INVENTORYING AND MONITORING PROTOCOLS OF VERTEBRATES IN NATIONAL PARKS OF THE EASTERN UNITED STATES: MAMMALS

Technical Report NPS/PHSO/NRTR-97/073

by Richard H. Yahner[1], Gerald L. Storm[2], Gregory S. Keller[3], Bradley D. Ross[4], and Ronald W. Rohrbaugh, Jr.[5]

[1]Professor of Wildlife Conservation, [2]Adjunct Associate Professor of Wildlife Management, and [5]Research Associate

School of Forest Resources
The Pennsylvania State University
University Park, PA 16802

[3]Research Assistant and [4]Research Associate

Intercollege Graduate Degree Program in Ecology
The Pennsylvania State University
University Park, PA 16802

October 1997

Cooperative Agreement 4000-9-8004
Supplemental Agreement No. 21

National Park Service
Philadelphia Support Office
Stewardship and Partnerships
U.S. Custom House
200 Chestnut Street
Philadelphia, PA 19106

Table of Contents

List of Tables iv
List of Figures ix
List of Appendices x
Acknowledgments xii
Executive Summary xiii
Introduction 1
Study Areas 3
Gettysburg National Military Park and Eisenhower National Historic Site 3
Hopewell Furnace National Historic Site 3
Valley Forge National Historical Park 4
Study Sites Used for Protocol Testing 4
Gettysburg National Military Park and Eisenhower National Historic Site 5
Hopewell Furnace National Historic Site 5
Valley Forge National Historical Park 12
Vehicular-Road Survey Routes 12
Scent-Station Route 12
Methods 18
Pitfall-Trapping Protocol 18
Live-Trapping Protocol 18
Drift-Fence Protocol 21
Vehicular-Road Survey Protocol 21
Scent-Station Survey Protocol 23
Description and Update of the Faunal Database 23
Results 25
Gettysburg National Military Park and Eisenhower National Historic Site 25
Hopewell Furnace National Historic Site 25
Valley Forge National Historical Park 25
Time Required to Establish Transects and Sampling Point 29
Pitfall-Trapping Protocol 29
Gettysburg National Military Park and Eisenhower National Historic Site 29
Grassland Habitat 29
Old-Field Habitat 29
Lowland-Forest Habitat 29
Upland-Forest Habitat 29
Hopewell Furnace National Historic Site 29
Grassland Habitat 29
Old-Field Habitat 29
Lowland-Forest Habitat 31
Upland-Forest Habitat 31

Live-Trapping Protocol 31
Gettysburg National Military Park and Eisenhower National Historic Site 31
1993 Grassland Habitat 31
1993 Old-Field Habitat 31
1993 Forest Habitat 31
1993 Rock Wall Trapping Sites 31
1994 Grassland Habitat 37
1994 Old-Field Habitat 37
1994 Forest Habitat 37
Hopewell Furnace National Historic Site 37
Grassland Habitat 37
Old-Field Habitat 37
Lowland-Forest Habitat 37
Upland-Forest Habitat 37
Valley Forge National Historical Park 42
Grassland Habitat 42
Old-Field Habitat 42
Lowland-Forest Habitat 42
Upland-Forest Habitat 42
Time Required for Trapping 42
Drift Fence with Pitfall-Trapping at Hopewell Furnace National Historic Site 42
Grassland Habitat 42
Old-Field Habitat 44
Lowland-Forest Habitat 44
Upland-Forest Habitat 44
All Habitats 44
Drift Fence with Live-Trapping at Hopewell Furnace National Historic Site 44
Old-Field Habitat 44
Lowland-Forest Habitat 44
Upland-Forest Habitat 48
All Habitats 48
Time Required for Drift-Fence Protocol 48
Vehicular-Road Survey Protocol 48
Gettysburg National Military Park and Eisenhower National Historic Site 48
Hopewell Furnace National Historic Site 48
Valley Forge National Historical Park 51
Scent-Station Survey Protocol 51
Discussion 53
Gettysburg National Military Park and Eisenhower National Historic Site 53
Hopewell Furnace National Historic Site 53
Valley Forge National Historical Park 54
Suggested Inventory and Monitoring Program for Mammals 55
Introductory Considerations 55

Types of Information Needed 56
Duration and Scope of Project 56
Ecological and Logistical Constraints 57
Suggested Sampling Protocols 58
Taxonomic-Specific Recommendations for Mammal Inventorying and Monitoring 61
Order Didelphimorphia 61
Order Insectivora 61
Order Chiroptera 66
Order Lagomorpha 66
Order Rodentia 66
Family Sciuridae 66
Family Muridae 69
Small Mammal Communities (Insectivores, Murids, and Sciurids Combined) 78
Order Carnivora 78
Literature Cited 81

List of Tables

Table 1. Study sites, study site codes, habitat types, transect lengths (m), and number of sampling points for protocol testing in 1993 at Gettysburg National Military Park and Eisenhower National Historic Site 6

Table 2. Study sites for live-trapping only during July and August 1993 and 1994 (year of trapping), study site codes, habitat types, transect lengths (m), and number of live-traps at Gettysburg National Military Park and Eisenhower National Historic Site 8

Table 3. Study sites, study site codes, habitat types, transect lengths (m), and number of sampling points for protocol testing at Hopewell Furnace National Historic Site 10

Table 4. Study sites, study site codes, habitat types, transect lengths (m), and number of sampling points for protocol testing at Valley Forge National Historical Park 13

Table 5. Seasons and study sites used for the small (S) and large (L) live-trapping protocols (LTT), pitfall-trapping protocol (PFT), and drift-fence protocol (DFE) at GETT-EISE, HOFU, and VAFO during 1993-95 19

Table 6. Number of mammalian species predicted, number of species documented by WOC[a] and during 1 July 1992 to 30 June 1996 by PO[b] and PTC[c], total species documented, and percent of predicted species documented at Gettysburg National Military Park and Eisenhower National Historic Site 26

Table 7. Number of mammalian species predicted, number of species documented by WOC[a] and during 1 July 1992 to 30 June 1996 by PO[b] and PTC[c], total species documented, and percent of predicted species documented Hopewell Furnace National Historic Site 27

Table 8. Number of mammalian species predicted, number of species documented by WOC[a] and during 1 July 1992 to 30 June 1996 by PO[b] and PTC[c], total species documented, and percent of predicted species documented at Valley Forge National Historical Park 28

Table 9. Total number of individuals and, in parentheses, average number of individuals (no./100 trapnights) of three small mammal species captured in pitfall traps at two grassland (PMG and VDG), four old-field (WOF, MOF, POF, and DOF), two lowland-forest (DDL and LFL), and two upland-forest (LRU and BRU) sites during summer 1993 at Gettysburg National Military Park and Eisenhower National Historic Site 30

Table 10. Total number of individuals and, in parentheses, average number of individuals (no./100 trapnights) of four small mammal species captured in pitfall traps at two old-field (PLO and PUO), four lowland-forest (PLL, HOL, FCL, and FCR), and two upland-forest (PLU and SCU) sites during summer 1994 and 1995 at Hopewell Furnace National Historic Site 31

Table 11. Total number of different individuals, total number of recaptures, and, in parentheses, average number of individuals (no./100 trapnights) of two small mammal species captured in small live-traps at two grassland sites during summer 1993 at Gettysburg National Military Park and Eisenhower National Historic Site 33

Table 12. Total number of different individuals, total number of recaptures, and, in parentheses, average number of individuals (no./100 trapnights) of four small mammal species captured in small live-traps at four old-field sites during summer 1993 at Gettysburg National Military Park and Eisenhower National Historic Site 34

Table 13. Total number of different individuals, total number of recaptures, and, in parentheses, average number of individuals (no./100 trapnights) of five small mammal species captured in small live-traps at four forest sites during summer 1993 at Gettysburg National Military Park and Eisenhower National Historic Site 35

Table 14. Total number of different individuals, total number of recaptures, and, in parentheses, average number of individuals (no./100 trapnights) of three small mammal species captured in small live-traps at five rock wall sites during summer 1993 at Gettysburg National Military Park and Eisenhower National Historic Site 36

Table 15. Total number of different individuals, total number of recaptures, and, in parentheses, average number of individuals (no./100 trapnights) of three small mammal species captured in small live-traps at three grassland (PMG, RRG, and SAG), one old-field (EOF), and two forest (SCL and CHU) sites during summer 1994 at Gettysburg National Military Park and Eisenhower National Historic Site 38

Table 16. Total number of different individuals, total number of recaptures, and, in parentheses, average number of individuals (no./100 trapnights) of four mammal species captured in small live-traps at two old-field sites during the summers of 1994 and 1995 at Hopewell Furnace National Historic Site 39

Table 17. Total number of different individuals, total number of recaptures, and, in parentheses, average number of individuals (no./100 trapnights) of three mammal species captured in small live-traps at four lowland-forest sites during the summers of 1994 and 1995 at Hopewell Furnace National Historic Site 40

Table 18. Total number of different individuals, total number of recaptures, and, in parentheses, average number of individuals (no./100 trapnights) of three mammal species captured in small live-traps at two upland-forest sites during the summers of 1994 and 1995 at Hopewell Furnace National Historic Site 41

Table 19. Total number of different individuals, total number of recaptures, and, in parentheses, average number of individuals (no./100 trapnights) of four mammal species captured in small and large live-traps at one grassland site (GWG), one old-field site (VOF), two lowland-forest sites (JWL and RRL), and two upland-forest sites (MMU and MJU) during mid-August 1995 at Valley Forge National Historical Park 43

Table 20. Total number of individuals, and, in parentheses, average number of individuals (no./100 trapnights) of four mammal species captured in pitfall traps with and without drift fences at two old-field sites (PLO and PUO), four lowland-forest sites (PLL, FCR, FCL, and HOL), and two upland-forest sites (SCU and PLU) during the summers of 1994 and 1995 at Hopewell Furnace National Historic Site 45

Table 21. Total number of individuals and, in parentheses, average number of individuals (no./100 trapnights) of four mammal species captured in pitfall traps with and without drift fences at eight study sites during the summers of 1994 and 1995 at Hopewell Furnace National Historic Site 46

Table 22. Total number of different individuals, total number of recaptures, and, in parentheses, average number of individuals (no./100 trapnights) of five mammal species captured in small live-traps with and without drift fences at two old-field sites (PLO and PUO), four lowland-forest sites (PLL, FCR, FCL, and HOL), and two upland-forest sites (SCU and PLU) during the summers of 1994 and 1995 at Hopewell Furnace National Historic Site 47

Table 23. Total number of different individuals, total number of recaptures, and, in parentheses, average number of individuals (no./100 trapnights) of five mammal species captured in small live-traps with and without drift fences at eight study sites during the summers of 1994 and 1995 at Hopewell Furnace National Historic Site 49

Table 24. Total number of individuals detected, number of individuals/km, in parentheses, survey route length, and total distance surveyed while conducting the vehicular-road survey protocol during five morning surveys during 1993 and 1994 at Gettysburg National Military Park and Eisenhower National Historic Site (GETT-EISE), two morning surveys during 1995 at Hopewell Furnace National Historic Site (HOFU), and two morning and two night surveys during 1995 at Valley Forge National Historical Park (VAFO). 50

Table 25. Number of scent stations containing anise oil, synthetic fermented egg, and total scent stations visited by four mammal species during 1995 at Valley Forge National Historical Park 52

Table 26. Habitats, seasons, type of data obtained, survey specifications, time, labor, materials, cost, limitations, and Pro-Cite citations for the pitfall-trapping protocol (without drift fences) for Order Insectivora 62

Table 27. Habitats, seasons, type of data obtained, survey specifications, time, labor, materials, cost, limitations, and Pro-Cite citations for live-trapping protocol (without drift fences) for the Order Insectivora 63

Table 28. Habitats, seasons, type of data obtained, survey specifications, time, labor, materials, cost, limitations, and Pro-Cite citations for drift-fence protocol (with pitfall traps) for the Order Insectivora 64

Table 29. Habitats, seasons, type of data obtained, survey specifications, time, labor, materials, cost, limitations, and Pro-Cite citations for drift-fence protocol (with live-traps) for the Order Insectivora 65

Table 30. Habitats, seasons, type of data obtained, survey specifications, time, labor, materials, cost, limitations, and Pro-Cite citations for the vehicular-road survey protocol for the Order Lagomorpha 67

Table 31. Habitats, seasons, type of data obtained, survey specifications, time, labor, materials, cost, limitations, and Pro-Cite citations for the vehicular-road survey protocol for the Order Rodentia, Family Sciuridae 68

Table 32. Habitats, seasons, type of data obtained, survey specifications, time, labor, materials, cost, limitations, and Pro-Cite citations for the scent-station protocol for the Order Rodentia, Family Sciuridae 70

Table 33. Habitats, seasons, type of data obtained, survey specifications, time, labor, materials, cost, limitations, and Pro-Cite citations for the live-trapping protocol with small and large traps (without drift fences) for the Order Rodentia, Family Sciuridae 71

Table 34. Habitats, seasons, type of data obtained, survey specifications, time, labor, materials, cost, limitations, and Pro-Cite citations for the drift-fence protocol (with live-traps) for the Order Rodentia, Family Sciuridae 72

Table 35. Habitats, seasons, type of data obtained, survey specifications, time, labor, materials, cost, limitations, and Pro-Cite citations for the live-trapping protocol (without drift fences) for the Order Rodentia, Family Muridae 73

Table 36. Habitats, seasons, type of data obtained, survey specifications, time, labor, materials, cost, limitations, and Pro-Cite citations for the pitfall-trapping protocol (without drift-fences) for the Order Rodentia, Family Muridae 74

Table 37. Habitats, seasons, type of data obtained, survey specifications, time, labor, materials, cost, limitations, and Pro-Cite citations for the drift-fence protocol (with pitfall traps) for the Order Rodentia, Family Muridae 75

Table 38. Habitats, seasons, type of data obtained, survey specifications, time, labor, materials, cost, limitations, and Pro-Cite citations for the drift-fence protocol (with live-traps) for the Order Rodentia, Family Muridae 76

Table 39. Habitats, seasons, type of data obtained, survey specifications, time, labor, materials, cost, limitations, and Pro-Cite citations for the scent-station protocol for the Order Rodentia, Family Muridae 77

Table 40. Habitats, seasons, type of data obtained, survey specifications, time, labor, materials, cost, limitations, and Pro-Cite citations for the pitfall-trapping (GETT-EISE and HOFU), live-trapping (GETT-EISE, HOFU, and VAFO), and drift-fence protocols (HOFU) for small mammal communities 79

Table 41. Habitats, seasons, type of data obtained, survey specifications, time, labor, materials, cost, limitations, and Pro-Cite citations for the scent-station protocol for the Order Carnivora 80

List of Figures

Figure 1. Locations of two grassland (PMG and VDG), four old-field (WOF, POF, MOF, and DOF), two lowland-forest (DDL and LFL), and two upland-forest (LRU and BRU) transects used for protocol testing at Gettysburg National Military Park and Eisenhower National Historic Site 7

Figure 2. Locations of five rock wall transects (PMR, VDR, DDR, HPR, and SWR) used in 1993 and six transects (PMG, RRG, SAG, EOF, SCL, and CHU) used in 1994 for live-trapping at Gettysburg National Military Park and Eisenhower National Historic Site 9

Figure 3. Locations of the grassland (HRG), two old-field (PLO and PUO), four lowland-forest (PLL, HOL, FCR, and FCL), and two upland-forest (PLU and SCU) transects used for protocol testing at Hopewell Furnace National Historic Site 11

Figure 4. Locations of the one grassland (GWG), one old-field (VOF), two lowland-forest (RRL and JWL), and two upland-forest (MMU and MJU) transects used for protocol testing at Valley Forge National Historical Park 14

Figure 5. Location of the 20.8-km vehicular-road survey route at Gettysburg National Military Park and Eisenhower National Historic Site 15

Figure 6. Location of the 8.0-km vehicular-road survey route at Hopewell Furnace National Historic Site 16

Figure 7. Location of the 11.3-km vehicular-road survey route and scent-station route at Valley Forge National Historical Park 17

Figure 8. Spatial arrangement of the pitfall and live-trapping sampling points with drift fences (at HOFU only) and without drift fences (at GETT-EISE and HOFU). Sampling points at VAFO do not include pitfall traps 22

List of Appendices

Appendix 1. Mammal section of the Faunal Database for Gettysburg National Military Park and Eisenhower National Historic Site from 1 July 1992 to 30 June 1996 86

Appendix 2. Mammal section of the Faunal Database for Hopewell Furnace National Historic Site from 1 July 1992 to 30 June 1996 90

Appendix 3. Mammal section of the Faunal Database for Valley Forge National Historical Park from 1 July 1992 to 30 June 1996 94

Appendix 4. *Pro-Cite* Group Names for all classes of vertebrate species in the Faunal Database for Gettysburg National Military Park and Eisenhower National Historic Site, Hopewell Furnace National Historic Site, Valley Forge National Historical Park (Variable No. 5) 98

Appendix 5. Codes for sources of documentation used for the occurrence status in the Faunal Database for Gettysburg National Military Park and Eisenhower National Historic Site, Hopewell Furnace National Historic Site, Valley Forge National Historical Park (Variable No. 8) 99

Appendix 6. Codes for the residency status of vertebrate species in the Faunal Database for Gettysburg National Military Park and Eisenhower National Historic Site, Hopewell Furnace National Historic Site, Valley Forge National Historical Park (Variable No. 9) 100

Appendix 7. Codes for the federal and state legal population status of vertebrate species in the Faunal Database for Gettysburg National Military Park and Eisenhower National Historic Site, Hopewell Furnace National Historic Site, Valley Forge National Historical Park (Variable No. 10) 101

Appendix 8. Codes for the survey protocols for inventorying and monitoring vertebrate species in the Faunal Database at Gettysburg National Military Park and Eisenhower National Historic Site, Hopewell Furnace National Historic Site, Valley Forge National Historical Park (Variables No. 11 and No. 12) 102

Appendix 9. Instructions for ordering a copy of the Faunal Database from the National Park Service 103

Appendix 10. Small mammal live-trapping (LTT) and pitfall-trapping (PFT) data for adults (A), sub-adults (S), juveniles (J), unknown (U-K), males (M), and females (F) at all study sites and rock wall sites during summer 1993 and at additional trapping sites during summer 1994 for Gettysburg National Military Park and Eisenhower National Historic Site 104

Appendix 11. Small mammal live-trapping (LTT) and pitfall-trapping (PFT) data for adults (A), sub-adults (S), juveniles (J), unknown (U-K), males (M), and females (F) with and without drift fences at all study sites during mid-August 1994 and mid-July 1995 for Hopewell Furnace National Historic Site 126

Appendix 12. Small mammal live-trapping data for adults (A), sub-adults (S), juveniles (J), unknown (U-K), males (M), and females (F) at all study sites during mid-August 1995 for Valley Forge National Historical Park 140

Acknowledgments

Funding for the project was provided by the National Park Service. We appreciate cooperation of National Park Service personnel, especially Mr. John Karish. Thanks are also extended to those individuals who helped with field assistance and data collection and to Ms. Sherri Shawver for clerical assistance.

Executive Summary

We conducted a long-term project (1992-1996) designed to provide a comprehensive review of vertebrates (amphibians, reptiles, birds, and mammals) in four national parks in the eastern United States. We field tested select protocols at Gettysburg National Military Park (GETT), Eisenhower National Historic Site (EISE), Hopewell Furnace National Historic Site (HOFU), and Valley Forge National Historical Park (VAFO) to (1) determine the effectiveness of protocols for inventorying and monitoring terrestrial vertebrates in terms of time, labor, cost, and types of data obtained and (2) predict and document the number of terrestrial vertebrate species within the parks. The focus of this report is mammals.

We had predicted that 59 mammalian species potentially occurred at each GETT-EISE, HOFU, and VAFO. Of these predicted species, nine (15%) species at GETT-EISE, six (10%) species at HOFU, and 18 (31%) species at VAFO had been previously documented within the park by observers (e.g., park personnel) and noted on National Park Service Wildlife Observation Cards.

We tested five protocols for inventorying and monitoring mammals from 1 July 1992 to 30 June 1996: pitfall trapping, live-trapping, drift-fence with pitfall and live-traps, vehicular-road surveys, and scent stations. Three protocols (pitfall-trapping, live-trapping, and vehicular-road survey) were tested at GETT-EISE, four protocols (except scent stations) were tested at HOFU, and three protocols (except pitfall-trapping and drift fences) were tested at VAFO. Based on the test of these protocols, 13, eight, and eight species were detected at GETT-EISE, HOFU, and VAFO, respectively. Additional mammalian species were observed by project researchers at GETT-EISE (n = 5), HOFU (n = 7), and VAFO (n = 1). Based on the total number of species recorded by protocol testing and personnel observations from 1 July 1992 to 30 June 1996, 12 (67%) of 18 species at GETT-EISE, 12 (80%) of 15 species at HOFU, and one (11%) of nine species at VAFO had not been officially documented in the parks prior to our study.

Based on our field testing of protocols at GETT-EISE, HOFU, and VAFO, we recommend use of the scent-station protocol for the Order Didelphimorphia; pitfall-trapping, live-trapping, and drift-fence protocols for the Order Insectivora and the Family Muridae (Order Rodentia); the scent-station protocol for the Order Carnivora; and the vehicular-road survey protocol for the Family Sciuridae (Order Rodentia) and the Order Lagomorpha. Additional study will be necessary to increase the number of species documented from certain taxa, such as insectivores (Order Insectivora) and bats (Order Chiroptera).

Introduction

We conducted a long-term project (1992-1996) designed to provide a comprehensive review of vertebrates (amphibians, reptiles, birds, and mammals, excluding white-tailed deer [*Odocoileus virginianus*] and black bear [*Ursus americanus*]) in four national parks in the eastern United States: Gettysburg National Military Park (GETT), Eisenhower National Historic Site (EISE), Hopewell Furnace National Historic Site (HOFU), and Valley Forge National Historical Park (VAFO). The focus of this report is mammals. Deer were not included in this study because they were the subject of another study (Storm et al. 1989), and bear were excluded because they principally are a more northerly species. Information on presence, relative abundance, and distribution of vertebrates on these public lands is important to National Park Service (NPS) personnel (hereafter referred to as resource management specialists) who are mandated to manage natural resources. As large tracts of public lands, such as national parks, become more insular with increased habitat fragmentation because of agriculture, urbanization, or other land use, 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 1995).

In years 1 and 2 of this long-term project, we surveyed the literature for protocols used in studies designed to inventory and monitor mammals. We also were interested in assessing cost-, labor-, and time-constraints associated with each protocol. Protocols were organized in a hierarchial fashion, depending on specific goals and types of data needed at a given park. We also intended that these protocols would be tested and applied in the eastern deciduous forest region so that trends in mammalian populations could be monitored on a regional basis. A summary of these protocols is given in Technical Report NPS/MAR/NRTR-94/057 (Yahner et al. 1994a).

Also in years 1 and 2, we conducted an extensive search of available databases on mammals (e.g., published and unpublished species lists and range maps) on mammals that were predicted to occur or were documented in the four national parks. The search included all mammal species, except deer and bear. We also combined land-use data for each park with known habitat requirements and ranges of mammalian species in the eastern deciduous forest to augment the list of species predicted to occur at the four parks. Furthermore, we determined primary and secondary habitat, occurrence status, residency status, legal population status, and types of inventory and monitoring protocols applicable to each predicted and documented mammal species. A summary of mammals and other vertebrate fauna associated with the four parks is presented in Technical Report NPS/MAR/NRTR-94/058 (Yahner et al. 1994b, 1994c).

We selected a subset of inventorying and monitoring protocols identified in Technical Report NPS/MAR/NRTR-94/057 to test at GETT-EISE during years 2 and 3, at HOFU during years 3 and 4, and at VAFO during year 4 of our study (Yahner et al. 1994a). Protocols selected for testing in the field were principally those conducted on taxa that were not well represented in the list of documented species (e.g., rodents and insectivores) (Yahner et al. 1994b). By testing these

protocols at each of the four parks, we obtained information on the feasibility of each protocol (i.e., amount of time, labor, and money required to conduct the protocol), mammalian species documented by the protocol, and habitat use by mammalian species in the parks. This information is important to resource management specialists who are mandated to manage native and nonnative species. Information obtained from testing of protocols will allow resource management specialists to develop time-, labor-, and cost-efficient management plans that satisfy specific objectives for a given mammalian species that may be documented or predicted to occur in a park.

This report can be used with Technical Report NPS/MAR/NRTR-94/057, which is entitled "Inventorying and Monitoring Protocols of Vertebrates in National Park Areas of the Eastern United States: The Bibliographic Report" (Yahner et al. 1994a), and Technical Report NPS/MAR/NRTR-94/058, which is entitled "Inventorying and Monitoring Protocols of Vertebrates in National Park Areas of the Eastern United States: The Faunal Report" (Yahner et al. 1994b, 1994c). When used together, these reports synthesize comprehensive information on inventorying and monitoring protocols, and ecological, biological, and legal data for mammals and other vertebrate fauna in the eastern deciduous forest.

In this final report, we present information on our efforts to:

1. field test selected protocols to document terrestrial mammalian species and habitats used by these species in Gettysburg National Military Park and Eisenhower National Historic Site, Hopewell Furnace National Historic Site, and Valley Forge National Historical Park;

2. determine the effectiveness of selected protocols for mammals in terms of time, labor, cost, and types of data obtained; and

3. update the Faunal Databases for each of the parks.

Study Areas

Gettysburg National Military Park and Eisenhower National Historic Site

Gettysburg National Military Park and Eisenhower National Historic Site are located in Adams County, south central Pennsylvania, comprising 1,511 ha and 279 ha, respectively. The town of Gettysburg (population = 7,025) is surrounded by GETT (Rand McNally 1993); EISE is southwest and contiguous with GETT. The parks are located within the Triassic Lowland Section of the Piedmont Province, which corresponds to the Carolinian Life Zone (Rhoads 1903, Genoways and Brenner 1985).

The topography of the parks is gentle, consisting mainly of rolling hills. There are two principal landforms that traverse GETT: Cemetery Ridge and Seminary Ridge. These two parallel ridges are 1.6 km apart and are oriented north-south. The mean elevation in the parks is 168 m, and the highest point is Big Round Top (240 m) (Yahner et al. 1991). There are 10 ponds, numerous small wetlands, and three predominant drainages: Rock Creek in the east, Plum Run in the center, and Willoughby Run in the west of the parks.

Fifty percent (756 ha) of GETT is agricultural land (cropland and pasture), and 36% (547 ha) is forestland. The remaining 14% is comprised of maintained areas, residential areas, or other types of human-dominated developed land (Yahner et al. 1991). Eighty-three percent (232 ha) of EISE is agricultural land, 3% is forestland, and 14% is maintained areas, residential areas, and other developed land (Yahner et al. 1991). Crop species at the parks include barley, corn, hay (timothy, clover, alfalfa, and fescue), sorghum, oats, rye, soybeans, and winter wheat (Yahner et. al. 1991). Forestland contains mature tree species that typify Appalachian forest types and are principally oak (*Quercus* spp.), hickory (*Carya* spp.), and tulip poplar (*Liriodendron tulipifera*) (Kuchler 1964, Yahner et al. 1991).

Hopewell Furnace National Historic Site

Hopewell Furnace National Historic Site is located in Berks and Chester Counties, southeastern Pennsylvania. The 350-ha park is situated in a rural setting, approximately 10 km southwest of Pottstown (population = 21,831), and is contiguous on all but the southeast side with French Creek State Park (Rand McNally 1993). HOFU is contained within the Piedmont Upland Section and the Conestoga Valley Section of the Piedmont Province, which are within the Carolinian Life Zone (Rhoads 1903, Genoways and Brenner 1985).

The southern two-thirds of HOFU is dominated by relatively moderate topography with little relief, with the exception of one forested hill (elevation = 220 m) near the southern border of the

park. The northern one-third of the park is dominated by a forested south-facing slope with a maximum elevation of 280 m and a mean slope of 10%. The minimum elevation near the headwaters of French Creek is 146 m (Russell 1987).

Forest occurs on 262 ha (75%) of HOFU. The principal overstory trees are oak, tulip poplar, red maple (*Acer rubrum*), sycamore (*Platanus occidentalis*), red cedar (*Juniperus virginiana*), ash (*Fraxinus* spp.), elm (*Ulmus* spp.), and black walnut (*Juglans nigra*). Red cedar is only found in early successional stands. The remaining 88 ha (25%) are either developed, historic, or agricultural areas. Agricultural areas consist of 13 fields totaling 60 ha and are maintained in pastures, hay fields, and row crops (Russell 1987).

Valley Forge National Historical Park

Valley Forge National Historical Park is located in Montgomery and Chester Counties, southeastern Pennsylvania. The area of VAFO is 1,192 ha. The park is surrounded by urban-suburban land-use types and is approximately 20 km northwest of Philadelphia (population = 1,585,577) (Rand McNally 1993). VAFO is located within the Triassic Lowland Section of the Piedmont Province in the Carolinian Life Zone (Rhoads 1903, Genoways and Brenner 1985).

The topography of VAFO is relatively gentle, consisting of rolling uplands and low hills, with elevations ranging from 10 to 150 m. Fifty-seven percent (679 ha) of the park is composed of old-fields, fields mowed annually, and fields mowed biweekly; 38% (453 ha) is woodlands. The remaining 5% (60 ha) of VAFO includes developed areas (e.g., buildings), barren areas (e.g., dirt parking lots), and wetlands (e.g., small ponds) (Cypher 1986).

Woodlands consist of mature forests, early successional-stage forests, floodplain forests, and conifer plantations. The dominant understory and overstory species in woodlands include flowering dogwood (*Cornus florida*), red maple, boxelder (*Acer negundo*), tulip poplar, black gum (*Nyssa sylvatica*), chestnut oak (*Quercus prinus*), northern red oak (*Quercus rubra*), ash (*Fraxinus spp.*), sassafras (*Sassafras albidum*), and white pine (*Pinus strobus*) (Cypher 1986).

Study Sites Used for Protocol Testing

At each of the parks, we divided habitats for mammal sampling into three types: grassland, old-field, and forest. Forest habitat was subdivided into upland sites and lowland sites associated with water. Ten study sites in 1993 were selected randomly at GETT-EISE, nine sites at HOFU, and six sites at VAFO for comparing protocols (Tables 1-4). Within each of these sites, a transect was established in a random direction for the field testing of specific protocols. Transect lengths at each site at GETT-EISE depended upon the amount of habitat available. For example,

because of the limited amount of old-field habitat at Devil's Den, the DOF transect was only 300 m; the DDL transect, however, was 600 m because of the abundance of lowland forest habitat at Devil's Den (Table 1). Transects at HOFU and VAFO were each 600 m in length. Sampling points along each transect were placed 50 m into the habitat edge and thereafter at 150-m intervals. At steep sites (e.g., MJU) or those associated with water (e.g., LFL), the transect followed the contour of the landscape. In addition, five rock wall sites were established in 1993 and six transects in 1994 at GETT-EISE for live-trapping only.

Gettysburg National Military Park and Eisenhower National Historic Site

Ten study sites were selected for mammal sampling in 1993 (Table 1, Fig. 1). Two of these sites were in grassland habitat (Pennsylvania Monument Grassland [PMG] and Valley of Death Grassland [VDG]), four in old-field habitat (Picnic Area Old-Field [POF], Devil's Den Old-Field [DOF], McMillan Old-Field [MOF], and Warfield Ridge Old-Field [WOF]), two in lowland-forest habitat (Devil's Den Lowland [DDL] and Landfill Lowland [LFL]), and two in upland-forest habitat (Little Round Top Upland [LRU] and Big Round Top Upland [BRU]).

For live-trapping only, the rock wall sites selected in 1993 included one grassland site (Pennsylvania Monument Rock Wall [PMR]), two grassland/forest edge sites (Valley of Death Rock Wall [VDR] and Devil's Den Rock Wall [DDR]), one old-field/forest edge site (Horse Path Rock Wall [HPR]), and one forest site (Sedgwick Avenue Rock Wall [SWR]) (Table 2, Fig. 2). In 1994, we selected two grassland sites (Red Rock Road Grassland [RRG] and Sedgwick Avenue Grassland [SAG]), one old-field site (Eisenhower Old-Field [EOF]), and two forest sites (South Confederate Lowland [SCL] and Culp's Hill Upland [CHU]) for live-trapping. The original PMG transect also was used in 1994 for live-trapping.

Hopewell Furnace National Historic Site

Nine study sites were selected for mammal sampling at HOFU (Table 3, Fig. 3). One was in grassland habitat (Hopewell Road Grassland [HRG]), two in old-field/edge habitat (Powerline Lowland Old-Field [PLO] and Powerline Upland Old-Field [PUO]), four in lowland-forest habitat (Powerline Lowland [PLL], French Creek Lowland [FCL], Hopewell Road Lowland [HOL], and French Creek Riparian [FCR]), and two in upland-forest habitat (Powerline Upland [PLU] and Route 345 S-Curve Upland [SCU]). Unlike all the other sites at HOFU which contained a 600-m transect, we established a 750-m transect with six sampling points at the HRG site. Because HRG was the only grassland site at HOFU, we used an equal number of sampling points to test trapping protocols with and without drift fences.

Table 1. Study sites, study site codes, habitat types, transect lengths (m), and number of sampling points for protocol testing in 1993 at Gettysburg National Military Park and Eisenhower National Historic Site.

STUDY SITE	CODE	HABITAT TYPE	TRANS. LENGTH	NUMBER POINTS
Pennsylvania Monument Grassland	PMG	Grassland	800	6
Valley of Death Grassland	VDG	Grassland (with marsh)	600	5
Warfield Ridge Old-Field	WOF	Old-Field	450	4
Picnic Old-Field	POF	Old-Field	150	2
McMillan Old-Field	MOF	Old-Field	300	3
Devil's Den Old-Field	DOF	Old-Field	300	3
Devil's Den Lowland	DDL	Lowland-Forest	600	5
Landfill Lowland	LFL	Lowland-Forest	600	5
Little Round Top Upland	LRU	Upland-Forest	450	4
Big Round Top Upland	BRU	Upland-Forest	750	6
TOTAL			5000	43

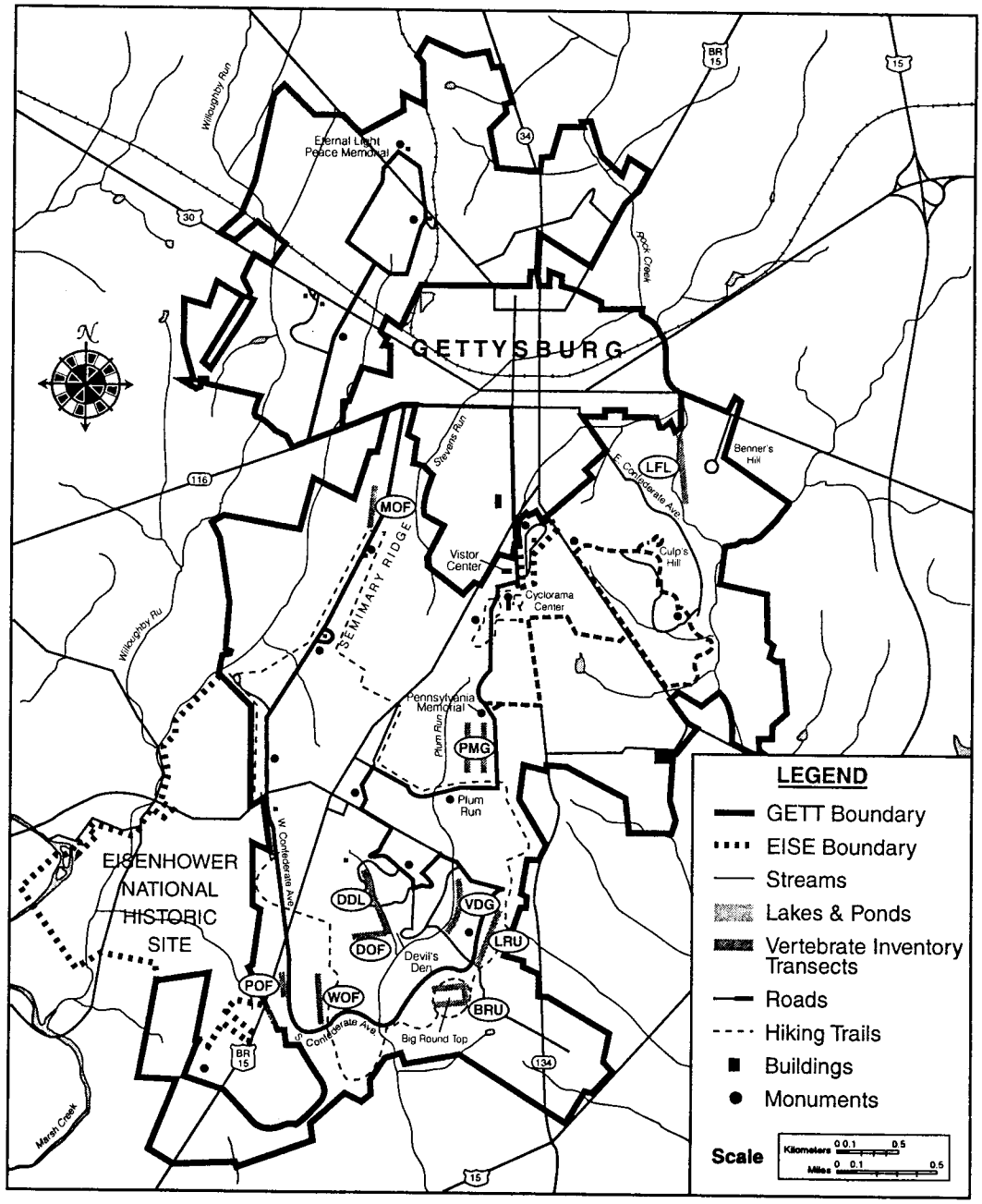


Figure 1. Locations of two grassland (PMG and VDG), four old-field (WOF, POF, MOF, and DOF), two lowland-forest (DDL and LFL), and two upland-forest (LRU and BRU) transects used for protocol testing at Gettysburg National Military Park and Eisenhower National Historic Site.

Table 2. Study sites for live-trapping only during July and August 1993 and 1994 (year of trapping), study site codes, habitat types, transect lengths (m), and number of live-traps at Gettysburg National Military Park and Eisenhower National Historic Site.

STUDY SITE (YEAR)	CODE	HABITAT TYPE	TRANS. LENGTH	NUMBER TRAPS
Pennsylvania Memorial Rock Wall (1993)	PMR	Grassland	300	13
Valley of Death Rock Wall (1993)	VDR	Grassland/ Forest Edge	150	7
Devil's Den Rock Wall (1993)	DDR	Grassland/ Forest Edge	225	10
Horse Path Rock Wall (1993)	HPR	Old-Field/Forest Edge	525	22
Sedgwick Ave. Rock Wall (1993)	SWR	Lowland-Forest	200	9
PA Monument Grassland (1994)	PMG	Grassland	225	10
Red Rock Rd. Grassland (1994)	RRG	Grassland	225	10
Sedgwick Ave. Grassland (1994)	SAG	Grassland	225	10
Eisenhower Old-Field (1994)	EOF	Old-Field	225	10
S. Confederate Lowland (1994)	SCL	Lowland-Forest	225	10
Culp's Hill Upland (1994)	CHU	Upland-Forest	225	10

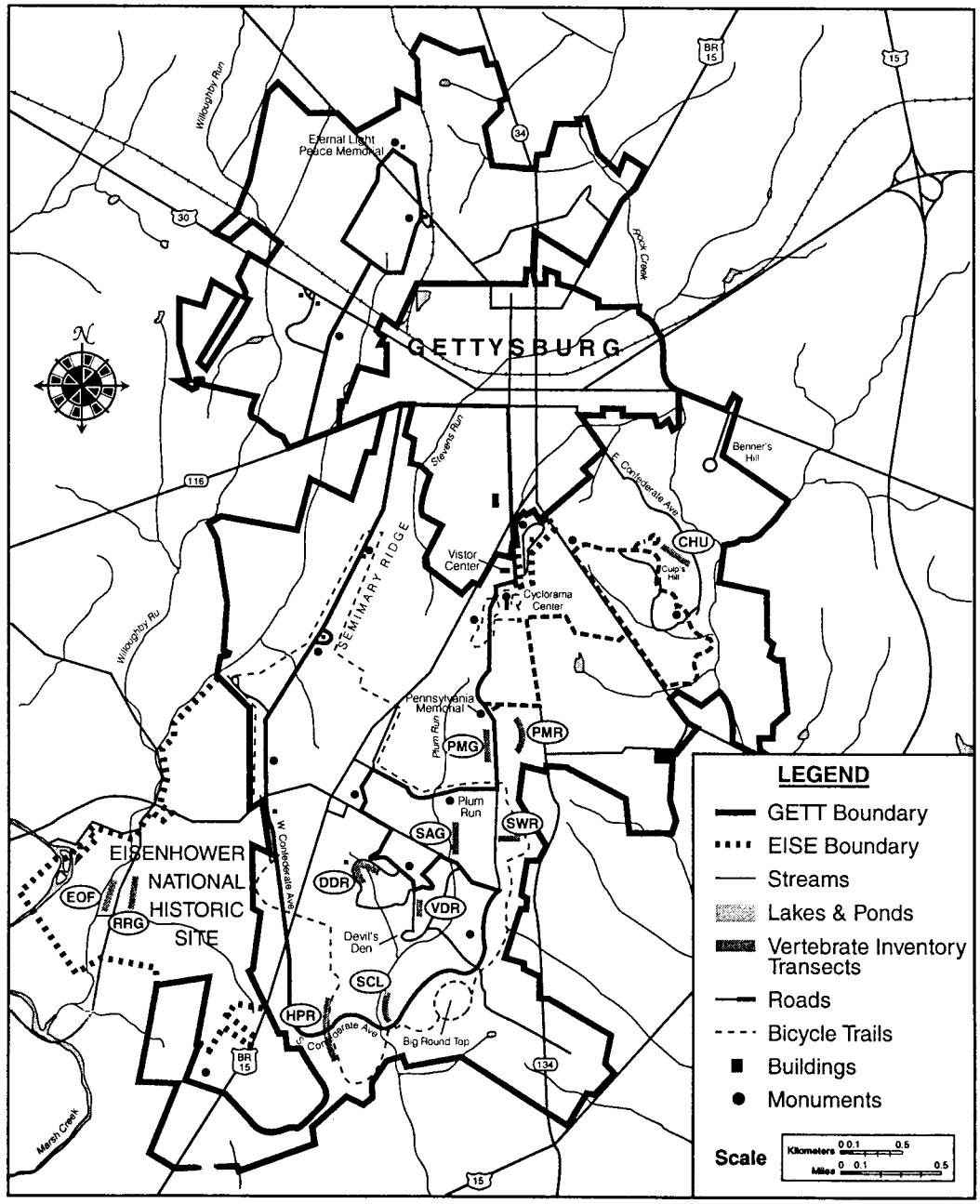


Figure 2. Locations of five rock wall transects (PMR, VDR, DDR, HPR, and SWR) used in 1993 and six transects (PMG, RRG, SAG, EOF, SCL, and CHU) used in 1994 for live-trapping at Gettysburg National Military Park and Eisenhower National Historic Site.

Table 3. Study sites, study site codes, habitat types, transect lengths (m), and number of sampling points for protocol testing at Hopewell Furnace National Historic Site.

STUDY SITE	CODE	HABITAT TYPE	TRANS. LENGTH	NUMBER POINTS
Hopewell Road Grassland	HRG	Grassland	750	6
Powerline Lowland Old-Field	PLO	Old-Field	600	5
Powerline Upland Old-Field	PUO	Old-Field	600	5
Powerline Lowland	PLL	Lowland-Forest	600	5
Hopewell Road Lowland	HOL	Lowland-Forest	600	5
French Creek Riparian	FCR	Lowland-Forest	600	5
French Creek Lowland	FCL	Lowland-Forest	600	5
Powerline Upland	PLU	Upland-Forest	600	5
Route 345 S-Curve Upland	SCU	Upland-Forest	600	5
TOTAL			5400	45

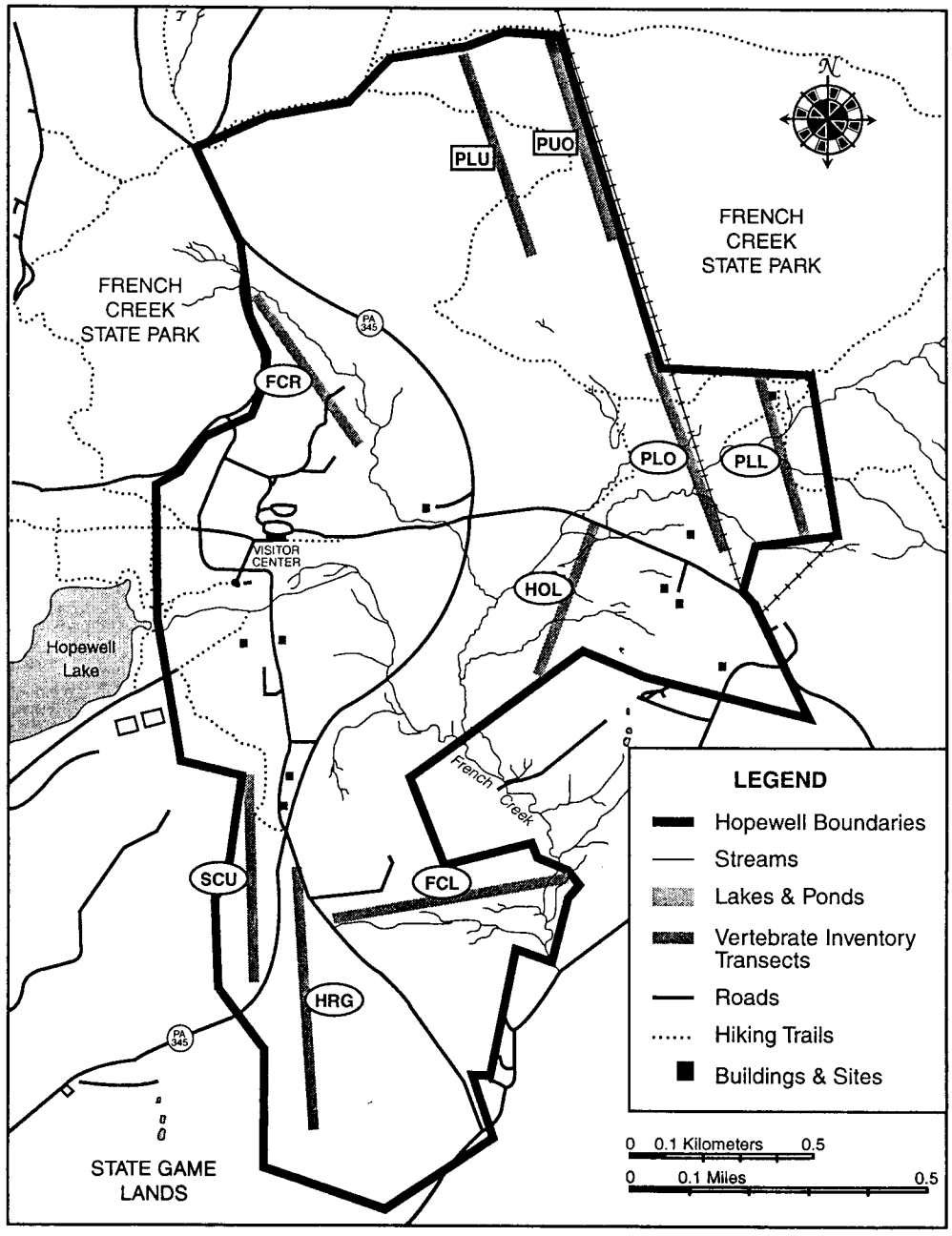


Figure 3. Locations of the grassland (HRG), two old-field (PLO and PUO), four lowland-forest (PLL, HOL, FCR, and FCL), and two upland-forest (PLU and SCU) transects used for protocol testing at Hopewell Furnace National Historic Site.

Valley Forge National Historical Park

Six study sites were selected for mammal sampling at VAFO (Table 4, Fig. 4). One of these study sites was in grassland (General Wayne's Grassland/Field 57 [GWG]), one in old-field/edge habitat (Valley Forge Old-Field/Field 77 [VOF]), two in lowland-forest habitat (Railroad Lowland [RRL] and James White Lowland [JWL]), and two in upland-forest habitat (Mount Misery Upland [MMU] and Mount Joy Upland [MJU]).

Vehicular-Road Survey Routes

We also established a vehicular road-survey route through each of the parks for use with the vehicular-road survey protocol. We selected secondary roads that encompassed a variety of representative habitats. The length of the route varied among parks, depending upon park size and number of low-use secondary roads. The route was 20.8 km (13 miles) at GETT-EISE, 8.0 km (5 miles) at HOFU, and 11.3 km (7 miles) at VAFO (Figs. 5-7, respectively).

Scent-Station Route

We established a 4.5-km transect along the railroad tracks adjacent to the RRL transect at VAFO for use with the scent-station survey protocol (Fig. 7). Stations along the transect were placed at the starting point and thereafter at 500-m intervals for a total of 10 stations.

Table 4. Study sites, study site codes, habitat types, transect lengths (m), and number of sampling points for protocol testing at Valley Forge National Historical Park.

STUDY SITE	CODE	HABITAT TYPE	TRANS. LENGTH	NUMBER POINTS
General Wayne's Grassland (Field 57)	GWG	Grassland	600	5
Valley Forge Old-Field (Field 77)	VOF	Old-Field	600	5
Railroad Lowland	RRL	Lowland-Forest	600	5
James White Lowland	JWL	Lowland-Forest	600	5
Mount Misery Upland	MMU	Upland-Forest	600	5
Mount Joy Upland	MJU	Upland-Forest	600	5
TOTAL			3600	30

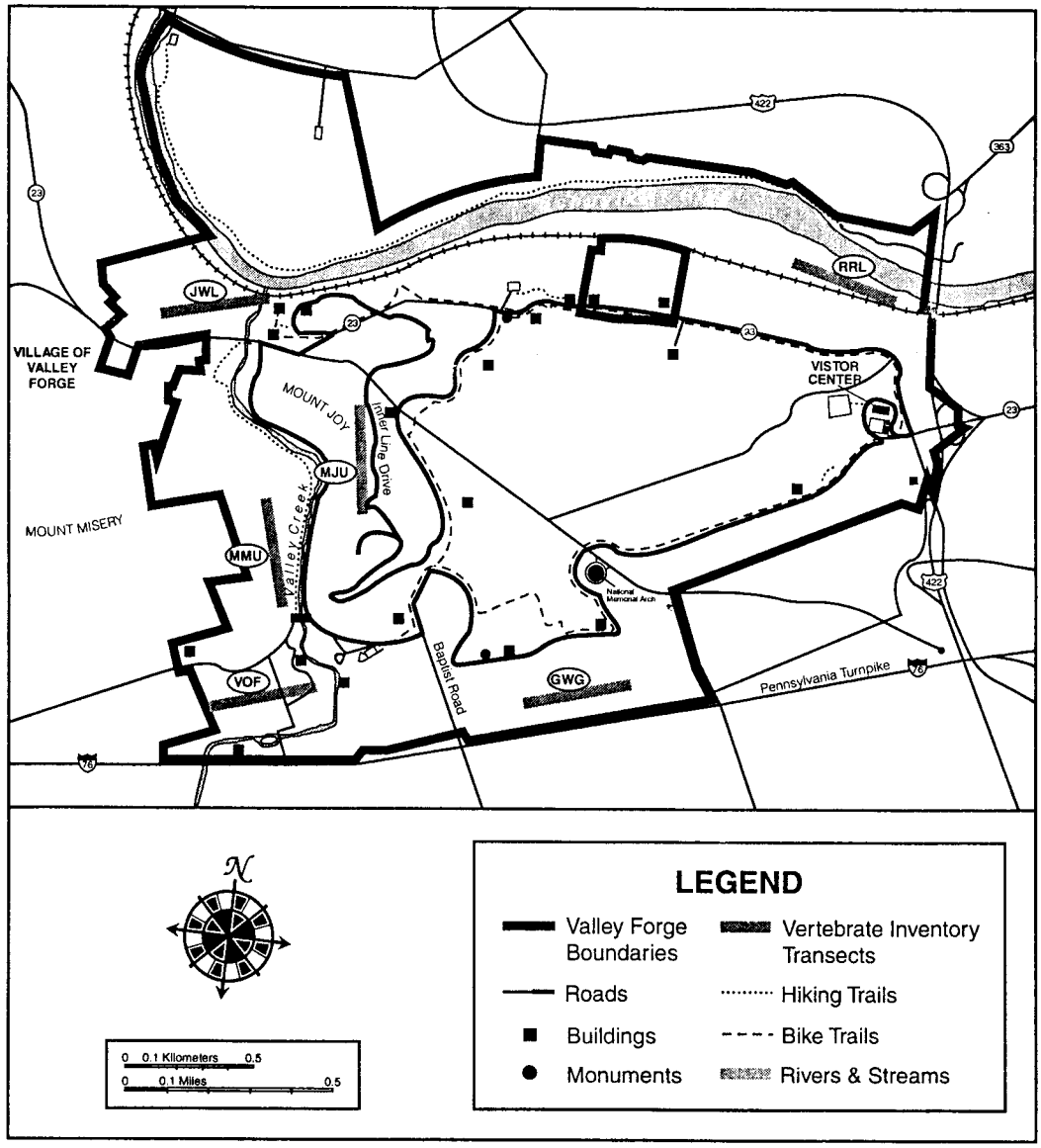


Figure 4. Locations of the one grassland (GWG), one old-field (VOF), two lowland-forest (RRL and JWL), and two upland-forest (MMU and MJU) transects used for protocol testing at Valley Forge National Historical Park.

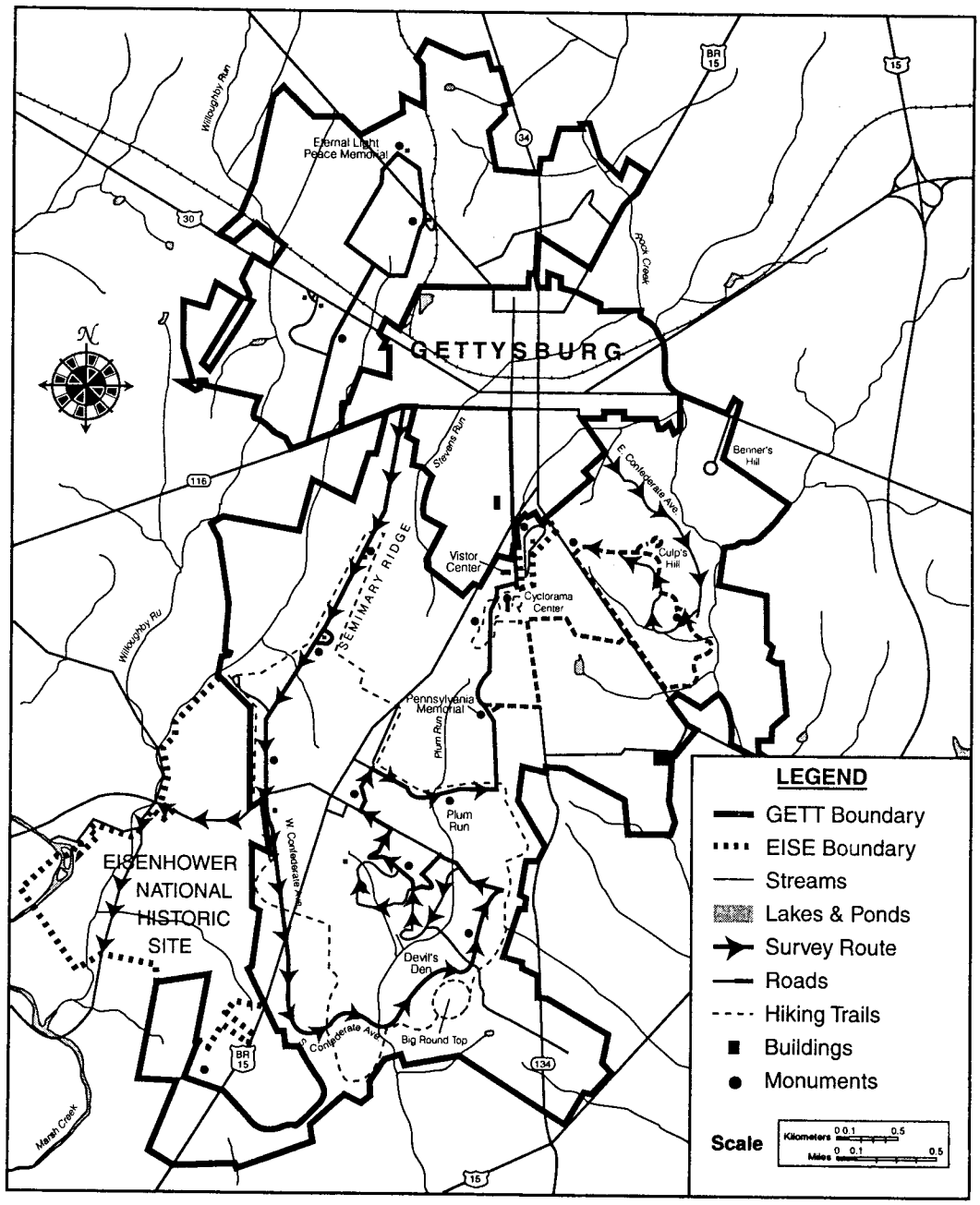


Figure 5. Location of the 20.8-km vehicular-road survey route at Gettysburg National Military Park and Eisenhower National Historic Site.

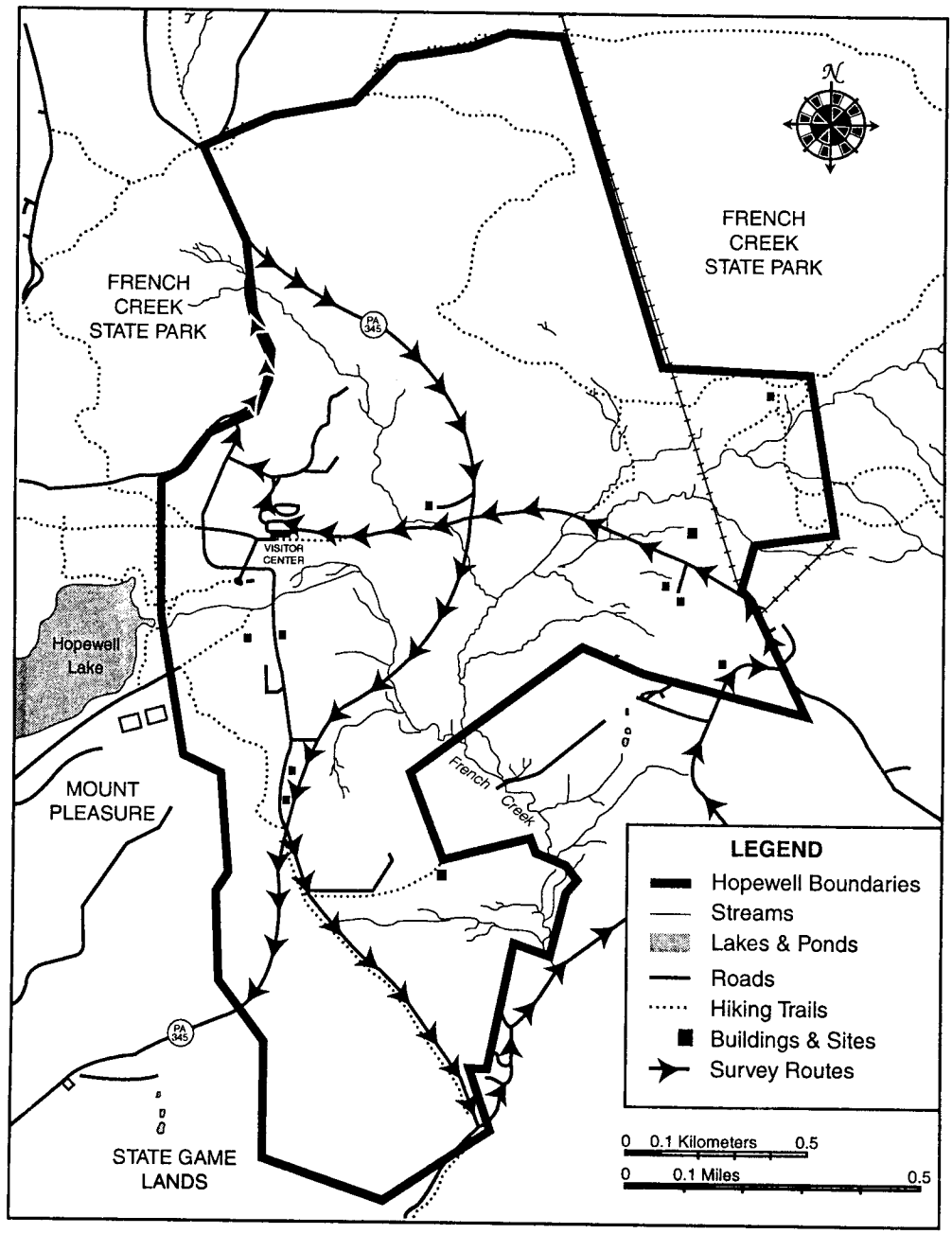


Figure 6. Location of the 8.0-km vehicular-road survey route at Hopewell Furnace National Historic Site.

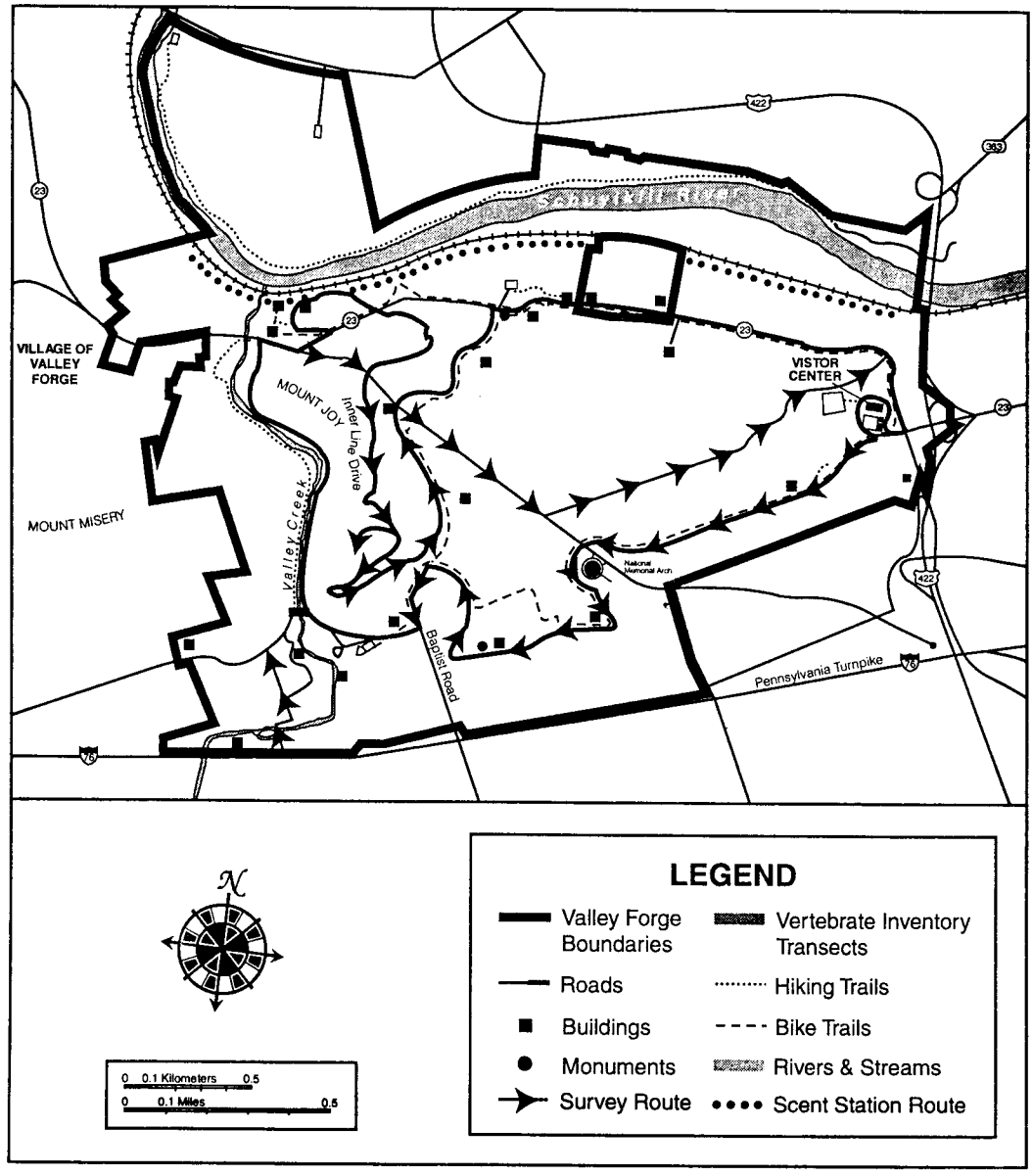


Figure 7. Location of the 11.3-km vehicular-road survey route and scent-station route at Valley Forge National Historical Park.

Methods

Pitfall-Trapping Protocol

We implemented the pitfall-trapping protocol to survey small mammals (Nixon et al. 1967, Cushwa and Burnham 1974, Lacki et al. 1990, Slade et al. 1993) at 10 study sites at GETT-EISE during summer 1993, at all nine study sites at HOFU during summer 1994, and at six study sites at HOFU during 1995 (Table 5). At each sampling point along transects, we excavated a hole for a pitfall container at least 1 week prior to trapping in order to minimize soil disturbance during the trapping period. One day prior to trapping, we placed a 1-gallon metal container in each hole with the opening oriented upward and flush with the soil surface. Pitfall traps were unbaited and checked each morning. Each trap was open for 2-4 consecutive nights (each night termed a trapnight) for a total of 13 nights during 1993 at GETT-EISE and six nights during 1994 at HOFU. Traps were open for five consecutive nights at HOFU during 1995. We conducted 559 trapnights with pitfalls during 1993 at GETT-EISE (43 sampling points during 13 nights), 270 trapnights with pitfalls during 1994 at HOFU (45 sampling points during six nights), and 150 trapnights with pitfalls during 1995 at HOFU (30 sampling points during five nights).

Live-Trapping Protocol

We live-trapped small mammals (Nixon et al. 1967, Cushwa and Burnham 1974, Lacki et al. 1990, Slade et al. 1993) at 10 GETT-EISE study sites during summer 1993, at all nine HOFU study sites during summer 1994 and six HOFU study sites during summer 1995, and at all six VAFO study sites during summer 1995 (Table 5) in the following manner. We placed two small Tomahawk live-traps (8 x 8 x 26 cm) a distance of 5 m from each sampling point and perpendicular to the transect (one on each side of the transect). Traps were baited with a mixture of peanut butter and rolled oats and supplied with a small piece of cotton for bedding. The treadle on each trap was set as sensitive as possible so that all small mammals, including small shrews, would spring the trap. Traps were checked each morning. Each trap was open two to four consecutive nights for a total of 13 nights at GETT-EISE during 1993 and six nights at HOFU during 1994. Traps were open for five consecutive nights at GETT during 1994 and at HOFU and VAFO during 1995. Based on two live-traps at each sampling point, we trapped 1118 trapnights during 1993 at GETT-EISE, 540 trapnights during 1994 at HOFU, 300 trapnights during 1995 at HOFU, and 300 trapnights with live-traps during 1995 at VAFO.

We conducted additional live-trapping to test a different live-trap arrangement and to increase the small mammals documented at GETT-EISE during July and August 1993 at five rock wall sites and during July 1994 at six study sites. We placed one small live-trap, which was baited with peanut butter and rolled oats and supplied with cotton for bedding, every 25 m along a given

Table 5. Seasons and study sites used for the small (S) and large (L) live-trapping protocols (LTT), pitfall-trapping protocol (PFT), and drift-fence protocol (DFE) at GETT-EISE, HOFU, and VAFO during 1993-95. No large live-traps were used unless otherwise noted. Study site abbreviations are defined in Tables 1-4.

Study Site	Summer 1993	Summer 1994	Summer 1995
GETT-EISE:			
PMG	LTT PFT	LTT	
VDG	LTT PFT		
WOF	LTT PFT		
POF	LTT PFT		
MOF	LTT PFT		
DOF	LTT PFT		
DDL	LTT PFT		
LFL	LTT PFT		
LRU	LTT PFT		
BRU	LTT PFT		
PMR	LTT		
VDR	LTT		
DDR	LTT		
HPR	LTT		
SWR	LTT		
RRG		LTT	
SAG		LTT	
EOF		LTT	
SCL		LTT	
CHU		LTT	

Table 5. (continued

Study Site	Summer 1993	Summer 1994	Summer 1995
HOFU:			
HRG		LTT PFT DFE	
PLO		LTT PFT DFE	LTT PFT DFE
PUO		LTT PFT DFE	LTT PFT DFE
PLL		LTT PFT DFE	LTT PFT DFE
HOL		LTT PFT DFE	
FCR		LTT PFT DFE	LTT PFT DFE
FCL		LTT PFT DFE	
PLU		LTT PFT DFE	LTT PFT DFE
SCU		LTT PFT DFE	LTT PFT DFE
VAFO:			
GWG			LTT (L&S)
VOF			LTT (L&S)
RRL			LTT (L&S)
JWL			LTT (L&S)
MMU			LTT (L&S)
MJU			LTT (L&S)

transect. We used 61 traps for 10 nights (3-4 consecutive nights at a time) for a total of 610 trapnights (19 July-6 August) at rock wall sites in 1993 and 60 traps for five consecutive nights for a total of 300 trapnights (12 July-16 July) at PMG, RRG, SAG, EOF, SCL, and CHU in 1994.

At the same time as with small live-traps, we also conducted five nights of live-trapping with large Tomahawk live-traps (13 x 13 x 41 cm) at VAFO during 1995. Because of the limited number of large live-traps, we placed one large trap at the first two sampling points on the transect at each site (n = 6) for a total of 12 large live-traps and 60 trapnights. As with small live-traps, large live-traps were baited with a mixture of peanut butter and rolled oats and were supplied with cotton.

For each small mammal captured, we recorded species, sex (rodents only), weight (g), and condition (i.e., pregnant, lactating, scrotal, dead, or recapture). We then marked rodents with numbered, metal ear tags, released the animals, and rebaited and reopened the traps if trapping that night. Dead individuals in good pelage condition were collected, prepared as museum specimens, tagged with location of capture, and placed in the Terrestrial Vertebrate Museum, School of Forest Resources, The Pennsylvania State University.

Drift-Fence Protocol

We tested the effectiveness of drift fences used in conjunction with pitfall and live-traps versus traps without drift fences at HOFU during summer 1994 and 1995 (Table 5). Drift fences were constructed of erosion cloth stapled to three wooden stakes, each 90-cm in length. Fences were 5-m long and 75-cm high. We placed a drift fence on each side of a pitfall trap perpendicular to the transect at alternate sampling points at each study site (Fig. 8). Live-traps were placed at the outer ends of each of the drift fences. Half of the grassland (n = 3), old-field (n = 5), lowland-forest (n = 10), and upland-forest (n = 5) sampling points contained drift fences.

Vehicular-Road Survey Protocol

We conducted vehicular-road surveys for mammals (Newman 1959, Rajala 1983) during July and August at GETT-EISE, HOFU, and VAFO. Surveys were conducted from 15 minutes before sunrise until 2 hours after sunrise (morning survey) or from 2 hours before sunset until sunset (evening survey). We drove the survey route at 15-25 km/hr and scanned all unobstructed habitat within a 100-m lateral distance of the road; all live mammals (excluding white-tailed deer) were noted. We conducted the road survey five times in the morning during 1993-94 at GETT-EISE, twice in the morning during 1995 at HOFU, and twice both in morning and evening during 1995 at VAFO. Temperature (°C), precipitation, percent cloud cover, wind velocity (kph), and starting

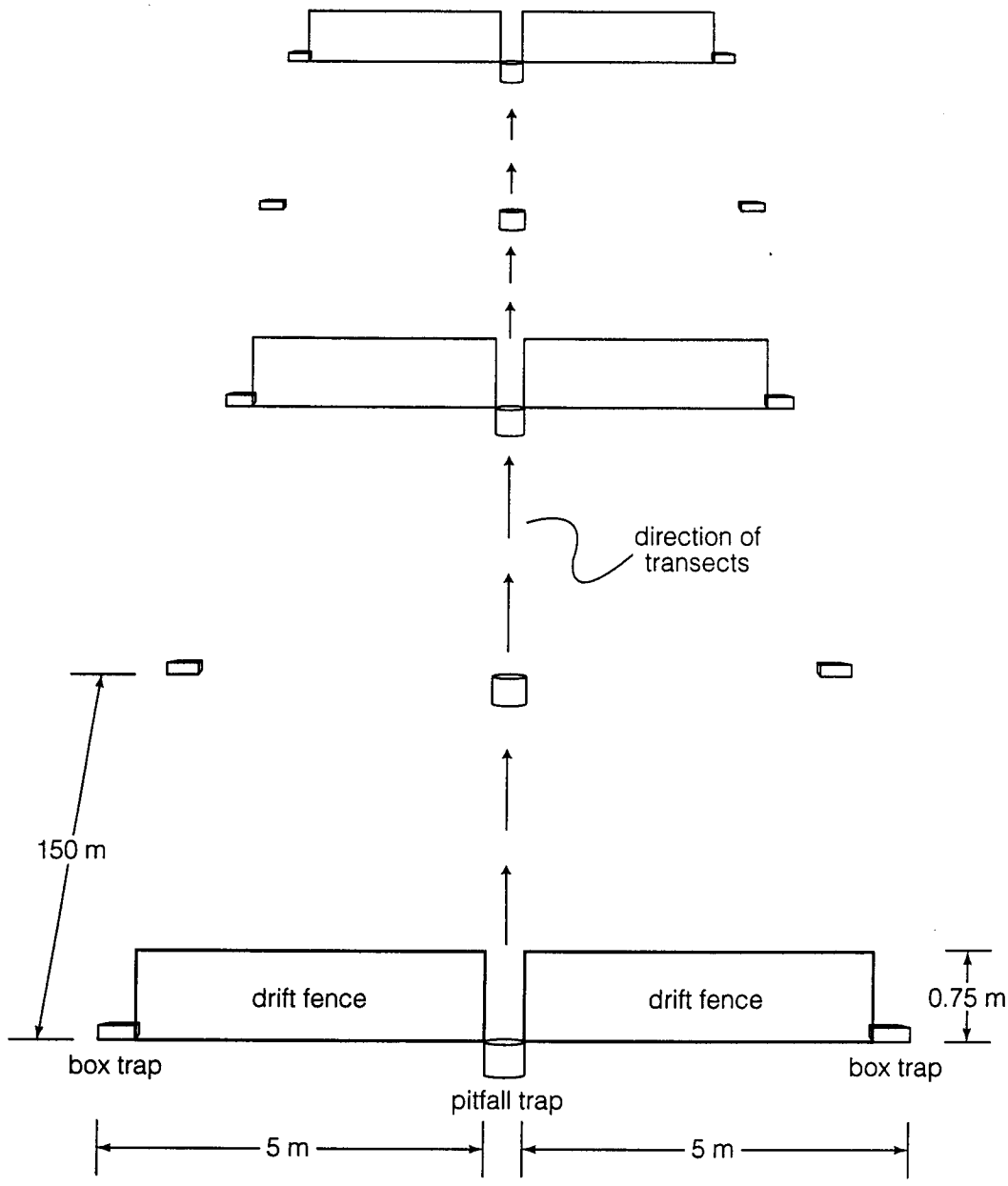


Figure 8. Spatial arrangement of the pitfall and live-trapping sampling points with drift fences (at HOFU only) and without drift fences (at GETT-EISE and HOFU). Sampling points at VAFO did not include pitfall traps.

and ending times were recorded for each survey. The number of each species of mammal observed was converted to a per km basis for standardization and comparison.

Scent-Station Survey Protocol

We conducted the scent-station survey protocol for mammals (Clark and Campbell 1983, Conner et al. 1983) during August 1995 at VAFO. We placed 10 sampling points at 500-m intervals along the railroad tracks adjacent to the RRL transect (Fig. 7). At each point, we established a scent station by sifting dry topsoil (approximately 1.7 gallons per station) onto a 1-m diameter circle. We then placed a small piece of cotton saturated with a liquid attractant (anise oil or synthetic fermented egg [SFE]) on the ground at the center of the station. We alternated the type of attractant to give five stations with anise oil and five stations with SFE. We checked

stations each of the following two mornings and identified all mammal tracks within the circle. We smoothed the sifted topsoil after tracks were identified the first morning. Because it was not possible to determine the number of individuals of each species visiting the station, scent stations were used only to detect the presence of a given species at each station. Abundance or density estimates could not be calculated.

Description and Update of the Faunal Database

The comprehensive Faunal Database for each of the parks (GETT-EISE, HOFU, and VAFO) was presented and detailed directions on its use was given in Technical Report NPS/MAR/NRTR-94/058 (Yahner et al. 1994b, 1994c). The database, which is maintained on the computer program *dBase III Plus* under the filenames GETT.DBF for GETT-EISE, HOFU.DBF for HOFU, and VAFO.DBF for VAFO, includes information on taxonomy, habitat use, residency status, legal status, and inventorying and monitoring protocols for all terrestrial vertebrate species (amphibians, reptiles, birds, and mammals) that were predicted or documented to occur in the parks. Scientific names for all vertebrate species mentioned in this report are given in the Faunal Database.

The database has been modified from that described in Yahner et al. (1994b, 1994c) to include mammalian species observed through 30 June 1996 by project researchers. Twelve variables are in the Faunal Database, including the original 11 variables plus a new variable (Field-tested Protocol, variable 12) that describes the protocol(s) field tested by us to document a given species at the parks. We also added a new code (PTC) to Occurrence Status (variable 8) to note a species that was documented while field-testing one or more of the protocols.

The mammal section of the current Faunal Database is presented in Appendix 1 for GETT-EISE, Appendix 2 for HOFU, and Appendix 3 for VAFO; these appendices give information on variables 1, 2, 5, and 8-12. Appendices 4-7 include the codes for variables 5 and 8-10 in the Faunal Database. Appendix 8 includes the codes for variables 11 and 12. Below is an example of a species entered in the database:

(1) Common Name (Meadow Vole)
(2) Scientific Name (*Microtus pennsylvanicus*)
(3) Family Name (Muridae)
(4) Order (Rodentia)
(5) *Pro-Cite* Group Name (Rodentia)
(6) Primary Habitat (31 [Herbaceous Rangeland])
(7) Secondary Habitat (21, 33 [Pasture, Mixed Rangeland])
(8) Occurrence Status (PTC, WOC)
(9) Residency Status (Permanent Resident)
(10) Legal Population Status (Protected)
(11) Protocol (STT [Snap-trapping])
(12) Field-Tested Protocol (LTT [Live-trapping]).

The Faunal Database can be modified continually by adding recently documented species. For instance, the occurrence status (variable 8) of a vertebrate species can be updated when it was designated as "predicted" but is later documented within the parks. Changes in taxonomic classification (variables 1-4) and legal status (variable 10) of each species can be updated. In addition, variable 11 (Protocol) and variable 12 (Field-Tested Protocol) in the Faunal Database can be modified as protocols are field tested or as new protocols are published for surveying mammals in the eastern United States.

The Faunal Database is available in diskette or hard copy form from the National Park Service, Chief Scientist, Philadelphia Support Office, U.S. Custom House, 200 Chestnut Street, Philadelphia, PA 19106 (Appendix 9).

Results

Gettysburg National Military Park and Eisenhower National Historic Site

We predicted that 59 mammalian species potentially occurred at GETT-EISE (Yahner et al. 1994b, 1994c) (Table 6). Of these species, nine (15%) species had been documented previously within the parks by various personnel and noted on National Park Service Wildlife Observation Cards. Based on field tests of protocols in our study, we found 13 mammalian species predicted or previously documented to occur at GETT-EISE. We also found 10 species through personal observations, including five species not found by protocol testing. By our field testing of protocols and personal observations of researchers at GETT-EISE, we increased the number of documented mammals to 21 species. Most of these documented species were from the Orders Carnivora (46%) and Rodentia (41%).

Hopewell Furnace National Historic Site

We also predicted that 59 mammalian species could probably be found at HOFU (Yahner et al. 1994b, 1994c) (Table 7). Of these species, six (10%) species had been documented previously within the park by various personnel and noted on National Park Service Wildlife Observation Cards. Based on field tests of protocols in our study, we found eight mammalian species predicted or previously documented to occur at HOFU. We also found 10 species by personal observations, including eight species not found by protocol testing. By our field testing of protocols and personal observations of researchers at HOFU, we increased the number of documented mammals to 18 species. Most of these documented species were representatives of the Order Rodentia (41%).

Valley Forge National Historical Park

We predicted that 59 mammalian species potentially occurred at VAFO (Yahner et al. 1994b, 1994c) (Table 8). Of these species, 18 (31%) species had been documented previously within the park by various personnel and noted on National Park Service Wildlife Observation Cards. Based on field tests of protocols in our study, we found eight mammalian species predicted or previously documented to occur at VAFO. We also found three species by personal observations, including the red fox, which was not found by protocol testing. By our field testing of protocols and personal observations of researchers at VAFO, we increased the number of documented mammals to 19 species. As at HOFU, the majority of documented species consisted of members of the Order Rodentia (50%).

Table 6. Number of mammalian species predicted, number of species documented by WOC[a] and during 1 July 1992 to 30 June 1996 by PO[b] and PTC[c], total species documented, and percent of predicted species documented at Gettysburg National Military Park and Eisenhower National Historic Site.

		Number Documented				
	No. Pred.	WOC	PO	PTC	Total	% Pred.
Mammalia	59	9	10	13	21	(36%)
Didelphimorphia	1	0	0	0	0	(0%)
Insectivora	8	1	1	2	3	(38%)
Chiroptera	11	0	2	0	2	(18%)
Carnivora	13	5	2	3	6	(46%)
Rodentia	22	3	4	7	9	(41%)
Lagomorpha	3	0	1	1	1	(33%)

[a] WOC = National Park Service Wildlife Observation Cards.
[b] PO = Personal observations by project researchers.
[c] PTC = Field testing of protocols by project researchers.

Table 7. Number of mammalian species predicted, number of species documented by WOC[a] and during 1 July 1992 to 30 June 1996 by PO[b] and PTC[c], total species documented, and percent of predicted species documented at Hopewell Furnace National Historic Site.

		Number Documented				
	No. Pred.	WOC	PO	PTC	Total	% Pred.
Mammalia	59	6	10	8	18	(31%)
Didelphimorphia	1	1	0	0	1	(100%)
Insectivora	8	0	0	2	2	(25%)
Chiroptera	11	0	2	0	2	(18%)
Carnivora	13	3	2	0	3	(23%)
Rodentia	22	2	5	5	9	(41%)
Lagomorpha	3	0	1	1	1	(33%)

[a] WOC = National Park Service Wildlife Observation Cards.
[b] PO = Personal observations by project researchers.
[c] PTC = Field testing of protocols by project researchers.

Table 8. Number of mammalian species predicted, number of species documented by WOC[a] and during 1 July 1992 to 30 June 1996 by PO[b] and PTC[c], total species documented, and percent of predicted species documented at Valley Forge National Historical Park.

		Number Documented				
	No. Pred.	WOC	PO	PTC	Total	% Pred.
Mammalia	59	18	3	8	19	(32%)
Didelphimorphia	1	1	0	0	1	(100%)
Insectivora	8	3	0	0	3	(38%)
Chiroptera	11	0	0	0	0	(0%)
Carnivora	13	3	1	2	3	(23%)
Rodentia	22	10	2	5	11	(50%)
Lagomorpha	3	1	0	1	1	(33%)

[a] WOC = National Park Service Wildlife Observation Cards.
[b] PO = Personal Observations by project researchers.
[c] PTC = Field testing of protocols by project researchers.

Time Required to Establish Transects and Sampling Points

On average, it required 1.75 person-hours and 1.4 person-hours to establish a 600-m transect (five sampling points) at HOFU and VAFO, respectively. This included time to establish the starting point and direction of the transect, traverse the transect, and mark each 50-m interval with surveyors flagging. We did not calculate the time required to establish a transect at GETT-EISE. The greater average time necessary to establish a transect at HOFU versus VAFO was attributed to more rugged terrain at HOFU than at VAFO.

Pitfall-Trapping Protocol

Gettysburg National Military Park and Eisenhower National Historic Site

Grassland Habitat: We captured one meadow jumping mouse at a grassland site (PMG) during 143 trapnights (Table 9, Appendix 10).

Old-Field Habitat: We observed two Maryland shrews and one northern short-tailed shrew in pitfall traps at old-field sites during 156 trapnights (Table 9). Both Maryland shrews were captured at the WOF site, and the northern short-tailed shrew was captured at the POF site (Appendix 10). This resulted in 1.9 individuals/100 trapnights for all species combined.

Lowland-Forest Habitat: We found one Maryland shrew and one northern short-tailed shrew during 130 trapnights at lowland-forest sites (Table 9). The total number of individuals/100 trapnights was 1.5 for all species combined.

Upland-Forest Habitat: We captured two Maryland shrews and two northern short-tailed shrews during 130 trapnights at upland-forest sites (Table 9). All individuals were found at the BRU site (Appendix 10). The total number of individuals/100 trapnights was 3.1 for all species combined.

Hopewell Furnace National Historic Site

Grassland Habitat: No species was captured at HRG during 1994.

Old-Field Habitat: We captured 11 masked shrews at two old-field sites during 1994 and 1995 combined (Table 10), giving 10.0 masked shrews/100 trapnights. Eight shrews were found at the PLO site.

Table 9. Total number of individuals and, in parentheses, average number of individuals (no./100 trapnights) of three small mammal species captured in pitfall traps at two grassland (PMG and VDG), four old-field (WOF, MOF, POF, and DOF), two lowland-forest (DDL and LFL), and two upland-forest (LRU and BRU) sites during summer 1993 at Gettysburg National Military Park and Eisenhower National Historic Site. No individuals were recaptured. Study site abbreviations are defined in Table 1.

Species	Grassland	Old-Field	Lowland-Forest	Upland-Forest	Total
Maryland Shrew	0 (0.0)	2 (1.3)	1 (0.8)	2 (1.5)	5 (0.9)
Northern Short-tailed Shrew	0 (0.0)	1 (0.6)	1 (0.8)	2 (1.5)	4 (0.7)
Meadow Jumping Mouse	1 (0.7)	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.2)
Trapnights	143	156	130	130	559
Total	1 (0.7)	3 (1.9)	2 (1.5)	4 (3.1)	10 (1.8)

Table 10. Total number of individuals and, in parentheses, average number of individuals (no./100 trapnights) of four small mammal species captured in pitfall traps at two old-field (PLO and PUO), four lowland-forest (PLL, HOL, FCL, and FCR), and two upland-forest (PLU and SCU) sites during summer 1994 and 1995 at Hopewell Furnace National Historic Site. No individuals were recaptured. Study site abbreviations are defined in Table 3.

Species	Old-Field	Lowland-Forest	Upland-Forest	Total
Masked Shrew	11 (10.0)	1 (0.6)	2 (1.8)	14 (3.6)
Northern Short-tailed Shrew	0 (0.0)	2 (1.2)	1 (0.9)	3 (0.8)
Meadow Vole	0 (0.0)	1 (0.6)	0 (0.0)	1 (0.3)
Meadow Jumping Mouse	0 (0.0)	1 (0.6)	0 (0.0)	1 (0.3)
Trapnights	110	170	110	390
Total	11 (10.0)	5 (2.9)	3 (2.2)	19 (4.9)

Lowland-Forest Habitat: We found two northern short-tailed shrews, one masked shrew, one meadow vole, and one meadow jumping mouse at lowland-forest sites during 1994 and 1995 combined (Table 10). Both short-tailed shrews were captured at the FCR site; other species were captured at the HOL site.

Upland-Forest Habitat: We noted two masked shrews and one northern short-tailed shrew at two upland-forest sites during 1994 and 1995 combined (Table 10). Both masked shrews were found at the SCU site; the northern short-tailed shrew was found at the PLU site. The total number of individuals/100 trapnights was 2.2 for all species combined.

Live-Trapping Protocol

Gettysburg National Military Park and Eisenhower National Historic Site

1993 Grassland Habitat: We captured five prairie deer mice (plus seven recaptures) and three meadow voles during 286 trapnights at two grassland sites in 1993 (Table 11). All deer mice were found at PMG, and all voles were found at VDG. This resulted in 2.8 individuals/100 trapnights for all species combined.

1993 Old-Field Habitat: We captured 21 white-footed mice (plus 30 recaptures), three Maryland shrews, three eastern chipmunks, two meadow voles (plus one recapture), and one northern short-tailed shrew at four old-field sites in 1993 (Table 12). The Maryland shrews and meadow voles were noted only at the WOF site. We captured 6.7 white-footed mice/100 trapnights, and the rate of recapture for this species was 59%. The POF site had the highest number of white-footed mice/100 trapnights (13.5). The total number of individuals/100 trapnights was greater in old-field habitats (9.6) than in grassland habitat (2.8).

1993 Forest Habitat: We captured 86 white-footed mice (plus 141 recaptures), six northern short-tailed shrews, five eastern chipmunks, one meadow jumping mouse, and one meadow vole during 520 trapnights at four forest sites in 1993 (Table 13). Most (60%) white-footed mice were recorded at the DDL and LFL sites combined. Five of the six northern short-tailed shrews were captured at the LRU site, and four of the five eastern chipmunks were found at the DDL site.

The total number of individuals/100 trapnights in forest habitat (19.0) was more than twice as many as in other habitats.

1993 Rock Wall Trapping Sites: We captured 55 white-footed mice (plus 102 recaptures), two prairie deer mice, and two northern short-tailed shrews during 610 trapnights at five rock wall sites in 1993 (Table 14). Forty-seven (85%) of the white-footed mice were captured at the HPR,

Table 11. Total number of different individuals, total number of recaptures, and, in parentheses, average number of individuals (no./100 trapnights) of two small mammal species captured in small live-traps at two grassland sites (PMG and VDG) during summer 1993 at Gettysburg National Military Park and Eisenhower National Historic Site. Study site abbreviations are defined in Table 1.

	Study Site		
Species	PMG	VDG	Total
Prairie Deer Mouse	5, 7 (3.2)	0, 0 (0.0)	5, 7 (1.7)
Meadow Vole	0, 0 (0.0)	3, 0 (2.3)	3, 0 (1.0)
Trapnights	156	130	286
Total	5, 7 (3.2)	3, 0 (2.3)	8, 7 (2.8)

Table 12. Total number of different individuals, total number of recaptures, and, in parentheses, average number of individuals (no./100 trapnights) of four small mammal species captured in small live-traps at four old-field sites during summer 1993 at Gettysburg National Military Park and Eisenhower National Historic Site. Study site abbreviations are defined in Table 1.

Species	Study Site				Total
	WOF	POF	MOF	DOF	
White-footed Mouse	3, 3 (2.9)	7, 6 (13.5)	4, 5 (5.1)	7, 16 (9.0)	21, 30 (6.7)
Meadow Vole	2, 1 (1.9)	0, 0 (0.0)	0, 0 (0.0)	0, 0 (0.0)	2, 1 (0.6)
Eastern Chipmunk	0, 0 (0.0)	1, 0 (1.9)	1, 0 (1.3)	1, 0 (1.3)	3, 0 (1.0)
Maryland Shrew	3, 0 (2.9)	0, 0 (0.0)	0, 0 (0.0)	0, 0 (0.0)	3, 0 (1.0)
Northern Short-tailed Shrew	0, 0 0.0	0, 0 0.0	0, 0 0.0	1, 0 (1.3)	1, 0 (0.3)
Trapnights	104	52	78	78	312
Total	8, 4 (7.7)	8, 6 (15.4)	5, 5 (6.4)	9, 16 (11.5)	30, 31 (9.6)

Table 13. Total number of different individuals, total number of recaptures, and, in parentheses, average number of individuals (no./100 trapnights) of five small mammal species captured in small live-traps at four forest sites during summer 1993 at Gettysburg National Military Park and Eisenhower National Historic Site. Study site abbreviations are defined in Table 1.

Species	Study Site				Total
	DDL	LFL	LRU	BRU	
White-footed Mouse	27, 36 (20.8)	25, 58 (19.2)	12, 19 (11.5)	22, 28 (14.1)	86, 141 (16.5)
Northern Short-tailed Shrew	0, 0 (0.0)	0, 0 (0.0)	5, 0 (4.8)	1, 0 (0.6)	6, 0 (1.2)
Eastern Chipmunk	4, 0 (3.0)	0, 0 (0.0)	0, 0 (0.0)	1, 0 (0.6)	5, 0 (1.0)
Meadow Jumping Mouse	1, 0 (0.8)	0, 0 (0.0)	0, 0 (0.0)	0, 0 (0.0)	1, 0 (0.2)
Meadow Vole	0, 0 (0.0)	1, 0 (0.8)	0, 0 (0.0)	0, 0 (0.0)	1, 0 (0.2)
Trapnights	130	130	104	156	520
Total	32, 36 (24.6)	26, 58 (20.0)	17, 19 (16.3)	24, 28 (15.4)	99, 141 (19.0)

Table 14. Total number of different individuals, total number of recaptures, and, in parentheses, average number of individuals (no./100 trapnights) of three small mammal species captured in small live-traps at five rock wall sites during summer 1993 at Gettysburg National Military Park and Eisenhower National Historic Site. Study site abbreviations are defined in Table 2.

Species	Study Site					Total
	HPR	DDR	PMR	SWR	VDR	
White-footed Mouse	25, 52 (11.4)	10, 22 (10.0)	12, 25 (9.2)	6, 3 (6.7)	2, 0 (2.9)	55, 102 (9.0)
Prairie Deer Mouse	0, 0 (0.0)	0, 0 (0.0)	2, 0 (1.5)	0, 0 (0.0)	0, 0 (0.0)	2, 0 (0.3)
Northern Short-tailed Shrew	2, 0 (0.9)	0, 0 (0.0)	0, 0 (0.0)	0, 0 (0.0)	0, 0 (0.0)	2, 0 (0.3)
Trapnights	220	100	130	90	70	610
Total	27, 52 (12.3)	10, 22 (10.0)	14, 25 (10.8)	6, 3 (6.7)	2, 0 (2.9)	59, 102 (9.7)

DDR, and PMR sites combined. Both deer mice were found at the PMR site, and both northern short-tailed shrews were found at the HPR site. Rate of capture for all sites was 9.7 individuals/ 100 trapnights for all species combined.

1994 Grassland Habitat: We captured 20 meadow voles (plus two recaptures) and six white-footed mice (plus one recapture) during 150 trapnights at three grassland (PMG, RRG, and SAG) sites in 1994 (Table 15). Most meadow voles (15) were found at the RRG site, and most white-footed mice (5) were found at the SAG site. The total number of individuals/100 trapnights was 17.3.

1994 Old-Field Habitat: We found two meadow voles at the EOF site during 50 trapnights during 1994.

1994 Forest Habitat: We noted 12 white-footed mice (plus four recaptures) and one northern short-tailed shrew during 100 trapnights at two forest sites (SCL and CHU) during 1994 (Table 15). Eight of the 12 mice were captured at the SCL site. Rate of capture for all sites was 13.0 individuals/100 trapnights.

Hopewell Furnace National Historic Site

Grassland Habitat: We captured one northern short-tailed shrew at the HRG site during 72 trapnights in 1994.

Old-Field Habitat: We found 27 white-footed mice (plus 25 recaptures), two meadow voles, and one each of eastern chipmunk and meadow jumping mouse during 220 trapnights at two old-field sites during 1994-95 (Table 16). Most (70%) white-footed mice were noted at the PUO site, and all other species were captured at the PLO site. The total rate of capture for all species combined was 14.1 individuals/100 trapnights.

Lowland-Forest Habitat: We captured 65 white-footed mice (plus 63 recaptures), two eastern chipmunks (plus one recapture), and one northern short-tailed shrew during 340 trapnights at four lowland-forest sites during 1994 and 1995 (Table 17). All chipmunk and shrew captures were observed at the FCR site. Most (72%) white-footed mice were noted at PLL and FCR sites combined. The total number of individuals/100 trapnights in lowland-forest sites (20.0) was greater than at old-field sites (14.1).

Upland-Forest Habitat: We captured 31 white-footed mice (plus 22 recaptures), one eastern chipmunk, and one northern short-tailed shrew during 220 trapnights at two upland-forest sites during 1994 and 1995 (Table 18). The chipmunk and short-tailed shrew and most (68%) white-footed mice were found at the PLU site. We noted 15.0 individuals/100 trapnights for all species combined.

Table 15. Total number of different individuals, total number of recaptures, and, in parentheses, average number of individuals (no./100 trapnights) of three small mammal species captured in small live-traps at three grassland (PMG, RRG, and SAG), one old-field (EOF), and two forest (SCL and CHU) sites during summer 1994 at Gettysburg National Military Park and Eisenhower National Historic Site. Study site abbreviations are defined in Table 2.

Species	Grassland	Old-Field	Forest	Total
White-footed Mouse	6, 1 (4,0)	0, 0 (0.0)	12, 4 (12.0)	18, 5 (6.0)
Northern Short-tailed Shrew	0, 0 (0.0)	0, 0 (0.0)	1, 0 (1.0)	1, 0 (0.3)
Meadow Vole	20, 2 (13.3)	2, 0 (4.0)	0, 0 (0.0)	22, 2 (7.3)
Trapnights	150	50	100	300
Total	26, 3 (17.3)	2, 0 (4.0)	13, 4 (13.0)	41, 7 (13.7)

Table 16. Total number of different individuals, total number of recaptures, and, in parentheses, average number of individuals (no./100 trapnights) of four mammal species captured in small live-traps at two old-field sites during the summers of 1994 and 1995 at Hopewell Furnace National Historic Site. Study site abbreviations are defined in Table 3.

Species	Study Site		Total
	PLO	PUO	
White-footed Mouse	8, 8 (7.3)	19, 17 (17.3)	27, 25 (12.3)
Eastern Chipmunk	1, 0 (0.9)	0, 0 (0.0)	1, 0 (0.5)
Meadow Vole	2, 0 (1.8)	0, 0 (0.0)	2, 0 (0.9)
Meadow Jumping Mouse	1, 0 (0.9)	0, 0 (0.0)	1, 0 (0.5)
Trapnights	110	110	220
Total	12, 8 (10.9)	19, 17 (17.3)	31, 25 (14.1)

Table 17. Total number of different individuals, total number of recaptures, and, in parentheses, average number of individuals (no./100 trapnights) of three mammal species captured in small live-traps at four lowland-forest sites during the summers of 1994 and 1995 at Hopewell Furnace National Historic Site. Study site abbreviations are defined in Table 3.

	Study Site				
Species	PLL	HOL	FCR	FCL	Total
White-footed Mouse	24, 15 (21.8)	10, 11 (16.7)	23, 30 (20.9)	8, 6 (13.3)	65, 62 (19.1)
Eastern Chipmunk	0, 0 (0.0)	0, 0 (0.0)	2, 1 (1.8)	0, 0 (0.0)	2, 1 (0.5)
Northern Short-tailed Shrew	0, 0 (0.0)	0, 0 (0.0)	1, 0 (0.9)	0, 0 (0.0)	1, 0 (0.3)
Trapnights	110	60	110	60	340
Total	24, 15 (21.8)	10, 11 (16.7)	26, 31 (23.6)	8, 6 (13.3)	68, 63 (20.0)

Table 18. Total number of different individuals, total number of recaptures, and, in parentheses, average number of individuals (no./100 trapnights) of three mammal species captured in small live-traps at two upland-forest sites during the summers of 1994 and 1995 at Hopewell Furnace National Historic Site. Study site abbreviations are defined in Table 3.

	Study Site		
Species	PLU	SCU	Total
White-footed Mouse	21, 17 (19.1)	10, 5 (9.1)	31, 22 (14.1)
Eastern Chipmunk	1, 0 (0.9)	0, 0 (0.0)	1, 0 (0.5)
Northern Short-tailed Shrew	1, 0 (0.9)	0, 0 (0.0)	1, 0 (0.5)
Trapnights	110	110	220
Total	23, 17 (20.9)	10, 5 (9.1)	33, 22 (15.0)

Valley Forge National Historical Park

Grassland Habitat: The meadow vole was the only species captured at the grassland site in 1995. Twenty-two meadow voles (plus two recaptures) were observed at GWG, and all voles were captured in small live-traps (Appendix 12).

Old-Field Habitat: We found four meadow voles (plus two recaptures) during 50 trapnights with small live-traps at the old-field site during 1995. The rate of capture at the old-field site (8.0) was much lower than at the grassland site (44.0).

Lowland-Forest Habitat: We captured 18 white-footed mice (plus 15 recaptures) and one gray squirrel at the two lowland-forest sites during 1995 (Table 19). The squirrel at JWL was found in a large live-trap (20 large trapnights), and all white-footed mice were found in small live-traps. The total rate of capture for all species combined and both trap sizes was 15.8/100 trapnights.

Upland-Forest Habitat: We captured two gray squirrels and one eastern chipmunk with large traps (20 trapnights) at two upland-forest sites during 1995 (Table 19). No mammals were captured in small traps. The chipmunk and one squirrel were found at MMU. The total rate of capture for all species and both trap sizes combined was 2.5 individuals/100 trapnights.

Time Required for Trapping

It required 20.5 person-hours to place 43 pitfall traps during summer 1993 at GETT-EISE; hence, each pitfall trap required an average of 0.5 person-hours to dig. In addition, approximately 8.0 person-hours were necessary to open and bait 147 live-traps (5.6 person-hours/100 live-traps). We needed 9.5 person-hours (5.0 person-hours/100 traps) to check all pitfall traps and live-traps; to tag, measure, and release all captures; and to rebait the live-traps during summer 1993.

It required 8.5 person-hours (11.8 person-hours/100 traps) to open and bait 72 live-traps during August 1995 at VAFO. In addition, checking and rebaiting the live-traps and tagging, measuring, and releasing all captures required approximately 8.0 person-hours (11.1 person-hours/100 traps) each day. We did not record time necessary to bait and check traps at GETT-EISE during 1994 or at HOFU during 1994 and 1995.

Drift Fence with Pitfall-Trapping at Hopewell Furnace National Historic Site

Grassland Habitat: No species was captured at HRG during 1994.

Table 19. Total number of different individuals, total number of recaptures, and, in parentheses, average number of individuals (no./100 trapnights) of four mammal species captured in small and large live-traps at one grassland site (GWG), one old-field site (VOF), two lowland-forest sites (JWL and RRL), and two upland-forest sites (MMU and MJU) during mid-August 1995 at Valley Forge National Historical Park. Study site abbreviations are defined in Table 4.

	Grassland		Old-Field		Lowland-Forest		Upland-Forest		Total	
Species	Small	Large	Small	Large	Small	Large	Small	Large	Small	Large
Meadow Vole	22, 2 (44.0)	0, 0 (0.0)	4, 2 (8.0)	0, 0 (0.0)	0, 0 (0.0)	0, 0 (0.0)	0, 0 (0.0)	0, 0 (0.0)	26, 4 (8.7)	0, 0 (0.0)
White-footed Mouse	0, 0 (0.0)	0, 0 (0.0)	0, 0 (0.0)	0, 0 (0.0)	18, 15 (18.0)	0, 0 (0.0)	0, 0 (0.0)	0, 0 (0.0)	18, 15 (6.0)	0, 0 (0.0)
Eastern Chipmunk	0, 0 (0.0)	0, 0 (0.0)	0, 0 (0.0)	0, 0 (0.0)	0, 0 (0.0)	0, 0 (0.0)	0, 0 (0.0)	1, 0 (5.0)	0, 0 (0.0)	1, 0 (1.7)
Gray Squirrel	0, 0 (0.0)	0, 0 (0.0)	0, 0 (0.0)	0, 0 (0.0)	0, 0 (0.0)	1, 0 (5.0)	0, 0 (0.0)	2, 0 (10.0)	0, 0 (0.0)	3, 0 (5.0)
Trapnights	50	10	50	10	100	20	100	20	300	60
Total	22, 2 (44.0)	0, 0 (0.0)	4, 2 (8.0)	0, 0 (0.0)	18, 15 (18.0)	1, 0 (5.0)	0, 0 (0.0)	3, 0 (15.0)	44, 19 (14.7)	4, 0 (6.7)

Old-Field Habitat: We captured 11 masked shrews in pitfall traps during 110 trapnights at two old-field sites at HOFU during 1994 and 1995 (Table 20). Seven and four masked shrews were noted with drift fences and without drift fences, respectively.

Lowland-Forest Habitat: We captured one each of masked shrew, northern short-tailed shrew, meadow jumping mouse, and meadow vole in pitfall traps with drift fences during 85 trapnights at four lowland-forest sites at HOFU during 1994 and 1995 (Table 20). A short-tailed shrew was found in a pitfall trap without drift fences. The total number of individuals/100 trapnights captured with drift fences was 4.7, which was greater than the number of individuals/100 trapnights captured without drift fences (1.2).

Upland-Forest Habitat: We captured two masked shrews and one northern short-tailed shrew during 55 trapnights in pitfall traps with drift fences at two upland-forest sites at HOFU during 1994 and 1995 (Table 20). No species was recorded during 55 trapnights in pitfall traps without drift fences at upland-forest sites. This resulted in 5.5 individuals/100 trapnights in pitfall traps with drift fences.

All Habitats: In summary, we noted 14 individuals of four species during 195 trapnights with drift fences and five individuals of two species during 195 trapnights without drift fences at all eight sites combined during 1994 and 1995 (Table 21). The most common species captured with pitfall traps was the masked shrew, particularly when drift fences were used. A total of 7.2 individuals/100 trapnights and 2.6 individuals/100 trapnights of all species combined was noted with and without drift fences, respectively.

Drift Fence with Live-trapping at Hopewell Furnace National Historic Site

Old-Field Habitat: We found 12 white-footed mice (plus 11 recaptures) and one meadow vole in live-traps with drift fences during 110 trapnights at old-field sites at HOFU during 1994 and 1995 (Table 22). In contrast, we noted 15 white-footed mice (plus 14 recaptures), one meadow jumping mouse, and one eastern chipmunk in live-traps without drift fences during 110 trapnights. The total number of individuals/100 trapnights was higher without drift fences (15.5) than with drift fences (11.8) for all species combined.

Lowland-Forest Habitat: We captured 32 white-footed mice (plus 37 recaptures) and one eastern chipmunk in live-traps with drift fences during 170 trapnights at lowland-forest sites at HOFU during 1994 and 1995 (Table 22). Of the 35 individuals that we captured in live-traps without drift fences, we found 33 white-footed mice (plus 25 recaptures), one northern short-tailed shrew, and one eastern chipmunk (plus one recapture). The total number of individuals/100 trapnights for all species combined was 19.4 with drift fences and 20.6 without drift fences.

Table 20. Total number of individuals, and, in parentheses, average number of individuals (no./100 trapnights) of four mammal species captured in pitfall traps with and without drift fences at two old-field sites (PLO and PUO), four lowland-forest sites (PLL, FCR, FCL, and HOL), and two upland-forest sites (SCU and PLU) during the summers of 1994 and 1995 at Hopewell Furnace National Historic Site. No individuals were recaptured. Study site abbreviations are defined in Table 3.

Species	Old-Field		Lowland Forest		Upland Forest	
	Drift Fence	No Drift Fence	Drift Fence	No Drift Fence	Drift Fence	No Drift Fence
Masked Shrew	7 (12.7)	4 (7.3)	1 (1.2)	0 (0.0)	2 (3.6)	0 (0.0)
Northern Short-tailed Shrew	0 (0.0)	0 (0.0)	1 (1.2)	1 (1.2)	1 (1.8)	0 (0.0)
Meadow Jumping Mouse	0 (0.0)	0 (0.0)	1 (1.2)	0 (0.0)	0 (0.0)	0 (0.0)
Meadow Vole	0 (0.0)	0 (0.0)	1 (1.2)	0 (0.0)	0 (0.0)	0 (0.0)
Trapnights	55	55	85	85	55	55
Total	7 (12.7)	4 (7.3)	4 (4.7)	1 (1.2)	3 (5.5)	0 (0.0)

Table 21. Total number of individuals and, in parentheses, average number of individuals (no./100 trapnights) of four mammal species captured in pitfall traps with and without drift fences at eight study sites during the summers of 1994 and 1995 at Hopewell Furnace National Historic Site. No individuals were recaptured.

Species	Drift Fence	No Drift Fence
Masked Shrew	10 (5.1)	4 (2.1)
Northern Short-tailed Shrew	2 (1.0)	1 (0.5)
Meadow Vole	1 (0.5)	0 (0.0)
Meadow Jumping Mouse	1 (0.5)	0 (0.0)
Trapnights	195	195
Total	14 (7.2)	5 (2.6)

Table 22. Total number of different individuals, total number of recaptures, and, in parentheses, average number of individuals (no./100 trapnights) of five mammal species captured in small live-traps with and without drift fences at two old-field sites (PLO and PUO), four lowland-forest sites (PLL, FCR, FCL, and HOL), and two upland-forest sites (SCU and PLU) during the summers of 1994 and 1995 at Hopewell Furnace National Historic Site. Study site abbreviations are defined in Table 3.

Species	Old-Field		Lowland-Forest		Upland-Forest	
	Drift Fence	No Drift Fence	Drift Fence	No Drift Fence	Drift Fence	No Drift Fence
Northern Short-tailed Shrew	0, 0 (0.0)	0, 0 (0.0)	0, 0 (0.0)	1, 0 (0.6)	1, 0 (0.9)	0, 0 (0.0)
White-footed Mouse	12, 11 (10.9)	15, 14 (13.6)	32, 37 (18.8)	33, 25 (19.4)	15, 12 (13.6)	16, 10 (14.6)
Meadow Jumping Mouse	0, 0 (0.0)	1, 0 (0.9)	0, 0 (0.0)	0, 0 (0.0)	0, 0 (0.0)	0, 0 (0.0)
Meadow Vole	1, 0 (0.9)	0, 0 (0.0)	0, 0 (0.0)	0, 0 (0.0)	0, 0 (0.0)	0, 0 (0.0)
Eastern Chipmunk	0, 0 (0.0)	1, 0 (0.9)	1, 0 (0.6)	1, 1 (0.6)	0, 0 (0.0)	1, 0 (0.9)
Trapnights	110	110	170	170	110	110
Total	13, 11 (11.8)	17, 14 (15.5)	33, 37 (19.4)	35, 26 (20.6)	16, 12 (14.6)	17, 10 (15.5)

Upland-Forest Habitat: We noted 15 white-footed mice (plus 12 recaptures) and one northern short-tailed shrew in live-traps with drift fences during 110 trapnights at two upland-forest sites at HOFU during 1994 and 1995 (Table 22). In live-traps without drift fences, we captured 16 white-footed mice (plus 10 recaptures) and one eastern chipmunk. This resulted in a total of 14.6 individuals/100 trapnights and 15.5 individuals/100 trapnights for all species combined with and without drift fences, respectively.

All Habitats: In summary, we found 62 individuals (plus 60 recaptures) of four species during 390 trapnights with drift fences and 69 individuals (plus 50 recaptures) of four species during 390 trapnights without drift fences in live-traps for all habitats combined at HOFU during 1994 and 1995 (Table 23). We noted more white-footed mice, which was the most numerous species, without drift fences; however, we found more recaptures with drift fences. No meadow voles were captured in live-traps without drift fences, and no meadow jumping mice were captured in live-traps with drift fences at any site. A total of 15.9 individuals/100 trapnights and 17.7 individuals/100 trapnights of all species combined was noted with and without drift fences, respectively.

Time Required for Drift-Fence Protocol

It required an average of 0.25 person-hours/sampling point to install drift fences at HOFU. This was in addition to time required to place pitfall traps and live-traps.

Vehicular-Road Survey Protocol

Gettysburg National Military Park and Eisenhower National Historic Site

We noted 45 (79%) eastern chipmunks, 10 (18%) gray squirrels, one (2%) woodchuck, and one (2%) eastern cottontail while conducting five road surveys (each survey was 20.8 km in length) during the summers of 1993 and 1994 (Table 24). The average numbers of eastern chipmunks and gray squirrels observed per survey was 9.0 and 2.0, respectively, giving 0.43 eastern chipmunk/km and 0.10 gray squirrels/km. The survey route required 2.5 hours to set-up and test-run, and each survey required an average of 65 minutes (3.1 minutes/km) to conduct.

Hopewell Furnace National Historic Site

We observed one gray squirrel and one eastern cottontail while conducting two road surveys (each survey was 8.0 km) during the summer of 1995 (Table 24), or 0.50 individuals of each species per survey. The average number of gray squirrels and eastern cottontails observed per km was 0.06 and 0.06, respectively. The road survey route required 2.0 hours to set-up and test-run, and each survey required an average of 25.0 minutes (3.1 minutes/km) to conduct.

Table 23. Total number of different individuals, total number of recaptures, and, in parentheses, average number of individuals (no./100 trapnights) of five mammal species captured in small live-traps with and without drift fences at eight study sites during the summers of 1994 and 1995 at Hopewell Furnace National Historic Site

Species	Drift Fence	No Drift Fence
White-footed Mouse	59, 60 (15.1)	64, 49 (16.4)
Eastern Chipmunk	1, 0 (0.3)	3, 1 (0.8)
Northern Short-tailed Shrew	1, 0 (0.3)	1, 0 (0.3)
Meadow Vole	1, 0 (0.3)	0, 0 (0.0)
Meadow Jumping Mouse	0, 0 (0.0)	1, 0 (0.3)
Trapnights	390	390
Total	62, 60 (15.9)	69, 50 (17.7)

Table 24. Total number of individuals detected, number of individuals/km (in parentheses), survey route length, and total distance surveyed while conducting the vehicular-road survey protocol during five morning surveys during 1993 and 1994 at Gettysburg National Military Park and Eisenhower National Historic Site (GETT-EISE), two morning surveys during 1995 at Hopewell Furnace National Historic Site (HOFU), and two morning and two night surveys during 1995 at Valley Forge National Historical Park (VAFO).

	GETT-EISE	HOFU	VAFO
Eastern Chipmunk	45 (0.43)	0 (0.00)	0 (0.00)
Gray Squirrel	10 (0.10)	1 (0.06)	29 (0.64)
Woodchuck	1 (0.01)	0 (0.00)	32 (0.71)
Eastern Cottontail	1 (0.01)	1 (0.06)	10 (0.22)
Total	57 (0.55)	2 (0.13)	71 (1.57)
Survey route length (km)	20.8	8.0	11.3
Total distance surveyed (km)	104.0	16.0	45.2

Valley Forge National Historical Park

We recorded 32 (45%) woodchucks, 29 (41%) gray squirrels, and 10 (14%) eastern cottontails while conducting the four vehicular-road surveys (each survey was 11.3 km in length) in August 1995 (Table 24). The average numbers of woodchucks, gray squirrels, and eastern cottontails observed per survey were 8.00, 7.25, and 2.50, respectively. Based on the total distance surveyed (45.2 km), 0.71 woodchucks, 0.64 gray squirrels, and 0.22 cottontails per km were seen.

During the two morning road surveys, 18 (51%) woodchucks, 13 (37%) gray squirrels, and four (11%) eastern cottontails were noted. The average numbers of woodchucks, gray squirrels, and eastern cottontails observed per morning road survey were 9.00, 6.50, and 2.00, respectively; numbers of woodchucks, gray squirrels, and eastern cottontails observed per km were 0.80, 0.58, and 0.18, respectively.

During the two evening road surveys, 14 (39%) woodchucks, 16 (44%) gray squirrels, and six (17%) eastern cottontails were found. The average numbers of woodchucks, gray squirrels, and eastern cottontails detected per evening road survey were 7.00, 8.00, and 3.00, respectively; numbers of woodchucks, gray squirrels, and eastern cottontails detected per km were 0.62, 0.71, and 0.27, respectively. The road survey route required 2.5 hours to establish and test-run. A survey required an average of 64 minutes (5.7 minutes/km) to conduct.

Scent-Station Survey Protocol

Nine (45%) of 20 scent-station nights were visited by four mammal species during two consecutive survey nights (10 stations per survey) during mid-August 1995 at VAFO (Table 25). Each of the nine stations was visited by only one mammal species. Four (44%) of the stations visited were by raccoons, two (22%) each by striped skunks and gray squirrels, and one (11%) by a white-footed mouse. One station also was visited by an unknown bird species. The average number of station-nights visited by raccoons, striped skunks, gray squirrels, and white-footed mice per survey was 2.0, 1.0, 1.0, 0.5, respectively.

Four of the stations visited contained anise oil; three of the visits were by raccoons and one visit was by the mouse. Five (50%) of the 10 stations containing synthetic fermented egg were visited by three species: two striped skunks, two gray squirrels, and one raccoon. The average number of stations containing synthetic fermented egg visited by striped skunks, gray squirrels, and raccoons per survey were 1.0, 1.0, and 0.5, respectively.

A scent-station survey (10 stations) required 9.0 person-hours to establish (0.9 person-hours per station) and an average of 55 minutes (5.5 minutes/station) to check for mammal tracks.

Table 25. Number of scent stations containing anise oil, synthetic fermented egg, and total scent stations visited by four mammal species during 1995 at Valley Forge National Historical Park.

	Anise Oil	Synthetic Fermented Egg	Total
Raccoon	3	1	4
Striped Skunk	0	2	2
Gray Squirrel	0	2	2
White-footed Mouse	1	0	1
Number of station-nights	10	10	20
Total	4	5	9

Discussion

Gettysburg National Military Park and Eisenhower National Historic Site

We documented 13 mammalian species while testing three protocols at GETT-EISE. Seven of these species were found with live-traps, and three species were noted with pitfall traps. The Maryland shrew and the Northern short-tailed shrew were found more often in pitfall traps than live-traps. Pitfall traps required 0.5 person-hours/trap to dig but no maintenance, whereas live-traps required less time (0.1 person-hours/live-traps) to set but more maintenance (e.g., opening and baiting) than pitfall traps. Hence, we found that live-trapping is advantageous to pitfall trapping to survey small mammals. However, pitfalls have the advantage of sampling amphibians and reptiles at the same time as mammals.

The vehicular-road survey protocol documented four mammalian species at GETT-EISE and required little time to set-up and conduct. The relative effectiveness of this protocol to survey medium-sized mammals is unknown because we tested no other protocols that emphasized these species.

Hopewell Furnace National Historic Site

We detected four mammalian species with each of three protocols at HOFU: the live-trapping protocol without drift fences, live-trapping protocol with drift fences, and pitfall-trapping protocol with drift fences. In contrast, we noted only two species, the northern short-tailed shrew and the masked shrew, in pitfall traps without drift fences. We found the highest abundances of two very common forest mammals, the white-footed mouse and the eastern chipmunk, in live-traps without drift fences.

The use of drift fences with pitfall traps increased the number of species and individuals captured over pitfall traps without drift fences. For instance, the meadow vole and the meadow jumping mouse occurred in pitfall traps with drift fences but not in pitfall traps without drift fences. Moreover, we found a three-fold increase in number of individuals captured of all species combined in pitfall traps with drift fences than in pitfall traps without drift fences.

In contrast to our results with pitfall traps, we captured fewer individuals in live-traps with drift fences compared to live-traps without drift fences. The meadow vole was not captured in live-traps without drift fences, whereas the meadow jumping mouse was not captured in live-traps with drift fences.

Although the vehicular-road survey protocol required little time to establish and conduct, it was not as effective for surveying medium-sized mammals at HOFU as compared to GETT-EISE. We found only two species with this protocol at HOFU.

Valley Forge National Historical Park

We detected four mammalian species each with the live-trapping protocol and the scent-station survey protocol. Eastern chipmunks and meadow voles were found exclusively by live-trapping, and the raccoon and striped skunk were detected only with the scent-station protocol.

We did not capture any insectivores at VAFO using the live-trapping protocol. Because insectivores tend to be more active in wet conditions, the drought conditions experienced at the park between April 1995 and the trapping period may have precluded their activity and capture (Yahner 1992). The drought also may have been responsible for the low number of live-trap captures (3 individuals/100 trapnights) at the two upland-forest sites.

The vehicular-road survey protocol was particularly useful for observing woodchucks and eastern cottontails. This protocol required little time to set-up and test-run (2.5 person-hours) and to conduct (1.0 person-hours).

Suggested Inventory and Monitoring Program for Mammals

Introductory Considerations

Sixty-three extant species of mammals occur in Pennsylvania, compared to 372 species of birds and 75 species of amphibians and reptiles (Yahner 1997). In our study of four national parks in Pennsylvania from 1992-96, we predicted that 59 mammal species could potentially be found at GETT-EISE, HOFU, and VAFO (Tables 6-8); 59 species represents 94% of the extant mammalian species in the state. These predictions were based on various types of information, e.g., published field guides of the geographic distribution of mammals in the state.

Only 31-36% of the 59 mammalian species predicted to occur in the parks were documented in our study. At least three reasons may explain this low number of documented species. First, numbers of certain species in a given park may be too low to be easily detected within the scope of our project. Second, some species require specific inventory protocols that were not tested in our study. For example, bat detectors are an excellent way to monitor breeding populations of bats, but they were not tested in our study. Third, geographic distributions given for some species in popular field guides are often very broad. Hence, a park may be within the potential geographic range of a particular species, but that species may not be found in the park because the park is relatively small or may not contain all the necessary ecological requirements of the species. Thus, because of ecological and logistical constraints, a natural resource manager using typical inventory and monitoring procedures and efforts should probably expect to document only about 40-60% of the total mammalian species predicted to occur in a given park, which includes between 25 and 40 of the extant species in Pennsylvania.

Natural resource managers should develop a comprehensive inventory and monitoring program for mammals that has reasonable objectives, given the ecological and logistical constraints of a particular park. We recommend that each park achieve at least two specific objectives:

(1) To inventory and monitor approximately 40-60% of the predicted species richness (list of species) of mammals in the park.
(2) To inventory and monitor the relative abundance of key subsets of the mammalian fauna in the park.

However, before these objectives can be achieved, at least two interrelated and specific questions should be addressed by natural resource managers before beginning an inventory and monitoring program for mammals: (1) What types of information are needed about mammal abundance and distribution in a park? (2) What are potential ecological and logistical constraints that may influence the success of the program?

Types of Information Needed

Natural resource managers interested in an inventory and monitoring program for mammals initially begin by simply deriving a list of documented species in a park; this simple measure of mammal diversity is termed species richness. A list of previously documented species often can be readily obtained from existing data sources, such as previous studies conducted in the park, museum voucher specimens, or NPS wildlife observation cards (WOC). The use of WOC is particularly useful because often these records are ongoing and can be maintained over an extended time period by park personnel with little effort; WOC provide information on relatively uncommon species in a park, such as mobile, wide-ranging carnivores (e.g., mink). However, the expertise of the observer must be taken into consideration.

A measure of species richness of mammals in a given park has considerable value because it may be determined with relatively low cost and labor and may be used in the long-term for monitoring of mammalian biodiversity within the park and contiguous areas. This measure, however, has two disadvantages. First, a complete list of all mammals in a park may be difficult to obtain because of the cryptic nature of some mammals and because some species may require considerable time, monies, and expertise to inventory and monitor (e.g., bats). Second, a simple list of species gives no information on the abundance and distribution of mammals in the park.

Natural resource managers may wish to increase their understanding of mammalian fauna in a park by stating additional objectives that determine some measure of the relative abundance of a given subset(s) of mammals. Small mammals (i.e., rodents, shrews, and chipmunks) are an excellent subset of species to include in an inventory and monitoring program because are major components of the food chain and, hence, are excellent barometers of environmental change or degradation. Furthermore, they typically consist of a variety of species, have relatively high population numbers, and occur in a variety of habitats. For example, in our study, we documented between 44-50% of the predicted species of rodents in each of the four parks. With minimal training and experience, most small mammals can be readily captured at the same time of year (late summer-early autumn) and using the same survey protocol (e.g., trap type, number of trap-nights) in a variety of habitats. Verification of species identity by experts familiar with mammalian taxonomy of the region, however, is advised because some species exhibit similar external characteristics (e.g., pelage coloration).

Duration and Scope of Project

If an objective of natural resource managers is simply to obtain some information of the presence/absence of mammals in a given park, then a conservative list of predicted and documented list of species can be obtained within a relatively short time period (e.g., few months). This can be achieved by collating a list of mammalian species recorded in the park

from previous natural resource studies, museum voucher specimens, wildlife observation cards, or other sources of information. However, a comprehensive measure of species richness using formal sampling protocols may take a much longer time period, depending on the availability of resources and expertise. Monitoring the presence/absence of species for a minimum of 3 years may be required to determine whether or not various mammalian species are resident or transient in a park.

We recommend that the relative abundance of a given subset(s) of mammalian species be determined for a minimum of 2-3 years because some environmental perturbation may affect the likelihood of capturing certain species in any given year. For instance, during a 3-year study of mammalian communities associated with managed forest stands in central Pennsylvania, shrews were not captured in one year because of a severe summer drought (Yahner 1992). If a project were limited to a single field season, an inaccurate picture of mammalian abundance may be obtained as a result of natural year-to-year fluctuations in mammalian population numbers.

The scope of an inventory and monitoring program should include a major portion of a given park rather than a small subsection of the park. Some mammalian species may be relatively mobile, and populations may be widely distributed but relatively uncommon throughout the park. Thus, establishing several areas as survey sites is advantageous. In addition, the scope of an inventory and monitoring program should not be restricted to a single habitat type, e.g., deciduous forest, unless logistical constraints restrict the scope of the program or because that particular habitat/cover type comprises the vast majority of the park acreage. Most parks, however, contain more than one habitat/cover type (i.e., deciduous forest, coniferous forest, old-field, grassland, wetland) of appreciable size. If possible, each habitat/cover type within the park that comprises at least 10 ha should be sampled for mammals. However, critical or sensitive habitat/cover types, such as wetlands or rock outcrops, that are less than 10 ha may be included in the sampling design because these may contain mammalian species with very specific habitat requirements not found elsewhere in the park. Habitat/cover types that are dynamic and highly disturbed for much of the year, e.g., pastureland and cropland, should be avoided in the sampling design. As a general rule, the amount of effort devoted to inventorying or monitoring mammals in a given habitat/cover type should be approximately proportionate to the availability of that type in order to ensure similar sampling effort across per unit area of habitat/cover type.

Ecological and Logistical Constraints

Information on predicted species of mammals in a park is helpful because it gives natural resource managers some indication of the probability of finding a particular species in a given park. However, although the geographic range of a mammalian species may overlap the boundaries of a park based on inspection of range maps given in field guides, a given species may not occur in the park. The absence of a given species may be attributed to the fact that its abundance is low not only in the park but in the region contiguous to the park or that its

ecological requirements are not met in the park. Thus, objectives designed to inventory and monitoring certain species may not be realistic for ecological reasons. Natural resource managers may wish to consult with experts familiar with the ecological requirements of mammals in question before conducting an indepth and comprehensive survey of certain species, particularly if logistical considerations are important.

Some inventory and monitoring objectives may not be reasonable because of logistical constraints. For instance, a small mammal survey will require live traps, significant field time, and some expertise in identification of captured animals; thus, this inventory and monitoring protocol involves a significant investment of time and labor. Road surveys may be best suited for parks with extensive infrastructure throughout the park.

Suggested Sampling Protocols

Based on our evaluation of protocols at GETT-EISE, HOFU, and VAFO, we suggest a combination of three sampling protocols for inventorying and monitoring mammals: small mammal trapping, vehicular-road survey, and scent-station survey. Additional details for each protocol (e.g., types of data collected, cost of equipment) are given in the next section of this report. Furthermore, we recommend the continued use of wildlife observation cards and offer some additional considerations for an inventory and monitoring program.

For each protocol, data should be carefully and accurately collected. If possible and depending on the protocol, data collected may include the species, sex class, age class, weight, reproductive status, location, habitat/cover type, date, and time of each animal captured or observed. Data should be kept on standardized data field sheets. If a computerized faunal database is available for a park, data collected should be added to the database.

1. Small mammal trapping: Small (approximately 8 x 8 x 26 cm) and large (13 x 13 x 41 cm) live-traps with or without drift fences and pitfall traps with drift fences (see sections entitled "Live-Trapping Protocol" and "Pitfall-Trapping Protocol," respectively) should be used. Pitfall traps with drift fences will capture shrews (Order Insectivora); small live-traps will also capture shrews, as well as chipmunks (Order Rodentia, Family Sciuridae) and rodents (Order Rodentia, Family Muridae); and large live-traps will capture chipmunks and squirrels (Order Rodentia, Family Sciuridae) and rabbits (Order Lagomorpha). The most common habitat/cover types in terms of total acreage in the park should be sampled; these should include types that comprise at least 10 ha (25 acres) and exclude pastureland and cropland. Special attention may also be given to critical or sensitive types, such as wetlands and rock outcrops.

   At least two permanent sampling areas should be established in each habitat/cover type. At each area, a grid or series of random transects should be established. Within the grid or

along the transects at each sampling area, 50 sampling points should be spaced at 25- to 50-m intervals. At each point, two small live-traps should be placed, giving a total of 100 small live-traps per area. At 10 of these sampling points selected at random, one pitfall trap with drift fences also should be placed. Also, at 10 of these sampling points, one large live-trap should be placed. Live-traps should be provided with a small amount of bedding and bait (e.g., peanut butter and oatmeal mixture). Traps should be open for 5 consecutive days in both late summer and early fall (July through August and September through October), giving 10 days of sampling or 1,000 trapnights (5 days x 100 traps x 2 trapping sessions) for small live-traps, 100 trapnights (5 days x 10 traps x 2 trapping sessions) for large live-traps, and 100 trapnights (5 days x 10 traps x 2 trapping sessions) for pitfall traps during each sampling area per year. If traps are left open continuously during the sampling period, they must be checked each day at dawn and before dusk; traps checked at dawn will provide information on captures of nocturnal small mammals, whereas traps monitored before dusk will give data on captures of diurnal mammals. For a sufficient inventory, small mammal trapping should be conducted for a minimum of 2 years. If long-term monitoring is an objective, trapping should be conducted for two consecutive years at 5-year intervals. This sampling protocol will provide a suitable measure of species richness and relative abundance (expressed as number of different individuals captured per 100 trapnights) in a given park.

2. Vehicular-road survey: At least one permanent vehicular-road survey route should be established in a park. The survey route should traverse representative habitat/cover types and avoid heavily traveled roads, if possible. We recommend that the length of the route be at least 8 km (5 miles) and that the width be 100 m lateral distance of the road. Road surveys can be valuable in documenting species richness and relative abundance (expressed as number of animals of each species observed per km) of a variety of mammals, including deer, Virginia opossums (Order Didelphimorphia), rabbits (Order Lagomorpha), squirrels (Order Rodentia, Family Sciuridae), and carnivores (e.g., foxes, raccoons; Order Carnivora). Squirrels can be surveyed using diurnal surveys, whereas the other species are more readily observed with nocturnal surveys (dawn and dusk). We recommend at least four road surveys be conducted during the summer months (July through August), including two diurnal (15 minutes before sunrise until 2 hours after sunrise) and two nocturnal surveys (2 hours before sunset until sunset). If weather conditions permit, additional nocturnal road surveys may be considered during the winter months for inventorying and monitoring medium-sized mammals, e.g., rabbits. Vehicular-road surveys should be conducted for at least 2 years to inventory medium-sized mammals, and thereafter at 2- to 3-year intervals to monitor these mammalian species.

3. Scent-station survey: We recommend that at least two permanent scent-station transects be established in the park. Scent stations can be used to determine the presence of various members of the Order Carnivora, such as skunks, raccoons, and foxes (Nottingham et al. 1989). Transects should each be 5-km long and traverse representative habitat/cover types. Transects can be placed along streams, unimproved roads, railroad tracks, or other linear

features of a park that are not well travelled by park visitors. Scent stations should be placed at 500-m intervals; cotton saturated with anise oil or synthetic fermented egg should be used as the attractant. All scent stations in the park should be operated simultaneously for 1-2 nights and be checked for tracks the following morning(s). Scent-station surveys should be conducted in August or September, before leaf fall in autumn. These surveys should be conducted for at least 2 years to inventory carnivores, and thereafter at 2- to 3-year intervals to monitor these mammalian species.

4. Wildlife observation cards: Each park should maintain a catalog of wildlife sightings on wildlife observation cards. These cards provide valuable long-term data on wildlife in the park. Natural resource managers and other personnel should continue to document incidental sightings of wildlife, road-kill information, and other interesting facts noted about wildlife while conducting day-to-day duties at the park.

5. Additional considerations: If resources, such as personnel, time, and monies, are available, the scope of an inventory and monitoring program for mammals can be expanded. For example, surveys of bats may require inspection of summer nurseries in abandoned buildings as well as use of specific equipment, e.g., bat detectors. The presence of subterranean species, like moles, will require interpretation of field sign or use of special types of traps. Voucher specimens should be obtained for as many mammal species as possible to serve as a permanent record of a species in a given park.

In conclusion, the types of protocols and the extent to which each is used to inventory and monitor mammals in a given park will depend on resource management objectives of the parks. Natural resource managers should determine what types of data are needed and what are the ecological constraints within the park.

Taxonomic-Specific Recommendations for Mammal Inventorying and Monitoring

A major objective of our study was to select a set of protocols to field test that were specific to the major vertebrate groups at each of the parks. The effectiveness of these protocols was then based on their ability to detect various species that were predicted to occur at the parks in terms of labor, time, and cost required to conduct the protocols. A protocol was particularly effective if it documented species with relatively little time and labor and low cost.

We concentrated our effort surveying certain abundant taxa (e.g., Rodentia) and placed considerably less emphasis on taxa for which relatively few survey protocols have been developed (e.g., bats). Although our field testing for mammals is complete, we recommend that future work focus less abundant taxa and on taxa that were not effectively documented by our subset of protocols.

Below are our recommendations for inventorying and monitoring specific taxonomic groups, based on our field test of protocols at GETT-EISE, HOFU, and VAFO. We will note the most effective protocol for inventorying a given taxon and, if appropriate, alternative protocols if labor or monies are limited.

Order Didelphimorphia

We did not document the Virginia opossum at any of the parks via field-testing of protocols. This species was found at HOFU by personal observation. This species is most likely to be documented using the scent-station protocol or nocturnal vehicular-road survey protocol.

Order Insectivora

Pitfall trapping with drift fences was the most effective protocol to survey insectivores at the parks (Tables 26-29). We captured more Maryland and northern short-tailed shrews per 100 trapnights at GETT-EISE and more masked and northern short-tailed shrews per 100 trapnights at HOFU with pitfall traps compared to live-traps. Although drift fences required additional labor (0.25 person-hours/sampling point) to install and cost $5.06/sampling point for materials, they increased the rate of capture (2.5 fold) for insectivores at HOFU. If labor or monies are limited, pitfall trapping without drift fences, as was completed at GETT-EISE, may be an acceptable, but less effective, option. Alternatively, drift fences also may be placed at every other pitfall trapping station (see Fig. 8) to reduce costs or labor but still maintain a higher capture rate than would be accomplished without any drift fences.

Table 26. Habitats, seasons, type of data obtained, survey specifications, time, labor, materials, cost, limitations, and Pro-Cite citations for the pitfall-trapping protocol (without drift fences) for Order Insectivora.

	Comments
Habitats:	Wetland[a], riparian[a], forest[a], old-field[a], grassland[a], agricultural
Seasons:	Spring, summer[b], fall, winter
Type of data: Presence Relative Abundance Density	 Yes Yes No
Number of species detected at: GETT-EISE HOFU VAFO	 2 2 NA[c]
Survey Specifications:	at least 10 pitfall traps per habitat type spaced at 150 m intervals for 5 consecutive nights; trapping should be conducted once during late summer and once during early fall
Time:	0.5 person-hours/pitfall trap to dig and 10.4 person-hours/100 pitfall traps to check
Labor:	1-2 personnel
Materials:	1-gallon cans, posthole digger
Cost:	$30 for posthole digger
Limitations:	Cultural Compliance Permit may be required to dig pitfall holes
Citations:	Boonstra and Krebs 1978 (#1030); Gibbons and Semlitsch 1982 (#3350); Howard and Brock 1961 (#4120); Walters 1989 (#8590)

[a] Habitats tested for this project.
[b] Seasons tested for this project.
[c] Protocol not conducted at VAFO.

Table 27. Habitats, seasons, type of data obtained, survey specifications, time, labor, materials, cost, limitations, and Pro-Cite citations for live-trapping protocol (without drift fences) for the Order Insectivora.

	Comments
Habitats:	Wetland[a], riparian[a], forest[a], old-field[a], grassland[a], agricultural
Seasons:	Spring, summer[b], fall, winter
Type of data: Presence Relative Abundance Density	 Yes Yes Yes
Number of species detected at: GETT-EISE HOFU VAFO	 2 1 0
Survey Specifications:	at least 100 live-traps per habitat type (50 sampling points with two traps each) spaced at 25-50 m intervals; traps open for 5 consecutive nights during 2 trapping sessions (once during late summer and once during early fall)
Time:	9.3 person-hours/100 live-traps to open and bait and 11.0 person-hours/100 live-traps to check at GETT-EISE; 11.8 person-hours/100 live-traps to open and bait and 11.1 person-hours/100 live-traps to check at VAFO
Labor:	1-2 personnel
Materials:	Tomahawk live-traps (Model #101 for small) from Tomahawk Live Trap Co., Tomahawk, WI (Ph. #715-453-3550), #1 Monel metal ear tags (Style 1005-1) and Pliers (Style 1005-1S) from National Band and Tag Co., Newport, KY (Ph. #606-261-2035), Measuring equipment, Bait (peanut butter and rolled oats), Cotton bedding
Cost:	Live-traps = $14.66/small trap; Monel ear tags = $9.08/100 tags; Pliers = $13.91; Bait = $5.00 for baiting approximately 300 traps; Cotton bedding = $1.50 for 300 traps
Limitations:	Trapping permit may be required
Citations:	Cushwa and Burnham 1974 (#2060); Nixon et al. 1967 (#6010); Lacki et al. 1990 (#5000); Slade et al. 1993 (#7510)

[a] Habitats tested for this project.
[b] Seasons tested for this project.

Table 28. Habitats, seasons, type of data obtained, survey specifications, time, labor, materials, cost, limitations, and Pro-Cite citations for drift-fence protocol (with pitfall traps) for the Order Insectivora.

	Comments
Habitats:	Wetland, riparian[a], forest[a], old-field[a], grassland[a], agricultural
Seasons:	Spring, summer[b], fall, winter
Type of data: Presence Relative Abundance Density	 Yes Yes Yes
Number of species detected at: GETT-EISE HOFU VAFO	 NA[c] 2 NA[c]
Survey Specifications:	same as pitfall-trapping protocol
Time:	0.25 person-hours/sampling point in addition to time for pitfall-trapping protocol
Labor:	2 personnel
Materials:	10 m of drift fence for each sampling point
Cost:	$5.06 per sampling point (10 m x 45 cm) for erosion cloth (stakes included)
Limitations:	Cultural Compliance Permit may be required
Citations:	

[a] Habitats tested for this project.
[b] Seasons tested for this project.
[c] Protocol not conducted at GETT-EISE and VAFO.

Table 29. Habitats, seasons, type of data obtained, survey specifications, time, labor, materials, cost, limitations, and Pro-Cite citations for drift-fence protocol (with live-traps) for the Order Insectivora.

	Comments
Habitats:	Wetland, riparian[a], forest[a], old-field[a], grassland[a], agricultural
Seasons:	Spring, summer[b], fall, winter
Type of data: Presence Relative Abundance Density	 Yes Yes Yes
Number of species detected at: GETT-EISE HOFU VAFO	 NA[c] 1 NA[c]
Survey Specifications:	same as live-trapping protocol
Time:	0.25 person-hours/sampling point in addition to time for live-trapping protocol
Labor:	2 personnel
Materials:	10 m of drift fence for each sampling point
Cost:	$5.06 per sampling point (10 m x 45 cm) for erosion cloth (stakes included)
Limitations:	Cultural Compliance Permit may be required
Citations:	

[a] Habitats tested for this project.
[b] Seasons tested for this project.
[c] Protocol not conducted at GETT-EISE and VAFO.

We documented a small number of insectivores at each of the parks (two of eight predicted at GETT-EISE, two of eight predicted at HOFU, and none of eight predicted at VAFO) even though we tested three protocols to survey them. To increase the number of captures and number of species documented, we suggest trapping with pitfall traps and drift fences during five consecutive nights in late summer (July through August) and during five consecutive nights in early fall (September through October). We recommend at least 10 pitfall traps spaced 150 m apart per habitat type; this would give 100 trapnights per habitat type (10 traps x 5 nights x 2 periods). This will increase the number of trapnights and captures without overtrapping the selected trapsites during one long trapping period.

Order Chiroptera

We did not emphasize survey protocols to document bat species at the parks. The little brown myotis and big brown bat, however, were noted at GETT-EISE and HOFU via personal observations. No bat species was observed at VAFO. Surveys of bats may require inspection of summer nurseries in abandoned buildings as well as use of specific equipment, e.g., bat detectors.

Order Lagomorpha

We found the eastern cottontail at each of the four parks using the vehicular-road survey protocol (Table 30). Because this protocol is cost-, labor, and time-efficient, we recommend its use to survey lagomorphs; we suggest at least two morning (15 minutes before sunrise to 2 hours after sunrise) and two evening surveys (2 hours before sunset to sunset) be conducted each summer (July through August). If weather conditions and time and monies permit, additional nocturnal road survey may be conducted during winter (December through February). It also can be used for long-term monitoring of cottontail populations by conducting this protocol annually using the same survey route.

Order Rodentia

Family Sciuridae

As with the eastern cottontail, eastern gray squirrels, eastern chipmunks, and woodchucks were documented with the vehicular-road survey protocol in at least one park. This protocol can be used for efficient long-term monitoring of sciurids (Table 31). We recommend at least two

Table 30. Habitats, seasons, type of data obtained, survey specifications, time, labor, materials, cost, limitations, and Pro-Cite citations for the vehicular-road survey protocol for the Order Lagomorpha.

	Comments
Habitats:	Wetland[a], riparian[a], forest[a], old-field[a], grassland[a], agricultural[a]
Seasons:	Summer[b], Winter
Type of data: Presence Relative Abundance Density	 Yes Yes No
Number of species detected at: GETT-EISE HOFU VAFO	 1 0 1
Survey Specifications:	at least 2 morning and two evening road surveys during summer and winter; survey route should encompass representative habitat types and be at least 8 km in length
Time:	0.20 hours/km of survey length to map and test-run, 4.0 minutes/km of survey length to conduct
Labor:	1 driver, 1 observer
Materials:	Vehicle, map
Cost:	cost of gasoline
Limitations:	difficult to conduct in a high-use park or on busy roads; best conducted on park roads with little traffic
Citations:	Flinders and Hansen 1973 (#2990); Newman 1959 (#5960); Rajala 1983 (#6580); Stanley and Bart 1991 (#7740)

[a] Habitats tested for this project.
[b] Seasons tested for this project.

Table 31. Habitats, seasons, type of data obtained, survey specifications, time, labor, materials, cost, limitations, and Pro-Cite citations for the vehicular-road survey protocol for the Order Rodentia, Family Sciuridae.

	Comments
Habitats:	Wetland[a], riparian[a], forest[a], old-field[a], grassland[a], agricultural[a]
Seasons:	Summer[b], Winter
Type of data: Presence Relative Abundance Density	 Yes Yes No
Number of species detected at: GETT-EISE HOFU VAFO	 3 1 2
Survey Specifications:	at least 2 morning and two evening road surveys during summer; survey route should encompass representative habitat types and be at least 8 km in length
Time:	0.20 hours/km of survey length to map and test-run, 4.0 minutes/km of survey length to conduct
Labor:	1 driver, 1 observer
Materials:	vehicle, map
Cost:	cost of gasoline
Limitations:	difficult to conduct in a high-use park or on busy roads; best conducted on park roads with little traffic
Citations:	Flinders and Hansen 1973 (#2990); Newman 1959 (#5960); Rajala 1983 (#6580); Stanley and Bart 1991 (#7740)

[a] Habitats tested for this project.
[b] Seasons tested for this project.

morning and two evening surveys be conducted in summer along a permanent road survey route (at least 8.0 km in length). The gray squirrel also was documented with the scent-station protocol (Table 32). Unlike the vehicular-road survey protocol, however, relative abundance cannot be determined using the scent-station protocol.

Gray squirrels and chipmunks were both captured in a limited number of large live-traps at VAFO; both large and small live-traps provided the only source of documentation of eastern chipmunks at both HOFU and VAFO (Table 33). This protocol has the advantage of individual marking and subsequent identification of known animals to provide a density estimate but requires considerably more time to conduct (9.3 and 11.8 person-hours/100 traps to open at GETT-EISE and VAFO, respectively, and 11.0 and 11.1 person-hours/100 traps for five consecutive nights to check at GETT-EISE and VAFO, respectively) and has a higher cost (cost of traps, ear tags, pliers, bait, and cotton bedding versus cost of gasoline) than the vehicular-road survey protocol. Live-traps without drift fences (Table 33) are preferred over live-traps with drift fences (Table 34) when inventorying chipmunks. Drift fences also added additional cost ($5.06/sampling point) and labor (0.25 person-hours/sampling point).

We recommend a minimum of 10 large live-traps spaced at 150-m intervals (for squirrels and chipmunks) and 100 small live-traps (two at each sampling point) spaced at 25-50-m intervals (for chipmunks) per habitat type. Trapping should be conducted for at least five consecutive nights each in late summer (July through August) and early fall (September through October) to give 100 trapnights per habitat type with large traps (10 large live-traps x 5 days x 2 sessions) and 1000 trapnights per habitat type with small traps (100 small live-traps x 5 days x 2 sessions).

Family Muridae

Mice and voles were most effectively surveyed using small live-traps at each of the parks. We documented four murid species at GETT-EISE, two species at HOFU, and two species at VAFO using small live-traps (Table 35). Although we captured one meadow jumping mouse in a pitfall trap at GETT-EISE, this was not an effective protocol to survey mice and voles (Table 36). The low capture rate and the lack of white-footed and prairie deer mice captures in pitfall traps makes this protocol much less effective compared to live-trapping. Drift fences increased the number of captures in pitfall traps (Table 37), but not in live-traps (Table 38) at HOFU. However, the number of individuals captured in pitfall traps with drift fences was much lower compared to live-traps. Because of the additional cost ($5.06/sampling point) and labor (0.25 person-hours/sampling point) associated with drift fences, we do not recommend that they be used with live-traps if the specific goal of the resource management specialist is to inventory mice and vole populations. To survey murids, we recommend a minimum of 100 small live-traps (two traps at 50 sampling points) spaced 25-50-m apart per habitat type. Trapping should occur each in late summer (July through August) and early fall (September through October) during 5 consecutive nights; this would give 1000 trapnights per habitat type (100 traps x 5 days x 2 sessions). Furthermore, we do not suggest using the scent-station protocol to survey the family Muridae even though we documented the white-footed mouse with this protocol (Table 39).

Table 32. Habitats, seasons, type of data obtained, survey specifications, time, labor, materials, cost, limitations, and Pro-Cite citations for the scent-station protocol for the Order Rodentia, Family Sciuridae.

	Comments
Habitats:	Wetland, forest, agricultural, forest-edge[a]
Seasons:	Spring, summer[b], fall, winter
Type of data: Presence Relative Abundance Density	 Yes No No
Number of species detected at: GETT-EISE HOFU VAFO	 NA[c] NA[c] 1
Survey Specifications:	at least two scent-station transects placed along low-use road, railroad, stream, or other linear feature; 10 stations separated by 500 m along each transect in representative habitat types; 2 nights per session during late summer
Time:	0.9 person-hours/station to set-up; 5.5 minutes (0.09 person-hours)/station to traverse the transect, check for and identify tracks
Labor:	1-2 personnel
Materials:	Scent, cotton balls, rake, shovel, sifter
Cost:	Scent: Anise Oil = $10.00/4 oz.; Synthetic Fermented Egg = $3.00/4 oz.; Red Fox Urine (not tested by project researchers) = $1.75/4 oz.
Limitations:	Requires no precipitation during and two days prior to the survey; abundance and density estimates cannot be calculated; Cultural Compliance Permit may be required
Citations:	Clark and Campbell 1983 (#1800); Conner et al. 1983 (#1920)

[a] Habitats tested for this project.
[b] Seasons tested for this project.
[c] Protocol not conducted at GETT-EISE and HOFU.

Table 33. Habitats, seasons, type of data obtained, survey specifications, time, labor, materials, cost, limitations, and Pro-Cite citations for the live-trapping protocol with small and large traps (without drift fences) for the Order Rodentia, Family Sciuridae.

	Comments
Habitats:	Wetland[a], riparian[a], forest[a], old-field[a], grassland[a], agricultural
Seasons:	Spring, summer[b], fall, winter
Type of data: Presence Relative Abundance Density	 Yes Yes Yes
Number of species detected at: GETT-EISE HOFU VAFO	 1 1 2
Survey Specifications:	at least 100 small traps (two traps at 50 sampling points) spaced at 25-50-m intervals and 10 large traps per habitat type spaced at 150-m intervals; traps open for 5 consecutive nights during 2 trapping periods (once during late summer and once during early fall)
Time:	9.3 person-hours/100 live-traps to open and bait and 11.0 person-hours/100 live-traps to check at GETT-EISE; 11.8 person-hours/100 live-traps to open and bait and 11.1 person-hours/100 live-traps to check at VAFO
Labor:	1-2 personnel
Materials:	Tomahawk live-traps (Model #101 for small and Model #201 for large traps) from Tomahawk Live Trap Co., Tomahawk, WI (Ph. #715-453-3550), #1 Monel metal ear tags (Style 1005-1) and Pliers (Style 1005-1S) from National Band and Tag Co., Newport, KY (Ph. #606-261-2035), Measuring equipment, Bait (peanut butter and rolled oats), Cotton bedding
Cost:	Live-traps = $14.66/small trap and $23.12/large trap; Monel ear tags = $9.08/100 tags; Pliers = $13.91; Bait = $5.00 for baiting approximately 300 traps; Cotton bedding = $1.50 for 300 traps
Limitations:	Trapping permit may be required
Citations:	Cushwa and Burnham 1974 (#2060); Nixon et al. 1967 (#6010); Lacki et al. 1990 (#5000); Slade et al. 1993 (#7510)

[a] Habitats tested for this project.
[b] Seasons tested for this project.

Table 34. Habitats, seasons, type of data obtained, survey specifications, time, labor, materials, cost, limitations, and Pro-Cite citations for the drift-fence protocol (with live-traps) for the Order Rodentia, Family Sciuridae

	Comments
Habitats:	Wetland, riparian[a], forest[a], old-field[a], grassland[a], agricultural
Seasons:	Spring, summer[b], fall, winter
Type of data: Presence Relative Abundance Density	 Yes Yes Yes
Number of species detected at: GETT-EISE HOFU VAFO	 NA[c] 1 NA[c]
Survey Specifications:	same as live-trapping protocol
Time:	0.25 person-hours/sampling point in addition to time for live-trapping protocol
Labor:	2 personnel
Materials:	10 m of drift fence for each sampling point
Cost:	$5.06 per sampling point (10 m x 45 cm) for erosion cloth (stakes included)
Limitations:	Cultural Compliance Permit may be required
Citations:	

[a] Habitats tested for this project.
[b] Seasons tested for this project.
[c] Protocol not conducted at GETT-EISE and VAFO.

Table 35. Habitats, seasons, type of data obtained, survey specifications, time, labor, materials, cost, limitations, and Pro-Cite citations for the live-trapping protocol (without drift fences) for the Order Rodentia, Family Muridae.

	Comments
Habitats:	Wetland[a], riparian[a], forest[a], old-field[a], grassland[a], agricultural
Seasons:	Spring, summer[b], fall, winter
Type of data: Presence Relative Abundance Density	 Yes Yes Yes
Number of species detected at: GETT-EISE HOFU VAFO	 4 2 2
Survey Specifications:	at least 100 live-traps per habitat type (50 sampling points with two traps each) spaced at 25-50 m intervals; traps open for 5 consecutive nights during 2 trapping periods (once during late summer and once during early fall)
Time:	9.3 person-hours/100 live-traps to open and bait and 11.0 person-hours/100 live-traps to check at GETT-EISE; 11.8 person-hours/100 live-traps to open and bait and 11.1 person-hours/100 live-traps to check at VAFO
Labor:	1-2 personnel
Materials:	Tomahawk live-traps (Model #101 for small) from Tomahawk Live Trap Co., Tomahawk, WI (Ph. #715-453-3550), #1 Monel metal ear tags (Style 1005-1) and Pliers (Style 1005-1S) from National Band and Tag Co., Newport, KY (Ph. #606-261-2035), Measuring equipment, Bait (peanut butter and rolled oats), Cotton bedding
Cost:	Live-traps = $14.66/small trap; Monel ear tags = $9.08/100 tags; Pliers = $13.91; Bait = $5.00 for baiting approximately 300 traps; Cotton bedding = $1.50 for 300 traps
Limitations:	Trapping permit may be required
Citations:	Cushwa and Burnham 1974 (#2060); Nixon et al. 1967 (#6010); Lacki et al. 1990 (#5000); Slade et al. 1993 (#7510)

[a] Habitats tested for this project.
[b] Seasons tested for this project.

Table 36. Habitats, seasons, type of data obtained, survey specifications, time, labor, materials, cost, limitations, and Pro-Cite citations for the pitfall-trapping protocol (without drift fences) for the Order Rodentia, Family Muridae.

	Comments
Habitats:	Wetland[a], riparian[a], forest[a], old-field[a], grassland[a], agricultural
Seasons:	Spring, summer[b], fall, winter
Type of data: Presence Relative Abundance Density	 Yes Yes Yes
Number of species detected at: GETT-EISE HOFU VAFO	 1 0 NA[c]
Survey Specifications:	at least 10 pitfall traps per habitat type spaced at 150 m intervals for 5 consecutive nights; trapping should be conducted once during late summer and once during early fall
Time:	0.5 person-hours/pitfall trap to dig and 10.4 person-hours/100 pitfall traps to check
Labor:	1-2 personnel
Materials:	1-gallon cans, posthole digger
Cost:	$30 for posthole digger
Limitations:	Cultural Compliance Permit may be required to dig pitfall holes
Citations:	Boonstra and Krebs 1978 (#1030); Gibbons and Semlitsch 1982 (#3350); Howard and Brock 1961 (#4120); Walters 1989 (#8590)

[a] Habitats tested for this project.
[b] Seasons tested for this project.
[c] Protocol not conducted at VAFO.

Table 37. Habitats, seasons, type of data obtained, survey specifications, time, labor, materials, cost, limitations, and Pro-Cite citations for the drift-fence protocol (with pitfall traps) for the Order Rodentia, Family Muridae.

	Comments
Habitats:	Wetland, riparian[a], forest[a], old-field[a], grassland[a], agricultural
Seasons:	Spring, summer[b], fall, winter
Type of data: Presence Relative Abundance Density	 Yes Yes Yes
Number of species detected at: GETT-EISE HOFU VAFO	 NA[c] 2 NA[c]
Survey Specifications:	same as pitfall-trapping protocol
Time:	0.25 person-hours/sampling point in addition to time for pitfall-trapping protocol
Labor:	2 personnel
Materials:	10 m of drift fence for each sampling point
Cost:	$5.06 per sampling point (10 m x 45 cm) for erosion cloth (stakes included)
Limitations:	Cultural Compliance Permit may be required
Citations:	

[a] Habitats tested for this project.
[b] Seasons tested for this project.
[c] Protocol not conducted at GETT-EISE and VAFO.

Table 38. Habitats, seasons, type of data obtained, survey specifications, time, labor, materials, cost, limitations, and Pro-Cite citations for the drift-fence protocol (with live-traps) for the Order Rodentia, Family Muridae.

	Comments
Habitats:	Wetland, riparian[a], forest[a], old-field[a], grassland[a], agricultural
Seasons:	Spring, summer[b], fall, winter
Type of data: Presence Relative Abundance Density	 Yes Yes Yes
Number of species detected at: GETT-EISE HOFU VAFO	 NA[c] 2 NA[c]
Survey Specifications:	same as live-trapping protocol
Time:	0.25 person-hours/sampling point in addition to time for live-trapping protocol
Labor:	2 personnel
Materials:	10 m of drift fence for each sampling point
Cost:	$5.06 per sampling point (10 m x 45 cm) for erosion cloth (stakes included)
Limitations:	Cultural Compliance Permit may be required
Citations:	

[a] Habitats tested for this project.
[b] Seasons tested for this project.
[c] Protocol not conducted at GETT-EISE and VAFO.

Table 39. Habitats, seasons, type of data obtained, survey specifications, time, labor, materials, cost, limitations, and Pro-Cite citations for the scent-station protocol for the Order Rodentia, Family Muridae.

	Comments
Habitats:	Wetland, forest, agricultural, forest-edge[a]
Seasons:	Spring, summer[b], fall, winter
Type of data: Presence Relative Abundance Density	 Yes No No
Number of species detected at: GETT-EISE HOFU VAFO	 NA[c] NA[c] 1
Survey Specifications:	at least two scent-station transects placed along low-use road, railroad, stream, or other linear feature; 10 stations separated by 500 m along each transect in representative habitat types; 2 nights per session during late summer
Time:	0.9 person-hours/station to set-up; 5.5 minutes (0.09 person-hours)/station to traverse the transect, check for and identify tracks
Labor:	1-2 personnel
Materials:	Scent, cotton balls, rake, shovel, sifter
Cost:	Scent: Anise Oil = $10.00/4 oz.; Synthetic Fermented Egg = $3.00/4 oz.; Red Fox Urine (not tested by project researchers) = $1.75/4 oz.
Limitations:	Requires no precipitation during and two days prior to the survey; abundance and density estimates cannot be calculated; Cultural Compliance Permit may be required
Citations:	Clark and Campbell 1983 (#1800); Conner et al. 1983 (#1920)

[a] Habitats tested for this project.
[b] Seasons tested for this project.
[c] Protocol not conducted at GETT-EISE and HOFU.

Small Mammal Communities (Insectivores, Murids, and Sciurids Combined)

The goal of a resource management specialist may be to survey an entire small mammal community (insectivores, murids, and sciurids) at the park rather than surveying a select group or family of small mammals. We recommend a combination of protocols (live-trapping, pitfall trapping, and drift fences) to achieve this goal (Table 40). For example, 50 sampling points spaced at 25- or 50-m intervals should be placed along a transect in each habitat type. At all 50 points, two small live-traps should be set, giving a total of 100 small live-traps per habitat type. At 10 points (every fifth point), the two live-traps can be connected to a centrally located pitfall trap with 5-m drift fences (Fig. 8). We found a slight decrease in the number of captures in live-traps but an increase in the number of captures in pitfall traps with drift fences. Therefore, this arrangement will provide a compromise between pitfall traps with and live-traps without drift fences. In addition to using small live-traps, a small number of large live-traps (10 large live-traps per habitat type) may lead to the capture of larger mammals (i.e., gray, fox, and red squirrels, eastern chipmunks).

Trapping should be conducted once in late summer (July through August) and once in early fall (September through October) for five consecutive nights each. This would result in 1000 trapnights with small traps (100 traps x 5 nights x 2 periods), 100 trapnights with large traps (10 traps x 5 days x 2 sessions), and 100 trapnights with pitfall traps (10 traps x 5 days x 2 sessions) per habitat type.

Order Carnivora

We tested only the scent-station protocol to survey carnivores. Two carnivore species, raccoon and striped skunk were found with this protocol. It required little time, cost, and personnel to conduct (Table 41). We recommend using scent stations to survey carnivores during late summer (July through August) or early fall (September through October) because of the requirement for rain-free conditions. We suggest a minimum of 10 stations separated by 500 m along each of two transects placed along low-use road, railroad, stream, or other linear feature. Stations should be checked after each night for two consecutive nights for tracks. Transects should provide coverage of representative habitat types.

Table 40. Habitats, seasons, type of data obtained, survey specifications, time, labor, materials, cost, limitations, and Pro-Cite citations for the pitfall-trapping (GETT-EISE and HOFU), live-trapping (GETT-EISE, HOFU, and VAFO), and drift-fence protocols (HOFU) for small mammal communities.

	Comments
Habitats:	Wetland[a], riparian[a], forest[a], old-field[a], grassland[a], agricultural
Seasons:	Spring, summer[b], fall, winter
Type of data: Presence Relative Abundance Density	 Yes Yes Yes
Number of species detected at: GETT-EISE HOFU VAFO	 7 6 4
Survey Specifications:	same as pitfall- and live-trapping with drift fences for insectivores and murids
Time:	9.3 person-hours/100 live-traps to open and bait and 11.0 person-hours/100 live-traps to check at GETT-EISE; 11.8 person-hours/100 live-traps to open and bait and 11.1 person-hours/100 live-traps to check at VAFO; 0.25 person-hours/point to install drift fence; 0.5 person-hours/pitfall trap to dig
Labor:	2-3 personnel
Materials:	Tomahawk live-traps (Model #101 for small and Model #201 for large traps) from Tomahawk Live Trap Co., Tomahawk, WI (Ph. #715-453-3550), #1 Monel metal ear tags (Style 1005-1) and Pliers (Style 1005-1S) from National Band and Tag Co., Newport, KY (Ph. #606-261-2035), Measuring equipment, Bait (peanut butter and rolled oats), Cotton bedding, Drift fence, Posthole digger, 1-gallon metal cans
Cost:	Live-traps = $14.66/small trap and $23.12/large trap; Monel ear tags = $9.08/100 tags; Pliers = $13.91; Bait = $5.00 for baiting approximately 300 traps; Cotton bedding = $1.50 for 300 traps; Drift fence = $5.06/point; Posthole digger = $30
Limitations:	
Citations:	Cushwa and Burnham 1974 (#2060); Nixon et al. 1967 (#6010); Lacki et al. 1990 (#5000); Slade et al. 1993 (#7510); Boonstra and Krebs 1978 (#1030); Gibbons and Semlitsch 1982 (#3350); Howard and Brock 1961 (#4120); Walters 1989 (#8590)

[a] Habitats tested for this project.
[b] Seasons tested for this project.

Table 41. Habitats, seasons, type of data obtained, survey specifications, time, labor, materials, cost, limitations, and Pro-Cite citations for the scent-station protocol for the Order Carnivora.

	Comments
Habitats:	Wetland, forest, agricultural, forest-edge[a]
Seasons:	Spring, summer[b], fall, winter
Type of data: Presence Relative Abundance Density	 Yes No No
Number of species detected at: GETT-EISE HOFU VAFO	 NA[c] NA[c] 2
Survey Specifications:	at least two scent-station transects placed along low-use road, railroad, stream, or other linear feature; 10 stations separated by 500 m along each transect in representative habitat types; 2 nights per session during late summer
Time:	0.9 person-hours/station to set-up; 5.5 minutes (0.09 person-hours)/station to traverse the transect, check for and identify tracks
Labor:	1-2 personnel
Materials:	Scent, cotton balls, rake, shovel, sifter
Cost:	Scent: Anise Oil = $10.00/4 oz.; Synthetic Fermented Egg = $3.00/4 oz.; Red Fox Urine (not tested by project researchers) = $1.75/4 oz.
Limitations:	Requires no precipitation during and two days prior to the survey; abundance and density estimates cannot be calculated; Cultural Compliance Permit may be required
Citations:	Clark and Campbell 1983 (#1800); Conner et al. 1983 (#1920)

[a] Habitats tested for this project.
[b] Seasons tested for this project.
[c] Protocol not conducted at GETT-EISE and HOFU.

Literature Cited

Ambrose, J. P. and S. P. Bratton. 1990. Trends in landscape heterogeneity along the borders of Great Smoky Mountains National Park. Conserv. Biol. 4:135-143.

Aubrey, K. B., L. C. L. Jones, and P. A. Hall. 1988. Use of woody debris by Plethodontid salamanders in Douglas-rid forests in Washington. Pages 32-37 *in* Szaro, R. C., K. E. Severson, and D. R. Patton, eds. Management of amphibians, reptiles, and small mammals in North America: Proceedings of the symposium, July 19-21, 1988. Flagstaff, AZ.

Bart, F., and S. P. Klosiewski. 1989. Use of presence-absence to measure changes in avian density. J. Wildl. Manage. 53:847-852.

Bock, C. E., and L. W. Lepthien. 1975. Patterns of bird species diversity revealed by Christmas counts versus breeding bird surveys. Western Birds 6:95-100.

Boonstra, R., and C. J. Krebs. 1978. Pitfall trapping of *Microtus townsendii*. J. Mammal. 59:136-148.

Brower, J. E., and J. H. Zar. 1984. Field and laboratory methods for general ecology, 2nd ed. Wm. C. Brown Co., Dubuque, IA.

Burtt, H. E., and B. P. Burtt. 1982. Reliability of the Christmas bird count. Redstart 49:90-93.

Conner, R. N., and J. G. Dickson. 1980. Strip transect sampling and analysis for avian habitat studies. Wildl. Soc. Bull. 8:4-10.

Cushwa, C. T., and K. P. Burnham. 1974. An inexpensive live-trap for snowshoe hares. J. Wildl. Manage. 38:939-941.

Cypher, E. A. 1986. Seasonal use of food types by white-tailed deer at Valley Forge National Historical Park, Pennsylvania. M.S. Thesis, Pennsylvania State Univ. 42pp.

Dalrymple, G. H. 1988. The herpetofauna of Long Pine Key, Everglades National Park, in relation to vegetation and hydrology. Pages 72-86 *in* Szaro, R. C., K. E. Severson, and D. R. Patton, eds. Management of amphibians, reptiles, and small mammals in North America: Proceedings of the symposium, July 19-21, 1988. Flagstaff, AZ.

DeGraaf, R. M., and M. Yamasaki. 1992. A nondestructive technique to monitor the relative abundance of terrestrial salamanders. Wildl. Soc. Bull. 20:260-264.

Diem, K. L., and K. H. Lu. 1960. Factors influencing waterfowl censuses in the parklands, Alberta, Canada. J. Wildl. Manage. 24:113-133.

Drennan, S. R. 1981. The Christmas Bird Count: an overlooked and underused sample. Pages 24-29 *in* Ralph, C. J., and J. M. Scott, eds. Estimating numbers of terrestrial birds. Stud. Avian Biol. 6.

Emlen, J. T. 1971. Population densities of birds derived from transect counts. Auk 88:323-342.

Faanes, C. A., and D. Bystrak. 1981. The role of observer bias in the North American Breeding Bird Survey. Pages 353-359 *in* Ralph, C. J., and J. M. Scott, eds. Estimating numbers of terrestrial birds. Stud. Avian Biol. 6.

Flinders, J. T., and R. M. Hansen. 1973. Abundance and dispersion of leporids within a shortgrass ecosystem. J. Mammal. 54:287-291.

Franzreb, K. E. 1981. The determination of avian densities using the variable-strip and fixed-width transect surveying methods. Pages 139-145 *in* Ralph, C. J., and J. M. Scott, eds. Estimating numbers of terrestrial birds. Stud. Avian Biol. 6.

Fuller, R. J., and D. R. Langslow. 1984. Estimating numbers of birds by point counts: how long should counts last. Bird Study 31:195-202.

Genoways, H. H., and F. J. Brenner (eds.). 1985. Species of special concern in Pennsylvania. Special Publication of Carnegie Museum of Natural History, Number 11. Pittsburgh, PA. 430 pp.

Gibbons, J. W., and R. D. Semlitsch. 1982. Terrestrial drift fences with pitfall traps: an effective technique for quantitative sampling of animal populations. Brimleyana 7:1-16.

Herrington, R. E. 1988. Talus use by amphibians and reptiles in the Pacific Northwest. Pages 217-221 *in* Szaro, R. C., K. E. Severson, and D. R. Patton, eds. Management of amphibians, reptiles, and small mammals in North America. Proceedings of the symposium, July 19-21, 1988. Flagstaff, AZ.

Hewitt, O. H. 1967. A road-count index to breeding populations of red-winged blackbirds. J. Wildl. Manage. 31:39-47.

Howard, W. E., and E. M. Brock. 1961. A drift-fence pit trap that preserves captured rodents. J. Wildl. Manage. 42:386-391.

Hutto, R. L., and S. L. Mosconi. 1981. Lateral detectability profiles for line transect bird censuses: Some problems and an alternative. Pages 382-387 *in* Ralph, C. J., and J. M. Scott, eds. Estimating numbers of terrestrial birds. Stud. Avian Biol. 6.

Hutto, R. L., Pletschet, S. M., Hendricks, P. 1986. A fixed-radius point count method for nonbreeding and breeding season use. Auk 103:593-602.

International Bird Census Committee. 1977. Censusing breeding birds by the IPA method. Polish Ecol. Stud. 3:15-17.

Johnson, R. R., and J. J. Dinsmore. 1986. The use of tape-recorded calls to count Virginia rails and soras. Wilson Bull. 98:303-306.

Jones, K. B. 1988. Distribution and habitat associations of herpetofauna in Arizona: Comparisons by habitat type. Pages 109-128 *in* Szaro, R. C., K. E. Severson, and D. R. Patton, eds. Management of amphibians, reptiles, and small mammals in North America: Proceedings of the symposium, July 19-21, 1988. Flagstaff, AZ.

Kimmel, J. T., and R. H. Yahner. 1990. Response of northern goshawks to tapes conspecific and great horned owl calls. J. Raptor Res. 24:107-112.

Kuchler, A. W. 1964. Potential natural vegetation of the conterminous United States. Amer. Biol. Soc. Spec. Pub. 36. 116 pp.

Lacki, M. J., W. T. Peneston, and F. D. Vogt. 1990. A comparison of the efficiency of two types of live traps for capturing muskrats, *Ondatra zibethicus*. Can. Field Nat. 104:594-596.

McKinstry, D. M., M. A. Lethaby, and H. N. Cunningham. 1991. Amphibians and reptiles of Presque Isle State Park, Erie County, Pennsylvania. J. Pa. Acad. Sci. 65:17-23.

Newman, D. E. 1959. Factors influencing the winter roadside counts of cottontails. J. Wildl. Manage. 23:290-294.

Nixon, C. M., W. R. Edwards, and L. L. Eberhardt. 1967. Estimating squirrel abundance from live trapping data. J. Wildl. Manage. 31:96-101.

Nottingham, B. G., Jr., K. G. Johnson, and M. R. Pelton. 1989. Evaluation of scent-station surveys to monitor raccoon density. Wildl. Soc. Bull. 17:29-35.

Petraborg, W. H., E. G. Wellein, and V. E. Gunvalson. 1953. Roadside drumming counts: A spring census method for ruffed grouse. J. Wildl. Manage. 17:292-295.

Pro-Cite Version 1.4. 1988. Personal Bibliographic Software, Inc. Ann Arbor, MI.

Rajala, P. 1983. Population trends in the mountain hare in northern Finland as related to the 1979-81 roadside census. Finn. Game Res. 41:5-12.

Ramotnik, C. A., and N. J. Scott, Jr. 1988. Habitat requirements of New Mexico's endangered salamanders. Pages 54-63 *in* Szaro, R. C., K. E. Severson, and D. R. Patton, eds. Management of amphibians, reptiles, and small mammals in North America: Proceedings of the symposium, July 19-21, 1988. Flagstaff, AZ.

Rand McNally. 1993. Commercial atlas and marketing guide, 124th edition, USA.

Rhoads, S. N. 1903. The mammals of Pennsylvania and New Jersey. Privately printed, Philadelphia, PA. 266 pp.

Robbins, C. S., S. Droege, and J. R. Saur. 1989. Monitoring bird populations with breeding bird survey and atlas data. Ann. Zool. Fenn. 26:297-304.

Saunder, D. W., T. L. Linder, R. B. Dahlgren, and W. L. Tucker. 1971. An evaluation of the roadside technique for censusing breeding waterfowl. J. Wildl. Manage. 35:538-543.

Slade, N. A., M. A. Eifler, N. M. Gruenhagen, and A. L. Davelos. 1993. Differential effectiveness of standard and long Sherman live-traps in capturing small mammals. J. Mammal. 74:156-161.

Smith, C. R., ed. 1990. Handbook for atlassing American breeding birds. Vt. Inst. Nat. Sci. 70 pp.

Stanley, T. R., Jr., and J. Bart. 1991. Effects of roadside habitat and fox density on a snow track survey for foxes in Ohio. Ohio J. Sci. 91:186-190.

Storm, G. L., R. H. Yahner, D. F. Cottam, and G. M. Vecellio. 1989. Population status, movement patterns, habitat use, and impact of white-tailed deer at Gettysburg National Military Park and Eisenhower National Historic Site, Pennsylvania. U. S. Natl. Park Serv. Tech. Rep. NPS/MAR/NRTR-89/044.

Sullivan, B. K. 1981. Distribution and relative abundance of snakes along a transect in California. J. Herpetol. 15:247-248.

Verner, J., and L. V. Ritter. 1986. Hourly variation in morning point counts of birds. Auk 103:117-124.

Walters, B. B. 1989. Differential capture of deer mice with pitfalls and live traps. Acta Theriol. 34:643-647.

Yahner, R. H. 1992. Dynamics of a small mammal community in a fragmented forest. Amer. Midl. Nat. 127:381-391.

Yahner, R. H. 1995. Eastern deciduous forest: ecology and wildlife conservation. Univ. Minnesota Press, Minneapolis.

Yahner, R. H. 1997. Historic, present, and future status of Pennsylvania vertebrates: some issues of conservation concern. J. Pa. Acad. Sci. (In press).

Yahner, R. H., G. L., Storm, R. E. Melton, G. M. Vecellio, and D. F. Cottam. 1991. Floral inventory and vegetative cover type mapping of Gettysburg National Military Park and Eisenhower National Historic Site. U.S. Dept. Inter., Nat. Park Serv. Tech. Rep. NPS/MAR/NRTR-91/050. 149 pp.

Yahner, R. H., G. L. Storm, G. S. Keller, and R. W. Rohrbaugh. 1994a. Inventorying and monitoring protocols of vertebrates in National Park areas of the eastern United States: the bibliographic report. U.S. Dept. Inter., Nat. Park Serv. Tech. Rep. NPS/MAR/NRTR-94/057. 199 pp.

Yahner, R. H., G. L. Storm, G. S. Keller, and R. W. Rohrbaugh. 1994b. Inventorying and monitoring protocols of vertebrates in national park areas of the eastern United States: the faunal report. U.S. Dept. Inter., Nat. Park Serv. Tech. Rep. NPS/MAR/NRTR-94/058. 81 pp.

Yahner, R. H., G. L. Storm, G. S. Keller, and R. W. Rohrbaugh. 1994c. Inventorying and monitoring protocols of vertebrates in national park areas of the eastern United States: the faunal report. U.S. Dept. Inter., Nat. Park. Serv. Tech. Rep. NPS/MAR/NRTR-94/058. 83 pp. (with addendum).

Appendix 1. Mammal section of the Faunal Database for Gettysburg National Military Park and Eisenhower National Historic Site from 1 July 1992 to 30 June 1996.

Appendix 1.

Common Name	Scientific Name	Pro-Cite Group Name	Occurrence Status	Residency Status	Legal Pop. Status	Protocol	Field Tested Protocol
VIRGINIA OPOSSUM	Didelphis virginiana	Didelphimorphia	R	R	FB	TRS TRA SST NIG RKI LTT MAR CRE	
MASKED SHREW	Sorex cinerius	Insectivora	WOC	R	PR	TRS PFT STT LTT DFE MAR CRE	
MARYLAND SHREW	Sorex fontinalis	Insectivora	PTC	R	PR	TRS PFT STT LTT DFE MAR CRE	PFT LTT
SMOKY SHREW	Sorex fumeus	Insectivora	R	R	PR	TRS PFT STT LTT DFE MAR CRE	
LONG-TAILED SHREW	Sorex dispar	Insectivora	R	R	PR	TRS PFT STT LTT DFE MAR CRE	
NORTHERN WATER SHREW	Sorex palustris	Insectivora	R	R	PR - C2	TRS PFT STT LTT DFE MAR CRE	
NORTHERN SHORT-TAILED SHREW	Blarina brevicauda	Insectivora	PTC PO	R	PR	TRS PFT STT LTT DFE MAR CRE	PFT LTT
EASTERN MOLE	Scalopus aquaticus	Insectivora	R	R	PR	TRS PFT STT LTT DFE MAR CRE	
STARNOSE MOLE	Condylura cristata	Insectivora	R	R	PR	TRS PFT STT LTT DFE MAR CRE	
HAIRYTAIL MOLE	Parascalops aquaticus	Insectivora	R	R	PR	TRS PFT STT LTT DFE MAR CRE	
NORTHERN MYOTIS	Myotis septentrionalis	Chiroptera	R	P	PR - C2	V&C ROC NET LTT BAN CRE	
LITTLE BROWN MYOTIS	Myotis lucifugus	Chiroptera	PO	R	PR	V&C ROC NET LTT BAN CRE	
INDIANA MYOTIS	Myotis sodalis	Chiroptera	R	R	FE - E	V&C ROC NET LTT BAN CRE	
SMALL FOOTED MYOTIS	Myotis leibii	Chiroptera	R	R	ST - T	V&C ROC NET LTT BAN CRE	
SILVER-HAIRED BAT	Lasionycteris noctivagans	Chiroptera	R	S	PR - C2	V&C ROC NET LTT BAN CRE	
EASTERN PIPISTRELLE	Pipistrellus subflavus	Chiroptera	R	R	PR	V&C ROC NET LTT BAN CRE	
RED BAT	Lasiurus borealis	Chiroptera	R	S	PR	V&C ROC NET LTT BAN CRE	
BIG BROWN BAT	Eptesicus fuscus	Chiroptera	PO	R	PR	V&C ROC NET LTT BAN CRE	
HOARY BAT	Lasiurus cinereus	Chiroptera	R	S	PR	V&C ROC NET LTT BAN CRE	
SEMINOLE BAT	Lasiurus seminolus	Chiroptera	R	S	PR - C3	V&C ROC NET LTT BAN CRE	
EVENING BAT	Nycticeius humeralis	Chiroptera	R	S	PR - C2	V&C ROC NET LTT BAN CRE	
RACCOON	Procyon lotor	Carnivora	PTC WOC	R	GM	LTT TRS V&C SCI DLI TRA SST NIG RKI RCE AER MAR CRE	RKI
LEAST WEASEL	Mustela nivalis	Carnivora	R	R	FB - C3	LTT TRS V&C SCI DLI TRA SST NIG RKI RCE AER MAR CRE	
ERMINE	Mustela erminea	Carnivora	R	R	FB	LTT TRS V&C SCI DLI TRA SST NIG RKI RCE AER MAR CRE	
LONG-TAILED WEASEL	Mustela frenata	Carnivora	PO WOC	R	FB	LTT TRS V&C SCI DLI TRA SST NIG RKI RCE AER MAR CRE	
MINK	Mustela vison	Carnivora	PTC WOC	R	FB	LTT TRS V&C SCI DLI TRA SST NIG RKI RCE AER MAR CRE	RKI
FISHER	Martes pennanti	Carnivora	R	R	FB -E/X	TRS V&C SCI DLI TRA SST NIG RKI RCE AER MAR CRE	

Appendix 1.

Common Name	Scientific Name	Pro-Cite Group Name	Occurrence Status	Resi-dency Status	Legal Pop. Status	Protocol	Field Tested Protocol
MARTEN	Martes americanus	Carnivora	R	R	FB -E/X	TRS V&C SCI DLI TRA SST NIG RKI RCE AER MAR CRE	
RIVER OTTER	Lutra canadensis	Carnivora	R	R	FB - C1	TRS V&C SCI DLI TRA SST NIG RKI RCE AER MAR CRE	
EASTERN SPOTTED SKUNK	Spilogale putorius	Carnivora	R	R	FB - C3	TRS V&C SCI DLI TRA SST NIG RKI RCE AER MAR CRE	
STRIPED SKUNK	Mephitis mephitis	Carnivora	PTC	R	FB	TRS V&C SCI DLI TRA SST NIG RKI RCE AER MAR CRE	RKI
RED FOX	Vulpes vulpes	Carnivora	PO WOC	R	FB	TRS V&C SCI DLI TRA SST NIG RKI RCE AER MAR CRE	
GRAY FOX	Urocyon cinereoargenteus	Carnivora	WOC	R	FB	TRS V&C SCI DLI TRA SST NIG RKI RCE AER MAR CRE	
BOBCAT	Felis rufus	Carnivora	R	R	FB - C1	TRS V&C SCI DLI TRA SST NIG RKI RCE AER MAR CRE	
WOODCHUCK	Marmota monax	Rodentia	PTC PO WOC	R	GM	TRS V&C TRA RKI SNR LTT MAR CRE	RCE
EASTERN CHIPMUNK	Tamias striatus	Rodentia	PTC PO	R	PR	TRS V&C TRA RKI SNR LTT MAR CRE	LTT RCE RKI
EASTERN GRAY SQUIRREL	Sciurus carolinensis	Rodentia	PTC PO WOC	R	GM	TRS V&C TRA RKI SNR LTT MAR CRE	RCE RKI
EASTERN FOX SQUIRREL	Sciurus niger	Rodentia	R	R	GM	TRS V&C TRA RKI SNR LTT MAR CRE	
RED SQUIRREL	Tamiasciurus hudsonicus	Rodentia	R	R	GM	TRS V&C TRA RKI SNR LTT MAR CRE	
SOUTHERN FLYING SQUIRREL	Glaucomys volans	Rodentia	WOC	R	PR	TRS V&C TRA RKI SNR LTT MAR CRE	
NORTHERN FLYING SQUIRREL	Glaucomys sabrinas	Rodentia	R	R	PR - C2	TRS V&C TRA RKI SNR LTT MAR CRE	
BEAVER	Castor canadensis	Rodentia	R	R	FB	TRS DLI TRA BTR AER LTT MAR CRE	
WHITE-FOOTED MOUSE	Peromyscus leucopus	Rodentia	PTC	R	PR	TRS TRA PFT STT LTT DFE MAR CRE	LTT
DEER MOUSE	Peromyscus maniculatus	Rodentia	PTC	R	PR	TRS TRA PFT STT LTT DFE MAR CRE	LTT

Appendix 1.

Common Name	Scientific Name	Pro-Cite Group Name	Occurrence Status	Resi-dency Status	Legal Pop. Status	Protocol	Field Tested Protocol
EASTERN WOODRAT	Neotoma floridana	Rodentia	R	R	ST - T	TRS TRA PFT STT LTT DFE MAR CRE	
SOUTHERN BOG LEMMING	Synaptomys cooperi	Rodentia	R	R	PR	TRS TRA PFT STT LTT DFE MAR CRE	
BOREAL RED-BACKED VOLE	Clethrionomys gapperi	Rodentia	R	R	PR	TRS TRA PFT STT LTT DFE MAR CRE	
MEADOW VOLE	Microtus pennsylvanicus	Rodentia	PTC	R	PR	TRS TRA PFT STT LTT DFE MAR CRE	LTT
ROCK VOLE	Microtus chrotorrhinus	Rodentia	R	R	PR - C1	TRS TRA PFT STT LTT DFE MAR CRE	
WOODLAND VOLE	Microtus pinetorum	Rodentia	R	R	PR	TRS TRA PFT STT LTT DFE MAR CRE	
MUSKRAT	Ondatra zibethicus	Rodentia	PO	R	FB	TRS TRA DLI NIG LTT DFE MAR CRE	
NORWAY RAT	Rattus norvegicus	Rodentia	R	R	NN	TRS TRA PFT STT LTT DFE MAR CRE	
HOUSE MOUSE	Mus musculus	Rodentia	R	R	NN	TRS TRA PFT STT LTT DFE MAR CRE	
MEADOW JUMPING MOUSE	Zapus hudsonicus	Rodentia	PTC	R	PR	TRS TRA PFT STT LTT DFE MAR CRE	PFT LTT
WOODLAND JUMPING MOUSE	Napaeozapus insignis	Rodentia	R	R	PR	TRS TRA PFT STT LTT DFE MAR CRE	
PORCUPINE	Erethizon dorsatum	Rodentia	R	R	PR	TRS TRA NIG RKI RCE LTT MAR CRE	
SNOWSHOE HARE	Lepus americana	Lagomorpha	R	R	GM - C1	TRS SCI TRA SST NIG RCE LTT SNR MAR CRE	
EASTERN COTTONTAIL	Sylvilagus floridanus	Lagomorpha	PTC PO	R	GM	TRS SCI TRA SST NIG RCE LTT SNR MAR CRE	RCE
NEW ENGLAND COTTONTAIL	Sylvilagus transitionalis	Lagomorpha	R	R	GM - C1	TRS SCI TRA SST NIG RCE LTT SNR MAR CRE	

Appendix 2. Mammal section of the Faunal Database for Hopewell Furnace National Historic Site from 1 July 1992 to 30 June 1996.

Appendix 2.

Common Name	Scientific Name	Pro-Cite Group Name	Occurrence Status	Residency Status	Legal Pop. Status	Protocol	Field Tested Protocol
VIRGINIA OPOSSUM	Didelphis virginiana	Didelphimorphia	PO WOC	R	FB	TRS TRA SST NIG RKI LTT MAR CRE	
MASKED SHREW	Sorex cinerius	Insectivora	PTC	R	PR	TRS PFT STT LTT DFE MAR CRE	PFT DFE
MARYLAND SHREW	Sorex fontinalis	Insectivora	R	R	PR	TRS PFT STT LTT DFE MAR CRE	
SMOKY SHREW	Sorex fumeus	Insectivora	R	R	PR	TRS PFT STT LTT DFE MAR CRE	
LONG-TAILED SHREW	Sorex dispar	Insectivora	R	R	PR	TRS PFT STT LTT DFE MAR CRE	
NORTHERN WATER SHREW	Sorex palustris	Insectivora	R	R	PR - C2	TRS PFT STT LTT DFE MAR CRE	
SHORT-TAILED SHREW	Blarina brevicauda	Insectivora	PTC	R	PR	TRS PFT STT LTT DFE MAR CRE	LTT PFT DFE
EASTERN MOLE	Scalopus aquaticus	Insectivora	R	R	PR	TRS PFT STT LTT DFE MAR CRE	
STARNOSE MOLE	Condylura cristata	Insectivora	R	R	PR	TRS PFT STT LTT DFE MAR CRE	
HAIRYTAIL MOLE	Parascalops aquaticus	Insectivora	R	R	PR	TRS PFT STT LTT DFE MAR CRE	
NORTHERN MYOTIS	Myotis septentrionalis	Chiroptera	R	P	PR - C2	V&C ROC NET LTT BAN CRE	
LITTLE BROWN MYOTIS	Myotis lucifugus	Chiroptera	PO	R	PR	V&C ROC NET LTT BAN CRE	
INDIANA MYOTIS	Myotis sodalis	Chiroptera	R	R	FE - E	V&C ROC NET LTT BAN CRE	
SMALL FOOTED MYOTIS	Myotis leibii	Chiroptera	R	R	ST - T	V&C ROC NET LTT BAN CRE	
SILVER-HAIRED BAT	Lasionycteris noctivagans	Chiroptera	R	S	PR - C2	V&C ROC NET LTT BAN CRE	
EASTERN PIPISTRELLE	Pipistrellus subflavus	Chiroptera	R	R	PR	V&C ROC NET LTT BAN CRE	
RED BAT	Lasiurus borealis	Chiroptera	R	S	PR	V&C ROC NET LTT BAN CRE	
BIG BROWN BAT	Eptesicus fuscus	Chiroptera	PO	R	PR	V&C ROC NET LTT BAN CRE	
HOARY BAT	Lasiurus cinereus	Chiroptera	R	S	PR	V&C ROC NET LTT BAN CRE	
SEMINOLE BAT	Lasiurus seminolus	Chiroptera	R	S	PR - C3	V&C ROC NET LTT BAN CRE	
EVENING BAT	Nycticeius humeralis	Chiroptera	R	S	PR - C2	V&C ROC NET LTT BAN CRE	
RACCOON	Procyon lotor	Carnivora	PO WOC	R	GM	LTT TRS V&C SCI DLI TRA SST NIG RKI RCE AER MAR CRE	
LEAST WEASEL	Mustela nivalis	Carnivora	R	R	FB - C3	LTT TRS V&C SCI DLI TRA SST NIG RKI RCE AER MAR CRE	
ERMINE	Mustela erminea	Carnivora	WOC	R	FB	LTT TRS V&C SCI DLI TRA SST NIG RKI RCE AER MAR CRE	
LONG-TAILED WEASEL	Mustela frenata	Carnivora	R	R	FB	LTT TRS V&C SCI DLI TRA SST NIG RKI RCE AER MAR CRE	
MINK	Mustela vison	Carnivora	R	R	FB	LTT TRS V&C SCI DLI TRA SST NIG RKI RCE AER MAR CRE	
FISHER	Martes pennanti	Carnivora	R	R	FB -E/X	TRS V&C SCI DLI TRA SST NIG RKI RCE AER MAR CRE	

Appendix 2.

Common Name	Scientific Name	Pro-Cite Group Name	Occurrence Status	Resi-dency Status	Legal Pop. Status	Protocol	Field Tested Protocol
MARTEN	Martes americanus	Carnivora	R	R	FB -E/X	TRS V&C SCI DLI TRA SST NIG RKI RCE AER MAR CRE	
RIVER OTTER	Lutra canadensis	Carnivora	R	R	FB - C1	TRS V&C SCI DLI TRA SST NIG RKI RCE AER MAR CRE	
EASTERN SPOTTED SKUNK	Spilogale putorius	Carnivora	R	R	FB - C3	TRS V&C SCI DLI TRA SST NIG RKI RCE AER MAR CRE	
STRIPED SKUNK	Mephitis mephitis	Carnivora	R	R	FB	TRS V&C SCI DLI TRA SST NIG RKI RCE AER MAR CRE	
RED FOX	Vulpes vulpes	Carnivora	PO WOC	R	FB	TRS V&C SCI DLI TRA SST NIG RKI RCE AER MAR CRE	
GRAY FOX	Urocyon cinereoargenteus	Carnivora	R	R	FB	TRS V&C SCI DLI TRA SST NIG RKI RCE AER MAR CRE	
BOBCAT	Felis rufus	Carnivora	R	R	FB - C1	TRS V&C SCI DLI TRA SST NIG RKI RCE AER MAR CRE	
WOODCHUCK	Marmota monax	Rodentia	PO WOC	R	GM	TRS V&C TRA RKI SNR LTT MAR CRE	
EASTERN CHIPMUNK	Tamias striatus	Rodentia	PTC PO	R	PR	TRS V&C TRA RKI SNR LTT MAR CRE	LTT DFE
EASTERN GRAY SQUIRREL	Sciurus carolinensis	Rodentia	PTC PO	R	GM	TRS V&C TRA RKI SNR LTT MAR CRE	RCE
EASTERN FOX SQUIRREL	Sciurus niger	Rodentia	R	R	GM	TRS V&C TRA RKI SNR LTT MAR CRE	
RED SQUIRREL	Tamiasciurus hudsonicus	Rodentia	PO	R	GM	TRS V&C TRA RKI SNR LTT MAR CRE	
SOUTHERN FLYING SQUIRREL	Glaucomys volans	Rodentia	WOC	R	PR	TRS V&C TRA RKI SNR LTT MAR CRE	
NORTHERN FLYING SQUIRREL	Glaucomys sabrinas	Rodentia	R	R	PR - C2	TRS V&C TRA RKI SNR LTT MAR CRE	
BEAVER	Castor canadensis	Rodentia	R	R	FB	TRS DLI TRA BTR AER LTT MAR CRE	
WHITE-FOOTED MOUSE	Peromyscus leucopus	Rodentia	PTC	R	PR	TRS TRA PFT STT LTT DFE MAR CRE	LTT DFE
DEER MOUSE	Peromyscus maniculatus	Rodentia	R	R	PR	TRS TRA PFT STT LTT DFE MAR CRE	

Appendix 2.

Common Name	Scientific Name	Pro-Cite Group Name	Occurrence Status	Resi-dency Status	Legal Pop. Status	Protocol	Field Tested Protocol
EASTERN WOODRAT	Neotoma floridana	Rodentia	R	R	ST - T	TRS TRA PFT STT LTT DFE MAR CRE	
SOUTHERN BOG LEMMING	Synaptomys cooperi	Rodentia	R	R	PR	TRS TRA PFT STT LTT DFE MAR CRE	
BOREAL RED-BACKED VOLE	Clethrionomys gapperi	Rodentia	R	R	PR	TRS TRA PFT STT LTT DFE MAR CRE	
MEADOW VOLE	Microtus pennsylvanicus	Rodentia	PTC	R	PR	TRS TRA PFT STT LTT DFE MAR CRE	LTT PFT DFE
ROCK VOLE	Microtus chrotorrhinus	Rodentia	R	R	PR - C1	TRS TRA PFT STT LTT DFE MAR CRE	
WOODLAND VOLE	Microtus pinetorum	Rodentia	R	R	PR	TRS TRA PFT STT LTT DFE MAR CRE	
MUSKRAT	Ondatra zibethicus	Rodentia	R	R	FB	DLI NIG TRS TRA LTT MAR CRE	
NORWAY RAT	Rattus norvegicus	Rodentia	R	R	NN	TRS TRA PFT STT LTT DFE MAR CRE	
HOUSE MOUSE	Mus musculus	Rodentia	R	R	NN	TRS TRA PFT STT LTT DFE MAR CRE	
MEADOW JUMPING MOUSE	Zapus hudsonicus	Rodentia	PTC	R	PR	OPI CRE DFE MAR TRA QUA PFT STT LTT	LTT PFT DFE
WOODLAND JUMPING MOUSE	Napaeozapus insignis	Rodentia	PO	R	PR	OPI CRE DFE MAR TRA QUA PFT STT LTT	
PORCUPINE	Erethizon dorsatum	Rodentia	R	R	PR	TRS TRA NIG RKI RCE LTT MAR CRE	
SNOWSHOE HARE	Lepus americana	Lagomorpha	R	R	GM - C1	TRS SCI TRA SST NIG RCE LTT SNR MAR CRE	
EASTERN COTTONTAIL	Sylvilagus floridanus	Lagomorpha	PTC PO	R	GM	TRS SCI TRA SST NIG RCE LTT SNR MAR CRE	RCE
NEW ENGLAND COTTONTAIL	Sylvilagus transitionalis	Lagomorpha	R	R	GM - C1	TRS SCI TRA SST NIG RCE LTT SNR MAR CRE	

Appendix 3. Mammal section of the Faunal Database for Valley Forge National Historical Park from 1 July 1992 to 30 June 1996.

Appendix 3.

Common Name	Scientific Name	Pro-Cite Group Name	Occurrence Status	Residency Status	Legal Pop. Status	Protocol	Field Tested Protocol
VIRGINIA OPOSSUM	Didelphis virginiana	Didelphimorphia	WOC	R	FB	TRS TRA SST NIG RKI LTT MAR CRE	
MASKED SHREW	Sorex cinerius	Insectivora	WOC	R	PR	TRS PFT STT LTT DFE MAR CRE	
MARYLAND SHREW	Sorex fontinalis	Insectivora	R	R	PR	TRS PFT STT LTT DFE MAR CRE	
SMOKY SHREW	Sorex fumeus	Insectivora	R	R	PR	TRS PFT STT LTT DFE MAR CRE	
LONG-TAILED SHREW	Sorex dispar	Insectivora	R	R	PR	TRS PFT STT LTT DFE MAR CRE	
NORTHERN WATER SHREW	Sorex palustris	Insectivora	R	R	PR - C2	TRS PFT STT LTT DFE MAR CRE	
NORTHERN SHORT-TAILED SHREW	Blarina brevicauda	Insectivora	WOC	R	PR	TRS PFT STT LTT DFE MAR CRE	
EASTERN MOLE	Scalopus aquaticus	Insectivora	R	R	PR	TRS PFT STT LTT DFE MAR CRE	
STARNOSE MOLE	Condylura cristata	Insectivora	WOC	R	PR	TRS PFT STT LTT DFE MAR CRE	
HAIRYTAIL MOLE	Parascalops aquaticus	Insectivora	R	R	PR	TRS PFT STT LTT DFE MAR CRE	
NORTHERN MYOTIS	Myotis septentrionalis	Chiroptera	R	R	PR - C2	V&C ROC NET LTT BAN CRE	
LITTLE BROWN MYOTIS	Myotis lucifugus	Chiroptera	R	R	PR	V&C ROC NET LTT BAN CRE	
INDIANA MYOTIS	Myotis sodalis	Chiroptera	R	R	FE - E	V&C ROC NET LTT BAN CRE	
SMALL FOOTED MYOTIS	Myotis leibii	Chiroptera	R	R	ST - T	V&C ROC NET LTT BAN CRE	
SILVER-HAIRED BAT	Lasionycteris noctivagans	Chiroptera	R	S	PR - C2	V&C ROC NET LTT BAN CRE	
EASTERN PIPISTRELLE	Pipistrellus subflavus	Chiroptera	R	R	PR	V&C ROC NET LTT BAN CRE	
RED BAT	Lasiurus borealis	Chiroptera	R	S	PR	V&C ROC NET LTT BAN CRE	
BIG BROWN BAT	Eptesicus fuscus	Chiroptera	R	R	PR	V&C ROC NET LTT BAN CRE	
HOARY BAT	Lasiurus cinereus	Chiroptera	R	S	PR	V&C ROC NET LTT BAN CRE	
SEMINOLE BAT	Lasiurus seminolus	Chiroptera	R	S	PR - C3	V&C ROC NET LTT BAN CRE	
EVENING BAT	Nycticeius humeralis	Chiroptera	R	S	PR - C2	V&C ROC NET LTT BAN CRE	
RACCOON	Procyon lotor	Carnivora	PTC WOC	R	GM	LTT TRS V&C SCI DLI TRA SST NIG RKI RCE AER MAR CRE	SST
LEAST WEASEL	Mustela nivalis	Carnivora	R	R	PR - C3	LTT TRS V&C SCI DLI TRA SST NIG RKI RCE AER MAR CRE	
ERMINE	Mustela erminea	Carnivora	R	R	FB	LTT TRS V&C SCI DLI TRA SST NIG RKI RCE AER MAR CRE	
LONG-TAILED WEASEL	Mustela frenata	Carnivora	R	R	FB	LTT TRS V&C SCI DLI TRA SST NIG RKI RCE AER MAR CRE	
MINK	Mustela vison	Carnivora	R	R	FB	LTT TRS V&C SCI DLI TRA SST NIG RKI RCE AER MAR CRE	
FISHER	Martes pennanti	Carnivora	R	R	FB -E/X	TRS V&C SCI DLI TRA SST NIG RKI RCE AER MAR CRE	

Appendix 3.

Common Name	Scientific Name	Pro-Cite Group Name	Occurrence Status	Residency Status	Legal Pop. Status	Protocol	Field Tested Protocol
MARTEN	Martes americanus	Carnivora	R	R	FB -E/X	TRS V&C SCI DLI TRA SST NIG RKI RCE AER MAR CRE	
RIVER OTTER	Lutra canadensis	Carnivora	R	R	FB - C1	TRS V&C SCI DLI TRA SST NIG RKI RCE AER MAR CRE	
EASTERN SPOTTED SKUNK	Spilogale putorius	Carnivora	R	R	FB - C3	TRS V&C SCI DLI TRA SST NIG RKI RCE AER MAR CRE	
STRIPED SKUNK	Mephitis mephitis	Carnivora	PTC WOC	R	FB	TRS V&C SCI DLI TRA SST NIG RKI RCE AER MAR CRE	SST
RED FOX	Vulpes vulpes	Carnivora	PO WOC	R	FB	TRS V&C SCI DLI TRA SST NIG RKI RCE AER MAR CRE	
GRAY FOX	Urocyon cinereoargenteus	Carnivora	R	R	FB	TRS V&C SCI DLI TRA SST NIG RKI RCE AER MAR CRE	
BOBCAT	Felis rufus	Carnivora	R	R	FB - C1	TRS V&C SCI DLI TRA SST NIG RKI RCE AER MAR CRE	
WOODCHUCK	Marmota monax	Rodentia	PTC PO WOC	R	GM	TRS V&C TRA RKI SNR LTT MAR CRE	RCE
EASTERN CHIPMUNK	Tamias striatus	Rodentia	PTC	R	PR	TRS V&C TRA RKI SNR LTT MAR CRE	LTT
EASTERN GRAY SQUIRREL	Sciurus carolinensis	Rodentia	PTC PO WOC	R	GM	TRS V&C TRA RKI SNR LTT MAR CRE	SST LTT RCE
EASTERN FOX SQUIRREL	Sciurus niger	Rodentia	R	R	GM - C2	TRS V&C TRA RKI SNR LTT MAR CRE	
RED SQUIRREL	Tamiasciurus hudsonicus	Rodentia	WOC	R	GM	TRS V&C TRA RKI SNR LTT MAR CRE	
SOUTHERN FLYING SQUIRREL	Glaucomys volans	Rodentia	WOC	R	PR	TRS V&C TRA RKI SNR LTT MAR CRE	
NORTHERN FLYING SQUIRREL	Glaucomys sabrinas	Rodentia	R	R	PR - C2	TRS V&C TRA RKI SNR LTT MAR CRE	
BEAVER	Castor canadensis	Rodentia	R	R	FB	TRS SLI TRA BTR AER LTT MAR CRE	
WHITE-FOOTED MOUSE	Peromyscus leucopus	Rodentia	PTC WOC	R	PR	TRS TRA PFT STT LTT DFE MAR CRE	SST LTT
DEER MOUSE	Peromyscus maniculatus	Rodentia	R	R	PR	TRS TRA PFT STT LTT DFE MAR CRE	

Appendix 3.

Common Name	Scientific Name	Pro-Cite Group Name	Occurrence Status	Residency Status	Legal Pop. Status	Protocol	Field Tested Protocol
EASTERN WOODRAT	Neotoma floridana	Rodentia	R	R	ST - T	TRS TRA PFT STT LTT DFE MAR CRE	
SOUTHERN BOG LEMMING	Synaptomys cooperi	Rodentia	R	R	PR	TRS TRA PFT STT LTT DFE MAR CRE	
BOREAL RED-BACKED VOLE	Clethrionomys gapperi	Rodentia	R	R	PR	TRS TRA PFT STT LTT DFE MAR CRE	
MEADOW VOLE	Microtus pennsylvanicus	Rodentia	PTC WOC	R	PR	TRS TRA PFT STT LTT DFE MAR CRE	LTT
ROCK VOLE	Microtus chrotorrhinus	Rodentia	R	R	PR - C1	TRS TRA PFT STT LTT DFE MAR CRE	
WOODLAND VOLE	Microtus pinetorum	Rodentia	R	R	PR	TRS TRA PFT STT LTT DFE MAR CRE	
MUSKRAT	Ondatra zibethicus	Rodentia	WOC	R	FB	DLI TRS NIG TRA LTT MAR CRE	
NORWAY RAT	Rattus norvegicus	Rodentia	WOC	R	NN	TRS TRA PFT STT LTT DFE MAR CRE	
HOUSE MOUSE	Mus musculus	Rodentia	WOC	R	NN	TRS TRA PFT STT LTT DFE MAR CRE	
MEADOW JUMPING MOUSE	Zapus hudsonicus	Rodentia	WOC	R	PR	OPI CRE DFE MAR TRA QUA PFT STT LTT	
WOODLAND JUMPING MOUSE	Napaeozapus insignis	Rodentia	R	R	PR	OPI CRE DFE MAR TRA QUA PFT STT LTT	
PORCUPINE	Erethizon dorsatum	Rodentia	R	R	PR	TRS TRA NIG RKI RCE LTT MAR CRE	
SNOWSHOE HARE	Lepus americana	Lagomorpha	R	R	GM - C1	TRS SCI TRA SST NIG RCE LTT SNR MAR CRE	
EASTERN COTTONTAIL	Sylvilagus floridanus	Lagomorpha	PTC WOC	R	GM	TRS SCI TRA SST NIG RCE LTT SNR MAR CRE	RCE
NEW ENGLAND COTTONTAIL	Sylvilagus transitionalis	Lagomorpha	R	R	GM - C1	TRS SCI TRA SST NIG RCE LTT SNR MAR CRE	

Appendix 4. *Pro-Cite* Group Names for all classes of vertebrate species in the Faunal Database for Gettysburg National Military Park and Eisenhower National Historic Site, Hopewell Furnace National Historic Site, and Valley Forge National Historical Park (Variable No. 5).

Pro-Cite Group	Fauna
Didelphimorphia	Virginia Opossum
Insectivora	Shrews, Moles
Chiroptera	Bats
Carnivora	Raccoon, Weasels, Skunks, Canids, and Felids
Rodentia	
Sciuridae	Squirrels, Chipmunks, Prairie Dogs, and Ground Squirrels
Castoridae	Beaver
Muridae	Mice, Rats, Lemmings, and Voles
Erethizontidae	Porcupine
Lagomorpha	Rabbits and Hares

Appendix 5. Codes for sources of documentation used for the occurrence status in the Faunal Database for Gettysburg National Military Park and Eisenhower National Historic Site, Hopewell Furnace National Historic Site, Valley Forge National Historical Park (Variable No. 8)

Code	Documentation
PTC	Observation while conducting an appropriate protocol
PO	Personal observation
WOC	National Park Service wildlife observation card
BBA	Pennsylvania Game Commission Breeding Bird Atlas
BBS	U.S. Fish and Wildlife Service Breeding Bird Survey
CBC	Audubon Society Christmas Bird Count
R	Predicted occurrence from published range maps

Appendix 6. Codes for the residency status of vertebrate species in the Faunal Database for Gettysburg National Military Park and Eisenhower National Historic Site, Hopewell Furnace National Historic Site, Valley Forge National Historical Park (Variable 9)

Code	Residency Status
W	Winter Resident
S	Summer Resident
R	Year-round Resident
M	Migrant
A	Accidental

Appendix 7. Codes for the federal and state legal population status of vertebrate species in the Faunal Database for Gettysburg National Military Park and Eisenhower National Historic Site, Hopewell Furnace National Historic Site, Valley Forge National Historical Park (Variable No. 10)

Legal Status:

FE = Federally Endangered

FT = Federally Threatened

SE = State Endangered

ST = State Threatened

SV = State Vulnerable

EX = State Extirpated

NN = State Non-native

PR = State Protected

GM = State Game

FB = State Furbearer

PA Biological Survey Classification:

E = Endangered

T = Threatened

X = Extirpated

C1 = State At Risk Candidate Species

C2 = State Rare Candidate Species

C3 = State Status Undetermined Species

Appendix 8. Codes for the survey protocols for inventorying and monitoring vertebrate species in the Faunal Database at Gettysburg National Military Park and Eisenhower National Historic Site, Hopewell Furnace National Historic Site, Valley Forge National Historical Park (Variable No. 11 and No. 12)

FTRS	=	Fixed-width Transect
VTRS	=	Variable-width Transect
VCP	=	Variable-width Circular-plot
FPCO	=	Fixed-radius Point Count
UPCO	=	Unlimited-radius Point Count
SMA	=	Spot-mapping
V&C	=	Communication (and Vocalization) Index
IRE	=	Interspecific Recording
COR	=	Conspecific Recording
SCI	=	Scat/Sign Index
OPI	=	Pellet Index
DLI	=	Dam/Lodge/Den Index
TRA	=	Tracking
SST	=	Scent Station
NCO	=	Nest Count
ROC	=	Roost Count
FLC	=	Flush Count
NIG	=	Nightlighting
SOU	=	Sounding
RKI	=	Road Kill
RCE	=	Road Survey
BTR	=	Boat Survey
AER	=	Aerial Survey
QUA	=	Quadrat
NET	=	Netting (Mist-net)
TNE	=	Tadpole Netting
SNR	=	Snaring
PFT	=	Pitfall Trapping
STT	=	Snap-trapping
LTT	=	Live-trapping
BCT	=	Bal-chatri Trapping
NBT	=	Nestbox Trapping
FTR	=	Funnel-trapping
DFE	=	Drift Fence
MAR	=	Marking
BAN	=	Banding/Tagging
CRE	=	Capture-recapture
LTR	=	Log-turning/Rock-turning
CVB	=	Coverboard
AST	=	Artificial Shelter
TSE	=	Timed Search
FSV	=	Feeder Survey

Appendix 9. Instructions for ordering a copy of the Faunal Database from the National Park Service

For a copy of the Faunal Database send a letter to: National Park Service, Chief Scientist, Philadelphia Support Office, U.S. Custom House, 200 Chestnut Street, Philadelphia, PA 19106. The letter should include the following:

(1) Your name and mailing address.

(2) Requested form of the database: 3.5" or 5.25" diskette or hard copy.

(3) National park area(s) of interest: Gettysburg National Military Park/Eisenhower National Historic Site, Hopewell Furnace National Historic Site, or Valley Forge National Historical Park.

Appendix 10. Small mammal live-trapping (LTT) and pitfall-trapping (PFT) data for adults (A), sub-adults (S), juveniles (J), unknown (U-K), males (M), and females (F) at all study sites and rock wall sites during summer 1993 and at additional trapping sites during summer 1994 for Gettysburg National Military Park and Eisenhower National Historic Site.

SITE: Pennsylvania Monument Grassland (PMG)
SPECIES: Deer Mouse (*Peromyscus maniculatus*)

DATE	A-M	A-F	S-M	S-F	J-M	J-F	U-K	TOTAL	RECAPS
7/28/93	1	0	0	1	0	0	0	2	0
8/05/93	0	0	0	0	0	0	1	1	0
8/10/93	1	0	0	0	0	0	0	1	1
8/11/93	1	0	0	0	1	0	0	2	1
8/12/93	1	0	0	0	0	1	0	2	2
8/13/93	1	0	0	0	1	0	0	2	2
8/24/93	1	0	0	0	1	0	0	2	1
TOTAL	6	0	0	1	3	1	1	12	7

92% of all individuals captured at PMG
Percent Recaptures (7/12) = 58%
No./100 Trapnights = 5.13; Total Trapnights =234
No./100 LTT-Trapnights = 7.7; Total LTT-Trapnights = 156
No./100 PFT-Trapnights = 0; Total PFT-Trapnights = 78
Sex Ratio = 9M:2F = 1:0.22
Age Ratio = 6A:1S:4J = 1:0.17:0.67

OTHER SPECIES:
Meadow Jumping Mouse (*Zapus hudsonius*)
1 U-K captured 8/2/93 (pitfall)

Appendix 10. (continued)

SITE: Valley of Death Grassland (VDG)
SPECIES: Meadow Vole (*Microtus pennsylvanicus*)
1 A-F captured 7/13/93
1 A-M captured 7/23/93
1 U-K captured 7/28/93
Total Trapnights = 195
Total LTT Trapnights = 130
Total PFT Trapnights = 65
All live-trap captures; no recaptures

Appendix 10. (continued)

SITE: Warfield Ridge Old-Field (WOF)
SPECIES: White-footed Mouse (*Peromyscus leucopus*)

DATE	A-M	A-F	S-M	S-F	J-M	J-F	U-K	TOTAL	RECAPS
7/13/93	0	0	0	1	0	0	0	1	0
7/14/93	0	0	0	1	0	0	0	1	1
7/22/93	0	1	0	1	0	0	0	2	0
7/23/93	0	0	0	0	0	0	1	1	1
7/28/93	0	0	0	0	0	0	1	1	1
TOTAL	0	1	0	3	0	0	2	6	3

Total Captures = 9; 43% of all individuals captured at WOF
Percent Recaptures = 50%
No./100 Trapnights = 3.8; Total Trapnights = 156
No./100 LTT trapnights = 5.8; Total LTT Trapnights = 104
No./100 PFT Trapnights = 0.0; Total PFT Trapnights = 52
Sex Ratio = 0M:4F
Age Ratio = 1A:3S:0J = 1:3:0

OTHER SPECIES:
Meadow Vole (*Microtus pennsylvanicus*)
1 U-K captured 7/23/93
1 U-K captured 7/28/93
1 re-captured 8/05/93
All live-trap captures

Maryland Shrew (*Sorex fontinalis*)
1 captured 7/30/93 (pitfall)
1 captured 8/04/93 (pitfall)
1 captured 8/05/93 (live-trap)
2 captured 8/06/93 (live-trap)
All live-trap captures; no recaptures

Appendix 10. (continued)

SITE: Picnic Old-Field (POF)
SPECIES: White-footed Mouse (*Peromyscus leucopus*)

DATE	A-M	A-F	S-M	S-F	J-M	J-F	U-K	TOTAL	RECAPS
7/13/93	2	1	0	0	0	0	0	3	0
7/14/93	1	1	0	0	0	0	0	2	1
7/20/93	1	0	0	0	0	0	0	1	0
7/21/93	1	0	0	0	0	0	0	1	1
7/22/93	1	0	0	0	0	0	0	1	1
7/23/93	1	0	0	0	0	0	0	1	1
7/29/93	1	0	0	0	0	0	0	1	1
7/30/93	2	0	0	0	0	0	0	2	1
8/06/93	0	0	1	0	0	0	0	1	0
TOTAL	10	2	1	0	0	0	0	13	6

87% of all individuals captured at POF
Percent Recaptures (6/13) = 46%
No./100 Trapnights = 16.67; Total Trapnights = 78
No./100 LTT Trapnights = 25.0; Total LTT Trapnights = 52
No./100 PFT Trapnights = 0.0; Total PFT Trapnights = 26
Sex Ratio = 11M:1F = 1:0.1
Age Ratio = 12A:1S:0J = 1:0.08:0
Mean Adult Weight (g) (± SD) = 20.17 (± 2.71), n = 6

OTHER SPECIES:
Northern Short-tailed Shrew (*Blarina brevicauda*)
1 captured 7/21/93 (pitfall)

Eastern Chipmunk (*Tamias striatus*)
1 A-F captured 8/05/93 (live-trap)
Weight (g) = 78

Appendix 10. (continued)

SITE: McMillan Old-Field (MOF)
SPECIES: White-footed Mouse (*Peromyscus leucopus*)

DATE	A-M	A-F	S-M	S-F	J-M	J-F	U-K	TOTAL	RECAPS
7/21/93	1	0	0	0	0	0	0	1	0
7/27/93	1	0	0	1	0	0	0	2	0
7/28/93	0	1	0	0	0	0	0	1	0
7/30/93	1	1	0	0	0	0	0	2	2
8/04/93	0	1	0	0	0	0	0	1	1
8/05/93	0	1	0	0	0	0	0	1	1
8/06/93	0	1	0	0	0	0	0	1	1
TOTAL	3	5	0	1	0	0	0	9	5

90% of all individuals captured at MOF
Percent Recaptures (5/9) = 56%
No./100 Trapnights = 7.69; Total Trapnights = 117
No./100 LTT Trapnights = 11.5; Total LTT Trapnights = 78
No./100 PFT Trapnights = 0.0; Total PFT Trapnights = 39
Sex Ratio = 3M:6F = 1:2
Age Ratio = 8A:1S:0J = 1:0.13:0.00
Mean Adult Weight (g) (± SD) = 22.0 (± 3.6), n = 3

OTHER SPECIES:
Eastern Chipmunk (*Tamias striatus*)
1 U-K captured 7/23/93 (live-trap)

Appendix 10. (continued)

SITE: Devil's Den Old-Field (DOF)
SPECIES: White-footed Mouse (*Peromyscus leucopus*)

DATE	A-M	A-F	S-M	S-F	J-M	J-F	U-K	TOTAL	RECAPS
7/13/93	0	0	0	0	0	0	0	0	0
7/14/93	0	0	0	0	0	0	0	0	0
7/20/93	0	0	0	0	0	0	0	0	0
7/21/93	0	1	0	0	0	0	0	1	0
7/22/93	1	0	0	0	0	0	0	1	0
7/23/93	0	2	0	0	0	0	0	2	1
7/27/93	1	0	0	0	0	0	0	1	1
7/28/93	0	0	0	0	0	0	0	0	0
7/29/93	1	1	0	0	0	0	0	2	1
7/30/93	2	1	0	0	0	0	0	3	2
8/04/93	2	1	0	1	0	0	1	5	4
8/05/93	3	1	0	0	0	0	0	4	4
8/06/93	1	1	0	2	0	0	0	4	3
TOTAL	11	8	0	3	0	0	1	23	16

92% of all individuals captured at DOF
Percent Recaptures (16/23) = 70%
No./100 Trapnights = 19.7; Total Trapnights = 117
No./100 LTT Trapnights = 29.5; Total LTT Trapnights = 78
No./100 PFT Trapnights = 0.0; Total PFT Trapnights = 39
Sex Ratio = 11M:11F = 1:1
Age Ratio = 19A:3S:0J = 1:0.16:0.0
Mean Adult Weight (g) (± SD) = 18.0 (± 2.0), n = 5

OTHER SPECIES:
Eastern Chipmunk (*Tamias striatus*)
1 A-M (85 g) captured 7/23/93 (live-trap)

Northern Short-tailed Shrew (*Blarina brevicauda*)
1 U-K captured 7/14/93 (live-trap)

Appendix 10. (continued)

SITE: Devil's Den Lowland (DDL)
SPECIES: White-footed Mouse (*Peromyscus leucopus*)

DATE	A-M	A-F	S-M	S-F	J-M	J-F	U-K	TOTAL	RECAPS
7/13/93	1	0	0	0	0	0	1	2	0
7/14/93	0	2	0	0	0	0	0	2	0
7/20/93	3	1	1	0	0	0	0	5	2
7/21/93	3	2	0	0	0	2	0	7	4
7/22/93	2	0	0	0	0	1	1	4	1
7/23/93	1	0	0	0	0	2	0	3	2
7/27/93	1	2	0	0	0	1	3	7	3
7/28/93	1	1	0	0	0	1	0	3	2
7/29/93	1	3	0	0	0	0	0	4	2
7/30/93	2	0	0	0	0	1	0	3	3
8/04/93	2	5	0	0	0	1	1	9	7
8/05/93	3	2	0	1	0	0	0	6	5
8/06/93	2	3	0	3	0	0	0	8	5
TOTAL	22	21	1	4	0	9	6	63	36

91% of all individuals captured at DDL
Percent Recaptures (36/63) = 57%
No./100 Trapnights = 32.3; Total Trapnights = 195
No./100 LTT Trapnights = 48.4; Total LTT Trapnights = 130
No./100 PFT Trapnights = 0.0; Total PFT Trapnights = 65
Sex Ratio = 23M:34F = 1:1.5
Age Ratio = 43A:5S:9J = 1:0.12:0.21
Mean Adult Weight (g) (± SD) = 19.47 (± 4.03), n = 15

OTHER SPECIES:

Eastern Chipmunk (*Tamias striatus)*
1 A-M captured 7/22/93
1 A-F captured 7/30/93
1 A-M and 1 A-F captured 8/05/93
All live-trap captures
Mean Adult Weight (g) = 80.2

Maryland Shrew (*Sorex fontinalis*)
1 U-K captured 7/20/93 (pitfall)

Meadow Jumping Mouse (*Zapus hudsonius*)
1 U-K captured 7/27/93 (live-trap)

Appendix 10. (continued)

SITE: Landfill Lowland (LFL)
SPECIES: White-footed Mouse (*Peromyscus leucopus*)

DATE	A-M	A-F	S-M	S-F	J-M	J-F	U-K	TOTAL	RECAPS
7/21/93	0	1	0	0	0	1	0	2	0
7/22/93	0	3	0	0	0	0	0	3	1
7/23/93	3	1	0	2	0	0	1	7	0
7/27/93	1	1	0	0	0	0	1	3	2
7/28/93	1	1	0	1	0	0	2	5	3
7/29/93	0	2	0	2	0	0	2	6	5
7/30/93	3	2	0	2	0	0	1	8	6
8/04/93	3	3	0	0	0	0	2	8	6
8/05/93	3	1	0	1	0	0	2	7	6
8/06/93	2	2	0	0	0	0	1	5	5
8/11/93	3	3	0	0	0	0	1	7	7
8/12/93	2	2	0	1	0	0	3	8	7
8/13/93	1	1	0	0	0	1	3	6	6
8/24/93	2	5	0	0	0	0	1	8	4
TOTAL	24	28	0	9	0	2	20	83	58

98% of all individuals captured at LFL
Percent Recaptures (58/83) = 70%
No./100 Trapnights = 42.6; Total Trapnights = 195
No./100 LTT Trapnights = 63.8; Total LTT Trapnights = 130
No./100 PFT Trapnights = 0.0; Total PFT Trapnights = 65
Sex Ratio = 24M:39F = 1:1.6
Age Ratio = 52A:9S:2J = 1:0.17:0.04
Mean Adult Weight (g) (± SD) = 15.1 (± 6.15), n = 10

OTHER SPECIES:
Northern Short-tailed Shrew (*Blarina brevicauda*)
1 U-K captured 7/20/93 (pitfall)

Meadow Vole (*Microtus pennsylvanicus*)
1 A-F captured 7/21/93 (live-trap)

Appendix 10. (continued)

SITE: Little Round Top Upland (LRU)
SPECIES: White-footed Mouse (*Peromyscus leucopus*)

DATE	A-M	A-F	S-M	S-F	J-M	J-F	U-K	TOTAL	RECAPS
7/13/93	0	1	0	0	0	0	0	1	0
7/14/93	2	0	0	0	0	0	0	2	0
7/20/93	2	0	1	0	0	0	0	3	1
7/21/93	1	1	1	0	0	0	0	3	2
7/22/93	2	1	0	1	0	0	0	4	3
7/23/93	1	1	0	1	0	0	0	3	2
7/28/93	1	1	0	0	0	0	1	3	1
7/29/93	1	1	0	1	0	0	0	3	3
7/30/93	2	0	0	0	0	0	1	3	2
8/04/93	1	0	0	0	0	0	2	3	2
8/05/93	2	0	0	1	0	0	0	3	3
TOTAL	15	6	2	4	0	0	4	31	19

86% of all individuals captured at LRU
Percent Recaptures (19/31) = 61%
No./100 Trapnights = 19.9; Total Trapnights = 156
No./100 LTT Trapnights = 29.8; Total LTT Trapnights = 104
No./100 PFT Trapnights = 0.0; Total PFT Trapnights = 52
Sex Ratio = 17M:10F = 1:0.59
Age Ratio = 21A:6S:0J = 1:0.29:0
Mean Adult Weight (g) (± SD) = 20.0 (± 1.0), n = 3

OTHER SPECIES:
Northern Short-tailed Shrew (*Blarina brevicauda*)
1 U-K captured 7/20/93
2 U-K captured 7/27/93
1 U-K captured 7/29/93
1 U-K captured 8/04/93
All live-trap captures; no recaptures

Appendix 10. (continued)

SITE: Big Round Top Upland (BRU)
SPECIES: White-footed Mouse (*Peromyscus leucopus*)

DATE	A-M	A-F	S-M	S-F	J-M	J-F	U-K	TOTAL	RECAPS
7/20/93	0	0	1	0	0	0	0	1	0
7/21/93	2	0	0	0	0	0	0	2	0
7/22/93	3	0	0	0	1	0	1	5	2
7/23/93	3	0	1	1	0	0	0	5	3
7/27/93	2	0	2	0	0	0	0	4	3
7/28/93	1	0	2	0	0	0	1	4	2
7/29/93	2	0	0	1	0	0	0	3	2
7/30/93	1	1	1	0	0	0	0	3	1
8/04/93	3	0	0	1	0	0	1	5	1
8/05/93	0	1	1	0	0	0	1	3	2
8/10/93	1	0	0	1	0	0	2	4	4
8/11/93	3	0	1	2	0	0	0	6	4
8/12/93	0	0	0	1	0	0	0	1	1
8/13/93	3	0	0	1	0	0	0	4	3
TOTAL	24	2	9	9	0	0	6	50	28

89% of all individuals captured at BRU
Percent Recaptures (28/50) = 56%
No./100 Trapnights = 21.3; Total Trapnights = 234
No./100 LTT Trapnights = 32.1; Total LTT Trapnights = 156
No./100 PFT Trapnights = 0.0; Total PFT Trapnights = 78
Sex Ratio = 33M:11F = 1:0.33
Age Ratio = 26A:18S:0J = 1:0.69:0.00
Mean Adult Weight (g) (± SD) = 20.0 (± 2.5), n = 9

Appendix 10. (continued)

OTHER SPECIES:

Northern Short-tailed Shrew (*Blarina brevicauda)*
1 U-K captured 7/20/93 (pitfall)
1 U-K captured 7/29/93 (pitfall)
1 U-K captured 8/12/93 (live-trap)
All live-trap captures; no recaptures

Eastern Chipmunk (*Tamias striatus*)
1 A-F captured 8/11/93 (live-trap)

Maryland Shrew (*Sorex fontinalis*)
2 U-K captured 8/12/93 (pitfall)

Appendix 10. (continued)

SITE: Horse Path Rocks (HPR)
SPECIES: White-footed Mouse (*Peromyscus leucopus*)

DATE	A-M	A-F	S-M	S-F	J-M	J-F	U-K	TOTAL	RECAPS
7/20/93	1	1	1	0	0	0	2	5	0
7/21/93	2	1	0	5	0	0	1	9	1
7/22/93	2	3	0	4	0	0	1	10	7
7/23/93	2	3	0	2	0	0	2	9	8
7/27/93	3	3	1	5	0	0	1	13	10
7/28/93	3	2	1	4	0	0	0	10	10
7/29/93	5	2	1	3	0	0	2	13	11
7/30/93	1	2	0	1	0	0	0	4	3
8/05/93	1	0	1	1	0	0	0	3	1
8/06/93	0	0	0	0	0	0	1	1	1
TOTAL	20	17	5	25	0	0	10	77	52

97% of all individuals captured at HPR
Percent Recaptures (52/77) = 68%
No./100 Trapnights = 35.0; Total Trapnights = 220
Sex Ratio = 25M:42F = 1:1.68
Age Ratio = 37A:30S:0J = 1:0.81:0
Mean Adult Weight (g) (± SD) = 20.64 (± 3.38), n = 11
Live-traps only (no pitfall traps used)

OTHER SPECIES:
Northern Short-tailed Shrew (*Blarina brevicauda*)
1 U-K captured 7/27/93
1 U-K captured 8/06/93
All live-trap captures; no recaptures

Appendix 10. (continued)

SITE: Devil's Den Rocks (DDR)
SPECIES: White-footed Mouse (*Peromyscus leucopus*)

DATE	A-M	A-F	S-M	S-F	J-M	J-F	U-K	TOTAL	RECAPS
7/20/93	1	0	1	0	0	0	0	2	0
7/21/93	1	1	1	0	0	0	0	3	2
7/22/93	1	1	0	0	0	0	1	3	2
7/23/93	1	2	0	0	0	0	0	3	2
7/27/93	0	1	0	1	0	2	1	5	1
7/28/93	0	1	0	1	1	0	1	4	3
7/29/93	1	1	0	1	0	1	1	5	5
7/30/93	1	2	0	1	0	1	2	7	7
TOTAL	6	9	2	4	1	4	6	32	22

100% of all individuals captured at DDR
Percent Recaptures (22/32) = 69%
No./100 Trapnights = 32.0; Total Trapnights = 100
Sex Ratio = 9M:17F = 1:1.89
Age Ratio = 15A:6S:5J = 1:0.40:0.33
Mean Adult Weight (g) (± SD) = 21 (± 1.0), n = 3
Live-traps only (no pitfall traps used)

OTHER SPECIES : None

Appendix 10. (continued)

SITE: Pennsylvania Monument Rocks (PMR)
SPECIES: White-footed Mouse (*Peromyscus leucopus*)

DATE	A-M	A-F	S-M	S-F	J-M	J-F	U-K	TOTAL	RECAPS
7/20/93	1	0	0	0	0	0	0	1	0
7/21/93	3	0	0	0	0	0	0	3	1
7/22/93	4	2	0	0	0	0	0	6	3
7/23/93	3	1	0	0	0	0	0	4	4
7/27/93	2	2	0	1	0	0	0	5	3
7/28/93	2	2	0	1	0	0	1	6	5
7/29/93	2	2	0	1	0	0	0	5	5
7/30/93	3	2	0	1	0	0	0	6	3
8/05/93	0	1	0	0	0	0	0	1	1
TOTAL	20	12	0	4	0	0	1	37	25

95% of all individuals captured at PMR
Percent Recaptures (25/37) = 68
No./100 Trapnights = 28.5; Total Trapnights = 130
Sex Ratio = 20M:16F = 1:0.8
Age Ratio = 32A:4S:0J = 1:0.13:0.00
Mean Adult Weight (g) (± SD) = 18.8 (± 5.54), n = 5
Live-traps only (no pitfall traps used)

OTHER SPECIES:
Deer Mouse (*Peromyscus maniculatus*)
1 U-K captured 7/29/93
1 U-K captured 8/05/93

Appendix 10. (continued)

SITE: Sedgwick Rocks (SWR)
SPECIES: White-footed Mouse (*Peromyscus leucopus*)

DATE	A-M	A-F	S-M	S-F	J-M	J-F	U-K	TOTAL	RECAPS
7/21/93	1	1	0	0	0	0	0	2	0
7/22/93	0	1	0	0	0	0	0	1	1
7/23/93	1	1	0	0	0	0	0	2	1
7/27/93	1	0	0	0	0	0	0	1	1
7/29/93	0	1	0	0	0	1	0	2	0
7/30/93	0	0	0	0	0	1	0	1	0
TOTAL	3	4	0	0	0	2	0	9	3

100% of all individuals captured at SWR
Percent Recaptures (3/9) = 33%
No./100 Trapnights = 10.0; Total Trapnights = 90
Sex Ratio = 3M:6F = 1:2
Age Ratio = 7A:0S:2J = 1:0.00:0.29
Mean Adult Weight (g) (± SD) = 21.5 (± 3.11), n = 4
Live-traps only (no pitfall traps used)

OTHER SPECIES: None

Appendix 10. (continued)

SITE: Valley of Death Rocks (VDR)
SPECIES: White-footed Mouse (*Peromyscus leucopus*)
1 A-M captured 7/20/93
1 U-K captured 7/20/93
Total Trapnights = 70
All live-trap captures; no recaptures
Live-traps only (no pitfall traps used)

Appendix 10. (continued)

SITE: Pennsylvania Monument Grassland (PMG)
SPECIES: Meadow Vole (*Microtus pennsylvanicus*)
1 A-F captured 7/12/94
1 A-F and 1 J-M captured 7/14/94
1 J-M recaptured 7/15/94
1 J-M captured 7/16/94
Total Trapnights = 50
Live-traps only (no pitfall traps used)

Appendix 10. (continued)

SITE: Red Rock Road Grassland (RRG)
SPECIES: Meadow Vole (*Microtus pennsylvanicus*)

DATE	A-M	A-F	S-M	S-F	J-M	J-F	U-K	TOTAL	RECAPS
7/12/94	3	0	0	0	0	0	0	3	0
7/13/94	2	1	0	0	0	0	0	3	0
7/14/94	3	0	0	0	1	0	0	4	0
7/15/94	1	2	0	0	0	0	0	3	0
7/16/94	0	3	0	0	0	0	0	3	1
TOTAL	9	6	0	0	1	0	0	16	1

94% of all individuals captured at RRG
Percent Recaptures (1/16) = 6%
No./100 Trapnights = 32; Total Trapnights = 50
Sex Ratio = 10M:6F = 1:0.6
Age Ratio = 15A:0S:1J = 1:0.00:0.06
Mean Adult Weight (g) = 36.8, n = 14
Live-traps only (no pitfall traps used)

OTHER SPECIES:
White-footed Mouse (*Peromyscus leucopus*)
1 A-M captured 7/13/94

Appendix 10. (continued)

SITE: Sedgwick Avenue Grassland (SAG)
SPECIES: White-footed Mouse (*Peromyscus leucopus*)
1 A-M captured 7/12/94
1 A-M captured 7/13/94
1 A-F captured 7/14/94
1 A-M captured 7/15/94
1 A-F captured 7/16/94
1 A-F recaptured 7/16/94
Mean Adult Weight (g) = 17.4, n = 5

OTHER SPECIES: Meadow Vole (*Microtus pennsylvanicus*)
1 A-M captured 7/14/94
Total Trapnights = 50
Live-traps only (no pitfall traps used)

Appendix 10. (continued)

SITE: Eisenhower Old-Field
SPECIES: Meadow Vole (*Microtus pennsylvanicus*)
1 A-M captured 7/13/94
1 A-M captured 7/16/94
Total Trapnights = 50
All live-trap captures; no recaptures
Live-traps only (no pitfall traps used)

Appendix 10. (continued)

SITE: South Confederate Lowland (SCL)
SPECIES: White-footed Mouse (*Peromyscus leucopus*)

DATE	A-M	A-F	S-M	S-F	J-M	J-F	U-K	TOTAL	RECAPS
7/12/94	0	0	0	0	0	0	0	0	0
7/13/94	0	0	0	0	0	0	0	0	0
7/14/94	1	1	0	0	0	0	0	2	0
7/15/94	1	1	0	0	0	0	0	2	0
7/16/94	4	3	0	0	0	0	0	7	3
TOTAL	6	5	0	0	0	0	0	11	3

92% of all individuals captured at SCL
Percent Recaptures (3/11) = 27.3%
No./100 Trapnights = 22; Total Trapnights = 50
Sex Ratio = 6M:5F = 1:0.83
Age Ratio = 11A:0S:0J = 1:0.00:0.00
Mean Adult Weight (g) = 16.4, n = 8
Live-traps only (no pitfall traps used)

OTHER SPECIES:
Northern Short-tailed Shrew (*Blarina brevicauda*)
1 U-K captured 7/15/94

Appendix 10. (continued)

SITE: Culp's Hill Upland (CHU)
SPECIES: White-footed Mouse (*Peromyscus leucopus*)
1 A-M captured 7/15/94
3 A-M captured 7/16/94
1 A-M recaptured 7/16/94
Mean Adult Weight (g) = 16.5, n = 4
Total Trapnights = 50
Live-traps only (no pitfall traps used)

Appendix 11. Small mammal live-trapping (LTT) and pitfall-trapping (PFT) data for adults (A), sub-adults (S), juveniles (J), unknown (U-K), males (M), and females (F) with and without drift fences at all study sites during mid-August 1994 and mid-July 1995 for Hopewell Furnace National Historic Site. All individuals were captured in live-traps unless noted otherwise.

SITE: Powerline Lowland Old-field (PLO)
SPECIES: White-footed Mouse (*Peromyscus leucopus*)

DATE	A-F	A-M	S-F	S-M	J-F	J-M	U-K	TOTAL	RECAPS
8/12/94	0	1	0	0	1	0	0	2	--
8/13/94	0	0	1	0	0	0	0	1	0
8/14/94	0	1	0	0	0	0	0	1	0
8/16/94	0	1	0	0	0	0	0	1	1
8/17/94	0	0	1	0	1	0	0	2	2
8/18/94	0	0	1	0	1	1	0	3	2
TOTAL	0	3	3	0	3	1	0	10	5

66.7% of all individuals captured at PLO
Percent Recaptures (5/10) = 50.0%
No./100 Trapnights = 11.1; Total Trapnights = 90
No./100 Live-trap Trapnights = 16.7; 60 Total Live-trap Nights
No./100 Pitfall Trapnights = 0.0; 30 Total Pitfall Trapnights
No./100 Trapnights with Drift Fences = 13.9; 36 Total Drift Fence Trapnights
No./100 Trapnights without Drift Fences = 9.3; 54 Total Non-Drift Fence Trapnights
Sex Ratio = 4M:6F = 1.0:1.5
Age Ratio = 3A:3S:4J = 1.0:1.0:1.33
Mean Adult Weight (g) (± SD) = 19.5 (± 4.9), n = 2

OTHER SPECIES:
Masked Shrew (*Sorex cinereus*)
1 captured 8/13/94 PFT with Drift Fence
1 captured 8/14/94 PFT without Drift Fence
1 captured 8/16/94 PFT without Drift Fence
1 captured 8/17/94 PFT without Drift Fence

Meadow Vole (*Microtus pennsylvanicus*)
1 A-M captured 8/17/94 LTT with Drift Fence

Appendix 11. (continued)

SITE: Powerline Upland Old-field (PUO)
SPECIES: White-footed Mouse (*Peromyscus leucopus*)

DATE	A-F	A-M	S-F	S-M	J-F	J-M	U-K	TOTAL	RECAPS
8/11/94	0	1	1	2	0	0	0	4	--
8/12/94	0	0	0	2	0	0	0	2	0
8/13/94	0	2	3	1	0	0	0	6	1
8/14/94	1	2	2	2	0	0	0	7	6
8/16/94	0	3	1	1	0	0	0	5	3
8/18/94	1	2	0	1	0	0	0	4	2
TOTAL	2	9	7	9	0	0	0	27	12

92.6% of all individuals captured at PUO
Percent Recaptures (12/27) = 44.4%
No./100 Trapnights = 30.0; Total Trapnights = 90
No./100 Live-trap Trapnights = 30.0; 60 Total Live-trap Trapnights
No./100 Pitfall Trapnights = 0.0; 30 Total Pitfall Trapnights
No./100 Trapnights with Drift Fences = 22.2; 54 Total Drift Fence Trapnights
No./100 Trapnights w/o Drift Fences = 41.7; 36 Total Non-Drift Fence Trapnights
Sex Ratio = 18M:9F = 1.0:0.5
Age Ratio = 11A:16S:0J = 1.00:1.45:0.00
Mean Adult Weight (g) (± SD) = 18.1 (± 2.6), n = 7

OTHER SPECIES:
Masked Shrew (*Sorex cinereus*)
1 captured 8/13/94 PFT with Drift Fence
2 captured 8/16/94 PFT with Drift Fence

Appendix 11. (continued)

SITE: Powerline Lowland (PLL)
SPECIES: White-footed Mouse (*Peromyscus leucopus*)

DATE	A-F	A-M	S-F	S-M	J-F	J-M	U-K	TOTAL	RECAPS
8/12/94	0	2	0	0	0	0	0	2	--
8/13/94	1	2	0	0	0	0	0	3	1
8/14/94	0	3	0	0	0	0	2	5	2
8/16/94	0	0	0	0	0	0	1	1	1
8/17/94	0	2	0	1	0	0	1	4	2
8/18/94	2	0	2	0	0	0	2	6	1
TOTAL	3	9	2	1	0	0	6	21	7

100.0% of all individuals captured at PLL
Percent Recaptures (7/21) = 33.3%
No./100 Trapnights = 23.3; Total Trapnights = 90
No./100 Live-trap Trapnights = 35.0; 60 Total Live-trap Nights
No./100 Pitfall Trapnights = 0.0; 30 Total Pitfall Trapnights
No./100 Trapnights with Drift Fences = 22.2; 36 Total Drift Fence Trapnights
No./100 Trapnights without Drift Fences = 24.1; 54 Total Non-Drift Fence Trapnights
Sex Ratio = 10M:5F = 1.00:0.50
Age Ratio = 12A:3S:0J = 1.00:0.25:0.00
Mean Adult Weight (g) (± SD) = 22.5 (± 2.5), n = 6

OTHER SPECIES: NONE

Appendix 11. (continued)

SITE: Hopewell Road Lowland (HOL)
SPECIES: White-footed Mouse (*Peromyscus leucopus*)

DATE	A-F	A-M	S-F	S-M	J-F	J-M	U-K	TOTAL	RECAPS
8/12/94	2	0	0	0	0	0	0	2	--
8/13/94	3	3	1	0	0	0	0	7	1
8/15/94	2	1	0	1	0	0	0	4	3
8/16/94	1	1	0	0	0	0	0	2	2
8/17/94	1	1	0	0	0	0	0	2	2
8/18/94	3	1	0	0	0	0	0	4	3
TOTAL	12	7	1	1	0	0	0	21	11

87.5% of all individuals captured at HOL
Percent Recaptures (11/21) = 52.4%
No./100 Trapnights = 23.3; Total Trapnights = 90
No./100 Live-trap Trapnights = 35.0; 60 Total Live-trap Nights
No./100 Pitfall Trapnights = 0.0; 30 Total Pitfall Trapnights
No./100 Trapnights with Drift Fences = 30.6; 36 Total Drift Fence Trapnights
No./100 Trapnights without Drift Fences = 18.5; 54 Total Non-Drift Fence Trapnights
Sex Ratio = 8M:13F = 1.00:1.63
Age Ratio = 19A:2S:0J = 1.00:0.11:0.00
Mean Adult Weight (g) (± SD) = 19.6 (± 2.1), n = 8

OTHER SPECIES:
Masked Shrew (*Sorex cinereus*)
1 captured 8/16/94 PFT with Drift Fence

Meadow Vole (*Microtus pennsylvanicus*)
1 captured 8/17/94 PFT with Drift Fence

Meadow Jumping Mouse (*Zapus hudsonius*)
1 captured 8/17/94 PFT with Drift Fence

Appendix 11. (continued)

SITE: French Creek Riparian (FCR)
SPECIES: White-footed Mouse (*Peromyscus leucopus*)

DATE	A-F	A-M	S-F	S-M	J-F	J-M	U-K	TOTAL	RECAPS
8/12/94	1	3	0	0	0	0	0	4	--
8/13/94	1	4	1	0	0	0	0	6	3
8/14/94	1	5	1	1	0	0	0	8	7
8/15/94	0	2	0	0	0	0	1	3	2
8/16/94	2	3	1	0	1	0	1	8	5
8/18/94	3	3	1	1	0	0	0	8	4
TOTAL	8	20	4	2	1	0	2	37	21

100.0% of all individuals captured at FCR
Percent Recaptures (21/37) = 56.8%
No./100 Trapnights = 35.2; Total Trapnights = 90
No./100 Live-trap Trapnights = 52.9; 60 Total Live-trap Nights
No./100 Pitfall Trapnights = 0.0; 30 Total Pitfall Trapnights
No./100 Trapnights with Drift Fences = 41.3; 54 Total Drift Fence Trapnights
No./100 Trapnights without Drift Fences = 26.2; 36 Total Non-Drift Fence Trapnights
Sex Ratio = 22M:13F = 1.00:0.59
Age Ratio = 28A:6S:1J = 1.00:0.21:0.04
Mean Adult Weight (g) (± SD) = 19.5 (± 2.6), n = 11

OTHER SPECIES: NONE

Appendix 11. (continued)

SITE: French Creek Lowland (FCL)
SPECIES: White-footed Mouse (*Peromyscus leucopus*)

DATE	A-F	A-M	S-F	S-M	J-F	J-M	U-K	TOTAL	RECAPS
8/12/94	1	0	1	0	0	0	0	2	--
8/13/94	2	1	1	0	0	0	0	4	2
8/15/94	2	3	0	0	0	0	0	5	1
8/17/94	0	0	1	0	0	0	0	1	1
8/18/94	1	0	1	0	0	0	0	2	2
TOTAL	6	4	4	0	0	0	0	14	6

100.0% of all individuals captured at FCL
Percent Recaptures (6/14) = 42.9%
No./100 Trapnights = 18.7; Total Trapnights = 75
No./100 Live-trap Trapnights = 28.0; 50 Total Live-trap Nights
No./100 Pitfall Trapnights = 0.0; 25 Total Pitfall Trapnights
No./100 Trapnights with Drift Fences = 20.0; 45 Total Drift Fence Trapnights
No./100 Trapnights without Drift Fences = 16.7; 30 Total Non-Drift Fence Trapnights
Sex Ratio = 4M:10F = 1.00:2.50
Age Ratio = 10A:4S:0J = 1.00:0.40:0.00
Mean Adult Weight (g) (± SD) = 21.9 (± 3.4), n = 7

OTHER SPECIES: NONE

Appendix 11. (continued)

SITE: Powerline Upland (PLU)
SPECIES: White-footed Mouse (*Peromyscus leucopus*)

DATE	A-F	A-M	S-F	S-M	J-F	J-M	U-K	TOTAL	RECAPS
8/11/94	0	1	0	1	0	0	0	2	--
8/12/94	2	1	0	0	0	0	0	3	1
8/13/94	2	1	0	1	0	0	1	5	2
8/14/94	0	3	1	1	0	0	0	5	2
8/18/94	3	1	0	1	0	0	0	5	1
TOTAL	7	7	1	4	0	0	1	20	6

95.0% of all individuals captured at PLU
Percent Recaptures (6/20) = 30.0%
No./100 Trapnights = 26.7; Total Trapnights = 75
No./100 Live-trap Trapnights =40.0; 50 Total Live-trap Nights
No./100 Pitfall Trapnights = 0.0; 25 Total Pitfall Trapnights
No./100 Trapnights with Drift Fences = 30.0; 30 Total Drift Fence Trapnights
No./100 Trapnights without Drift Fences = 24.4; 45 Total Non-Drift Fence Trapnights
Sex Ratio = 11M:8F = 1.00:0.73
Age Ratio = 14A:5S:0J = 1.00:0.36:0.00
Mean Adult Weight (g) (± SD) = 17.7 (± 2.3), n = 10

OTHER SPECIES:
Northern Short-tailed Shrew (*Blarina brevicauda*)
1 captured 8/14/94 PFT with Drift Fence

Appendix 11. (continued)

SITE: S-Curve Upland (SCU)
SPECIES: White-footed Mouse (*Peromyscus leucopus*)

DATE	A-F	A-M	S-F	S-M	J-F	J-M	U-K	TOTAL	RECAPS
8/12/94	1	1	0	0	0	0	0	2	--
8/13/94	2	1	0	0	0	0	0	3	0
8/15/94	3	0	0	0	0	0	0	3	2
8/16/94	0	1	0	0	0	0	0	1	1
8/17/94	1	0	0	0	0	0	0	1	1
8/18/94	0	1	0	0	1	0	0	2	0
TOTAL	7	4	0	0	1	0	0	12	4

91.6% of all individuals captured at SCU
Percent Recaptures (4/12) = 33.3%
No./100 Trapnights = 13.3; Total Trapnights = 90
No./100 Live-trap Trapnights =20.0; 60 Total Live-trap Nights
No./100 Pitfall Trapnights = 0.0; 30 Total Pitfall Trapnights
No./100 Trapnights with Drift Fences = 11.1; 54 Total Drift Fence Trapnights
No./100 Trapnights without Drift Fences = 16.7; 36 Total Non-Drift Fence Trapnights
Sex Ratio = 4M:8F = 1.00:2.00
Age Ratio = 11A:0S:1J = 1.00:0.00:0.09
Mean Adult Weight (g) (± SD) = 18.0 (± 2.8), n = 6

OTHER SPECIES:
Masked Shrew (*Sorex cinereus*)
1 captured 8/18/94 PFT with Drift Fence

Appendix 11. (continued)

SITE: Powerline Lowland Old-Field
SPECIES: White-footed Mouse (*Peromyscus leucopus*)

1 A-M captured 7/19/95 LTT with Drift Fence
1 A-M captured 7/20/95 LTT without Drift Fence
1 A-M recaptured 7/20/95 LTT with Drift Fence
1 A-M recaptured 7/21/95 LTT with Drift Fence
1 S-F captured 7/22/95 LTT without Drift Fence
1 S-F recaptured 7/23/95 LTT without Drift Fence

Masked Shrew (*Sorex cinereus*)

1 captured 7/19/95 PFT with Drift Fence
1 captured 7/20/95 PFT with Drift Fence
1 captured 7/22/95 PFT with Drift Fence
1 captured 7/22/95 PFT without Drift Fence

Meadow Jumping Mouse (*Zapus hudsonius*)

1 A-M captured 7/20/95 LTT without Drift Fence

Meadow Vole (*Microtus pennsylvanicus*)

1 A-M captured 7/21/95 LTT with Drift Fence

Eastern Chipmunk (*Tamias striatus*)

1 A-M captured 7/23/95 LTT without Drift Fence

Appendix 11. (continued)

SITE: Powerline Upland Old-Field
SPECIES: White-footed Mouse (*Peromyscus leucopus*)

DATE	A-F	A-M	S-F	S-M	J-F	J-M	U-K	TOTAL	RECAPS
7/19/95	0	2	0	0	0	0	0	2	--
7/20/95	0	2	1	0	0	0	0	3	2
7/21/95	0	0	1	0	0	0	0	1	1
7/22/95	1	0	1	0	0	0	0	2	1
7/23/95	0	0	1	0	0	0	0	1	1
TOTAL	1	4	4	0	0	0	0	9	5

100.0% of all individuals captured at PUO
Percent Recaptures (5/9) = 55.6%
No./100 Trapnights = 12.0; Total Trapnights = 75
No./100 Live-trap Trapnights = 18.0; 50 Total Live-trap Trapnights
No./100 Pitfall Trapnights = 0.0; 25 Total Pitfall Trapnights
No./100 Trapnights with Drift Fences = 6.7; 45 Total Drift Fence Trapnights
No./100 Trapnights w/o Drift Fences = 20.0; 30 Total Non-Drift Fence Trapnights
Sex Ratio = 4M:5F = 1.0:1.25
Age Ratio = 5A:4S:0J = 1.00:0.80:0.00
Mean Adult Weight (g) (± SD) = 19.33 (± 2.31), n = 3

OTHER SPECIES: NONE

Appendix 11. (continued)

SITE: Powerline Lowland (PLL)
SPECIES: White-footed Mouse (*Peromyscus leucopus*)

DATE	A-F	A-M	S-F	S-M	J-F	J-M	U-K	TOTAL	RECAPS
7/19/95	1	1	0	0	0	0	0	2	--
7/20/95	0	1	0	0	0	0	0	1	1
7/21/95	1	1	0	1	1	0	1	5	1
7/22/95	1	3	0	0	1	0	0	5	3
7/23/95	2	2	0	0	1	0	0	5	3
TOTAL	5	8	0	1	3	0	1	18	8

100.0% of all individuals captured at PLL
Percent Recaptures (8/18) = 44.4%
No./100 Trapnights = 24.0; Total Trapnights = 75
No./100 Live-trap Trapnights = 36.0; 50 Total Live-trap Trapnights
No./100 Pitfall Trapnights = 0.0; 25 Total Pitfall Trapnights
No./100 Trapnights with Drift Fences = 16.7; 30 Total Drift Fence Trapnights
No./100 Trapnights w/o Drift Fences = 28.9; 45 Total Non-Drift Fence Trapnights
Sex Ratio = 9M:8F = 1.0:0.89
Age Ratio = 13A:1S:3J = 1.00:0.08:0.23
Mean Adult Weight (g) (± SD) = 18.42 (± 3.99), n = 7

OTHER SPECIES: NONE

Appendix 11. (continued)

SITE: French Creek Riparian (FCR)
SPECIES: White-footed Mouse (*Peromyscus leucopus*)

DATE	A-F	A-M	S-F	S-M	J-F	J-M	U-K	TOTAL	RECAPS
7/19/95	1	0	1	1	0	0	0	3	--
7/20/95	0	2	0	1	0	0	0	3	1
7/21/95	0	0	1	2	0	0	0	3	2
7/22/95	1	0	1	2	0	0	0	4	3
7/23/95	0	1	1	1	0	0	0	3	3
TOTAL	2	3	4	7	0	0	0	16	9

72.7% of all individuals captured at FCR
Percent Recaptures (9/16) = 56.3%
No./100 Trapnights = 21.3; Total Trapnights = 75
No./100 Live-trap Trapnights = 32.0; 50 Total Live-trap Trapnights
No./100 Pitfall Trapnights = 0.0; 25 Total Pitfall Trapnights
No./100 Trapnights with Drift Fences = 26.7; 45 Total Drift Fence Trapnights
No./100 Trapnights w/o Drift Fences = 13.3; 30 Total Non-Drift Fence Trapnights
Sex Ratio = 10M:6F = 1.0:0.6
Age Ratio = 5A:11S:0J = 1.00:2.20:0.00
Mean Adult Weight (g) (± SD) = 19.67 (± 2.52), n = 3

OTHER SPECIES:
Northern Short-tailed Shrew *(Blarina brevicauda)*
1 Adult captured 7/20/95 PFT with Drift Fence
1 Adult captured 7/21/95 PFT without Drift Fence
1 Adult captured 7/21/95 LTT without Drift Fence

Eastern Chipmunk (*Tamias striatus*)
1 A-M captured 7/19/95 LTT without Drift Fence
1 A-M recaptured 7/20/95 LTT without Drift Fence
1 A-M captured 7/22/95 LTT with Drift Fence

Appendix 11. (continued)

SITE: Powerline Upland (PLU)
SPECIES: White-footed Mouse (*Peromyscus leucopus*)

DATE	A-F	A-M	S-F	S-M	J-F	J-M	U-K	TOTAL	RECAPS
7/19/95	0	2	0	0	0	0	0	2	--
7/20/95	1	1	0	0	2	0	0	4	1
7/21/95	1	0	0	0	2	0	0	3	3
7/22/95	2	0	0	1	2	0	0	5	3
7/23/95	1	1	0	1	1	0	0	4	4
TOTAL	5	4	0	2	7	0	0	18	11

90.0% of all individuals captured at PLU
Percent Recaptures (11/18) = 61.1%
No./100 Trapnights = 24.0; Total Trapnights = 75
No./100 Live-trap Trapnights = 36.0; 50 Total Live-trap Trapnights
No./100 Pitfall Trapnights = 0.0; 25 Total Pitfall Trapnights
No./100 Trapnights with Drift Fences = 40.0; 30 Total Drift Fence Trapnights
No./100 Trapnights w/o Drift Fences = 13.3; 45 Total Non-Drift Fence Trapnights
Sex Ratio = 6M:12F = 1.0:2.0
Age Ratio = 9A:2S:7J = 1.00:0.22:0.78
Mean Adult Weight (g) (± SD) = 19.25 (± 1.26), n = 4

OTHER SPECIES:
Northern Short-tailed Shrew (*Blarina brevicauda*)
1 Adult captured 7/23/95 LTT with Drift Fence

Eastern Chipmunk (*Tamias striatus*)
1 A-F captured 7/22/95 LTT without Drift Fence

Appendix 11. (continued)

SITE: S-Curve Upland (SCU)
SPECIES: White-footed Mouse (*Peromyscus leucopus*)
1 A-M captured 7/22/95 LTT without Drift Fence
1 A-M recaptured 7/23/95 LTT without Drift Fence
1 S-F captured 7/23/95 LTT without Drift Fence

Masked Shrew (*Sorex cinereus*)
1 captured 7/19/95 PFT with Drift Fence

Appendix 12. Small mammal live-trapping data for adults (A), sub-adults (S), juveniles (J), unknown (U-K), males (M), females (F), and recaptures at all study sites during mid-August 1995 for Valley Forge National Historical Park. All individuals were captured in small live-traps unless noted otherwise. Total does not include number of recaptures.

SITE: General Wayne Grassland (GWG)
SPECIES: Meadow Vole (*Microtus pennsylvanicus*)

DATE	A-M	A-F	S-M	S-F	J-M	J-F	U-K	TOTAL	RECAPS
8/14	1	1	0	1	0	2	0	5	0
8/15	1	0	4	0	0	0	0	5	0
8/16	0	1	1	1	0	1	0	4	1
8/17	2	2	0	0	0	1	0	5	1
8/18	2	1	1	0	0	0	1	5	0
TOTAL	6	5	6	2	0	4	1	24	2

100% of all individuals captured at GWG
Percent recaptures (2/24) = 8.3%
No./100 trapnights (small traps) = 48; Total trapnights (small traps) = 50
Sex ratio = 12M:11F = 1.00:0.92
Age ratio = 11A:8S:4J = 1.00:0.73:0.36
Mean adult weight (g) (± SD) = 39.96 (± 7.11), n = 11

OTHER SPECIES: None

Appendix 12. (continued)

SITE: Valley Forge Old-Field (VOF)
SPECIES: Meadow Vole (*Microtus pennsylvanicus)*

DATE	A-M	A-F	S-M	S-F	J-M	J-F	U-K	TOTAL	RECAPS
8/14	1	0	0	0	0	0	0	1	0
8/15	1	0	0	0	0	0	0	1	1
8/16	1	0	0	0	0	0	0	1	0
8/17	2	0	0	0	0	0	0	2	1
8/18	0	1	0	0	0	0	0	1	0
TOTAL	5	1	0	0	0	0	0	6	2

100% of all individuals captured at VOF
Percent recaptures (2/6) = 33.3%
No./100 trapnights (small traps) = 12; Total trapnights (small traps) = 50
Sex ratio = 5M:1F = 1.00:0.20
Age ratio = 6A:0S:0J = 1.00:0.00:0.00
Mean adult weight (g) (± SD) = 43.13 (± 8.87), n = 4

OTHER SPECIES: None

Appendix 12. (continued)

SITE: Rail Road Lowland (RRL)
SPECIES: White-footed Mouse (*Peromyscus leucopus*)

DATE	A-M	A-F	S-M	S-F	J-M	J-F	U-K	TOTAL	RECAPS
8/14	1	0	0	0	0	0	0	1	0
8/15	1	0	0	1	0	0	0	2	1
8/16	2	1	0	0	0	0	0	3	0
8/17	1	4	0	0	0	0	0	5	2
8/18	2	3	0	0	0	0	0	5	5
TOTAL	7	8	0	1	0	0	0	16	8

100% of all individuals captured at RRL
Percent recaptures (8/16) = 50.0%
No./100 trapnights (small traps) = 32; Total trapnights (small traps) = 50
Sex ratio = 7M:9F = 1.00:1.29
Age ratio = 15A:1S:0J = 1.00:0.07:0.00
Mean adult weight (g) (± SD) = 18.64 (± 4.22), n = 7

OTHER SPECIES: None

Appendix 12. (continued)

SITE: James White Lowland (JWL)
SPECIES: White-footed Mouse (*Peromyscus leucopus*)

DATE	A-M	A-F	S-M	S-F	J-M	J-F	U-K	TOTAL	RECAPS
8/14	1	0	1	0	0	0	0	2	0
8/15	0	1	0	0	1	0	0	2	0
8/16	1	1	0	0	1	0	0	3	2
8/17	1	1	0	0	1	1	0	4	2
8/18	2	2	0	0	1	1	0	6	3
TOTAL	5	5	1	0	4	2	0	17	7

94% of all individuals captured at JWL
Percent recaptures (7/17) = 41.2%
No./100 trapnights (small traps) = 34; Total trapnights (small traps) = 50
Sex ratio = 10M:7F = 1.00:0.70
Age ratio = 10A:1S:6J = 1.00:0.10:0.60
Mean adult weight (g) (± SD) = 20.08 (± 4.72), n = 6

OTHER SPECIES:
Gray Squirrel (*Sciurus carolinensis*)
1 A-M captured 8/16 in a large live-trap; Total trapnights (large traps) = 10

Appendix 12. (continued)

SITE: Mount Misery Upland (MMU)
SPECIES: Gray Squirrel (*Sciurus carolinensis*)
1 A-F captured 8/15 in a large live-trap; Total trapnights (large traps) = 10
Eastern Chipmunk (*Tamias striatus*)
1 A-F captured 8/17 in a large live-trap; Total trapnights (large traps) = 10

SITE: Mount Joy Upland (MJU)
SPECIES: Gray Squirrel (*Sciurus carolinensis*)
1 A-M captured 8/18 in a large live-trap; Total trapnights (large traps) = 10