



## Affected Environment

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- 3.2 Natural Resources
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## Chapter 3: Affected Environment

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### 3.1 Introduction

Valley Forge NHP is located in the Piedmont physiographic province of Pennsylvania. In general, the Piedmont is an area with elevations ranging from 100 to 500 feet above sea level and includes rolling uplands, low hills, fertile valleys, and well-drained soils. These features, combined with the prevailing climate of long, warm summers and an average annual precipitation of 46 inches, made this the leading agricultural area of the state before urban and suburban development supplanted farming.

Many cultural remnants of the colonial and revolutionary periods exist throughout the Delaware Valley. The park's proximity to numerous revolutionary war sites and to Philadelphia, the "cradle of liberty," places it at the center of some of the most culturally and historically rich areas in the eastern United States. Over time, the park has gained significance as a refuge for plants and animals, a destination for renewal and recreation, and a place of outstanding natural scenic beauty.

This chapter describes the existing conditions of the site resources relevant to the proposed action. These resources were previously identified as impact topics retained for further analysis (Chapter 1, Section 1.7.1) and include vegetation and special status plant species; white-tailed deer population; other wildlife, wildlife habitat, and special status animal species; cultural landscapes; historic structures; archeological resources; visitor use and experience; socioeconomic resources and adjacent lands; public safety; and park operations. Relevant impact topics were selected based on agency and public concerns, regulatory and planning requirements, and known resource issues. The information provided in this chapter will be used as context for comparing the potential impacts of each alternative, which are presented in Chapter 4: Environmental Consequences.

Resources not analyzed in detail within the context of this plan/EIS include geohazards, soils and water quality, prime farmlands, paleontological resources, floodplains and wetlands, air quality, climate change, energy requirements and conservation potential, soundscapes, museum collections, ethnographic resources, Indian Trust resources and sacred sites, and environmental justice. A brief discussion of these resources and why they were dismissed from detailed analysis may be found in Chapter 1, Section 1.7.2: Issues and Impact Topics Considered but Dismissed from Further Analysis.

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### 3.2 Natural Resources

#### 3.2.1 Vegetation and Special Status Plant Species

Vegetation within Valley Forge NHP is a mix of different forest, grassland, and wetland communities, with maintained landscapes (e.g., mowed lawn) surrounding key interpretive and educational elements (Podniesinski et al. 2005) (Figure 7). Forests and grasslands comprise approximately 65% of the park landscape. The predominant vegetative communities within the park and the invasive species that threaten these communities are discussed in greater detail below.

## Forest Types

As defined by the National Vegetation Classification System, the park forests are dominated by 5 primary communities and include:

- Modified Successional Forest (VAFO-type) – 456 acres
- *Liriodendron tulipifera* [tuliptree] Forest Alliance – 374 acres
- *Quercus alba* [white oak] Forest Alliance – 204 acres
- *Quercus prinus* [chestnut oak] Forest Alliance – 186 acres
- *Platanus-Fraxinus* [sycamore-ash] Floodplain Forest – 170 acres

The Modified Successional Forest type is dominated by white ash (*Fraxinus americana*), black walnut (*Juglans nigra*), and American elm (*Ulmus americana*). Additional dominant canopy species may include tree-of-heaven (*Ailanthus altissima*), black locust (*Robinia pseudoaccia*), and eastern red cedar (*Juniperus virginiana*). Typical subcanopy species include box elder (*Acer negundo*), flowering dogwood (*Cornus florida*), black cherry (*Prunus serotina*), and sassafras (*Sassafras albidum*). This common forest type is found throughout the park on areas with a history of disturbance, such as abandoned farmland and forest gaps (Podniesinski et al. 2005). It is particularly common in the eastern and northern portions of the park, where forest cover is more fragmented.

The *Liriodendron tulipifera* [tuliptree] Forest Alliance is most common in the western portion of the park, south of the Schuylkill River, although it is also found scattered throughout the park. While tuliptree is dominant in many stands, black oak (*Quercus velutina*) and white ash are co-dominant or sub-dominant in others. Other trees found in this alliance include red maple (*Acer rubrum*), red oak (*Quercus rubra*), and sassafras. Shrub species included in this forest association include dogwood, spicebush (*Lindera benzoin*), black haw (*Viburnum pruniflorum*), and mountain laurel (*Kalmia latifolia*); however, they are declining and in many cases missing from this alliance due to the heavy browsing by white-tailed deer (Podniesinski et al. 2005).

The two oak communities, *Quercus alba* [white oak] Forest Alliance and *Quercus prinus* [chestnut oak] Forest Alliance, found on moderate to steep slopes, are the predominant forest types on Mount Misery and Mount Joy. Dominating both alliances are the dry oak species: white oak and chestnut oak. In the *Quercus prinus* alliance, black gum (*Nyssa sylvatica*) and scarlet oak (*Quercus coccinea*) may be co-dominants. Co-dominant species in the *Quercus alba* alliance are red maple, sweet birch (*Betula lenta*), tuliptree, beech (*Fagus grandifolia*), scarlet oak, and sassafras. The shrub layer for the *Quercus prinus* alliance is often moderate to dense stands of mountain laurel or young black gum. Typical tall shrubs in the *Quercus alba* alliance include flowering dogwood, witch hazel (*Hamamelis virginiana*), and mountain laurel (Podniesinski et al. 2005). As with other forest alliances within the park, shrub species are declining and in many cases missing from this alliance due to heavy browsing by white-tailed deer.

Located primarily along the floodplain of the Schuylkill River and Valley Creek, the *Platanus-Fraxinus* [sycamore-ash] Floodplain Forest is characterized by a mix of green ash (*Fraxinus pennsylvanica*), sycamore (*Plantanus occidentalis*), and silver maple (*Acer saccharinum*). This community may also have black walnut, box elder, and river birch present (*Betula nigra*). Common species in the subcanopy include green ash, box elder, silver maple, and American elm. Shrub species included in this forest association are typically spicebush, multiflora rose (*Rosa multiflora*), and raspberries (*Rubus* spp.). Shrub species are declining and in many cases missing from this alliance due to heavy browsing by white-tailed deer.





**Figure 7**  
Vegetative Communities







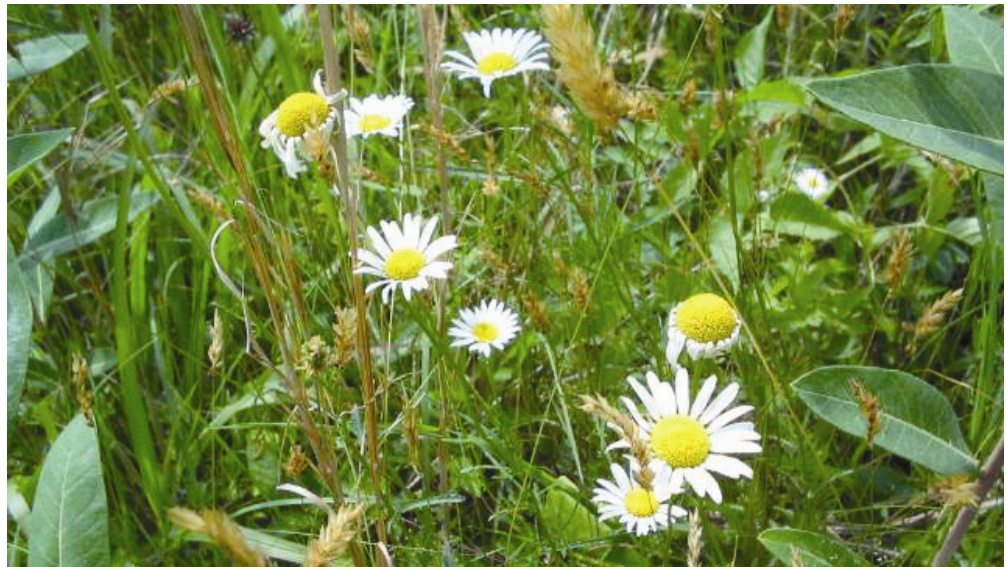
Wetlands and lowland forest provide habitat for 66% of the reptiles and amphibians that live at Valley Forge NHP. (Photo courtesy of Bill Moses.)

Other smaller vegetation alliances found within Valley Forge NHP include Successional Old Fields Pine Plantation, *Acer saccharinum* [silver maple] Temporarily Flooded Forest Alliance (found only along the northern shore of the Schuylkill River), Mixed White Pine Planted Forest, and *Catalpa speciosa* Forest.

The park includes four state champion trees, a tree that is particularly impressive or an unusual example of a species due to its size, shape, age, or other trait that epitomizes the character of the species (NPS 2007j).

### Meadows and Grasslands

After forested lands, grasslands (*Festuca herbaceous* alliance) comprise the second largest percentage of park property. This particular vegetation community includes mowed lawn and tall grass meadows. The park's tall grass meadows represent one of the largest occurrences of remnant open grasslands in eastern Pennsylvania and have been identified as important habitat for breeding grassland bird species (Yahner et al. 2001). In 2007, a meadow inventory documented the presence of 337 plant species, dominated by warm and cool season grasses. Common cool season grasses observed in June and July were sweet vernal grass (*Anthoxanthum odoratum*), brome grass (*Bromus* sp.), orchard grass (*Dactylis glomerata*), red fescue (*Festuca rubra*), tall fescue (*Lolium pratense*), timothy (*Phleum pratense*), and bluegrass (*Poa* spp.). Common warm season grasses observed in August and September were redtop (*Agrostis gigantea*), broomsedge bluestem (*Andropogon virginicus*), purple lovegrass (*Eragrostis spectabilis*), panic grass (*Panicum anceps*), little bluestem (*Schizachyrium scoparium*), and purple top (*Tridens flavus*) (Furedi, Seymour, and Podniesinski 2008). The cool season meadow community is generally dominated by nonnative grass species but the warm season meadow community is dominated by native grasses.



Valley Forge NHP contains one of the largest areas of natural meadow in Southeastern Pennsylvania.

In addition to grasses, forbs and woody species are also present in the fields. Some commonly encountered forbs were boneset (*Eupatorium* spp.), common yarrow (*Achillea millefolium*), common milkweed (*Asclepias syriaca*), thistles (*Cirsium* spp.), common yellow oxalis (*Oxalis stricta*), mountainmint (*Pycnanthemum* spp.), horse nettle (*Solanum carolinense*), and goldenrod (*Solidago* spp.). Forbs not only increase species diversity in the fields but also provide a food source for butterflies and other insects. In addition to grasses, forbs such as milkweed, thistle, and common mullein (*Verbascum thapsus*) provide vertical structure in fields. Vertical structure in meadows is particularly important during the breeding season (e.g., vocalization) and in predator-prey relations (e.g., visibility). Woody species were present in the fields but mostly uncommon (Furedi, Seymour, and Podniesinski 2008).

Several small wet meadows exist north of the Schuylkill River and within the Grand Parade area. These areas are open, usually grass-dominated meadows, which are typically flooded early in the growing season but are generally dry for much of the year. Although flooding may help to keep these systems open, some are regularly mowed. This community type on some sites may be dominated by one or two species, but is typically mixed. Representative species include rice cut grass (*Leersia oryzoides*), wool-grass (*Scirpus cyperinus*), bugleweed (*Lycopus uniflorus*), smartweeds (*Polygonum* spp.), three-way sedge (*Dulichium arundinaceum*), marsh fern (*Thelypteris palustris*), sedges (*Cyperus* spp.), soft rush (*Juncus effusus*), Virginia chain-fern (*Woodwardia virginica*), beggar's ticks (*Bidens* spp.), dwarf St. John's wort (*Hypericum mutilum*), Joe-pye-weed (*Eupatorium* spp.), cinnamon fern (*Osmunda cinnamomea*), bluejoint (*Calamagrostis canadensis*), New York ironweed (*Vernonia noveboracensis*), arrowhead (*Sagittaria rigida*, *S. latifolia*), reed canary-grass (*Phalaris arundinacea*), rattlesnake grass (*Glyceria canadensis*), black bulrush (*Scirpus atrovirens*), and spike-rushes (*Eleocharis* spp.). Scattered shrubs may be present, and nonnative species such as purple loosestrife (*Lythrum salicaria*) and a variety of nonnative grasses are frequently found in these meadows (Podniesinski et al. 2005).



## Special Status Plant Species

Special status plant species include federally and state-listed species. Federally listed species are those that are afforded special protection by the Endangered Species Act due to their rare or threatened existence. State-listed species are considered to be rare or threatened within a specific state and are protected by state legislation. To date, there are no known federally listed plant species confirmed to occur within Valley Forge NHP. There are, however, eight state-listed (or proposed for listing) plants that are known or expected to occur within the park (Table 8). The status and distribution of these species and their essential habitats within Valley Forge NHP is largely unknown. Efforts are underway to determine this information so that management and protection of these species can be addressed.

**Table 8 Special Status Plant Species Confirmed within Valley Forge NHP**

Plant Species	State Status <sup>a</sup>	State Rank <sup>a</sup>	Susceptibility to Deer Browsing
Broadleaf ironweed ( <i>Vernonia glauca</i> )	Endangered	S1 <sup>b</sup>	High
Possumhaw ( <i>Viburnum nudum</i> )	Endangered	S1	High
Bushy bluestem ( <i>Andropogon glomeratus</i> )	Tentatively undetermined; proposed for listing as rare	S3 <sup>d</sup>	Low
Elliott's broomsedge ( <i>Andropogon gyrans</i> )	No current legal status; under review for future listing as rare	S3	Low
Sundial lupine ( <i>Lupinus perennis</i> )	Rare	S3	High
Toothcup ( <i>Rotala ramosior</i> )	Rare	S3	High
Sand blackberry ( <i>Rubus cuneifolius</i> )	Tentatively undetermined; proposed for listing as endangered	S1	Low
Netted chainfern ( <i>Woodwardia areolata</i> )	No current legal status; proposed for listing as threatened	S2 <sup>c</sup>	High

a Source: Pennsylvania Natural Heritage Program 2008

b S1 = Critically impaired; typically 5 or fewer occurrences or very few remaining individuals or acres across Pennsylvania

c S2 = Imperiled; typically 6-20 occurrences or few remaining individuals or acres across Pennsylvania

d S3 = Vulnerable; typically 21-100 occurrences across Pennsylvania

Of the known state-endangered plants, possumhaw (*Viburnum nudum*) is the only one currently protected by fencing. Fencing is necessary, as it is highly susceptible to deer browsing. It was reported in the park in 1993. It is believed that all individuals of the species have since disappeared, except the one that is protected from white-tailed deer browsing (NPS 2007j).

Other species that are highly susceptible to deer browsing include the broadleaf ironweed (*Vernonia glauca*), the sundial lupine (*Lupinus perennis*), and the netted chainfern (*Woodwardia areolata*). Broadleaf ironweed is known to be present at one location within the park and is scheduled to be fenced in 2009. Sundial lupine is thought to be extirpated. Netted chainfern has only recently been identified in the park and has yet to be fenced.

The state-listed rare plant, toothcup (*Rotala ramosior*), is also highly susceptible to deer browse. It occurs on the north side of the park, 1 of 12 known locations in the commonwealth as of 1994 (Newbold 1994). As of 2007, this species is still present within the park. It is possible that this species will be removed from the state list because it is a tiny plant now seen more frequently, as it has been the subject of recent searches (NPS 2007j).

Bushy bluestem (*Andropogon glomeratus*), Elliott's broomsedge (*Andropogon gyrans*), and sand blackberry (*Rubus cuneifolius*) were all recently documented or confirmed as present within the park. These species have yet to be protected by fencing, but face less of a threat from deer browsing due to their taste and/or location in the park environment.

### **Invasive Nonnative Plant Species**

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One of the largest threats to the park's flora is the growing population of exotic (nonnative) invasive plant species. The prevalence of invasive plant species has been a concern for several decades. Invasive species exhibit early rapid and prolific growth and therefore out-compete native vegetation for space, light, water, and nutrients. The absence of native vegetation results in degraded habitats for native animals. Nonnative invasives can alter entire ecosystems and threaten biodiversity, if left unchecked.

White-tailed deer enhance the ability of invasive, nonnative plants to establish and spread through selective browsing and removal of competing native plant species. Many nonnative plants are unpalatable to local herbivores or resistant to local pathogens (Keane and Crawley 2002; Latham et al. 2005). Species that are known to be unpalatable to deer include garlic mustard (*Alliaria petiolata*), Japanese barberry (*Berberis thunbergii*), Japanese honeysuckle (*Lonicera japonica*), Japanese stilt grass (*Microstegium vimineum*), and tree-of-heaven (Southeast Exotic Pest Council 2005). The invasiveness of unpalatable, nonnative plant species is exacerbated when they are avoided by deer in favor of more palatable native species (Anderson, Dhillon, and Kelley 1996; Williams 1996; Ward 2000). As native species in the forest understory disappear and food becomes scarce, deer become less selective but still avoid invasive species (Latham et al. 2005).

Of the plants identified in a 1985 flora and fauna study, 35% were found to be nonnative (Cypher, Yahner, and Cypher 1985). A similar proportion of nonnative plant species are present in the park today, although their cover and distribution may have increased over time (Podniesinski et al. 2005; Heister, Fairchild, and Faulds 2002). For example, stiltgrass was identified in the park in 1985 but was not a dominant species. Today, stiltgrass covers much of the forest floor. The dense cover of nonnative species such as stiltgrass, may prevent the establishment and growth of other plants even after release from heavy browsing (e.g., tree and shrub seedlings) (Horsley and Marquis 1983; Stromayer and Warren 1997; Waller and Alverson 1997). These conditions can be avoided through continued action under the park's integrated pest management activities.

Over 180 nonnative plant species have been documented within Valley Forge NHP and are present in various habitats parkwide. Approximately 32 (18%) of these are considered high priority due to their level of environmental threat and likelihood for successful control or eradication (Table 9). Efforts to control nonnative, invasive plant species through integrated pest management actions will focus on these high priority species.

**Table 9 High Priority Invasive Plant Species**

Common Name	Scientific Name
Autumn-olive	<i>Elaeagnus umbellata</i>
Bull thistle	<i>Cirsium vulgare</i>
Canada thistle	<i>Cirsium arvense</i>
Chinese lespedeza	<i>Lespedeza cuneata</i>
Chinese privet	<i>Ligustrum sinense</i>
Common mullein	<i>Verbascum Thapsus</i>
Common privet	<i>Ligustrum vulgare</i>
Crown vetch	<i>Coronilla varia</i>
Garlic mustard	<i>Alliaria petiolata</i>
Japanese barberry	<i>Berberis thunbergii</i>
Japanese honeysuckle	<i>Lonicera japonica</i>
Japanese hops	<i>Humulus japonicas</i>
Japanese knotweed	<i>Polygonum cuspidatum</i>
Japanese stiltgrass	<i>Microstegium vimineum</i>
Japanese wisteria	<i>Wisteria floribunda</i>
Lesser celandine	<i>Ranunculus ficaria</i>
Mile-a-minute vine	<i>Polygonum perfoliatum</i>
Morrow's bush honeysuckle	<i>Lonicera morrowii</i>
Mugwort; common wormwood	<i>Artemisia vulgaris</i>
Multiflora rose	<i>Rosa multiflora</i>
Norway maple	<i>Acer platanoides</i>
Oriental bittersweet	<i>Celastrus orbiculatus</i>
Oriental lady's thumb	<i>Polygonum caespitosum</i>
Phragmites; common reed	<i>Phragmites australis</i>
Princess tree	<i>Paulownia tomentosa</i>
Red fescue	<i>Festuca rubra</i>
Reed canary grass	<i>Phalaris arundinacea</i>
Spotted knapweed	<i>Centaurea maculosa</i>
Stinging nettle	<i>Urtica dioica</i>
Tree of heaven	<i>Ailanthus altissima</i>
Wineberry	<i>Rubus phoenicolasius</i>
Zebra grass; Chinese silver grass	<i>Miscanthus sinensis</i>

### Current Vegetation Status and the Role of Deer

Numerous authors have suggested that overabundant populations of white-tailed deer can greatly alter the composition and structure of forest plant communities (Hough 1965; Frelich and Lorimer 1985; Alverson 1988; Strole and Anderson 1992; Balgooyen and Waller 1995; Redding 1995; Rooney and Dress 1997; Augustine and Jordan 1998; Augustine and McNaughton 1998; Van Deelen 1999; McWilliams et al. 2004). In Pennsylvania forests, abundant deer populations have impeded the establishment and growth of sufficient tree seedlings to regenerate forests and researchers describe the regeneration problem as “ubiquitous rather than specific to a particular region, owner, or forest type.” In 2004, it was estimated that only 50-65% of plots sampled across the state exhibited adequate tree-seedling and sapling regeneration, due to heavy deer browsing pressure (McWilliams et al. 2004; Marquis



1981; Horsely and Marquis 1983; Tilghman 1989). Selective browsing by deer has shifted ground-flora composition toward grasses and sedges and caused a decline in the overall number of plant species present (Marquis 1981; Horsely and Marquis 1983; Tilghman 1989). For example, between 1929 and 1995, the number of shrub and herbaceous species in monitoring plots within a heavily browsed forest in northwestern Pennsylvania declined 59-80% (Rooney and Dress 1997). Similar trends have been documented by NPS staff at the park.

In 1992, 30-paired vegetation monitoring plots (15 fenced, 15 unfenced) were erected within the park's forests to detect changes in the abundance and species composition of the forest understory plant community over time. Within fenced plots, the typical plant species expected for the area are present. Outside fenced areas, the forest floor is essentially bare or dominated by nonnative plant species. Between 1993 and 2003, the number of plant species present in fenced plots increased 27-32% and the number of species in unfenced plots decreased 6-15% over time. By 2003, on average, only 28% of the plants present in the fenced plots were also present in the unfenced plots (Diefenbach 2007).

A similar trend was observed for the diversity and abundance of tree seedlings in fenced and unfenced plots. In 2003, unfenced plots generally contained about one-third the number of tree seedlings present in fenced plots. These data also reveal that in unfenced plots adequate forest regeneration has not occurred since 1995. In 2003, no tree seedlings were found taller than 25 cm (9.8 inches) in unfenced monitoring plots. In fenced plots between 1993 and 2003, the number of plots with adequate tree regeneration increased from 3% to 27%. In 2003, fenced plots contained tree seedlings in all six height categories ranging from 0 to 150 cm (0-59 inches) in height (Diefenbach, Vreeland, and K. M. Heister 2008).



High levels of deer browsing have led to removal of most plants from the forest understory. Deer preference for certain plants has also led to a shift in species composition from native to primarily nonnative plant species.

### 3.2.2 White-tailed Deer Population

#### General Ecology

White-tailed deer are medium-sized ungulates, native to North America, and regarded as one of the most adaptable mammals in the world (Hesselton and Hesselton 1982). Among the reasons for this adaptability are the hardiness, reproductive capability, wide range of plant species accepted as food, and the tolerance deer express for close contact with humans.

Most abundant in the eastern woodlands, white-tailed deer are typically considered forest dwellers, but often frequent wetlands, meadows, or woodland openings while feeding. Deer also forage along forest margins, in orchards, and on farmlands. When

deer populations become excessive, damage to vegetation may result, and in addition, their winter food may be reduced to the point where starvation results (Martin, Zim, and Nelson 1951).

The diet of white-tailed deer consists of twigs from shrubs and trees, as well as herbaceous (nonwoody) plants, which are eaten frequently in spring and summer when they are abundant. Acorns, blackgum fruits, persimmons, and other kinds of fruits are consumed in late summer and fall. Some of the plants that deer browse heavily in the winter season are selected by necessity rather than choice (Martin, Zim, and Nelson 1951).

White-tailed deer are well known for their ability to rapidly increase reproductive productivity given abundant food resources, and to limit productivity in the presence of less nutritious forage (Verme 1965, 1969; Hesselton and Hesselton 1982). On good range containing abundant food, deer tend to produce more than one young, usually twins, and sometimes triplets. Where food is limited, the number of births is typically restricted to a single fawn, and sometimes the doe does not ovulate (Morton and Cheatum 1946; Verme 1965; Hesselton and Hesselton 1982). Nutrition plays an important role in influencing the onset of puberty, with yearling (1.5 year old) does on submarginal range possibly remaining sexually immature, while doe fawns on nutritious range possibly become reproductively active as early as six or seven months of age (Verme and Ullrey 1984). The potential for rapid expansion of deer populations, coupled with the wide variety of plant species deer consume, can result in substantial impacts to plant communities (Marquis 1981; Shafer 1965).

## Home Range

Home range and movement of deer relative to the park boundary was determined by researchers at PSU (Lovallo and Tzilkowski 2003). A total of 90 female and 15 male deer were marked and tracked between 1997 and 1999. Of the observed females, 79% had greater than 50% of their home range area within the park and traveled on average only 401 feet beyond the park boundary. Average annual home range area for females with more than 50% of their home range area within the park was 0.46 square miles. Approximately 21% of females had less than 50% of their home range area within the park and traveled, on average, 1,325 feet beyond the park boundary (Figure 8). Average annual home range of female deer with less than 50% of their home range area within the park was 0.35 square miles (Lovallo and Tzilkowski 2003). Deer tended to concentrate in the center and southern portions of the park. Movement of deer across the park boundary was most frequent along the southeastern park boundary adjacent to the Glen Hardie neighborhood, along the southwestern park boundary to residential communities on Mount Misery, and between NPS land and private property on the northern park boundary near Pawlings Road (Figure 9) (Lovallo and Tzilkowski 2003).

## White-tailed Deer Population Size and Density

Deer population numbers have been monitored at Valley Forge since 1983. Annual spotlight counts and compartment surveys are used to monitor population density and determine trends in deer abundance over time.

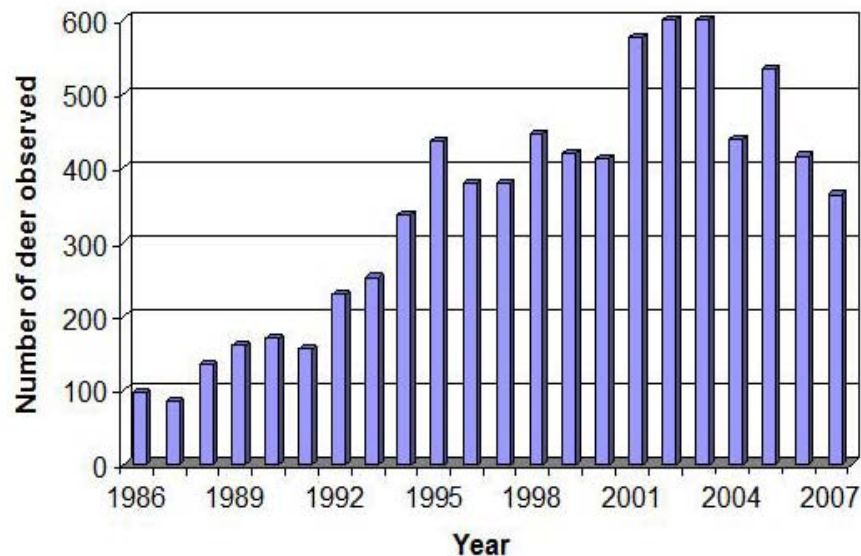
### **Baseline (1983-1985)**

From 1983-1985, researchers from PSU provided a baseline estimate of deer population size based on a combination of data from aerial surveys, fecal pellet group counts, spotlight counts, diurnal observations of deer, and browsing-grazing surveys (Cypher, Yahner, and Cypher 1985). The maximum population size was

estimated to be 165-185 individuals (summer) potentially declining to 110-120 individuals after fall, winter, and spring mortality (Cypher, Yahner, and Cypher 1985). Overall, this represents an annual range in deer density of 21 to 35 deer per square mile.

#### ***Fall Spotlight Surveys (1986 - Present)***

Park staff continues to conduct fall spotlight counts according to the standard protocol and route established by Cypher, Yahner, and Cypher (1985) (Appendix A). Annual spotlight counts allow for comparison of deer abundance across years to provide an estimate of population growth. Spotlight count data indicate that the deer population at Valley Forge NHP has increased significantly between 1986 and 2007. On average, the deer population has increased about 10% each year, with significant fluctuations appearing after 1996 (Figure 10).



**Figure 10**      **Number of Deer Observed during Fall Spotlight Surveys between 1986 and 2007**

#### ***Spring Compartment Counts (1997 - Present)***

Park staff continues to conduct spring compartment counts on an annual basis according to the protocol established by Lovallo and Tzilkowski (2003) (Appendix A). Counts are conducted simultaneously over five sections or “compartments” within the park during late April or early May (Figure 11). The total number of deer observed across all compartments is multiplied by a sighting index of 0.58 to estimate total deer population size. The sighting index represents the proportion of the deer population not observed during deer counts (Lovallo and Tzilkowski 2003). Data from these counts indicates an increase in deer population size from 772 individuals to 1,023 individuals (146 to 193 deer per square mile) between 1997 and 2007, reaching a maximum of 1,398 (264 deer per square mile) in 2003 (Figure 12).





- Park Boundary
- Inholdings
- Average Distance (1325 ft.) Traveled by Female White-tailed Deer from the Valley Forge NHP Boundary



**Figure 8**  
Average Distance Traveled by Female White-tailed Deer from the Valley Forge NHP Boundary







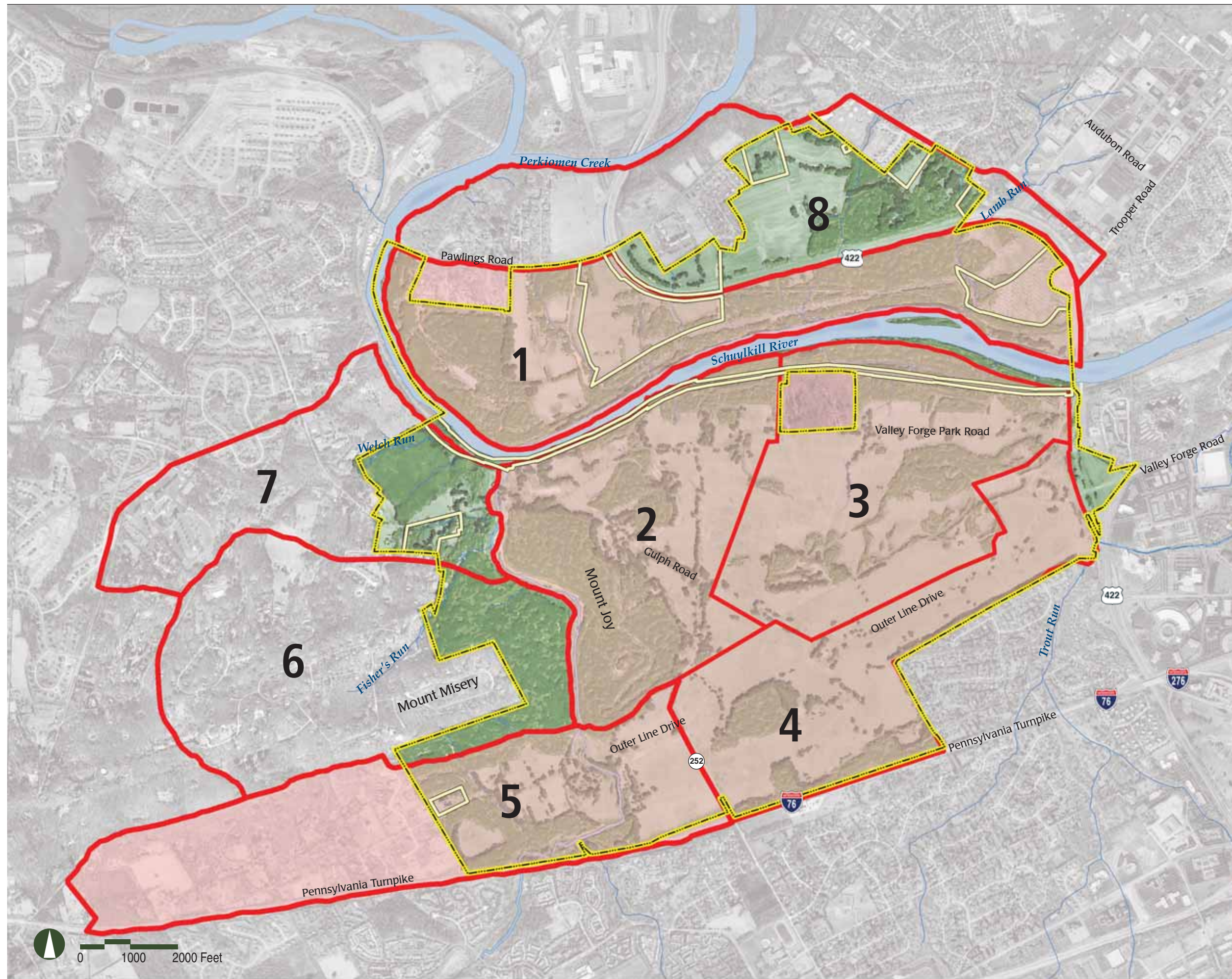


**Figure 9**  
Deer Crossing Areas Along the Park Boundary









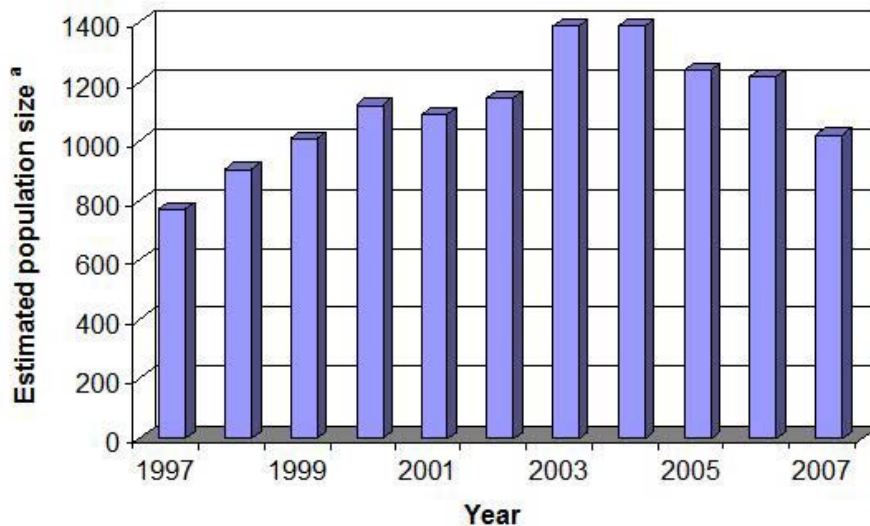
- Park Boundary
- Inholdings
- Deer Monitoring Compartments
- Compartments Monitored during Spring Deer Count



**Figure 11**  
Spring Survey Compartments  
for White-tailed Deer Population Monitoring







**Figure 12 Estimated Deer Population Size based on Spring Compartment Counts between 1997 and 2007**

a The total number of deer observed across all compartments is multiplied by a sighting index of 0.58 to estimate total deer population size.

Spring survey compartments include some private lands surrounding the park (compartment 5) and thus these counts also provide limited information on deer population size in adjacent communities. Spring compartment counts indicated that on private lands within compartment 5, deer population size increased from 8 to 42 deer per square mile between 2001 and 2008 (average density of 29 deer per square mile).

The deer population density in and around the park has varied and will continue to vary over time depending on factors such as winter temperatures, snow depth and duration, disease, habitat conditions, deer movements, and acorn production. Changes in vegetation and vegetation management (e.g., mowing) may also influence the sighting index figure, resulting in wide variations in estimated population size. However, based on ongoing population surveys, the deer population has increased, and in the absence of any population management measures, this trend is expected to continue over time, with some fluctuation due to weather and other factors.

### White-tailed Deer Birth Rate

The birth rate for the park's deer population is unknown. It is known that single births, twins, and triplets occur within the herd. It is also assumed that the Valley Forge NHP deer population maintains a birth rate similar to those populations in areas surrounding the park. Therefore, based on information compiled by the PGC for Wildlife Management Unit 5C (including the park), the average adult doe produces 1.8 embryos per year. A yearling averages 0.4 embryos per year.

### White-tailed Deer Mortality

Researchers from PSU first assessed deer mortality and mortality factors at Valley Forge NHP between 1981 and 1985 (Cypher, Yahner, and Cypher 1985). Evaluation of 101 deer carcasses identified the major factors contributing to deer mortality as deer-vehicle collisions (87%), deer-train collisions (4%), poaching (2%), legal harvest (1%), and unknown (6%). The annual deer mortality rate was estimated at approximately 29% and conversely, annual survival rate for deer at Valley Forge



NHP was estimated at approximately 71% (Cypher, Yahner, and Cypher 1985). Mortality was reportedly highest in the fall (51%) and lowest in spring. High mortality rates in fall were attributed to increased movements of deer at this time of year and the mast production by oak trees that line many park roadways. Increased activity along the roadways resulted in increased deer-vehicle collisions. Fawns and adult females experienced the highest mortality across all seasons with no deaths among adult males in either winter or spring (Cypher, Yahner, and Cypher 1985).

Park staff evaluated deer carcasses between 1984 and 1995 based on carcass location reports from park staff and visitors. Over 1,100 carcasses were examined and location, cause of death, age (fawn, yearling, adult), and sex were recorded. The total number of deer killed increased significantly (332%) between 1984 and 1995, with an average of 93 dead deer reported annually. Trends in deer mortality were closely associated with deer population trends as indicated by deer spotlight counts (Heister 1996). The primary cause of mortality was deer-vehicle collisions (84%). Other contributing factors were consistent with those identified by Cypher, Yahner, and Cypher (1985). Legal harvest and poaching activities accounted for 10% of deer deaths and deer-train collisions, dogs, mowers, and accidental deaths accounted for 6% of mortality. Mortality was highest in fall (49%) lowest in spring (14%). Adult females and adult males experienced the highest mortality across all seasons. Additionally, a decrease in the proportion of fawns killed was observed over time which may be attributed to an increase in the number older animals, as reported in other suburban deer populations (Heister 1996).

Information related to annual mortality and survival rates also was provided through the 1997-1999 mark-recapture study conducted by PSU (Lovallo and Tzilkowski 2003). Results are generally consistent with results from Cypher, Yahner, and Cypher (1985) and Heister (1996). During the course of this project, 32% (39 of 120) of marked deer were reported dead. The primary cause of mortality was deer-vehicle collisions (69%), most of which occurred during the fall. Annual mortality was relatively low (17%) and annual survival was relatively high (83%) (Lovallo and Tzilkowski 2003).

### **White-tailed Deer Population Health**

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Body measurements (e.g., weight, chest girth) are often the most easily obtained data that wildlife managers have available to them and provide direct evidence of growth and physical condition. The health of the white-tailed deer population was qualitatively evaluated by researchers from PSU in 1983-1984 (Cypher, Yahner, and Cypher 1985). Their condition was assessed based on productivity, antler growth, and general overall appearance. Researchers concluded that the herd was in good condition (Cypher, Yahner, and Cypher 1985). A similar conclusion was reached in 2003, by Lovallo and Tzilkowski who stated that, “captured deer at [Valley Forge NHP] appeared to be typical white-tailed deer in terms of gross appearance, condition, and size, as compared to other deer examined in Pennsylvania.”

Park staff have continued to evaluate the health of the deer population through collection of morphological measurements from animals killed in deer-vehicle collisions between 1992 and 2006. Analysis of this data has only been completed between 1992 and 1995. During that time, no trends in body size were detected in fawn, yearling, or adult deer. However, comparison of body size (mean hind leg length, total body length, and chest girth) with other Pennsylvania deer populations suggested that deer at Valley Forge NHP were generally smaller in size. This difference was most pronounced in fawns and yearlings (Heister 1996).

Differences in growth are often most noticeable in juvenile deer because fawn size and weight are affected by maternal condition before birth and habitat quality post-partum (Heister 1996). In 1997-1999, park staff captured 109 fawns to evaluate fawn condition and trends in condition over time (Rowe and Heister 1999). Sex, hind leg length, chest girth, total body length, and weight were recorded and fawns were marked with a colored, numbered ear tag. Results indicated that mass and chest girth were significantly larger in male versus female fawns. Although not statistically significant, all female body measurements exhibited a decreasing trend between 1997 and 1999. Male fawn weight also decreased between 1997 and 1999. Despite these trends, there is no clear indication that the health of the deer at Valley Forge NHP is declining.

### **Food Habits and Habitat Use**

Analysis of fecal pellets collected by Cypher, Yahner, and Cypher (1985) was used to determine seasonal use of food types and use of food types relative to seasonal use of field habitats at Valley Forge NHP. Results indicated that herbaceous vegetation (forbs, leaves of woody plants, and conifer needles) was the predominant food type in all seasons, except fall (Cypher, Yahner, and Cypher 1985; Cypher, Yahner, and Cypher 1988). In fall and spring, acorns and grasses were important food resources. Use of woody browse was similar among seasons and meadow browse was highest during fall, winter with no snow cover, and spring. Field use was lowest during the summer, when preferred woodland species were abundant and during winter with snow cover. Deer were most often observed in forested habitat during the day and in field habitats at night for forage and bedding (Cypher, Yahner, and Cypher 1985). Field habitats were considered to have year-round importance to the park deer population (Cypher, Yahner, and Cypher 1985; Cypher, Yahner, and Cypher 1988).

Lovallo and Tzilkowski (2003) evaluated patterns of habitat use using radio-telemetry in 1997-1999. Results confirm the importance of field habitats and relative use of field versus forested habitats suggested by Cypher, Yahner, and Cypher (1988). Between 1997 and 1999, white-tailed deer at Valley Forge NHP used forested habitats more frequently during the day and field habitats more frequently at night. Home range of deer included approximately 50% forest with the amount of meadow ranging from 25-31% and 37-41%, for male and female deer, respectively. Results also indicated that when deer moved out of the park at night, they did not use habitats in proportion to their availability. Deer frequented forested and agricultural areas more than expected and residential areas less than expected (Lovallo and Tzilkowski 2003).

### **Factors that can Affect Deer Population Health**

Deer herds in poor physical condition have typically exceeded the nutritional carrying capacity (the point at which deer herd health is at equilibrium with nutritional value obtained from forage). Poor herd health indicates that the habitat has been stressed and is no longer supporting healthy deer (Eve 1981).

When deer density is high, signs of nutritional stress (such as low body and internal organ mass, low fecal nitrogen levels, and high prevalence of parasitic infections) typically occur. When deer density is reduced to the nutritional carrying capacity, all of these indicators show improved condition (Sams et al. 1998).

The park does not currently conduct any specific deer health studies. However, visual observations are made of the herd, and deer showing visible signs of disease are noted. To date, only ticks and the relatively harmless papilloma virus have been noted by park staff.



Deer papillomavirus is occasionally observed within the park. The virus causes skin tumors that are generally non-fatal unless they interfere with vision, eating, or other necessary functions. (Photo courtesy of Bill Moses.)

## Diseases of Concern

A number of diseases of concern exist in eastern deer populations. These include parasites, malnutrition, bluetongue virus, and epizootic hemorrhagic disease. CWD has recently been documented in West Virginia (more than 200 miles from the park); new documented cases are being watched, as it is thought to be spread easily in areas with high concentrations of deer. The various diseases of concern are briefly described below.

### ***Parasitism***

Parasitism occurs when an organism grows, feeds, and is sheltered on or in a different organism, resulting in a type of symbiosis in which one species benefits at the expense of the other. There are many varieties of parasites, both internal and external. Parasites can have a variety of consequences from minimal to marked, on an individual or population.

### ***Malnutrition***

Malnutrition is the condition that develops when the body does not get adequate amounts of the vitamins, minerals, and other nutrients necessary to maintain healthy tissues and organ function. Malnutrition can be caused by exceeding the nutritional carrying capacity.

### ***Bluetongue Virus***

Bluetongue virus is an insect-transmitted, viral disease of ruminant mammals and a close relative to Epizootic Hemorrhagic Disease. According to the PGC, bluetongue is not thought to cause illness in free-ranging white-tailed deer but does affect domestic animals (PCWDTF 2007). A bluetongue virus infection may cause inflammation, swelling, and hemorrhage of the mucous membranes of the mouth, nose, and tongue. Inflammation and soreness of the feet also are associated with bluetongue virus. Bluetongue virus is considered by the Office International des Epizooties (the international organization that sets animal health standards) to be a disease that has the potential to spread rapidly.

### ***Epizootic Hemorrhagic Disease***

Epizootic hemorrhagic disease (EHD) is an insect-borne viral disease of ruminants. The disease causes widespread hemorrhages in mucous membranes, skin, and viscera, the result of disseminated intravascular clotting. Strains of epizootic hemorrhagic disease can cause widespread vascular lesions similar to those described for bluetongue virus. Degenerative changes (focal hemorrhage or dry and gray-white appearance, or both) in striated musculature are prominent in the esophagus, larynx, tongue, and skeletal muscles. Epizootic hemorrhagic disease in white-tailed deer can lead to death. Often, deer are found dead around waterholes, suggesting that they had a high fever and were dehydrated (Stott 1998). Confirmed outbreaks of EHD in Pennsylvania occurred in 2002 and 2007. The largest outbreak, in 2007, resulted in the death of over 1,000 white-tailed deer across nine counties in southwestern Pennsylvania (PCWDTF 2007).

Biting gnats spread EHD from animal to animal. Animals cannot directly contract the disease from other animals. The disease is most prevalent in the United States in the southern and southwestern states. EHD is a seasonal disease that is generally observed in the late summer and early fall. Virus transmission begins in the early spring with the onset of insect flight activity and continues until the first hard frosts (APHIS 2003).

Not all deer infected with epizootic hemorrhagic disease or bluetongue virus will die; this is known because many normal deer have antibodies that indicate prior exposure to various viruses. Deer that recover develop immunity to the specific virus, which protects against re-infection by the same virus. However, it is not known how well this immunity cross-protects deer against other hemorrhagic viruses. When deer survive infection with a virus from one virus type (epizootic hemorrhagic disease or bluetongue virus), there is good evidence to indicate they are not protected from disease caused by subsequent infection with a different virus strain (Southeastern Cooperative Wildlife Disease Study 2000).

### ***Chronic Wasting Disease***

CWD belongs to a group of diseases known as transmissible spongiform encephalopathies, which include scrapie, bovine spongiform encephalopathy, and Creutzfeldt-Jakob disease. The diseases are grouped because of similarity in clinical features, pathology, and presumed etiology: the infectious agents are hypothesized to be prions (infectious proteins without associated nucleic acids). Transmissible spongiform encephalopathies cause distinctive lesions in the brain and consistently result in death.

Deer and elk affected by CWD show loss of body condition and changes in behavior. Affected animals may demonstrate a variety of behavioral signs, including decreased fear of humans and isolation from the remainder of the herd. Animals in the later stages of the disease become emaciated. Excessive drinking and urination are common in the terminal stages because of specific lesions in the brain. Many animals in terminal stages have excessive salivation and drooling. Death is inevitable once clinical signs are visible.

The clinical course of CWD varies from a few days to several months. While a protracted clinical course is typical, occasionally death may occur suddenly; this may be more common in the wild than in the relative security of captivity.

The health risk for humans consuming elk or deer infected with CWD is unknown; however, the risk is likely extremely low. This risk is based on an analysis of existing research studies that indicate no established link between the disease and similar human transmissible encephalopathy diseases. Current literature reviews and experts agree that more information is needed and that many questions remain unanswered about the transmissibility of CWD to humans. Appendix C provides additional information on CWD diagnosis and response.

### **3.2.3 Other Wildlife, Wildlife Habitat, and Special Status Animal Species**

The diversity of aquatic and terrestrial habitats at Valley Forge NHP provides foraging opportunities, breeding habitat, and shelter for a variety of wildlife species. Tall grass meadows are critical habitat for obligate grassland birds, butterflies, and small mammals. Forested areas provide valuable habitat for larger mammals such as fox and opossum, as well as migrating songbirds and raptors. White-tailed deer use both of these habitats. Shore birds, waterfowl, amphibians, small reptiles and mammals also make use of the park's wetlands and floodplains for habitat.

Records of wildlife sightings have been kept in the park since the 1970s, and comprehensive inventories have been conducted since 1999. Rigorous inventories recently completed include a three-year bird survey completed in 2001 and a herpetofaunal (reptile/amphibian) survey completed in 2002. Single-year surveys have been completed for fish (2003) and small terrestrial mammals (2004), and a single-year survey of bats was completed in 2005.



## Mammals

Since 1979, 30 species of mammals have been observed at Valley Forge NHP. White-tailed deer, red foxes (*Vulpes vulpes*), grey squirrels (*Sciurus carolinensis*), and woodchucks (*Marmota monax*) are among the most frequently observed mammals during the day. White-tailed deer, raccoons (*Procyon lotor*), and bats are among the most frequently observed mammals during the night. Other species less often observed by park visitors but abundant in the park include white-footed mice (*Peromyscus leucopus*), northern short-tailed shrews (*Blarina brevicauda*), striped skunks (*Mephitis mephitis*), and Virginia opossums (*Didelphis virginiana*). Mammal inventories conducted during the past two years also have detected coyote (*Canis latrans*), a weasel species (ermine or long-tailed) (*Mustela* sp.), long-eared bats (*Nyctophilus geoffroyi*), and red bats (*Lasiurus borealis*). American mink (*Mustela vison*) were documented in the park in 2008. Vagrant black bears (*Ursus americanus*) have been sighted in the park in 1998 and 2003, but none are known to inhabit the park (Yahner, Kubel, and Ross 2006).

## Birds

Beginning with authorization of the national historical park in 1976, the NPS conducted field observations and produced a checklist of bird species observed within the park by staff, members of the Audubon Society, and volunteers. This “Bird Sightings List” includes 227 bird species. Of those, 82 are confirmed as having bred in the park. According to the list, birding “hot spots,” particularly good areas to watch birds, are the top of Mount Joy, along the Valley Creek Trail, and along the River Trail.



The eastern meadowlark is a grassland specialist commonly observed at Valley Forge NHP. (Photo courtesy of Bill Moses.)

Pennsylvania State University completed a three-year bird inventory in the park between May 1999 and May 2001. Valley Forge NHP was one of six national park units in Pennsylvania to be inventoried by the university over the same time period. A combination of survey methods was used: point-count, vehicular-road, diurnal raptor and vulture, riparian bird, and owl surveys. Of the six units, the highest number of species was recorded at Valley Forge – 163 species total. While no federally endangered or threatened bird species were observed, 22 species of special concern were documented (Table 10).

During the 1999-2000 breeding season, a total of 91 species was observed. Most of the species categorized as “abundant” and “common” were permanent residents. Samples taken in forested areas found some long-distance migrants, such as red-eyed vireo, wood thrush, and ovenbird, to be prevalent along with permanent residents. However, permanent residents dominated samples taken in herbaceous habitat areas. Of the most prevalent migrants, most were edge specialists. A small number of migrants were grassland specialists, including the bobolink (*Dolichonyx oryzivorus*) and red-winged blackbird (Yahner 2001). The least prevalent types of birds identified in these surveys were the ground nesting birds. These birds include the black-billed cuckoo, hooded warbler, and white-eyed vireo.

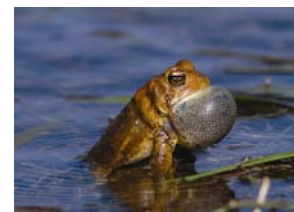
**Table 10** Bird Species of Special Concern

Common Name	Scientific Name	Status
American Black Duck	<i>Anas rubripes</i>	Audubon Watchlist
Black Throated Blue Warbler	<i>Dendroica caerulescens</i>	Audubon Watchlist
Blue Winged Warbler	<i>Vermivora pinus</i>	Federal Management Concern
Canada Warbler	<i>Wilsonia canadensis</i>	Audubon Watchlist
Cerulean Warbler	<i>Dendroica cerulea</i>	Federal Management Concern
Chestnut Sided Warbler	<i>Dendroica pennsylvanica</i>	Federal Management Concern
Eastern Meadowlark	<i>Sturnella magna</i>	Federal Management Concern
Field Sparrow	<i>Spizella pusilla</i>	Federal Management Concern
Grasshopper Sparrow	<i>Ammodramus savannarum</i>	Federal Management Concern
Long Eared Owl	<i>Asio otus</i>	State Imperiled
Louisiana Waterthrush	<i>Seiurus motacilla</i>	Federal Management Concern
Marsh Wren	<i>Cistothorus palustris</i>	State Imperiled/Vulnerable
Northern Flicker	<i>Colaptes auratus</i>	Federal Management Concern
Northern Harrier	<i>Circus cyaneus</i>	Federal Management Concern
Northern Saw Whet Owl	<i>Aegolius acadicus</i>	State Vulnerable
Osprey	<i>Pandion haliaetus</i>	State Threatened
Pied Billed Grebe	<i>Podilymbus podiceps</i>	State Vulnerable
Red Headed Woodpecker	<i>Melanerpes erythrocephalus</i>	Federal Management Concern
Red Shouldered Hawk	<i>Buteo lineatus</i>	Federal Management Concern
Veery	<i>Catharus fuscescens</i>	Federal Management Concern
Wood Thrush	<i>Hylocichla mustelina</i>	Federal Management Concern
Worm Eating Warbler	<i>Helmitheros vermivorus</i>	Federal Management Concern

## Reptiles and Amphibians

West Chester University conducted a herpetofaunal inventory throughout Valley Forge NHP over a 2½ -year period from September 1999 – February 2002 (Tiebout 2002). A combination of methods were used, including cover boards, drift fence arrays, substrate surveying in forests and streams, aquatic trapping, basking turtle surveys, and anura calling surveys. Based on these surveys, 29 species were documented in the park, including seven species previously not recorded within the park. The species collected include seven salamanders, eight frogs and toads, six turtles, and eight snakes.

Over two-thirds of the herpetofauna collected at Valley Forge were supported by just two of the surveyed habitat types – wetlands (including ponds and vernal pools) and lowland forests. Considered as the herpetofauna “hot spot” within the park, the northern floodplain of the Schuylkill River was found to have both habitat types interspersed together. The northern floodplain has a mix of vernal pools, former impounding basins, and vegetated wetland areas. The other five habitat types surveyed also are necessary to support all the species in the park: upland forest, tall grass meadows, Valley Creek, Schuylkill River, and their tributaries (other streams or drainages). The 29 species varied widely in their patterns of habitat use (Tiebout 2002).



The American toad is one of the park's most common amphibians. (Photo courtesy of Bill Moses.)

None of the species found during the survey are listed as rare, threatened, or endangered at the state or federal level. However, some of the species found in the park appear to be rare or limited to a restricted geographic range within the park, making these species vulnerable to local extinction: eastern newt, slimy salamander, wood frog, Fowler's toad, common musk turtle, common map turtle, northern brown snake, and eastern milk snake (Tiebout 2002). While not found during the inventory completed through February 2002, the redbelly turtle, a state-threatened species, also has been documented within the park (Cypher, Yahner, and Cypher 1985).

A panel of herpetologists subsequently convened and determined that 9 of the 29 species found within the park have high conservation value based on five evaluation criteria: keystone species, habitat specialists, large area requirements, persecuted, and water quality sensitive. The seven species with the highest conservation value are

- Northern Dusky Salamander (*Desmognathus fuscus*)
- Longtail Salamander (*Eurycea longicauda*)
- Northern Red Salamander (*Pseudotriton ruber ruber*)
- Common Map Turtle (*Graptemys geographica*)
- Eastern Box Turtle (*Terrapene carolina*)
- Queen Snake (*Regina septemvittata*)
- Northern Copperhead (*Agkistrodon contortrix mokase*)

Given surrounding development pressures and the diversity of critical reptile/amphibian habitat available, the park serves as an important refuge for these species that are otherwise rare, declining, or threatened elsewhere in Pennsylvania (Tiebout 2002).

### Special Status Animal Species

Special status species include federal- and state-listed species. Federally listed species are those that are afforded special protection by the Endangered Species Act due to their rare or threatened existence. State-listed species are considered to be rare or threatened within a specific state and are protected by state legislation. To date, there are no known federally-listed animal species confirmed to occur within Valley Forge NHP. There are, however, five state-listed (or proposed for listing) animals that are known to occur within the park (Table 11). Only one species, the red-bellied turtle (*Pseudemys rubriventris*), is considered a park resident. Observation of the bald eagle (*Haliaeetus leucocephalus*), osprey (*Pandion haliaetus*), peregrine falcon (*Falco peregrinus*), and yellow-bellied flycatcher (*Empidonax flaviventris*) is described as occasional, rare, or extremely rare within the park. The status and distribution of these species and their essential habitats within Valley Forge NHP is largely unknown. Efforts are underway to determine this information for resident species so that management and protection can be addressed. No efforts are underway to specifically address migratory or species that use the park rarely other than to maintain healthy and diverse native plant communities.

**Table 11 Special Status Animal Species Confirmed within Valley Forge NHP**

Animal Species	State Status <sup>a</sup>	Relative Abundance
Bald eagle ( <i>Haliaeetus leucocephalus</i> )	Endangered	Occasional <sup>b</sup> (all seasons)
Osprey ( <i>Pandion haliaetus</i> )	Threatened	Occasional (spring and fall)
Peregrine falcon ( <i>Falco peregrinus</i> )	Endangered	Rare <sup>c</sup> (spring and fall)
Red-bellied turtle ( <i>Pseudemys rubriventris</i> )	Threatened	Rare (resident)
Yellow-bellied flycatcher ( <i>Empidonax flaviventris</i> )	Endangered	Extremely rare <sup>d</sup>

a Source: Valley Forge National Historical Park Bird List 2007.

b Occasional = occurs in the park at least once every few years, but not necessarily every year.

c Rare = present, but usually seen only a few times each year.

d Extremely rare = occurs in the park less than once every few years.

### Current Status of Other Wildlife and Role of Deer

White-tailed deer impact other animals through alteration of habitat and direct competition for limited food resources (Latham et al. 2005). Habitat alteration results from removal of forest understory vegetation, leading to a decline in food, cover, and nesting sites for forest bird communities (ground and intermediate-nesting species) and some insect communities (Latham et al. 2005). Browsing of the understory cover greatly reduces the amount of habitat available for nesting of certain bird species. Densities of species such as the black-billed cuckoo, hooded warbler, and white-eyed vireo will continue to remain low within the park unless the herbaceous and shrub layers are restored (Yahner 2001). In northwestern Pennsylvania, long-term monitoring of bird communities in forested enclosures containing varied deer densities (10, 20, 38, and 64 deer per square mile) documented a reduction in species richness and abundance of 27% and 37%, respectively, for intermediate-canopy-nesting bird species at higher deer densities (deCalesta 1994).

Loss of forest understory vegetation may also negatively impact insect populations, often dependent on a very narrow range of host plants (Strong, Lawton, and Southwood 1984; Stewart 2001). Loss of native nectar plants in both forests and grasslands may especially impact butterflies and other pollinators. The production of acorns and other tree nuts, known as mast, is a critical food source for many small mammals, birds, and deer preparing for the winter season. During low mast production years, abundant deer populations may directly compete with other wildlife for this important resource. This competition negatively impacts reproduction and over-winter survival of species such as the eastern chipmunk (*Tamias striatus*), gray squirrel (*Sciurus carolinensis*), and white-footed mouse (*Peromyscus leucopus*) (Martin, Zim, and Nelson 1951; Miller and Getz 1977; Gashwiler 1979; Ostfeld, Jones, and Wolff 1996; Brooks and Healy 1988; McShea and Rappole 1992, 1997; McShea and Schwede 1993; McShea 2000).



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## 3.3 Cultural Resources

### 3.3.1 Cultural Landscapes

The cultural landscape of Valley Forge NHP primarily reflects two periods: the 1777-78 winter encampment of the Continental Army and the commemorative park overlay that began to develop in the late 19th century. The encampment landscape is nationally significant, while the commemorative landscape is significant at the state level. Additional layers of history are present in the park landscape: the park possesses state or local significance for its industrial, transportation, agricultural, conservation, and recreational associations.

A Cultural Landscape Inventory (CLI) for the park was completed in 1999, documenting all known cultural and natural features that contribute to the National Register significance of the park. A Draft Cultural Landscape Report (CLR) was completed in 2002, including both contextual research and cultural landscape documentation for the park. The report thoroughly described the evolution of the park through the use of narrative description and visual images; developed historic contexts for the park and identified their associated cultural resources; refined existing conditions documentation previously compiled in the CLI; and evaluated the significance and integrity of the landscape and its features according to National Register criteria (Susan Maxman Architects and John Milner Associates). The *Valley Forge NHP General Management Plan/Environmental Impact Statement* (NPS 2007j) provides a summary of this information; therefore, a brief description of the key resources potentially impacted by the deer population and its management is provided below.

The encampment was a temporary military overlay upon an existing agricultural and industrial landscape that itself was based on a confluence of natural features and systems. Features such as heights, slope, and water were critical to the selection of sites for encampment fortifications, roads, and shelter. As is common with military sites from the revolution, many of the detailed elements no longer survive. The most critical landscape features, those that drew General Washington to this strategic site, remain, however, and have a high degree of integrity.

A contemporaneous map suggests that about 30% of the area was wooded when the troops arrived. To establish and sustain the camp, every tree within a several-mile radius was cut and used for hut construction and earthworks or burned as fuel. The logging also provided clear defensive views of the river and the surrounding area. Wooden rail farm fences were dismantled and used, and hedgerows were sacrificed for fuel.

The encampment landscape retains integrity of landform, topography, views, and aspect, including Mounts Joy and Misery and the Grand Parade; natural systems and features, including the Schuylkill River, Valley Creek, and numerous springs; and circulation elements, such as Valley Forge Road (PA Route 23), Gulph Road, Baptist Road trace, Yellow Springs Road trace, and the river. More difficult to see but still present is physical evidence of the pre-encampment settlement patterns, including field boundaries, portions of some farm clusters, and remnants of the once-thriving iron forge industry. Much evidence remains of the military adaptations made to support the encampment and fortify the position, including portions of the inner and outer line defenses, the known sites of earthen forts and road systems, and various buildings and structures that were used for officers' quarters, storage, or livestock. These are more than sufficient to convey the story of the encampment and its meaning.



Historical documents reveal the park was about 30% forested when George Washington and the Continental Army arrived in 1777.

The park landscape most readily visible today reflects neither the wretched devastation that characterized most of the duration of the encampment nor the prosperous industrial village, farmsteads, and agricultural fields that were present both when the encampment began and also within a few years of its conclusion. Instead, the landscape today most closely reflects the state park commemorative period.

This approach to park development and commemoration was modeled on the example of Gettysburg. Unlike Gettysburg, however, where there was a clear and commonly understood mandate to preserve the battlefield just as it was in 1863, the Valley Forge commemorative landscape is the product of vacillation between the desire to restore elements of the landscape to encampment-period conditions and the desire to beautify the site in honor of its importance. A romanticized view of the past led the park commission to alter or erase most of the characteristic agricultural and industrial elements, including most of the historic structures, fences, walls, hedgerows, and farm and village lanes. A reforestation program was implemented for Mounts Misery and Joy, and commemorative groves of dogwood and allées of oaks and lindens were planted. The current approach to management of the park landscape is preservation of the major features of the cultural landscape (NPS 2007j).

### 3.3.2 Historic Structures

The park contains 81 historic buildings and numerous individual structures (ruins, monuments, markers, statues, roads, earthworks, walls, and other man-made features) that reflect its history and contribute to the significance of the park. For the plan/EIS, structures impacted by the deer population and its management include the original earthworks and four reconstructed forts. There are approximately 5,500 linear feet of original earthworks, all of which are located in the forested areas of Mount Joy. These resources are losing integrity and in danger of being lost, as trampling and loss of vegetative cover leads to rapid erosion.

### 3.3.3 Archeological Resources

The archeological heritage of Valley Forge NHP is both vast and of enormous significance. The park's archeological resources document every major period of its occupation and are critical to a full appreciation and interpretation of the site's rich history. These archeological sites range over 8,500 years of human history. Of special concern are the sites and structures shaped by the encampment of the Continental Army. These encampment resources are of the highest significance for the park, since they represent the richest material memory left to us from the participants.



Archeological sites in the park reveal over 8,500 years of human history.

Until the establishment of the national historical park, relatively little archeological investigation had been undertaken at Valley Forge. Beginning with a survey of the park by the University of Pennsylvania's Museum Applied Science Center for Archeology in the late 1970s and continuing in the 1980s with the work of Valley Forge Archeological Team Director James Kurtz, a large amount of data was compiled. Although the great majority of the sites found during this period of intense activity have yet to be fully understood and delineated, research recently completed at the site of the Pennsylvania Brigade has demonstrated conclusively that the encampment archeological resources contain the potential for a future harvest of data that is of inestimable value to the nation's cultural legacy and the edification of the public, residing beneath a commemorative landscape of great power and serenity.

The Archeological Overview and Assessment (in three volumes) details the range and value of these resources. The third volume, *Brigade Areas and Encampment Resources* (NPS 2002a), concentrates only on the sites of the encampment resources, and the results change the way historians/researchers look at these sites. In particular, the recent excavation of the Pennsylvania Brigade indicates that encampment resources are present in both quality and quantity beyond what was



previously believed. The eastern area of the park has not been studied extensively; however, archeological surveys conducted in 2004 and 2005 would contribute to a future overview and assessment for this area. Archeological research confirms that almost all encampment-era resources lie close to the surface and are easily affected by surface disturbance, including erosion and trampling.

### 3.4 Visitor Use and Experience

Prior to being established as a state park in 1893, Valley Forge was a popular summer tourist attraction, particularly for visitors who were fascinated by the ties to George Washington. After establishment, the park became a place to not only learn about early American history, but also to enjoy picnics and strolls, and to take in the scenery. By the 1930s it was estimated that nearly one million annual visitors were coming to the park and concerns were expressed about the impact of visitation on the historic resources and landscape of Valley Forge. In the latter half of the 20th century, as the area around Valley Forge experienced tremendous growth and development, the park became an increasingly popular place for area residents to enjoy the outdoors. During this time, recreational uses such as walking, jogging, and biking became especially common pastimes, and this trend has continued.



Deer watching is a popular visitor activity in the park.

The Public Use Statistics Office of the NPS estimates that Valley Forge NHP reported a total of 1.3 million visits in 2007. Over the past 10 years, annual attendance numbers range from a high of 1.9 million in 1997 to the 2004 low of 1.0 million. While attendance figures do not present precise information in terms of absolute numbers, they have followed a consistent estimation protocol that makes it possible to make relative observations. Visitation figures for January through June of 2005, as compared to the same six months in 2004, show a 29% increase in visits, however, and it is not possible to predict future visitation with certainty, if all current factors remain as is.

In 2001, Valley Forge NHP conducted its first visitor study in 15 years. This study sampled 755 visitors at six locations in the park over a seven day period in August. The numbers are not statistically precise and the study results do not necessarily apply to visitors during other times of the year. However, they provide useful indications about park visitation during the peak summer season. Some of the relevant information that emerged from this study includes the following:

- A substantial percentage of visitors are recreational users of the park who come regularly. About two-thirds (66%) of all visitor groups had at least one person who came to the park at least once a month.
- The two most popular activities among visitors are walking/running and visiting historic structures: recreation is by far the most popular use of the park.
- Groups with frequent visitors are apt to bring along infrequent guests, however. Of all individuals surveyed, 55% had only come to the park once in the past year.
- The park is used year-round. Even though the questionnaire was administered during the summer, over 50% of respondents said that they also use the park in the spring and fall, and 42% use it in the winter.
- The average age of visitors to the park is 45 – lower than at many other historic attractions. The reasonably low age is likely due mostly to recreational users and school groups.

Additionally, park staff report that visitor use varies according to season: more historical visits take place in the summer, and more recreational visits occur in the spring, fall, and to some extent winter. Traditionally, school-group bus tours predominate in the spring and senior groups in the fall. As one would expect, there also is a distinct increase in recreation visits on weekends and on days with nice weather.

Another visitor survey was completed in 2007 to assess the role of the park's deer population on the visitor experience (Leong and Decker 2007). Although survey respondents recognized the damage that the deer cause through overbrowsing and vehicle collisions, deer still are considered an attractive resource at the park. Many respondents noted that deer-watching was one of the enjoyable activities they experienced at Valley Forge NHP. Many respondents did believe that the sight of malnourished, sick, or injured deer detracted from their experience.

At Valley Forge NHP, no area of the park is farther than 2,000 feet from a road or railroad. Because the park is surrounded by development and crossed by through-traffic, natural sounds are heavily masked by transportation and other extrinsic sounds. However, visitors continue to value the green, undeveloped landscape as an escape from its modern surroundings.

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### **3.5 Socioeconomic Resources and Adjacent Lands**

Heavy population concentrations characterize the area extending from Wilmington, Delaware to Trenton, New Jersey, including the greater Philadelphia. Valley Forge NHP is part of five townships: Schuylkill and Tredyffrin Townships in Chester County; and Upper Merion, West Norriton, and Lower Providence Townships in Montgomery County (see Figure 1).

The park is greatly affected by its location within a major eastern metropolitan area. Although agricultural production and its associated landscape dominated the region throughout most of the 20th century, southeastern Pennsylvania farms in the past two decades have yielded to suburban sprawl. Few farms and open spaces remain, having been replaced by residential, commercial, and office development serving local residents as well as greater Philadelphia commuters.

A densely developed industrial/commercial corridor interspersed with new and older residential development extends northwest from Philadelphia and engulphs the park. This area is the region's largest suburban office and retail complex and includes one of the nation's largest shopping malls, King of Prussia. Threading between the park and the commercial areas is the regional highway network, including several heavily traveled expressways. These include US 422, which passes through the park, and the Pennsylvania Turnpike, I-76/I-276, which passes along the park's southern boundary, connecting Philadelphia to the rest of the state.

### 3.5.1 Landscaping and Property Values

The median property value of owner-occupied units in Chester County was \$182,500 as of the 2000 Census. The median property value in Montgomery County was \$162,700. Landscaping can have a significant impact on property values, enhancing the resale value of a property by up to 15%, with a treed lot selling for 7–14% more than a lot without trees (Nuss 2000). Furthermore, landscaping expenditures are often easily recovered when selling, with 100–200% of landscaping costs typically recovered (Taylor 2003). Therefore, improvements to landscaping may be seen as a successful way to improve property values.

Deer can have a highly destructive effect on landscaping. Their diet varies seasonally according to what food is available. Browse, which refers to trees, shrubs, and vines, makes up a substantial part of the diet of the average deer. As habitat dwindles due to development pressure and as deer populations grow, deer may turn to surrounding residential areas for food, particularly in late fall, winter, and early spring, when other food sources may be scarce. An average adult deer consumes approximately six to ten pounds of food per day during late spring, summer, and fall (McDonald and Hollingsworth 2007). In many residential areas surrounding protected areas, such as Valley Forge NHP, deer cause virtually year-round damage to landscaping, which can be costly to replace.

Deer damage shrubs and landscape vegetation by eating the buds, leaves, flowers, and twigs, and by rubbing on the bark. In home gardens, deer often eat leaves, flowers, stems, or other edible parts. They also often trample plants as they move through the landscape (West Virginia University 1985). Damage typically extends as high as six feet, which is the highest an average deer can reach.

These damages not only affect the value of the home, but result in the loss of millions of dollars worth of plants. A 1997 survey of 60 million households estimated that deer-related damage to plants and landscape results in losses of \$251 million a year. Focused investigations in southeastern New York found that the replacement costs for trees and shrubs lost to deer damage averaged \$500 per household (Curtis 2007).

Valley Forge NHP receives a number of communications each year about deer issues, and the majority involve concerns about deer consuming landscaping plants or road kill clean-up. The park began compiling a list of people who inquired about



the impacts of deer on neighboring landscaping in the early 1990s. This information was used to develop a mailing list but did not track the number of complaints or inquiries the park received on the subject. This list has been regularly updated as communications are received. There have been no reported incidences of deer aggression towards park visitors or park neighbors.

A 2007 study examined local residents' opinions related to deer damage in and around Valley Forge NHP. Opinions on the level of impact to local properties varied; however, there was a clear understanding that the park and the surrounding properties provided the deer with an excellent food source. While opinions also varied on how to address deer impact on the community, individuals interviewed for the study recognized the interdependence between what deer management actions the park takes and those taken by the surrounding community. It was recognized that success cannot be achieved by one without cooperation from the other (Leong and Decker 2007).

### 3.5.2 Vehicular Damage

Collisions with deer affect vehicular maintenance costs. Based on insurance claims across the nation, Pennsylvania has had the highest number of deer-vehicle collisions in four of the last five years, averaging 99,000 incidents a year. Pennsylvania also has the highest number of deer-vehicle collisions per mile of road, with a collision occurring every 1.22 miles of public road (Frye 2007).

Collisions may result in injuries or death to the passengers and the deer, as well as damages to the vehicle. Vehicle repair bills following a deer collision ranged from \$1,200 to \$2,200, with an average value of \$1,577 in 1993 dollars (Conover et al. 1995). Between 1986 and 2000, insurance claims related to deer-vehicle collisions in the northeastern United States<sup>1</sup> totaled \$390,520,000. Costs in Pennsylvania were estimated at \$150,000,000, or nearly 40% of the total cost in the region (Drake et al. 2005). These figures do not include the cost for medical expenses or deer carcass disposal. These incidents affect public safety and are addressed below, under 3.6 Public Safety.

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## 3.6 Public Safety

Various safety concerns could result from implementation of the alternatives described in this Draft plan/EIS. Safety applies to both park visitors and park employees. The NPS is committed to providing appropriate, high-quality opportunities for visitors to enjoy parks in a safe and healthy environment. A visitor accident or incident is defined as an accidental event affecting any non-NPS employee that results in serious injury or illness requiring medical treatment, or in death. Park rangers and employees post public notices on bulletin boards around the park and on the park website and also contact visitors directly in order to ensure that visitors to Valley Forge NHP are properly informed regarding safety concerns. In FY 2007, a total of 13 visitor accidents/incidents occurred at Valley Forge NHP. The majority of these involved bicycling activities, insect bites, and falls.

Deer-vehicle collisions are a threat to human safety and are one of the predominant sources of deer mortality. It is widely believed that the number of deer-vehicle collisions is directly related to traffic volume, vehicular speed, deer abundance, and

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<sup>1</sup> Statistics include 13 states: Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, Virginia, and West Virginia.

time of year. Within the park, the majority of deer vehicle collisions occur between October and December coinciding with mast production (e.g. acorns) and the deer mating season (e.g. increased deer movements).

Valley Forge NHP visitor safety incidents are based on park law enforcement data documented through the Case Incident Reporting System. On average, 86 deer-vehicle collisions per year occurred within the park between 1997 and 2007. These collisions were reported by law enforcement under reporting codes 80-00-10 (Car vs. Deer, Reported) and 66-00-01 (Car vs. Deer, Hit and Run). Many of these collisions (67%) are hit and run accidents that do not result in the immediate death of the deer. This makes it difficult to assess the impact of these collisions on deer health.

In addition to visitor safety, park staff is also proactive about protecting the safety of employees. Most injuries or accidents are sustained by maintenance staff and park rangers, who often perform manual work outdoors. In FY 2007 a total of three lost-time injuries were sustained by park staff. The most widespread injuries were back and knee injuries. No injuries have occurred related to deer management activities performed to date; however, NPS staff would be exposed to additional potential safety risks if deer management activities were added to their work routine.

The potential occurrence of Lyme disease also is often cited as a safety concern by both park visitors and employees. Lyme disease is a bacterial infection transmitted by the bite of deer ticks (*Ixode scapularis*). Pennsylvania ranks second in the nation for number of reported cases of the disease, with the majority being reported from southeastern areas of the state near Valley Forge NHP (PA Department of Health 2008). Early symptoms are flu-like, but left untreated this disease may result in serious illness affecting joints, the heart, and other organs. The deer tick acquires the Lyme disease bacterium when it takes a first blood meal from the white-footed mouse – the carrier of the disease. Subsequent blood meals may be provided by any mammalian host, including white-tailed deer. Therefore, even in the absence of any deer within the park, Lyme disease would likely still occur. Conversely, as stated previously, a greater number of hosts (deer) may support a higher population of deer ticks increasing the probability of human-tick encounters. A sample of 116 nymphal and adult deer ticks collected from various habitats within the park in 1995 revealed the presence of Lyme disease within 3% of the tick population (Heister 1996). It is unknown how many employees have contracted Lyme disease as a result of deer tick bites within the park.

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### 3.7 Park Operations

The staff of Valley Forge NHP are organized into five operating divisions: Planning and Resource Management, Ranger Activities, Business Services, the office of the Superintendent, and Facilities Management. There are 63 full-time equivalent positions (FTE) (Table 12). The permanent staff is augmented by a seasonal or temporary workforce, which changes from year to year due to funding variations. Typically the seasonal workforce in natural resource management has included conservation interns through the Student Conservation Association, two to four college internship students, volunteers, and varying numbers of seasonal employees. The federally appropriated budget for Fiscal Year 2007 was \$5,633,000 which comprised 84.6% labor and 15.3% all other costs (NPS 2008h). All divisions have been operating with declining numbers of staff as well as inadequate funding for nonpersonnel costs. After adjusting for inflation, the park's base budget has declined by more than 11% since 1985 (NPS 2007h). Table 12 provides a summary of the Valley Forge NHP operating budgets for 2006 and 2007.

**Table 12 Valley Forge NHP Operating Budget for 2006 and 2007\***

<b>Division</b>	<b>2006 Full-time Employees</b>	<b>2006 Operating Budget</b>	<b>2007 Full-time Employees</b>	<b>2007 Operating Budget</b>
Office of the Superintendent	3	\$388,700	5	\$411,844
Business Services	13	\$899,033	7	\$674,736
Planning and Resource Management	8	\$675,600	8	\$597,975
Ranger Activities	22	\$1,784,700	18	\$1,705,499
Facilities Management	26	\$1,940,967	25	\$2,242,946
<b>Total</b>	<b>72</b>	<b>\$5,689,000</b>	<b>63</b>	<b>\$5,633,000</b>

\* ONPS base funds only

### Planning and Resource Management

Eight FTE are assigned to park planning and management of cultural and natural resources. Museum services staff and the archeologist/GIS specialist do not perform activities specifically related to deer management. The Division Chief oversees the deer management program, but it is led on a day-to-day basis by the Natural Resource Manager. Four positions are dedicated to natural resource management, including a natural resource interpreter. The natural resource management staff currently devote about 10-15% of their time to deer management activities, which includes maintaining small exclosures, conducting annual fall spotlight surveys and spring deer counts, conducting vegetation monitoring, developing interpretive materials for the public, conducting educational programs, and implementing data management procedures (data entry, data checking, data analysis). The natural resource management staff also coordinates volunteers to help conduct annual fall spotlight counts and spring deer counts. Table 13 provides a breakdown of the annual costs allocated for deer management activities at Valley Forge NHP.

**Table 13 Valley Forge NHP Deer Management Operating Budget**

<b>Action</b>	<b>Assumptions</b>	<b>Cost/Year</b>
Vegetation Monitoring	Carried out every 5 years. Involves 30 days of field work for NPS staff plus assistance from a botanist. Includes annual exclosure check, data analysis, and reporting.	\$8,838
Deer Population Monitoring	Includes fall spotlight counts and spring compartment counts. Includes NPS staff time along with volunteer hours.	\$1,702
Small Fenced Areas	Staff time to monitor and maintain existing small fenced areas, as well as supplies and equipment.	\$6,000
Roadkill Removal	Time for NPS staff to remove deer from park roads, as well as contracted removal.	\$3,511
Public Education	NPS staff time	\$2,211
CWD Opportunistic, Targeted, and Enhanced Targeted Surveillance	NPS staff time for monitoring and coordination, as well as supplies.	\$1,020-\$10,305
<b>Total</b>		<b>\$23,282-\$32,567</b>



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## Ranger Activities

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The Ranger Activities Division includes 18 FTE who perform law enforcement functions and interpretive functions at Valley Forge NHP.

Nine FTE require law enforcement commissions. Their responsibilities include tasks associated with forest or structural fire control; protecting property and resources; investigating violations, complaints, trespass/encroachment, and accidents; conducting search and rescue; and collecting information on cultural or natural resources. In addition to these duties, during deer hunting season, park rangers conduct patrols within the park to discourage poachers and they work with PGC staff to investigate poaching incidents. Law enforcement rangers are responsible for euthanizing injured deer and other animals, coordinating removal of vehicle-killed deer from roadways, and occasional collection of biological data from road-killed deer (e.g., sex, age, location).

Nine park rangers conduct interpretive and education activities at Valley Forge NHP. Involvement of interpretive staff in deer management is restricted to the dispersal of general information on deer management activities and policy in the park, knowledge of what supplemental materials are available to the public and where additional information may be obtained, and providing timely and accurate information to the public and others on public meetings, interpretive programs, etc. related to deer management and other natural resource topics.

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## Business Services

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Seven FTE staff the division of Business Services, however none perform tasks specifically related to deer management. The primary responsibility of the Business Services is to provide administrative support to all divisions and functions within the park. Administrative support functions include human resources, budget and finance, procurement and contracting, and information management.

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## The Office of the Superintendent

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The Office of the Superintendent is staffed by the Superintendent, Assistant Superintendent, and three staff. The Superintendent and Assistant Superintendent have attended numerous public meetings, provided briefings and briefing statements, and interact on a regular basis with the public, members of local, state and federal government agencies, and state and federal representatives on matters related to deer management.

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## Facilities Management

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Twenty-five FTEs staff the Maintenance Division at Valley Forge NHP. These staff perform general maintenance tasks that are rarely related to deer management. Some facilities management staff help upon request with tasks such as fence repair. Any maintenance services provided to construct or maintain large exclosures or other deer management related tasks considered in this environmental impact statement would require project funding.

The primary responsibility of the Facilities Management Division is to provide for the general upkeep and maintenance of all park buildings, grounds, and infrastructure, including oversight of a variety of construction projects.

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