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Philadelphia, Pennsylvania



Inventory of Mammals at Valley Forge National Historical Park

Technical Report NPS/NER/NRTR—2006/070



ON THE COVER

Gray squirrel (*Sciurus carolinensis*) near the Hayman House at Valley Forge National Historical Park, Pennsylvania.

Photograph by: Jacob E. Kubel

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Executive Summary

We conducted an inventory of mammalian species at Valley Forge National Historical Park (VAFO), Pennsylvania, during 2004. Our objective was to update existing records of mammalian species observed previously in the park and, possibly, add records of species not observed previously. Opportunistic observations, spotlight surveys, and live-trapping were used to inventory mammals.

We documented 1,124 encounters of 21 species of mammals: Virginia opossum (scientific names provided in Appendix A), masked shrew, northern short-tailed shrew, big brown bat, eastern cottontail, eastern chipmunk, gray squirrel, red squirrel, southern flying squirrel, woodchuck, white-footed mouse, meadow vole, Norway rat, meadow jumping mouse, common raccoon, coyote, red fox, feral cat, striped skunk, an unidentified weasel, and white-tailed deer. Big brown bat, coyote, and feral cat represent new records at VAFO; the weasel (either ermine or long-tailed weasel) would be a new record, but the sighting was not reliable and is considered an unconfirmed sighting. Our results will also update historic records stored in the NPSpecies database (NPS 2003, 2004). Of 17 species, three (Norway rat, red squirrel, and southern flying squirrel) were last documented by McKeever (1979), four (Virginia opossum, northern short-tailed shrew, masked shrew, and meadow jumping mouse) were last documented by Cypher et al. (1985), nine (eastern cottontail, eastern chipmunk, gray squirrel, meadow vole, white-footed mouse, woodchuck, common raccoon, red fox, and striped skunk) were last documented by Yahner et al. (1997), and one (white-tailed deer) was last documented by Lovallo and Tzilkowski (2003).

Data that we collected cannot be used to estimate relative abundance or absolute abundance of particular species, but we do suggest residency and abundance classifications based on definitions used by the NPSpecies database (Wotawa 2004). Specifically, we concluded that meadow vole, white-footed mouse, and white-tailed deer should be classified as breeders and abundant in the park. Masked shrew, northern short-tailed shrew, eastern chipmunk, gray squirrel, common raccoon, and red fox should be classified as common breeders, and Virginia opossum should be classified as uncommon to rare breeder. Eastern cottontail and woodchuck should be classified as common residents; whereas, red squirrel and feral cat should be classified as uncommon to rare residents. Southern flying squirrel likely is a resident, but abundance is unknown. Residency of striped skunk is unknown, and abundance should be classified as uncommon to rare. Residency of coyote also is unknown, and abundance likely is rare. Both residency and abundance are unknown for big brown bat, meadow jumping mouse, and Norway rat.

We did not encounter federal or state listed threatened or endangered species. However, geographic ranges of least shrew, evening bat, silver-haired bat, small-footed myotis, Appalachian cottontail, and eastern fox squirrel (Burt and Grossenheider 1980; Merritt 1987), which are species of special concern in Pennsylvania (PANHP 2006), overlap with VAFO. A long-term monitoring program, rather than intensive short-term research, might be effective in determining presence of species not encountered during our inventory. Finally, we identified a problem of feral cats residing within the park boundary, which pose a threat to native wildlife at VAFO.

Acknowledgments

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Introduction

The National Park Service (NPS) has determined that park managers need comprehensive information about the biological resources in parks in order to maintain biodiversity and natural ecosystems (NPS 2000). As large tracts of public lands, such as national parks, become more insular from increased habitat fragmentation because of agricultural development, urbanization, or other land uses, these lands will be increasingly valuable for the long-term maintenance of faunal diversity and the functional integrity of landscapes and ecosystems in the eastern United States (Ambrose and Bratton 1990; Yahner 2000). One of the first steps required to achieve the NPS goal of conserving biodiversity in national parks is to conduct baseline inventories of vertebrate and plant species in the parks. Data from inventories can provide knowledge of presence, distribution, and relative abundance of park biota and, therefore, aid in evaluation of management plans and actions for certain species.

Several biological research projects have been conducted recently at Valley Forge National Historical Park (VAFO), Pennsylvania. Some consisted of protocol testing for surveys of amphibians and reptiles (hereinafter referred to as herpetofauna) (Lutcher 1996; Carfioli 1998, 2000; Yahner et al. 1999) or small mammals (Yahner et al. 1997). Others were inventories of bird (Yahner et al. 2001) and herpetofauna (Tiebout 2003a) species at VAFO, and another examined abundance and movement of white-tailed deer (scientific names provided in Appendix A) at the park (Lovallo and Tzilkowski 2003).

Although those projects added considerable knowledge about biological resources at VAFO, park managers have expressed needs for additional data. For example, researchers have been prohibited since 1997 from entering particular sectors of the park that are known to be contaminated with asbestos and other pollutants; the sectors are part of a general region called the Asbestos Release Site (ARS) and are now classified individually as Areas of Concern (Foster Wheeler Environmental Corporation 2003; Yahner et al. 2006a). Therefore, the most recent inventory of herpetofauna (Tiebout 2003a) did not include sampling in Areas of Concern, and there is little knowledge about how presence of contaminants might influence vertebrate populations in these areas. Additionally, VAFO acquired a parcel of land in 2004 known as the Schwoebel tract (later renamed “Waggonseller Farm”), but few data about wildlife or plants on the tract are available. Moreover, new data regarding presence of mammalian species parkwide is needed because existing records are outdated (e.g., McKeever 1979; Cypher et al. 1985), based on studies that were limited in scope (McKeever 1979; Cypher et al. 1985; Yahner et al. 1997; Lovallo and Tzilkowski 2003), or based on reports that could not be verified (e.g., Wildlife Observation Cards submitted by the general public).

Given the gaps in knowledge about presence, distribution, and relative abundance of terrestrial vertebrates and plants at VAFO, we conducted a three-part, one-year-long inventory project during 2004, with the findings of each part published in a separate report. The first part (Yahner et al. 2006a) consisted of inventories of herpetofauna and small mammals in the ARS Areas of Concern (hereinafter referred to as ARS inventory project). The second part (Yahner et al. 2006b) consisted of inventories of herpetofauna, mammals, birds, and woody plants in the Schwoebel tract (hereinafter referred to as Schwoebel inventory project). The third part (this report) was a parkwide inventory of mammals at VAFO.

Unlike the first two inventories, the parkwide inventory of mammals was not intended to be a comprehensive investigation of presence, distribution, and relative abundance. Rather, the specific objective was to update existing records of mammalian species observed previously in the park and, possibly, add records of species not observed previously (i.e., document presence of as many mammal species as possible). The inventory relied partly on data collected during the ARS and Schwoebel inventory projects (Yahner et al. 2006a, 2006b).

Standards and Compliance

Activities conducted during this study were approved by the Institutional Animal Care and Use Committee at The Pennsylvania State University (IACUC No. 16262). Mammalian data collected during the ARS inventory project (Yahner et al. 2006a) are included in the results reported for this project. Because the ARS is classified as a “Superfund” site (Environmental Protection Agency identification number PA9141733080) under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (EPA 2006), investigators scheduled to enter ARS Areas of Concern (J. E. Kubel and B. D. Ross) received certification 3 March 2004 for completion of HAZWOPER training (24-h course plus 8-h site-specific training). After reviewing the research proposal for this study, M. Carfioli (Ecologist at VAFO), E. Cram (Safety Officer at VAFO), and P. Pryor (U.S. Public Health Service) assisted with development and approval of a Site-Specific Health and Safety Plan in compliance with Occupational Safety and Health Administration Standard 1910.120 (OSHA 1994). J. E. Kubel and B. D. Ross were certified as Site Supervisors in the plan.

Study Area

VAFO was established in 1976 to commemorate the 6-month encampment of George Washington's army at Valley Forge during the Revolutionary War. The park consists of 1,408 ha (3,479 ac) in Montgomery and Chester counties, southeastern Pennsylvania; approximately 1,316 ha (3,254 ac) were under federal ownership during this study. VAFO is surrounded by industrial, commercial, and residential development, as well as major highways to the north, south, and east. The topography is relatively gentle, with rolling uplands and low hills; elevation ranges from 18–161 m (59–528 ft) (Tiebout 2003a). Of the total acreage under federal ownership, 374 ha (924 ac) are forest (relatively mature woodlands and plantations), 362 ha (894 ac) are grassland (mowed not more than once per year), 181 ha (447 ac) are successional forest (old-fields and relatively young woodlots with open or patchy canopy), 135 ha (334 ac) are lawn, 120 ha (297 ac) are developed (buildings, roads, parking lots, etc.), 57 ha (141 ac) are wetland (small ponds, rivers, wet meadows, etc.), 45 ha (111 ac) are cropland, and 42 ha (104 ac) are ornamental grove and nursery (Lundgren et al. 2002; Figure 1). The Schuylkill River is the major drainage and traverses the park from west to east.

Because we conducted the ARS and Schwoebel inventory projects (Yahner et al. 2006a, 2006b) concurrently with the parkwide mammal inventory, we subdivided VAFO into four sectors for collection of data: 1) Areas of Concern in the ARS, 2) reference plots associated with Areas of Concern, 3) the Schwoebel tract, and 4) other areas within VAFO. The first sector comprised 15 Areas of Concern located in the central and eastern portions of VAFO (Figure 2) and totaled 39 ha (96 ac). The second sector comprised five reference plots (Figure 2) located outside Areas of Concern (but within VAFO) and totaled approximately 4 ha (10 ac). Cover types in Areas of Concern and reference plots were predominantly successional forest and grassland; further details regarding characteristics of these sectors are discussed by Yahner et al. (2006a). The Schwoebel tract (Figure 2) was 29 ha (72 ac) and consisted mainly of old nursery cover (abandoned tree nursery representing an early successional woodlot comprised of exotic or cultivated woody plant species); further details regarding this sector are discussed by Yahner et al. (2006b). The fourth sector (other areas within VAFO) consisted primarily of cover types that were not represented in other sectors, especially forest and wet meadow.

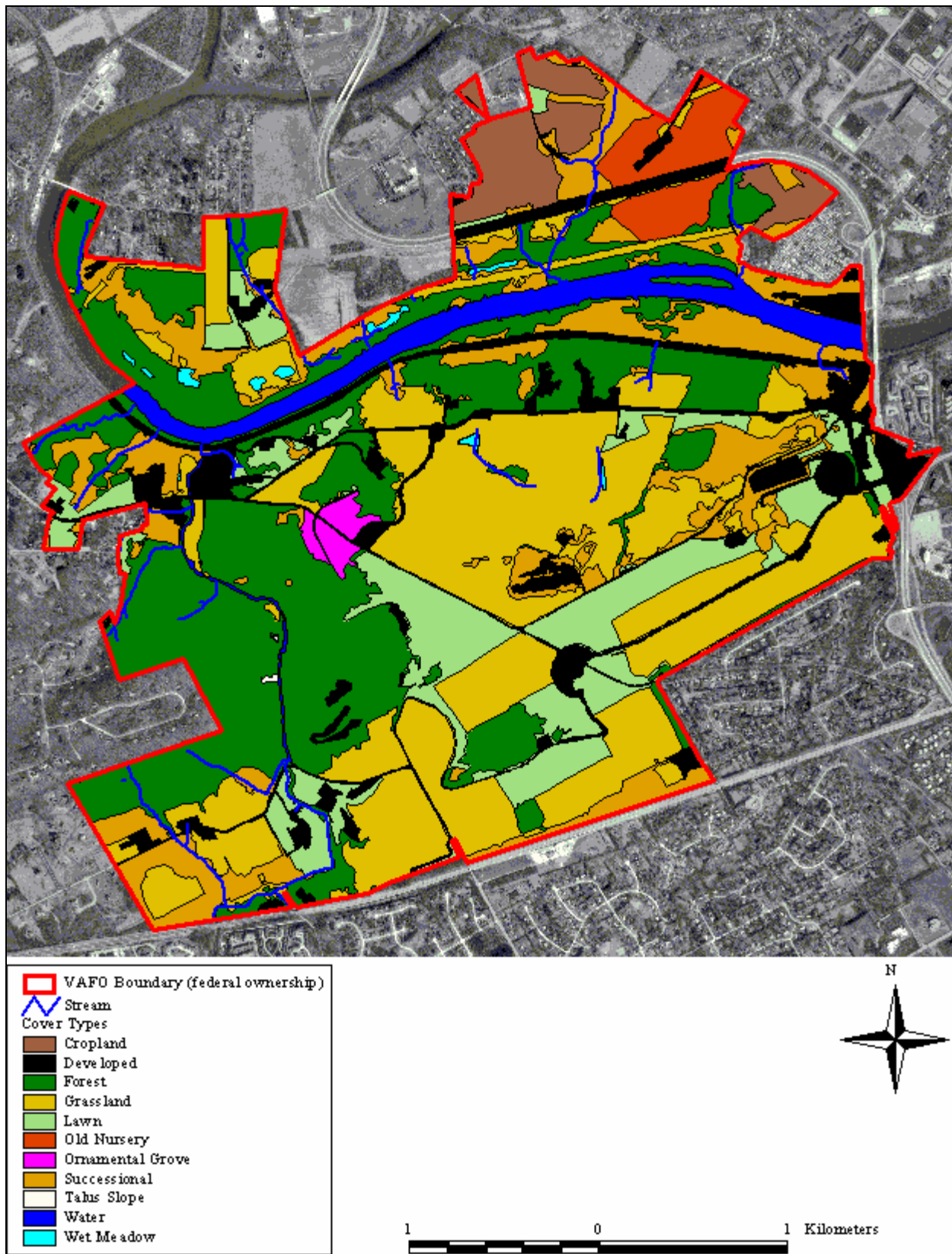


Figure 1. Cover types (modified from Lundgren et al. 2002) at Valley Forge National Historical Park (VAFO), Pennsylvania.

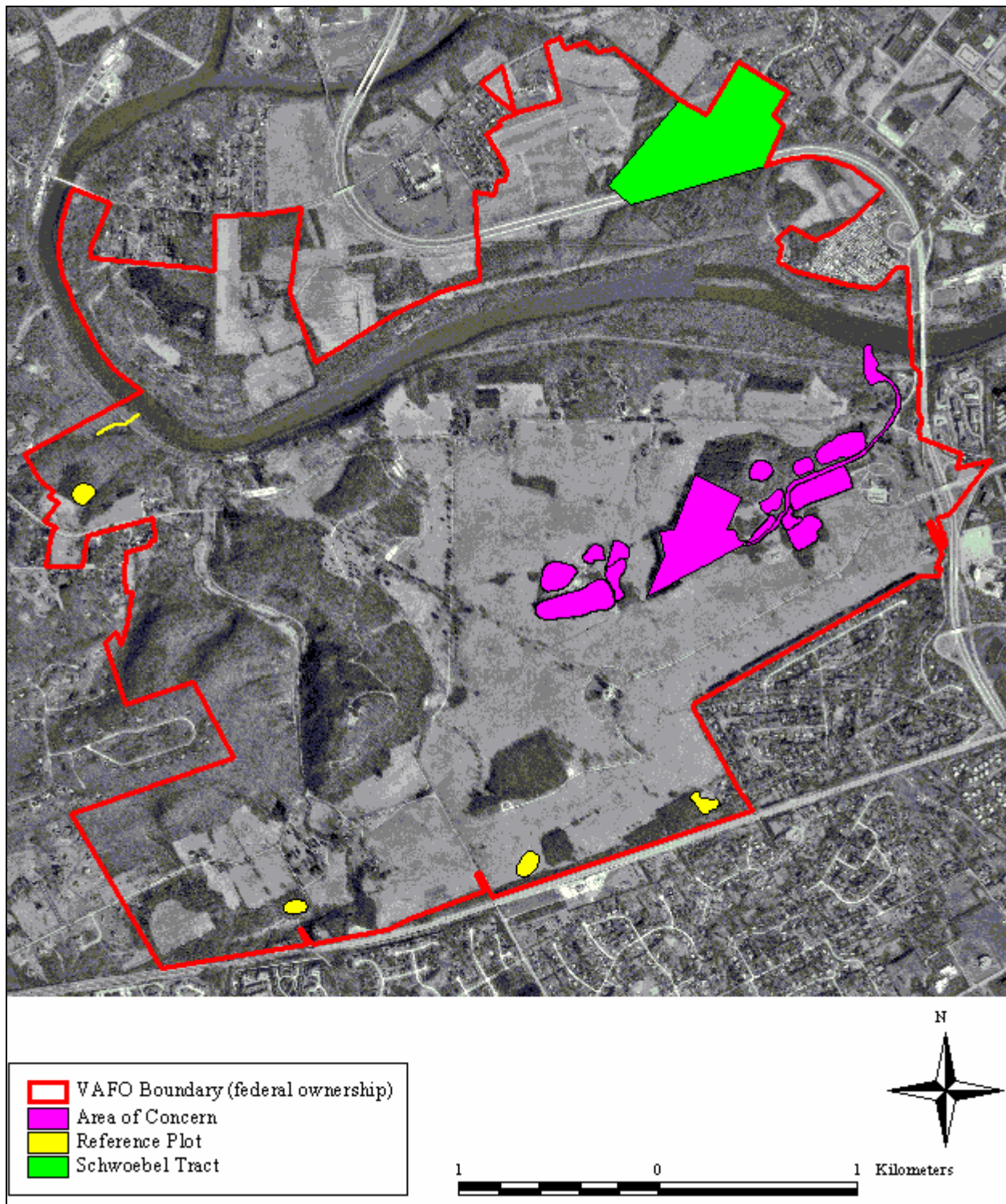


Figure 2. Locations of study areas (Asbestos Release Site [ARS] Areas of Concern, reference plots, and Schwoebel tract) used in the ARS and Schwoebel inventory projects (Yahner et al. 2006a, 2006b) at Valley Forge National Historical Park (VAFO), Pennsylvania.

Methods

Historical and Predicted Species

During winter 2004, we generated a list of 46 mammalian species (Table 1) that were predicted to occur at VAFO by reviewing the NPSpecies database of the NPS for information about species known to occur previously at the park. The NPSpecies database (NPS 2003) documents the occurrence of vertebrates and vascular plants in national parks, based on information from a variety of reliable sources, such as published reports and museum records. At the time we created our list, information regarding confirmed observations of mammals at VAFO had been updated in the NPSpecies database as recently as July 2003 (J. Keefer, NPSpecies Database Manager, pers. comm., 2004). However, a comprehensive inventory of mammals at VAFO has not been conducted (i.e., most records in the NPSpecies database are derived from research projects that were limited in scope), so records in the database ($n = 21$ species; Table 1) do not necessarily give a complete account of species currently residing in the park. Therefore, we used published species range maps (Burt and Grossenheider 1980; Merritt 1987) to identify additional species that potentially occur in the park and included such species ($n = 25$) in our list of “predicted” mammals (Table 1).

Sampling Design

Development of an efficient sampling strategy was critical to the parkwide inventory of mammals because the objective was to document presence of as many species as possible under constraints of a limited time period (one year) and coordination with concurrent inventories elsewhere in the park (Yahner et al 2006a, 2006b). Given those circumstances, we focused our sampling efforts on areas that seemed to provide the most suitable habitat for species that were on our predicted list (as opposed to basing sampling efforts on a random design). Hence, the first step in developing a sampling strategy was to evaluate presence and distribution of macrohabitats at VAFO.

Park personnel provided us with geographic information system (GIS) files that were used in combination with ArcView GIS software (ESRI 2000) to develop a cover-type map of VAFO. The GIS files, which are based on data collected during the vegetation mapping project at VAFO (Lundgren et al. 2002), depict 23 distinct vegetation alliances; some of these alliances are classified in accordance with the National Vegetation Classification System (Grossman et al. 1998). For the purpose of simplifying cover types to be considered for sampling efforts, we combined the 23 alliances to create 11 cover types (Figure 1; Table 2). The 11 cover types represent practical classifications of vegetation communities and are based primarily on the importance of vegetation structure to general habitat requirements of various wildlife species. Therefore, these classifications allow for development of species- and habitat-specific management guidelines with respect to future land use or population monitoring.

The 11 cover types used to classify vegetation communities were: 1) forest, 2) successional, 3) old nursery, 4) grassland, 5) wet meadow, 6) water, 7) talus slope, 8) ornamental grove, 9) cropland, 10) lawn, and 11) developed. We defined forest cover as relatively mature woodlots or plantations. This cover type typically has a closed canopy dominated by true canopy species

Table 1. Species predicted to occur^a during the inventory of mammals at Valley Forge National Historical Park, Pennsylvania, 2004.

Common Name	Scientific Name	Doc./Pred. ^b
Didelphids		
Virginia opossum	<i>Didelphis virginiana</i>	D
Insectivores		
eastern mole	<i>Scalopus aquaticus</i>	P
hairy-tailed mole	<i>Parascalops breweri</i>	P
least shrew	<i>Cryptotis parva</i>	P
masked shrew	<i>Sorex cinereus</i>	D
northern short-tailed shrew	<i>Blarina brevicauda</i>	D
smoky shrew	<i>Sorex fumeus</i>	P
star-nosed mole	<i>Condylura cristata</i>	D
Bats		
big brown bat	<i>Eptesicus fuscus</i>	P
eastern pipistrelle	<i>Pipistrellus subflavus</i>	P
evening bat	<i>Nycticeius humeralis</i>	P
hoary bat	<i>Lasiurus cinereus</i>	P
little brown myotis	<i>Myotis lucifugus</i>	P
northern myotis	<i>Myotis septentrionalis</i>	P
red bat	<i>Lasiurus borealis</i>	P
seminole bat	<i>Lasiurus seminolus</i>	P
silver-haired bat	<i>Lasionycteris noctivagans</i>	P
small-footed myotis	<i>Myotis leibii</i>	P
Lagomorphs		
eastern cottontail	<i>Sylvilagus floridanus</i>	D
Appalachian cottontail	<i>Sylvilagus obscurus</i>	P
Rodents		
American beaver	<i>Castor canadensis</i>	P
common muskrat	<i>Ondatra zibethicus</i>	D
deer mouse	<i>Peromyscus maniculatus</i>	D
eastern chipmunk	<i>Tamias striatus</i>	D
eastern fox squirrel	<i>Sciurus niger vulpinus</i>	P
gray squirrel	<i>Sciurus carolinensis</i>	D
house mouse	<i>Mus musculus</i>	D
meadow jumping mouse	<i>Zapus hudsonius</i>	D
meadow vole	<i>Microtus pennsylvanicus</i>	D
Norway rat	<i>Rattus norvegicus</i>	D
red squirrel	<i>Tamiasciurus hudsonicus</i>	D
southern bog lemming	<i>Synaptomys cooperi</i>	P
southern flying squirrel	<i>Glaucomys volans</i>	D
southern red-backed vole	<i>Clethrionomys gapperi</i>	P
white-footed mouse	<i>Peromyscus leucopus noveboracensis</i>	D
woodchuck	<i>Marmota monax</i>	D
woodland vole	<i>Microtus pinetorum</i>	P

Table 1. Species predicted to occur^a during the inventory of mammals at Valley Forge National Historical Park, Pennsylvania, 2004 (continued).

Common Name	Scientific Name	Doc./Pred. ^b
Carnivores		
common raccoon	<i>Procyon lotor</i>	D
coyote	<i>Canis latrans</i>	P
ermine	<i>Mustela erminea</i>	P
gray fox	<i>Urocyon cinereoargenteus</i>	P
long-tailed weasel	<i>Mustela frenata</i>	P
mink	<i>Mustela vison</i>	P
red fox	<i>Vulpes vulpes</i>	D
striped skunk	<i>Mephitis mephitis</i>	D
Artiodactyls		
white-tailed deer	<i>Odocoileus virginianus</i>	D

^aList of species is based on published range maps (Burt and Grossenheider 1980; Merritt 1987) and records in the NPSpecies database (NPS 2003), which uses reliable sources (e.g., published reports or museum records) to classify the status of species in national parks.

^bDocumented or predicted: D = documented between 1979 and 1997; P = never documented in the park, but range maps (Burt and Grossenheider 1980; Merritt 1987) indicate possible presence and, therefore, species is predicted.

Table 2. Nomenclature and designation of cover types occurring at Valley Forge National Historical Park (VAFO), Pennsylvania.

Alliance Description ^a	NVCS Alliance No. ^b	Cover Type ^c
<i>Pinus strobus</i> Planted Forest	I.A.8.C.x.8	Forest
<i>Tsuga canadensis</i> Planted Forest	I.A.8.C.x.70	Forest
<i>Quercus rubra</i> Planted Forest	--	Forest
<i>Catalpa speciosa</i> Planted Forest	--	Forest
<i>Liriodendron tulipifera</i> Planted Forest	I.B.2.N.a.24	Forest
<i>Quercus prinus</i> – (<i>Quercus coccinea</i> , <i>Quercus velutina</i>) Forest	I.B.2.N.a.36	Forest
<i>Acer saccharinum</i> Temporarily Flooded Forest	I.B.2.N.d.4	Forest
<i>Platanus occidentalis</i> – (<i>Fraxinus pennsylvanica</i> , <i>Celtis laevigata</i> , <i>Acer saccharinum</i>) Temporarily Flooded Forest	I.B.2.N.d.13	Forest
Mixed White Pine – Hardwood Planted Forest	--	Forest
Successional Forest (Local Type)	--	Forest
Successional Old Field / Shrubland (Local Type)	--	Successional
Old Nursery Site	--	Successional
<i>Dactylis glomerata</i> – <i>Rumex acetosella</i> Cultivated Herbaceous	V.A.5.C.x.5	Old Nursery
Old Quarry / Reclamation Site	--	Grassland
<i>Calamagrostis canadensis</i> Seasonally Flooded Herbaceous	V.A.5.N.k.39	Grassland
Water	--	Wet Meadow
<i>Quercus rubra</i> – <i>Quercus prinus</i> Woodland	II.B.2.N.a.24	Water
Planted Ornamental Tree Grove	--	Talus Slope
Cropland	--	Ornamental Grove
<i>Dactylis glomerata</i> – <i>Rumex acetosella</i> Cultivated Herbaceous (Mowed)	--	Cropland
Transportation Corridor	--	Lawn
Developed Land	--	Developed

^aDescriptions of alliances given in GIS files provided by VAFO personnel; most descriptions can be found in a draft report by Lundgren et al. (2002).

^bAlliance classification number is given in accordance with the National Vegetation Classification System (NVCS) (Grossman et al. 1998; Lundgren et al. 2002); many alliances described in the GIS files are not recognized in the NVCS and, hence, are denoted with "--".

^cCover type classifications that were used during the inventory of mammals at VAFO, 2004.

(e.g., eastern white pine [*Pinus strobus*], tulip poplar [*Liriodendron tulipifera*], sycamore [*Platanus occidentalis*]); the sub-canopy and shrub layers are relatively open or sparse. Successional cover consists of relatively young woodlots or old-fields/shrublands; the canopy is typically open or patchy, the sub-canopy and shrub layers are relatively dense, and there is usually substantial vine cover. Old nursery cover consists of areas formerly used as tree nurseries; this cover type represents a relatively early successional stage, but we made a distinction between it and successional cover because old nursery cover consists predominantly of exotic or cultivated vegetation. We defined grassland cover as grassy areas generally lacking woody vegetation taller than grass and mowed not more than once per year, wet meadow cover as seasonally flooded grasslands, and water cover as permanent or semi-permanent water bodies. Talus slope consists of rocky areas located on hillsides and generally lacking vegetation; canopy is typically sparse or absent, except beyond the periphery of the talus area. Ornamental groves are relatively open areas consisting primarily of planted trees; natural colonization and encroachment by woody plants is generally discouraged (e.g., by mowing). We defined cropland cover as agricultural areas, lawn cover as frequently (e.g., weekly or bi-weekly) mowed grassy areas, and developed cover as primarily abiotic areas lacking natural vegetation (e.g., roads, parking lots, buildings).

We concentrated sampling efforts in forest, successional, grassland, wet meadow, and water cover types by assuming that they offered the most potential for supporting populations of mammals, compared to anthropogenic habitats, such as ornamental grove, cropland, lawn, and developed cover types. However, we did sample developed cover types for several species that commonly occur in or near human developments (e.g., house mouse, Norway rat, southern flying squirrel, bats). Although talus slope can be considered a natural cover type, we did not sample it because it is relatively rare at VAFO (<0.4 ha [1.0 ac]) and is not more likely than other cover types to attract species on our list of predicted mammals. Old nursery cover represents an anthropogenic cover type, but it was sampled intensively because it is the predominant cover type at the Schwoebel tract.

Sampling occurred exclusively during 2004 and included all surveys conducted during the ARS and Schwoebel inventories (see Yahner et al. 2006a, 2006b for sampling designs used during those projects). Location, date, cover type, protocol, time elapsed, observer, and weather conditions were recorded for all mammal encounters and surveys. Weather conditions included a sky code, wind scale, and ambient air temperature (in shade), as described by Tiebout (2003b). Sampling protocols consisted of opportunistic observations of animals or their signs (e.g., tracks, fur, burrows, scats), roadside spotlight surveys, and live-trapping. We selected this combination of protocols because we believe it would be the most efficient way to maximize the number of cover types sampled. Additionally, these protocols are less labor-intensive and result in lower animal mortality relative to other methods of sampling mammals (e.g., pitfall and snap trapping). Opportunistic observations were the only means by which we attempted to inventory bats, as identification of bats often requires that individuals be handled, and capture of bats requires very intensive sampling effort and specialized training. Furthermore, the park anticipated funding in 2005 for research specific to bats (M. Carfioli, VAFO Ecologist, pers. comm., 2004).

Opportunistic Observations

Opportunistic observations consisted of sightings of animals or animal sign that occurred incidentally during surveys for non-mammalian taxa (e.g., birds and herpetofauna), unplanned searches for bats in anthropogenic structures (e.g., buildings), or any other time that investigators were present in the park. Hence, opportunistic observations potentially sampled all mammalian species at the park. Generally, we recorded an opportunistic observation of a mammal if: 1) the particular species had not yet been documented during the inventory; 2) the species was considered to be relatively uncommon or rare at VAFO; 3) the individual was unique in some fashion (e.g., deformed, marked, etc.); or 4) a large group (arbitrarily, >10 individuals) was encountered. For each species encountered, we recorded number of individuals and means of identification (i.e., via visual observation, aural observation, handling, or sign). All observations occurred between March and October.

Spotlight Surveys

Spotlight surveys entailed driving slowly (≤ 40 km/h [25 mph]) along park roads during nighttime hours and using headlights and a large flashlight to view mammals in or near the roadway. In the absence of physical barriers, such as vegetation or fog, the flashlight was capable of illuminating mammals located ≥ 100 m (328 ft) from the roadway. Although any mammalian species occurring at the ground surface near a roadway could be detected during a spotlight survey, we expected the method to most frequently yield encounters of larger mammals that are active at night (e.g., white-tailed deer, coyote, red fox, gray fox, common raccoon, striped skunk, Virginia opossum, and cottontails).

We recorded route and mileage (km) traveled for each survey. For each species encountered, we noted number of individuals and distance from the road. Nine spotlight surveys were conducted between 17:50 and 0:35 EST from March–October, traversing a total of 117 km (73 mi). The survey route at the Schwoebel tract ($n = 3$ surveys) consisted of a 0.3-km (0.2-mi) driveway through the interior of the tract. Survey routes elsewhere at VAFO ($n = 6$ surveys) were variable and ranged from 10.5–26.7 km (6.5–16.6 mi).

Live-trapping

We used live-trapping from June–October for the purpose of documenting species not already encountered during the ARS and Schwoebel inventory projects (Yahner et al. 2006a, 2006b) or via opportunistic observations and spotlight surveys during this project. Species that we attempted to trap were termed “target species” and consisted of eastern fox squirrel, feral cat, house mouse, mink, smoky shrew, southern bog lemming, southern flying squirrel, and weasels (ermine and long-tailed weasel). Eastern mole, hairy-tailed mole, star-nosed mole, least shrew, deer mouse, southern red-backed vole, and woodland vole were candidates to be listed as target species, but they were excluded from the list because intensive trapping efforts in grasslands and successional forest during the ARS and Schwoebel inventory projects (Yahner et al. 2006a, 2006b) were just as likely to detect presence of those species as live-trapping elsewhere in the park. Species that generally are very difficult to live-trap (e.g., American beaver, muskrat, gray fox) also were excluded from the list of target species. Appalachian cottontail, formerly known as New England cottontail in Pennsylvania (Chapman et al. 1992), was a candidate to be listed as

a target species. We were unable to locate preferred habitat of this rabbit (i.e., high-elevation forest with lush herbaceous groundcover; Merritt 1987) at VAFO and, therefore, excluded Appalachian cottontail from the list of target species on the basis that species-specific sampling points could not be established. However, Appalachian cottontail was sampled indirectly via live-trapping because it potentially could be captured in traps placed at sampling points for other species.

Sampling points ($n = 29$; Figure 3) were established at locations where target species were most likely to occur in the park, based on habitat requirements of those species. Feral cat was not a predicted species (Table 1), but we designated it a target species because we documented opportunistic observations of cats in the southeast sector of the park (at MT-V-028; Figure 3) during August 2004 and could not determine whether the individuals were domestic or feral without closer inspection (e.g., for presence of a collar). House mice live in close association with humans and may occur in houses, barns, or other buildings where food is stored (Merritt 1987). Although buildings are present at the ARS and the Schwoebel tract, they may not provide ideal habitat for house mice because the buildings are not used by humans as living quarters and, therefore, probably do not provide substantial sources of heat or food. Hence, we designated house mouse as a target species and sampled at a building (MT-V-023; Figure 3) that served as living quarters for people. In addition, we sampled the yard surrounding the building for southern flying squirrels because of an unconfirmed report of flying squirrels living in an adjacent (≤ 25 m [82 ft]) building during 2003. Based on habitat preferences (Burt and Grossenheider 1980; Merritt 1987), trapping results at other national parks in Pennsylvania (Yahner et al. 2004), and absence of preferred habitats in the ARS and the Schwoebel tract, we sampled wet meadows for southern bog lemmings, the shoreline of Valley Creek for mink, and mature forest for smoky shrews, southern flying squirrels, and weasels (Figure 3). Sampling for smoky shrews occurred on a rocky hillside with relatively well-developed leaf litter, sampling for southern flying squirrels occurred near (≤ 100 m [328 ft]) potential nesting sites (i.e., trees with cavities) or locations of unconfirmed sightings, and sampling for weasels tended to occur near (≤ 50 m [164 ft]) water. In addition, three points (MT-V-025, MT-V-026, and MT-V-027; Figure 3) were established at the Schwoebel tract for sampling weasels because of a sighting of an unidentified weasel there by J. E. K. during August 2004. Eastern fox squirrels occur in open woods and forest edges (Merritt 1987), so sampling points established in wooded areas for southern flying squirrels and weasels were used for fox squirrels, as well (Figure 3).

Three types of traps were used: small ($17.3 \times 6.4 \times 5.1$ cm [$6.8 \times 2.5 \times 2.0$ in]) Sherman live-traps, medium ($13 \times 13 \times 41$ cm [$5 \times 5 \times 16$ in]) Tomahawk live-traps, and large ($26 \times 32 \times 81$ cm [$10 \times 12 \times 32$ in]) Tomahawk live-traps. Sherman traps were baited with peanut butter, and Tomahawk traps were baited with ground beef, tuna, or balls of peanut butter and oats. Sherman traps were used to capture mammals that were the size of eastern chipmunk or smaller (e.g., mice, voles, young rats), medium Tomahawk traps were used to capture mammals between the size of eastern chipmunk and striped skunk, and large traps were used to capture mammals the size of rabbits or larger. Peanut butter and oats were expected to attract rodents and omnivores; whereas, ground beef and tuna were expected to attract carnivores and scavengers.

Sampling effort varied for each target species (Table 3) and was based largely on logistical compatibility with concurrent research activities (Yahner et al. 2006a, 2006b) at VAFO. At each

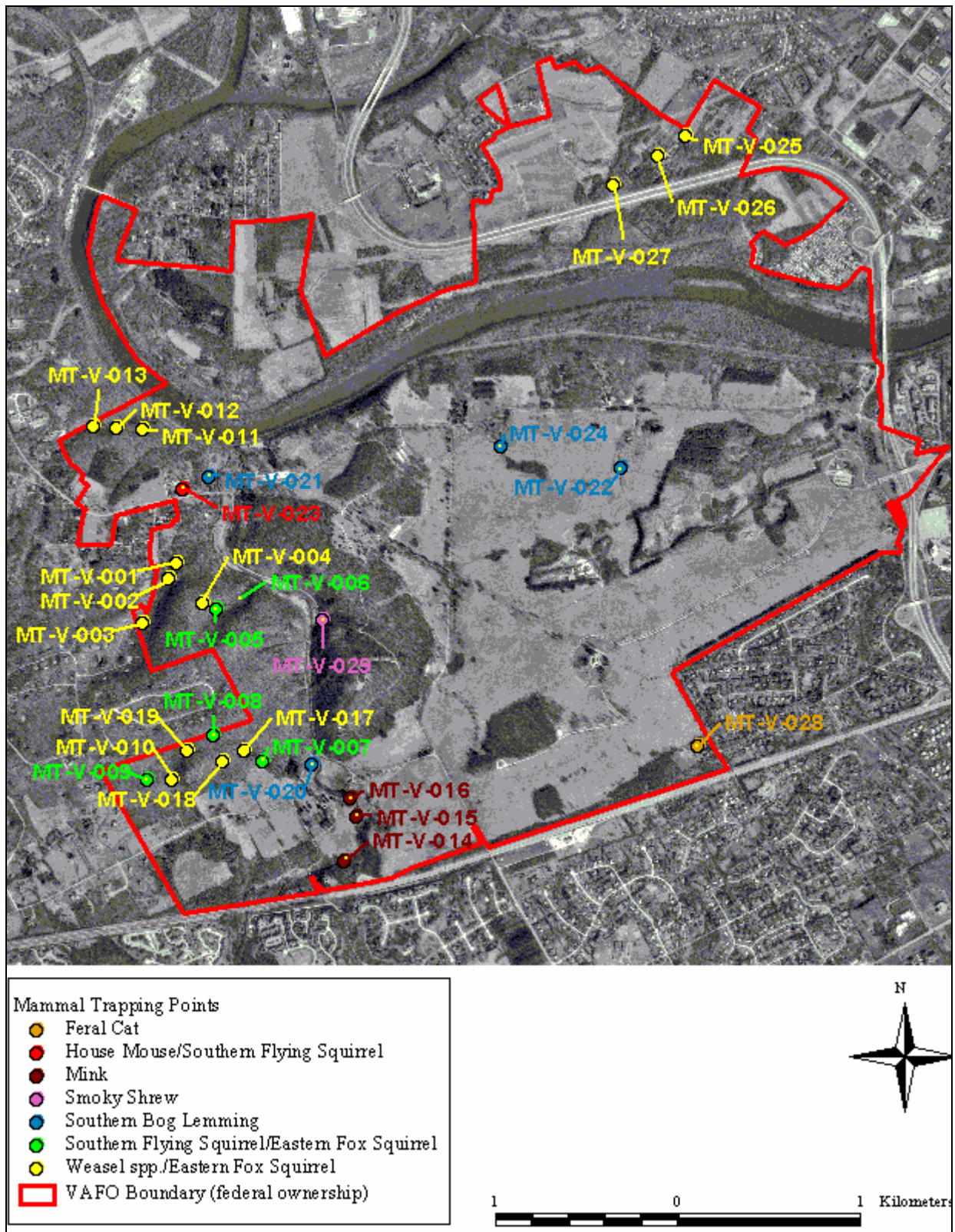


Figure 3. Sampling points established for live-trapping of target species during the parkwide inventory of mammals at Valley Forge National Historical Park (VAFO), Pennsylvania, 2004. Points are categorized by target species, with each point given a unique identification sequence.

Table 3. Sampling effort for live-trapping of target species during the inventory of mammals at Valley Forge National Historical Park, Pennsylvania, 2004.

Target Species	No. Sampling Points ^a	No. Trap Nights ^b
eastern fox squirrel	19	190
feral cat	1	3
house mouse	1	6
mink	3	18
smoky shrew	1	120
southern bog lemming	4	210
southern flying squirrel	6	111
weasel spp.	14	112

^aNumber of sampling points established specifically for the purpose of capturing the target species.

^bTrap night = one trap set over one night.

sampling point, 1–30 traps were placed for a period of 1–6 days consecutively; traps were placed at some points for multiple periods. Number and type of traps, number of trapping periods, and length (days) of trapping periods at each sampling point were chosen arbitrarily because effectiveness of trapping efforts was difficult to determine. For instance, several factors can influence trapping success: 1) general degree of difficulty in live-trapping a particular target species; 2) likelihood that a target species occurs at or near a sampling point; 3) disturbance of traps by non-target species; and 4) weather conditions. The third factor was particularly problematic during this inventory, as baits placed in medium Tomahawk traps set for southern flying squirrels, weasels, or eastern fox squirrels often were stolen by mammals presumably too small to trigger the trap (e.g., white-footed mice). Conversely, Sherman traps and medium Tomahawk traps were triggered by mammals that attempted to take the baits but presumably were too large to enter the traps (e.g., common raccoons). To remedy these problems, we placed all types of traps at some sampling points in an attempt to capture common raccoons and white-footed mice and, hence, prevent them from disturbing traps set for other species.

When we used more than one trap at a sampling point that included a Tomahawk trap, we usually spaced individual traps 1–5 m (3–16 ft) apart. However, when we used only Sherman traps to sample a particular species (e.g., southern bog lemming or smoky shrew), we placed traps at 10-m (33-ft) intervals along one or two transects centered on the sampling point. We placed all traps on the ground for target species other than eastern fox squirrel, southern flying squirrel, and house mouse. For squirrels, we placed some traps 0.5–1.5 m (1.6–4.9 ft) off the ground on large logs or fallen trees at sampling points MT-V-005, MT-V-006, MT-V-007, and MT-V-009 (Figure 3). Additionally, we placed traps approximately 5 m (16 ft) off the ground on the bole of an uprooted and leaning tree at MT-V-008, on the main stem of a treetop that had broken off and become lodged in the crotch of a forked tree at MT-V-009, and on the roof of the Hayman House at MT-V-023 (Figure 3). For house mouse, we placed traps throughout the Hayman House at MT-V-023.

Trapping conducted as part of the ARS and Schwoebel inventories (Yahner et al. 2006a, 2006b) occurred during two trapping sessions (summer and fall) for each inventory and consisted of

Sherman live-traps (13×13×41 cm [5×5×16 in]) baited with peanut butter and set at 10-m (33-ft) intervals along transects of varying length. Traps were set at each transect for one night per session, resulting in totals of 289, 100, and 230 trap nights (trap night = one trap set over one night) in Areas of Concern, reference plots, and the Schwoebel tract, respectively (Yahner et al. 2006a, 2006b). Numbers of trap nights were distributed proportionally to area (ha) of each cover type present at the study areas.

Traps were checked daily during all three inventories, and animals captured were identified to species and released at the point of capture (except for feral cats, which were left in the care of park personnel). When possible, we recorded age class (newborn, juvenile, adult) and sex class of individuals captured.

Data Storage

Spatial Data

We used a global positioning system (GPS) unit (Trimble ProXR) owned by the park to identify locations of sampling points. We stored GPS locations electronically as GIS shapefiles and used those files in combination with files previously provided by park personnel to create GIS data layers containing the post-processed locations. We created all layers using ArcView GIS software (ESRI 2000). Electronic copies of spatial data sets and FGDC compliant metadata have been submitted to the park.

Non-Spatial Data

All survey data were stored electronically in MS Excel spreadsheets and in an MS Access database. We created a database whose format is compatible with that of existing park databases. The database and associated metadata have been submitted to the park.

Data Analysis

We summarized number of individual encounters (an individual encounter equals one animal or its sign observed at a particular time) of mammals with respect to species richness, distribution (by study area and cover type), and protocol. Summaries included all mammalian data recorded during the ARS and Schwoebel inventory projects (Yahner et al. 2006a, 2006b). We did not mark animals, so number of individual encounters does not necessarily equate to number of individual animals observed.

Voucher Specimens

We did not collect voucher specimens. At the onset of the inventory, our goal was to photograph at least one individual for each species encountered. However, because of difficulty in subduing mammals for photographs, and for logistical reasons, we photographed only three species. Digital copies (JPEG files) of all voucher photos have been submitted to the park. Copies of JPEG files are stored at the School of Forest Resources, The Pennsylvania State University (contact: Dr. Richard H. Yahner).

Results

We documented 1,124 encounters of 21 mammalian species at VAFO (Tables 4 and 5). Records comprised five encounters of didelphids ($n = 1$ species), 34 encounters of insectivores ($n = 2$ species), five encounters of bats ($n = 1$ species), five encounters of lagomorphs ($n = 1$ species), 369 encounters of rodents ($n = 9$ species), 71 encounters of carnivores ($n = 6$ species, including unidentified *Mustela* sp.), and 635 encounters of artiodactyls ($n = 1$ species; Table 4). Some individuals were not identified to species because only a field sign was observed or because a complete view or handling of an individual was unattainable. Such observations are classified as “unidentified species” and included four encounters of bats (genus unknown), 10 encounters of mice (*Peromyscus* sp.), one encounter of a squirrel (genus unknown), three encounters of voles (genus unknown), seven encounters of fox (genus unknown), and one encounter of a weasel (*Mustela* sp.; Table 4). The three most commonly encountered species were white-tailed deer ($n = 635$ encounters), white-footed mouse ($n = 209$), and meadow vole ($n = 97$; Table 4).

Based on our review of the NPSpecies database (NPS 2004), three species represent new records at VAFO: big brown bat, coyote, and feral cat. The unidentified weasel (ermine or long-tailed weasel) would have been a new record, but the encounter of this individual was very brief (three sec) and is considered an unconfirmed sighting.

We encountered more individuals in lawn ($n = 405$ encounters) than in other cover types, but only three species (common raccoon, red fox, and white-tailed deer) were observed in lawn cover, and almost all of those encounters ($n = 391$) were of deer during spotlight surveys (Table 6). Most other encounters occurred in grassland ($n = 318$ encounters; 10 species) and successional ($n = 194$ encounters; 15 species) cover, followed by old nursery ($n = 69$ encounters; 12 species), forest ($n = 64$ encounters; 8 species), developed ($n = 41$ encounters; 11 species), wet meadow ($n = 29$ encounters; 1 species), water ($n = 3$ encounters; 2 species), and ornamental grove ($n = 1$ encounter; 1 species; Table 6).

We encountered more individuals via spotlight surveys ($n = 494$ encounters) than by any other protocol, but spotlight surveys yielded observations of only four species (woodchuck, common raccoon, red fox, and white-tailed deer), and the protocol did not account for any species that were not detected by other means (Table 7). In contrast, opportunistic observations yielded 310 encounters of 20 species, including nine species (masked shrew, big brown bat, eastern cottontail, meadow jumping mouse, Norway rat, red squirrel, coyote, striped skunk, and a weasel [ermine or long-tailed weasel]) that were not encountered by any other protocol (Table 7). Live-trapping yielded 320 encounters of nine species, including one species (southern flying squirrel) that was not encountered by any other protocol (Table 7).

Species Encountered During the Inventory

Here, we present details (e.g., locations of observations, evidence of reproduction) regarding encounters of each species. Age classes of observed individuals are given only when adults were distinguished from juveniles, or when newborns were observed. Such statistics are not indicative of age structure of a population, but they may be evidence of breeding activity at the park.

Table 4. Species and number of individual encounters recorded during the inventory of mammals at Valley Forge National Historical Park, Pennsylvania, 2004.

Species Common Name	Total No. Encounters ^a
Didelphids	
Virginia opossum	5
Insectivores	
masked shrew	16
northern short-tailed shrew	18
Bats	
big brown bat	1
unidentified bat species	4
Lagomorphs	
eastern cottontail	5
Rodents	
eastern chipmunk	8
gray squirrel	25
meadow jumping mouse	1
meadow vole	97
Norway rat	1
red squirrel	3
southern flying squirrel	1
white-footed mouse	209
woodchuck	10
unidentified mouse species	10
unidentified squirrel species	1
unidentified vole species	3
Carnivores	
common raccoon	24
coyote	1
feral cat	7
red fox	30
striped skunk	1
unidentified fox species	7
unidentified weasel species	1
Artiodactyls	
white-tailed deer	635
Total no. encounters	1,124
Total no. species	21

^aEncounter = individual animal or its sign observed at a particular time; animals were not marked, so totals may include multiple observations of some individuals.

Table 5. Species and number of individual encounters^a (by study area) recorded during the inventory of mammals at Valley Forge National Historical Park, Pennsylvania, 2004.

Species Common Name	AOC ^b	REF ^c	SCHW ^d	VAFO ^e	Total
Didelphids					
Virginia opossum			2	3	5
Insectivores					
masked shrew		12	4		16
northern short-tailed shrew	12	5	1		18
Bats					
big brown bat				1	1
unidentified bat species	1		2	1	4
Lagomorphs					
eastern cottontail	1	1	3		5
Rodents					
eastern chipmunk		1		7	8
gray squirrel	15	3	6	1	25
meadow jumping mouse			1		1
meadow vole	30	26	10	31	97
Norway rat				1	1
red squirrel	2	1			3
southern flying squirrel				1	1
white-footed mouse	88	28	44	49	209
woodchuck	6	1	2	1	10
unidentified mouse species	2	2	6		10
unidentified squirrel species	1				1
unidentified vole species	1	1	1		3
Carnivores					
common raccoon	4	4	2	14	24
coyote	1				1
feral cat			1	6	7
red fox	3	2	10	15	30
striped skunk				1	1
unidentified fox species	6	1			7
unidentified weasel species			1		1
Artiodactyls					
white-tailed deer	148	13	5	469	635
Total no. encounters	321	101	101	601	1,124
Total no. species	12	12	15	14	21

^aEncounter = individual animal or its sign observed at a particular time; animals were not marked, so totals may include multiple observations of some individuals.

^bAreas of Concern, from the Asbestos Release Site inventory project (Yahner et al. 2006a).

^cReference plots, from the Asbestos Release Site inventory project (Yahner et al. 2006a).

^dSchwoebel tract, from the Schwoebel inventory project (Yahner et al. 2006b).

^eOther locations within Valley Forge National Historical Park.

Table 6. Species and number of individual encounters (by cover type) recorded during the inventory of mammals at Valley Forge National Historical Park, Pennsylvania, 2004.

Species	Cover Type	Total No. Encounters ^a
Virginia opossum	developed	3
	forest	1
	old nursery	1
masked shrew	developed	1
	grassland	11
	old nursery	1
	successional	3
northern short-tailed shrew	forest	1
	grassland	7
	old nursery	1
	successional	9
big brown bat	developed	1
unidentified bat species	developed	1
	grassland	1
	successional	2
eastern cottontail	old nursery	2
	successional	3
eastern chipmunk	forest	7
	successional	1
gray squirrel	developed	3
	forest	1
	old nursery	4
	successional	17
meadow jumping mouse	old nursery	1
meadow vole	grassland	60
	old nursery	6
	successional	2
	wet meadow	29
Norway rat	developed	1
red squirrel	successional	3
southern flying squirrel	forest	1
white-footed mouse	developed	5
	forest	45
	grassland	16
	old nursery	43
	successional	100
woodchuck	developed	2
	grassland	2
	successional	6
unidentified mouse species	old nursery	6
	successional	4
unidentified squirrel species	successional	1
unidentified vole species	old nursery	1
	successional	2

Table 6. Species and number of individual encounters (by cover type) recorded during the inventory of mammals at Valley Forge National Historical Park, Pennsylvania, 2004 (continued).

Species	Cover Type	Total No. Encounters ^a
common raccoon	developed	4
	forest	7
	grassland	3
	lawn	2
	old nursery	1
	successional	5
	water	2
coyote	successional	1
feral cat	developed	5
	forest	1
	grassland	1
red fox	developed	11
	grassland	4
	lawn	12
	old nursery	1
	successional	2
striped skunk	successional	1
unidentified fox species	grassland	3
	successional	4
unidentified weasel species	old nursery	1
white-tailed deer	developed	3
	grassland	210
	lawn	391
	old nursery	1
	ornamental grove	1
	successional	28
	water	1
All species combined	developed	41
	forest	64
	grassland	318
	lawn	405
	old nursery	69
	ornamental grove	1
	successional	194
	water	3
	wet meadow	29
Total no. encounters	all types	1,124
Total no. species	all types	21

^aEncounter = individual animal or its sign observed at a particular time; animals were not marked, so totals may include multiple observations of some individuals.

Table 7. Species and number of individual encounters (by protocol) recorded during the inventory of mammals at Valley Forge National Historical Park, Pennsylvania, 2004.

Species	Protocol	Total No. Encounters ^a
Virginia opossum	opportunistic observation	2
	live-trapping	3
masked shrew	opportunistic observation	16
northern short-tailed shrew	opportunistic observation	7
	live-trapping	11
big brown bat	opportunistic observation	1
unidentified bat species	opportunistic observation	4
eastern cottontail	opportunistic observation	5
eastern chipmunk	opportunistic observation	1
	live-trapping	7
gray squirrel	opportunistic observation	24
	live-trapping	1
meadow jumping mouse	opportunistic observation	1
meadow vole	opportunistic observation	19
	live-trapping	78
Norway rat	opportunistic observation	1
red squirrel	opportunistic observation	3
southern flying squirrel	live-trapping	1
white-footed mouse	opportunistic observation	1
	live-trapping	208
woodchuck	opportunistic observation	9
	spotlight survey	1
unidentified mouse species	opportunistic observation	10
unidentified squirrel species	opportunistic observation	1
unidentified vole species	opportunistic observation	3
common raccoon	opportunistic observation	10
	spotlight survey	4
	live-trapping	10
coyote	opportunistic observation	1
feral cat	opportunistic observation	6
	live-trapping	1
red fox	opportunistic observation	14
	spotlight survey	16
striped skunk	opportunistic observation	1
unidentified fox species	opportunistic observation	7
unidentified weasel species	opportunistic observation	1
white-tailed deer	opportunistic observation	162
	spotlight survey	473
All species combined	opportunistic observation	310
	spotlight survey	494
	live-trapping	320
Total no. encounters	all protocols	1,124
Total no. species	all protocols	21

^aEncounter = individual animal or its sign observed at a particular time; animals were not marked, so totals may include multiple observations of some individuals.

Didelphids

Virginia Opossum: We recorded five encounters of Virginia opossums, including two dead juveniles on the driveway at the Schwoebel tract. Additionally, we trapped one adult opossum each at sampling points MT-V-003, MT-V-023, and MT-V-025 (Figure 3).

Insectivores

Masked Shrew: We recorded 16 encounters of masked shrews; all encounters were via incidental observations. We encountered 12 individuals at reference plots and four individuals at the Schwoebel tract. One of the observations at a reference plot was a nest with four young. All other observations were of individuals presumed to be adults, based on body size (length and mass). Most observations occurred in grassland cover, but some masked shrews were encountered in successional, old nursery, and developed cover types (Table 6).

Northern Short-tailed Shrew: We recorded 18 encounters of northern short-tailed shrews distributed among Areas of Concern, reference plots, and the Schwoebel tract (Table 5). The species was encountered primarily in successional and grassland cover types, but one individual each was observed in forest and old nursery cover types (Table 6). All individuals encountered were presumed to be adults, based on body size (length and mass).

Bats

Big Brown Bat: We recorded one confirmed encounter of a big brown bat, which represents a new record at VAFO (NPS 2004). The individual was observed behind a shutter of a building next to Washington's Headquarters (near MT-V-021; Figure 3) and subsequently captured by hand for identification purposes. In addition, we suspect that at least several encounters of unidentified bats (Table 5) were big brown bats (based on size of the individuals observed).

Lagomorphs

Eastern Cottontail: We noted eastern cottontails on five occasions; all encounters were via opportunistic observations. We observed this species at Areas of Concern, reference plots, and the Schwoebel tract (Table 5). All individuals were presumed to be adults, based on visual estimation of body size.

Rodents

Eastern Chipmunk: We recorded eight encounters of eastern chipmunks, with all but one occurring via live-trapping in the forest cover type (Tables 6 and 7). Most individuals were captured at sampling points MT-V-002, MT-V-003, MT-V-006, MT-V-014, and MT-V-018 (Figure 3), but one was observed incidentally at a reference plot.

Gray Squirrel: We recorded 25 encounters of gray squirrels distributed throughout the park (Table 5) among successional, old nursery, developed, and forest cover types (Table 6). We noted nests in Areas of Concern and a family unit (adult with juveniles) at the Schwoebel tract.

Meadow Jumping Mouse: We encountered one meadow jumping mouse via an opportunistic observation near the southwestern sector of the Schwoebel tract (Figure 2). The observation occurred in the old nursery cover type.

Meadow Vole: Meadow vole was the third most frequently encountered ($n = 97$ encounters) species during our inventory and was observed in grassy habitats throughout the park (Tables 5 and 6). We noted an additional three observations of voles that could not be captured for identification purposes. We believe those individuals were meadow voles because we did not confirm presence of other vole species during the inventory, and the observations occurred in or near grassy habitats. We observed all age classes (newborn, juvenile, adult) of meadow voles, including pregnant individuals.

Norway Rat: The last confirmed observation of Norway rat at VAFO occurred in 1979 (McKeever 1979; NPS 2004). We found a dead Norway rat in a barn at MT-V-028 (Figure 3), but extreme desiccation of the individual suggested that it had died months or years prior to our discovery. The barn had been used to house domesticated animals (e.g., horses) prior to the onset of our inventory, and we observed that a local resident was placing bowls of food (e.g., commercial cat food and chicken) for feral cats in the barn on a regular basis during 2004. Therefore, the barn may have provided suitable sources of food or shelter for Norway rats. We did not observe evidence of the species elsewhere in the park during the inventory.

Red Squirrel: We recorded three encounters of red squirrels distributed among Areas of Concern and reference plots (Table 5). We suspect that an additional observation of an unidentified squirrel at night was a red squirrel, based on vocalization of the observed individual. All encounters occurred in successional habitat.

Southern Flying Squirrel: Although we received several reports of flying squirrels occurring inside buildings within the park boundary during the past several years, and we set live-traps for flying squirrels at six sampling points (Figure 3) for a total of 111 trap nights (Table 3), we observed only one individual. Ironically, the individual was captured in a Sherman trap set for smoky shrews at sampling point MT-V-029 (Figure 3) on the last day of the inventory project.

White-footed Mouse: White-footed mouse was the second most frequently encountered ($n = 209$ encounters) species and occurred throughout the park (Tables 4 and 5). We noted an additional 10 observations of mice that could not be captured for identification purposes. We believe those individuals were white-footed mice because we did not confirm presence of other *Peromyscus* during the inventory. We observed all age classes (newborn, juvenile, adult) of white-footed mice, including newborn young in nests. Most encounters occurred in successional, old nursery, and forest cover types, but white-footed mice occurred also in grassland and developed cover types (Table 6).

Woodchuck: We recorded 10 encounters of woodchucks throughout the park (Tables 5), not including dozens of observations of burrows that may have been created by the species. Almost all encounters were opportunistic observations (Table 7). Of particular note was an individual that resided underneath the front porch of the Hayman House (MT-V-023; Figure 3) for the duration of the inventory. Woodchucks occurred also in grassland and successional cover types (Table 6). All individuals were presumed to be adults, based on visual estimation of body size.

Carnivores

Common Raccoon: We recorded 24 encounters of common raccoons distributed among seven cover types throughout the park (Tables 5 and 6), including 10 individuals that were captured at sampling points MT-V-001, MT-V-007, MT-V-014, MT-V-015, MT-V-019, MT-V-023, and MT-V-027 (Figure 3). We observed both juveniles and adults.

Coyote: We recorded one observation of coyote sign (scat in the “Maintenance Area Ruins” Area of Concern; see Yahner et al. 2006a) during the inventory, which represents a new record at the park (NPS 2004). Shortly afterwards, we received a report that an adult coyote was seen in the general vicinity of our observation (M. Carfioli, VAFO Ecologist, pers. comm., 2004).

Feral Cat: We recorded seven encounters of cats during the inventory; all individuals were presumed to be adults, based on visual estimation of body size. One of the seven observations occurred just within the northern boundary of the Schwoebel tract (Table 5; Figure 2) and probably was a pet of a local resident, as the cat was observed frequently in a residential area just outside the park boundary and appeared to be tame. A second observation occurred near sampling point MT-V-016 (Figure 3) and also may have been a pet animal, given that behavior of the individual was similar to that of the cat observed at the Schwoebel tract. However, the remaining five observations, which occurred at MT-V-028 (Figure 3), were two or three individuals that we believed to be truly feral. We observed those individuals in and around the same barn where we encountered the Norway rat, but they fled whenever we approached for closer observation. We eventually captured one individual inside the barn via live-trapping; the individual did not have a collar or identification tag, so it was presumed to be feral and a new record at the park (NPS 2004).

Red Fox: We recorded 30 encounters of red fox in lawn, developed, grassland, successional, and old nursery cover types throughout the park (Tables 5 and 6). One individual at the Schwoebel tract resembled the grayish-colored cross phase described by Burt and Grossenheider (1980). We recorded an additional six observations of fox sign and one observation of a fox that could not be identified to species because we could not get a complete view of the individual (the individual was either a cross-phase red fox or a gray fox). We observed an adult red fox carrying food to a den located within the interior of the Schwoebel tract, and we observed pups at the Schwoebel tract and elsewhere within the park boundary.

Striped Skunk: Our only encounter of a striped skunk was a pile of fur at the edge of a field in the extreme southwestern corner of the park.

Unidentified Weasel: After walking around the corner of a shed at the Schwoebel tract on 27 August, J. E. K. briefly (3 sec) observed an unidentified mammal. Based on size, color, and gait of the animal, we believe the individual was either an ermine or long-tailed weasel. Subsequent trapping efforts (15 trap nights among three sampling points) at the Schwoebel tract were unsuccessful in capturing the individual.

Artiodactyls

White-tailed Deer: We recorded 635 encounters of white-tailed deer distributed among seven cover types throughout the park (Tables 5 and 6). Most encounters ($n = 473$) were recorded

during spotlight surveys (Table 7). We observed both adults and fawns. Further details about ecology of white-tailed deer at VAFO are discussed by Lovallo and Tzilkowski (2003).

Discussion

Species Encountered During the Inventory

We documented presence of three species (big brown bat, coyote, and feral cat) for which previously confirmed records at VAFO did not exist (NPS 2004). Results of our inventory also updated confirmed records in the NPSpecies database (NPS 2004) for three species (Norway rat, red squirrel, and southern flying squirrel), which were last documented by McKeever (1979), four species (Virginia opossum, northern short-tailed shrew, masked shrew, and meadow jumping mouse) that were last documented by Cypher et al. (1985), nine species (eastern cottontail, eastern chipmunk, gray squirrel, meadow vole, white-footed mouse, woodchuck, common raccoon, red fox, and striped skunk) that were documented by Yahner et al. (1997), and one species (white-tailed deer) that was documented by Lovallo and Tzilkowski (2003).

In addition to producing updated records of mammals at VAFO, our inventory increased knowledge about: 1) presence of particular species at VAFO; 2) sectors and cover types of the park where those species can be found; and 3) sampling protocols that may be effective for future monitoring of the species. However, we caution that our results are limited in their usefulness for estimating other population parameters (e.g., relative abundance, absolute abundance, density) because our sampling design consisted mainly of opportunistic observations and non-standardized methods of spotlight-surveying and live-trapping. Factors that limit application of our data include possible double-counting of individuals, differences in detection probability among species, and no assurance that proportions of populations detected over time and space were consistent (Conroy 1996).

A portion of our results (those from the ARS and Schwoebel inventories [Yahner et al. 2006a, 2006b]) was derived from standardized methods of trapping small mammals, so we have some basis for speculating about abundance of certain species. In addition, evidence of breeding activity, combined with observations of particular species during multiple times of year or of species with relatively small home ranges, allowed us to speculate on residency of some species within the park. Herein, we suggested residency and abundance classifications of mammalian species encountered at VAFO, based on survey data, other incidental observations, general ecology of each species, and definitions used by the NPSpecies database (Wotawa 2004; Appendix B).

Residency

Evidence of breeding activity (e.g., nests) and observations of newborn young or juveniles indicated that Virginia opossum, masked shrew, gray squirrel, meadow vole, white-footed mouse, common raccoon, red fox, and white-tailed deer reproduce in the park and should be given the residency status of “Breeder” (Appendix B). We suggest that northern short-tailed shrew and eastern chipmunk also be classified as “Breeder” because the species have small home ranges (Burt and Grossenheider 1980; Merritt 1987). Hence, presence of multiple individuals in interior portions of the park is evidence of breeding populations because of limited dispersal ability. Eastern cottontail, meadow jumping mouse, southern flying squirrel, and woodchuck

probably breed in the park, but our inventory did not document evidence of breeding by these species.

We suggest “Resident” status (Appendix B) for eastern cottontail, red squirrel, southern flying squirrel, woodchuck, and feral cat, based on locations and timing of encounters, availability of suitable habitat, and size of home ranges (Burt and Grossenheider 1980; Merritt 1987).

Although we observed only one southern flying squirrel, the species is relatively difficult to detect, and we received several reports of the species nesting in buildings within the park and in bird houses on the park boundary. Big brown bat, meadow jumping mouse, and striped skunk are probably resident species, but our data were insufficient evidence to make that conclusion.

Based on our data and ecology of the following species, we suggest “Unknown” status (Appendix B) for big brown bat, meadow jumping mouse, Norway rat, coyote, ermine, long-tailed weasel, and striped skunk. The park is not outside the usual range for any of these species, but our data are insufficient to conclude that significant populations are maintained at VAFO. Big brown bat may be “Migratory” (Appendix B; Burt and Grossenheider 1980), but we cannot make that conclusion. Meadow jumping mouse was encountered only once, and the observation occurred near the northern edge of the park. Likewise, we observed coyote sign only once, and the species has a large home range (800–8,000 ha [1,977–19,768 ac]; Merritt 1987), so we cannot conclude that a population occurs at VAFO. Our lone observation of a Norway rat was a dead individual, but condition of the remains was not such that we could conclude the individual had been alive within the past several years. We encountered striped skunk only once, but the observation was of remains only, and it occurred near the park boundary. Our unconfirmed sighting of an ermine or a long-tailed weasel is not sufficient evidence to conclude that either species maintains a population at VAFO.

Abundance

Our results suggest that meadow vole, white-footed mouse, and white-tailed deer should be classified as “Abundant” at VAFO because the species can be found year round and in relatively large numbers at suitable habitats throughout the park (Appendix B). We suggest a minimum status of “Common” (Appendix B) for masked shrew, northern short-tailed shrew, eastern cottontail, eastern chipmunk, gray squirrel, woodchuck, common raccoon, and red fox, based on number, frequency, and distribution of observations. For example, we did not encounter masked or northern short-tailed shrews frequently, but they are relatively difficult to detect, were distributed throughout the park, and tend to have high reproductive rates (Merritt 1987). Hence, our encounters are suggestive of well-established populations of these shrews.

Virginia opossum, red squirrel, feral cat, and striped skunk are relatively easy to detect by our sampling methods (J. E. K., pers. obs.), so our few observations of these species suggest they should be classified as “Uncommon” to “Rare” (Appendix B). Coyote signs (e.g., scat) are relatively easy to detect when individuals use an area continually (J. E. K., pers. obs.), but we observed sign only once and, therefore, suggest that coyote be classified as “Rare.”

Big brown bat, meadow jumping mouse, and southern flying squirrel are difficult to detect by the sampling methods we used (J. E. K., pers. obs.); we conservatively estimate abundance of those species as “Unknown” (Appendix B) because abundance could range from “Rare” to

“Common.” Our observation of a dead Norway rat and unconfirmed sighting of an ermine or long-tailed weasel are not sufficient evidence to conclude that either species is present in the park, so we suggest a classification of “Unknown” for these species.

Species Not Encountered During the Inventory

We did not document confirmed sightings of 27 species on our list of 46 predicted mammals. Species not encountered included five insectivores (eastern mole, hairy-tailed mole, least shrew, smoky shrew, and star-nosed mole), nine bats (eastern pipistrelle, evening bat, hoary bat, northern myotis, little brown myotis, red bat, Seminole bat, silver-haired bat, and small-footed myotis), one lagomorph (Appalachian cottontail), eight rodents (American beaver, common muskrat, deer mouse, eastern fox squirrel, house mouse, southern bog lemming, southern red-backed vole, and woodland vole), and four carnivores (ermine, long-tailed weasel, mink, and gray fox). There are historical records of confirmed sightings of only four of those species (star-nosed mole, common muskrat, deer mouse, and house mouse) at VAFO prior to our inventory (NPS 2004). Although the NPSpecies database does not list classifications of residency or abundance for species not listed as “Present” in a park (Wotawa 2004), we discuss below whether we believe species not encountered during our inventory are absent at VAFO or were missed by our surveys.

Insectivores

Moles: According to the NPSpecies database (NPS 2004), the only record of a mole species at VAFO is an observation of a star-nosed mole (Cypher et al. 1985). Anecdotally, star-nosed moles were observed in the basement of a building at VAFO as recently as the late 1990s (M. Carfioli, VAFO Ecologist, pers. comm., 2004). Moles are difficult to sample because they are subterranean. Potentially, moles active at the ground surface would have been subject to capture via >1,300 trap nights throughout the park during our inventory. We did not encounter sign of burrowing activity by moles, but such sign could be missed easily because not all parts of the park were visited regularly. Therefore, we do not have sufficient data to conclude that eastern, hairy-tailed, and star-nosed moles are absent at VAFO. However, if present, they likely are uncommon or rare.

Shrews: There are no confirmed records of a least shrew at VAFO (NPS 2004). The state rank of the least shrew is listed currently as “S1 – Critically Imperiled,” and the state status is listed as “PE – Pennsylvania Endangered” (PANHP 2006). Least shrews prefer early successional habitats, such as old fields, abandoned pasture, and meadows (Merritt 1987); based on our cover-type map, we estimate that 400–580 ha (988–1,433 ac) of such habitat occurs at VAFO. We set live-traps for a total of 659 trap nights in grassy habitats of Areas of Concern, reference plots, the Schwoebel tract, and other locations at VAFO; however, least shrews are very small (4.0–6.0 g [0.1–0.2 oz]; Merritt 1987) and, therefore, may be difficult to capture via live-trapping. Yet, we recorded 16 encounters of masked shrews via incidental observations, so we would expect to encounter a least shrew opportunistically if the species were as common as masked shrew; hence, we suggest that the least shrew is absent at VAFO.

There are no confirmed records of smoky shrews at VAFO (NPS 2004). Smoky shrews prefer cool, moist forests where rotting logs and rocky outcrops with accumulations of humus and leaf

mold occur (Merritt 1987). We set live-traps for a total of 120 trap nights at MT-V-029 (an area providing such habitat) and 131 trap nights at other locations that might represent suitable habitat for the species. Given our results, we suggest that the smoky shrew is uncommon, rare, or absent at VAFO.

Bats

There were no confirmed records of particular bat species at VAFO prior to our inventory (NPS 2004). A maternity colony of bats (species unknown) occurred in a breezeway at Washington's Headquarters prior to 2004 (M. Carfioli, VAFO Ecologist, pers. comm., 2006), but use of the breezeway by the bats was later discouraged by the park and the colony no longer exists there. However, caves occur in several Areas of Concern in the ARS and might provide suitable habitat for breeding colonies of multiple species of bats. Therefore, we do not speculate on presence or abundance of eastern pipistrelle, evening bat, hoary bat, little brown myotis, northern myotis, red bat, Seminole bat, silver-haired bat, and small-footed myotis at VAFO. The small-footed myotis is listed currently as state threatened in Pennsylvania, and evening and silver-haired bats are proposed for "Candidate Rare" status in the state (PANHP 2006).

Lagomorphs

Appalachian cottontails are listed currently as "SU – state rank currently unrankable due to lack of information or due to substantially conflicting information about status or trends" in Pennsylvania (PANHP 2006). There are no confirmed records of the species at VAFO (NPS 2004). Preferred habitat for the species is dense, high-elevation forest with lush herbaceous groundcover (Merritt 1987; see Chapman et al. 1992), which is virtually non-existent at the park, so the species is probably absent at VAFO.

Rodents

Squirrels: The state rank of eastern fox squirrels in Pennsylvania is "SU – state rank currently unrankable due to lack of information or due to substantially conflicting information about status or trends," and the species is proposed for "Candidate Rare" status in the state (PANHP 2006). The species prefers open deciduous woods or forest edges with a poorly developed understory, especially when such habitat is adjacent to cultivated fields or orchards (Merritt 1987). Based on this description, VAFO seemingly provides ideal habitat for the species. However, behaviors (e.g., foraging near roadsides where lawn and mast trees coincide) of fox squirrels make the species easy to detect (J. E. K., pers. obs.). Furthermore, fox squirrels were sampled during 190 trap nights in appropriate habitat over the course of our inventory. If eastern fox squirrels were present at the park, we should have encountered them numerous times during the inventory. Given our results, and no confirmed records of the species at VAFO (NPS 2004), we suggest that eastern fox squirrels are absent in the park.

Beavers: American beavers occur along rivers, streams, and small lakes that are bordered by stands of trees (Merritt 1987). However, beavers and their signs (e.g., felled trees and resulting stumps, dams, lodges) are relatively conspicuous and should have been observed easily during our inventory if present at the park. Given our results, and that there are no confirmed records of the species at VAFO (NPS 2004), American beavers are probably absent in the park.

Native Rats, Mice, and Voles: We included deer mouse on our predicted list because of the existence of a single record (Gutowski et al. 1995) listed in the NPSpecies database (NPS 2004); however, we are suspicious of that record for several reasons. First, VAFO is outside the range of all subspecies of deer mouse that occur in Pennsylvania (Merritt 1987). Second, the record was an incidental sighting of an individual mouse during a biological survey of Valley Creek, and there is no evidence that the individual was handled. There are several ways to distinguish deer mouse from white-footed mouse (e.g., by measuring proportional length of the tail; Merritt 1987), but all require very close examination and, therefore, handling of animals. Mice were subject to capture during >1,300 trap nights throughout the park in 2004; we handled individual mice >200 times, and all encounters were those of white-footed mice. Therefore, we believe deer mice are either absent or very rare at VAFO.

Southern bog lemmings occur in damp meadows, old-field communities, grassy clearings in forests, and margins of springs (Burt and Grossenheider 1980; Merritt 1987), but there are no confirmed records of the species at VAFO (NPS 2004). We set live-traps for a total of 210 trap nights at four sampling points (MT-V-020, MT-V-021, MT-V-022, and MT-V-024; Figure 3), which were chosen specifically for capturing bog lemmings. An additional 459 trap nights occurred in other areas that may have provided suitable habitat. Therefore, our results suggest that the southern bog lemming is absent or rare at VAFO.

Southern red-backed voles most commonly occur in coniferous, deciduous, and mixed forests having an abundance of mosses and ferns (Merritt 1987), but this type of habitat is rare at VAFO. Woodland voles inhabit old fields, thickets, edges of agricultural land, fencerows, and orchards (Merritt 1987); based on our cover-type map of the park, 33–214 ha (82–529 ac) of such habitat occurs at the park. We set live-traps for a total of 293 trap nights in forest habitat and 461 trap nights in early successional, open woodlot, and woodlot-grassland edge habitats. Given our failure to capture southern red-backed and woodland voles, and that there are no confirmed records of either species at VAFO (NPS 2004), we suggest that both species are absent or rare at the park.

The NPSpecies database (NPS 2004) documents one record of a common muskrat at VAFO (Cypher et al. 1985). The species occurs in marshes, ponds, lakes, and slow-flowing streams (Merritt 1987). Although Valley Creek may provide suitable habitat for muskrats, we walked the shoreline of the creek numerous times and did not observe the species or its sign during our inventory. If present at VAFO, common muskrats are rare or uncommon.

Old World Rats and Mice: The NPSpecies database (NPS 2004) documents one record of house mouse at VAFO (McKeever 1979). House mice typically inhabit houses, barns, granaries, and other anthropogenic structures (Merritt 1987). We observed rodent activity in the walls of Hayman House (MT-V-023; Figure 3) and set live-traps inside the house for a total of six trap nights. In addition to that special effort to capture house mice, we could have expected to capture the species during other trapping efforts ($n = 24$ trap nights) on the roof and in the yard at Hayman House and in and adjacent to abandoned buildings at the Schwoebel tract. Given our results and the absence of a confirmed record of the species since 1979, we suggest that house mouse is absent, rare, or uncommon at VAFO.

Carnivores

Dogs and Foxes: Gray fox prefer deciduous forest with rocky terrain and brushy cover but will utilize meadows, swamps, and abandoned fields on a temporary basis (Merritt 1987). Although rocky terrain is present in forest habitat on Mt. Misery and Mt. Joy, brushy cover (e.g., mountain laurel [*Kalmia latifolia*]) rarely occurs as a thicket that is dense enough to provide meaningful cover. We traversed portions of Mt. Misery numerous times but did not observe sign of wild canids. Given our results, and that there are no confirmed records of gray fox at VAFO (NPS 2004), the species probably does not occur at the park more than occasionally, if at all.

Weasels: There are no confirmed records of ermine, long-tailed weasel, or mink at VAFO (NPS 2004). Ermine usually inhabit open woodlands and brushy thickets, and long-tailed weasels inhabit interior and edge portions of mature forests, farm woodlands, and marshes (Merritt 1987). Although J. E. K. observed what appeared to be an ermine or long-tailed weasel at the Schwoebel tract, the sighting was too brief to be considered a reliable record. We set live-traps for a total of 112 trap nights at 14 sampling points (MT-V-001 through MT-V-004, MT-V-010 through MT-V-013, MT-V-017 through MT-V-019, and MT-V-025 through MT-V-027; Figure 3) established specifically for capturing ermine and long-tailed weasels. Additionally, the two species would have been subject to capture at other trapping locations for a total of 65 trap nights. Mink usually occur near water and are most abundant along banks or shorelines of streams, rivers, ponds, and lakes. We set live-traps for a total of 18 trap nights at three sampling points (MT-V-014 through MT-V-016; Figure 3) established specifically for capturing mink. Valley Creek might provide suitable habitat for mink, but we did not encounter sign (e.g., tracks) of the species along that stream or any others within the park. Our results, combined with the fact that ermine, long-tailed weasel, and mink are relatively difficult to detect, suggest that the species are absent, rare, or uncommon at VAFO.

Conclusions

Our inventory provides documentation of three species (big brown bat, coyote, and feral cat) of mammals at VAFO for which reliable records previously did not exist (NPSpecies 2004). In addition, the inventory updates records for 17 other species at the park and increases understanding of the distribution of those species with respect to geographic location and cover type. Although our data are not appropriate for estimating certain population parameters (e.g., relative abundance among species, absolute abundance, or density of particular species), we are able to suggest classifications of residency and abundance as they relate to listings in the NPSpecies database (NPS 2003; Wotawa 2004). Specifically, we found that meadow vole, white-footed mouse, and white-tailed deer should be classified as breeders and as abundant in the park. Masked shrew, northern short-tailed shrew, eastern chipmunk, gray squirrel, common raccoon, and red fox should be classified as breeders and as common, and Virginia opossum should be classified as a breeder and as uncommon to rare. Eastern cottontail and woodchuck should be classified as residents and as common, whereas red squirrel and feral cat should be classified as residents and as uncommon to rare. Southern flying squirrel likely is a resident, but abundance is unknown. Residency of striped skunk is unknown, and abundance should be classified as uncommon to rare. Residency of coyote also is unknown, and abundance is rare. Both residency and abundance are unknown for big brown bat, meadow jumping mouse, and Norway rat. In addition to the above 20 species, we may have observed an ermine or long-tailed weasel at the Schwoebel tract; however, the record is not reliable and should be considered an unconfirmed sighting.

Our sampling efforts failed to document evidence for presence of an additional 25 species that potentially occur at VAFO, based on historical records (four species) and published range maps (21 species; Burt and Grossenheider 1980; Merritt 1987). Of the 25 species, nine (least shrew, Appalachian cottontail, American beaver, eastern fox squirrel, deer mouse, southern bog lemming, southern red-backed vole, woodland vole, and gray fox) are either absent or rare at VAFO, and seven (eastern mole, hairy-tailed mole, star-nosed mole, smoky shrew, common muskrat, house mouse, and mink) are absent, rare, or uncommon. We are not confident in speculating on status of the remaining nine species (eastern pipistrelle, evening bat, hoary bat, little brown myotis, northern myotis, red bat, Seminole bat, silver-haired bat, and small-footed myotis); research by The Nature Conservancy is addressing the need for information about presence of those species at VAFO (M. Carfioli, VAFO Ecologist, pers. comm., 2005).

Management Implications

We did not encounter any species federally listed as threatened or endangered (USFWS 2005) or state listed as vertebrates of special concern in Pennsylvania (PANHP 2006). Therefore, management activities at VAFO would not be expected to impact any mammalian species of conservation concern. However, managers should keep in mind that VAFO does overlap with the geographic ranges of six species (least shrew, evening bat, silver-haired bat, small-footed myotis, Appalachian cottontail, and eastern fox squirrel) that are of special concern in Pennsylvania (Burt and Grossenheider 1980; Merritt 1987; PANHP 2006).

We do not recommend that the NPS invest additional resources into investigating possible presence of Appalachian cottontail, American beaver, eastern fox squirrel, deer mouse, or gray fox at VAFO unless there is a desire to manage those species specifically. Lack of suitable habitat at the park, combined with failure of our inventory to detect presence of the species, suggests that they are absent. Likewise, future efforts to document presence of least shrew, smoky shrew, southern bog lemming, southern red-backed vole, woodland vole, common muskrat, house mouse, ermine, long-tailed weasel, and mink might be served better by a long-term monitoring program than through short-term, specialized research, as future discovery of one or more of these species may be more a product of chance than of intensive sampling effort. However, intensive survey efforts that include pitfall-trapping may be worthwhile for updating the status of eastern, hairy-tailed, and star-nosed moles. If there is a need to manage house mouse or Norway rat, we recommend trapping (live-traps or snap-traps, depending on management objectives) in buildings and other anthropogenic structures throughout the park.

The Wildlife Society (2005) encourages and supports the humane elimination of feral cat colonies because feral and free-ranging domestic cats are exotic predators that contribute significantly to the mortality of small mammals, birds, reptiles, and amphibians. Impacts of feral and free-ranging domestic cats on native wildlife are exacerbated when such cats are fed by humans, especially in areas where habitat for native wildlife occurs as an “island” (TWS 2005). Our inventory confirmed that such circumstances exist at VAFO, and we believe the problem of feral cats inhabiting the park should be considered by park managers when designing and implementing management strategies for promotion and maintenance of natural diversity of wildlife and wildlife habitat.

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Appendix A. Common and scientific names of mammals cited in this report (Jones et al. 1997).

Common Name	Scientific Name
American beaver	<i>Castor canadensis</i>
Appalachian cottontail	<i>Sylvilagus obscurus</i>
big brown bat	<i>Eptesicus fuscus</i>
common muskrat	<i>Ondatra zibethicus</i>
common raccoon	<i>Procyon lotor</i>
coyote	<i>Canis latrans</i>
deer mouse	<i>Peromyscus maniculatus</i>
eastern chipmunk	<i>Tamias striatus</i>
eastern cottontail	<i>Sylvilagus floridanus</i>
eastern fox squirrel	<i>Sciurus niger vulpinus</i>
eastern mole	<i>Scalopus aquaticus</i>
eastern pipistrelle	<i>Pipistrellus subflavus</i>
ermine	<i>Mustela erminea</i>
evening bat	<i>Nycticeius humeralis</i>
feral cat	<i>Felis catus</i>
gray fox	<i>Urocyon cinereoargenteus</i>
gray squirrel	<i>Sciurus carolinensis</i>
hairy-tailed mole	<i>Parascalops breweri</i>
hoary bat	<i>Lasiurus cinereus</i>
house mouse	<i>Mus musculus</i>
least shrew	<i>Cryptotis parva</i>
little brown myotis	<i>Myotis lucifugus</i>
long-tailed weasel	<i>Mustela frenata</i>
masked shrew	<i>Sorex cinereus</i>
meadow jumping mouse	<i>Zapus hudsonius</i>
meadow vole	<i>Microtus pennsylvanicus</i>
mink	<i>Mustela vison</i>
New England cottontail	<i>Sylvilagus transitionalis</i>
northern myotis	<i>Myotis septentrionalis</i>
northern short-tailed shrew	<i>Blarina brevicauda</i>
Norway rat	<i>Rattus norvegicus</i>
red bat	<i>Lasiurus borealis</i>
red fox	<i>Vulpes vulpes</i>
red squirrel	<i>Tamiasciurus hudsonicus</i>
seminole bat	<i>Lasiurus seminolus</i>
silver-haired bat	<i>Lasionycteris noctivagans</i>
small-footed myotis	<i>Myotis leibii</i>
smoky shrew	<i>Sorex fumeus</i>
southern bog lemming	<i>Synaptomys cooperi</i>
southern flying squirrel	<i>Glaucomys volans</i>
southern red-backed vole	<i>Clethrionomys gapperi</i>
star-nosed mole	<i>Condylura cristata</i>
striped skunk	<i>Mephitis mephitis</i>
Virginia opossum	<i>Didelphis virginiana</i>
white-footed mouse	<i>Peromyscus leucopus noveboracensis</i>
white-tailed deer	<i>Odocoileus virginianus</i>
woodchuck	<i>Marmota monax</i>
woodland vole	<i>Microtus pinetorum</i>

Appendix B. Classifications^a of residency and abundance used by the NPSpecies database (NPS 2003) to describe the status of animal species present in national parks.

Label	Definition	Comment
Residency	Current residency classification for each ANIMAL species in each park.	Applicable only to ANIMALS with the <i>Local List</i> checkbox checked and a <i>Park Status</i> of "Present". The values attempt to balance temporal and behavioral considerations. In practice, the entered value should apply (although there are numerous exceptions) to the residency of the organism at the time that the organism is engaged in its principle behavior (e.g. breeding, migrating, hibernating, etc.) in, or most important behavior to, the park.
Breeder	Population reproduces in the park.	
Resident	A significant population is maintained in the park for more than two months each year, but it is not known to breed there.	
Migratory	Migratory species that occurs in park approximately two months or less each year and does not breed there.	
Vagrant	Park is outside of the species' usual range.	
Unknown	Residency status in park is unknown.	
Abundance	The current abundance of each organism in each park.	Applicable only to organisms with the <i>Local List</i> checkbox checked and a <i>Park Status</i> of "Present". The values attempt to balance abundance with suitable habitat, and temporal/behavioral considerations. In practice, the entered value should apply (although there are numerous exceptions) to the abundance in the most suitable habitat of the organism, and at the time that the organism is engaged in it's principle behavior in (e.g. breeding, migrating, hibernating, etc.), or most important behavior to, the park.
Abundant	May be seen daily, in suitable habitat and season, and counted in relatively large numbers.	
Common	May be seen daily, in suitable habitat and season, but not in large numbers.	
Uncommon	Likely to be seen monthly in appropriate season/habitat. May be locally common.	
Rare	Present, but usually seen only a few times each year.	
Occasional	Occurs in the park at least once every few years, but not necessarily every year.	
Unknown	Abundance unknown.	

^aTaken from Wotawa (2004).

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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