federally endangered northeastern beach tiger beetle and American burying beetle may be particularly important.

Flora

Despite the plant species inventories that have been conducted, the need to delineate plant communities and enumerate the species in the particular communities still exists. We believe that work is underway but it is not available for the current synthesis so is identified as an information gap. We do know the following:

(1) The health of the forest in the park cannot be expressed in terms commonly understood in forest inventory and monitoring systems. Neither species composition, nor stand ages, nor densities for the greater portion of the forest at the park are now known. Thus, little can be said about forest habitat quality for fauna, the risks of disease and insect infestations, and aesthetic considerations with regard to management in concert with the mission and stated goals for the Birthplace.

(2) We cannot say how current forested areas were used at various points in history and how long current forest areas have been forested. We wonder if cleared lands have been cleared for a long time. Most answers to such questions can only be speculative at this point. Abrams and Black (2000) look at a small area of the forest, apparently the oldest, but the small size of their study means findings from that study cannot be extrapolated to the rest of the park property. When someone asks if deforestation was a major factor in ecological impacts of historical periods described, generic answers may suffice but do not address specific conditions seen at the Birthplace.

Whether or not any alterations to forested areas are planned, prediction of change as a result of passive management in these areas requires baseline data on age, density and composition to predict environmental impacts. The study by Abrams and Black (2000) was insufficiently broad to provide such information, and none of the plant species inventories encountered supplies such data.

(2) Because fieldwork to determine alien plant species occurrences was performed in autumn, early alien ephemerals may have been missed (such as garlic mustard and others). Additional reconnaissance should be conducted in the spring to supplement what is currently known. To date, ongoing efforts to identify alien species have been hampered by a lack of experienced volunteers, researchers, and funding.

(3) No data exist concerning fungi in the park--neither species that occur nor abundance of specimens.

Fauna

Amphibians and Reptiles: Additional documentation to add to the overall amphibian and reptile species list for the park could be accomplished in three ways: (1) routine accumulation of digital photographs of road-kills, especially snakes, with appropriate documentation (date and location), (2) use of several cover board arrays monitored periodically, and (3) use of natural history (animal) sighting cards completed by knowledgeable visitors. Reinstatement of the latter program would result in a valuable source of information for natural resource management staff if accompanied by verifiable information such as a photograph or specimen (Mitchell 2005). Further work to document snake species at the park should include the use of cover boards as part of the sampling plan.

Additional herpetological work at the park could include methods for acquiring species abundance and detailed distribution information of all species documented during this inventory.

Lepidoptera and Odonata: The results of the Lepidoptera and Odonata study by Chazal (2005) represent an important component in developing an understanding of the biodiversity of the Birthplace because virtually nothing was previously known about the diversity of these species or their habitat utilization within the park. Chazal (2005) indicates that similar inventories should be conducted in the future because of the need to increase baseline knowledge. There is also potential for observing additional species. Nocturnal surveys would be especially useful in furthering an understanding of Lepidoptera within the park (Chazal 2005).

Beetles and Arachnids: No inventories of beetle and arachnid species have been discovered during the synthesis compilation. Given the importance of several beetle species potentially occurring in the region, such an inventory is probably warranted. At the least, definitive statements by experts in the field should be obtained for documentation during the environmental assessment process.

Mammals: Currently, insufficient data exists to provide an accurate accounting of arboreal, semi-arboreal, and bat species within the park. Additional inventory work should be conducted to determine the status of species that have been detected in small numbers (e.g., the southeastern shrew, marsh rice rat, southern flying squirrel, long-tailed weasel) or that have existing records but no recent documentation (e.g., the woodland vole, muskrat, house mouse, Norway rat, and mink). Further investigation should also focus on the smaller shrews to more accurately determine their distribution and abundance (Barry and Dolbeare 2006).

Aquatic Species: Determining American eel populations in Popes Creek could help address the regional question about the status of this species in east coast waters (Atkinson 2005).

Determining reasons behind closure of the shellfishery in Popes Creek and the proximal waters of the Potomac merits attention.

Information regarding shellfish populations within the waters surrounding the park is lacking and should be addressed in future aquatic surveys.

Special Topics

Viewshed

The last study of the viewshed at the park was completed nearly 20 years ago (Doherty 1987). Considering the importance of this topic and the changes that have occurred in the past 20 years, the importance of updating this information should be apparent.

Air Quality

According to the information available, air quality monitoring stations that exist are close enough to provide the information needed to make judgments regarding ambient conditions at the park.

Lightscape

Unless the visiting hours at the Birthplace change, there appears to be no need for more information concerning this topic.

Soundscape

No information other than anecdotal statements and personal experience exists to support judgments concerning the effects of noise on perceptions of park visitors. Ambient noise analysis and baseline data would be needed to make any decisions about potential actions concerning this topic. It is not apparent that having such data would make a difference in terms of available actions or decisions that could be made.

Recommended Future Actions

While recognizing the value of the park, the park profile (NPS 2005d) identifies several development and operational needs for improving visitor experiences and park management. These needs include facilities rehabilitation, facilities development, and infrastructure improvement, as well as continued management to improve the condition of the natural and cultural resources. As these development and operational needs are addressed, it is necessary to understand impacts these changes will produce and account for them in the park's General Management Plan. The natural resource synthesis has drawn together the facts known about conditions at the Birthplace. Interpreting the facts prompts varied recommendations. In this section recommendations attributed to specific persons or reports will be so indicated, and recommendations offered by authors of the current synthesis will be so indicated.

Ellsworth (2003) asserts that “maintenance of high quality natural resources at the park is critical from an historical, environmental, and legislative perspective. Congressional intent upon establishing this national monument was to preserve the site in order to allow visitors to appreciate the setting and experiences of George Washington's boyhood.”

In his report, Ellsworth (2003) encourages park staff to continue efforts “to remain abreast of proposed development in the vicinity. [He says] identification and continued interaction with the parties associated with local land management will facilitate this process.” The current assessment fully supports how critical involvement in local decision-making is to the Birthplace.

Ellsworth (2003) also calls for a working list of potential and extant cooperators to be compiled and maintained for operational guidance. Comprehensive monitoring and research needs are beyond the scope of the park's current staff and funding abilities. Recognizing available resources, supporting appropriate resource management initiatives, encouraging research, and reviewing resource assessments in a timely fashion will allow best management practices to be observed. Again, the current synthesis suggests that limited staff time and inevitable gaps in resource management expertise need to be addressed through cooperation with other federal and state agencies whenever possible.

Physical Resources

Geological Resources

As this synthesis identifies considerable issues concerning physical status of the Birthplace landscape, attention to prior recommendations seems warranted. However, the current authors did not encounter a strong rationale for actions proposed in all cases. Collecting fossils, clearly against the law, creates a potentially untenable enforcement demand on staff time. In contrast, the extent to which natural processes at work are transforming shoreline and island structures in Popes Creek and should therefore be tolerated seems debatable. Moreover, while it may be easy to suggest monitoring each aspect of change, resultant data and expended effort should be linked to definitive goals. The NPS must decide how much it will intervene in natural processes and what level of expenditure it will make to countermand otherwise inevitable change.

For instance, a report by Thornberry-Ehrlich (2005) presents recommendations for the park that can be grouped in three categories. The first category deals with physical character of the site.

- Perform several shoreline surveys per year to detect seasonal variations. Possibly recruit a volunteer to monitor the shoreline by walking the 1-2 hour distance each season using a GPS. Supplement these surveys with LIDAR and aerial photograph analyses.
- Monitor changes to islands within Popes Creek estuary.
- Identify weaker areas along the bluffs for targeted resource management efforts.
- Monitor topographic changes due to surface and cliff erosion.

As earlier sections of this report have pointed out, however, natural surface and cliff erosion processes were acting long before the park was established, and island formation and deformation is subject to larger scale influences than the NPS can effectively control. Thus, the current authors can concur with the desire to monitor changes if specific mitigation is an aim or if interpretation of the changes is deemed important to the park mission. Otherwise undue expenditure of effort and time might be wasted. Again, a decision during the NPS planning process will be needed.

The second category encompasses the paleontology and archeology resources. If, as this synthesis has discovered, these resources are deemed integral to the park mission and their ongoing status is crucial for interpretation, then recommendations from Thornberry-Ehrlich (2005) are germane.

- Monitor paleontological exposures as they are exposed by erosion.
- Determine a way to prevent fossil specimen collecting.
- Map archaeological sites.

More specifically, during the course of this synthesis process, Vincent Santucci developed four recommendations to facilitate management of the park's paleontological resources (NPS, George Washington Memorial Parkway, V. Santucci, Chief Ranger, pers. comm., 2006):

- Paleontological localities should be formally documented at the park by completing the official NPS paleontological locality forms.
- Paleontological locality condition assessments should be undertaken.
- A paleontological resource monitoring prescription should be established for threatened paleontological resources (see Santucci et al. 2006).
- A social science study to assess visitor attitudes and perceptions about the park fossils and how these translate into behaviors at the park should be undertaken.

Santucci indicates the first two recommendations could be accomplished on site in a couple of days. After that, he says, it should be possible to develop a management prescription in a few months.

The third category presented by Thornberry-Ehrlich (2005) addresses the park's status relative to its surroundings. The general recommendation suggested by this synthesis is for the NPS to engage to the extent possible in regional and local planning and decision-making efforts.

- Perform studies to define the impact of surrounding land use patterns on the geomorphology of the landscape at the Birthplace.

- Keep rigorous track of land use and development and create community profiles in surrounding areas. Possibly employ a GIS to monitor land use changes.
- Promote environmentally sound methods of developing land parcels, including partial clearing of trees and proper construction of stable slopes.

The authors of this synthesis assume that the last recommendation pertains to development in areas surrounding the Birthplace and that building methods in the park would employ such methods as a matter of NPS policy.

Water Resources

The park must remain active in adjacent land use planning activities. For instance, park staff should be as involved as is reasonably possible in discussions and initiatives to protect water quality in all waters in and adjacent to the park. When task forces and public involvement processes are established, the NPS needs to be represented as a stakeholder in decision-making. When issues such as zoning, riparian zone management, sewage treatment facilities, and Total Maximum Daily Loads (TMDL) are concerned, the NPS needs to ensure that park concerns are included in consideration of the issues.

The authors of this synthesis recommend a cautious approach by the NPS to watershed study efforts advocated by some proponents during preparation of this document. Mixed results in the existing data and watershed changes in recent years suggest that Popes Creek has only marginally better than average water quality and that its potential for degradation is greater. Digitizing the Popes Creek watershed would enhance analysis of issues concerning this resource and contributions from upstream sources. But the extent of monitoring and types of monitoring proposed need to be considered in light of park priorities and where resources will come from to accomplish proposed tasks. Again, potential end uses of such information at the park should be a practical limit to how much effort is expended.

Thornberry-Ehrlich (2005) has provided a number of recommendations for studying conditions of the park's waters. One category concerns Popes Creek:

- Promote the Birthplace as a site to monitor continuous fluvial processes and geochemical changes in the Popes Creek watershed.
- Cooperate with the USGS to obtain further cores within the Popes Creek watershed to accompany cores from the delta and estuary mouth.
- Monitor hydrologic changes of Popes Creek and its interface with the Potomac River.
- Determine the salinity gradient within Popes Creek estuary.
- Monitor sediments for pollutants and nutrients.
- Establish a baseline for comparison of water quality at Popes Creek.

While some of the previous bullet points pose interesting research questions, their practical value to managing the park toward its intended mission are not clear. If interpretation of the resource and its current status relative to past conditions is the goal, only the core sampling makes sense. If, however, interpreting the park's changing surroundings becomes an important focus, then the other points all can contribute valuable information.

Another group of recommendations from Thornberry-Ehrlich (2005) concerns groundwater quality. These seem more crucially important to the continued function of the park and are endorsed by the synthesis because groundwater from wells is used on site. Thus, changes in groundwater would potentially affect visitor and staff health. Potential drift from offsite contamination into the groundwater supply would be the presumed focus of such efforts.

- Inventory groundwater levels.
- Test water quality at any existing springs.
- Perform dye tests to look at hydro-geologic effects of local geologic structures on the watershed.
- Test for and monitor phosphate and volatile hydrocarbon levels in groundwater at the park, focusing on areas near facilities.

Biotic Resources

Future plans for altering areas of park land that may include habitat loss should be reviewed thoroughly in terms of which species use those habitats, how much of the habitat exists within the controlled boundaries of the park, how susceptible similar areas outside the park are to being altered, and how the affected areas function in the mix of habitats existing and interacting in the park.

Flora

The main issue seems to be how aggressively NPS should manipulate the landscape to recapture conditions prevalent during the historic era of interest. It is unlikely that the relatively passive management that created current conditions prevailed during the time of Washington's early childhood. The constraints on such restoration would be the current ecological sensitivity of the general public and NPS itself. Therefore, the overall recommendation would be to resolve that implicit question of what are desired cultural and natural resource conditions at the Birthplace. Involving stakeholders in discussions of this matter will be essential but will not necessarily be an easy thing to do.

No matter how the question is resolved, a timber inventory of the entire forested acreage based on a systematic sampling design should be obtained to provide data required for planning. The reasons for this have been articulated in previous sections noting the lack of descriptive data about the forest, which constitutes 50% of the park landscape. Disease and insect pest risk assessments depend on knowing stand basal area, average diameter, tree density, and annual growth increment. None of the plant inventories done previously were designed to provide such quantitative information, and vegetation mapping at the alliance level identifies communities rather than specific constituent elements. Forest health monitoring without such data is impossible.

Fungi should be inventoried. Often overlooked in discussions of biodiversity, fungi have gained greater attention in Europe than in the US. These organisms are known indicators of site conditions and plant community health. They provide small mammals with important dietary components and are crucially important wood decay organisms, thus recycling materials in

natural systems. Recent attention to long-term ecosystem sustainability suggests that certain fungal species may be good indicators of long-term stable conditions.

Ellsworth (2003) suggested that warm season grassland and meadow species should be encouraged. He does not mention grain or other crops. He noted that plans are underway for thinning a tree stand at the park, which will be planted with native grasses. This project could be managed to provide varied benefits to the park, including potential for an interpretive trail, which could culminate at a cliff wall overlook of the Potomac River. Scientific opportunities include observing changes in species dynamics associated with this vegetative community alteration. Native grass seeds could be harvested and eventually support desired farming practices at the park by making seed source available to rehabilitate other fields and pastures within the Birthplace.

The Cultural Landscape Report (OCULUS 1998.) also advocates a changeover from fescues to native warm-season grasses. In fact, the park is currently working on implementing native grasses and has proposed working with the NRCS to collect native seed and propagate root material for reestablishment in fields currently seeded in red and tall fescue.

Ellsworth (2003) pointed out that meadow maintenance should include a management strategy (e.g. fire) to control successional change. Currently, the park's draft fire management plan identifies fire as a vegetation management tool.

Potentially, the invasive species treatment plan noted in Appendix A of the report by Åkerson and Moräwe (2000) could be expanded by conducting further inventories in the spring. Figure 2 of that document shows sketches of infestation epicenters within the park. Apparently, addressing invasive species around the maintenance service area could greatly impact the observed problems. Such action could also limit the spread of pest species to other parts of the park by personnel and equipment using this area. Unintentional transport of invasive species' seeds is a primary mechanism for spread of such species to new locations.

Fauna

A comprehensive natural habitat management plan for conservation of native species and their habitats should be developed for the park. It has been suggested that a management plan would ensure that this area is maintained in its natural conditions. However, that raises the question of what is meant by natural conditions, since evidence indicates that this landscape has been manipulated by humans, to some extent, since the Stone Age.

The NPS has to decide the desired population size of the various species (deer, raccoons, for example) it wants within the park and act accordingly. No "natural" number exists to be discovered. Inventories for two types of faunal species, beetles and arachnids, still need to be conducted at the park. Below are recommendations arising from the studies of animals that have been done.

Amphibians and Reptiles: This synthesis concurs with the specific recommendations that Mitchell (2005) lists for management of amphibian and reptile species at the park:

- Perform an additional species inventory for salamanders and snakes. Further work to document snake species should include the use of cover boards as part of its sampling plan.
- Elucidate park use by northern diamondback terrapins to provide a better understanding of the abundance, distribution, and habitat use of this rare species. Determine areas of the park where high concentrations of box turtles occur and avoid opening these areas to recreational activities.
- The public should not be allowed to release any animals that have been in captivity, and park management should educate park visitors on this issue.
- Specific habitats that should be monitored on a regular basis for the occurrence and persistence of amphibians and reptiles, including tidal marshes, hardwood forests, and seasonal (vernal) pools.
- Educational materials should be developed on the park's ecology, flora and fauna, and their interactions with human history at the park.
- Park raccoon populations should be monitored, and population control measures implemented to protect all amphibians and reptiles, especially turtles and their nests.
- Develop a comprehensive natural habitat management plan to conserve amphibians and reptiles at the Birthplace. View long-term habitat management at the park within the context of the landscape matrix in and around the park.

Lepidoptera and Odonata: The high density of Lepidoptera species found in the open fields at the park indicates that reducing mowing to twice a year (early spring and late fall) might allow more Lepidoptera to complete their life cycle. Perhaps a systematic rotation of mowing times on the fields in hay production could be instituted so timely production of quality hay and the life cycles of the Lepidoptera could be balanced across the available acreage (Chazal 2005).

Birds: A plan for managing bald eagle habitat at the park should be developed in consultation with Jeffrey Cooper, non-game bird coordinator with the Virginia Department of Game and Inland Fisheries. The concentration of eagles in the park vicinity is a definite public attraction that should be considered worth increased management emphasis. Enhancing roosting and nesting territory is a proven strategy for sustaining and increasing eagle habitation so long as food availability is not a limiting factor.

Mammals: Barry and Dolbeare (2006) suggest the need for further sampling of wetlands and grasslands for mammal species as well as targeting small shrews for further documentation through the careful use of pitfall traps. Care should be taken not to disturb any archeological remains when setting these traps. Barry and Dolbeare also suggest two management strategies to be considered, continued, or enhanced:

- Afford special consideration for the protection and conservation of wetlands that support a number of mammal species in the park. Regulate visitor use of specific areas where sensitive wetland species (e.g., the river otter) occur.

- Maintain diverse herbaceous communities and interrupt succession in managed fields by careful attention to mowing and burning schedules.

The rapacity of raccoons is well known among wildlife biologists, and Mitchell has mentioned the concern over what are called “subsidized predators.” The importance of keeping raccoon and deer populations under control is underscored by the public health concerns (e.g., rabies) that appear with an overabundance of the first species (Barry and Dolbeare 2006). A large deer population may also drastically alter habitats for other species, such as reptiles and amphibians, creating significant population impacts for those species (Mitchell 2005). Barry and Dolbeare (2006) suggest that the park:

- Use management practices that either reduce the raccoon population or the consequences of human activities that sustain it (e.g., more frequent monitoring of picnic areas and trash removal).
- Use management practices to control the white-tailed deer population to preserve vegetation communities and understory cover important to mammals and birds.

This current synthesis discovered no data or reports to suggest that these species present greater problems at the Birthplace than they do anywhere else on the landscape but concurs with the general recommendations for management to control their numbers before such problems occur.

Aquatic species: Precautions should be taken to preserve the narrow forested buffers on the steep slopes adjacent to Digwood Swamp and Beach Road, and possibly consideration should be given to widening the buffer zones by allowing a few more meters of the surrounding fields to succeed back to forest. These buffer zones help maintain water quality in these systems and mitigate impacts from chance events. The park should also pursue programs like National Estuarine Research Reserve System (NERRS) that will provide additional resource protection (Ellsworth 2003). While much of the influence to the park’s aquatic communities lies beyond the NPS staff’s immediate control, the NPS should remain active in land use planning activities in the vicinity of the Birthplace (Ellsworth 2003, Atkinson 2004).

Special Topics

Westmoreland County is revising zoning ordinances (Westmoreland County 2005) with an implementation approach of grandfathering existing zoning districts, but all new practices falling under the new zoning requirements. The Birthplace should stay involved with this process, as it will impact development in the adjacent rural communities, which will affect surrounding scenic views, water quality, traffic, noise, and other issues important to the park.

For instance, the park should attempt to persuade Westmoreland County not to extend sewer and water systems to areas in which development would have the most impact on the Birthplace. Given the problems often associated with leaking septic systems, perhaps the park could encourage establishment of a special district where landowner education about proper maintenance, and then modest cost-share assistance, would be available.

While the greatest threat to views from the park continues to come from development pressures on surrounding properties, a number of the landowners in the vicinity of the park have deep roots in the area and are proud of their association with the birthplace of George Washington. As a result, some landowners in the area are enthusiastic about the role they play in preserving the historic setting of the Birthplace. However, it has been recognized that while many landowners have maintained their intent to preserve this setting, it would be beneficial to enter into viewshed easement agreements to prevent future degradation (Doherty 1987). Doherty states that “conservation easements are probably the most effective means of conserving the setting of Washington’s birthplace.” Easements allow historic land uses to be maintained while at the same time conferring benefits on the individual who remains a private property owner. Landowners are benefited in that their land remains as they specify, they retain the use rights they require for certain compatible uses, and they may be eligible for charitable deductions. Doherty (1987) also mentions several other options for preserving the setting of the Birthplace, including Westmoreland County Comprehensive Planning, Historic District zoning, shoreline setback requirements, and agricultural zoning.

Conclusion

This synthesis comes to one major conclusion that drives all others. The National Park Service, in planning for the future at the Birthplace, must decide how the park will fulfill its mission amid changing conditions that surround it now and could impact it ever more significantly in the future.

If hosting research concerning environmental change at the Birthplace is desirable, then efforts to monitor and interpret that change in historical context may be valuable. Pointing to and studying surrounding factors that impact the Birthplace now and have created its unique position within the landscape would prove useful. Researchers could add to the story to be told here.

If interpreting the past predominates, then much monitoring and study of current conditions and changing conditions, posed as possible efforts by scientists, could be foregone. Focus on the past condition at the time of George Washington and his family’s residence here suggests that changes in current resource conditions should be considered to replicate a greater sense of the family’s presence. Interpreting that reconstructed landscape in light of the surrounding changes since would still be valuable but would not require the same scientific effort.

Establishing a balance between these two aims may be possible if the resources (staff and funds) and the cooperators needed are assembled and organized to proceed. A vision of the landscape desired and a practicable plan for its creation are needed.

Report Card

The following report card (Table 22) reflects the authors' opinions based on existing information located via documentary sources or provided by experts doing commissioned studies for the NPS. The report card provides very broad summary results from the evaluation enabled by the synthesis process. For each resource category below, material in the document's text should provide ample details to further understanding of the status and trend indicators. "Evidence" indicated in the report card only describes the kind of information provided in the document.

The report card should suggest topics where closer scrutiny is probably warranted. In-depth studies during the planning process could address environmental impact questions if particular resource categories are involved.

Table 22. Status and trends in conditions of natural resources for George Washington Birthplace National Monument.

Resource	Status ^a	Trend ^b	Evidence
Geology	Good condition	<-->	
Soil	Significant concern	∨	Erosion along the Potomac shore
Paleontology	Caution	<-->	Collecting fossils was a habit of visitors to the Park but is now prohibited
Surface water quality	Caution	∨	Warning signs against shellfish consumption
Wetland extent	Significant concern	∨	Loss of acreage in Popes Creek over an extended period
Wetland function	Good condition	<-->	Most functional capacities are rated good to high
Landscape plants	Good condition	<-->	Detailed plans exist and are implemented for care of horticultural plants
Natural areas	Caution	<-->	Some exotic species intrusion; change of wetland species composition
Forests	Status unknown	?	Without inventory, forest health and habitat conditions are questionable
Animals	Good condition	<-->	Cumulatively inventories suggest an appropriate mix of species for ecoregion
Amphibians & reptiles	Good condition	<-->	High species diversity and healthy individuals have been noted
Butterflies & moths	Good condition	<-->	Inventory results
Birds	Good condition	<-->	Inventory results
Mammals	Good condition	<-->	Inventory results
Fish	Good condition	<-->	Inventory results
Federal threatened & endangered species	Good condition	∧, ?	Eagle population may be increasing; two possible species may need study
State listed species	Good condition	?	Thirteen state listed species have been identified in the park; no trends
Air quality	Caution	∨	Regional traffic increases lowering ambient conditions
Lightscape	Caution	∨	Increasing development will increase light intrusion, affecting night vistas
Viewshed	Caution	∨	Park perimeter is vulnerable to development, especially across Popes Creek
Soundscape	Concern	<-->	Testing at Dahlgren intrudes on tranquility and feel of 18th century life

^aCaution = may be a developing concern.

^b<--> Condition is unchanged/unchanging, ∨ Condition is deteriorating, ∧ Condition is improving, ? Unknown trend in condition

Bibliography

This section includes literature cited in this report as well as other publications, reports, websites, etc. that may be of use to the reader.

- Abrams, M.D. 1992. Fire and the Development of Oak Forests. *Bioscience* 42(5):346-353.
- Abrams, M.D. 2001. Eastern White Pine Versatility in the Presettlement Forest. *BioScience* 51(11):1-13.
- Abrams, M.D and B. A. Black. 2000. Dendroecological analysis of a mature loblolly pine-mixed hardwood forest at the George Washington Birthplace National Monument, Eastern Virginia. *Journal of the Torrey Botanical Society* 127(2):139-148.
- Åkerson, J. and R. Moräwe. 2000. Strategic plan for managing alien invasive vegetation: George Washington Birthplace National Monument. Washington's Birthplace, Virginia.
- Atkinson, J. 2005. Fish Inventories of Mid-Atlantic and Northeast Coastal and Barrier Network Parks within Virginia, Maryland and Pennsylvania, 2004 Annual Report. Shenandoah National Park. Luray, VA. 60 p.
- Atkinson, J. 2005. Fisheries Projects Update. Shenandoah National Park Resource Management Newsletter:3-5.
- Barry, R.E. and T. L. Dolbeare. 2005. GEWA_THST_MammalDatabase110705.zip. MS Access Database. National Park Service, Northeast Coastal and Barrier Network. Kingston, RI.
- Barry, R.E. and T. L. Dolbeare. 2006. Inventory of mammals of George Washington Birthplace National Monument. Technical Report NPS/NER/NRTR-XXXX/XXX (draft). National Park Service. Philadelphia, PA.
- Bellavia, G., P. Bitzel, and C. Pepper. 1996. Historic Landscape Preservation Maintenance Plan. US Department of the Interior, National Park Service, Olmstead Center for Landscape Preservation. Brookline, MA.
- Belval, D.L., K. Beppler, and M. D. Flora. 1997. Water Resources Management Plan, George Washington Birthplace National Monument, Virginia. U.S. Geological Survey, Virginia District. Richmond, VA. 66 p.
(http://www.nature.nps.gov/water/management_plans/gewa_final_screen.pdf).
- Bigelow, C. 2006a. Bacterial TMDL development for shellfish waters in Westmoreland County. PowerPoint Presentation.

- Bigelow, C. 2006b. Water Quality Impairments in Popes Creek. PowerPoint presentation. Roundtable on Natural Resources: George Washington Birthplace National Monument. Westmoreland County, VA. July 27, 2006.
- Bradshaw, D.S. In prep. Data from George Washington Birthplace National Monument avian inventory. Technical Report NPS/NER/NRTR-XXXX/XXX. National Park Service, Northeast Region. Philadelphia, PA..
- Bruggeman, S.C. 2005. George Washington Birthplace National Monument Administrative History 1930 - 2000 (Draft 2). National Park Service and College of William and Mary. 256 p.
- Chazal, A.C. 2005. Lepidoptera and Odonata surveys of George Washington Birthplace National Monument, Westmoreland County Virginia. Natural Heritage Technical Report 05-06. Virginia Department of Conservation and Recreation, Division of Natural Heritage. Richmond, VA. 40 p.
- Chesapeake Bay Program. 2005. GIS Resources. <ftp://ftp.chesapeakebay.net>
- Chesapeake Bay Program. 2006. Oyster Management Plan. <http://www.chesapeakebay.net/cop.htm> (28 November 2006).
- Chesapeake Bay Stock Assessment Committee. 2005. Chesapeake Bay Blue Crab Advisory Report. http://www.chesapeakebay.net/blue_crab.htm (1 October 2006).
- Comiskey, J. 2006. Northeast Coastal and Barrier Network Inventory and Monitoring Program: George Washington Birthplace National Monument. PowerPoint presentation. Roundtable on Natural Resources: George Washington Birthplace National Monument. Westmoreland County, VA. July 27, 2006.
- Conner, C. and M. Albert. 2004. Weather Station Inventory and Preliminary Needs Assessment for the Northeast Coastal and Barrier Network. National Park Service. 15 p.
- Davis, C. 2004. George Washington Birthplace National Monument wetland information for GMP. National Park Service Northeast Region. 10 p.
- Devine, Hugh A., Perver K. Baran, Justin M. Shedd, Gary B. Blank, and Criss Swaim. October 2006. A catalog of spatial data for George Washington Birthplace National Monument. Final Report. National Park Service, Park Planning and Special Studies. Philadelphia, PA.
- Dickinson, W.R. 2000. Changing Times: the Holocene legacy. *Environmental History* 5(4):483-502.
- Dodge, J.M. 2000. A Floristic Survey of the Potomac River Watershed in Westmoreland County, Virginia, from Bridges Creek to Currioman Bay. George Mason University. Fairfax, VA. 127 p.

- Doherty, J.L., J. G. Eugster, W. M. Senville, J. DiBello, and D. Lange. 1987. Conserving the setting of George Washington Birthplace: National Park Service, Mid-Atlantic Regional Office, Division of Park and Resource Planning. 65 p.
- Eckerlin, R.P. 1991. The herpetofauna of George Washington Birthplace National Monument. *Catesbeiana* 11(1):11-17.
- Ellsworth, A.C. 2003. George Washington Birthplace NM (GEWA) natural resources synthesis. U.S Department of the Interior, National Park Service, Northeast Region. 10 p.
- Fabre, L.L. 2003. Review of monitoring programs for vertebrates of the Northeast Coastal and Barrier Network. http://www1.nature.nps.gov/im/units/ncbn/products/Monitoring_Plan/VertebrateMonitoringPrograms.pdf (2 March 2006).
- Ferrick, M.G. and L.W. Gatto. 2005. Quantifying the effect of a freeze-thaw cycle on soil erosion: Laboratory experiments. *Earth Surface Processes and Landforms*. 30(10):1305-1326.
- Fleming, G.P., P. P. Coulling, K.D. Patterson, and K. Taverna. 2006. The natural communities of Virginia: classification of ecological community groups. Second approximation. Version 2.2. Virginia Department of Conservation and Recreation, Division of Natural Heritage, Richmond, VA. <http://www.dcr.virginia.gov/dnh/ncintro.htm>
- French, G. 1985. Erosion rates along the coastal boundaries of the George Washington Birthplace National Monument. Department of Geography, University of Maryland, College Park. Report to the National Park Service.
- Frost, C. 1998. Presettlement fire frequency regimes of the United States: A first approximation. Pages 70-81 in T. L. Pruden and L. A. Brennan, editors. *Fire in ecosystem management: Shifting the from suppression to prescription*. Tall Timbers Fire Ecology Conference Proceedings, No. 20. Tall Timbers Research Station, Tallahassee, FL.
- Frost, C., J. Walker, and R. K. Peet. 1986. Fire-dependent savannas and pariries of the southeast: Original extent, preservation status and management problems. Pages 348-357 in D. L. Kulhavy and R. N. Connor, editors. *Wilderness and natural areas in the eastern United States: A management challenge*. Nacogdoches, TX: Center for Allied Studies, School of Forestry, Stephen F. Austin University.
- Frost, C.C. and L. J. Musselman. 1987. History and vegetation of the Blackwater Ecologic Preserve. *Castanea* 52(1):16-46.
- Garber, S.D. and J. Burger. 1995. A 20-year study documenting the relationship between turtle decline and human recreation. *Ecological Applications* 5:1151-1162.
- Gilmore, R.G., P. Moyer, and C. Alblinger. 2001. An archaeological assessment of George Washington's Birthplace National Monument. National Park Service. 254 p.

- Gottfried, M.D., D. J. Bohaska, and F. C. Whitmore, Jr. 1994. Miocene Cetaceans of the Chesapeake group. Pages 229-238 in A. Berta and T. A. Demere, editors. Contributions in Marine Mammal Paleontology Honoring Frank C. Whitmore, Jr. Proceedings of the San Diego Society of Natural History 29.
- Grossman, D. H., D. Faber-Longendoen, A. S. Weakley, M. Anderson, P. Bourgeron, R. Crawford, K. Goodin, S. Landaal, K. Metzler, K. D. Patterson, M. Pyne, M. Reid, and L. Sneddon. 1998. International classification of ecological communities: terrestrial vegetation of the United States. Volume I. The National Vegetation Classification System: development, status and applications. The Nature Conservancy. Arlington, VA. 126pp.
- Hardaway, C.S., Jr. 1999. Shoreline erosion guidance for Chesapeake Bay: Virginia. In T. A. Barnard, Jr., editor. Virginia wetlands management handbook, 2nd Edition. 28 pp.
- Harwood, J.M. 2002. An archaeological evaluation of threatened cultural resources within the George Washington Birthplace National Monument. The Colonial Williamsburg Foundation, Department of Archaeological Research. 33 p.
- Hastings, W. 2005. Resource Lands Assessment – Northern Neck. PowerPoint Presentation.
- Hastings, W. 2005. Resource Lands Assessment – Westmoreland County. PowerPoint Presentation.
- Holladay, S. D., J. C. Wolf, S. A. Smith, D. E. Jones, and J. L. Robertson. 2001. Aural abscesses in wild-caught box turtles (*Terrapene carolina*): possible role of organochlorine-induced hypervitaminosis A. *Ecotoxicology and Environmental Safety* 48:99-106.
- James-Piri, Mary-Jane. 2004. Wetland and Water Quality Issues for Parks of the Northeastern U.S: A Scoping Report for the Northeast Coastal and Barrier Network. http://www1.nature.nps.gov/im/units/ncbn/products/Monitoring_Plan/WetlandWQRpt2004.pdf (26 June 2006).
- Johnson, E. 1985. Seasonal checklist of birds, George Washington Birthplace National Monument. National Park Service, George Washington Birthplace National Monument.
- Kenworthy, J., Santucci, V.L. 2003. Paleontological Resource Inventory and Monitoring Northeast Coastal and Barrier Network. Kemmerer, WY: National Park Service. 21-25 p.
- Killeffer, S.E. 1999. Natural heritage resources of Virginia: Rare vascular plants. Natural Heritage Tech Report 99-11. Richmond, VA: VA Department of Conservation and Recreation, Division of Natural Heritage. 36 p.
- Knisley, C.B. and T. D. Schultz. 1997. The biology of Tiger Beetles and a Guide to the Species of the South Atlantic States. Virginia Museum of Natural History, Special Publication Number 5. VMNH, Martinsville, VA.

- Kopp, B.S., H. A. Neckles, and S. W. Nixon. 2002. Candidate variables for monitoring estuarine nutrient enrichment within the NPS Coastal and Barrier Network. Report. National Park Service, Northeast Coastal and Barrier Network.
- Kozol, A.J. 1990. NICROPHOROUS AMERICANUS 1989 laboratory population at Boston University: A report prepared for the U.S. Fish and Wildlife Service. Unpublished.
- Kozol, A.J., M. Scott, and J. Traniello. 1988. The American burying beetle, NICROPHORUS AMERICANUS: Studies on the natural history of a declining species. *Psyche* 95(3-4): 167-176.
- Lam, G.E. 1985. The Flora of George Washington's Birthplace National Park. Unpublished student report. Fairfax, VA: George Mason University. 7 p. plus appendix.
- Lewis, M.E. 2001. Level One Water-Quality Inventory and Monitoring: George Washington Birthplace National Monument (GEWA), Virginia. Richmond, VA: U.S. Geological Survey. 13 p.
- Ludwig, J.C., K. A. Buhlmann, and C. A. Pague. 1993. A Natural Heritage Inventory of Mid-Atlantic Region National Parks in Virginia - George Washington Birthplace National Monument. Virginia Department of Conservation and Recreation, Division of Natural Heritage and National Park Service.
- Martinez, V., M. Woodward, J. J. Frye, R. Moräwe, W. Sanders, J. B. Storke, C. Smith, and L. M. George. 2004. Strategic Plan for George Washington Birthplace National Monument, Fiscal Year 2005-2008. National Park Service. 37 p.
- McLennan, J.D. 1971. Miocene sharks teeth of Calvert County. *Maryland Geological Survey, Pamphlet Series*. <http://www.mgs.md.gov/esic/brochures/ccliffs.html> (2006). 3 p.
- McLennan, J.D. 1973. Calvert Cliffs, Maryland. *Maryland Geological Survey, Pamphlet Series*. <http://www.mgs.md.gov/esic/brochures/sharks.html> (2006). 3 p.
- Meng, A.A. and J. F. Harsh. 1988. Hydrogeologic Framework of the Virginial Coastal Plain: U.S. Geological Survey Professional Paper 1404-C. 82 p.
- Mercer, J.L. 1978. Westmoreland County Tidal Marsh Inventory. Gloucester Point, VA: Virginia Institute of Marine Science, College of William and Mary. 108 p.
- Miller, A.J. 1987. Shore erosion as a sediment source to the tidal Potomac River, Maryland and Virginia. U.S. Geological Survey Water-Supply Paper, Report W2234-E, pp. E1-E45.
- Milstead, B., S. Stevens, M. Albert, and M. Duffy. 2005. Northeast Coastal and Barrier Network Summary Information. National Park Service.
- Mitchell, J.C. 2005. Inventory of Amphibians and Reptiles of George Washington Birthplace National Monument. Philadelphia, PA: National Park Service, Northeast Region. Report NPS/NERCHAL/NRTR-2005/007. 37 p.

- Mixon, R.B., W. L. Berquist, W. L. Newell, and G. H. Johnson. 1989. Geologic map and generalized cross sections of the coastal plain and adjacent parts of the piedmont, Virginia. 1:250,000.
- Moräwe, R. 2004. Smithsonian Museum of Natural History trip report: Documentation of paleontological resources, George Washington Birthplace National Monument.
- Myrick, A.C. 1979. Variation, taphonomy, and adaptation of the Rhabdosteidae. University of California, Los Angeles. 411 p.
- National Park Service (NPS). 1997. Baseline water quality data inventory and analysis George Washington Birthplace National Monument. National Park Service, Water Resources Division. Fort Collins, CO. 493 p.
- National Park Service (NPS). 1999. George Washington Birthplace National Monument: Long Range Interpretive Plan. <http://www.nps.gov/gewa/parkmgmt/upload/George%20Washington%20Birthplace%20Long%20Range%20Interpretive%20Plan.pdf> (13 September 2005).
- National Park Service (NPS). 2000. Resources Management Plan: George Washington Birthplace National Monument. Central Administrative Files, George Washington Birthplace National Monument, VA
- National Park Service (NPS). 2002a. Air Quality Monitoring Considerations for the Northeast Coastal and Barrier Network. http://www1.nature.nps.gov/im/units/ncbn/inv_other.cfm (12 December 2005).
- National Park Service (NPS). 2002b. Ambient Air Quality Sites for the Northeast Coastal and Barrier Network. http://www1.nature.nps.gov/im/units/ncbn/inv_other.cfm (12 December 2005).
- National Park Service (NPS). 2002c. Geologic Resource Management Action Plan. Working Draft.
- National Park Service (NPS). 2002d. Geologic Resources Division 2002 Annual Report. Denver, CO: U.S. Department of Interior, National Park Service. 80 p.
- National Park Service (NPS). 2002e. Scoping Meeting Indicator Definitions. George Washington Birthplace National Monument, VA.
- National Park Service (NPS). 2002f. Scoping Meeting Worksheet Geoindicator Table George Washington Birthplace National Monument. George Washington Birthplace National Monument, VA. 7 p.
- National Park Service (NPS). 2002g. Sensitive Air Quality Related Values of Northeast Coastal and Barrier Network Parks. <http://www2.nature.nps.gov/air/permits/aris/networks/ncbn.cfm> (12 December 2005).

- National Park Service (NPS). 2004a. National Park Service Social Science Program FY2004 Annual Report. National Park Service. 15 p.
- National Park Service (NPS). 2004b. Strategic Plan - George Washington Birthplace National Monument. <http://www.nps.gov/gewa/parkmgmt/upload/Strategic%20Plan%20for%20George%20Washington%20Birthplace.pdf> (7 September 2005).
- National Park Service (NPS). 2005a. Cultural Landscape Inventory: George Washington Birthplace National Monument. 378 p.
- National Park Service (NPS). 2005b. Air Quality Monitoring Site Reports. *National Park Service, Nature and Science, Explore Air*. <http://www2.nature.nps.gov/air/monitoring/MonHist/index.cfm> (12 December 2005).
- National Park Service (NPS). 2005c. NPS Data Store. <http://science.nature.nps.gov/nrdata/> (2006).
- National Park Service (NPS). 2005d. Park Profile - George Washington Birthplace National Monument. <http://www.nps.gov/gewa/parkmgmt/upload/George%20Washington%20Birthplace%20Park%20Profile%202005.pdf> (7 October 2005).
- National Park Service (NPS). 2006a. NatureBib. <http://science1.nature.nps.gov/naturebib/nb/simple/clean> (28 January 2006)
- National Park Service (NPS). 2006b. Program Plan to Assess Watershed Conditions. *National Park Service, Nature & Science, Explore Water*. <http://www.nature.nps.gov/water/watershedconds.cfm> (12 February 2006).
- National Park Service (NPS). 2006c. Northeast Coastal and Barrier Network, Inventory & Monitoring Program. *National Park Service, Inventory & Monitoring Program*. <http://www1.nature.nps.gov/im/units/ncbn/index.htm> (2006).
- NatureServe. 2005. NatureServe Explorer: An online encyclopedia of life. <http://www.natureserve.org/explorer> (2006).
- NatureServe. 2006. International Ecological Classification Standard: Terrestrial Ecological Classifications. NatureServe Central Databases. Arlington, VA. U.S.A. <http://www.natureserve.org/explorer/> (2006)
- Newell, W., O. Bricker, M. Robertson, and I. Clark. 2000. Popes Creek Estuary, Holocene fill sequence. Interpreted for Hoverprobe 2000 cores near Washington Birthplace National Monument, Westmoreland County, VA, U.S. Geological Survey Poster, Reston, Virginia.
- Newell, W., O. P. Bricker, and M. S. Robertson. 2002. Geologic map of the Colonial Beach South 7.5' quadrangle, Virginia, U.S. Geological Survey Map, 2002.

- Newell, W. and R. Moräwe. 2006. Research in Small Estuary Dynamics at George Washington Birthplace National Monument. PowerPoint presentation. Roundtable on Natural Resources: George Washington Birthplace National Monument. Westmoreland County, VA. July 27, 2006.
- Nicholson, J.C., United States. Soil Conservation Service, and Virginia Polytechnic Institute and State University. 1981. Soil survey of Westmoreland County, Virginia. Washington, D.C.: U.S. Dept. of Agriculture Soil Conservation Service. vii, 96 , 24 of plates p.
- North Carolina State University, Center for Earth Observation (NCSU-CEO). 2002a. George Washington Birthplace National Monument Color Infrared Orthorectified Photomosaic – Leaf-off (ERDAS Imagine IMG and MrSID formats). National Park Service. George Washington Birthplace National Monument, VA.
- North Carolina State University, Center for Earth Observation (NCSU-CEO). 2002b. George Washington Birthplace National Monument Formation Level Vegetation and Fire Fuel Models (ESRI ArcGIS 8.2 personal geodatabase and shapefile). National Park Service. George Washington Birthplace National Monument, VA.
- Northeast Coastal and Barrier Network (NCBN). 2004. Northeast Coastal and Barrier Network Park Descriptions. http://www.nature.nps.gov/im/units/ncbn/products/Monitoring_Plan/NCBNParkDescrip2004.pdf. (January 2007).
- NPSpecies – The National Park Service Biodiversity Database. Secure online version. <https://science1.nature.nps.gov/npspecies/> (last accessed December 2006).
- OCULUS. 1998. Cultural Landscape Report of the George Washington Birthplace National Monument. Vol 1: Historical and existing conditions document. Philadelphia, PA: National Park Service Report, Philadelphia Support Office. 188 p.
- Painter, H.F. and R. P. Eckerlin. 1993. The mammalian fauna and ectoparasites of George Washington Birthplace National Monument, Westmoreland County, Virginia. *Banisteria* 2:10-13.
- Poag, C. Wylie. 1997. The Chesapeake Bay bolide: Modern consequences of an ancient cataclysm. <http://woodshole.er.usgs.gov/epubs/bolide/> (January 2007).
- Raithel, C. 1991. American burying beetle (*NICROPHORSUS AMERICANUS*) Recovery Plan. U.S. Fish and Wildlife Service. Newton Corner, Massachusetts. 80 pp.
- Santucci, V. 2006. George Washington Birthplace National Monument: Paleontological Resources. PowerPoint presentation. Roundtable on Natural Resources: George Washington Birthplace National Monument. Westmoreland County, VA. July 27, 2006.
- Santucci, V.L., J. P. Kenworthy, and A. L. Koch. 2006. Monitoring In Situ Paleontological Resources. U.S. Department of the Interior, National Park Service. 17 p.

- Silberhorn, G.M. and J. Shields. 1995. Change Detection Study of Vegetation and Area of Popes Creek Tidal Marsh Complex. GEWA: Virginia Institute of Marine Science Contract Report CA 4000-1-2-21. 9 p.
- Simon, N.S. 2006. George Washington Birthplace National Monument and Popes Creek Watershed: Irreplaceable Reference Watershed for the Chesapeake Bay. PowerPoint presentation. Roundtable on Natural Resources: George Washington Birthplace National Monument. Westmoreland County, VA. July 27, 2006.
- Simon, N.S., O. P. Bricker, W. Newell, J. McCoy, and R. Moräwe. 2005. The distribution of phosphorous in Popes Creek, VA, and in the Pocomoke River, MD: Two watersheds with different land management practices in the Chesapeake Bay basin. *Water, Air and Soil Pollution* 164(1-4):189-204.
- Stevens, S. and B. Milstead. 2002. NPS Inventory and Monitoring Program Northeast Coastal and Barrier Network Vital Signs Process. U.S. Department of the Interior, National Park Service.
- Stevens, S., B. Milstead, M. Albert, and G. Entsminger. 2005. Northeast Coastal and Barrier Network Vital Signs Plan. Technical Report NPS/NER/NRTR—2005/025. National Park Service. Boston, Massachusetts.
- Sustainable Science, LLC. 2006. Wetland Inventory and Mapping Project. Denton, MC. U.S. Department of the Interior, National Park Service. 214 p.
- The Conservation Fund. 2005. George Washington Birthplace Regional and Community Profile [CD]. Chapel Hill, NC.
- Thornberry-Ehrlich, T.L. 2005. George Washington Birthplace National Monument Geologic Resource Manangement Issues Scoping Summary. Colorado State University. 31 p.
- Treifke, R.H. 1973. Stratigraphic units of the lower Cretaceous through Miocene series. Part I in *Geologic Studies, Coastal Plain of Virginia*. Virginia Division of Mineral Resources Bulletin 83:1-78.
- Townsend, John F. 2006. Natural Heritage Resources of Virginia: Rare Plants. Natural Heritage Technical Report 06-07. Virginia Department of Conservation and Recreation, Division of Natural Heritage, Richmond, Virginia. Unpublished Report. April 2006. 58 pages plus appendices.
- U.S. Department of Agriculture (USDA). 2005. Geospatial data gateway. <http://datagateway.nrcs.usda.gov/> (2006).
- U.S. Fish and Wildlife Service (USFWS). 1994. Northeastern beach tiger beetle (*Cincindela dorsalis dorsalis*) Recovery Plan. Hadley, MA. 60 p.
- University of Virginia. 2005. Virginia Geographic Information Network. <http://www.vgin.virginia.gov/> (2006).

- Virginia Department of Environmental Quality (VA DEQ). 2002. 2002 305(b) Water quality assessment report. <http://www.deq.state.va.us/water/305b.html>
- Virginia Department of Game and Inland Fisheries (VADGIF). 2006. Virginia Fish and Wildlife Information Service. <http://vafwis.org/WIS/ASP/default.asp> (12 June 2006).
- Virginia Institute of Marine Science, Management CfCR. 2005. The Comprehensive Coastal Inventory Program (CCI) Online Databases. <http://ccrm.vims.edu/gisdatabases.html> (2006).
- Virginia Polytechnic Institute and State University (VPISU). 2006. The Gypsy Moth in Virginia. <http://www.gypsymoth.ento.vt.edu/vagm/pesticides.html> (8 Dec. 2006).
- Westmoreland County. 2005. Westmoreland County Revised Zoning Ordinance - Draft. Westmoreland County. p 295.
- Wiencek, H. 2003. An imperfect god : George Washington, his slaves, and the creation of America. New York: Farrar, Straus and Giroux. 404 p., [16] p. of plates
- Wilcox, J.K. 1989. Recent vegetation and area changes in a tidal marsh located at Popes Creek, Virginia [M.A.]. Gloucester Point, VA: College of William and Mary. 41 p.
- Wilson, J.C. 1984. Virginia's Northern Neck, a pictorial history. Norfolk, VA: Doonning. 224 p.
- Wright, D.B. and R. E. Eshelman. 1987. Miocene tayassuidae (mammalia) from the Chesapeake group of the mid-atlantic coast and their bearing on marine-nonmarine correlation. *Journal of Paleontology* 61(3):604-618.

Appendix A. Description of the Lumbee-Leaf Lenoir soil association extracted from Nicholson et al. (1981).

The Lumbee-Leaf-Lenoir association is composed of poorly drained and somewhat poorly drained, level to nearly level, loamy soils on the low marine terrace. This association consists of broad flats bordered on the north and east by the Potomac River and its tidal estuaries, and on the south and west by slightly higher, nearly level, and better drained soils. Seasonal wetness is common in this association. Slopes range from 0 to 2 percent.

This association makes up about 15 percent of Westmoreland County. The association is about 40 percent Lumbee soils, 25 percent Leaf soils, 10 percent Lenoir soils, and 25 percent soils of minor extent.

The Lumbee soils are poorly drained. They have a surface layer of dark grayish brown loam and a subsoil of mottled, light brownish gray clay loam and loam.

The Leaf soils are also poorly drained. They have a surface layer of dark gray silt loam and a subsoil of mottled, dark gray clay and silty clay.

The Lenoir soils are somewhat poorly drained. They have a surface layer of grayish brown silt loam and a subsoil of mottled, light olive brown silty clay loam and gray clay.

The minor soils consist of Bohicket soils in tidal marshes; poorly drained Bibb soils and very poorly drained Levy soils along drainageways and adjacent to or near tidal waters; moderately well drained Nansemond soils on broad, low-lying flats and moderately well drained Tetotum soils on broad, low-lying flats and on narrow side slopes along tidal waters or drainageways and ridgetops; well drained State soils on broad areas or narrow ridges between more poorly drained soils; and well drained Rumford soils in short, sloping and steep areas above and at the heads of drainageways.

About a third of the acreage of this unit has been cleared and is mostly used for cultivated crops. The uncleared acreage consists of wet, flat areas and steep areas around drainageways that are generally in mixed softwoods and hardwoods.

Seasonal wetness is the main limitation for farming in this association. The better drained soils and the soils that have been artificially drained are suitable for cultivated crops, mainly corn and soybeans. Increasing organic matter content and using lime and fertilizer to offset acidity and low natural fertility are main management needs.

The soils in this association are well suited to trees. The soils are managed for pines and hardwoods. Productivity is high, but the rate of seedling mortality is moderate to severe. The use of logging equipment is limited by prolonged periods of wetness.

Seasonal wetness is the main limitation of this association for waste disposal facilities and building sites. The soils are poor as roadfill material.

Appendix B. Water quality tables.

Table B1. Field Parameter Data (Lewis 2001).

[ft³/s, cubic feet per second; °C, degrees Celsius; μ S/cm, microsiemens per centimeter at 25 °C; mg/L, milligrams per liter; mg/L as CaCO₃, milligrams per liter as calcium carbonate; <, less than; e, estimated value; --, no data]

Date	Time	Discharge (ft ³ /s)	Water temperature (°C)	pH (units)	Specific conductance (μ S/cm)	Dissolved oxygen (mg/L)	Alkalinity (mg/L as CaCO ₃)
Popes Creek at Point of Point near Wakefield, VA (0166087750)							
Oct 07, 1998	11:00	--	18.4	7.4	17,100	6.0	84
Dec 16, 1998	12:15	--	6.7	7.3	18,800	9.4	61
Feb 02, 1999	09:20	--	6.1	7.2	15,000	10.8	48
Jun 14, 1999	11:45	--	26.8	7.4	15,700	--	66
Popes Creek at Burnt House Point near Wakefield, VA (0166087760)							
Oct 07, 1998	08:05	--	18.8	7.1	17,400	7.0	83
Dec 16, 1998	09:00	--	6.7	7.4	20,000	7.5	56
Feb 02, 1999	08:30	--	5.9	7.4	16,800	11.4	67
Jun 14, 1999	10:30	--	25.1	7.8	14,300	--	68
Bridges Creek at Mouth near Wakefield, VA (01660860)							
Oct 06, 1998	12:00	0	--	--	--	--	--
Dec 15, 1998	10:00	0	5.8	7.4	1,210	9.1	159
Feb 03, 1999	08:20	2.9	6.2	6.9	4,000	5.0	109
Jun 15, 1999	09:35	4.95	23.0	6.6	16,300	2.5	89
Dancing Marsh near Wakefield, VA (0166087770)							
Oct 06, 1998	13:00	0.07	18.7	6.8	655	9.3	26
Dec 15, 1998	13:00	.063	7.4	7.1	2,050	9.9	60
Feb 03, 1999	10:45	0.17	8.0	6.7	550	10.6	13
Jun 15, 1999	10:45	0.046	21.4	6.5	3,000	4.7	39
Spring at Dancing Marsh near Wakefield, VA - 55PS1 (381108076551101)							
Oct 06, 1998	11:00	0.05	17.0	6.6	311	8.7	65
Dec 15, 1998	14:40	<0.01e	11.0	--	296	--	--
Feb 03, 1999	12:30	0.00	12.6	6.5	240	3.2	44
Jun 15, 1999	13:30	0.002	16.5	6.5	220	2.5	36

Table B2. Bacterial Data (Lewis 2001).

[col/100 ml; colonies per 100 milliliters; >, greater than; K, non-ideal colony count; --, no data]

Date	Time	Total coliform (col/100 ml)	Fecal coliform (col/100 ml)	Fecal streptococcus (col/100 ml)
Popes Creek at Point of Point near Wakefield, VA (0166087750)				
Oct 07, 1998	11:00	>1,300	1,100	580
Dec 16, 1998	12:15	180	67K	94K
Feb 02, 1999	09:20	>250	200	220
Jun 14, 1999	11:45	500	260	100
Popes Creek at Burnt House Point near Wakefield, VA (0166087760)				
Oct 07, 1998	08:05	310	150K	170
Dec 16, 1998	09:00	160K	76K	97K
Feb 02, 1999	08:30	100K	20K	67K
Jun 14, 1999	10:30	300	130	16K
Bridges Creek at Mouth near Wakefield, VA (01660860)				
Oct 06, 1998	12:00	--	--	--
Dec 15, 1998	10:00	4,000	2,700	1,800
Feb 03, 1999	08:20	1,700	660	740
Jun 15, 1999	09:35	1,500	1,080	1,440
Dancing Marsh near Wakefield, VA (0166087770)				
Oct 06, 1998	13:00	2,800	1,200	1,300
Dec 15, 1998	13:00	380	200	460
Feb 03, 1999	10:45	310	73K	170K
Jun 15, 1999	10:45	10,455	2,200	4,600
Spring at Dancing Marsh near Wakefield, VA -55PS1 (381108076551101)				
Oct 06, 1998	11:00	>10,000	>10,000	>10,000
Dec 15, 1998	14:40	--	--	--
Feb 03, 1999	12:30	>10,000	>10,000	>10,000
Jun 15, 1999	13:30	310	26K	64K

Table B3. Nutrient Data (Lewis 2001).

[mg/L, milligrams per liter; N, nitrogen; P, phosphorous; < less than; --, no data]

Date	Time	Nitrogen, nitrite, dissolved (mg/L as N)	Nitrogen, nitrate + nitrite, dissolved (mg/L as N)	Nitrogen, ammonia, dissolved (mg/L as N)	Nitrogen, ammonia + organic, total (mg/L as N)	Nitrogen, ammonia + organic, dissolved (mg/L as N)
Popes Creek at Point of Point near Wakefield, VA (0166087750)						
Oct 07, 1998	11:00	<0.01	0.05	0.03	0.6	0.3
Dec 16, 1998	12:15	<0.01	0.06	0.03	0.4	0.3
Feb 02, 1999	09:20	0.01	0.22	0.09	0.5	0.3
Jun 14, 1999	11:45	<0.01	<0.05	<0.02	0.8	0.1
Popes Creek at Burnt House Point near Wakefield, VA (0166087760)						
Oct 07, 1998	08:05	<0.01	<0.05	0.02	1	0.3
Dec 16, 1998	09:00	0.01	0.05	0.03	0.5	0.3
Feb 02, 1999	08:30	0.01	0.36	0.12	0.5	0.4
Jun 14, 1999	10:30	<0.01	<0.05	<0.02	0.7	0.2
Bridges Creek at Mouth near Wakefield, VA (01660860)						
Oct 06, 1998	12:00	--	--	--	--	--
Dec 15, 1998	10:00	0.01	0.05	0.04	2.6	1.3
Feb 03, 1999	08:20	0.01	0.12	0.56	2.2	1.5
Jun 15, 1999	09:35	<0.01	<0.05	<0.02	0.8	0.4
Dancing Marsh near Wakefield, VA (0166087770)						
Oct 06, 1998	13:00	<0.01	0.39	0.18	0.8	0.4
Dec 15, 1998	13:00	0.01	0.07	0.07	0.6	0.4
Feb 03, 1999	10:45	0.01	0.32	0.06	0.5	0.4
Jun 15, 1999	10:45	<0.01	<0.05	<0.02	1.1	1.1
Spring at Dancing Marsh near Wakefield, VA - 55PS1 (381108076551101)						
Oct 06, 1998	11:00	0.04	4.9	0.03	0.7	0.2
Dec 15, 1998	14:40	--	--	--	--	--
Feb 03, 1999	12:30	0.01	3	0.03	0.6	0.2
Jun 15, 1999	13:30	--	--	--	--	--

Table B3. Nutrient Data (Lewis 2001) (continued).

[mg/L, milligrams per liter; N, nitrogen; P, phosphorous; < less than;
e, estimated value; --, no data]

Date	Time	Phosphorus, total (mg/L as P)	Phosphorus, dissolved (mg/L as P)	Orthophosphate, dissolved (mg/L as P)
Popes Creek at Point of Point near Wakefield, VA (0166087750)				
Oct 07, 1998	11:00	0.09	<0.05	0.03
Dec 16, 1998	12:15	0.04e	<0.05	0.01
Feb 02, 1999	09:20	0.034	0.011	0.01
Jun 14, 1999	11:45	0.097	0.012	0.01
Popes Creek at Burnt House Point near Wakefield, VA (0166087760)				
Oct 07, 1998	08:05	0.17	0.03e	0.03
Dec 16, 1998	09:00	0.05	<0.05	0.01
Feb 02, 1999	08:30	0.028	0.012	<0.01
Jun 14, 1999	10:30	0.076	0.011	0.01
Bridges Creek at Mouth near Wakefield, VA (01660860)				
Oct 06, 1998	12:00	--	--	--
Dec 15, 1998	10:00	1.4	0.85	0.78
Feb 03, 1999	08:20	0.69	0.56	0.51
Jun 15, 1999	09:35	0.19	0.13	0.01
Dancing Marsh near Wakefield, VA (0166087770)				
Oct 06, 1998	13:00	0.10	0.05e	0.05
Dec 15, 1998	13:00	0.06	0.04e	0.02
Feb 03, 1999	10:45	0.045	0.021	0.02
Jun 15, 1999	10:45	0.18	0.091	0.01
Spring at Dancing Marsh near Wakefield, VA - 55PS1 (381108076551101)				
Oct 06, 1998	11:00	0.09	<0.05	0.04
Dec 15, 1998	14:40	--	--	--
Feb 03, 1999	12:30	0.06	0.02	0.02
Jun 15, 1999	13:30	--	--	--

Table B4. Major-Element Data (Lewis 2001).

[mg/l, milligrams per liter, <, less than; --, no data]

Date	Time	Calcium, dissolved (mg/L as Ca)	Magnesium, dissolved (mg/L as Mg)	Sodium, dissolved (mg/L as Na)	Potassium, dissolved (mg/L as K)	Alkalinity (mg/L as CaCO ₃)	Sulfate, dissolved (mg/L as SO ₄)
Popes Creek at Point of Point near Wakefield, VA (0166087750)							
Oct 07, 1998	11:00	130	370	3,100	110	78	720
Dec 16, 1998	12:15	--	--	--	--	--	--
Feb 02, 1999	09:20	--	--	--	--	--	--
Jun 14, 1999	11:45	--	--	--	--	--	--
Popes Creek at Burnt House Point near Wakefield, VA (0166087760)							
Oct 07, 1998	08:05	130	380	3,100	110	76	740
Dec 16, 1998	09:00	--	--	--	--	--	--
Feb 02, 1999	08:30	--	--	--	--	--	--
Jun 14, 1999	10:30	--	--	--	--	--	--
Bridges Creek at Mouth near Wakefield, VA (01660860)							
Oct 06, 1998	12:00	--	--	--	--	--	--
Dec 15, 1998	10:00	--	--	--	--	--	--
Feb 03, 1999	08:20	37	76	620	26	49	150
Jun 15, 1999	09:35	--	--	--	--	--	--
Dancing Marsh near Wakefield, VA (0166087770)							
Oct 06, 1998	13:00	11	16	120	5.5	29	23
Dec 15, 1998	13:00	--	--	--	--	--	--
Feb 03, 1999	10:45	--	--	--	--	--	--
Jun 15, 1999	10:45	--	--	--	--	--	--
Spring at Dancing Marsh near Wakefield, VA - 55PS1 (381108076551101)							
Oct 06, 1998	11:00	42	3.1	11	1.2	65	22
Dec 15, 1998	14:40	--	--	--	--	--	--
Feb 03, 1999	12:30	33	2.6	8.1	1.0	54	22
Jun 15, 1999	13:30	--	--	--	--	--	--

Table B4. Major-Element Data (Lewis 2001) (continued).

[mg/l, milligrams per liter, <, less than; --no data]

Date	Time	Chloride, dissolved (mg/l as Cl)	Fluoride, dissolved (mg/L as F)	Silica, dissolved (mg/L as SiO ₂)
Popes Creek at Point of Point near Wakefield, VA (0166087750)				
Oct 07, 1998	11:00	5,500	0.5	3.9
Dec 16, 1998	12:15	--	--	--
Feb 02, 1999	09:20	--	--	--
Jun 14, 1999	11:45	--	--	--
Popes Creek at Burnt House Point near Wakefield, VA (0166087760)				
Oct 07, 1998	08:05	5,500	0.5	4.1
Dec 16, 1998	09:00	--	--	--
Feb 02, 1999	08:30	--	--	--
Jun 14, 1999	10:30	--	--	--
Bridges Creek at Mouth near Wakefield, VA (01660860)				
Oct 06, 1998	12:00	--	--	--
Dec 15, 1998	10:00	--	--	--
Feb 03, 1999	08:20	1,100	0.2	13
Jun 15, 1999	09:35	--	--	--
Dancing Marsh near Wakefield, VA (0166087770)				
Oct 06, 1998	13:00	220	<0.1	11
Dec 15, 1998	13:00	--	--	--
Feb 03, 1999	10:45	--	--	--
Jun 15, 1999	10:45	--	--	--
Spring at Dancing Marsh near Wakefield, VA - 55PS1 (381108076551101)				
Oct 06, 1998	11:00	25	<0.1	13
Dec 15, 1998	14:40	--	--	--
Feb 03, 1999	12:30	20	<0.1	14
Jun 15, 1999	13:30	--	--	--

Table B5. Trace-Element Data (Lewis 2001).

[$\mu\text{g/L}$, micrograms per liter; <, less than; --, no data]

Date	Time	Aluminum, total ($\mu\text{g/L}$ as Al)	Arsenic, total ($\mu\text{g/L}$ as As)	Barium, total ($\mu\text{g/L}$ as Ba)	Beryllium, total ($\mu\text{g/L}$ as Be)	Cadmium, total ($\mu\text{g/L}$ as Cd)	Chromium, total ($\mu\text{g/L}$ as Cr)	Cobalt, total ($\mu\text{g/L}$ as Co)	Copper, total ($\mu\text{g/L}$ as Cu)	Iron, total ($\mu\text{g/L}$ as Fe)
Popes Creek at Point of Point near Wakefield, VA (0166087750)										
Oct 07, 1998	11:00	--	--	--	--	--	--	--	--	--
Dec 16, 1998	12:15	--	--	--	--	--	--	--	--	--
Feb 02, 1999	09:20	--	--	--	--	--	--	--	--	--
Jun 14, 1999	11:45	502	<1	60.1	<20.0	<4	<1.0	<4	10	1,390
Popes Creek at Burnt House Point near Wakefield, VA (0166087760)										
Oct 07, 1998	08:05	--	--	--	--	--	--	--	--	--
Dec 16, 1998	09:00	--	--	--	--	--	--	--	--	--
Feb 02, 1999	08:30	--	--	--	--	--	--	--	--	--
Jun 14, 1999	10:30	322	<1	51.7	<20.0	<4	<1.0	<4	5	766
Bridges Creek at Mouth near Wakefield, VA (01660860)										
Oct 06, 1998	12:00	--	--	--	--	--	--	--	--	--
Dec 15, 1998	10:00	--	--	--	--	--	--	--	--	--
Feb 03, 1999	08:20	--	--	--	--	--	--	--	--	--
Jun 15, 1999	09:35	<140	1	72.5	<20.0	<4	<1.0	<4	<4	651
Dancing Marsh near Wakefield, VA (0166087770)										
Oct 06, 1998	13:00	--	--	--	--	--	--	--	--	--
Dec 15, 1998	13:00	--	--	--	--	--	--	--	--	--
Feb 03, 1999	10:45	--	--	--	--	--	--	--	--	--
Jun 15, 1999	10:45	99.8	<1	51.7	<4.0	<1	<1.0	<1	<1	2,230
Spring at Dancing Marsh near Wakefield, VA - 55PS1 (381108076551101)										
Oct 06, 1998	11:00	--	--	--	--	--	--	--	--	--
Dec 15, 1998	14:40	--	--	--	--	--	--	--	--	--
Feb 03, 1999	12:30	--	--	--	--	--	--	--	--	--
Jun 15, 1999	13:30	113	<1	12.6	<4.0	<1	<1.0	<1	5	152

Table B5. Trace-Element Data (Lewis 2001) (continued).

[$\mu\text{g/L}$, micrograms per liter; <, less than; e, estimated value; --, no data]

Date	Time	Lead, total ($\mu\text{g/L}$ as Pb)	Lithium, total ($\mu\text{g/L}$ as Li)	Manganese, total ($\mu\text{g/L}$ as Mn)	Mercury, total ($\mu\text{g/L}$ as Hg)	Molyb- denum, total ($\mu\text{g/L}$ as Mo)	Nickel, total ($\mu\text{g/L}$ as Ni)	Selenium, total ($\mu\text{g/L}$ as Se)	Silver, total ($\mu\text{g/L}$ as Ag)	Zinc, total ($\mu\text{g/L}$ as Zn)
Popes Creek at Point of Point near Wakefield, VA (0166087750)										
Oct 07, 1998	11:00	--	--	--	--	--	--	--	--	--
Dec 16, 1998	12:15	--	--	--	--	--	--	--	--	--
Feb 02, 1999	09:20	--	--	--	--	--	--	--	--	--
Jun 14, 1999	11:45	<4	41.9e	94.6	<0.1	4.0	<4	<1	<4	<200
Popes Creek at Burnt House Point near Wakefield, VA (0166087760)										
Oct 07, 1998	08:05	--	--	--	--	--	--	--	--	--
Dec 16, 1998	09:00	--	--	--	--	--	--	--	--	--
Feb 02, 1999	08:30	--	--	--	--	--	--	--	--	--
Jun 14, 1999	10:30	<4	60.5	37.5	<0.1	4.0	<4	<1	<4	<200
Bridges Creek at Mouth near Wakefield, VA (01660860)										
Oct 06, 1998	12:00	--	--	--	--	--	--	--	--	--
Dec 15, 1998	10:00	--	--	--	--	--	--	--	--	--
Feb 03, 1999	08:20	--	--	--	--	--	--	--	--	--
Jun 15, 1999	09:35	<4	54.9e	295	<0.1	4.0	<4	<1	<4	<200
Dancing Marsh near Wakefield, VA (0166087770)										
Oct 06, 1998	13:00	--	--	--	--	--	--	--	--	--
Dec 15, 1998	13:00	--	--	--	--	--	--	--	--	--
Feb 03, 1999	10:45	--	--	--	--	--	--	--	--	--
Jun 15, 1999	10:45	<1	6.2e	219	<0.1	<1.0	<1	<1	<1	<40
Spring at Dancing Marsh near Wakefield, VA - 55PS1 (381108076551101)										
Oct 06, 1998	11:00	--	--	--	--	--	--	--	--	--
Dec 15, 1998	14:40	--	--	--	--	--	--	--	--	--
Feb 03, 1999	12:30	--	--	--	--	--	--	--	--	--
Jun 15, 1999	13:30	<1	<12	3.6	<0.1	<1.0	3	<1	<1	<40

Appendix C. NPSpecies list of vascular plant species documented at George Washington Birthplace National Monument as of December 2006.

Order	Family	Scientific Name	Common Names	Abundance	Nativity	Cultivation
Alismatales	Alismataceae	Sagittaria latifolia	wapato	Uncommon	Native	NA
Apiales	Apiaceae	Foeniculum vulgare	sweet fennel	Common	Non-Native	Not cultivated
Apiales	Apiaceae	Hydrocotyle verticillata	whorled pennyroyal	Common	Native	NA
Apiales	Apiaceae	Ptilimnium capillaceum	threadleaf mockbishopweed	Uncommon	Native	NA
Apiales	Apiaceae	Sanicula canadensis	Canadian blacksnakeroot	Uncommon	Native	NA
Apiales	Araliaceae	Aralia spinosa	devils walkingstick	Uncommon	Native	NA
Apiales	Araliaceae	Hedera helix	English ivy	Uncommon	Non-Native	Not cultivated
Arales	Araceae	Peltandra virginica	Virginia peltandra	Uncommon	Native	NA
Arales	Lemnaceae	Lemna valdiviana	Valdivia's duckweed	Common	Native	NA
Arales	Lemnaceae	Spirodela polyrrhiza	greater duckweed	Common	Native	NA
Asterales	Asteraceae	Achillea millefolium	yarrow (common)	Common	Native	NA
Asterales	Asteraceae	Ambrosia artemisiifolia	small ragweed	Uncommon	Native	NA
Asterales	Asteraceae	Antennaria plantaginifolia	woman's tobacco	Common	Native	NA
Asterales	Asteraceae	Anthemis arvensis	scentless chamomile	Common	Non-Native	Not cultivated
Asterales	Asteraceae	Arctium minus	wild rhubarb	Common	Native	NA
Asterales	Asteraceae	Artemisia vulgaris	mugwort	Common	Non-Native	Not cultivated
Asterales	Asteraceae	Aster pilosus	white oldfield aster	Common	Native	NA
Asterales	Asteraceae	Aster spectabilis	western showy aster	Uncommon	Native	NA
Asterales	Asteraceae	Aster tenuifolius	saline aster	Uncommon	Native	NA
Asterales	Asteraceae	Aster undulatus	waxyleaf aster	Uncommon	Native	NA
Asterales	Asteraceae	Aster vimineus		Uncommon	Native	NA
Asterales	Asteraceae	Baccharis halimifolia	eastern baccharis	Common	Native	NA
Asterales	Asteraceae	Bidens bipinnata	spanish-needles	Uncommon	Native	NA
Asterales	Asteraceae	Bidens discoidea	swamp beggar-ticks	Uncommon	Native	NA
Asterales	Asteraceae	Bidens frondosa	tickseed sunflower	Common	Native	NA
Asterales	Asteraceae	Bidens polylepis		Common	Native	NA
Asterales	Asteraceae	Centaurea cyanus	garden cornflower	Uncommon	Non-Native	Not cultivated

Appendix C. NPSpecies list of vascular plant species documented at George Washington Birthplace National Monument as of December 2006 (continued).

Order	Family	Scientific Name	Common Names	Abundance	Nativity	Cultivation
Asterales	Asteraceae	Chondrilla juncea	skeletonweed	Uncommon	Non-Native	Not cultivated
Asterales	Asteraceae	Cirsium arvense	field thistle	Common	Non-Native	Not cultivated
Asterales	Asteraceae	Cirsium discolor	field thistle	Uncommon	Native	NA
Asterales	Asteraceae	Cirsium pumilum	pasture thistle	Uncommon	Native	NA
Asterales	Asteraceae	Cirsium vulgare	spear thistle	Uncommon	Non-Native	Not cultivated
Asterales	Asteraceae	Conoclinium coelestinum	blue mistflower	Uncommon	Native	NA
Asterales	Asteraceae	Conyza canadensis	marestail	Common	Native	NA
Asterales	Asteraceae	Eclipta prostrata	yerba de tajo	Uncommon	Native	NA
Asterales	Asteraceae	Elephantopus carolinianus	leafy elephantfoot	Common	Native	NA
Asterales	Asteraceae	Elephantopus tomentosus	hairy elephantfoot	Uncommon	Native	NA
Asterales	Asteraceae	Erechtites hieracifolia	burnweed	Uncommon	Native	NA
Asterales	Asteraceae	Erigeron annuus	eastern daisy fleabane	Common	Native	NA
Asterales	Asteraceae	Erigeron strigosus	rough fleabane	Common	Native	NA
Asterales	Asteraceae	Eupatorium dubium	coastalplain joepyeweed	Uncommon	Native	NA
Asterales	Asteraceae	Eupatorium hyssopifolium	hyssopleaf thoroughwort	Common	Native	NA
Asterales	Asteraceae	Eupatorium perfoliatum	common boneset	Uncommon	Native	NA
Asterales	Asteraceae	Eupatorium rotundifolium	roundleaf thoroughwort	Common	Native	NA
Asterales	Asteraceae	Eupatorium serotinum	lateflowering thoroughwort	Uncommon	Native	NA
Asterales	Asteraceae	Euthamia graminifolia	flattop goldentop	Uncommon	Native	NA
Asterales	Asteraceae	Gamochaeta purpurea	spoonleaf purple everlasting	Uncommon	Native	NA
Asterales	Asteraceae	Gnaphalium obtusifolium		Uncommon	Native	NA
Asterales	Asteraceae	Hieracium gronovii	queendevil	Uncommon	Native	NA
Asterales	Asteraceae	Hieracium venosum	rattlesnakeweed	Common	Native	NA
Asterales	Asteraceae	Hypochaeris radicata	spotted catsear	Uncommon	Non-Native	Not cultivated
Asterales	Asteraceae	Iva frutescens	Jesuit's bark	Common	Native	NA
Asterales	Asteraceae	Krigia virginica	Virginia dwarf dandelion	Common	Native	NA
Asterales	Asteraceae	Lactuca serriola	wild lettuce	Uncommon	Non-Native	Not cultivated
Asterales	Asteraceae	Leucanthemum vulgare	oxeyedaisy	Uncommon	Non-Native	Not cultivated
Asterales	Asteraceae	Mikania scandens	climbing hempweed	Common	Native	NA

Appendix C. NPSpecies list of vascular plant species documented at George Washington Birthplace National Monument as of December 2006 (continued).

Order	Family	Scientific Name	Common Names	Abundance	Nativity	Cultivation
Asterales	Asteraceae	Pluchea odorata	sweetscent	Uncommon	Native	NA
Asterales	Asteraceae	Pyrrhopappus carolinianus	Carolina false-dandelion	Uncommon	Native	NA
Asterales	Asteraceae	Rudbeckia hirta	blackeyesusan	Common	Native	NA
Asterales	Asteraceae	Senecio smallii		Uncommon	Native	NA
Asterales	Asteraceae	Smallanthus uvedalius	hairy leafcup	Common	Native	NA
Asterales	Asteraceae	Solidago canadensis var. scabra	Canadian goldenrod	Uncommon	Native	NA
Asterales	Asteraceae	Solidago erecta		Uncommon	Native	NA
Asterales	Asteraceae	Solidago juncea	early goldenrod	Uncommon	Native	NA
Asterales	Asteraceae	Solidago nemoralis	gray goldenrod	Uncommon	Native	NA
Asterales	Asteraceae	Solidago rugosa	wrinkleleaf goldenrod	Common	Native	NA
Asterales	Asteraceae	Solidago sempervirens	seaside goldenrod	Uncommon	Native	NA
Asterales	Asteraceae	Sonchus asper	spiny-leaf sow-thistle	Uncommon	Non-Native	Not cultivated
Asterales	Asteraceae	Tanacetum vulgare	tansy	Common	Non-Native	Not cultivated
Asterales	Asteraceae	Taraxacum officinale	faceclock	Common	Non-Native	Not cultivated
Asterales	Asteraceae	Verbesina occidentalis	yellow crownbeard	Common	Native	NA
Asterales	Asteraceae	Vernonia glauca	broadleaf ironweed	Uncommon	Native	NA
Asterales	Asteraceae	Vernonia noveboracensis	New York ironweed	Uncommon	Native	NA
Asterales	Asteraceae	Xanthium strumarium	rough cocklebur	Common	Native	NA
Callitrichales	Callitrichaceae	Callitriche heterophylla	variedleaf waterstarwort	Uncommon	Native	NA
Callitrichales	Callitrichaceae	Callitriche terrestris	terrestrial waterstarwort	Uncommon	Native	NA
Campanulales	Campanulaceae	Lobelia cardinalis	cardinalflower	Uncommon	Native	NA
Campanulales	Campanulaceae	Lobelia inflata	Indian-tobacco	Common	Native	NA
Campanulales	Campanulaceae	Triodanis perfoliata	Venus lookingglass	Common	Native	NA
Capparales	Brassicaceae	Arabidopsis thaliana	mouseear cress	Uncommon	Non-Native	Not cultivated
Capparales	Brassicaceae	Arabis laevigata	smooth rockcress	Uncommon	Native	NA
Capparales	Brassicaceae	Barbarea verna	early yellowrocket	Uncommon	Non-Native	Not cultivated
Capparales	Brassicaceae	Barbarea vulgaris	yellow rocket	Uncommon	Non-Native	Not cultivated
Capparales	Brassicaceae	Cakile edentula	American searocket	Uncommon	Native	NA
Capparales	Brassicaceae	Capsella bursa-pastoris	shepherdspurse	Common	Non-Native	Not cultivated
Capparales	Brassicaceae	Cardamine concatenata	cutleaf toothwort	Common	Native	NA

Appendix C. NPSpecies list of vascular plant species documented at George Washington Birthplace National Monument as of December 2006 (continued).

Order	Family	Scientific Name	Common Names	Abundance	Nativity	Cultivation
Capparales	Brassicaceae	Cardamine pensylvanica	Quaker bittercress	Uncommon	Native	NA
Capparales	Brassicaceae	Hesperis matronalis	mother-of-the-evening	Common	Native	NA
Capparales	Brassicaceae	Lepidium campestre	field pepperweed	Common	Non-Native	Not cultivated
Capparales	Brassicaceae	Lepidium virginicum	Virginian peppergrass	Common	Native	NA
Capparales	Brassicaceae	Lunaria annua	annual honesty	Uncommon	Non-Native	Not cultivated
Capparales	Brassicaceae	Raphanus raphanistrum	wild radish	Common	Non-Native	Not cultivated
Capparales	Brassicaceae	Rorippa palustris	yellow watercress	Uncommon	Native	NA
Capparales	Brassicaceae	Sisymbrium officinale	wild mustard	Uncommon	Non-Native	Not cultivated
Capparales	Brassicaceae	Teesdalia nudicaulis	barestem teasdalia	Common	Non-Native	Not cultivated
Caryophyllales	Amaranthaceae	Amaranthus cannabinus	tidalmarsh amaranth	Uncommon	Native	NA
Caryophyllales	Amaranthaceae	Amaranthus hybridus	smooth pigweed	Common	Native	NA
Caryophyllales	Amaranthaceae	Amaranthus retroflexus	rough pigweed	Common	Native	NA
Caryophyllales	Amaranthaceae	Iresine rhizomatosa	rootstock bloodleaf	Uncommon	Native	NA
Caryophyllales	Cactaceae	Opuntia compressa		Uncommon	Native	NA
Caryophyllales	Cactaceae	Opuntia humifusa	pricklypear	Rare	Native	NA
Caryophyllales	Caryophyllaceae	Arenaria serpyllifolia	thymeleaf sandwort	Uncommon	Non-Native	Not cultivated
Caryophyllales	Caryophyllaceae	Cerastium glomeratum	sticky chickweed	Common	Non-Native	Not cultivated
Caryophyllales	Caryophyllaceae	Cerastium vulgatum	mouseear chickweed	Common	Non-Native	Not cultivated
Caryophyllales	Caryophyllaceae	Dianthus armeria	Deptford's pink	Uncommon	Non-Native	Not cultivated
Caryophyllales	Caryophyllaceae	Lychnis alba	white cockle	Common	Non-Native	Not cultivated
Caryophyllales	Caryophyllaceae	Lychnis coronaria	rose campion	Uncommon	Non-Native	Not cultivated
Caryophyllales	Caryophyllaceae	Sagina decumbens	trailing pearlwort	Common	Native	NA
Caryophyllales	Caryophyllaceae	Saponaria officinalis	sweet Betty	Common	Non-Native	Not cultivated
Caryophyllales	Caryophyllaceae	Scleranthus annuus	knawel	Common	Non-Native	Not cultivated
Caryophyllales	Caryophyllaceae	Stellaria media	nodding chickweed	Common	Non-Native	Not cultivated
Caryophyllales	Chenopodiaceae	Atriplex patula	spear saltweed	Uncommon	Non-Native	Not cultivated
Caryophyllales	Chenopodiaceae	Chenopodium album	white goosefoot	Uncommon	Non-Native	Not cultivated
Caryophyllales	Chenopodiaceae	Chenopodium ambrosioides	Mexican-tea	Uncommon	Non-Native	Not cultivated
Caryophyllales	Chenopodiaceae	Salsola kali	tumbleweed	Uncommon	Native	NA
Caryophyllales	Molluginaceae	Mollugo verticillata	green carpetweed	Common	Non-Native	Not cultivated

Appendix C. NPSpecies list of vascular plant species documented at George Washington Birthplace National Monument as of December 2006 (continued).

Order	Family	Scientific Name	Common Names	Abundance	Nativity	Cultivation
Caryophyllales	Phytolaccaceae	Phytolacca americana	pokeweed	Common	Native	NA
Celastrales	Aquifoliaceae	Ilex integra		Uncommon	Non-Native	Not cultivated
Celastrales	Aquifoliaceae	Ilex opaca	American holly	Common	Native	NA
Celastrales	Aquifoliaceae	Ilex verticillata	common winterberry	Common	Native	NA
Celastrales	Celastraceae	Celastrus orbiculatus	oriental bittersweet	Uncommon	Non-Native	Not cultivated
Celastrales	Celastraceae	Celastrus scandens	waxwork	Common	Native	NA
Commelinales	Commelinaceae	Commelina communis	common dayflower	Common	Non-Native	Not cultivated
Cornales	Cornaceae	Cornus amomum	silky dogwood	Uncommon	Native	NA
Cornales	Cornaceae	Cornus florida	flowering dogwood	Common	Native	NA
Cornales	Nyssaceae	Nyssa sylvatica	blackgum	Uncommon	Native	NA
Cyperales	Cyperaceae	Carex albicans var. australis	stellate sedge	Uncommon	Native	NA
Cyperales	Cyperaceae	Carex blanda	woodland sedge	Uncommon	Native	NA
Cyperales	Cyperaceae	Carex cephalophora	ovalleaf sedge	Common	Native	NA
Cyperales	Cyperaceae	Carex crinita	fringed sedge	Common	Native	NA
Cyperales	Cyperaceae	Carex crinita var. crinita	fringed sedge	Common	Native	NA
Cyperales	Cyperaceae	Carex laxiflora var. laxiflora	broad looseflower sedge	Uncommon	Native	NA
Cyperales	Cyperaceae	Carex lurida	shallow sedge	Common	Native	NA
Cyperales	Cyperaceae	Carex retroflexa	reflexed sedge	Common	Native	NA
Cyperales	Cyperaceae	Carex stipata	stalk-grain sedge	Uncommon	Native	NA
Cyperales	Cyperaceae	Carex swanii	Swan's sedge	Uncommon	Native	NA
Cyperales	Cyperaceae	Carex vulpinoidea	fox sedge	Uncommon	Native	NA
Cyperales	Cyperaceae	Cyperus echinatus	globe flatsedge	Uncommon	Native	NA
Cyperales	Cyperaceae	Cyperus esculentus		Common	Native	NA
Cyperales	Cyperaceae	Cyperus filicinus	fern flatsedge	Uncommon	Native	NA
Cyperales	Cyperaceae	Cyperus lancastris	manyflower flatsedge	Uncommon	Native	NA
Cyperales	Cyperaceae	Cyperus odoratus	rusty flat sedge	Uncommon	Native	NA
Cyperales	Cyperaceae	Cyperus pseudovegetus	marsh flatsedge	Uncommon	Native	NA
Cyperales	Cyperaceae	Cyperus strigosus	strawcolored nutgrass	Uncommon	Native	NA
Cyperales	Cyperaceae	Eleocharis acicularis	needle spikesedge	Common	Native	NA
Cyperales	Cyperaceae	Eleocharis obtusa	blunt spikesedge	Common	Native	NA

Appendix C. NPSpecies list of vascular plant species documented at George Washington Birthplace National Monument as of December 2006 (continued).

Order	Family	Scientific Name	Common Names	Abundance	Nativity	Cultivation
Cyperales	Cyperaceae	Eleocharis parvula	little-head spikerush	Common	Native	NA
Cyperales	Cyperaceae	Schoenoplectus americanus	Schoenoplectus	Common	Native	NA
Cyperales	Cyperaceae	Scirpus cyperinus	woolgrass	Uncommon	Native	NA
Cyperales	Cyperaceae	Scirpus robustus		Uncommon	Native	NA
Cyperales	Poaceae	Agrostis perennans	upland bentgrass	Common	Native	NA
Cyperales	Poaceae	Agrostis stolonifera	spreading bent	Common	Non-Native	Not cultivated
Cyperales	Poaceae	Agrostis tenuis		Common	Non-Native	Not cultivated
Cyperales	Poaceae	Alopecurus carolinianus	tufted meadow-foxtail	Uncommon	Native	NA
Cyperales	Poaceae	Andropogon virginicus	yellow bluestem	Common	Native	NA
Cyperales	Poaceae	Anthoxanthum odoratum	sweet vernalgrass	Common	Non-Native	Not cultivated
Cyperales	Poaceae	Arthraxon hispidus	small carpgrass	Common	Non-Native	Not cultivated
Cyperales	Poaceae	Bromus japonicus	Japanese chess	Common	Non-Native	Not cultivated
Cyperales	Poaceae	Bromus tectorum	wild oats	Common	Non-Native	Not cultivated
Cyperales	Poaceae	Cenchrus tribuloides	sanddune sandbur	Uncommon	Native	NA
Cyperales	Poaceae	Chasmanthium laxum	spike uniola	Uncommon	Native	NA
Cyperales	Poaceae	Cinna arundinacea	sweet woodreed	Common	Native	NA
Cyperales	Poaceae	Cynodon dactylon	motie molulu	Common	Non-Native	Not cultivated
Cyperales	Poaceae	Dactylis glomerata	orchardgrass	Common	Non-Native	Not cultivated
Cyperales	Poaceae	Danthonia spicata	poverty wild oat grass	Common	Native	NA
Cyperales	Poaceae	Deschampsia flexuosa	wavy hairgrass	Uncommon	Native	NA
Cyperales	Poaceae	Dichanthelium acuminatum	tapered rosette grass	Common	Native	NA
Cyperales	Poaceae	Dichanthelium clandestinum	deertongue	Uncommon	Native	NA
Cyperales	Poaceae	Dichanthelium lanuginosum		Common	Native	NA
Cyperales	Poaceae	Dichanthelium scoparium	velvet panicum	Common	Native	NA
Cyperales	Poaceae	Dichanthelium sphaerocarpon	roundseed panicum	Uncommon	Native	NA
Cyperales	Poaceae	Dichanthelium spretum	Eaton's rosette grass	Uncommon	Native	NA
Cyperales	Poaceae	Digitaria sanguinalis	redhair crabgrass	Common	Non-Native	Not cultivated
Cyperales	Poaceae	Distichlis spicata	seashore saltgrass	Common	Native	NA
Cyperales	Poaceae	Echinochloa crus-galli	watergrass	Uncommon	Non-Native	Not cultivated
Cyperales	Poaceae	Echinochloa walteri	walter's barnyard grass	Common	Native	NA

Appendix C. NPSpecies list of vascular plant species documented at George Washington Birthplace National Monument as of December 2006 (continued).

Order	Family	Scientific Name	Common Names	Abundance	Nativity	Cultivation
Cyperales	Poaceae	<i>Eleusine indica</i>	wiregrass	Common	Non-Native	Not cultivated
Cyperales	Poaceae	<i>Elymus hystrix</i> var. <i>hystrix</i>	eastern bottlebrush grass	Uncommon	Native	NA
Cyperales	Poaceae	<i>Elymus villosus</i>	slender wild-rye	Common	Native	NA
Cyperales	Poaceae	<i>Elymus virginicus</i>	Virginia wildrye	Common	Native	NA
Cyperales	Poaceae	<i>Eragrostis hirsuta</i>	bigtop lovegrass	Uncommon	Native	NA
Cyperales	Poaceae	<i>Eragrostis pilosa</i>	Indian lovegrass	Uncommon	Native	NA
Cyperales	Poaceae	<i>Eragrostis spectabilis</i>	purple lovegrass	Common	Native	NA
Cyperales	Poaceae	<i>Festuca pratensis</i>		Common	Non-Native	Not cultivated
Cyperales	Poaceae	<i>Glyceria striata</i>	fowl mannagrass	Uncommon	Native	NA
Cyperales	Poaceae	<i>Hordeum pusillum</i>	little wildbarley	Common	Native	NA
Cyperales	Poaceae	<i>Hystrix patula</i>		Common	Native	NA
Cyperales	Poaceae	<i>Leersia oryzoides</i>	rice cutgrass	Uncommon	Native	NA
Cyperales	Poaceae	<i>Leersia virginica</i>	whitegrass	Common	Native	NA
Cyperales	Poaceae	<i>Lolium perenne</i>	perennial ryegrass	Common	Non-Native	Not cultivated
Cyperales	Poaceae	<i>Miscanthus sinensis</i>	eulalia	Rare	Non-Native	Not cultivated
Cyperales	Poaceae	<i>Muhlenbergia schreberi</i>	nimblewill muhly	Uncommon	Native	NA
Cyperales	Poaceae	<i>Panicum amarum</i>	bitter panicum	Uncommon	Native	NA
Cyperales	Poaceae	<i>Panicum anceps</i>	beaked panicum	Common	Native	NA
Cyperales	Poaceae	<i>Panicum dichotomiflorum</i>	western witchgrass	Uncommon	Native	NA
Cyperales	Poaceae	<i>Panicum virgatum</i>	switchgrass	Common	Native	NA
Cyperales	Poaceae	<i>Paspalum dilatatum</i>	water grass	Uncommon	Non-Native	Not cultivated
Cyperales	Poaceae	<i>Paspalum floridanum</i>	Florida paspalum	Uncommon	Native	NA
Cyperales	Poaceae	<i>Paspalum laeve</i>	field paspalum	Common	Native	NA
Cyperales	Poaceae	<i>Phleum pratense</i>	timothy	Uncommon	Non-Native	Not cultivated
Cyperales	Poaceae	<i>Phragmites australis</i>	common reed	Common	Native	NA
Cyperales	Poaceae	<i>Poa annua</i>	walkgrass	Common	Non-Native	Not cultivated
Cyperales	Poaceae	<i>Poa compressa</i>	flat-stem blue grass	Common	Non-Native	Not cultivated
Cyperales	Poaceae	<i>Poa pratensis</i>	Kentucky bluegrass	Common	Native	NA
Cyperales	Poaceae	<i>Schizachyrium scoparium</i>	little bluestem	Common	Native	NA
Cyperales	Poaceae	<i>Setaria faberi</i>	tall green bristlegrass	Common	Non-Native	Not cultivated

Appendix C. NPSpecies list of vascular plant species documented at George Washington Birthplace National Monument as of December 2006 (continued).

Order	Family	Scientific Name	Common Names	Abundance	Nativity	Cultivation
Cyperales	Poaceae	Setaria glauca	yellow foxtail	Common	Non-Native	Not cultivated
Cyperales	Poaceae	Setaria parviflora	yellow bristlegrass	Common	Native	NA
Cyperales	Poaceae	Setaria viridis	wild millet	Uncommon	Native	NA
Cyperales	Poaceae	Spartina alterniflora	smooth cordgrass	Common	Native	NA
Cyperales	Poaceae	Spartina cynosuroides	big cordgrass	Common	Native	NA
Cyperales	Poaceae	Spartina patens	saltmeadow cordgrass	Common	Native	NA
Cyperales	Poaceae	Tridens flavus	purpletop tridens	Common	Native	NA
Cyperales	Poaceae	Tripsacum dactyloides	eastern gamagrass	Uncommon	Native	NA
Cyperales	Poaceae	Triticum aestivum	wheat	Uncommon	Non-Native	Not cultivated
Cyperales	Poaceae	Zizania aquatica	annual wildrice	Common	Native	NA
Dipsacales	Caprifoliaceae	Kolkwitzia amabilis	beautybush	Unknown	Non-Native	Unknown
Dipsacales	Caprifoliaceae	Lonicera japonica	Japanese honeysuckle	Common	Non-Native	Not cultivated
Dipsacales	Caprifoliaceae	Sambucus canadensis	american elder	Common	Native	NA
Dipsacales	Caprifoliaceae	Viburnum nudum	possumhaw viburnum	Common	Native	NA
Dipsacales	Caprifoliaceae	Viburnum prunifolium	blackhaw	Common	Native	NA
Dipsacales	Valerianaceae	Valerianella locusta	Lewiston cornsalad	Common	Non-Native	Not cultivated
Dipsacales	Valerianaceae	Valerianella radiata	beaked cornsalad	Common	Native	NA
Ebenales	Ebenaceae	Diospyros virginiana	Persimmon	Uncommon	Native	NA
Equisetales	Equisetaceae	Equisetum arvense	western horsetail	Common	Native	NA
Equisetales	Equisetaceae	Equisetum hyemale	western scouringrush	Common	Native	NA
Ericales	Ericaceae	Rhododendron periclymenoides	pink azalea	Uncommon	Native	NA
Ericales	Ericaceae	Vaccinium corymbosum	highbush blueberry	Common	Native	NA
Ericales	Monotropaceae	Monotropa uniflora	one-flower Indian-pipe	Uncommon	Native	NA
Ericales	Pyrolaceae	Chimaphila maculata	striped prince's-pine	Uncommon	Native	NA
Euphorbiales	Euphorbiaceae	Acalypha gracilens	slender threeseed mercury	Common	Native	NA
Euphorbiales	Euphorbiaceae	Acalypha rhomboidea	Virginia threeseed mercury	Common	Native	NA
Euphorbiales	Euphorbiaceae	Acalypha virginica	wax balls	Uncommon	Native	NA
Euphorbiales	Euphorbiaceae	Chamaesyce maculata	spotted spurge	Uncommon	Native	NA
Euphorbiales	Euphorbiaceae	Chamaesyce polygonifolia	seaside spurge	Uncommon	Native	NA
Euphorbiales	Euphorbiaceae	Euphorbia corollata	floweringspurge euphorbia	Uncommon	Native	NA

Appendix C. NPSpecies list of vascular plant species documented at George Washington Birthplace National Monument as of December 2006 (continued).

Order	Family	Scientific Name	Common Names	Abundance	Nativity	Cultivation
Fabales	Fabaceae	<i>Albizia julibrissin</i>	silk tree	Uncommon	Non-Native	Not cultivated
Fabales	Fabaceae	<i>Amorpha fruticosa</i>	lead plant	Uncommon	Native	NA
Fabales	Fabaceae	<i>Apios americana</i>	potato bean	Uncommon	Native	NA
Fabales	Fabaceae	<i>Cassia marilandica</i>		Uncommon	Native	NA
Fabales	Fabaceae	<i>Cercis canadensis</i>	Redbud	Uncommon	Native	NA
Fabales	Fabaceae	<i>Chamaecrista fasciculata</i>	sleeping plant	Uncommon	Native	NA
Fabales	Fabaceae	<i>Chamaecrista nictitans</i>	partridge-pea	Uncommon	Native	NA
Fabales	Fabaceae	<i>Desmodium canescens</i>	hoary ticktrefoil	Uncommon	Native	NA
Fabales	Fabaceae	<i>Desmodium glabellum</i>	Dillenius' ticktrefoil	Uncommon	Native	NA
Fabales	Fabaceae	<i>Desmodium laevigatum</i>	smooth ticktrefoil	Uncommon	Native	NA
Fabales	Fabaceae	<i>Galactia regularis</i>	eastern milkpea	Uncommon	Native	NA
Fabales	Fabaceae	<i>Kummerowia stipulacea</i>	korean lespedeza	Common	Non-Native	Not cultivated
Fabales	Fabaceae	<i>Kummerowia striata</i>	Japanese clover	Common	Non-Native	Not cultivated
Fabales	Fabaceae	<i>Lathyrus latifolius</i>	Perennial sweetpea	Uncommon	Non-Native	Not cultivated
Fabales	Fabaceae	<i>Lespedeza cuneata</i>	sericea lespedeza	Common	Non-Native	Not cultivated
Fabales	Fabaceae	<i>Lespedeza intermedia</i>	intermediate lespedeza	Uncommon	Native	NA
Fabales	Fabaceae	<i>Lespedeza procumbens</i>	trailing lespedeza	Uncommon	Native	NA
Fabales	Fabaceae	<i>Lespedeza repens</i>	creeping lespedeza	Uncommon	Native	NA
Fabales	Fabaceae	<i>Medicago lupulina</i>	yellow trefoil	Common	Non-Native	Not cultivated
Fabales	Fabaceae	<i>Melilotus alba</i>	white sweetclover	Common	Non-Native	Not cultivated
Fabales	Fabaceae	<i>Robinia pseudoacacia</i>	yellow locust	Uncommon	Native	NA
Fabales	Fabaceae	<i>Senna marilandica</i>	wild senna	Uncommon	Native	NA
Fabales	Fabaceae	<i>Strophostyles helvula</i>	Trailing wildbean	Uncommon	Native	NA
Fabales	Fabaceae	<i>Strophostyles umbellata</i>	pink fuzzybean	Uncommon	Native	NA
Fabales	Fabaceae	<i>Stylosanthes biflora</i>	sidebeak pencilflower	Common	Native	NA
Fabales	Fabaceae	<i>Trifolium arvense</i>	stone clover	Common	Non-Native	Not cultivated
Fabales	Fabaceae	<i>Trifolium dubium</i>	suckling clover	Common	Non-Native	Not cultivated
Fabales	Fabaceae	<i>Trifolium pratense</i>	red clover	Common	Non-Native	Not cultivated
Fabales	Fabaceae	<i>Trifolium repens</i>	white clover	Common	Non-Native	Not cultivated
Fagales	Betulaceae	<i>Alnus serrulata</i>	hazel alder	Common	Native	NA

Appendix C. NPSpecies list of vascular plant species documented at George Washington Birthplace National Monument as of December 2006 (continued).

Order	Family	Scientific Name	Common Names	Abundance	Nativity	Cultivation
Fagales	Fagaceae	<i>Fagus grandifolia</i>	American beech	Common	Native	NA
Fagales	Fagaceae	<i>Quercus alba</i>	white oak	Uncommon	Native	NA
Fagales	Fagaceae	<i>Quercus falcata</i>	southern red oak	Common	Native	NA
Fagales	Fagaceae	<i>Quercus michauxii</i>	swamp chestnut oak	Uncommon	Native	NA
Fagales	Fagaceae	<i>Quercus muehlenbergii</i>	chinkapin oak	Common	Native	NA
Fagales	Fagaceae	<i>Quercus pagoda</i>	texas oak	Uncommon	Native	NA
Fagales	Fagaceae	<i>Quercus palustris</i>	pin oak	Uncommon	Native	NA
Fagales	Fagaceae	<i>Quercus phellos</i>	willow oak	Uncommon	Native	NA
Fagales	Fagaceae	<i>Quercus prinus</i>	chestnut oak	Common	Native	NA
Fagales	Fagaceae	<i>Quercus rubra</i>	northern red oak	Uncommon	Native	NA
Fagales	Fagaceae	<i>Quercus stellata</i>	post oak	Uncommon	Native	NA
Fagales	Fagaceae	<i>Quercus velutina</i>	black oak	Uncommon	Native	NA
Gentianales	Apocynaceae	<i>Apocynum cannabinum</i>	prairie dogbane	Common	Native	NA
Gentianales	Apocynaceae	<i>Vinca major</i>	periwinkle	Common	Non-Native	Not cultivated
Gentianales	Apocynaceae	<i>Vinca minor</i>	myrtle	Uncommon	Non-Native	Not cultivated
Gentianales	Asclepiadaceae	<i>Asclepias incarnata</i>	swamp milkweed	Common	Native	NA
Gentianales	Asclepiadaceae	<i>Asclepias syriaca</i>	common milkweed	Common	Native	NA
Gentianales	Asclepiadaceae	<i>Asclepias tuberosa</i>	butterflyweed	Uncommon	Native	NA
Gentianales	Asclepiadaceae	<i>Asclepias verticillata</i>	whorled milkweed	Uncommon	Native	NA
Gentianales	Asclepiadaceae	<i>Cynanchum laeve</i>	sandvine	Uncommon	Native	NA
Gentianales	Asclepiadaceae	<i>Matelea carolinensis</i>	maroon Carolina milkvine	Uncommon	Native	NA
Gentianales	Asclepiadaceae	<i>Matelea gonocarpa</i>		Uncommon	Native	NA
Geraniales	Balsaminaceae	<i>Impatiens capensis</i>	spotted touch-me-not	Common	Native	NA
Geraniales	Geraniaceae	<i>Geranium carolinianum</i>	Carolina geranium	Common	Native	NA
Geraniales	Geraniaceae	<i>Geranium molle</i>	dovefoot geranium	Common	Non-Native	Not cultivated
Geraniales	Oxalidaceae	<i>Oxalis dillenii</i>	Dillen's oxalis	Common	Native	NA
Geraniales	Oxalidaceae	<i>Oxalis stricta</i>	yellow woodsorrel	Common	Native	NA
Hamamelidales	Hamamelidaceae	<i>Liquidambar styraciflua</i>	sweetgum	Common	Native	NA
Hamamelidales	Platanaceae	<i>Platanus occidentalis</i>	sycamore	Uncommon	Native	NA
Hydrocharitales	Hydrocharitaceae	<i>Elodea nuttallii</i>	western waterweed	Uncommon	Native	NA

Appendix C. NPSpecies list of vascular plant species documented at George Washington Birthplace National Monument as of December 2006 (continued).

Order	Family	Scientific Name	Common Names	Abundance	Nativity	Cultivation
Juglandales	Juglandaceae	<i>Carya cordiformis</i>	bitternut hickory	Common	Native	NA
Juglandales	Juglandaceae	<i>Carya glabra</i>	pignut hickory	Uncommon	Native	NA
Juglandales	Juglandaceae	<i>Juglans nigra</i>	black walnut	Uncommon	Native	NA
Juncales	Juncaceae	<i>Juncus coriaceus</i>	leathery rush	Common	Native	NA
Juncales	Juncaceae	<i>Juncus dichotomus</i>	forked rush	Common	Native	NA
Juncales	Juncaceae	<i>Juncus effusus</i>	lamp rush	Common	Native	NA
Juncales	Juncaceae	<i>Juncus tenuis</i>	wiregrass	Uncommon	Native	NA
Juncales	Juncaceae	<i>Luzula echinata</i>	hedgehog woodrush	Uncommon	Native	NA
Lamiales	Boraginaceae	<i>Myosotis macrosperma</i>	southern forget me not	Common	Native	NA
Lamiales	Lamiaceae	<i>Ajuga chamaepitys</i>	yellow bugle	Common	Non-Native	Not cultivated
Lamiales	Lamiaceae	<i>Calamintha nepeta</i>	lesser calamint	Common	Non-Native	Not cultivated
Lamiales	Lamiaceae	<i>Clinopodium vulgare</i>	wild basil	Uncommon	Native	NA
Lamiales	Lamiaceae	<i>Glechoma hederacea</i>	haymaids	Common	Non-Native	Not cultivated
Lamiales	Lamiaceae	<i>Hedeoma pulegioides</i>	American false pennyroyal	Uncommon	Native	NA
Lamiales	Lamiaceae	<i>Lamium amplexicaule</i>	henbit deadnettle	Common	Non-Native	Not cultivated
Lamiales	Lamiaceae	<i>Lamium purpureum</i>	red deadnettle	Uncommon	Non-Native	Not cultivated
Lamiales	Lamiaceae	<i>Leonurus cardiaca</i>	motherwort	Common	Non-Native	Not cultivated
Lamiales	Lamiaceae	<i>Lycopus virginicus</i>	Virginia water horehound	Common	Native	NA
Lamiales	Lamiaceae	<i>Mentha spicata</i>	spearmint	Common	Non-Native	Not cultivated
Lamiales	Lamiaceae	<i>Monarda punctata</i>	spotted beebalm	Common	Native	NA
Lamiales	Lamiaceae	<i>Nepeta cataria</i>	field balm	Common	Non-Native	Not cultivated
Lamiales	Lamiaceae	<i>Perilla frutescens</i>	Purple mint	Common	Non-Native	Not cultivated
Lamiales	Lamiaceae	<i>Prunella vulgaris</i>	selfheal	Uncommon	Non-Native	Not cultivated
Lamiales	Lamiaceae	<i>Salvia lyrata</i>	lyreleaf sage	Common	Native	NA
Lamiales	Lamiaceae	<i>Satureja calamintha</i> var. <i>nepeta</i>		Uncommon	Non-Native	Not cultivated
Lamiales	Lamiaceae	<i>Satureja vulgaris</i>		Uncommon	Native	NA
Lamiales	Lamiaceae	<i>Scutellaria integrifolia</i>	helmet flower	Uncommon	Native	NA
Lamiales	Lamiaceae	<i>Scutellaria lateriflora</i>	mad dog skullcap	Uncommon	Native	NA
Lamiales	Lamiaceae	<i>Teucrium canadense</i>	wood sage	Common	Native	NA
Lamiales	Lamiaceae	<i>Trichostema dichotomum</i>	forked bluecurls	Uncommon	Native	NA

Appendix C. NPSpecies list of vascular plant species documented at George Washington Birthplace National Monument as of December 2006 (continued).

Order	Family	Scientific Name	Common Names	Abundance	Nativity	Cultivation
Lamiales	Verbenaceae	Lippia lanceolata		Uncommon	Native	NA
Lamiales	Verbenaceae	Phryma leptostachya	lopseed	Common	Native	NA
Lamiales	Verbenaceae	Verbena hastata	swamp verbena	Common	Native	NA
Lamiales	Verbenaceae	Verbena simplex	simple verbena	Uncommon	Native	NA
Lamiales	Verbenaceae	Verbena urticifolia	white vervain	Uncommon	Native	NA
Laurales	Lauraceae	Lindera benzoin	spicebush	Uncommon	Native	NA
Laurales	Lauraceae	Sassafras albidum	sassafras	Uncommon	Native	NA
Liliales	Agavaceae	Yucca filamentosa	Adam's needle	Uncommon	Native	NA
Liliales	Iridaceae	Iris pseudacorus	yellow flag	Uncommon	Non-Native	Not cultivated
Liliales	Liliaceae	Allium canadense	wild onion	Uncommon	Native	NA
Liliales	Liliaceae	Allium vineale	wild garlic	Common	Non-Native	Not cultivated
Liliales	Liliaceae	Asparagus officinalis	garden-asparagus	Uncommon	Non-Native	Not cultivated
Liliales	Liliaceae	Hemerocallis fulva	tawny daylily	Uncommon	Non-Native	Unknown
Liliales	Liliaceae	Muscari racemosum		Uncommon	Non-Native	Not cultivated
Liliales	Liliaceae	Ornithogalum umbellatum	Star-of-Bethlehem	Uncommon	Non-Native	Not cultivated
Liliales	Smilacaceae	Smilax bona-nox	saw greenbrier	Uncommon	Native	NA
Liliales	Smilacaceae	Smilax glauca	cat greenbrier	Uncommon	Native	NA
Liliales	Smilacaceae	Smilax rotundifolia	roundleaf greenbrier	Common	Native	NA
Linales	Linaceae	Linum virginianum	woodland flax	Uncommon	Native	NA
Lycopodiales	Lycopodiaceae	Lycopodium flabelliforme		Uncommon	Native	NA
Magnoliales	Annonaceae	Asimina triloba	pawpaw	Common	Native	NA
Magnoliales	Magnoliaceae	Liriodendron tulipifera	yellow-poplar	Common	Native	NA
Magnoliales	Magnoliaceae	Magnolia grandiflora	southern magnolia	Rare	Native	NA
Magnoliales	Magnoliaceae	Magnolia virginiana	sweetbay	Uncommon	Native	NA
Malvales	Malvaceae	Abutilon theophrasti	velvetleaf Indian mallow	Uncommon	Non-Native	Not cultivated
Malvales	Malvaceae	Hibiscus moscheutos	swamp rosemallow	Common	Native	NA
Malvales	Malvaceae	Hibiscus syriacus	shrub-althea	Rare	Non-Native	Not cultivated
Malvales	Malvaceae	Kosteletzkya virginica	Virginia saltmarsh willow	Common	Native	NA
Malvales	Malvaceae	Malva neglecta	roundleaf mallow	Uncommon	Non-Native	Not cultivated
Malvales	Tiliaceae	Tilia americana	American basswood	Uncommon	Native	NA

Appendix C. NPSpecies list of vascular plant species documented at George Washington Birthplace National Monument as of December 2006 (continued).

Order	Family	Scientific Name	Common Names	Abundance	Nativity	Cultivation
Malvales	Tiliaceae	<i>Tilia americana</i> var. <i>heterophylla</i>	American basswood	Uncommon	Native	NA
Myricales	Myricaceae	<i>Myrica cerifera</i>	wax myrtle	Common	Native	NA
Myrtales	Lythraceae	<i>Ammannia latifolia</i>	pink redstem	Uncommon	Native	NA
Myrtales	Lythraceae	<i>Cuphea viscosissima</i>	blue waxweed	Uncommon	Native	NA
Myrtales	Lythraceae	<i>Decodon verticillatus</i>	swamp loosestrife	Common	Native	NA
Myrtales	Lythraceae	<i>Lythrum lineare</i>	wand lythrum	Uncommon	Native	NA
Myrtales	Onagraceae	<i>Circaea lutetiana</i> ssp. <i>canadensis</i>	broadleaf enchanter's nightshade	Uncommon	Native	NA
Myrtales	Onagraceae	<i>Ludwigia alternifolia</i>	seedbox	Uncommon	Native	NA
Myrtales	Onagraceae	<i>Ludwigia decurrens</i>	wingleaf waterprimrose	Uncommon	Native	NA
Myrtales	Onagraceae	<i>Ludwigia palustris</i>	marsh seedbox	Common	Native	NA
Myrtales	Onagraceae	<i>Oenothera biennis</i>	king's-cureall	Common	Native	NA
Myrtales	Onagraceae	<i>Oenothera laciniata</i>	cutleaf eveningprimrose	Common	Native	NA
Nymphaeales	Ceratophyllaceae	<i>Ceratophyllum echinatum</i>	spineless hornwort	Common	Native	NA
Nymphaeales	Nymphaeaceae	<i>Nuphar lutea</i>	yellow pondlily	Common	Native	NA
Ophioglossales	Ophioglossaceae	<i>Botrychium virginianum</i>	rattlesnake fern	Uncommon	Native	NA
Ophioglossales	Ophioglossaceae	<i>Ophioglossum vulgatum</i>	southern adderstongue	Uncommon	Native	NA
Orchidales	Orchidaceae	<i>Spiranthes vernalis</i>	upland ladiestresses	Uncommon	Native	NA
Pinales	Cupressaceae	<i>Juniperus virginiana</i>	red cedar juniper	Common	Native	NA
Pinales	Pinaceae	<i>Pinus taeda</i>	loblolly pine	Common	Native	NA
Pinales	Pinaceae	<i>Pinus virginiana</i>	Virginia pine	Common	Native	NA
Piperales	Saururaceae	<i>Saururus cernuus</i>	lizards tail	Common	Native	NA
Plantaginales	Plantaginaceae	<i>Plantago aristata</i>	largebracted plantain	Uncommon	Native	NA
Plantaginales	Plantaginaceae	<i>Plantago heterophylla</i>	slender plantain	Uncommon	Native	NA
Plantaginales	Plantaginaceae	<i>Plantago lanceolata</i>	ribwort	Common	Non-Native	Not cultivated
Plantaginales	Plantaginaceae	<i>Plantago rugelii</i>	Rugel's plantain	Common	Native	NA
Plantaginales	Plantaginaceae	<i>Plantago virginica</i>	Virginia plantain	Common	Native	NA
Polygalales	Polygalaceae	<i>Polygala mariana</i>	Maryland milkwort	Uncommon	Native	NA
Polygonales	Polygonaceae	<i>Polygonum aviculare</i>	yard knotweed	Common	Non-Native	Not cultivated
Polygonales	Polygonaceae	<i>Polygonum cespitosum</i> var. <i>longisetum</i>	oriental ladythumb	Common	Non-Native	Not cultivated
Polygonales	Polygonaceae	<i>Polygonum hydropiper</i>	mild water-pepper	Common	Non-Native	Not cultivated

Appendix C. NPSpecies list of vascular plant species documented at George Washington Birthplace National Monument as of December 2006 (continued).

Order	Family	Scientific Name	Common Names	Abundance	Nativity	Cultivation
Polygonales	Polygonaceae	Polygonum hydropiperoides	swamp smartweed	Uncommon	Native	NA
Polygonales	Polygonaceae	Polygonum pensylvanicum	pinweed	Uncommon	Native	NA
Polygonales	Polygonaceae	Polygonum prolificum		Uncommon	Native	NA
Polygonales	Polygonaceae	Polygonum punctatum	dotted smartweed	Common	Native	NA
Polygonales	Polygonaceae	Polygonum sagittatum	arrowvine	Uncommon	Native	NA
Polygonales	Polygonaceae	Polygonum setaceum	bog smartweed	Uncommon	Native	NA
Polygonales	Polygonaceae	Polygonum virginianum	Virginia smartweed	Common	Native	NA
Polygonales	Polygonaceae	Rumex acetosella	sheep sorrel	Common	Non-Native	Not cultivated
Polygonales	Polygonaceae	Rumex obtusifolius	bluntleaf dock	Common	Non-Native	Not cultivated
Polygonales	Polygonaceae	Rumex pulcher	fiddle dock	Common	Non-Native	Not cultivated
Polygonales	Polygonaceae	Rumex verticillatus	swamp dock	Common	Native	NA
Polypodiales	Aspleniaceae	Asplenium platyneuron	ebony spleenwort	Uncommon	Native	NA
Polypodiales	Blechnaceae	Woodwardia areolata	netted chainfern	Uncommon	Native	NA
Polypodiales	Blechnaceae	Woodwardia virginica	virginia chainfern	Uncommon	Native	NA
Polypodiales	Dennstaedtiaceae	Dennstaedtia punctilobula	eastern hayscented fern	Common	Native	NA
Polypodiales	Dryopteridaceae	Athyrium asplenoides		Common	Native	NA
Polypodiales	Dryopteridaceae	Athyrium filix-femina	subarctic lady fern	Uncommon	Native	NA
Polypodiales	Dryopteridaceae	Dryopteris intermedia	intermediate woodfern	Common	Native	NA
Polypodiales	Dryopteridaceae	Onoclea sensibilis	sensitive fern	Uncommon	Native	NA
Polypodiales	Dryopteridaceae	Polystichum acrostichoides	Christmas fern	Common	Native	NA
Polypodiales	Osmundaceae	Osmunda cinnamomea	cinnamon fern	Uncommon	Native	NA
Polypodiales	Osmundaceae	Osmunda regalis	royal fern	Uncommon	Native	NA
Polypodiales	Thelypteridaceae	Thelypteris noveboracensis	New York fern	Uncommon	Native	NA
Polypodiales	Thelypteridaceae	Thelypteris palustris	meadow fern	Common	Native	NA
Primulales	Primulaceae	Anagallis arvensis	scarlet pimpernel	Uncommon	Non-Native	Not cultivated
Primulales	Primulaceae	Lysimachia nummularia	moneywort	Uncommon	Non-Native	Not cultivated
Primulales	Primulaceae	Samolus parviflorus	water-pimpernel	Uncommon	Native	NA
Ranunculales	Berberidaceae	Berberis thunbergii	Japanese barberry	Rare	Non-Native	Not cultivated
Ranunculales	Menispermaceae	Menispermum canadense	common moonseed	Uncommon	Native	NA
Ranunculales	Ranunculaceae	Anemone virginiana	Virginia anemone	Uncommon	Native	NA

Appendix C. NPSpecies list of vascular plant species documented at George Washington Birthplace National Monument as of December 2006 (continued).

Order	Family	Scientific Name	Common Names	Abundance	Nativity	Cultivation
Ranunculales	Ranunculaceae	Aquilegia canadensis	red columbine	Uncommon	Native	NA
Ranunculales	Ranunculaceae	Clematis terniflora	yam-leaved clematis	Uncommon	Non-Native	Not cultivated
Ranunculales	Ranunculaceae	Consolida ajacis	rocket larkspur	Uncommon	Non-Native	Not cultivated
Ranunculales	Ranunculaceae	Eranthis hyemalis	winter aconite	Uncommon	Non-Native	Not cultivated
Ranunculales	Ranunculaceae	Ranunculus abortivus	smallflower crowfoot	Uncommon	Native	NA
Ranunculales	Ranunculaceae	Ranunculus bulbosus	yellow weed	Common	Non-Native	Not cultivated
Ranunculales	Ranunculaceae	Ranunculus hederaceus	ivy buttercup	Uncommon	Native	NA
Ranunculales	Ranunculaceae	Ranunculus parviflorus	sticktight buttercup	Common	Non-Native	Not cultivated
Ranunculales	Ranunculaceae	Ranunculus recurvatus	littleleaf buttercup	Uncommon	Native	NA
Ranunculales	Ranunculaceae	Ranunculus sardous	hairy buttercup	Uncommon	Non-Native	Not cultivated
Ranunculales	Ranunculaceae	Ranunculus sceleratus	cursed buttercup	Uncommon	Native	NA
Rhamnales	Elaeagnaceae	Elaeagnus umbellata	oleaster	Uncommon	Non-Native	Not cultivated
Rhamnales	Vitaceae	Parthenocissus quinquefolia	woodbine	Common	Native	NA
Rhamnales	Vitaceae	Vitis labrusca	fox grape	Common	Native	NA
Rhamnales	Vitaceae	Vitis rotundifolia	muscadine grape	Common	Native	NA
Rhamnales	Vitaceae	Vitis vulpina	wild grape	Common	Native	NA
Rosales	Grossulariaceae	Itea virginica	Virginia sweetspire	Uncommon	Native	NA
Rosales	Hydrangeaceae	Hydrangea quercifolia	oakleaf hydrangea	Uncommon	Native	NA
Rosales	Rosaceae	Amelanchier arborea	shadblow	Uncommon	Native	NA
Rosales	Rosaceae	Duchesnea indica	Indian strawberry	Common	Non-Native	Not cultivated
Rosales	Rosaceae	Fragaria vesca	woodland strawberry	Uncommon	Native	NA
Rosales	Rosaceae	Geum canadense	white avens	Common	Native	NA
Rosales	Rosaceae	Geum virginianum	cream avens	Uncommon	Native	NA
Rosales	Rosaceae	Potentilla canadensis	dwarf cinquefoil	Uncommon	Native	NA
Rosales	Rosaceae	Prunus hortulana	hortulan plum	Rare	Non-Native	Not cultivated
Rosales	Rosaceae	Prunus serotina	black chokecherry	Common	Native	NA
Rosales	Rosaceae	Pyracantha coccinea	scarlet firethorn	Rare	Non-Native	Not cultivated
Rosales	Rosaceae	Rosa palustris	swamp rose	Common	Native	NA
Rosales	Rosaceae	Rubus argutus	sawtooth blackberry	Common	Native	NA
Rosales	Rosaceae	Rubus occidentalis	black raspberry	Common	Native	NA

Appendix C. NPSpecies list of vascular plant species documented at George Washington Birthplace National Monument as of December 2006 (continued).

Order	Family	Scientific Name	Common Names	Abundance	Nativity	Cultivation
Rosales	Saxifragaceae	Heuchera americana	American alumroot	Uncommon	Native	NA
Rubiales	Rubiaceae	Cephalanthus occidentalis	common buttonbush	Uncommon	Native	NA
Rubiales	Rubiaceae	Diodia teres	rough buttonweed	Common	Native	NA
Rubiales	Rubiaceae	Diodia virginiana	Virginia buttonweed	Common	Native	NA
Rubiales	Rubiaceae	Galium aparine	white hedge	Common	Native	NA
Rubiales	Rubiaceae	Galium obtusum	bristly bedstraw	Common	Native	NA
Rubiales	Rubiaceae	Galium pilosum	hairy bedstraw	Uncommon	Native	NA
Rubiales	Rubiaceae	Galium tinctorium	stiff marsh bedstraw	Uncommon	Native	NA
Rubiales	Rubiaceae	Galium triflorum	sweetscented bedstraw	Common	Native	NA
Rubiales	Rubiaceae	Houstonia caerulea	azure bluet	Common	Native	NA
Rubiales	Rubiaceae	Mitchella repens	partridgeberry	Common	Native	NA
Rubiales	Rubiaceae	Sherardia arvensis	field madder	Common	Non-Native	Not cultivated
Salicales	Salicaceae	Populus grandidentata	bigtooth aspen	Uncommon	Native	NA
Salicales	Salicaceae	Salix nigra	black willow	Common	Native	NA
Sapindales	Aceraceae	Acer negundo	western boxelder	Uncommon	Native	NA
Sapindales	Aceraceae	Acer rubrum	red maple	Common	Native	NA
Sapindales	Aceraceae	Acer saccharinum	silver maple	Uncommon	Native	NA
Sapindales	Anacardiaceae	Rhus copallina	shining sumac	Common	Native	NA
Sapindales	Anacardiaceae	Rhus glabra	smooth sumac	Uncommon	Native	NA
Sapindales	Anacardiaceae	Toxicodendron radicans	poisonivy	Common	Native	NA
Sapindales	Simaroubaceae	Ailanthus altissima	tree-of-heaven	Uncommon	Non-Native	Not cultivated
Scrophulariales	Acanthaceae	Ruellia caroliniensis	Carolina wild petunia	Uncommon	Native	NA
Scrophulariales	Bignoniaceae	Campsis radicans	trumpet creeper	Common	Native	NA
Scrophulariales	Buddlejaceae	Polypremum procumbens	juniper leaf	Uncommon	Native	NA
Scrophulariales	Oleaceae	Ligustrum obtusifolium	border privet	Uncommon	Non-Native	Not cultivated
Scrophulariales	Oleaceae	Ligustrum sinense	common chinese privet	Common	Non-Native	Not cultivated
Scrophulariales	Scrophulariaceae	Agalinis purpurea	purple false foxglove	Uncommon	Native	NA
Scrophulariales	Scrophulariaceae	Gratiola virginiana	Virginia hedgehyssop	Uncommon	Native	NA
Scrophulariales	Scrophulariaceae	Kickxia elatine	sharppoint fluvellin	Common	Non-Native	Not cultivated
Scrophulariales	Scrophulariaceae	Linaria canadensis	Canada toadflax	Common	Native	NA

Appendix C. NPSpecies list of vascular plant species documented at George Washington Birthplace National Monument as of December 2006 (continued).

Order	Family	Scientific Name	Common Names	Abundance	Nativity	Cultivation
Scrophulariales	Scrophulariaceae	Verbascum blattaria	white moth mullein	Uncommon	Non-Native	Not cultivated
Scrophulariales	Scrophulariaceae	Verbascum thapsus	woolly mullein	Common	Non-Native	Not cultivated
Scrophulariales	Scrophulariaceae	Veronica arvensis	wall speedwell	Common	Non-Native	Not cultivated
Scrophulariales	Scrophulariaceae	Veronica hederifolia	ivy leaf speedwell	Common	Non-Native	Not cultivated
Scrophulariales	Scrophulariaceae	Veronica serpyllifolia	thyme leaf speedwell	Uncommon	Non-Native	Not cultivated
Solanales	Convolvulaceae	Calystegia sepium	wild morning glory	Uncommon	Native	NA
Solanales	Convolvulaceae	Convolvulus arvensis	smallflowered morning glory	Common	Non-Native	Not cultivated
Solanales	Convolvulaceae	Ipomoea hederacea		Common	Native	NA
Solanales	Convolvulaceae	Ipomoea lacunosa	whitestar	Uncommon	Native	NA
Solanales	Cuscutaceae	Cuscuta campestris	field dodder	Common	Native	NA
Solanales	Cuscutaceae	Cuscuta compacta	compact dodder	Uncommon	Native	NA
Solanales	Cuscutaceae	Cuscuta indecora	pretty dodder	Uncommon	Native	NA
Solanales	Cuscutaceae	Cuscuta pentagona	lespedeza dodder	Common	Native	NA
Solanales	Polemoniaceae	Phlox paniculata	fall phlox	Uncommon	Native	NA
Solanales	Solanaceae	Datura stramonium	thorn apple	Common	Non-Native	Not cultivated
Solanales	Solanaceae	Lycopersicon esculentum	garden tomato	Uncommon	Non-Native	Cultivated
Solanales	Solanaceae	Physalis longifolia var. subglabrata	longleaf groundcherry	Uncommon	Native	NA
Solanales	Solanaceae	Physalis virginiana	Virginia groundcherry	Uncommon	Native	NA
Solanales	Solanaceae	Solanum carolinense	sand briar	Common	Native	NA
Theales	Clusiaceae	Hypericum hypericoides	St. Andrews cross	Uncommon	Native	NA
Theales	Clusiaceae	Hypericum mutilum	dwarf St. Johnswort	Common	Native	NA
Theales	Clusiaceae	Hypericum perforatum	St. Johnswort	Uncommon	Non-Native	Not cultivated
Theales	Clusiaceae	Hypericum punctatum	spotted St. Johnswort	Uncommon	Native	NA
Theales	Clusiaceae	Triadenum virginicum	Virginia marsh St. Johnswort	Common	Native	NA
Typhales	Sparganiaceae	Sparganium americanum	American burreed	Uncommon	Native	NA
Typhales	Typhaceae	Typha angustifolia	narrowleaf cattail	Common	Native	NA
Urticales	Moraceae	Morus alba	white mulberry	Uncommon	Non-Native	Not cultivated
Urticales	Moraceae	Morus rubra	red mulberry	Uncommon	Native	NA
Urticales	Ulmaceae	Celtis laevigata	sugarberry	Uncommon	Native	NA
Urticales	Ulmaceae	Celtis occidentalis	western hackberry	Uncommon	Native	NA

Appendix C. NPSpecies list of vascular plant species documented at George Washington Birthplace National Monument as of December 2006 (continued).

Order	Family	Scientific Name	Common Names	Abundance	Nativity	Cultivation
Urticales	Ulmaceae	Ulmus americana	American elm	Uncommon	Native	NA
Urticales	Urticaceae	Boehmeria cylindrica	smallspike false nettle	Common	Native	NA
Urticales	Urticaceae	Pilea pumila	Canadian clearweed	Uncommon	Native	NA
Violales	Cucurbitaceae	Melothria pendula	Guadeloupe cucumber	Uncommon	Native	NA
Violales	Passifloraceae	Passiflora lutea	yellow passionflower	Uncommon	Native	NA
Violales	Violaceae	Viola cucullata	marsh blue violet	Uncommon	Native	NA
Violales	Violaceae	Viola rafinesquei		Common	Native	NA

Note: These data were deemed certified by a taxa expert on 07/15/05

Appendix D. NPSpecies list of reptile and amphibian species documented at George Washington Birthplace National Monument as of December 2006.

Taxa	Category	Family	Scientific Name	Common Name	Abundance	Residency	Nativity
Amphibian	Amphibian	Ranidae	<i>Rana clamitans melanota</i>	Northern Green Frog	Common	Resident	Native
Amphibian	Amphibian	Ranidae	<i>Rana catesbeiana</i>	Bullfrog	Common	Resident	Native
Amphibian	Amphibian	Bufo	<i>Bufo americanus americanus</i>	Eastern American Toad	Unknown	Resident	Native
Amphibian	Amphibian	Bufo	<i>Bufo fowleri</i>	Fowler's Toad	Abundant	Resident	Native
Amphibian	Amphibian	Hylidae	<i>Hyla chrysoscelis</i>	Cope's Gray Treefrog	Common	Resident	Native
Amphibian	Amphibian	Hylidae	<i>Hyla cinerea</i>	Green Treefrog	Common	Resident	Native
Amphibian	Amphibian	Hylidae	<i>Acris crepitans crepitans</i>	Northern Cricket Frog	Common	Resident	Native
Amphibian	Amphibian	Ambystomatidae	<i>Ambystoma maculatum</i>	Spotted Salamander	Abundant	Breeder	Native
Amphibian	Amphibian	Ambystomatidae	<i>Ambystoma opacum</i>	Marbled Salamander	Common	Breeder	Native
Amphibian	Amphibian	Salamandridae	<i>Notophthalmus viridescens viridescens</i>	Red-spotted Newt	Common	Breeder	Native
Amphibian	Amphibian	Plethodontidae	<i>Plethodon cinereus</i>	Redback Salamander*	NA	NA	Native
Amphibian	Amphibian	Plethodontidae	<i>Hemidactylium scutatum</i>	Four-toed Salamander	Uncommon	Breeder	Native
Amphibian	Amphibian	Hylidae	<i>Pseudacris crucifer</i>	Spring Peeper	Abundant	Resident	Native
Amphibian	Amphibian	Ranidae	<i>Rana sphenoccephala utricularia</i>	Southern Leopard Frog	Abundant	Breeder	Native
Reptile	Reptile	Colubridae	<i>Carphophis amoenus amoenus</i>	Eastern Worm Snake	Common	Breeder	Native
Reptile	Reptile	Colubridae	<i>Coluber constrictor constrictor</i>	Northern Black Racer	Common	Breeder	Native
Reptile	Reptile	Colubridae	<i>Diadophis punctatus edwardsii</i>	Northern Ringneck Snake	Uncommon	Breeder	Native
Reptile	Reptile	Colubridae	<i>Elaphe obsoleta obsoleta</i>	Black Rat Snake	Uncommon	Breeder	Native
Reptile	Reptile	Colubridae	<i>Lampropeltis getula getula</i>	Eastern Kingsnake	Unknown	Breeder	Native
Reptile	Reptile	Colubridae	<i>Nerodia sipedon sipedon</i>	Northern Water Snake	Uncommon	Breeder	Native
Reptile	Reptile	Colubridae	<i>Storeria dekayi dekayi</i>	Northern Brown Snake	Uncommon	Breeder	Native
Reptile	Reptile	Colubridae	<i>Thamnophis sirtalis sirtalis</i>	Common Garter Snake*	NA	NA	Native
Reptile	Reptile	Phrynosomatidae	<i>Sceloporus undulatus hyacinthinus</i>	Northern Fence Lizard*	NA	NA	Native
Reptile	Reptile	Scincidae	<i>Eumeces fasciatus</i>	Five-lined Skink	Uncommon	Breeder	Native
Reptile	Reptile	Scincidae	<i>Scincella lateralis</i>	Little Brown Skink	Uncommon	Breeder	Native
Reptile	Reptile	Teiidae	<i>Cnemidophorus sexlineatus sexlineatus</i>	Eastern Six-lined Racerunner	Unknown	Breeder	Native
Reptile	Reptile	Chelydridae	<i>Chelydra serpentina</i>	Snapping Turtle	Common	Breeder	Native
Reptile	Reptile	Emydidae	<i>Chrysemys picta picta</i>	Eastern Painted Turtle	Abundant	Breeder	Native

Appendix D. NPSpecies list of reptile and amphibian species documented at George Washington Birthplace National Monument as of December 2006 (continued).

Taxa Category	Family	Scientific Name	Common Name	Abundance	Residency	Nativity
Reptile	Emydidae	Malaclemys terrapin	Diamondback terrapin	Unknown	Breeder	Native
Reptile	Emydidae	Pseudemys rubriventris	Red-bellied turtle	Uncommon	Breeder	Native
Reptile	Emydidae	Terrapene carolina carolina	Eastern box turtle	Common	Breeder	Native
Reptile	Kinosternidae	Kinosternon subrubrum subrubrum	Eastern mud turtle	Uncommon	Breeder	Native
Reptile	Kinosternidae	Sternotherus odoratus	Common musk turtle	Uncommon	Breeder	Native

Note: These data were deemed certified by a taxa expert on 08/10/06

*Species is listed as "Probably Present" at George Washington Birthplace National Monument

Appendix E. Lepidoptera species observed at George Washington Birthplace National Monument, 2003-2004 (Chazal 2005).

Family	Scientific Name	Common Name
Hesperiidae	<i>Ancyloxypha numitor</i>	Least Skipper
Hesperiidae	<i>Atalopedes campestris</i>	Sachem
Hesperiidae	<i>Epargyreus clarus</i>	Silver-spotted skipper
Hesperiidae	<i>Erynnis horatius</i>	Horace's Duskywing
Hesperiidae	<i>Erynnis juvenalis</i>	Juvenal's Duskywing
Hesperiidae	<i>Euphyes vestris</i>	Dun Skipper
Hesperiidae	<i>Hylephila phyleus</i>	Fiery Skipper
Hesperiidae	<i>Lerema accius</i>	Clouded Skipper
Hesperiidae	<i>Panoquina panoquin</i>	Salt Marsh Skipper
Hesperiidae	<i>Poanes aaroni</i>	Aaron's Skipper
Hesperiidae	<i>Poanes viator zizaniae</i>	Broad-winged Skipper
Hesperiidae	<i>Poanes zabulon</i>	Zabulon Skipper
Hesperiidae	<i>Polites origenes</i>	Crossline Skipper
Hesperiidae	<i>Pompeius verna</i>	Little Glassywing
Hesperiidae	<i>Wallengrenia otho</i>	Southern Broken Dash
Lycaenidae	<i>Callophrys gryneus</i>	Juniper Hairstreak
Lycaenidae	<i>Callophrys henrici</i>	Henry's Elfin
Lycaenidae	<i>Calycopis cecrops</i>	Red-banded Hairstreak
Lycaenidae	<i>Celastrina ladon</i>	Spring Azure
Lycaenidae	<i>Celastrina neglecta</i>	Summer Azure
Lycaenidae	<i>Everes comyntas</i>	Eastern Tailed Blue
Lycaenidae	<i>Strymon melinus</i>	Gray Hairstreak
Nymphalidae	<i>Asterocampa celtis</i>	Hackberry Butterfly
Nymphalidae	<i>Cercyonis pegala pegala</i>	Common Wood Nymph
Nymphalidae	<i>Danaus plexippus</i>	Monarch
Nymphalidae	<i>Enodia anthedon</i>	Northern Pearly Eye
Nymphalidae	<i>Euptoieta claudia</i>	Variegated Fritillary
Nymphalidae	<i>Junonia coenia</i>	Common Buckeye
Nymphalidae	<i>Libytheana carinenta</i>	American Snout
Nymphalidae	<i>Limenitis arthemis astyanax</i>	Red-spotted Purple
Nymphalidae	<i>Megisto cymela</i>	Little Wood Satyr
Nymphalidae	<i>Nymphalis antiopa</i>	Mourning Cloak

Appendix E. Lepidoptera species observed at George Washington Birthplace National Monument, 2003-2004 (Chazal 2005) (continued).

Family	Scientific Name	Common Name
Nymphalidae	Phyciodes tharos	Pearl Crescent
Nymphalidae	Polygonia comma	Eastern Comma
Nymphalidae	Polygonia interrogationis	Question Mark
Nymphalidae	Satyrodes appalachia	Appalachian Brown
Nymphalidae	Speyeria cybele	Great Spangled Fritillary
Nymphalidae	Vanessa atalanta	Red Admiral
Nymphalidae	Vanessa cardui	Painted Lady
Nymphalidae	Vanessa virginiensis	American Lady
Papilionidae	Battus philenor	Pipevine Swallowtail
Papilionidae	Eurytides marcellus	Zebra Swallowtail
Papilionidae	Papilio glaucus	Eastern Tiger Swallowtail
Papilionidae	Papilio polyxenes	Black Swallowtail
Papilionidae	Papilio troilus	Spicebush Swallowtail
Pieridae	Anthocharis midea	Falcate Orangetip
Pieridae	Colias euytheme	Orange Sulphur
Pieridae	Colias philodice	Clouded Sulphur
Pieridae	Eurema nicippe	Sleepy Orange
Pieridae	Phoebis sennae	Cloudless Sulphur
Pieridae	Pieris rapae	Cabbage White

Appendix F. Odonata species observed at George Washington Birthplace National Monument, 2003-2004 (Chazal 2005).

Family	Scientific Name	Common Name
Aeshnidae	<i>Anax junius</i>	Common Green Darner
Aeshnidae	<i>Anax longipes</i>	Comet Darner
Aeshnidae	<i>Epiaeschna heros</i>	Swamp Darner
Aeshnidae	<i>Gomphaeschna furcillata</i>	Harlequin Darner
Cordulegastridae	<i>Cordulegaster maculata</i>	Twin-spotted Spiketail
Corduliidae	<i>Epithea cynosura</i>	Common Baskettail
Corduliidae	<i>Epithea princeps</i>	Prince Baskettail
Libellulidae	<i>Celithemis elisa</i>	Calico Pennant
Libellulidae	<i>Erythemis simplicicollis</i>	Eastern Pondhawk
Libellulidae	<i>Erythrodiplax berenice</i>	Seaside Dragonlet
Libellulidae	<i>Libellula axilena</i>	Bar-winged Skimmer
Libellulidae	<i>Libellula cyanea</i>	Spangled Skimmer
Libellulidae	<i>Libellula incesta</i>	Slaty Skimmer
Libellulidae	<i>Libellula luctuosa</i>	Widow Skimmer
Libellulidae	<i>Libellula needhami</i>	Needham's Skimmer
Libellulidae	<i>Libellula pulchella</i>	Twelve-spotted Skimmer
Libellulidae	<i>Libellula semifasciata</i>	Painted Skimmer
Libellulidae	<i>Libellula vibrans</i>	Great Blue Skimmer
Libellulidae	<i>Pachydiplax longipennis</i>	Blue Dasher
Libellulidae	<i>Pantala flavescens</i>	Wandering Glider
Libellulidae	<i>Pantala hymenaea</i>	Spot-winged Glider
Libellulidae	<i>Perithemis tenera</i>	Eastern Amberwing
Libellulidae	<i>Plathemis lydia</i>	Common Whitetail
Libellulidae	<i>Sympetrum vicinum</i>	Autumn Meadowhawk
Libellulidae	<i>Tamea carolina</i>	Carolina Saddlebags
Libellulidae	<i>Tamea lacerata</i>	Black Saddlebags
Calopterygidae	<i>Calopteryx maculata</i>	Ebony Jewelwing
Coenagrionidae	<i>Enallagma civile</i>	Familiar Bluet
Coenagrionidae	<i>Enallagma durum</i>	Big Bluet
Coenagrionidae	<i>Enallagma signatum</i>	Orange Bluet
Coenagrionidae	<i>Ischnura hastata</i>	Citrine Forktail

Appendix F. Odonata species observed at George Washington Birthplace National Monument, 2003-2004 (Chazal 2005) (continued).

Family	Scientific Name	Common Name
Coenagrionidae	<i>Ischnura posita</i>	Fragile Forktail
Coenagrionidae	<i>Ischnura ramburii</i>	Rambur's Forktail
Coenagrionidae	<i>Ischnura verticalis</i>	Eastern Forktail
Lestidae	<i>Lestes disjunctus australis</i>	Southern Spreadwing
Lestidae	<i>Lestes inaequalis</i>	Elegant Spreadwing
Lestidae	<i>Lestes rectangularis</i>	Slender Spreadwing

Appendix G. NPSpecies list of bird species documented at George Washington Birthplace National Monument as of December 2006.

Order	Family	Scientific Name	Common Name	Abundance	Residency	Nativity
Anseriformes	Anatidae	<i>Aix sponsa</i>	Wood Duck	Unknown	Migratory	Native
Anseriformes	Anatidae	<i>Anas acuta</i>	Northern Pintail	Unknown	Migratory	Native
Anseriformes	Anatidae	<i>Anas americana</i>	American Wigeon	Unknown	Unknown	Native
Anseriformes	Anatidae	<i>Anas clypeata</i>	Northern Shoveler	Unknown	Migratory	Native
Anseriformes	Anatidae	<i>Anas crecca</i>	Green-winged Teal	Unknown	Unknown	Native
Anseriformes	Anatidae	<i>Anas discors</i>	Blue-winged Teal	Unknown	Migratory	Native
Anseriformes	Anatidae	<i>Anas platyrhynchos</i>	Mallard	Unknown	Unknown	Native
Anseriformes	Anatidae	<i>Anas rubripes</i>	American Black Duck	Unknown	Migratory	Native
Anseriformes	Anatidae	<i>Anas strepera</i>	Gadwall	Unknown	Migratory	Native
Anseriformes	Anatidae	<i>Anser albifrons</i>	Greater White-fronted Goose	Unknown	Migratory	Native
Anseriformes	Anatidae	<i>Aythya affinis</i>	Lesser Scaup	Unknown	Migratory	Native
Anseriformes	Anatidae	<i>Aythya americana</i>	Redhead	Unknown	Migratory	Native
Anseriformes	Anatidae	<i>Aythya collaris</i>	Ring-necked Duck	Unknown	Migratory	Native
Anseriformes	Anatidae	<i>Aythya marila</i>	Greater Scaup	Unknown	Migratory	Native
Anseriformes	Anatidae	<i>Aythya valisineria</i>	Canvasback	Unknown	Migratory	Native
Anseriformes	Anatidae	<i>Branta canadensis</i>	Canada Goose	Unknown	Unknown	Native
Anseriformes	Anatidae	<i>Bucephala albeola</i>	Bufflehead	Unknown	Migratory	Native
Anseriformes	Anatidae	<i>Bucephala clangula</i>	Common Goldeneye	Unknown	Migratory	Native
Anseriformes	Anatidae	<i>Chen caerulescens</i>	Snow Goose	Unknown	Migratory	Native
Anseriformes	Anatidae	<i>Clangula hyemalis</i>	Oldsquaw	Unknown	Migratory	Native
Anseriformes	Anatidae	<i>Cygnus columbianus</i>	Tundra Swan	Unknown	Unknown	Native
Anseriformes	Anatidae	<i>Cygnus olor</i>	Mute Swan	Unknown	Migratory	Native
Anseriformes	Anatidae	<i>Lophodytes cucullatus</i>	Hooded Merganser	Unknown	Migratory	Native
Anseriformes	Anatidae	<i>Melanitta fusca</i>	White-winged Scoter	Unknown	Unknown	Native
Anseriformes	Anatidae	<i>Melanitta nigra</i>	Black Scoter	Unknown	Unknown	Native
Anseriformes	Anatidae	<i>Melanitta perspicillata</i>	Surf Scoter	Unknown	Migratory	Native
Anseriformes	Anatidae	<i>Mergus merganser</i>	Common Merganser	Unknown	Migratory	Native
Anseriformes	Anatidae	<i>Mergus serrator</i>	Red-breasted Merganser	Unknown	Migratory	Native
Anseriformes	Anatidae	<i>Oxyura jamaicensis</i>	Ruddy Duck	Unknown	Migratory	Native
Apodiformes	Apodidae	<i>Chaetura pelagica</i>	Chimney Swift	Unknown	Migratory	Native
Apodiformes	Trochilidae	<i>Archilochus colubris</i>	Ruby-throated Hummingbird	Unknown	Migratory	Native

Appendix G. NPSpecies list of bird species documented at George Washington Birthplace National Monument as of December 2006 (continued).

Order	Family	Scientific Name	Common Name	Abundance	Residency	Nativity
Ciconiiformes	Accipitridae	Accipiter cooperii	Cooper's Hawk	Uncommon	Unknown	Native
Ciconiiformes	Accipitridae	Accipiter striatus	Sharp-shinned Hawk	Uncommon	Unknown	Native
Ciconiiformes	Accipitridae	Buteo jamaicensis	Red-tailed Hawk	Common	Breeder	Native
Ciconiiformes	Accipitridae	Buteo lineatus	Red-shouldered Hawk	Unknown	Unknown	Native
Ciconiiformes	Accipitridae	Circus cyaneus	Northern Harrier	Unknown	Unknown	Native
Ciconiiformes	Accipitridae	Haliaeetus leucocephalus	Bald Eagle	Uncommon	Breeder	Native
Ciconiiformes	Accipitridae	Pandion haliaetus	Osprey	Common	Breeder	Native
Ciconiiformes	Ardeidae	Ardea herodias	Great Blue Heron	Common	Breeder	Native
Ciconiiformes	Ardeidae	Bubulcus ibis	Cattle Egret	Uncommon	Unknown	Native
Ciconiiformes	Ardeidae	Butorides striatus	Green-backed Heron	Uncommon	Unknown	Native
Ciconiiformes	Ardeidae	Butorides virescens	Green Heron	Uncommon	Breeder	Native
Ciconiiformes	Ardeidae	Casmerodius albus	Great Egret	Common	Unknown	Native
Ciconiiformes	Ardeidae	Nycticorax nycticorax	Black-crowned Night-Heron	Uncommon	Migratory	Native
Ciconiiformes	Charadriidae	Charadrius vociferus	Killdeer	Uncommon	Breeder	Native
Ciconiiformes	Ciconiidae	Cathartes aura	Turkey Vulture	Common	Migratory	Native
Ciconiiformes	Ciconiidae	Coragyps atratus	Black Vulture	Uncommon	Unknown	Native
Ciconiiformes	Falconidae	Falco sparverius	American Kestrel	Unknown	Breeder	Native
Ciconiiformes	Gaviidae	Gavia immer	Common Loon	Common	Migratory	Native
Ciconiiformes	Gaviidae	Gavia stellata	Red-throated Loon	Unknown	Migratory	Native
Ciconiiformes	Laridae	Larus argentatus	Herring Gull	Common	Breeder	Native
Ciconiiformes	Laridae	Larus atricilla	Laughing Gull	Common	Migratory	Native
Ciconiiformes	Laridae	Larus delawarensis	Ring-billed Gull	Common	Breeder	Native
Ciconiiformes	Laridae	Larus marinus	Great Black-backed Gull	Unknown	Unknown	Native
Ciconiiformes	Laridae	Sterna caspia	Caspian Tern	Uncommon	Migratory	Native
Ciconiiformes	Laridae	Sterna forsteri	Forster's Tern	Uncommon	Migratory	Native
Ciconiiformes	Laridae	Sterna hirundo	Common Tern	Uncommon	Migratory	Native
Ciconiiformes	Laridae	Sterna maxima	Royal Tern	Uncommon	Migratory	Native
Ciconiiformes	Phalacrocoracidae	Phalacrocorax auritus	Double-crested Cormorant	Common	Migratory	Native
Ciconiiformes	Podicipedidae	Podiceps auritus	Horned Grebe	Uncommon	Unknown	Native

Appendix G. NPSpecies list of bird species documented at George Washington Birthplace National Monument as of December 2006 (continued).

Order	Family	Scientific Name	Common Name	Abundance	Residency	Nativity
Ciconiiformes	Podicipedidae	Podiceps grisegena	Red-necked Grebe	Unknown	Migratory	Native
Ciconiiformes	Podicipedidae	Podilymbus podiceps	Pied-billed Grebe	Uncommon	Unknown	Native
Ciconiiformes	Scolopacidae	Actitis macularia	Spotted Sandpiper	Uncommon	Unknown	Native
Ciconiiformes	Scolopacidae	Calidris melanotos	Pectoral Sandpiper	Uncommon	Unknown	Native
Ciconiiformes	Scolopacidae	Tringa flavipes	Lesser Yellowlegs	Uncommon	Migratory	Native
Ciconiiformes	Scolopacidae	Tringa melanoleuca**		NA	Migratory	Native
Ciconiiformes	Threskiornithidae	Plegadis falcinellus	Glossy Ibis	Uncommon	Migratory	Native
Columbiformes	Columbidae	Columba livia	Rock Dove	Uncommon	Unknown	Native
Columbiformes	Columbidae	Zenaida macroura	Mourning Dove	Common	Breeder	Native
Coraciiformes	Alcedinidae	Ceryle alcyon	Belted Kingfisher	Uncommon	Unknown	Native
Cuculiformes	Coccyzidae	Coccyzus americanus	Yellow-billed Cuckoo	Common	Migratory	Native
Galliformes	Odontophoridae	Colinus virginianus virginianus	Northern Bobwhite	Unknown	Breeder	Native
Galliformes	Phasianidae	Meleagris gallopavo	Wild Turkey	Common	Breeder	Native
Gruiformes	Otididae	Otis asio	eastern screech owl	Unknown	Breeder	Native
Gruiformes	Rallidae	Fulica americana	American Coot	Uncommon	Migratory	Native
Passeriformes	Alaudidae	Eremophila alpestris	Horned Lark	Uncommon	Unknown	Native
Passeriformes	Bombycillidae	Bombycilla cedrorum	Cedar Waxwing	Common	Migratory	Native
Passeriformes	Certhiidae	Certhia americana	Brown Creeper	Uncommon	Breeder	Native
Passeriformes	Certhiidae	Cistothorus palustris	Marsh Wren	Uncommon	Migratory	Native
Passeriformes	Certhiidae	Poliophtila caerulea	Blue-gray Gnatcatcher	Common	Migratory	Native
Passeriformes	Certhiidae	Thryothorus ludovicianus	Carolina Wren	Common	Breeder	Native
Passeriformes	Certhiidae	Troglodytes troglodytes	Winter Wren	Uncommon	Migratory	Native
Passeriformes	Corvidae	Corvus brachyrhynchos	American Crow	Abundant	Breeder	Native
Passeriformes	Corvidae	Corvus ossifragus**		NA	Unknown	Native
Passeriformes	Corvidae	Cyanocitta cristata	Blue Jay	Common	Breeder	Native
Passeriformes	Fringillidae	Agelaius phoeniceus	Red-winged Blackbird	Common	Breeder	Native
Passeriformes	Fringillidae	Ammodramus sandwichensis savanna	savanna sparrow	Unknown	Breeder	Native
Passeriformes	Fringillidae	Ammodramus savannarum	Grasshopper Sparrow	Common	Migratory	Native
Passeriformes	Fringillidae	Calcarius lapponicus	Lapland Longspur	Unknown	Migratory	Native

Appendix G. NPSpecies list of bird species documented at George Washington Birthplace National Monument as of December 2006 (continued).

Order	Family	Scientific Name	Common Name	Abundance	Residency	Nativity
Passeriformes	Fringillidae	Cardinalis cardinalis	Northern Cardinal	Common	Breeder	Native
Passeriformes	Fringillidae	Carduelis pinus	Pine Siskin	Uncommon	Migratory	Native
Passeriformes	Fringillidae	Carduelis tristis	American Goldfinch	Abundant	Breeder	Native
Passeriformes	Fringillidae	Carpodacus mexicanus	House Finch	Unknown	Unknown	Native
Passeriformes	Fringillidae	Carpodacus purpureus	Purple Finch	Uncommon	Migratory	Native
Passeriformes	Fringillidae	Coccothraustes vespertinus	Evening Grosbeak	Uncommon	Migratory	Native
Passeriformes	Fringillidae	Dendroica auduboni	yellow-rumped warbler	Unknown	Migratory	Native
Passeriformes	Fringillidae	Dendroica caerulescens	Black-throated Blue Warbler	Unknown	Migratory	Native
Passeriformes	Fringillidae	Dendroica coronata	Yellow-rumped Warbler	Common	Migratory	Native
Passeriformes	Fringillidae	Dendroica discolor	Prairie Warbler	Uncommon	Migratory	Native
Passeriformes	Fringillidae	Dendroica dominica	Yellow-throated Warbler	Uncommon	Migratory	Native
Passeriformes	Fringillidae	Dendroica magnolia	Magnolia Warbler	Unknown	Migratory	Native
Passeriformes	Fringillidae	Dendroica palmarum	Palm Warbler	Unknown	Migratory	Native
Passeriformes	Fringillidae	Dendroica pensylvanica	Chestnut-sided Warbler	Unknown	Breeder	Native
Passeriformes	Fringillidae	Dendroica petechia	Yellow Warbler	Uncommon	Migratory	Native
Passeriformes	Fringillidae	Dendroica pinus	Pine Warbler	Uncommon	Migratory	Native
Passeriformes	Fringillidae	Dendroica striata	Blackpoll Warbler	Uncommon	Migratory	Native
Passeriformes	Fringillidae	Dendroica tigrina	Cape May Warbler	Unknown	Migratory	Native
Passeriformes	Fringillidae	Dendroica virens	Black-throated Green Warbler	Unknown	Migratory	Native
Passeriformes	Fringillidae	Geothlypis trichas	Common Yellowthroat	Common	Migratory	Native
Passeriformes	Fringillidae	Guiraca caerulea	Blue Grosbeak	Common	Migratory	Native
Passeriformes	Fringillidae	Icteria virens	Yellow-breasted Chat	Unknown	Breeder	Native
Passeriformes	Fringillidae	Icterus spurius	Orchard Oriole	Uncommon	Migratory	Native
Passeriformes	Fringillidae	Junco hyemalis	Dark-eyed Junco	Common	Unknown	Native
Passeriformes	Fringillidae	Loxia curvirostra**		NA	Migratory	Native
Passeriformes	Fringillidae	Melospiza georgiana	Swamp Sparrow	Uncommon	Migratory	Native
Passeriformes	Fringillidae	Melospiza melodia	Song Sparrow	Common	Breeder	Native
Passeriformes	Fringillidae	Mniotilta varia	Black-and-white Warbler	Uncommon	Migratory	Native
Passeriformes	Fringillidae	Molothrus ater	Brown-headed Cowbird	Uncommon	Breeder	Native
Passeriformes	Fringillidae	Parula americana	Northern Parula	Uncommon	Migratory	Native

Appendix G. NPSpecies list of bird species documented at George Washington Birthplace National Monument as of December 2006 (continued).

Order	Family	Scientific Name	Common Name	Abundance	Residency	Nativity
Passeriformes	Fringillidae	Passerella iliaca	Fox Sparrow	Unknown	Migratory	Native
Passeriformes	Fringillidae	Passerina cyanea	Indigo Bunting	Common	Migratory	Native
Passeriformes	Fringillidae	Pipilo erythrophthalmus	Rufous-sided Towhee	Common	Breeder	Native
Passeriformes	Fringillidae	Piranga olivacea	Scarlet Tanager	Uncommon	Migratory	Native
Passeriformes	Fringillidae	Piranga rubra	Summer Tanager	Uncommon	Migratory	Native
Passeriformes	Fringillidae	Poocetes gramineus	Vesper Sparrow	Uncommon	Migratory	Native
Passeriformes	Fringillidae	Quiscalus quiscula	Common Grackle	Common	Breeder	Native
Passeriformes	Fringillidae	Seiurus aurocapillus	Ovenbird	Unknown	Breeder	Native
Passeriformes	Fringillidae	Seiurus motacilla	Louisiana Waterthrush	Uncommon	Migratory	Native
Passeriformes	Fringillidae	Setophaga ruticilla	American Redstart	Unknown	Migratory	Native
Passeriformes	Fringillidae	Spizella passerina	Chipping Sparrow	Common	Migratory	Native
Passeriformes	Fringillidae	Spizella pusilla	Field Sparrow	Common	Migratory	Native
Passeriformes	Fringillidae	Sturnella magna**		NA	Breeder	Native
Passeriformes	Fringillidae	Vermivora peregrina	Tennessee Warbler	Unknown	Migratory	Native
Passeriformes	Fringillidae	Vermivora pinus	Blue-winged Warbler	Uncommon	Migratory	Native
Passeriformes	Fringillidae	Wilsonia citrina	Hooded Warbler	Unknown	Migratory	Native
Passeriformes	Fringillidae	Zonotrichia albicollis	White-throated Sparrow	Common	Unknown	Native
Passeriformes	Fringillidae	Zonotrichia leucophrys	White-crowned Sparrow	Unknown	Unknown	Native
Passeriformes	Hirundinidae	Hirundo rustica	Barn Swallow	Common	Migratory	Native
Passeriformes	Hirundinidae	Progne subis	Purple Martin	Common	Migratory	Native
Passeriformes	Hirundinidae	Stelgidopteryx serripennis	Northern Rough-winged Swallow	Uncommon	Migratory	Native
Passeriformes	Hirundinidae	Tachycineta bicolor	Tree Swallow	Uncommon	Migratory	Native
Passeriformes	Muscicapidae	Catharus guttatus	Hermit Thrush	Uncommon	Migratory	Native
Passeriformes	Muscicapidae	Catharus ustulatus	Swainson's Thrush	Unknown	Migratory	Native
Passeriformes	Muscicapidae	Hylocichla mustelina	Wood Thrush	Common	Migratory	Native
Passeriformes	Muscicapidae	Sialia sialis	Eastern Bluebird	Common	Breeder	Native
Passeriformes	Muscicapidae	Turdus migratorius	American Robin	Abundant	Migratory	Native
Passeriformes	Paridae	Parus bicolor	Tufted Titmouse	Common	Breeder	Native
Passeriformes	Paridae	Parus carolinensis	Carolina Chickadee	Common	Breeder	Native
Passeriformes	Passeridae	Anthus rubescens	American Pipit	Uncommon	Migratory	Native

Appendix G. NPSpecies list of bird species documented at George Washington Birthplace National Monument as of December 2006 (continued).

Order	Family	Scientific Name	Common Name	Abundance	Residency	Nativity
Passeriformes	Passeridae	Passer domesticus	House Sparrow	Abundant	Breeder	Native
Passeriformes	Regulidae	Regulus calendula	Ruby-crowned Kinglet	Uncommon	Migratory	Native
Passeriformes	Regulidae	Regulus satrapa	Golden-crowned Kinglet	Common	Unknown	Native
Passeriformes	Sittidae	Sitta canadensis	Red-breasted Nuthatch	Uncommon	Unknown	Native
Passeriformes	Sittidae	Sitta carolinensis	White-breasted Nuthatch	Uncommon	Breeder	Native
Passeriformes	Sturnidae	Dumetella carolinensis	Gray Catbird	Common	Breeder	Native
Passeriformes	Sturnidae	Mimus polyglottos	Northern Mockingbird	Common	Breeder	Native
Passeriformes	Sturnidae	Sturnus vulgaris	European Starling	Common	Breeder	Native
Passeriformes	Sturnidae	Toxostoma rufum	Brown Thrasher	Common	Breeder	Native
Passeriformes	Tyrannidae	Contopus virens	Eastern Wood-Pewee	Common	Migratory	Native
Passeriformes	Tyrannidae	Empidonax virescens	Acadian Flycatcher	Common	Migratory	Native
Passeriformes	Tyrannidae	Myiarchus crinitus	Great Crested Flycatcher	Common	Migratory	Native
Passeriformes	Tyrannidae	Sayornis phoebe	Eastern Phoebe	Uncommon	Migratory	Native
Passeriformes	Tyrannidae	Tyrannus tyrannus	Eastern Kingbird	Common	Migratory	Native
Passeriformes	Vireonidae	Vireo flavifrons	Yellow-throated Vireo	Unknown	Migratory	Native
Passeriformes	Vireonidae	Vireo griseus	White-eyed Vireo	Unknown	Migratory	Native
Passeriformes	Vireonidae	Vireo olivaceus	Red-eyed Vireo	Common	Migratory	Native
Piciformes	Picidae	Colaptes auratus	Northern Flicker	Common	Breeder	Native
Piciformes	Picidae	Dryocopus pileatus	Pileated Woodpecker	Uncommon	Breeder	Native
Piciformes	Picidae	Melanerpes carolinus	Red-bellied Woodpecker	Uncommon	Migratory	Native
Piciformes	Picidae	Melanerpes erythrocephalus	Red-headed Woodpecker	Uncommon	Breeder	Native
Piciformes	Picidae	Picoides pubescens	Downy Woodpecker	Uncommon	Breeder	Native
Piciformes	Picidae	Picoides villosus	Hairy Woodpecker	Uncommon	Breeder	Native
Piciformes	Picidae	Sphyrapicus varius	Yellow-bellied Sapsucker	Uncommon	Unknown	Native
Strigiformes	Strigidae	Bubo virginianus	Great Horned Owl	Uncommon	Unknown	Native
Strigiformes	Strigidae	Strix varia	Barred Owl	Unknown	Unknown	Native

Note: These data have not been deemed certified. Survey data collected from 2001-2002 is included in this list.

**This species is listed as "Probably Present" at George Washington Birthplace National Monument.

Appendix H. Bird species identified during 2003-2004 avian inventory at George Washington Birthplace National Monument (Bradshaw in prep.).

Code	Common Name	Scientific Name
ABDU	American Black Duck	<i>Anas rubripes</i>
ACFL	Acadian Flycatcher	<i>Empidonax Virescens</i>
AMCO	American Coot	<i>Fulica americana</i>
AMCR	American Crow	<i>Corvus brachyrhynchos</i>
AMGO	American Goldfinch	<i>Carduelis tristis</i>
AMKE	American Kestrel	<i>Falco sparverius</i>
AMPI	American Pipit	<i>Anthus rubescens</i>
AMRE	American Redstart	<i>Setophaga ruticilla</i>
AMRO	American Robin	<i>Turdus migratorius</i>
AMWI	American Widgeon	<i>Anas americana</i>
BAEA	Bald Eagle	<i>Haliaeetus leucocephalus</i>
BAOW	Barred Owl	<i>Strix varia</i>
BARS	Barn Swallow	<i>Hirundo rustica</i>
BAWW	Black-and-white Warbler	<i>Mniotilta varia</i>
BBWA	Belted Kingfisher	<i>Ceryle alcyon</i>
BEKI	Belted Kingfisher	<i>Ceryle alcyon</i>
BGGN	Blue-gray Gnatcatcher	<i>Poliophtila caerulea</i>
BHCO	Brown-headed Cowbird	<i>Molothrus ater</i>
BLGR	Blue Grosbeak	<i>Guiraca caerulea</i>
BLJA	Blue Jay	<i>Cyanocitta cristata</i>
BLVU	Black Vulture	<i>Coragyps atratus</i>
BRCR	Brown Creeper	<i>Certhia americana</i>
BRTH	Brown Thrasher	<i>Toxostoma rufum</i>
BTBW	Black-throated Blue Warbler	<i>Dendroica caerulescens</i>
BTNW	Black-throated Green Warbler	<i>Dendroica virens</i>
BUFF	Bufflehead	<i>Bucephala albeola</i>
CACH	Carolina Chickadee	<i>Poecile carolinensis</i>
CAGO	Canada Goose	<i>Branta canadensis</i>
CANV	Canvasback	<i>Aythya valisineria</i>
CARW	Carolina Wren	<i>Thryothorus ludovicianus</i>
CATE	Caspian Tern	<i>Sterna caspia</i>
CEDW	Cedar Waxwing	<i>Bombycilla cedrorum</i>
CHSP	Chipping Sparrow	<i>Spizella passerina</i>
CHSW	Chimney Swift	<i>Chaetura pelagica</i>
CMWA	Cape May Warbler	<i>Dendroica tigrina</i>
COGO	Common Goldeneye	<i>Bucephala clangula</i>
COGR	Common Grackle	<i>Quiscalus quiscula</i>
COHA	Cooper's Hawk	<i>Accipiter cooperii</i>
COLO	Common Loon	<i>Gavia immer</i>
COME	Common Merganser	<i>Mergus merganser</i>
COYE	Common Yellowthroat	<i>Geothlypis trichas</i>
CSWA	Chestnut-sided Warbler	<i>Dendroica pensylvanica</i>
DCCO	Double-crested Cormorant	<i>Phalacrocorax auritus</i>
DEJU	Dark-eyed Junco	<i>Junco hyemalis</i>
DOWO	Downy Woodpecker	<i>Picoides pubescens</i>

Appendix H. Bird species identified during 2003-2004 avian inventory at George Washington Birthplace National Monument (Bradshaw in prep.) (continued).

Code	Common Name	Scientific Name
EABL	Eastern Bluebird	<i>Sialia sialis</i>
EAKI	Eastern Kingbird	<i>Tyrannus tyrannus</i>
EAME	Eastern Meadowlark	<i>Sturnella magna</i>
EAPH	Eastern Phoebe	<i>Sayornis phoebe</i>
EASO	Eastern Screech Owl	<i>Otus asio</i>
EAWP	Eastern Wood-Pewee	<i>Contopus virens</i>
ETTI	Eastern Tufted Titmouse	<i>Baeolophus bicolor</i>
EUST	European Starling	<i>Sterna vulgaris</i>
FICR	Fish Crow	<i>Corvus ossifragus</i>
FISP	Field Sparrow	<i>Spizella pusila</i>
FOTE	Forster's Tern	<i>Sterna forsteri</i>
GADW	Gadwall	<i>Anas strepera</i>
GBBG	Great Black-backed Gull	<i>Larus marinus</i>
GBHE	Great Blue Heron	<i>Ardea herodias</i>
GCFL	Great Crested Flycatcher	<i>Myiarchus crinitus</i>
GCKI	Golden-crowned Kinglet	<i>Regulus satrapa</i>
GRCA	Gray Catbird	<i>Dumetella carolinensis</i>
GREG	Great Egret	<i>Ardea alba</i>
GRHE	Green Heron	<i>Butorides virescens</i>
GRSC	Greater Scaup	<i>Aythya marila</i>
GRSP	Grasshopper Sparrow	<i>Ammodramus savannarum</i>
HAWO	Hairy Woodpecker	<i>Picoides villosus</i>
HEGU	Herring Gull	<i>Larus argentatus</i>
HETH	Hermit Thrush	<i>Catharus guttatus</i>
HOFI	House Finch	<i>Carpodacus mexicanus</i>
HOGR	Horned Grebe	<i>Podiceps auritus</i>
HOLA	Horned Lark	<i>Eremophila alpestris</i>
HOME	Hooded Merganser	<i>Lophodytes cucullatus</i>
HOWA	Hooded Warbler	<i>Wilsonia citrina</i>
INBU	Indigo Bunting	<i>Passerina cyanea</i>
KILL	Killdeer	<i>Charadrius vociferus</i>
LALO	Lapland Longspur	<i>Calcarius lapponicus</i>
LESC	Lesser Scaup	<i>Aythya affinis</i>
MALL	Mallard	<i>Anas platyrhynchos</i>
MAWA	Magnolia Warbler	<i>Dendroica magnolia</i>
MODO	Mourning Dove	<i>Zenaida macroura</i>
MUSW	Mute Swan	<i>Cygnus olor</i>
MYWA	Myrtle Warbler	<i>Dendroica coronata</i>
NOBO	Northern Bobwhite	<i>Colinus virginianus</i>
NOCA	Northern Cardinal	<i>Cardinalis cardinalis</i>
NOFL	Northern Flicker	<i>Colaptes auratus</i>
NOHA	Northern Harrier	<i>Circus cyaneus</i>
NOMO	Northern Mockingbird	<i>Mimus polyglottos</i>
NOPA	Northern Parula	<i>Parula americana</i>
NOPI	Northern Pintail	<i>Anas acuta</i>
NRWS	Northern Rough-winged Swallow	<i>Stelgidopteryx serripennis</i>

Appendix H. Bird species identified during 2003-2004 avian inventory at George Washington Birthplace National Monument (Bradshaw in prep.) (continued).

Code	Common Name	Scientific Name
OROR	Orchard Oriole	<i>Icterus spurius</i>
OSPR	Osprey	<i>Pandion haliaetus</i>
OVEN	Ovenbird	<i>Seiurus aurocapillus</i>
PIWA	Pine Warbler	<i>Dendroica pinus</i>
PIWO	Pileated Woodpecker	<i>Dryocopus pileatus</i>
PRAW	Prairie Warbler	<i>Dendroica discolor</i>
PUMA	Purple Martin	<i>Progne subis</i>
RBGR	Ring-billed Gull	<i>Larus delawarensis</i>
RBGU	Ring-billed Gull	<i>Larus delawarensis</i>
RBME	Red-breasted Merganser	<i>Mergus serrator</i>
RBNU	Red-breasted Nuthatch	<i>Sitta canadensis</i>
RBWO	Red-bellied Woodpecker	<i>Melanerpes carolinus</i>
RCKI	Ruby-crowned Kinglet	<i>Regulus calendula</i>
REDH	Redhead	<i>Aythya americana</i>
REVI	Red-eyed Vireo	<i>Vireo olivaceus</i>
RHOW	Red-headed Woodpecker	<i>Melanerpes erythrocephalus</i>
RNDU	Ring-necked Duck	<i>Aythya collaris</i>
RNGR	Red-necked Grebe	<i>Podiceps grisegena</i>
RODO	Rock Dove	<i>Columba livia</i>
RTHA	Red-tailed Hawk	<i>Buteo jamaicensis</i>
RTHU	Ruby-throated Hummingbird	<i>Archilochus colubris</i>
RUDU	Ruddy Duck	<i>Oxyura jamaicensis</i>
RWBL	Red-winged Blackbird	<i>Agelaius phoeniceus</i>
SASP	Savanna Sparrow	<i>Passerculus sandwichensis</i>
SCAUP	Scaup sp.?	<i>Aythya sp.?</i>
SCTA	Scarlet Tanager	<i>Piranga olivacea</i>
SNGO	Snow Goose	<i>Chen caerulescens</i>
SOSP	Song Sparrow	<i>Melospiza melodia</i>
SPSA	Spotted Sandpiper	<i>Actitis macularia</i>
SUSC	Surf Scoter	<i>Melanitta perspicillata</i>
SUTA	Summer Tanager	<i>Piranga rubra</i>
SWSP	Swamp Sparrow	<i>Melospiza georgiana</i>
SWTH	Swainson's Thrush	<i>Catharus ustulatus</i>
TEWA	Tennessee Warbler	<i>Vermivora peregrina</i>
TRSW	Tree Swallow	<i>Tachycineta bicolor</i>
TUVU	Turkey Vulture	<i>Cathartes aura</i>
WBNU	White-breasted Nuthatch	<i>Sitta carolinensis</i>
WCSP	White-crowned Sparrow	<i>Zonotrichia leucophrys</i>
WEVI	White-eyed Vireo	<i>Vireo griseus</i>
WHSW	Tundra Swan	<i>Cygnus columbianus</i>
WITU	Wild Turkey	<i>Meleagris gallopavo</i>
WIWR	Winter Wren	<i>Troglodytes troglodytes</i>
WOTH	Wood Thrush	<i>Hylocichla mustelina</i>
WTSP	White-throated Sparrow	<i>Zonotrichia albicollis</i>
YBCH	Yellow-breasted Chat	<i>Icteria virens</i>

Appendix H. Bird species identified during 2003-2004 avian inventory at George Washington Birthplace National Monument (Bradshaw in prep.) (continued).

Code	Common Name	Scientific Name
YBCU	Yellow-billed Cuckoo	<i>Coccyzus americanus</i>
YBSA	Yellow-bellied Sapsucker	<i>Sphyrapicus varius</i>
YTVI	Yellow-throated Vireo	<i>Vireo flavifrons</i>
YTWA	Yellow-throated Warbler	<i>Dendroica dominica</i>

Appendix I. NPSpecies list of mammal species documented at George Washington Birthplace National Monument as of December 2006.

Order	Family	Scientific Name	Common Name	Abundance	Residency	Nativity
Artiodactyla	Cervidae	Odocoileus virginianus	White-tailed deer	Abundant	Breeder	Native
Carnivora	Canidae	Urocyon cinereoargenteus	Gray fox	Unknown	Breeder	Native
Carnivora	Canidae	Vulpes vulpes	Red fox	Unknown	Unknown	Native
Carnivora	Mephitidae	Mephitis mephitis	Striped skunk	Unknown	Breeder	Native
Carnivora	Mustelidae	Lutra canadensis	River otter	Unknown	Resident	Native
Carnivora	Procyonidae	Procyon lotor	Raccoon	Unknown	Breeder	Native
Didelphimorphia	Didelphidae	Didelphis virginiana	Virginia opossum	Unknown	Breeder	Native
Insectivora	Soricidae	Blarina brevicauda	Short-tailed shrew	Unknown	Breeder	Native
Insectivora	Talpidae	Scalopus aquaticus	Eastern mole	Unknown	Breeder	Non-Native
Lagomorpha	Leporidae	Sylvilagus floridanus	Eastern cottontail	Unknown	Breeder	Native
Rodentia	Castoridae	Castor canadensis	Beaver	Unknown	Breeder	Native
Rodentia	Muridae	Microtus pennsylvanicus	Meadow vole	Unknown	Breeder	Native
Rodentia	Muridae	Ondatra zibethicus	Muskrat**	Unknown	Breeder	Unknown
Rodentia	Muridae	Oryzomys palustris	Marsh rice rat	Unknown	Breeder	Unknown
Rodentia	Muridae	Peromyscus leucopus	White-footed mouse	Abundant	Breeder	Native
Rodentia	Sciuridae	Marmota monax	Woodchuck	Unknown	Breeder	Native
Rodentia	Sciuridae	Sciurus carolinensis	Gray squirrel	Unknown	Breeder	Native

Note: These data have not been deemed certified. Survey data collected from 2003-2005 is included in this list.

**This species is listed as "Probably Present" at George Washington Birthplace National Monument.

Appendix J. NPSpecies list of fish species documented at George Washington Birthplace National Monument as of December 2006.

Order	Family	Scientific Name	Common Name	Abundance	Residency	Nativity	Cultivation
Anguilliformes	Anguillidae	Anguilla rostrata	American eel	Uncommon	Migratory	Native	NA
Atheriniformes	Atherinopsidae	Menidia beryllina	tidewater silverside	Abundant	Breeder	Native	NA
Atheriniformes	Atherinopsidae	Menidia menidia	Atlantic silverside	Abundant	Migratory	Native	NA
Beloniformes	Belonidae	Strongylura marina	silver gar	Uncommon	Migratory	Native	NA
Clupeiformes	Clupeidae	Alosa pseudoharengus	white herring	Uncommon	Migratory	Native	NA
Clupeiformes	Clupeidae	Brevoortia tyrannus	mossbunker	Uncommon	Migratory	Native	NA
Clupeiformes	Clupeidae	Dorosoma cepedianum	skipjack	Common	Breeder	Native	NA
Clupeiformes	Engraulidae	Anchoa mitchilli	bay anchovy	Uncommon	Migratory	Native	NA
Cypriniformes	Cyprinidae	Cyprinus carpio	European carp	Common	Breeder	Non-Native	Not cultivated
Cypriniformes	Cyprinidae	Notemigonus crysoleucas	golden shiner	Uncommon	Breeder	Native	NA
Cyprinodontiformes	Cyprinodontidae	Cyprinodon variegatus	sheepshead pupfish	Uncommon	Breeder	Native	NA
Cyprinodontiformes	Fundulidae	Fundulus diaphanus	banded killifish	Abundant	Breeder	Native	NA
Cyprinodontiformes	Fundulidae	Fundulus heteroclitus	mummichog	Abundant	Breeder	Native	NA
Cyprinodontiformes	Fundulidae	Fundulus majalis	striped killifish	Abundant	Breeder	Native	NA
Cyprinodontiformes	Poeciliidae	Gambusia holbrooki	eastern mosquitofish	Uncommon	Breeder	Native	NA
Esociformes	Esocidae	Esox niger	chain pickerel	Uncommon	Breeder	Native	NA
Esociformes	Umbridae	Umbra pygmaea	eastern mudminnow	Uncommon	Breeder	Native	NA
Gasterosteiformes	Syngnathidae	Syngnathus fuscus	northern pipefish	Uncommon	Migratory	Native	NA
Perciformes	Centrarchidae	Enneacanthus gloriosus	bluespotted sunfish	Occasional	Breeder	Native	NA
Perciformes	Centrarchidae	Lepomis gibbosus	pumpkinseed	Uncommon	Breeder	Native	NA
Perciformes	Centrarchidae	Lepomis gulosus	warmouth	Uncommon	Breeder	Non-Native	Not cultivated
Perciformes	Centrarchidae	Lepomis macrochirus	bluegill	Uncommon	Breeder	Non-Native	Not cultivated
Perciformes	Centrarchidae	Pomoxis nigromaculatus	black crappie	Occasional	Breeder	Native	NA
Perciformes	Gobiidae	Gobiosoma bosc	naked goby	Occasional	Breeder	Native	NA
Perciformes	Moronidae	Morone americana	white perch	Abundant	Breeder	Native	NA
Perciformes	Moronidae	Morone saxatilis	striped bass	Abundant	Breeder	Native	NA
Perciformes	Percidae	Perca flavescens	yellow perch	Uncommon	Migratory	Native	NA
Perciformes	Pomatomidae	Pomatomus saltatrix	bluefish	Common	Migratory	Native	NA
Perciformes	Sciaenidae	Leiostomus xanthurus	spot	Uncommon	Migratory	Native	NA
Pleuronectiformes	Achiridae	Trinectes maculatus	hogchoker	Uncommon	Breeder	Native	NA

Appendix J. NPSpecies list of fish species documented at George Washington Birthplace National Monument as of December 2006 (continued).

Order	Family	Scientific Name	Common Name	Abundance	Residency	Nativity	Cultivation
Pleuronectiformes	Paralichthyidae	Paralichthys dentatus	summer flounder	Uncommon	Migratory	Native	NA
Siluriformes	Ictaluridae	Ameiurus catus	white catfish	Occasional	Breeder	Native	NA
Siluriformes	Ictaluridae	Ameiurus nebulosus	brown bullhead	Occasional	Breeder	Native	NA
Siluriformes	Ictaluridae	Ictalurus punctatus	graceful catfish	Common	Breeder	Non-Native	Not cultivated

Note: These data were deemed certified by a taxa expert on 05/02/06.

As the nation's primary conservation agency, the Department of the Interior has responsibility for most of our nationally owned public land and natural resources. This includes fostering sound use of our land and water resources; protecting our fish, wildlife, and biological diversity; preserving the environmental and cultural values of our national parks and historical places; and providing for the enjoyment of life through outdoor recreation. The department assesses our energy and mineral resources and works to ensure that their development is in the best interests of all our people by encouraging stewardship and citizen participation in their care. The department also has a major responsibility for American Indian reservation communities and for people who live in island territories under U.S. administration.

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