

**INVENTORYING AND MONITORING  
PROTOCOLS OF AMPHIBIANS AND  
REPTILES IN NATIONAL PARKS  
OF THE EASTERN UNITED STATES**

**Technical Report NPS/PHSO/NRTR-99/076**

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May 1999

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

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## Acknowledgments

Funding for the project was provided by the National Park Service. We appreciate the 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 amphibians and reptiles.

We tested five protocols for inventorying and monitoring amphibians and reptiles from 1 July 1992 to 30 June 1996: pitfall trapping, drift fence with pitfall traps, amphibian-call survey, coverboard survey, and natural-substrate survey. Four protocols (excluding drift fences) were tested at GETT-EISE, all five protocols were tested at HOFU, and three protocols (amphibian-call, coverboard, and natural-substrate surveys) were tested at VAFO.

We predicted that 27 amphibian species occurred at each of these parks. In addition, we predicted that 28, 27, and 28 reptilian species would be found at GETT-EISE, HOFU, and VAFO, respectively. Based on the test of protocols, nine amphibians and four reptiles were detected at GETT-EISE, 13 amphibians and three reptiles were detected at HOFU, and eight amphibians and two reptiles were detected at VAFO. In addition to species documented with protocols, one additional amphibian species at GETT-EISE was observed by project researchers. No additional amphibian species were found at HOFU and VAFO by project researchers. Six additional reptilian species at GETT-EISE, five additional reptilian species at HOFU, and two additional reptilian species at VAFO also were recorded by project researchers. In addition to species detected by researchers, no amphibian and six reptilian species at GETT-EISE, no amphibian and no reptilian species at HOFU, and seven amphibian and eight reptilian species at VAFO were documented previously within the park by observers (e.g., park personnel) on National Park Service Wildlife Observation Cards. Our research at the parks increased the number of documented species to 10 amphibians (37% of predicted) and 16 reptiles (57% of predicted) at GETT-EISE, 13 (48% of predicted) amphibians and eight (30% of predicted) reptiles at HOFU, and 14 (52% of predicted) amphibians and 12 (43% of predicted) reptiles at VAFO.

Based on our field testing of protocols at GETT-EISE, HOFU, and VAFO, we recommend use of the natural-substrate survey protocol for salamanders, snakes, and terrestrial turtles and the amphibian-call survey protocol for frogs. Additional study will be necessary to increase the number of species documented from certain taxa, such as snakes and turtles.

## 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 amphibians and reptiles. Information on presence, relative abundance, and distribution of amphibians and reptiles 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 increasingly will be 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 amphibians and reptiles. We also were interested in assessing cost-, labor-, and time-constraints associated with each protocol. Protocols were organized in a hierarchical 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 amphibian and reptilian 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 amphibians and reptiles (e.g., published and unpublished species lists and range maps) that were predicted to occur or were documented in the four national parks. We combined land-use data for each park with known habitat requirements and ranges of amphibian and reptilian 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 amphibian and reptilian species. A summary of amphibians and reptiles 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., salamanders, frogs) (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), amphibian and reptilian species documented by the protocol, and habitat use by amphibian and reptilian 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 amphibian or reptilian 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 amphibians, reptiles, 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 amphibian and reptilian species and habitats used by these species in Gettysburg National Military Park, Eisenhower National Historic Site, Hopewell Furnace National Historic Site, and Valley Forge National Historical Park;
2. determine the effectiveness of selected protocols for amphibians and reptiles 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% 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 contain 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 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, 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 amphibian and reptilian 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 were selected randomly at GETT-EISE, nine sites at HOFU, and four sites at VAFO. Within each of these sites, a transect was established in a random direction for the field testing of specific protocols. We arbitrarily

selected a starting point 50 m into the habitat edge from a road, trailhead, or convenient parking area. Sampling points along each transect were placed at the starting point and thereafter at 150-m intervals. 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 all 600 m in length except for HRG, which was 750 in length. At steep sites (e.g., MJU) or those associated with water (e.g., LFL), the transect followed the contour of the landscape. However, these transects differed little from a straight path.

#### Gettysburg National Military Park and Eisenhower National Historic Site

Ten study sites were selected for amphibian and reptilian sampling at GETT-EISE (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]). One additional site was selected (Fantasyland Ponds [FLP]) for use with the pitfall-trap protocol. No transect was established at this site; 11 pitfall holes were excavated at 25-m intervals around the perimeter of the pond.

#### Hopewell Furnace National Historic Site

Nine study sites were selected for amphibian and reptilian sampling at HOFU (Table 2, Fig. 2). One site was in grassland habitat (Hopewell Road Grassland [HRG]), two in old-field 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 other sites at HOFU, we established a 750-m transect with six sampling points at the HRG site. Because HRG was the only grassland site at HOFU, we needed an even 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 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            |

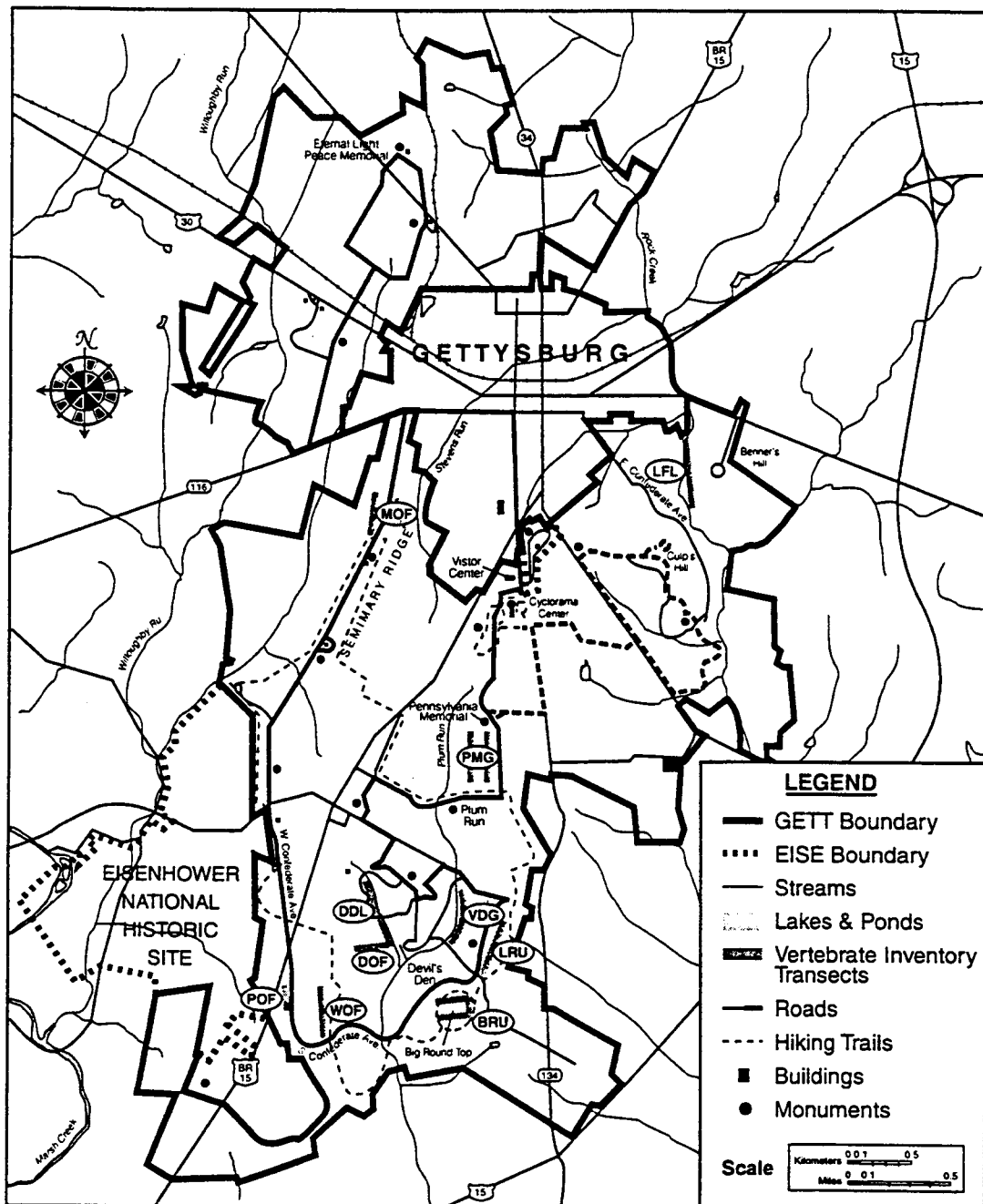


Figure 1. Locations of two grassland (PMG and VDG), four old-field (WOF, POF, MOF, and DOF), two lowland-forest (DDL and LFL), and two upland-forest (LRU and BRU) transects used for protocol testing at Gettysburg National Military Park and Eisenhower National Historic Site. Descriptions of codes are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

Table 2. 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                       |      |                | 5550          | 46            |

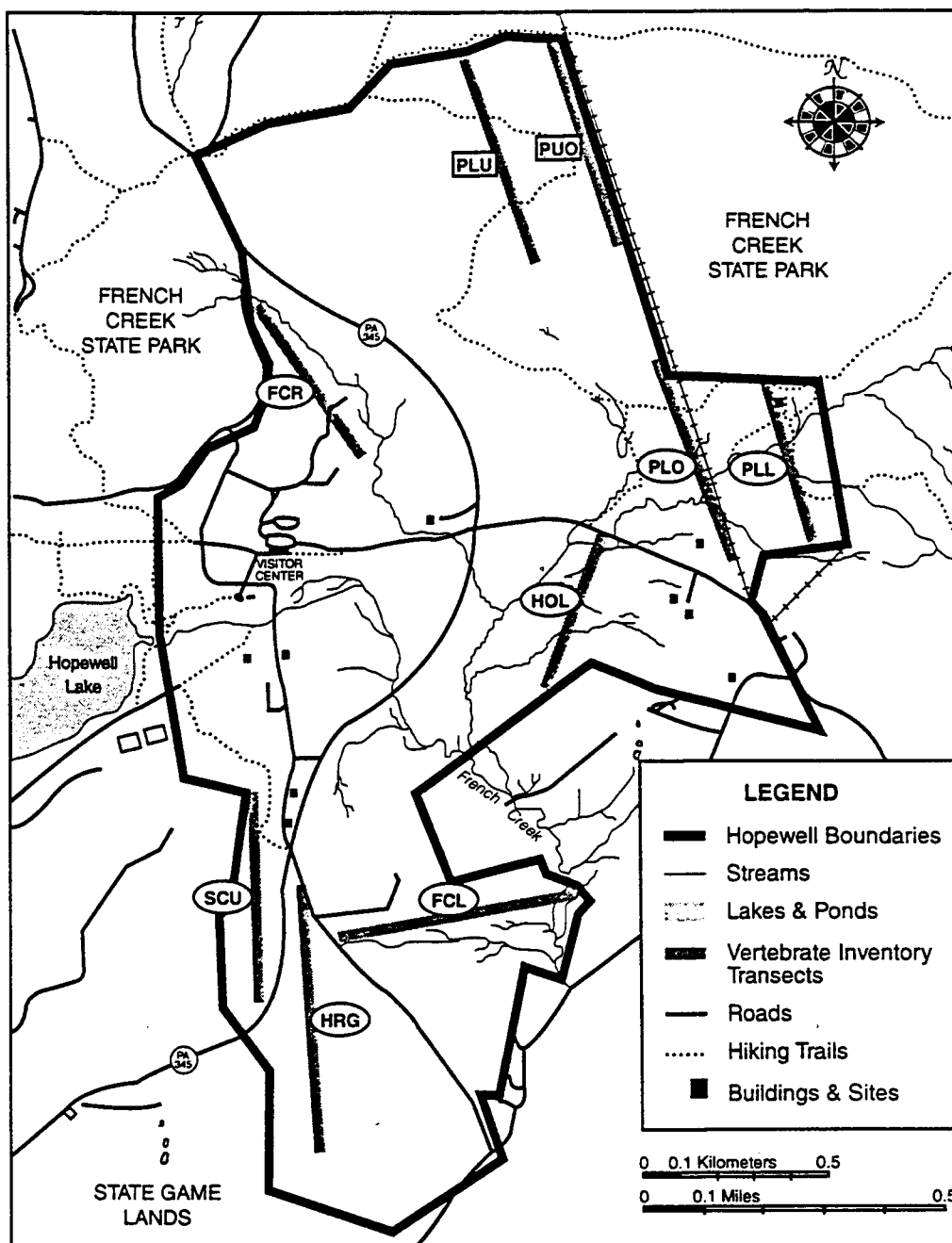


Figure 2. Locations of one grassland (HRG), two old-field (PLO and PUO), four lowland-forest (PLL, HOL, FCR, and FCL), and two upland-forest (PLU and SCU) transects used for protocol testing at Hopewell Furnace National Historic Site. Descriptions of codes are given in Table 2.

## Valley Forge National Historical Park

Four study sites were selected for vertebrate sampling at VAFO (Table 3, Fig. 3). Two sites were in lowland-forest habitat (Railroad Lowland [RRL] and James White Lowland [JWL]), and two were in upland-forest habitat (Mount Misery Upland [MMU] and Mount Joy Upland [MJU]).

## Vehicular-Road Survey Route

We established a vehicular road-survey route through each of the parks for use with the amphibian-call 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 mile) at VAFO (Figs. 4-6, respectively).

Table 3. 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 |
|---------------------|------|----------------|---------------|---------------|
| 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               |      |                | 2400          | 20            |

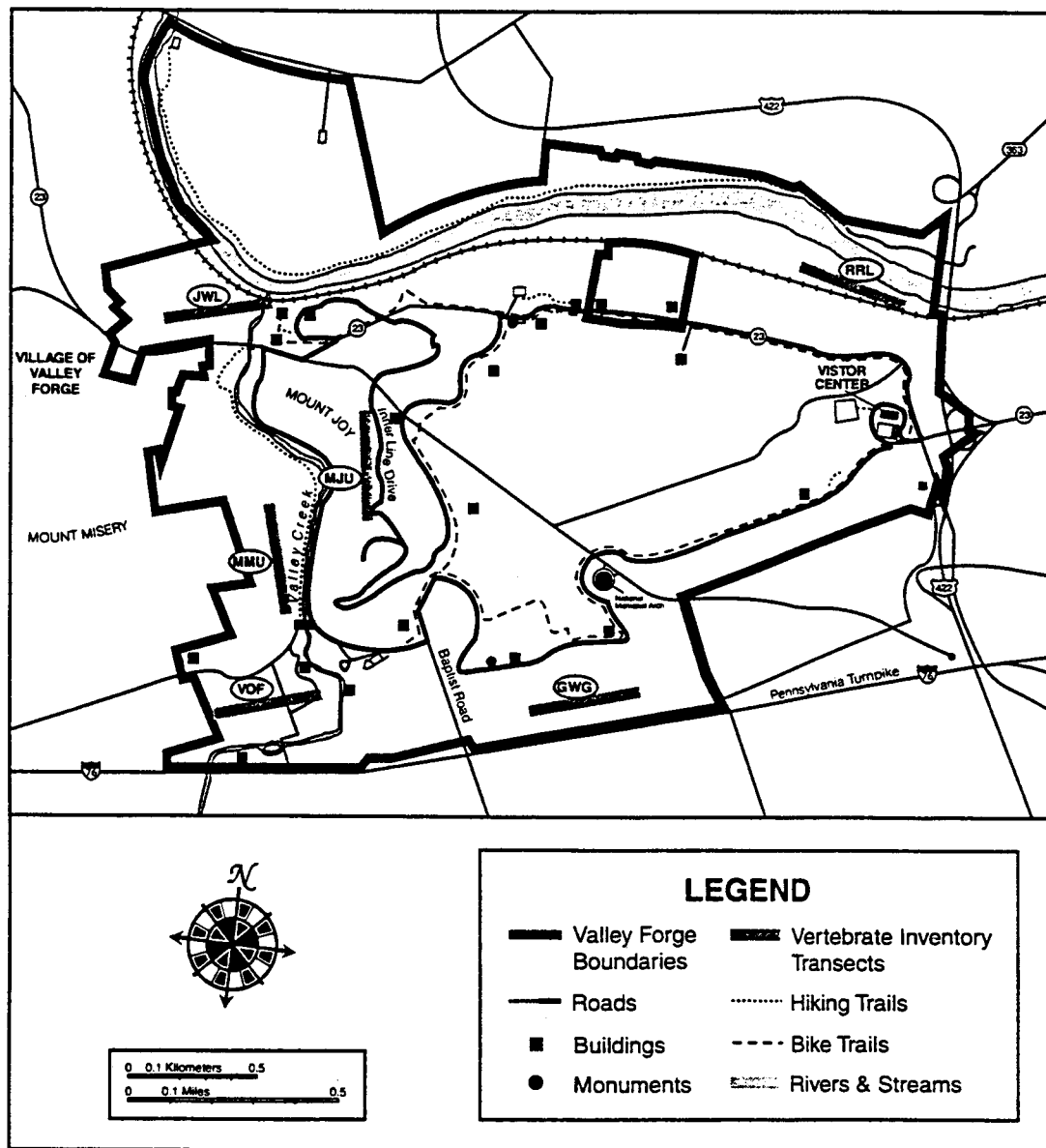


Figure 3. Locations of two lowland-forest (RRL and JWL) and two upland-forest (MMU and MJU) transects used for protocol testing at Valley Forge National Historical Park. Descriptions of codes are given in Table 3. Grassland (GWG) and old-field (VOF) sites were not used for amphibian and reptile sampling.

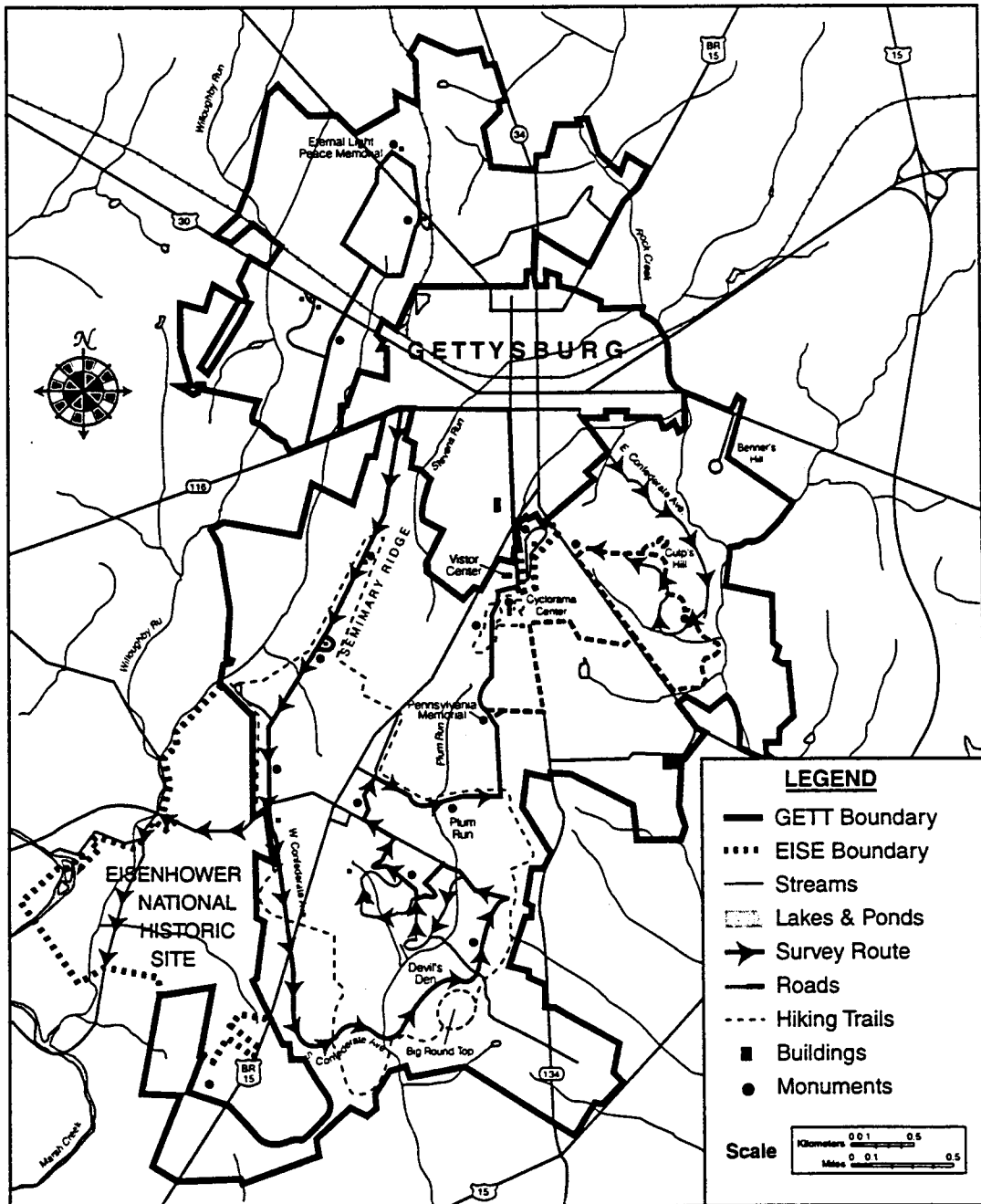


Figure 4. Location of the 20.8-km vehicular-road survey route at Gettysburg National Military Park and Eisenhower National Historic Site.

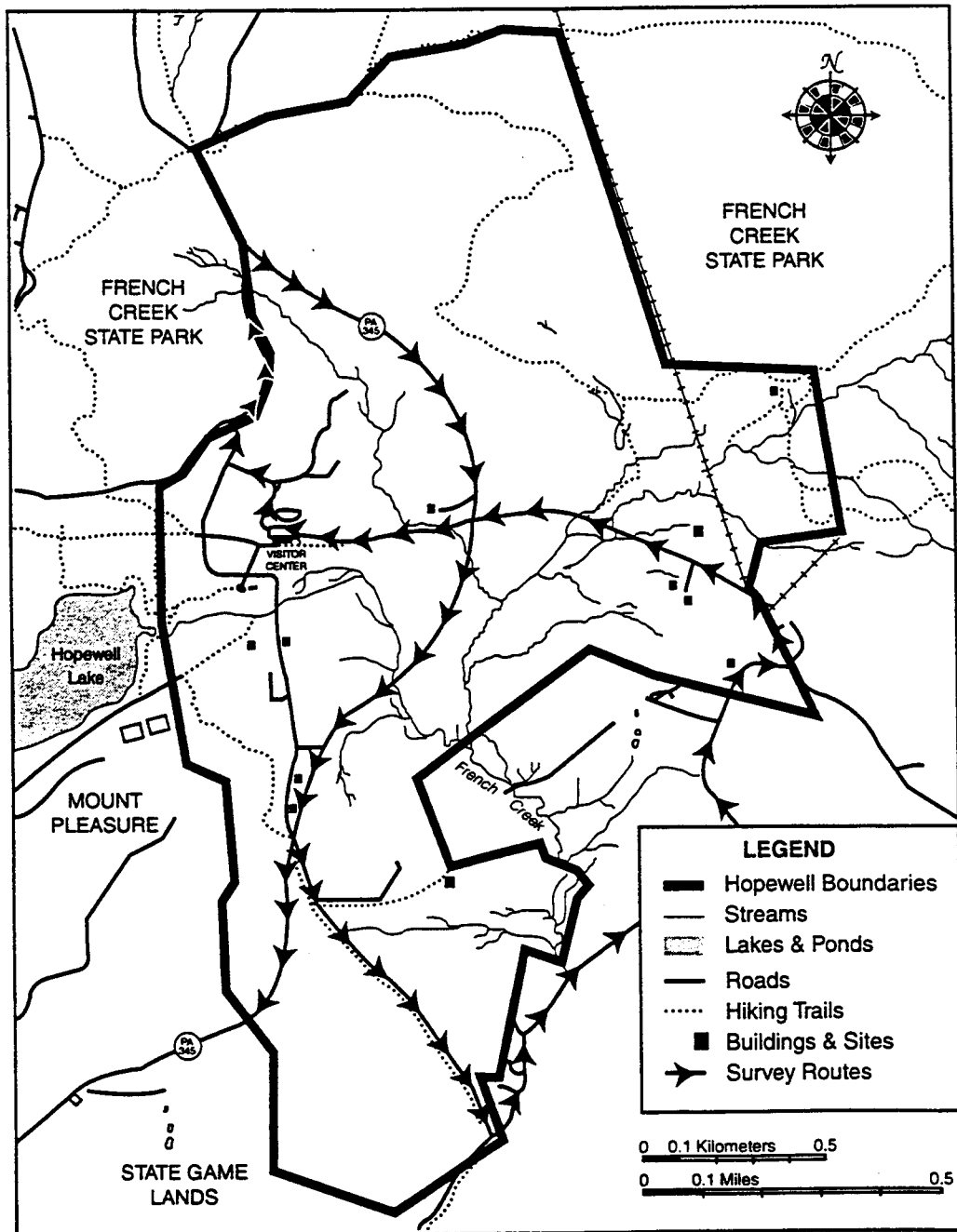


Figure 5. Location of the 8.0-km vehicular-road survey route at Hopewell Furnace National Historic Site.

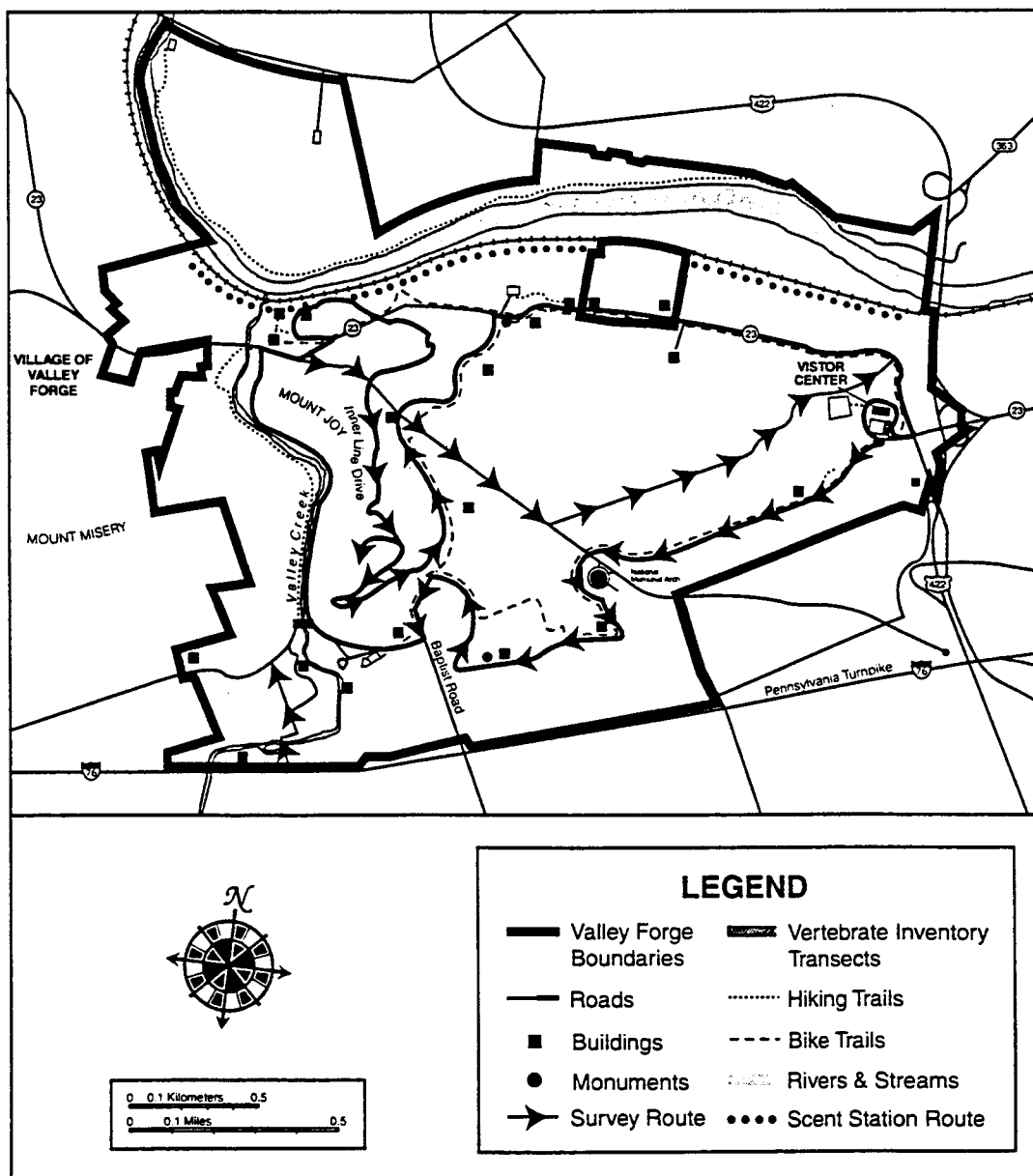


Figure 6. Location of the 11.3-km vehicular-road survey route at Valley Forge National Historical Park.



## Methods

### Natural-Substrate Survey Protocol

Amphibians and reptiles were surveyed using the natural-substrate survey protocol (also referred to previously as the rock- and log-turning protocol) (Aubrey et al. 1988, Dalrymple 1988, Herrington 1988, Ramotnik and Scott 1988) in April 1994 at GETT-EISE, in May 1995 at HOFU, and in May 1996 at VAFO. We conducted this protocol at all forest sites at each of the parks (four sites at GETT-EISE, six sites at HOFU, and four sites at VAFO) and at one old-field site each at GETT-EISE (POF) and at HOFU (PLO).

Transects were walked once each by a group of observers ( $n = 3-9$ ) spaced at 5-m intervals, with each observer surveying an area 5 m in width. Thus, the width of survey belt (range = 15-45 m) and area of coverage were a function of the number of observers. All rocks and logs ( $\geq 7.5$  cm in diameter) encountered within the width of the survey belt were turned over by observers and inspected for the presence of amphibians or reptiles. If an amphibian or a reptile were found, we recorded species, type of substrate (e.g., rock or log), and the diameter (cm) of the substrate. We also noted all amphibians and reptiles observed on top of the leaf litter. In addition, on a standardized data form, we recorded starting time and ending time, temperature ( $^{\circ}\text{C}$ ), wind velocity (kph), percent cloud cover, precipitation, and number of observers.

We calculated the relative density (no./ha) of amphibians and reptiles within each habitat type, based on the number of individuals observed along each survey belt and the area (ha) of coverage. We believe this was a relatively accurate, site-specific estimate of density because we turned over all rocks and logs along the survey belt. Caution should be used, however, when comparing these density estimates with other areas because density may be a direct function of the number of rocks and logs contained within a given site (Geer 1997). Because the natural-substrate survey protocol may be conducted with any number of observers, we calculated the amount of time required for each observer to conduct this protocol per 100 m of transect.

### Coverboard Protocol

We surveyed amphibians using the coverboard protocol (DeGraaf and Yamasaki 1992, Fellers and Drost 1994, Davis 1997) in spring and fall at each of the parks. Boards (2.5-cm x 20-cm x 3-m) were purchased and cut into 1-m lengths. We placed three pine boards (2.5-cm x 20-cm x 1-m) at each sampling point along the transects at all study sites, except PMG at GETT-EISE and HRG at HOFU ( $n = 37$  points and 111 coverboards at GETT-EISE,  $n = 40$

points and 120 coverboards at HOFU, and  $n = 20$  points and 60 coverboards at VAFO). Coverboards were placed 5 m from the sampling point flush with the soil surface. Coverboards were placed at GETT-EISE in late September and early October 1993, at HOFU in July 1995, and at VAFO in August 1995. We inspected the coverboards for amphibians three times at GETT-EISE (spring and fall 1994, and fall 1995), and twice each at HOFU and VAFO (fall 1995 and spring 1996). We recorded the number of individuals of each species found underneath the boards and the number of boards at each point that were missing. Relative abundance of each species per site was calculated as average number of individuals/point.

### Amphibian-Call Survey Protocol

Amphibians were surveyed using the amphibian-call survey protocol (McKinsty et al. 1991) in spring 1994 at GETT-EISE and in spring 1996 at HOFU and VAFO. Surveys were conducted between 1 April and 15 May from 3 to 6 hours after sunset. Three surveys were conducted at GETT-EISE, and two surveys were conducted at HOFU and VAFO. At GETT-EISE and HOFU, sampling points (13 points at GETT-EISE and eight points at HOFU) were established along the road survey route; each point was at a location where the road was within 30 m of a water source (e.g., small stream, vernal pond). Surveys were conducted at the road edge. Because of high levels of traffic at VAFO, we selected seven points associated with wetlands (i.e., vernal pool, marsh, river overflow, wet field) at least 100 m away from high-use roads and conducted the surveys at the wetland edge. At a sampling point, we allowed a 1-minute equilibrium period to elapse, and then listened for calls of breeding amphibians for 3 minutes. We identified the calling species and estimated the number of each species present. We calculated the number of amphibian contacts made per hour based on the total amount of time spent surveying and number of contacts made per survey. In addition, on a standardized data form, we recorded starting time and ending time, temperature ( $^{\circ}\text{C}$ ), wind velocity (kph), percent cloud cover, and precipitation.

### Pitfall-Trap Protocol

We implemented the pitfall-trap protocol to survey amphibians and reptiles (Howard and Brock 1961, Boonstra and Krebs 1978, Gibbons and Semlitsch 1982, Walters 1989) at 10 sites at GETT-EISE in summer 1993 (except the FLP site) and at all 11 sites in spring 1994, at all nine sites at HOFU in summer 1994, and at six study sites at HOFU in summer 1995 (Table 4). 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 the 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

Table 4. Seasons and study sites used for pitfall-trap (PFT) and drift-fence (DFE) protocols at GETT-EISE and HOFU in 1993-95. Study site codes are given in Tables 1-2.

| Study Site | Summer 1993 | Spring 1994 | Summer 1994 | Summer 1995 |
|------------|-------------|-------------|-------------|-------------|
| GETT-EISE: |             |             |             |             |
| PMG        | PFT         | PFT         |             |             |
| VDG        | PFT         | PFT         |             |             |
| WOF        | PFT         | PFT         |             |             |
| POF        | PFT         | PFT         |             |             |
| MOF        | PFT         | PFT         |             |             |
| DOF        | PFT         | PFT         |             |             |
| DDL        | PFT         | PFT         |             |             |
| LFL        | PFT         | PFT         |             |             |
| LRU        | PFT         | PFT         |             |             |
| BRU        | PFT         | PFT         |             |             |
| FLP        |             | PFT         |             |             |
| HOFU:      |             |             |             |             |
| HRG        |             |             | PFT DFE     |             |
| PLO        |             |             | PFT DFE     | PFT DFE     |
| PUO        |             |             | PFT DFE     | PFT DFE     |
| PLL        |             |             | PFT DFE     | PFT DFE     |
| HOL        |             |             | PFT DFE     |             |
| FCR        |             |             | PFT DFE     | PFT DFE     |
| FCL        |             |             | PFT DFE     |             |
| PLU        |             |             | PFT DFE     | PFT DFE     |
| SCU        |             |             | PFT DFE     | PFT DFE     |

checked every morning, except in spring 1994 at GETT-EISE when traps were checked every third morning. For each visit, we recorded the number of individuals per species.

In summer 1993 at GETT-EISE, traps were opened for 2-4 consecutive nights (each night termed a trapnight) during 4 consecutive weeks for a total of 13 nights. In spring 1994 at GETT-EISE, 24 pitfall traps were each opened for 35 consecutive nights, and 30 traps each were opened for 30 consecutive nights. In summer 1994 at HOFU, all traps were opened for 2-4 consecutive nights during 2 consecutive weeks for a total of 6 nights. In summer 1995 at HOFU, traps were opened for 5 consecutive nights. We conducted 559 trapnights in 1993 at GETT-EISE (43 sampling points during 13 nights), 1740 trapnights in spring 1994 at GETT-EISE (24 sampling points during 35 nights and 30 sampling points during 30 nights), 276 trapnights in 1994 at HOFU (46 sampling points during 6 nights), and 150 trapnights in 1995 at HOFU (30 sampling points during 5 nights).

### Drift-Fence Protocol

We tested the effectiveness of drift fences used in conjunction with pitfall traps at HOFU in summer 1994 and 1995 (Table 4). Drift fences were constructed of erosion cloth stapled to three wooden stakes, and each was 90 cm in length. Fences were 5-m long and 45-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. 7). Half of the grassland ( $n = 3$ ), old-field ( $n = 5$ ), lowland-forest ( $n = 10$ ), and upland-forest ( $n = 5$ ) sampling points contained drift fences.

### 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 amphibian and reptilian species observed at the four parks from 1 July 1992 to 30 June 1996 by project researchers. Twelve variables are in the Faunal Database; these include the original 11 variables and a new variable (Field-Tested Protocol, variable 12) that

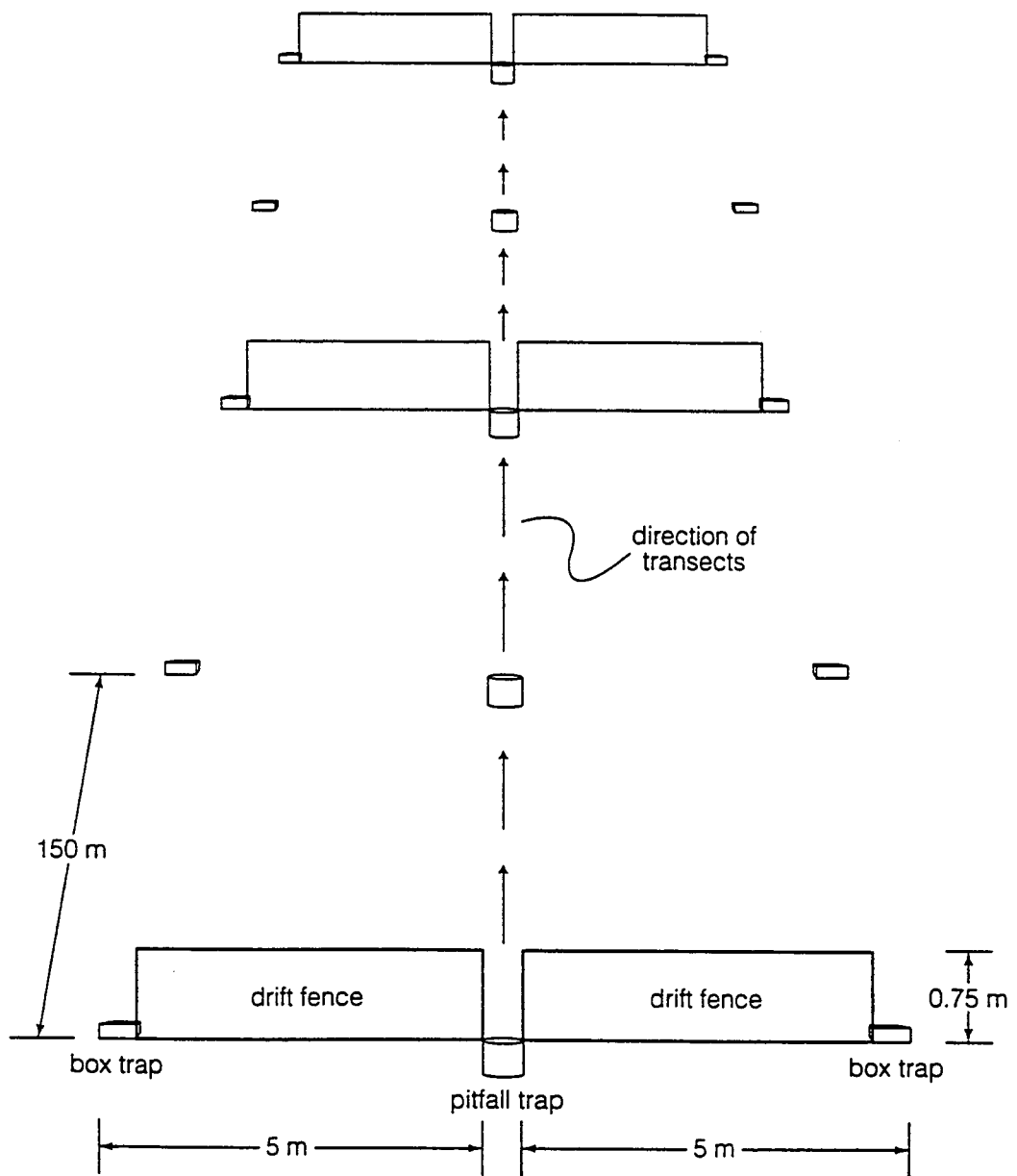


Fig. 7. Spatial arrangement of the pitfall and live-trapping sampling points with drift fences (at HOFU only) and without drift fences (at GETT-EISE and HOFU). Sampling points at VAFO do not include pitfall traps. Box traps were used for mammal surveys.

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.

Amphibian and reptilian sections of the current Faunal Database are 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, respectively. Appendix 8 includes the codes for variables 11 and 12. Below is an example of an amphibian species, the gray treefrog, entered in the database for HOFU:

- (1) Common Name (Gray Treefrog)
- (2) Scientific Name (*Hyla versicolor*)
- (3) Family Name (Hylidae)
- (4) Order (Salientia)
- (5) *Pro-Cite* (1988) Group Name (Salientia)
- (6) Primary Habitat (61 [Palustrine wetland])
- (7) Secondary Habitat (32, 41, 43 [Shrub and brush rangeland, deciduous forest, mixed forest])
- (8) Occurrence Status (PTC)
- (9) Residency Status (Permanent Resident)
- (10) Legal Population Status (Protected)
- (11) Protocol (PFT [Pitfall Trapping])
- (12) Field-Tested Protocol (RCE [Vehicular-Road Survey Protocol]).

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 if it were originally 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 amphibians and reptiles 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 55 amphibian and reptilian species potentially occurred at GETT-EISE (Yahner et al. 1994b, 1994c) (Table 5). These included 27 amphibian species (15 salamanders, 12 frogs) and 28 reptilian species (nine turtles, three lizards, and 16 snakes). Of these species, four (15%) amphibian species and 11 (39%) reptilian species were documented previously within the parks by various personnel on National Park Service Wildlife Observation Cards. Based on field tests of protocols in our study, we found 10 amphibian and four reptilian species predicted or previously documented to occur at GETT-EISE. We also found six amphibian and nine reptilian species through personal observations, including one amphibian and six reptiles 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 amphibian species to 10 species and the number of reptilian species to 16 species. The highest percentages of documented species were in the Orders Salientia (six of 12 predicted), Testudines (six of nine predicted), and Lacertilia (two of three predicted).

### Hopewell Furnace National Historic Site

We predicted that 27 amphibian species (15 salamanders, 12 frogs) and 27 reptilian species (nine turtles, two lizards, and 16 snakes) could probably be found at HOFU (Yahner et al. 1994b, 1994c) (Table 6). Of these species, no amphibian (0%) and two (7%) reptilian species were documented previously within the park by various personnel on National Park Service Wildlife Observation Cards. Based on field tests of protocols in our study, we found 13 species of amphibians and three species of reptiles predicted or previously documented to occur at HOFU. Seven amphibian and seven reptilian species were observed by us through personal observations, including five reptilian species not found by protocol testing. By field testing protocols and through personal observations of project researchers at HOFU, we increased the number of documented species to 13 amphibians and eight reptiles. We found six salamander, seven frog, three snake, and three turtle species that officially had not been documented in the park. Most of these documented species were representatives of the Order Salientia (seven of 12 predicted).

Table 5. Number of amphibian and reptilian species predicted, number of species documented by WOC<sup>a</sup> and from 1 July 1992 to 30 June 1996 by PO<sup>b</sup> and PTC<sup>c</sup>, total species documented, and percent of predicted species documented at Gettysburg National Military Park and Eisenhower National Historic Site.

|            | No. Pred. | Number Documented |    |     |       | % Pred. |
|------------|-----------|-------------------|----|-----|-------|---------|
|            |           | WOC               | PO | PTC | Total |         |
| Amphibia   | 27        | 4                 | 6  | 9   | 10    | (37%)   |
| Caudata    | 15        | 3                 | 2  | 4   | 4     | (27%)   |
| Salientia  | 12        | 1                 | 4  | 5   | 6     | (50%)   |
| Reptilia   | 28        | 11                | 9  | 4   | 16    | (57%)   |
| Testudines | 9         | 4                 | 5  | 2   | 6     | (67%)   |
| Lacertilia | 3         | 2                 | 0  | 0   | 2     | (67%)   |
| Serpentes  | 16        | 5                 | 4  | 2   | 8     | (50%)   |

<sup>a</sup> WOC = National Park Service Wildlife Observation Cards.

<sup>b</sup> PO = Personal observations by project researchers.

<sup>c</sup> PTC = Field testing of protocols by project researchers.

Table 6. Number of amphibian and reptilian species predicted, number of species documented by WOC<sup>a</sup> and from 1 July 1992 to 30 June 1996 by PO<sup>b</sup> and PTC<sup>c</sup>, total species documented, and percent of predicted species documented at Hopewell Furnace National Historic Site.

| Class:                |           | Number Documented |    |     |       |         |
|-----------------------|-----------|-------------------|----|-----|-------|---------|
| <i>Pro-Cite</i> Group | No. Pred. | WOC               | PO | PTC | Total | % Pred. |
| Amphibia              | 27        | 0                 | 7  | 13  | 13    | (48%)   |
| Caudata               | 15        | 0                 | 2  | 6   | 6     | (40%)   |
| Salientia             | 12        | 0                 | 5  | 7   | 7     | (58%)   |
| Reptilia              | 27        | 2                 | 7  | 3   | 8     | (30%)   |
| Testudines            | 9         | 1                 | 4  | 0   | 4     | (44%)   |
| Lacertilia            | 2         | 0                 | 0  | 0   | 0     | (0%)    |
| Serpentes             | 16        | 1                 | 3  | 3   | 4     | (25%)   |

<sup>a</sup> WOC = National Park Service Wildlife Observation Cards.

<sup>b</sup> PO = Personal observations by project researchers.

<sup>c</sup> PTC = Field testing of protocols by project researchers.

## Valley Forge National Historical Park

We predicted that 27 amphibian species (15 salamanders, 12 frogs) and 28 reptilian species (10 turtles, two lizards, and 16 snakes) potentially occurred at VAFO (Yahner et al. 1994b, 1994c) (Table 7). Of these species, 14 (52%) amphibian and 12 (43%) reptilian species were documented previously within the park by various personnel on National Park Service Wildlife Observation Cards. Based on field tests of protocols in our study, we detected seven amphibian and two reptilian species predicted or previously documented to occur at VAFO. In addition, we found two reptilian species through personal observations, neither of which were found by protocol testing. We did not document any new species at VAFO. As at HOFU, the highest percentage of amphibians and reptiles documented was in the Order Salientia (10 of 12 predicted).

## Time Required to Establish Transects and Sampling Points

It required 1.75 person-hours and 1.4 person-hours to establish each 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 time necessary to establish a transect at HOFU versus VAFO was attributed to more rugged terrain at HOFU than at VAFO.

## Natural-Substrate Survey Protocol

### Gettysburg National Military Park and Eisenhower National Historic Site

Old-Field Sites: No amphibians or reptiles were observed at the POF site using the natural-substrate survey protocol. Other old-field sites were not checked for amphibians because of a scarcity of rocks and logs.

We spent approximately 2.25 person-hours searching the POF site for amphibians and reptiles using the natural-substrate survey and coverboard protocols. Although the coverboards were checked for amphibians while conducting this protocol, no additional time was required to conduct the protocols together because coverboards were located along the transects. The natural-substrate survey protocol may be conducted with any number of observers; therefore, we calculated the amount of time required for each observer to conduct this protocol per hectare. Because each observer inventoried a 5-m wide area, time was

Table 7. Number of amphibian and reptilian species predicted, number of species documented by WOC<sup>a</sup> and from 1 July 1992 to 30 June 1996 by PO<sup>b</sup> and PTC<sup>c</sup>, total species documented, and percent of predicted species documented at Valley Forge National Historical Park.

| Class:                | Number Documented |     |    |     |       |         |
|-----------------------|-------------------|-----|----|-----|-------|---------|
| <i>Pro-Cite</i> Group | No. Pred.         | WOC | PO | PTC | Total | % Pred. |
| Amphibia              | 27                | 14  | 0  | 8   | 14    | (52%)   |
| Caudata               | 15                | 5   | 0  | 1   | 5     | (33%)   |
| Salientia             | 12                | 9   | 0  | 7   | 10    | (83%)   |
| Reptilia              | 28                | 12  | 2  | 2   | 12    | (43%)   |
| Testudines            | 10                | 6   | 1  | 1   | 6     | (60%)   |
| Lacertilia            | 2                 | 0   | 0  | 0   | 0     | (0%)    |
| Serpentes             | 16                | 6   | 1  | 1   | 6     | (38%)   |

<sup>a</sup>WOC = National Park Service Wildlife Observation Cards.

<sup>b</sup>PO = Personal Observations by project researchers.

<sup>c</sup>PTC = Field testing of protocols by project researchers.

calculated for 200 m of transect length (200-m long by 5-m wide = 1.0 ha). This protocol required 15.0 minutes/ha for each observer.

**Lowland-Forest Sites:** We observed 28 individuals of four amphibian species and 11 individuals of three reptilian species under rocks and logs at the two lowland-forest sites (DDL and LFL sites) (Table 8). The total area searched at these sites was approximately 3.6 ha; thus, the combined density of amphibians and reptiles at the lowland-forest sites was 10.8/ha. Rocks and logs provided refugia for nine (23%) and 18 (46%) individuals, respectively. An additional 12 (31%) individuals were detected on the surface of the leaf litter.

Of the 28 amphibians found at the two lowland-forest sites, 24 were red-backed salamanders, two were northern two-lined salamanders, one was a pickerel frog, and one was an American toad (Table 8). The density of red-backed salamanders was 6.7/ha at the lowland-forest sites. Nine and 15 of the red-backed salamanders were discovered under rocks and logs, respectively. Northern two-lined salamanders and the American toad were located under logs, whereas the pickerel frog was observed on the leaf litter.

Of the 11 reptiles detected at the lowland-forest sites, seven were eastern box turtles, three were spotted turtles, and one was an eastern garter snake (Table 8). The density of box turtles was 1.9/ha. All reptiles were observed on the leaf litter, and spotted turtles were observed near water (< 5 m).

Time spent searching for amphibians and reptiles at each site depended upon the number of observers and the transect lengths (e.g., 15.0 person-hours at DDL and 3.0 person-hours at LFL). Therefore, we calculated the time searched per hectare per observer. It required an average of 26.8 minutes per observer to sample each hectare for amphibians and reptiles at lowland-forest sites.

**Upland-Forest Sites:** We noted 61 individuals of seven species of amphibians and reptiles at the two upland-forest sites (LRU and BRU) (Table 9). The combined area of these two sites was 3.1 ha, and the total density of amphibians and reptiles was 19.7/ha. Seventeen (28%) and 40 (66%) individuals were found under rocks and logs, respectively; four (7%) individuals were located on the leaf litter.

Of the 56 individual amphibians observed at the upland-forest sites, 50 were red-backed salamanders, three were red-spotted newts, two were American toads, and one was a spotted salamander. The density of red-backed salamanders at the upland-forest sites was 16.1/ha. Eleven and 39 red-backed salamanders were found under rocks and logs, respectively. Three red-spotted newts in the terrestrial larval stage (red eft) were found under rocks. One

Table 8. Number of individuals and, in parentheses, density (no./ha) of amphibians and reptiles observed under rocks and logs, and on the leaf litter while conducting the natural-substrate survey protocol in spring 1994 during one visit at two lowland-forest sites combined (DDL and LFL) at Gettysburg National Military Park and Eisenhower National Historic Site. The area surveyed was 3.6 ha. Descriptions of site codes are given in Table 1.

| Species                       | Substrate  |             |             |              |
|-------------------------------|------------|-------------|-------------|--------------|
|                               | Rock       | Log         | Litter      | Total        |
| Northern Two-lined Salamander | 0<br>(0.0) | 2<br>(0.6)  | 0<br>(0.0)  | 2<br>(0.6)   |
| Red-backed Salamander         | 9<br>(2.5) | 15<br>(4.2) | 0<br>(0.0)  | 24<br>(6.7)  |
| Pickerel Frog                 | 0<br>(0.0) | 0<br>(0.0)  | 1<br>(0.3)  | 1<br>(0.3)   |
| American Toad                 | 0<br>(0.0) | 1<br>(0.3)  | 0<br>(0.0)  | 1<br>(0.3)   |
| Spotted Turtle                | 0<br>(0.0) | 0<br>(0.0)  | 3<br>(0.8)  | 3<br>(0.8)   |
| Eastern Box Turtle            | 0<br>(0.0) | 0<br>(0.0)  | 7<br>(1.9)  | 7<br>(1.9)   |
| Eastern Garter Snake          | 0<br>(0.0) | 0<br>(0.0)  | 1<br>(0.3)  | 1<br>(0.3)   |
| Total                         | 9<br>(2.5) | 18<br>(5.0) | 12<br>(3.3) | 39<br>(10.8) |

Table 9. Number of individuals and, in parentheses, density (no./ha) of amphibians and reptiles observed under rocks and logs, and on the leaf litter while conducting the natural-substrate survey protocol in spring 1994 during one visit at two upland-forest sites combined (LRU and BRU) at Gettysburg National Military Park and Eisenhower National Historic Site. The area surveyed was 3.1 ha. Descriptions of site codes are given in Table 1.

| Species                       | Substrate   |              |            |              |
|-------------------------------|-------------|--------------|------------|--------------|
|                               | Rock        | Log          | Litter     | Total        |
| Red-spotted Newt<br>(Red Eft) | 3<br>(1.0)  | 0<br>(0.0)   | 0<br>(0.0) | 3<br>(1.0)   |
| Spotted Salamander            | 1<br>(0.3)  | 0<br>(0.0)   | 0<br>(0.0) | 1<br>(0.3)   |
| Red-backed Salamander         | 11<br>(3.5) | 39<br>(12.6) | 0<br>(0.0) | 50<br>(16.1) |
| American Toad                 | 0<br>(0.0)  | 1<br>(0.3)   | 1<br>(0.3) | 2<br>(0.6)   |
| Eastern Box Turtle            | 0<br>(0.0)  | 0<br>(0.0)   | 1<br>(0.3) | 1<br>(0.3)   |
| Ring-necked Snake             | 2<br>(0.6)  | 0<br>(0.0)   | 0<br>(0.0) | 2<br>(0.6)   |
| Eastern Garter Snake          | 0<br>(0.0)  | 0<br>(0.0)   | 2<br>(0.6) | 2<br>(0.6)   |
| Total                         | 17<br>(5.5) | 40<br>(12.9) | 4<br>(1.3) | 61<br>(19.7) |

American toad each was observed under a log and on the surface of the leaf litter. The spotted salamander was noted under a rock.

Five of the individual reptiles observed at the upland-forest sites included two eastern garter snakes, two northern ring-necked snakes, and one eastern box turtle. Eastern garter snakes and the eastern box turtle were found on the leaf litter, and northern ring-necked snakes were observed under rocks.

We conducted the natural-substrate survey protocol with 16.5 person-hours at LRU and 5.0 person-hours at BRU. Standardized for the number of observers and transect length, it required an average of 39.6 minutes per observer to sample each hectare for amphibians and reptiles at upland-forest sites.

#### Hopewell Furnace National Historic Site

Old-Field Sites: We noted 22 individuals of five species of amphibians at the PLO site (Table 10). The total area of the survey belt was 1.2 ha, and the total density of amphibians and reptiles at these sites was 18.3/ha. No reptiles were observed at the PLO site. Two (9%) and 20 (91%) individuals were found under rocks and on the leaf litter, respectively; no individuals were located under logs.

The 22 amphibians observed included 16 pickerel frogs, two red-backed salamanders, two green frogs, one red-spotted newt, and one northern leopard frog. The density of pickerel frogs at the PLO site was 13.3/ha. All individuals were located on the leaf litter, except the two red-backed salamanders. The presence of French Creek, which traversed the PLO site, probably accounted for the large number of frogs.

We conducted the natural-substrate survey protocol in only 1.7 person-hours (four observers) at PLO because of the relatively low number of rocks and logs. Standardized for the number of observers and transect length, it required an average of 8.6 minutes per observer to sample each hectare for amphibians and reptiles at the PLO site.

Lowland-Forest Sites: We observed 219 individuals of six amphibian and one reptilian species by turning over rocks and logs at the four lowland-forest sites (PLL, HOL, FCR, and FCL sites) (Table 11). The total area of the survey belts was approximately 4.8 ha; thus, the combined density of amphibians and reptiles at the lowland-forest sites was 45.6/ha. Rocks and logs provided refugia for 20 (9%) and 188 (86%) individuals, respectively. An additional 11 (5%) individuals were detected on the surface of the leaf litter.

Table 10. Number of individuals and, in parentheses, density (no./ha) of amphibians and reptiles observed under rocks and logs, and on the leaf litter while conducting the natural-substrate survey protocol in spring and summer 1995 during one visit at one old-field site (PLO) at Hopewell Furnace National Historic Site. The area surveyed was 1.2 ha. Descriptions of site codes are given in Table 2.

| Species                       | Substrate  |            |              |              |
|-------------------------------|------------|------------|--------------|--------------|
|                               | Rock       | Log        | Litter       | Total        |
| Red-spotted Newt<br>(Red Eft) | 0<br>(0.0) | 0<br>(0.0) | 1<br>(0.8)   | 1<br>(0.8)   |
| Red-backed Salamander         | 2<br>(1.7) | 0<br>(0.0) | 0<br>(0.0)   | 2<br>(1.7)   |
| Green Frog                    | 0<br>(0.0) | 0<br>(0.0) | 2<br>(1.7)   | 2<br>(1.7)   |
| Pickerel Frog                 | 0<br>(0.0) | 0<br>(0.0) | 16<br>(13.3) | 16<br>(13.3) |
| Northern Leopard Frog         | 0<br>(0.0) | 0<br>(0.0) | 1<br>(0.8)   | 1<br>(0.8)   |
| Total                         | 2<br>(1.7) | 0<br>(0.0) | 20<br>(16.7) | 22<br>(18.3) |

Table 11. Number of individuals and, in parentheses, density (no./ha) of amphibians and reptiles observed under rocks and logs, and on the leaf litter while conducting the natural-substrate survey protocol in spring and summer 1995 during one visit at four lowland-forest sites combined (PLL, HOL, FCR, and FCL) at Hopewell Furnace National Historic Site. The area surveyed was 4.8 ha. Descriptions of site codes are given in Table 2.

| Species               | Substrate   |               |             |               |
|-----------------------|-------------|---------------|-------------|---------------|
|                       | Rock        | Log           | Litter      | Total         |
| Four-toed Salamander  | 0<br>(0.0)  | 1<br>(0.2)    | 0<br>(0.0)  | 1<br>(0.2)    |
| Red-backed Salamander | 20<br>(4.2) | 187<br>(39.0) | 1<br>(0.2)  | 208<br>(43.3) |
| Green Frog            | 0<br>(0.0)  | 0<br>(0.0)    | 1<br>(0.2)  | 1<br>(0.2)    |
| Pickerel Frog         | 0<br>(0.0)  | 0<br>(0.0)    | 3<br>(0.6)  | 3<br>(0.6)    |
| Wood Frog             | 0<br>(0.0)  | 0<br>(0.0)    | 2<br>(0.4)  | 2<br>(0.4)    |
| American Toad         | 0<br>(0.0)  | 0<br>(0.0)    | 3<br>(0.6)  | 3<br>(0.6)    |
| Northern Water Snake  | 0<br>(0.0)  | 0<br>(0.0)    | 1<br>(0.2)  | 1<br>(0.2)    |
| Total                 | 20<br>(4.2) | 188<br>(39.2) | 11<br>(2.3) | 219<br>(45.6) |

We noted 218 amphibians, including 208 red-backed salamanders, three pickerel frogs, three American toads, two wood frogs, one four-toed salamander, and one green frog at the lowland-forest sites. The density of red-backed salamanders at the lowland-forest sites was 43.3/ha. More than half (52%) of the red-backed salamanders, both wood frogs, and the green frog were observed at the PLL site. Twenty and 187 of the red-backed salamanders were discovered under rocks and logs, respectively. The four-toed salamander was located under a log, whereas all other observations were on the leaf litter. A northern water snake, the only reptile found at the lowland-forest sites, also was observed on the leaf litter within 5 m of French Creek.

It required a total of 10.0 person-hours (four observers) to survey all lowland-forest sites or 2.5 person-hours to survey one site. This resulted in an average of 12.6 minutes per observer to sample each hectare for amphibians and reptiles at lowland-forest sites.

**Upland-Forest Sites:** We noted 236 individuals of four amphibian species and two reptilian species at the two upland-forest sites (PLU and SCU) (Table 12). The combined area of these two sites was 2.4 ha, and the total density of amphibians and reptiles at these sites was 98.3/ha. Forty (17%) and 193 (82%) individuals were found under rocks and logs, respectively; three (1%) individuals were located on the leaf litter.

Of the 234 individual amphibians observed at the upland-forest sites, 230 were red-backed salamanders, two were American toads, one was a spotted salamander, and one was a slimy salamander. The density of red-backed salamanders at the upland-forest sites was 95.8/ha. Thirty-nine and 191 red-backed salamanders were found under rocks and logs, respectively. The spotted salamander was detected under a log, whereas the slimy salamander was noted under a rock. Both American toads were observed on the surface of the leaf litter. The ring-necked snake was found under a log, and the garter snake was detected on the leaf litter. The slimy salamander and garter snake were found at the PLU site, whereas the spotted salamander and ring-necked snake were found at the SCU site.

We conducted the natural-substrate survey protocol with 8.0 person-hours (four observers) at PLU and SCU. Standardized for the number of observers and transect length, we required an average of 20.0 minutes per observer to sample each hectare for amphibians and reptiles at upland-forest sites. More time was required to survey the upland-forest sites compared to other sites at HOFU because of the steep and rocky terrain.

### Valley Forge National Historical Park

**Lowland-Forest Sites:** We noted 11 red-backed salamanders, two eastern box turtles, and two pickerel frogs at the two lowland-forest sites (RRL and JWL) while conducting the

Table 12. Number of individuals and, in parentheses, density (no./ha) of amphibians and reptiles observed under rocks and logs, and on the leaf litter while conducting the natural-substrate survey protocol in spring and summer 1995 during one visit at two upland-forest sites combined (SCU and PLU) at Hopewell Furnace National Historic Site. The area surveyed was 2.4 ha. Descriptions of site codes are given in Table 2.

| Species               | Substrate    |               |            |               |
|-----------------------|--------------|---------------|------------|---------------|
|                       | Rock         | Log           | Litter     | Total         |
| Spotted Salamander    | 0<br>(0.0)   | 1<br>(0.4)    | 0<br>(0.0) | 1<br>(0.4)    |
| Red-backed Salamander | 39<br>(16.3) | 191<br>(79.6) | 0<br>(0.0) | 230<br>(95.8) |
| Slimy Salamander      | 1<br>(0.4)   | 0<br>(0.0)    | 0<br>(0.0) | 1<br>(0.4)    |
| American Toad         | 0<br>(0.0)   | 0<br>(0.0)    | 2<br>(0.8) | 2<br>(0.8)    |
| Ring-necked Snake     | 0<br>(0.0)   | 1<br>(0.4)    | 0<br>(0.0) | 1<br>(0.4)    |
| Eastern Garter Snake  | 0<br>(0.0)   | 0<br>(0.0)    | 1<br>(0.4) | 1<br>(0.4)    |
| Total                 | 40<br>(16.7) | 193<br>(80.4) | 3<br>(1.3) | 236<br>(98.3) |

natural-substrate survey protocol in 1996 (Table 13). The combined area of these two sites was 1.1 ha, and the total density of amphibians and reptiles was 13.3/ha. All red-backed salamanders were found under logs at the JWL site, all frogs and turtles were found on the leaf litter at the RRL site, and no individuals were located under rocks. The density of red-backed salamanders at the lowland-forest sites was 9.7/ha.

We conducted the natural-substrate survey protocol with 3.0 person-hours (3 observers) at RRL and JWL. When standardized for the number of observers and transect length, it required an average of 16.0 minutes per observer to sample each hectare for amphibians and reptiles at lowland-forest sites.

**Upland-Forest Sites:** We observed 54 red-backed salamanders, five American toads, two pickerel frogs, and one eastern milk snake at the two upland-forest sites (MMU and MJU) (Table 14). The combined area of these two sites was 1.8 ha, and the total density of amphibians and reptiles at these sites was 34.4/ha. Twenty-seven (44%) and 28 (45%) individuals were found under rocks and logs, respectively; seven (11%) individuals were located on the leaf litter. The density of red-backed salamanders at the upland-forest sites was 30.0/ha (14.4/ha under rocks and 15.6/ha under logs). The milk snake was detected under a rock, whereas toads and frogs were found on the leaf litter.

We conducted the natural-substrate survey protocol with 7.5 person-hours (three observers) at MMU and MJU. When standardized for the number of observers and transect length, it required an average of 25.0 minutes per observer to sample each hectare for amphibians and reptiles at upland-forest sites. This greater amount of survey time compared to lowland-forest sites is because of the rough terrain and large number of rocks to check for amphibians and reptiles at the upland-forest sites.

## Coverboard Protocol

### Gettysburg National Military Park and Eisenhower National Historic Site

**Old-Field Sites:** We found two red-backed salamanders and one eastern garter snake under coverboards at the old-field sites during three survey periods (Table 15). Both species were found in fall 1995; no amphibians or reptiles were found under the coverboards at old-field sites in spring and fall 1994. In spring 1994, all coverboards were missing at the VDG site due to washout, and three coverboards were missing at the MOF site in fall 1995.

Table 13. Number of individuals and, in parentheses, density (no./ha) of amphibians and reptiles observed under rocks and logs, and on the leaf litter while conducting the natural-substrate survey protocol in spring 1996 during one visit at two lowland-forest sites combined (RRL and JWL) at Valley Forge National Historical Site. The area surveyed was 1.1 ha. Descriptions of site codes are given in Table 3.

| Species               | Substrate  |             |            |              |
|-----------------------|------------|-------------|------------|--------------|
|                       | Rock       | Log         | Litter     | Total        |
| Red-backed Salamander | 0<br>(0.0) | 11<br>(9.7) | 0<br>(0.0) | 11<br>(9.7)  |
| Pickerel Frog         | 0<br>(0.0) | 0<br>(0.0)  | 2<br>(1.8) | 2<br>(1.8)   |
| Eastern Box Turtle    | 0<br>(0.0) | 0<br>(0.0)  | 2<br>(1.8) | 2<br>(1.8)   |
| Total                 | 0<br>(0.0) | 11<br>(9.7) | 4<br>(3.5) | 15<br>(13.3) |

Table 14. Number of individuals and, in parentheses, density (no./ha) of amphibians and reptiles observed under rocks and logs, and on the leaf litter while conducting the natural-substrate survey protocol in spring 1996 during one visit at upland-forest sites (MMU and MJU) at Valley Forge National Historical Site. The area surveyed was 1.8 ha. Descriptions of site codes are given in Table 3.

| Species               | Substrate    |              |            |              |
|-----------------------|--------------|--------------|------------|--------------|
|                       | Rock         | Log          | Litter     | Total        |
| Red-backed Salamander | 26<br>(14.4) | 28<br>(15.6) | 0<br>(0.0) | 54<br>(30.0) |
| Pickerel Frog         | 0<br>(0.0)   | 0<br>(0.0)   | 2<br>(1.1) | 2<br>(1.1)   |
| American Toad         | 0<br>(0.0)   | 0<br>(0.0)   | 5<br>(2.8) | 5<br>(2.8)   |
| Eastern Milk Snake    | 1<br>(0.6)   | 0<br>(0.0)   | 0<br>(0.0) | 1<br>(0.6)   |
| Total                 | 27<br>(15.0) | 28<br>(15.6) | 7<br>(3.9) | 62<br>(34.4) |

Table 15. Number of individuals and, in parentheses, relative abundance (no./sampling point = 3 boards) of amphibians and reptiles observed under coverboards in spring 1994 (S94), fall 1994 (F94), and fall 1995 (F95) at old-field (WOF, POF, MOF, and DOF), lowland-forest (DDL and LFL), and upland-forest (LRU and BRU) sites at Gettysburg National Military Park and Eisenhower National Historic Site. Descriptions of site codes are given in Table 1.

| Species                       | Old-Field Sites |            |             | Lowland-Forest Sites |             |             | Upland-Forest Sites |             |             |
|-------------------------------|-----------------|------------|-------------|----------------------|-------------|-------------|---------------------|-------------|-------------|
|                               | S94             | F94        | F95         | S94                  | F94         | F95         | S94                 | F94         | F95         |
| Northern Two-lined Salamander | 0<br>(0.0)      | 0<br>(0.0) | 0<br>(0.0)  | 0<br>(0.0)           | 0<br>(0.0)  | 1<br>(0.17) | 0<br>(0.0)          | 0<br>(0.0)  | 0<br>(0.0)  |
| Red-backed Salamander         | 0<br>(0.0)      | 0<br>(0.0) | 2<br>(0.18) | 3<br>(0.30)          | 2<br>(0.27) | 6<br>(1.0)  | 2<br>(0.26)         | 3<br>(0.39) | 1<br>(0.15) |
| Eastern Garter Snake          | 0<br>(0.0)      | 0<br>(0.0) | 1<br>(0.09) | 0<br>(0.0)           | 0<br>(0.0)  | 0<br>(0.0)  | 0<br>(0.0)*         | 0<br>(0.0)  | 0<br>(0.0)  |
| Total number of boards        | 36              | 36         | 33          | 30                   | 22          | 18          | 23                  | 23          | 20          |
| Total                         | 0<br>(0.0)      | 0<br>(0.0) | 3<br>(0.27) | 3<br>(0.30)          | 2<br>(0.27) | 7<br>(1.17) | 2<br>(0.26)         | 3<br>(0.39) | 1<br>(0.15) |

**Lowland-Forest Sites:** We found 12 amphibians of two species under coverboards at lowland-forest sites during three survey periods (Table 15). These included three red-backed salamanders in spring 1994, two red-backed salamanders in fall 1994, and six red-backed and one northern two-lined salamanders in fall 1995. Eight individuals were found at the LFL site and four were noted at the DDL site. The average observation rate of salamanders was 1.2/sampling point at the lowland-forest sites. Eight coverboards in fall 1994 and four coverboards in fall 1995 were missing at the lowland-forest sites.

**Upland-Forest Sites:** We noted six red-backed salamanders under coverboards at the two upland-forest sites during three survey periods (Table 15). Five of the six salamanders were detected at the LRU site. This resulted in an average observation rate of 0.60 salamanders/sampling point. Seven coverboards were missing in spring and fall 1994, and three additional boards were missing in fall 1995.

**Coverboard Labor and Cost:** Lumber for the coverboard protocol (37 boards [2.5 cm x 20 cm x 3 m]) cost \$220 and required 2.5 person-hours to cut into 1-m lengths (three boards at 37 sampling points). We spent 6.5 person-hours placing coverboards at the sampling points and 3.5 person-hours checking the coverboards for amphibians at all sites. Therefore, to establish and maintain the coverboard protocol at 10 sampling points, \$59.50 would be required for the cost of 30 boards (2.5 cm x 20 cm x 3 m), and 1.9 person-hours and 0.9 person-hours would be required to place and to check boards, respectively).

#### Hopewell Furnace National Historic Site

**Old-Field Sites:** We observed 13 red-backed salamanders in fall 1995 and spring 1996 at the two old-field sites (Table 16). Most (77%) salamanders were found in spring, almost 1 year after the coverboards were placed at the sites; most (85%) were found at the PUO site. The average number of red-backed salamanders detected per sampling point was 1.29. No coverboards were missing at the sites.

**Lowland-Forest Sites:** We detected 59 amphibians and reptiles of three species under coverboards at the four lowland-forest sites at HOFU (Table 16). As with all other sites, most (93%) of the individuals were red-backed salamanders. We also noted three northern two-lined salamanders and one eastern garter snake. Seventy-three percent of the individuals were found in the spring 1996 survey. Two of the northern two-lined salamanders were found at the FCR site, and the garter snake was found at the HOL site. For all species combined, we detected an average of 2.94 individuals/sampling point. No coverboards were missing from the lowland-forest sites.

Table 16. Number of individuals and, in parentheses, relative abundance (no./sampling point = 3 boards) of amphibians and reptiles observed under coverboards in fall 1995 (F95) and spring 1996 (S96) at two old-field (PLO and PUO), four lowland-forest (PLL, HOL, FCR, and FCL), and two upland-forest (PLU and SCU) sites combined at Hopewell Furnace National Historic Site. Descriptions of site codes are given in Table 2.

| Species                       | Old-Field Sites |             | Lowland-Forest Sites |              | Upland-Forest Sites |              |
|-------------------------------|-----------------|-------------|----------------------|--------------|---------------------|--------------|
|                               | F95             | S96         | F95                  | S96          | F95                 | S96          |
| Northern Two-lined Salamander | 0<br>(0.0)      | 0<br>(0.0)  | 1<br>(0.05)          | 2<br>(0.10)  | 0<br>(0.0)          | 0<br>(0.0)   |
| Red-backed Salamander         | 3<br>(0.30)     | 10<br>(1.0) | 15<br>(0.75)         | 40<br>(2.0)  | 11<br>(1.10)        | 26<br>(3.25) |
| Slimy Salamander              | 0<br>(0.0)      | 0<br>(0.0)  | 0<br>(0.0)           | 0<br>(0.0)   | 0<br>(0.0)          | 1<br>(0.13)  |
| Eastern Garter Snake          | 0<br>(0.0)      | 0<br>(0.0)  | 0<br>(0.0)           | 1<br>(0.05)  | 0<br>(0.0)          | 0<br>(0.0)   |
| Total number of boards        | 30              | 30          | 60                   | 60           | 30                  | 24           |
| Total                         | 3<br>(0.30)     | 10<br>(1.0) | 16<br>(0.8)          | 43<br>(2.15) | 11<br>(1.10)        | 27<br>(3.38) |

**Upland-Forest Sites:** We detected 37 red-backed salamanders and one slimy salamander at the two upland-forest sites at HOFU (Table 16). Most (68%) of the red-backed salamanders were found at the PLU site, whereas the slimy salamander was found at the SCU site. As with the lowland-forest sites, the greatest number of salamanders (71%) were noted in the spring 1996 survey. For both species combined, an average of 3.81 individuals/sampling point were detected at upland-forest sites. Six coverboards were missing in spring 1996.

**Coverboard Labor and Cost:** Lumber for the coverboard protocol (40 boards [2.5 cm x 20 cm x 3 m]) cost \$238 and required 2.5 person-hours to cut into 1-m lengths (three boards at 40 sampling points). We spent 6.0 person-hours placing coverboards at the sampling points and 4.6 person-hours checking the coverboards for amphibians at all sites. Therefore, to establish and maintain the coverboard protocol at 10 sampling points, \$59.50 would be required for the cost of 10 boards (2.5 cm x 20 cm x 3 m), and 1.5 person-hours and 1.2 person-hours would be required to place and to check boards, respectively.

### Valley Forge National Historical Park

**Lowland-Forest Sites:** We detected 14 red-backed salamanders under coverboards at the two lowland-forest sites (Table 17). As at HOFU, we found more individuals in spring ( $n = 9$ ) compared to fall ( $n = 5$ ). All individuals were found at the JWL site, and the average number of red-backed salamanders was 1.50/sampling point. Eleven coverboards were missing from the RRL site in spring because of high water levels along the river following the winter snowmelt.

**Upland-Forest Sites:** We found 12 red-backed salamanders under coverboards at the two upland-forest sites (Table 17). These included six each in spring and fall. Most (92%) individuals were observed at the MMU site. We observed an average of 1.2 salamanders/sampling point. One coverboard was missing from the MJU site.

**Coverboard Labor and Cost:** Lumber for the coverboard protocol (20 boards [2.5 cm x 20 cm x 3 m]) cost \$119 (\$5.95/point) and required 1.3 person-hours to cut into 1-m lengths. It required 4.0 person-hours to set coverboards at the two lowland- and two upland-forest sites and 3.25 person-hours to check coverboards at all sites. Therefore, to establish and maintain the coverboard protocol at 10 sampling points, 2.0 person-hours and 1.6 person-hours would be needed to place and to check the boards each visit, respectively.

Table 17. Number of individuals and, in parentheses, relative abundance (no./sampling point = 3 boards) of amphibians and reptiles observed under coverboards in fall 1995 (F95) and spring 1996 (S96) at two lowland-forest (JWL and RRL) and two upland-forest (MMU and MJU) sites combined at Valley Forge National Historical Park. Descriptions of site codes are given in Table 3.

| Species                | Lowland-Forest Sites |             | Upland-Forest Sites |             |
|------------------------|----------------------|-------------|---------------------|-------------|
|                        | F95                  | S96         | F95                 | S96         |
| Red-backed Salamander  | 5<br>(0.50)          | 9<br>(1.42) | 6<br>(0.62)         | 6<br>(0.62) |
| Total number of boards | 30                   | 19          | 29                  | 29          |
| Total                  | 5<br>(0.50)          | 9<br>(1.42) | 6<br>(0.62)         | 6<br>(0.62) |

## Amphibian-Call Survey Protocol

### Gettysburg National Military Park and Eisenhower National Historic Site

We heard 142 frogs and toads of five species during the three amphibian-call surveys conducted in April-May 1994 (Table 18). These included 91 (64%) spring peepers, 23 (16%) pickerel frogs, 22 (15%) American toads, five (3%) gray treefrogs, and one (1%) wood frog. The average number of spring peepers, pickerel frogs, American toads, and gray treefrogs heard per survey (during stationary time) was 30.3, 7.7, 7.3, and 1.7, respectively. The single wood frog was observed during the second survey. The average number of spring peepers, pickerel frogs, American toads, and gray treefrogs observed per hour of stationary survey time was 46.7, 11.8, 11.3, and 2.6, respectively. Greater than 90% of the amphibians were observed in the two April surveys.

The survey route required 2.5 hours to establish. However, the same route was used for all vehicular-road survey protocols conducted at the park. The time required to conduct the protocol averaged 70 minutes per survey (13 stopping points along the 20.8 km route).

### Hopewell Furnace National Historic Site

We heard 176 frogs and toads of four species during two amphibian-call surveys conducted in April-May 1996 (Table 18). As with GETT-EISE, the highest percentage of individuals were spring peepers (149 individuals, 85%), followed by gray treefrogs (21 individuals, 12%), green frogs (3 individuals, 2%) and American toads (3 individuals, 2%). The average number of spring peepers, gray treefrogs, green frogs, and American toads detected per survey (during stationary time) was 74.5, 10.5, 1.5, and 1.5, respectively, and the average number detected per hour of stationary survey time was 186.3, 26.3, 3.8, and 3.8, respectively. Unlike GETT-EISE, most (81%) frogs were found during the survey conducted in May. The survey route required 2.0 hours to establish. We required 52.5 minutes to conduct each survey (eight stopping points along the 8.0 km route).

### Valley Forge National Historical Park

We heard 176 frogs and toads of seven species during two amphibian-call surveys conducted in April-May 1996 (Table 18). As with the other parks, the highest percentage of individuals were spring peepers (135 individuals, 78%), followed by gray treefrogs (35 individuals, 20%), and pickerel frogs (2 individuals, 1%). We detected one individual each of green frog,

Table 18. Number of individuals and, in parentheses, relative abundance (number/hour of stationary time) of amphibians observed during the amphibian-call survey protocol during three surveys in spring 1994 at Gettysburg National Military Park and Eisenhower National Historic Site, and during two surveys in spring 1996 at Hopewell Furnace National Historic Site and Valley Forge National Historical Park.

| Species                                                          | GETT-EISE               | HOFU                  | VAFO                  |
|------------------------------------------------------------------|-------------------------|-----------------------|-----------------------|
| Green Frog                                                       | 0<br>(0.0)              | 3<br>(3.8)            | 1<br>(1.4)            |
| Pickerel Frog                                                    | 23<br>(11.8)            | 0<br>(0.0)            | 2<br>(2.9)            |
| Northern Leopard Frog                                            | 0<br>(0.0)              | 0<br>(0.0)            | 1<br>(1.4)            |
| Wood Frog                                                        | 1<br>(0.5)              | 0<br>(0.0)            | 1<br>(1.4)            |
| American Toad                                                    | 22<br>(11.3)            | 3<br>(3.8)            | 1<br>(1.4)            |
| Gray Treefrog                                                    | 5<br>(2.6)              | 21<br>(26.3)          | 35<br>(50.0)          |
| Spring Peeper                                                    | 91<br>(46.7)            | 149<br>(186.3)        | 135<br>(192.9)        |
| Number of Sampling Points<br>and Total Stationary<br>Survey Time | 13 points<br>1.95 hours | 8 points<br>0.8 hours | 7 points<br>0.7 hours |
| Total                                                            | 142<br>(72.8)           | 176<br>(220.0)        | 176<br>(251.4)        |

northern leopard frog, wood frog, and American toad. The average number of spring peepers, gray treefrogs, and pickerel frogs detected per survey (during stationary time) was 67.5, 17.5, and 1.0, respectively, and the average number detected per hour of stationary survey time was 192.9, 50.0, and 2.9, respectively. We found most frogs (68%) in the May survey.

We required 1.79 hours to conduct the amphibian-call survey protocol (7 sampling points throughout the park). Surveys at VAFO required considerably more time to conduct relative to the other parks because the sampling points were not located along the vehicular-road survey route. The greater amount of time is attributed to the additional travel time (driving and walking) between points.

### Pitfall-Trap Protocol

#### Gettysburg National Military Park and Eisenhower National Historic Site

We captured six American toads and one red-spotted newt in pitfall traps in summer 1993 at GETT-EISE (Table 19). All toads were captured at forest sites (DDL and BRU), and the red-spotted newt was found at a grassland site (VDG). We captured only one box turtle in pitfall traps in summer 1993. The average rate of capture was 1.3 amphibians/100 trapnights and 0.2 reptiles/100 trapnights in pitfall traps.

We noted three amphibian species in pitfall traps during 1740 trapnights in April-May 1994, including two red-backed salamanders, one American toad, and one spotted salamander (Table 20). The capture rate was 0.2 amphibians/100 trapnights. We found no reptiles using pitfall traps during this trapping period.

We required 20.5 person-hours to dig 43 pitfall traps (0.47 person-hours/pitfall trap) in summer 1993 and 3.0 person-hours to dig 11 additional pitfall traps (0.27 person-hours/pitfall trap) in spring 1994. This included time to dig the traps and travel time between sites.

Approximately 9.5 person-hours were required to check 43 pitfall traps and 86 live-traps (for mammals) per visit in summer 1993. We spent 5.5 person-hours per visit checking 54 pitfall traps (10.19 person-hours/100 traps) for captures in spring 1994. Four additional hours were required in summer 1993 because live-traps were checked at the same time.

Table 19. Total number of individuals and, in parentheses, average number of individuals (no./100 trapnights) of three amphibian and reptilian species captured in pitfall traps at two grassland (PMG and VDG), four old-field (MOF, POF, WOF, and DOF), two lowland-forest (DDL and LFL), and two upland-forest (LRU and BRU) sites in summer 1993 at Gettysburg National Military Park and Eisenhower National Historic Park. Descriptions of site codes are given in Table 1.

| Species          | Grassland  | Old-Field  | Lowland-Forest | Upland-Forest | Total      |
|------------------|------------|------------|----------------|---------------|------------|
| Red-spotted Newt | 1<br>(0.7) | 0<br>(0.0) | 0<br>(0.0)     | 0<br>(0.0)    | 1<br>(0.2) |
| American Toad    | 0<br>(0.0) | 0<br>(0.0) | 5<br>(3.8)     | 1<br>(0.8)    | 6<br>(1.1) |
| Box Turtle       | 0<br>(0.0) | 1<br>(0.6) | 0<br>(0.0)     | 0<br>(0.0)    | 1<br>(0.2) |
| Trapnights       | 143        | 156        | 130            | 130           | 559        |
| Total            | 1<br>(0.7) | 1<br>(0.6) | 5<br>(3.8)     | 1<br>(0.8)    | 8<br>(1.4) |

Table 20. Total number of individuals and, in parentheses, average number of individuals (no./100 trapnights) of three amphibian species captured in pitfall traps at one pond (FLP), two grassland (PMG and VDG), four old-field (MOF, POF, WOF, and DOF), two lowland-forest (DDL and LFL), and two upland-forest (LRU and BRU) sites in spring 1994 at Gettysburg National Military Park and Eisenhower National Historic Park. Descriptions of site codes are given in Table 1.

| Species               | Pond       | Grassland  | Old-Field  | Lowland-Forest | Upland-Forest | Total      |
|-----------------------|------------|------------|------------|----------------|---------------|------------|
| Red-backed Salamander | 0<br>(0.0) | 0<br>(0.0) | 0<br>(0.0) | 2<br>(0.6)     | 0<br>(0.0)    | 2<br>(0.1) |
| Spotted Salamander    | 0<br>(0.0) | 0<br>(0.0) | 0<br>(0.0) | 0<br>(0.0)     | 1<br>(0.3)    | 1<br>(0.1) |
| American Toad         | 0<br>(0.0) | 0<br>(0.0) | 0<br>(0.0) | 0<br>(0.0)     | 1<br>(0.3)    | 1<br>(0.1) |
| Trapnights            | 385        | 330        | 375        | 350            | 300           | 1740       |
| Total                 | 0<br>(0.0) | 0<br>(0.0) | 0<br>(0.0) | 2<br>(0.6)     | 2<br>(0.7)    | 4<br>(0.2) |

## Hopewell Furnace National Historic Site

Old-Field Sites: We captured seven red-backed salamanders, one wood frog, and four American toads in pitfall traps during 110 trapnights at two old-field sites in summer 1994 and 1995 combined (Table 20). All but three red-backed salamanders were found at the PUO site, and all captures were noted in 1994. The average rate of capture was 10.9 individuals/100 trapnights.

Lowland-Forest Sites: We captured 10 American toads, three red-backed salamanders, one four-toed salamander, one northern two-lined salamander, and one eastern garter snake during 170 trapnights at the four lowland-forest sites in 1994-95 (Table 21). We found 5.9 American toads/100 trapnights. Eight toads, the northern two-lined salamander, and the garter snake were captured at the FCR site, whereas the four-toed salamander was captured at the HOL site. The overall capture rate for all lowland-forest sites and species combined was 9.4 individuals/100 trapnights.

Upland-Forest Sites: We captured eight American toads and six red-backed salamanders during 110 trapnights at the two upland-forest sites in 1994-95 (Table 21). All toads and four salamanders were found at the SCU site; four toads were found in each the 1994 and the 1995 trapping period. The overall rate of capture for upland-forest sites was 12.7 individuals/100 trapnights.

## Drift-Fence Protocol

## Hopewell Furnace National Historic Site

Old-Field Sites: We captured eight individuals of three species in pitfall traps with drift fences and four individuals of two species in pitfall traps without drift fences at old-field sites in 1994-95 (Table 22). We found more red-backed salamanders and American toads in pitfall traps with drift fences than in pitfall traps without drift fences; we also found a wood frog with drift fences. The rate of capture was higher in pitfall traps with drift fences (14.5 individuals/100 trapnights) compared to the rate of capture without drift fences (7.3 individuals/100 trapnights).

Table 21. Total number of individuals and, in parentheses, average number of individuals (no./100 trapnights) of six amphibian and reptilian species captured in pitfall traps at two old-field (PLO and PUO), four lowland-forest (PLL, FCL, HOF, and FCR), and two upland-forest (PLU and SCU) sites in summer 1994 and 1995 at Hopewell Furnace National Historic Site. No individuals were captured in pitfall traps at the HRG site. Descriptions of site codes are given in Table 2.

| Species                       | Old-Field    | Lowland-Forest | Upland-Forest | Total        |
|-------------------------------|--------------|----------------|---------------|--------------|
| Four-toed Salamander          | 0<br>(0.0)   | 1<br>(0.6)     | 0<br>(0.0)    | 1<br>(0.3)   |
| Northern Two-lined Salamander | 0<br>(0.0)   | 1<br>(0.6)     | 0<br>(0.0)    | 1<br>(0.3)   |
| Red-backed Salamander         | 7<br>(6.4)   | 3<br>(1.8)     | 6<br>(5.5)    | 16<br>(4.1)  |
| Wood Frog                     | 1<br>(0.9)   | 0<br>(0.0)     | 0<br>(0.0)    | 1<br>(0.3)   |
| American Toad                 | 4<br>(3.6)   | 10<br>(5.9)    | 8<br>(7.3)    | 22<br>(5.6)  |
| Eastern Garter Snake          | 0<br>(0.0)   | 1<br>(0.6)     | 0<br>(0.0)    | 1<br>(0.3)   |
| Trapnights                    | 110          | 170            | 110           | 390          |
| Total                         | 12<br>(10.9) | 16<br>(9.4)    | 14<br>(12.7)  | 42<br>(10.8) |

Table 22. Total number of individuals and, in parentheses, average number of individuals (no./100 trapnights) of six amphibian and reptilian species captured in pitfall traps with and without drift fences at two old-field (PLO and PUO), four lowland-forest (PLL, FCL, HOF, and FCR), and two upland-forest (PLU and SCU) sites in summer 1994 and 1995 at Hopewell Furnace National Historic Site. No individuals were captured in pitfall traps at the HRG site. Descriptions of site codes are given in Table 2.

| Species                       | Old-Field   |                | Lowland-Forest |                | Upland-Forest |                |
|-------------------------------|-------------|----------------|----------------|----------------|---------------|----------------|
|                               | Drift Fence | No Drift Fence | Drift Fence    | No Drift Fence | Drift Fence   | No Drift Fence |
| Four-toed Salamander          | 0<br>(0.0)  | 0<br>(0.0)     | 0<br>(0.0)     | 1<br>(1.2)     | 0<br>(0.0)    | 0<br>(0.0)     |
| Northern Two-lined Salamander | 0<br>(0.0)  | 0<br>(0.0)     | 0<br>(0.0)     | 1<br>(1.2)     | 0<br>(0.0)    | 0<br>(0.0)     |
| Red-backed Salamander         | 4<br>(7.3)  | 3<br>(5.5)     | 3<br>(3.5)     | 0<br>(0.0)     | 6<br>(10.9)   | 0<br>(0.0)     |
| Wood Frog                     | 1<br>(1.8)  | 0<br>(0.0)     | 0<br>(0.0)     | 0<br>(0.0)     | 0<br>(0.0)    | 0<br>(0.0)     |
| American Toad                 | 3<br>(5.5)  | 1<br>(1.8)     | 6<br>(7.1)     | 4<br>(4.7)     | 6<br>(10.9)   | 2<br>(3.6)     |
| Eastern Garter Snake          | 0<br>(0.0)  | 0<br>(0.0)     | 1<br>(1.2)     | 0<br>(0.0)     | 0<br>(0.0)    | 0<br>(0.0)     |
| Trapnights                    | 55          | 55             | 85             | 85             | 55            | 55             |
| Total                         | 8<br>(14.5) | 4<br>(7.3)     | 10<br>(11.8)   | 6<br>(7.1)     | 12<br>(21.8)  | 2<br>(3.6)     |

**Lowland-Forest Sites:** We noted 10 individuals of three species in pitfall traps with drift fences and six individuals of three species in pitfall traps without drift fences at four lowland-forest sites in 1994-95 (Table 22). The American toad was the most numerous species in pitfall traps with drift fences (7.1 individuals/100 trapnights) and without drift fences (4.7 individuals/100 trapnights). Four-toed and northern two-lined salamanders were captured in pitfall traps without drift fences, and the red-backed salamanders and garter snake were captured in pitfall traps with drift fences. Total abundance for all species combined during 85 trapnights with pitfall traps was 11.8 individuals/100 trapnights with drift fences and 7.1 individuals/100 trapnights without drift fences.

**Upland-Forest Sites:** We found six red-backed salamanders and six American toads in pitfall traps with drift fences and two American toads in pitfall traps without drift fences at two upland-forest sites in 1994-95 (Table 22). This resulted in a capture rate of 21.8 individuals/100 trapnights with drift fences and 3.6 individuals/100 trapnights without drift fences.

**All Habitats:** In summary, we noted 30 individuals of four species during 195 trapnights with drift fences and 12 individuals of four species during 195 trapnights without drift fences at all eight sites combined (Table 23). We captured twice as many American toads and four times as many red-backed salamanders in pitfall traps when drift fences were used compared to traps without drift fences. A total of 15.4 individuals/100 trapnights and 6.2 individuals/100 trapnights of all species combined was noted with and without drift fences, respectively. We required 0.25 person-hours/sampling point to install drift fences. In addition, the 10 m of drift fences for each sampling point cost \$5.06.

Table 23. Total number of individuals and, in parentheses, average number of individuals (no./100 trapnights) of six amphibian and reptilian species captured in pitfall traps with and without drift fences at eight study sites combined in summer 1994 and 1995 at Hopewell Furnace National Historic Site. No individuals were captured in pitfall traps at the HRG site.

| Species                       | Drift Fence  | No Drift Fence |
|-------------------------------|--------------|----------------|
| Four-toed Salamander          | 0<br>(0.0)   | 1<br>(0.5)     |
| Northern Two-lined Salamander | 0<br>(0.0)   | 1<br>(0.5)     |
| Red-backed Salamander         | 13<br>(6.7)  | 3<br>(1.5)     |
| Wood Frog                     | 1<br>(0.5)   | 0<br>(0.0)     |
| American Toad                 | 15<br>(7.7)  | 7<br>(3.6)     |
| Eastern Garter Snake          | 1<br>(0.5)   | 0<br>(0.0)     |
| Trapnights                    | 195          | 195            |
| Total                         | 30<br>(15.4) | 12<br>(6.2)    |



## Discussion

### Gettysburg National Military Park and Eisenhower National Historic Site

We observed the greatest number of amphibian and reptilian species ( $n = 10$ ) with the natural-substrate survey protocol (Tables 8-9). Two reptile species, the spotted turtle and ring-necked snake, were not documented by other protocols. Comparisons of our results to other parks or other habitats may require that results be standardized on the basis of number of rocks and logs turned over, which was not included in this study (Geer 1997).

The amphibian-call survey protocol required the least amount of time (fewest person-hours), money, and materials to survey frogs and toads at Gettysburg National Military Park and Eisenhower National Historic Site. We heard five frog species; three of which, the gray treefrog, spring peeper, and wood frog, were not documented at the parks using other protocols or by previous wildlife observation card observations. Because the amphibian-call survey protocol can be standardized by distance, number of stopping points along the route, or amount of survey time, results obtained can be compared to other parks and survey periods. This protocol also was advantageous because it enabled us to survey much of the park in a relatively short amount of time (approximately 1 hour). Based on the amount of survey time, we noted the highest number of individuals (142) using this survey compared to the other protocols (Table 18) because frogs and toads were concentrated during the breeding season. However, given this concentration, counting of individuals is difficult, and numbers may not be higher than reported.

We found relatively few reptiles and amphibians ( $n = 19$  red-backed salamanders, one northern two-lined salamander, and one eastern garter snake) under coverboards during three survey periods (Table 15). Although coverboards required no maintenance after being placed at the sampling points and provided a standardized measure by keeping the habitat (i.e., number of boards) constant, they were relatively expensive.

Pitfall trapping yielded captures of five species and 12 individuals (Tables 19-20), but this protocol was labor-intensive. Traps had to be emptied at least once every 3 days to reduce mortality of captured amphibians and reptiles. Because of the amount of time to dig the pitfall traps (0.47 person-hours/pitfall trap) and check the traps (10.19 person-hours/100 traps every third day), the number of observations relative to time for surveys was low compared to other protocols.

## Hopewell Furnace National Historic Site

As at GETT-EISE, the natural-substrate survey and the amphibian-call survey were the most effective protocols for amphibians and reptiles at Hopewell Furnace National Historic Site. We found more species ( $n = 5$  salamanders, 5 frogs, and 3 snakes) and individuals ( $n = 477$ ) with the natural-substrate survey protocol, including two each of salamander, frog, and snake species not detected with other protocols (Tables 10-12). Although this protocol required between 0.4-1.0 hours to survey each site, only one visit per site was necessary to search thoroughly for amphibians and reptiles.

The amphibian-call survey protocol detected four frog species, including two species, the spring peeper and gray treefrog, not found with other protocols (Table 18). Because this protocol requires little time to conduct (approximately 1 hour), can cover a substantial portion of the park, and detects a large number of individuals and species, it was an effective survey protocol for frogs and toads. Increasing the number of surveys or the number of sampling points at a park may increase the number of species observed and the effectiveness of this protocol.

We found three amphibian and one snake species using the coverboards (Table 16), but several factors decrease the effectiveness of this protocol. The coverboard protocol may require several months between placement of coverboards and checking the coverboards for weathering (DeGraaf and Yamasaki 1992), and the boards need to be replaced after 2-3 years because they decompose rapidly. In other studies, however, salamanders used coverboards within 1 month of placement (R. H. Yahner, personal observation). Coverboards also are a relatively expensive protocol and require significant time to place and check. In addition, coverboards may be lost or, along riparian habitats, washed away during spring thaw. However, a major advantage of this protocol is that observations may be standardized by number of coverboards, which allows sites, habitat types, and parks to be compared directly. Coverboards also can be placed in precise locations for comparisons among sites, habitats, and parks.

Compared to GETT-EISE, pitfall trapping at HOFU resulted in a higher number of species and individuals captured (Tables 21-23). However, pitfall trapping was labor-intensive, requiring 0.5 person-hours/trap to dig and 10.4 person-hours/100 traps to check per. Drift fences with pitfall traps were effective in increasing the number of captures, although we found four species each with and without drift fences.

Unlike at GETT-EISE, turtles were not effectively surveyed with any of the protocols tested at HOFU. We documented four species (painted, spotted, snapping, and eastern box turtles) through personal observations, but no species were found while protocol testing. Other protocols, such as timed-area searches (Yahner 1974, Bouffard 1978), may increase the number of species documented and should be tested with the park.

## Valley Forge National Historical Park

The results at Valley Forge National Historical Park were consistent with those at GETT-EISE and HOFU. The amphibian-call survey protocol was very effective, with seven species and 176 individuals detected during two surveys (Table 18). This high species richness may have been due to the use of sampling points along transects rather than along the vehicular-road survey route. Thus, use of the amphibian-call survey along transects likely will increase survey time, but may be effective in increasing amphibian detection in parks with considerable vehicular traffic.

We found few amphibian and reptilian species using the natural-substrate survey protocol compared to GETT-EISE and HOFU (Tables 13-14). Only one salamander, two frog, and two reptilian species were observed at VAFO with this protocol. Drought conditions at VAFO in 1996 may have decreased the detection of salamanders.

Only one salamander species, the red-backed salamander, was found using the coverboard protocol. This was due partly to the drought, because subsequent coverboard surveys have resulted in observations of other species and more individuals than we found. However, we also found relatively few species at the other parks using the coverboard protocol. As at GETT-EISE and HOFU, this protocol was expensive compared to other protocols tested, and the low number of species detected may not warrant its use to survey amphibians and reptiles.



## Suggested Inventorying and Monitoring Program for Amphibians and Reptiles

### Introductory Considerations

Seventy-five extant species of amphibians and reptiles occur in Pennsylvania, compared to 372 species of birds and 63 species of mammals (Yahner 1997). In our study of four national parks in Pennsylvania from 1992-96, we predicted that 27 amphibian and 28 reptilian species could potentially be found at GETT-EISE and VAFO and 27 amphibian and 27 reptilian species could potentially be found at HOFU (Tables 6-8); 55 and 54 species represent 73% and 72%, respectively, of the extant amphibian and reptilian species in the state. These predictions were based on various types of information, e.g., published field guides of the geographic distribution of amphibians and reptilians in the state (Conant 1991, Behler and King 1992, Shaffer 1995).

Only 37-52% of the amphibian species predicted to occur at each of the four parks and 30-57% of the reptilian species predicted to occur at each of the four parks were documented in our study. At least three reasons may explain why we found a relatively low number of species. First, population densities 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, aquatic netting is an excellent way to monitor populations of aquatic turtles, but it was not tested in our study. Third, geographic distributions given for some species in popular field guides are often very broad (e.g., marbled salamander). 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. 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 amphibian and reptilian species predicted to occur in a given park, which includes between 30 and 45 of the extant species in Pennsylvania.

Natural resource managers should develop a comprehensive inventory and monitoring program for amphibians and reptiles 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 amphibians and reptiles in the park.
- (2) To inventory and monitor the relative abundance of key subsets of the amphibian and reptilian 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: (1) What types of information are needed about amphibian and reptilian 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 amphibians and reptiles initially begin by simply deriving a list of species which have been documented in a park; this simple measure of diversity is termed species richness. A list of species often can be obtained readily 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 secretive nocturnal species (e.g., Fowler's toad).

A measure of species richness of amphibians and reptiles 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 biodiversity within the park and contiguous areas. This measure, however, has two disadvantages. First, a complete list of all amphibians and reptiles in a park may be difficult to obtain because of the cryptic nature of some species and because some species may require considerable time, monies, and expertise to inventory and monitor. Second, a simple list of species gives no information on the abundance and distribution of amphibians and reptiles in the park.

Natural resource managers may wish to increase their understanding of amphibian and reptilian fauna in a park by stating additional objectives that determine some measure of the relative abundance of a given subset(s) of species. Salamanders are an excellent subset of species to include in an inventory and monitoring program because they are major components of the food chain and, hence, are excellent barometers of environmental change or degradation (Wyman 1990, Sadinski and Dunson 1992). 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 37-52% of the predicted species of salamanders in each of the four parks. With minimal training and experience, most salamanders can be readily observed at the same time of year (spring-early summer) and using the same survey protocol (e.g., natural-substrate survey) in forested habitats. Verification of species identity by experts familiar with amphibian and reptilian taxonomy of the region, however, is advised because some species exhibit similar external characteristics.

## Duration and Scope of Project

If an objective of natural resource managers is simply to obtain some information of the presence/absence of amphibians and reptiles 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 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 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 amphibian or reptilian species are resident in a park.

We recommend that the relative abundance of a given subset(s) of amphibian and reptilian species be determined for a minimum of 2-3 years. If a project were limited to a single field season, an inaccurate picture of amphibian and reptilian abundance may be obtained as a result of natural year-to-year fluctuations in population numbers based on short-term weather conditions (e.g., periodic drought) or some environmental perturbation, which may affect the likelihood of capturing certain species.

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 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 or cover type comprises the vast majority of the park acreage. Most parks, however, contain more than one habitat or cover type (i.e., deciduous forest, coniferous forest, old-field, grassland, wetland) of appreciable size. If possible, each habitat or cover type within the park that comprises at least 10 ha should be sampled for amphibians and reptiles. However, critical or sensitive habitat or cover types, such as wetlands, that are less than 10 ha should be included in the sampling design because these may contain species with very specific habitat requirements not found elsewhere in the park (e.g., breeding frogs). Habitat or 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 amphibians and reptiles in a given habitat or 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 or cover type.

## Ecological and Logistical Constraints

Information on predicted species of amphibians and reptiles 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 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 monitor certain species may not be realistic for ecological reasons. Natural resource managers may wish to consult with experts familiar with the ecological requirements of amphibians and reptiles in question before conducting an in-depth 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 survey of terrestrial salamanders may require pitfall traps with drift fences, significant field time, and some expertise in identification of captured animals; thus, this inventory and monitoring protocol involves an 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 three sampling protocols for inventorying and monitoring amphibians and reptiles: natural-substrate survey, amphibian-call survey, and pitfall trapping with drift fences. 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, location, habitat or 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. Natural-substrate survey protocol: The natural-substrate survey protocol should be used to survey salamanders (Order Caudata), frogs (Order Salientia), turtles (Order Testudines), and snakes (Order Lacertilia). The most common habitat or 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 spring seeps and other wetlands.

At least two permanent sampling areas should be established in each habitat or cover type. At each area, one random transect at least 500 m in length should be established. The natural-substrate survey should be conducted once along each transect in spring. Four to five observers each surveying an area 5 m in width will result in an area of 2.0 to 2.5 ha in each habitat type (2 transects/habitat type x 4 or 5 observers x 5 m x 500 m). For a sufficient inventory, this survey should be conducted for a minimum of 2 consecutive years. If long-term monitoring is an objective, the survey should be conducted for 2 consecutive years at 5-year intervals. This sampling protocol will provide a suitable measure of species richness and relative density (expressed as number of different individuals detected per ha) in a given park.

2. Amphibian-call survey protocol: At least one permanent vehicular-road survey route should be established in a park for use with the amphibian-call survey protocol. The survey route should traverse roads adjacent to representative wetlands (i.e., marsh, swamp, vernal ponds, river overwash, farm ponds) and avoid heavily traveled roads, if possible. We recommend that the length of the route be at least 8 km (5 miles) with at least 10 stopping points within 30 m of a wetland. Road surveys can be valuable in documenting species richness and relative abundance (expressed as number of animals of each species heard per stop) of a variety of frogs and toads (Order Salientia). If low-use roads adjacent to wetlands are not available, permanent sampling points can be established near wetlands to survey frogs. At least five sampling points should be established adjacent to a variety of wetlands. We recommend at least four road surveys be conducted in early spring-early summer (mid-March to early June) between 3 and 6 hours after sunset. Amphibian-call surveys should be conducted for at least 2 consecutive years to inventory frogs, and thereafter at 2- to 3-year intervals to monitor these species.

3. Pitfall trapping with drift fences: Pitfall traps with drift fences should be used to survey salamanders (Order Caudata), frogs (Order Salientia), turtles (Order Testudines), and lizards (Order Lacertilia). The most common habitat or 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.

At least two permanent sampling areas should be established in each habitat or cover type. At each area, at least one random transect (minimum length of 500 m) should be established. Along the transects at each sampling area, 10 sampling points should be spaced at 50- to 100-m intervals. At these sampling points, one pitfall trap with two drift fences should be placed. Traps should be open for five consecutive days in both spring and late summer (April-May and August-September), giving 10 days of sampling or 100 trapnights (5 days x 10 traps x 2 trapping sessions) for pitfall traps during each sampling area per season or 200 trapnights per

year for each habitat or cover type. For a sufficient inventory, trapping should be conducted for a minimum of 2 consecutive years. If long-term monitoring is an objective, trapping should be conducted for 2 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.

4. Coverboard Protocol: Coverboards should be used to provide a standardized index of the abundance of certain terrestrial salamanders, particularly red-backed salamanders, within forest habitats at each park. Coverboards also should be used in open habitats (grassland and old-field) to survey snakes. The most common habitat or 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 also may be given to critical or sensitive types, such as wetlands.

At least two permanent sampling areas should be established in each habitat or cover type. At each area, at least one random transect (minimum length of 500 m) should be established. Along the transects at each sampling area, 10 sampling points should be spaced at 50- to 100-m intervals. At these sampling points, three pine coverboards (2.5-cm x 20-cm x 1-m) should be placed flush with the soil by removing leaf litter or vegetation. After 3 months, coverboards should be checked at least once each in spring and fall or, if time and monies allow, monthly from April to October. For a sufficient inventory, coverboards should be checked for a minimum of 2 consecutive years. Long-term monitoring will require that new boards be placed at sampling points after 3 years because of rapid decomposition. Although this sampling protocol will provide a measure of relative density (expressed as number of different individuals detected per sampling point) of red-backed salamanders in a given park, use of coverboards should be combined with the natural-substrate survey protocol to provide an accurate estimate of species richness of terrestrial salamanders.

5. 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.

6. Additional considerations: If resources, such as personnel, time, and monies, are available, the scope of an inventory and monitoring program for amphibians and reptiles can be expanded by using other types of protocols or increasing the intensity of sampling with a given protocol. For example, surveys of snakes may require use of artificial shelters. The presence of lizards will require use of special types of traps. Fixed area (0.5 ha) timed-searches may be used to survey turtles (Yahner 1974). Voucher specimens should be obtained for as many 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 amphibians and reptiles 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 Amphibian and Reptilian 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 then was based on our 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 effective particularly if it documented a variety of species with relatively little time, labor, and cost.

We concentrated our effort surveying certain abundant taxa (e.g., Order Caudata) and placed considerably less emphasis on taxa for which relatively few survey protocols have been developed (e.g., snakes). Although our field testing for amphibians and reptiles is complete, we recommend that future work focus on 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 Caudata

The natural-substrate survey protocol was the most effective protocol to survey salamanders (Table 24). We found the most species at each of the parks (four species at GETT-EISE, five species at HOFU, and one species at VAFO) using this protocol. Coverboards and pitfall trapping (with and without drift fence) (Tables 25-27) both yielded fewer species and required much more time and money to conduct relative the natural-substrate survey protocol. In addition, all terrestrial salamander species detected with the coverboard and pitfall-trap protocols also were found with the natural-substrate survey protocol, with the exception of the northern two-lined salamander at HOFU. However, coverboards should be used to provide a standardized estimate of relative density of red-backed salamanders.

### Order Salientia

We documented the most frog species using the amphibian-call survey protocol at GETT-EISE and VAFO (Table 28). In contrast, the most frog species were found at HOFU using the natural-substrate survey protocol (Table 29). Based on the amphibian-call survey protocol, which was designed to survey frogs, we found four species at GETT-EISE, two

Table 24. Habitats, seasons, type of data obtained, survey specifications, time, labor, materials, cost, limitations, and *Pro-Cite* citations for the natural-substrate survey protocol for the Order Caudata.

|                                                             | Comments                                                                                                                                                                                |
|-------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Habitats:                                                   | Wetland, riparian <sup>a</sup> , forest <sup>a</sup> , old-field <sup>a</sup>                                                                                                           |
| Seasons:                                                    | Spring <sup>b</sup> , summer <sup>b</sup> , fall, winter                                                                                                                                |
| Type of data:<br>Presence<br>Relative Abundance<br>Density  | Yes<br>Yes<br>Yes                                                                                                                                                                       |
| Number of species detected at:<br>GETT-EISE<br>HOFU<br>VAFO | 4<br>5<br>1                                                                                                                                                                             |
| Survey Specifications:                                      | at least two 500-m transects per habitat type; 4 to 5 observers each survey a 5-m width along the transect; survey conducted once in spring along each transect for 2 consecutive years |
| Time:                                                       | average of 5.9 minutes/100 m at old-field sites, 9.2 minutes/100 m at lowland-forest sites, and 13.9 minutes/100 m at upland-forest sites                                               |
| Labor:                                                      | 4-5 personnel                                                                                                                                                                           |
| Materials:                                                  | none                                                                                                                                                                                    |
| Cost:                                                       | none                                                                                                                                                                                    |
| Limitations:                                                | none                                                                                                                                                                                    |
| Citations:                                                  | Aubrey et al. 1988 (#400); Dalrymple 1988 (#2090); Herrington 1988 (#3960); Ramotnik and Scott 1988 (#6680)                                                                             |

<sup>a</sup> Habitats tested for this project; others obtained from the literature.

<sup>b</sup> Seasons tested for this project; others obtained from the literature.

Table 25. Habitats, seasons, type of data obtained, survey specifications, time, labor, materials, cost, limitations, and *Pro-Cite* citations for the coverboard protocol for the Order Caudata.

|                                                             | Comments                                                                                                                                                                                                                                                    |
|-------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Habitats:                                                   | Wetland <sup>a</sup> , riparian <sup>a</sup> , forest <sup>a</sup> , old-field <sup>a</sup> , grassland <sup>a</sup>                                                                                                                                        |
| Seasons:                                                    | Spring <sup>b</sup> , summer <sup>b</sup> , fall <sup>b</sup>                                                                                                                                                                                               |
| Type of data:<br>Presence<br>Relative Abundance<br>Density  | Yes<br>Yes<br>No                                                                                                                                                                                                                                            |
| Number of species detected at:<br>GETT-EISE<br>HOFU<br>VAFO | 2<br>3<br>1                                                                                                                                                                                                                                                 |
| Survey Specifications:                                      | at least two 500-m transects per habitat type; 10 sampling points placed every 50 m along transects; three coverboards placed at each point; survey conducted at least once in spring and fall or every month from April to October for 2 consecutive years |
| Time:                                                       | average of 0.02 person-hours to cut each board; 0.18 person-hours to place and 0.12 person-hours to check boards at each point                                                                                                                              |
| Labor:                                                      | 2 personnel                                                                                                                                                                                                                                                 |
| Materials:                                                  | three 2.5-cm x 20-cm x 1-m pine boards at each sampling point                                                                                                                                                                                               |
| Cost:                                                       | \$1.98/board; \$5.95/sampling point                                                                                                                                                                                                                         |
| Limitations:                                                | must wait at least 3 months after placing coverboards to check for amphibians; more costly than alternate protocols; boards begin breaking down after 2 years and must be replaced                                                                          |
| Citations:                                                  | Davis 1997 (#9220); DeGraaf and Yamasaki 1992 (#2220); Fellers and Drost 1994 (#9230)                                                                                                                                                                       |

<sup>a</sup> Habitats tested for this project; others obtained from the literature.

<sup>b</sup> Seasons tested for this project; others obtained from the literature.

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

|                                                             | Comments                                                                                                                                                                                                       |
|-------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Habitats:                                                   | Wetland <sup>a</sup> , riparian <sup>a</sup> , forest <sup>a</sup> , old-field <sup>a</sup> , grassland <sup>a</sup> , agricultural                                                                            |
| Seasons:                                                    | Spring <sup>b</sup> , summer <sup>b</sup>                                                                                                                                                                      |
| Type of data:<br>Presence<br>Relative Abundance<br>Density  | Yes<br>Yes<br>No                                                                                                                                                                                               |
| Number of species detected at:<br>GETT-EISE<br>HOFU<br>VAFO | 3<br>3<br>NA <sup>c</sup>                                                                                                                                                                                      |
| Survey Specifications:                                      | at least two 500-m transects per habitat type and 10 pitfall traps per transect spaced at 50-m intervals; traps open for 5 consecutive nights; trapping to be conducted once in spring and once in late summer |
| Time:                                                       | average of 0.47 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:                                                | not a time-efficient protocol relative to number of captures                                                                                                                                                   |
| Citations:                                                  | Boonstra and Krebs 1978 (#1030); Gibbons and Semlitsch 1982 (#3350); Howard and Brock 1961 (#4120); Walters 1989 (#8590)                                                                                       |

<sup>a</sup> Habitats tested for this project; others obtained from the literature.

<sup>b</sup> Seasons tested for this project; others obtained from the literature.

<sup>c</sup> 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 the drift-fence protocol (with pitfall traps) for the Order Caudata.

|                                                             | Comments                                                                                                                                                                                                                                                                                                               |
|-------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Habitats:                                                   | Wetland, riparian <sup>a</sup> , forest <sup>a</sup> , old-field <sup>a</sup> , grassland <sup>a</sup> , agricultural                                                                                                                                                                                                  |
| Seasons:                                                    | Spring, summer <sup>b</sup> , fall, winter                                                                                                                                                                                                                                                                             |
| Type of data:<br>Presence<br>Relative Abundance<br>Density  | Yes<br>Yes<br>No                                                                                                                                                                                                                                                                                                       |
| Number of species detected at:<br>GETT-EISE<br>HOFU<br>VAFO | NA <sup>c</sup><br>1<br>NA <sup>c</sup>                                                                                                                                                                                                                                                                                |
| Survey Specifications:                                      | at least two 500-m transects per habitat type and 10 pitfall traps per transect spaced at 50-m intervals; two 5-m x 45-cm drift fences placed on each side of the pitfall trap and perpendicular to the transect; traps open for 5 consecutive nights; trapping to be conducted once in spring and once in late summer |
| Time:                                                       | average of 0.25 person-hours to prepare and place drift fences, 0.47 person-hours/pitfall trap to prepare traps and 10.4 person-hours/100 pitfall traps to check traps                                                                                                                                                 |
| Labor:                                                      | 2 personnel                                                                                                                                                                                                                                                                                                            |
| Materials:                                                  | 10 m of drift fence for each sampling point, 1-gallon cans, posthole digger                                                                                                                                                                                                                                            |
| Cost:                                                       | \$5.06 per sampling point (10 m x 45 cm) for erosion cloth (stakes included), \$30 for posthole digger                                                                                                                                                                                                                 |
| Limitations:                                                | none                                                                                                                                                                                                                                                                                                                   |
| Citations:                                                  | Brenner 1984 (#1150); Bury and Corn 1987 (#1450); Dodd 1991 (#2390); McKinstry et al. 1991 (#5680)                                                                                                                                                                                                                     |

<sup>a</sup> Habitats tested for this project; others obtained from the literature.

<sup>b</sup> Seasons tested for this project; others obtained from the literature.

<sup>c</sup> Protocol not conducted at GETT-EISE and VAFO.

Table 28. Habitats, seasons, type of data obtained, survey specifications, time, labor, materials, cost, limitations, and *Pro-Cite* citations for the natural-substrate survey protocol for the Order Salientia.

|                                                             | Comments                                                                                                                                                                                |
|-------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Habitats:                                                   | Wetland, riparian <sup>a</sup> , forest <sup>a</sup> , old-field <sup>a</sup>                                                                                                           |
| Seasons:                                                    | Spring <sup>b</sup> , summer <sup>b</sup> , fall, winter                                                                                                                                |
| Type of data:<br>Presence<br>Relative Abundance<br>Density  | Yes<br>Yes<br>Yes                                                                                                                                                                       |
| Number of species detected at:<br>GETT-EISE<br>HOFU<br>VAFO | 2<br>5<br>2                                                                                                                                                                             |
| Survey Specifications:                                      | at least two 500-m transects per habitat type; 4 to 5 observers each survey a 5-m width along the transect; survey conducted once in spring along each transect for 2 consecutive years |
| Time:                                                       | average of 5.9 minutes/100 m at old-field sites, 9.2 minutes/100 m at lowland-forest sites, and 13.9 minutes/100 m at upland-forest sites                                               |
| Labor:                                                      | 4-5 personnel                                                                                                                                                                           |
| Materials:                                                  | none                                                                                                                                                                                    |
| Cost:                                                       | none                                                                                                                                                                                    |
| Limitations:                                                | none                                                                                                                                                                                    |
| Citations:                                                  | Aubrey et al. 1988 (#400); Dalrymple 1988 (#2090); Herrington 1988 (#3960); Ramotnik and Scott 1988 (#6680)                                                                             |

<sup>a</sup> Habitats tested for this project; others obtained from the literature.

<sup>b</sup> Seasons tested for this project; others obtained from the literature.

Table 29. Habitats, seasons, type of data obtained, survey specifications, time, labor, materials, cost, limitations, and *Pro-Cite* citations for the amphibian-call survey protocol for the Order Salientia.

|                                                             | Comments                                                                                                                                                                                                                                                                        |
|-------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Habitats:                                                   | Wetland <sup>a</sup> , riparian <sup>a</sup> , forest <sup>a</sup> , grassland <sup>a</sup>                                                                                                                                                                                     |
| Seasons:                                                    | Spring <sup>a</sup> , summer                                                                                                                                                                                                                                                    |
| Type of data:<br>Presence<br>Relative Abundance<br>Density  | Yes<br>Yes<br>No                                                                                                                                                                                                                                                                |
| Number of species detected at:<br>GETT-EISE<br>HOFU<br>VAFO | 5<br>4<br>7                                                                                                                                                                                                                                                                     |
| Survey Specifications:                                      | road-survey route of at least 8-km through a variety of habitats associated with water; at least 10 stopping points within 30 m of a wetland; 3 surveys along route during spring, the first conducted immediately following snowmelt; survey conducted for 2 consecutive years |
| Time:                                                       | average of 2.5 hours to map and test-run and 4.0 minutes/km to survey                                                                                                                                                                                                           |
| Labor:                                                      | 2 observers                                                                                                                                                                                                                                                                     |
| Materials:                                                  | vehicle and map if conducted along the vehicular-road survey route; none otherwise                                                                                                                                                                                              |
| Cost:                                                       | cost of gasoline if conducted along the vehicular-road survey route; none otherwise                                                                                                                                                                                             |
| Limitations:                                                | difficult to conduct in a high-use park or on busy roads; best conducted on park roads with little traffic                                                                                                                                                                      |
| Citations:                                                  |                                                                                                                                                                                                                                                                                 |

<sup>a</sup> Habitats tested for this project; others obtained from the literature.

<sup>b</sup> Seasons tested for this project; others obtained from the literature.

species at HOFU, and five species at VAFO that were not detected with other protocols. This survey required relatively little time to conduct (4.0 minutes/km along a road survey route) compared to other protocols that documented frog species (natural-substrate survey protocol, and pitfall trapping with and without drift fences) (Tables 30-31). However, the amphibian-call survey requires considerable expertise in identifying calls of breeding frogs.

## Order Testudines

We detected two turtle species at GETT-EISE (eastern box and spotted), no species at HOFU, and one species at VAFO (eastern box) through protocol testing (Tables 32 and 33). The most time-efficient protocol to survey turtles was the natural-substrate survey protocol. The low number of turtle species observed at each park may have been due to three factors. First, we may not have sampled the appropriate habitats or sites within the parks. Second, the protocols that we tested may not have been appropriate for most turtle species. Third, few species and individuals may exist at the parks. Because of the high number of turtle species found through personal observations (three at GETT-EISE and four at HOFU) and documented by WOC (five at VAFO) but not found through protocol testing, it is likely that the appropriate habitats or sites were not sampled or the appropriate protocols were not conducted. Many of these observations, particularly at HOFU, were in areas where surveys were not conducted (e.g., historic and cultural areas). Further surveys of turtles at the parks should incorporate aquatic trapping protocols to detect species like the common snapping turtle, stinkpot, and painted turtle, or terrestrial searching protocols (timed-area search) to detect species like the eastern box turtle.

## Order Lacertilia

We did not detect lizard species at any of the parks. Although no protocol was designed specifically to document lizards, these species are most likely to be detected using the natural-substrate survey protocol, pitfall-trap protocol, or timed-area search. Both predicted lizard species were documented at GETT-EISE by WOC.

## Order Serpentes

We documented two snake species at GETT-EISE, three species at HOFU, and one species at VAFO testing the natural-substrate survey, coverboard, and drift fence with pitfall-trap protocols (Tables 34-36). Although the natural-substrate survey protocol was not specifically designed to survey snakes, we found the most species (two at GETT-EISE, three at HOFU,

Table 30. Habitats, seasons, type of data obtained, survey specifications, time, labor, materials, cost, limitations, and *Pro-Cite* citations for the pitfall-trap protocol (without drift fences) for the Order Salientia.

|                                                             | Comments                                                                                                                                                                                                       |
|-------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Habitats:                                                   | Wetland <sup>a</sup> , riparian <sup>a</sup> , forest <sup>a</sup> , old-field <sup>a</sup> , grassland <sup>a</sup> , agricultural                                                                            |
| Seasons:                                                    | Spring, summer <sup>b</sup> , fall, winter                                                                                                                                                                     |
| Type of data:<br>Presence<br>Relative Abundance<br>Density  | Yes<br>Yes<br>No                                                                                                                                                                                               |
| Number of species detected at:<br>GETT-EISE<br>HOFU<br>VAFO | 1<br>1<br>NA <sup>c</sup>                                                                                                                                                                                      |
| Survey Specifications:                                      | at least two 500-m transects per habitat type and 10 pitfall traps per transect spaced at 50-m intervals; traps open for 5 consecutive nights; trapping to be conducted once in spring and once in late summer |
| Time:                                                       | average of 0.47 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:                                                | not a time-efficient protocol relative to number of captures                                                                                                                                                   |
| Citations:                                                  | Boonstra and Krebs 1978 (#1030); Gibbons and Semlitsch 1982 (#3350); Howard and Brock 1961 (#4120); Walters 1989 (#8590)                                                                                       |

<sup>a</sup> Habitats tested for this project; others obtained from the literature.

<sup>b</sup> Seasons tested for this project; others obtained from the literature.

<sup>c</sup> Protocol not conducted at VAFO.

Table 31. 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 Salientia.

|                                                             | Comments                                                                                                                                                                                                                                                                                                               |
|-------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Habitats:                                                   | Wetland, riparian <sup>a</sup> , forest <sup>a</sup> , old-field <sup>a</sup> , grassland <sup>a</sup> , agricultural                                                                                                                                                                                                  |
| Seasons:                                                    | Spring, summer <sup>b</sup> , fall, winter                                                                                                                                                                                                                                                                             |
| Type of data:<br>Presence<br>Relative Abundance<br>Density  | Yes<br>Yes<br>No                                                                                                                                                                                                                                                                                                       |
| Number of species detected at:<br>GETT-EISE<br>HOFU<br>VAFO | NA <sup>c</sup><br>2<br>NA <sup>c</sup>                                                                                                                                                                                                                                                                                |
| Survey Specifications:                                      | at least two 500-m transects per habitat type and 10 pitfall traps per transect spaced at 50-m intervals; two 5-m x 45-cm drift fences placed on each side of the pitfall trap and perpendicular to the transect; traps open for 5 consecutive nights; trapping to be conducted once in spring and once in late summer |
| Time:                                                       | average of 0.25 person-hours to prepare and place drift fences, 0.47 person-hours/pitfall trap to prepare traps and 10.4 person-hours/100 pitfall traps to check traps                                                                                                                                                 |
| Labor:                                                      | 2 personnel                                                                                                                                                                                                                                                                                                            |
| Materials:                                                  | 10 m of drift fence for each sampling point, 1-gallon cans, posthole digger                                                                                                                                                                                                                                            |
| Cost:                                                       | \$5.06 per sampling point (10 m x 45 cm) for erosion cloth (stakes included), \$30 for posthole digger                                                                                                                                                                                                                 |
| Limitations:                                                | none                                                                                                                                                                                                                                                                                                                   |
| Citations:                                                  | Brenner 1984 (#1150); Bury and Corn 1987 (#1450); Dodd 1991 (#2390); McKinstry et al. 1991 (#5680)                                                                                                                                                                                                                     |

<sup>a</sup> Habitats tested for this project; others obtained from the literature.

<sup>b</sup> Seasons tested for this project; others obtained from the literature.

<sup>c</sup> Protocol not conducted at GETT-EISE and VAFO.

Table 32. Habitats, seasons, type of data obtained, survey specifications, time, labor, materials, cost, limitations, and *Pro-Cite* citations for the natural-substrate survey protocol for the Order Testudines.

|                                                             | Comments                                                                                                                                                                                |
|-------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Habitats:                                                   | Wetland <sup>a</sup> , riparian <sup>a</sup> , forest <sup>a</sup> , old-field <sup>a</sup> , grassland <sup>a</sup> , agricultural                                                     |
| Seasons:                                                    | Spring, summer <sup>b</sup> , fall, winter                                                                                                                                              |
| Type of data:<br>Presence<br>Relative Abundance<br>Density  | Yes<br>Yes<br>Yes                                                                                                                                                                       |
| Number of species detected at:<br>GETT-EISE<br>HOFU<br>VAFO | 2<br>0<br>1                                                                                                                                                                             |
| Survey Specifications:                                      | at least two 500-m transects per habitat type; 4 to 5 observers each survey a 5-m width along the transect; survey conducted once in spring along each transect for 2 consecutive years |
| Time:                                                       | average of 5.9 minutes/100 m at old-field sites, 9.2 minutes/100 m at lowland-forest sites, and 13.9 minutes/100 m at upland-forest sites                                               |
| Labor:                                                      | 4-5 personnel                                                                                                                                                                           |
| Materials:                                                  | none                                                                                                                                                                                    |
| Cost:                                                       | none                                                                                                                                                                                    |
| Limitations:                                                | none                                                                                                                                                                                    |
| Citations:                                                  | Aubrey et al. 1988 (#400); Dalrymple 1988 (#2090); Herrington 1988 (#3960); Ramotnik and Scott 1988 (#6680)                                                                             |

<sup>a</sup> Habitats tested for this project; others obtained from the literature.

<sup>b</sup> Seasons tested for this project; others obtained from the literature.

Table 33.. Habitats, seasons, type of data obtained, survey specifications, time, labor, materials, cost, limitations, and *Pro-Cite* citations for the pitfall-trap protocol (without drift fences) for the Order Testudines.

|                                                             | Comments                                                                                                                                                                                                       |
|-------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Habitats:                                                   | Wetland <sup>a</sup> , riparian <sup>a</sup> , forest <sup>a</sup> , old-field <sup>a</sup> , grassland <sup>a</sup> , agricultural                                                                            |
| Seasons:                                                    | Spring, summer <sup>b</sup> , fall, winter                                                                                                                                                                     |
| Type of data:<br>Presence<br>Relative Abundance<br>Density  | Yes<br>Yes<br>No                                                                                                                                                                                               |
| Number of species detected at:<br>GETT-EISE<br>HOFU<br>VAFO | 1<br>0<br>NA <sup>c</sup>                                                                                                                                                                                      |
| Survey Specifications:                                      | at least two 500-m transects per habitat type and 10 pitfall traps per transect spaced at 50-m intervals; traps open for 5 consecutive nights; trapping to be conducted once in spring and once in late summer |
| Time:                                                       | average of 0.47 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:                                                | not a time-efficient protocol relative to number of captures                                                                                                                                                   |
| Citations:                                                  | Boonstra and Krebs 1978 (#1030); Gibbons and Semlitsch 1982 (#3350); Howard and Brock 1961 (#4120); Walters 1989 (#8590)                                                                                       |

<sup>a</sup> Habitats tested for this project; others obtained from the literature.

<sup>b</sup> Seasons tested for this project; others obtained from the literature.

<sup>c</sup> Protocol not conducted at VAFO.

Table 34. Habitats, seasons, type of data obtained, survey specifications, time, labor, materials, cost, limitations, and *Pro-Cite* citations for the natural-substrate survey protocol for the Order Serpentes.

|                                                             | Comments                                                                                                                                                                                |
|-------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Habitats:                                                   | Wetland <sup>a</sup> , riparian <sup>a</sup> , forest <sup>a</sup> , old-field <sup>a</sup> , grassland <sup>a</sup> , agricultural                                                     |
| Seasons:                                                    | Spring, summer <sup>b</sup> , fall, winter                                                                                                                                              |
| Type of data:<br>Presence<br>Relative Abundance<br>Density  | Yes<br>Yes<br>Yes                                                                                                                                                                       |
| Number of species detected at:<br>GETT-EISE<br>HOFU<br>VAFO | 2<br>3<br>1                                                                                                                                                                             |
| Survey Specifications:                                      | at least two 500-m transects per habitat type; 4 to 5 observers each survey a 5-m width along the transect; survey conducted once in spring along each transect for 2 consecutive years |
| Time:                                                       | average of 5.9 minutes/100 m at old-field sites, 9.2 minutes/100 m at lowland-forest sites, and 13.9 minutes/100 m at upland-forest sites                                               |
| Labor:                                                      | 4-5 personnel                                                                                                                                                                           |
| Materials:                                                  | none                                                                                                                                                                                    |
| Cost:                                                       | none                                                                                                                                                                                    |
| Limitations:                                                | none                                                                                                                                                                                    |
| Citations:                                                  | Aubrey et al. 1988 (#400); Dalrymple 1988 (#2090); Herrington 1988 (#3960); Ramotnik and Scott 1988 (#6680)                                                                             |

<sup>a</sup> Habitats tested for this project; others obtained from the literature.

<sup>b</sup> Seasons tested for this project; others obtained from the literature.

Table 35. Habitats, seasons, type of data obtained, survey specifications, time, labor, materials, cost, limitations, and *Pro-Cite* citations for the coverboard protocol for the Order Serpentes.

|                                                             | Comments                                                                                                                                                                                                                                                    |
|-------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Habitats:                                                   | Wetland <sup>a</sup> , riparian <sup>a</sup> , forest <sup>a</sup> , old-field <sup>a</sup> , grassland <sup>a</sup>                                                                                                                                        |
| Seasons:                                                    | Spring <sup>b</sup> , summer <sup>b</sup> , fall <sup>b</sup>                                                                                                                                                                                               |
| Type of data:<br>Presence<br>Relative Abundance<br>Density  | Yes<br>Yes<br>No                                                                                                                                                                                                                                            |
| Number of species detected at:<br>GETT-EISE<br>HOFU<br>VAFO | 1<br>1<br>0                                                                                                                                                                                                                                                 |
| Survey Specifications:                                      | at least two 500-m transects per habitat type; 10 sampling points placed every 50 m along transects; three coverboards placed at each point; survey conducted at least once in spring and fall or every month from April to October for 2 consecutive years |
| Time:                                                       | average of 0.02 person-hours to cut each board; 0.18 person-hours to place and 0.12 person-hours to check boards at each point                                                                                                                              |
| Labor:                                                      | 2 personnel                                                                                                                                                                                                                                                 |
| Materials:                                                  | three 2.5-cm x 20-cm x 1-m pine boards at each sampling point                                                                                                                                                                                               |
| Cost:                                                       | \$1.98/board; \$5.95/sampling point                                                                                                                                                                                                                         |
| Limitations:                                                | must wait at least 3 months after placing coverboards to check for amphibians; more costly than alternate protocols; boards begin breaking down after 2 years and must be replaced                                                                          |
| Citations:                                                  | Davis 1997 (#9220); DeGraaf and Yamasaki 1992 (#2220); Fellers and Drost 1994 (#9230)                                                                                                                                                                       |

<sup>a</sup> Habitats tested for this project; others obtained from the literature.

<sup>b</sup> Seasons tested for this project; others obtained from the literature.

Table 36. 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 Serpentes.

|                                                             | Comments                                                                                                                                                                                                                                                                                                               |
|-------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Habitats:                                                   | Wetland, riparian <sup>a</sup> , forest <sup>a</sup> , old-field <sup>a</sup> , grassland <sup>a</sup> , agricultural                                                                                                                                                                                                  |
| Seasons:                                                    | Spring, summer <sup>b</sup> , fall, winter                                                                                                                                                                                                                                                                             |
| Type of data:<br>Presence<br>Relative Abundance<br>Density  | Yes<br>Yes<br>No                                                                                                                                                                                                                                                                                                       |
| Number of species detected at:<br>GETT-EISE<br>HOFU<br>VAFO | NA <sup>c</sup><br>1<br>NA <sup>c</sup>                                                                                                                                                                                                                                                                                |
| Survey Specifications:                                      | at least two 500-m transects per habitat type and 10 pitfall traps per transect spaced at 50-m intervals; two 5-m x 45-cm drift fences placed on each side of the pitfall trap and perpendicular to the transect; traps open for 5 consecutive nights; trapping to be conducted once in spring and once in late summer |
| Time:                                                       | average of 0.25 person-hours to prepare and place drift fences, 0.47 person-hours/pitfall trap to prepare traps and 10.4 person-hours/100 pitfall traps to check traps                                                                                                                                                 |
| Labor:                                                      | 2 personnel                                                                                                                                                                                                                                                                                                            |
| Materials:                                                  | 10 m of drift fence for each sampling point, 1-gallon cans, posthole digger                                                                                                                                                                                                                                            |
| Cost:                                                       | \$5.06 per sampling point (10 m x 45 cm) for erosion cloth (stakes included), \$30 for posthole digger                                                                                                                                                                                                                 |
| Limitations:                                                | none                                                                                                                                                                                                                                                                                                                   |
| Citations:                                                  | Brenner 1984 (#1150); Bury and Corn 1987 (#1450); Dodd 1991 (#2390); McKinstry et al. 1991 (#5680)                                                                                                                                                                                                                     |

<sup>a</sup> Habitats tested for this project; others obtained from the literature.

<sup>b</sup> Seasons tested for this project; others obtained from the literature.

<sup>c</sup> Protocol not conducted at GETT-EISE and VAFO.

and one at VAFO) testing this protocol. The garter snake was found at GETT-EISE and HOFU under coverboards; however, the coverboard protocol was not as time-efficient as the natural-substrate survey protocol. Furthermore, there is at least a 3-month interval between placing coverboards and checking them for snakes, whereas the natural-substrate survey protocol provides immediate documentation of species. However, use of larger wooden or corrugated metal coverboards may increase the number of individuals and snake species observed (Fitch 1992).

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Appendix 1. Amphibian and reptilian section of the Faunal Database for Gettysburg National Military Park and Eisenhower National Historic Site through 30 June 1996.



## APPENDIX 1.

| COMMON NAME                   | SCIENTIFIC NAME                     | PRO-CITE   | OCCURRENCE | RESIDENCY | LEGAL       | PROTOCOL                                | FIELD TESTED |
|-------------------------------|-------------------------------------|------------|------------|-----------|-------------|-----------------------------------------|--------------|
|                               |                                     | GROUP NAME | STATUS     | STATUS    | POP. STATUS |                                         | PROTOCOL     |
| HELLBENDER                    | <i>Cryptobranchus alleganiensis</i> | Caudata    | R          | R         |             | MAR TRS LTT NIG TSE                     |              |
| RED-SPOTTED NEWT              | <i>Notophthalmus viridescens</i>    | Caudata    | PTC PO     | R         |             | LTR DFE MAR TRS LTT PFT TSE CVB         | PFT LTR      |
| JEFFERSON SALAMANDER          | <i>Ambystoma jeffersonianum</i>     | Caudata    | R          | R         |             | LTR DFE MAR TRS LTT PFT TSE CVB         |              |
| SPOTTED SALAMANDER            | <i>Ambystoma maculatum</i>          | Caudata    | PTC WOC    | R         |             | LTR DFE MAR TRS LTT PFT TSE CVB         | PFT LTR      |
| MARbled SALAMANDER            | <i>Ambystoma opacum</i>             | Caudata    | R          | R         |             | LTR DFE MAR TRS LTT PFT TSE CVB         |              |
| NORTHERN DUSKY SALAMANDER     | <i>Desmognathus fuscus</i>          | Caudata    | R          | R         |             | LTR DFE MAR TRS LTT PFT TSE CVB         |              |
| MOUNTAIN DUSKY SALAMANDER     | <i>Desmognathus ochrophaeus</i>     | Caudata    | R          | R         |             | LTR DFE MAR TRS LTT PFT TSE CVB         |              |
| NORTHERN TWO-LINED SALAMANDER | <i>Eurycea bislineata</i>           | Caudata    | PTC WOC    | R         |             | LTR DFE MAR TRS LTT PFT TSE CVB         | LTR CVB      |
| LONG-TAILED SALAMANDER        | <i>Eurycea longicauda</i>           | Caudata    | R          | R         |             | LTR DFE MAR TRS LTT PFT TSE CVB         |              |
| NORTHERN SPRING SALAMANDER    | <i>Gyrinophilus porphyriticus</i>   | Caudata    | R          | R         |             | LTR DFE MAR TRS LTT PFT TSE CVB         |              |
| FOUR-TOED SALAMANDER          | <i>Hemidactylum scutatum</i>        | Caudata    | R          | R         |             | LTR DFE MAR TRS LTT PFT TSE CVB         |              |
| RED-BACKED SALAMANDER         | <i>Plethodon cinereus</i>           | Caudata    | PTC PO WOC | R         |             | LTR DFE MAR TRS LTT PFT TSE CVB         | PFT LTR CVB  |
| SLIMY SALAMANDER              | <i>Plethodon glutinosus</i>         | Caudata    | R          | R         |             | LTR DFE MAR TRS LTT PFT TSE CVB         |              |
| VALLEY AND RIDGE SALAMANDER   | <i>Plethodon hoffmani</i>           | Caudata    | R          | R         |             | LTR DFE MAR TRS LTT PFT TSE CVB         |              |
| NORTHERN RED SALAMANDER       | <i>Pseudotriton ruber</i>           | Caudata    | R          | R         |             | LTR DFE MAR TRS LTT PFT TSE CVB         |              |
| EASTERN SPADEFoot TOAD        | <i>Scaphiopus holbrookii</i>        | Salientia  | R          | R         |             | DFE LTT TSR V&C PFT TSE RCE             |              |
| BULLFROG                      | <i>Rana catesbeiana</i>             | Salientia  | R          | R         |             | DFE LTT TSR V&C PFT TNE TSE RCE         |              |
| GREEN FROG                    | <i>Rana clamitans</i>               | Salientia  | PO         | R         |             | DFE LTT TSR V&C PFT TNE TSE RCE         |              |
| NORTHERN LEOPARD FROG         | <i>Rana pipiens</i>                 | Salientia  | R          | R         |             | DFE LTT TSR V&C PFT TNE TSE RCE         |              |
| PICKEREL FROG                 | <i>Rana palustris</i>               | Salientia  | PTC PO     | R         |             | DFE LTT TSR V&C PFT TNE TSE RCE         | RCE          |
| WOOD FROG                     | <i>Rana sylvatica</i>               | Salientia  | PTC        | R         |             | DFE LTT TSR V&C PFT TNE TSE RCE         | RCE          |
| AMERICAN TOAD                 | <i>Bufo americanus</i>              | Salientia  | PTC PO     | R         |             | DFE LTT TSR V&C PFT TSE RCE             | PFT LTR RCE  |
| WOODHOUSE'S TOAD              | <i>Bufo woodhousi</i>               | Salientia  | R          | R         |             | DFE LTT TSR V&C PFT TSE RCE             |              |
| GRAY TREEFROG                 | <i>Hyla versicolor</i>              | Salientia  | PTC        | R         |             | DFE LTT TSR V&C PFT TNE TSE RCE         | RCE          |
| NORTHERN SPRING PEEPER        | <i>Hyla crucifer</i>                | Salientia  | PTC PO WOC | R         |             | DFE LTT TSR V&C PFT TNE TSE RCE         | RCE          |
| WESTERN CHORUS FROG           | <i>Pseudacris triseriata</i>        | Salientia  | R          | R         |             | DFE LTT TSR V&C PFT TNE TSE RCE         |              |
| COMMON SNAPPING TURTLE        | <i>Chelydra serpentina</i>          | Testudines | PO WOC     | R         |             | CRE DFE LTT BTR SOU TRA TRS PFT MAR TSE |              |
| STINKPOT                      | <i>Sternotherus odoratus</i>        | Testudines | PO WOC     | R         |             | CRE DFE LTT BTR SOU TRA TRS PFT MAR TSE |              |
| PAINTED TURTLE                | <i>Chrysemys picta</i>              | Testudines | PO WOC     | R         |             | CRE DFE LTT BTR SOU TRA TRS PFT MAR TSE |              |
| SPOTTED TURTLE                | <i>Clemmys guttata</i>              | Testudines | PTC PO     | R         |             | CRE DFE LTT BTR SOU TRA TRS PFT MAR TSE | LTR          |
| WOOD TURTLE                   | <i>Clemmys insculpta</i>            | Testudines | WOC        | R         |             | CRE DFE LTT BTR SOU TRA TRS PFT MAR TSE |              |
| BOG TURTLE                    | <i>Clemmys muhlenbergi</i>          | Testudines | R          | R         | SE          | CRE DFE LTT BTR SOU TRA TRS PFT MAR TSE |              |

## APPENDIX 1. (continued)

| COMMON NAME                | SCIENTIFIC NAME                  | PRO-CITE   | OCCURRENCE | RESIDENCY | LEGAL       | PROTOCOL                                | FIELD TESTED |
|----------------------------|----------------------------------|------------|------------|-----------|-------------|-----------------------------------------|--------------|
|                            |                                  | GROUP NAME | STATUS     | STATUS    | POP. STATUS |                                         | PROTOCOL     |
| MAP TURTLE                 | <i>Graptemys geographica</i>     | Testudines | R          | R         |             | CRE DFE LTT BTR SOU TRA TRS PFT MAR TSE |              |
| EASTERN BOX TURTLE         | <i>Terrapene carolina</i>        | Testudines | PTC PO     | R         |             | RCE CRE DFE LTT SOU TRA TRS PFT MAR TSE | LTT PFT LTR  |
| NORTHERN COAL SKINK        | <i>Eumeces anthracinus</i>       | Lacertilia | WOC        | R         |             | CRE DFE TRS SNR LTT STT PFT MAR TSE     |              |
| FIVE-LINED SKINK           | <i>Eumeces fasciatus</i>         | Lacertilia | WOC        | R         |             | CRE DFE TRS SNR LTT STT PFT MAR TSE     |              |
| WORM SNAKE                 | <i>Carphophis amoenus</i>        | Serpentes  | R          | R         |             | LTT STT TRS PFT MAR TRA TSE RCE AST     |              |
| NORTHERN BLACK RACER       | <i>Coluber constrictor</i>       | Serpentes  | PO         | R         |             | LTT STT TRS PFT MAR TRA TSE RCE AST     |              |
| RINGNECK SNAKE             | <i>Diadophis punctatus</i>       | Serpentes  | PTC WOC    | R         |             | LTT STT TRS PFT MAR TRA TSE RCE AST     | LTR          |
| CORN SNAKE                 | <i>Elaphe guttata</i>            | Serpentes  | R          | R         |             | LTT STT TRS PFT MAR TRA TSE RCE AST     |              |
| BLACK RAT SNAKE            | <i>Elaphe obsoleta</i>           | Serpentes  | PO WOC     | R         |             | LTT STT TRS PFT MAR TRA TSE RCE AST     |              |
| EASTERN HOGNOSE SNAKE      | <i>Heterodon platyrhinos</i>     | Serpentes  | WOC        | R         |             | LTT STT TRS PFT MAR TRA TSE RCE AST     |              |
| EASTERN MILK SNAKE         | <i>Lampropeltis triangulum</i>   | Serpentes  | R          | R         |             | LTT STT TRS PFT MAR TRA TSE RCE AST     |              |
| NORTHERN WATER SNAKE       | <i>Nerodia sipedon</i>           | Serpentes  | PO         | R         |             | LTT TRS PFT MAR SNA TSE                 |              |
| SMOOTH GREEN SNAKE         | <i>Opheodrys vernalis</i>        | Serpentes  | R          | R         |             | LTT STT TRS PFT MAR TRA TSE RCE AST     |              |
| QUEEN SNAKE                | <i>Regina septemvittata</i>      | Serpentes  | R          | R         |             | LTT TRS PFT MAR SNA TSE                 |              |
| BROWN SNAKE                | <i>Storeria dekayi</i>           | Serpentes  | R          | R         |             | LTT STT TRS PFT MAR TRA TSE RCE AST     |              |
| NORTHERN RED-BELLIED SNAKE | <i>Storeria occipitomaculata</i> | Serpentes  | R          | R         |             | LTT STT TRS PFT MAR TRA TSE RCE AST     |              |
| EASTERN RIBBON SNAKE       | <i>Thamnophis sauritus</i>       | Serpentes  | R          | R         |             | LTT STT TRS PFT MAR TRA TSE RCE AST     |              |
| EASTERN GARTER SNAKE       | <i>Thamnophis sirtalis</i>       | Serpentes  | PTC PO     | R         |             | LTT STT TRS PFT MAR TRA TSE RCE AST     | LTR LTT CVB  |
| SMOOTH EARTH SNAKE         | <i>Virginia valeriae</i>         | Serpentes  | R          | R         |             | LTT STT TRS PFT MAR TRA TSE RCE AST     |              |
| NORTHERN COPPERHEAD        | <i>Agkistrodon contortrix</i>    | Serpentes  | WOC        | R         |             | LTT STT TRS PFT MAR TRA TSE RCE AST     |              |
| TIMBER RATTLESNAKE         | <i>Crotalus horridus</i>         | Serpentes  | WOC        | R         |             | LTT STT TRS PFT MAR TRA TSE RCE AST     |              |

Appendix 2. Amphibian and reptilian section of the Faunal Database for Hopewell Furnace National Historic Site through to 30 June 1996.



## APPENDIX 2.

| COMMON NAME                   | SCIENTIFIC NAME                     | PRO-CITE   | OCCURRENCE | RESIDENCY | LEGAL       | PROTOCOL                                | FIELD TESTED    |
|-------------------------------|-------------------------------------|------------|------------|-----------|-------------|-----------------------------------------|-----------------|
|                               |                                     | GROUP NAME | STATUS     | STATUS    | POP. STATUS |                                         | PROTOCOL        |
| HELLBENDER                    | <i>Cryptobranchus alleganiensis</i> | Caudata    | R          | R         |             | TRS LTT MAR CRE TSE NIG                 |                 |
| EASTERN NEWT                  | <i>Notophthalmus viridescens</i>    | Caudata    | PTC        | R         |             | TRS PFT LTT DFE MAR CRE LTR CVB TSE     | LTR             |
| JEFFERSON SALAMANDER          | <i>Ambystoma jeffersonianum</i>     | Caudata    | R          | R         |             | TRS PFT LTT DFE MAR CRE LTR CVB TSE     |                 |
| SPOTTED SALAMANDER            | <i>Ambystoma maculatum</i>          | Caudata    | PTC PO     | R         |             | TRS PFT LTT DFE MAR CRE LTR CVB TSE     | LTR             |
| MARbled SALAMANDER            | <i>Ambystoma opacum</i>             | Caudata    | R          | R         |             | TRS PFT LTT DFE MAR CRE LTR CVB TSE     |                 |
| NORTHERN DUSKY SALAMANDER     | <i>Desmognathus fuscus</i>          | Caudata    | R          | R         |             | TRS PFT LTT DFE MAR CRE LTR CVB TSE     |                 |
| MOUNTAIN DUSKY SALAMANDER     | <i>Desmognathus ochrophaeus</i>     | Caudata    | R          | R         |             | TRS PFT LTT DFE MAR CRE LTR CVB TSE     |                 |
| NORTHERN TWO-LINED SALAMANDER | <i>Eurycea bislineata</i>           | Caudata    | PTC        | R         |             | TRS PFT LTT DFE MAR CRE LTR CVB TSE     | CVB PFT         |
| LONG-TAILED SALAMANDER        | <i>Eurycea longicauda</i>           | Caudata    | R          | R         |             | TRS PFT LTT DFE MAR CRE LTR CVB TSE     |                 |
| NORTHERN SPRING SALAMANDER    | <i>Gyrinophilus porphyriticus</i>   | Caudata    | R          | R         |             | TRS PFT LTT DFE MAR CRE LTR CVB TSE     |                 |
| FOUR-TOED SALAMANDER          | <i>Hemidactylum scutatum</i>        | Caudata    | PTC        | R         |             | TRS PFT LTT DFE MAR CRE LTR CVB TSE     | LTR PFT         |
| RED-BACKED SALAMANDER         | <i>Plethodon cinereus</i>           | Caudata    | PTC PO     | R         |             | TRS PFT LTT DFE MAR CRE LTR CVB TSE     | LTR CVB PFT DFE |
| SLIMY SALAMANDER              | <i>Plethodon glutinosus</i>         | Caudata    | PTC        | R         |             | TRS PFT LTT DFE MAR CRE LTR CVB TSE     | LTR CVB         |
| VALLEY AND RIDGE SALAMANDER   | <i>Plethodon hoffmani</i>           | Caudata    | R          | R         |             | TRS PFT LTT DFE MAR CRE LTR CVB TSE     |                 |
| NORTHERN RED SALAMANDER       | <i>Pseudotriton ruber</i>           | Caudata    | R          | R         |             | TRS PFT LTT DFE MAR CRE LTR CVB TSE     |                 |
| EASTERN SPADEFOOT             | <i>Scaphiopus holbrookii</i>        | Salientia  | R          | R         |             | TRS V&C RCE PFT LTT DFE TSE             |                 |
| BULLFROG                      | <i>Rana catesbeiana</i>             | Salientia  | R          | R         |             | TRS V&C RCE TNE PFT LTT DFE TSE         |                 |
| GREEN FROG                    | <i>Rana clamitans</i>               | Salientia  | PTC PO     | R         |             | TRS V&C RCE TNE PFT LTT DFE TSE         | LTR RCE         |
| NORTHERN LEOPARD FROG         | <i>Rana pipiens</i>                 | Salientia  | PTC        | R         |             | TRS V&C RCE TNE PFT LTT DFE TSE         | LTR             |
| PICKEREL FROG                 | <i>Rana palustris</i>               | Salientia  | PTC PO     | R         |             | TRS V&C RCE TNE PFT LTT DFE TSE         | LTR             |
| WOOD FROG                     | <i>Rana sylvatica</i>               | Salientia  | PTC PO     | R         |             | TRS V&C RCE TNE PFT LTT DFE TSE         | LTR PFT DFE     |
| AMERICAN TOAD                 | <i>Bufo americanus</i>              | Salientia  | PTC PO     | R         |             | TRS V&C RCE TNE PFT LTT DFE TSE         | LTR RCE PFT DFE |
| WOODHOUSE'S TOAD              | <i>Bufo woodhousei</i>              | Salientia  | R          | R         |             | TRS V&C RCE TNE PFT LTT DFE TSE         |                 |
| GRAY TREEFROG                 | <i>Hyla versicolor</i>              | Salientia  | PTC        | R         |             | TRS V&C RCE TNE PFT LTT DFE TSE         | RCE             |
| NORTHERN SPRING PEEPER        | <i>Hyla crucifer</i>                | Salientia  | PTC PO     | R         |             | TRS V&C RCE TNE PFT LTT DFE TSE         | RCE             |
| WESTERN CHORUS FROG           | <i>Pseudacris triseriata</i>        | Salientia  | R          | R         |             | TRS V&C RCE TNE PFT LTT DFE TSE         |                 |
| COMMON SNAPPING TURTLE        | <i>Chelydra serpentina</i>          | Testudines | PO WOC     | R         |             | TRS TRA SOU BTR PFT LTT DFE MAR CRE TSE |                 |
| STINKPOT                      | <i>Sternotherus odoratus</i>        | Testudines | R          | R         |             | TRS TRA SOU BTR PFT LTT DFE MAR CRE TSE |                 |
| PAINTED TURTLE                | <i>Chrysemys picta</i>              | Testudines | PO         | R         |             | TRS TRA SOU BTR PFT LTT DFE MAR CRE TSE |                 |
| SPOTTED TURTLE                | <i>Clemmys guttata</i>              | Testudines | PO         | R         |             | TRS TRA SOU BTR PFT LTT DFE MAR CRE TSE |                 |
| WOOD TURTLE                   | <i>Clemmys insculpta</i>            | Testudines | R          | R         |             | TRS TRA SOU BTR PFT LTT DFE MAR CRE TSE |                 |
| BOG TURTLE                    | <i>Clemmys muhlenbergi</i>          | Testudines | R          | R         | SE          | TRS TRA SOU BTR PFT LTT DFE MAR CRE TSE |                 |

## APPENDIX 2. (continued)

| COMMON NAME                | SCIENTIFIC NAME                  | PRO-CITE   | OCCURRENCE | RESIDENCY | LEGAL       | PROTOCOL                                    | FIELD TESTED    |
|----------------------------|----------------------------------|------------|------------|-----------|-------------|---------------------------------------------|-----------------|
|                            |                                  | GROUP NAME | STATUS     | STATUS    | POP. STATUS |                                             | PROTOCOL        |
| MAP TURTLE                 | <i>Graptemys geographica</i>     | Testudines | R          | R         |             | TRS TRA SOU BTR PFT LTT DFE MAR CRE TSE     |                 |
| EASTERN BOX TURTLE         | <i>Terrapene carolina</i>        | Testudines | PO         | R         |             | TRS TRA SOU PFT LTT DFE MAR CRE TSE RCE     |                 |
| COAL SKINK                 | <i>Eumeces anthracinus</i>       | Lacertilia | R          | R         |             | TRS SNR PFT STT LTT DFE MAR CRE TSE         |                 |
| FIVE-LINED SKINK           | <i>Eumeces fasciatus</i>         | Lacertilia | R          | R         |             | TRS SNR PFT STT LTT DFE MAR CRE TSE         |                 |
| WORM SNAKE                 | <i>Carphophis amoenus</i>        | Serpentes  | R          | R         |             | TRS TRA RCE PFT STT LTT DFE MAR CRE AST TSE |                 |
| NORTHERN BLACK RACER       | <i>Coluber constrictor</i>       | Serpentes  | R          | R         |             | TRS TRA RCE PFT STT LTT DFE MAR CRE AST TSE |                 |
| RING-NECKED SNAKE          | <i>Diadophis punctatus</i>       | Serpentes  | PTC        | R         |             | TRS TRA RCE PFT STT LTT DFE MAR CRE AST TSE | LTR             |
| CORN SNAKE                 | <i>Elaphe guttata</i>            | Serpentes  | R          | R         |             | TRS TRA RCE PFT STT LTT DFE MAR CRE AST TSE |                 |
| BLACK RAT SNAKE            | <i>Elaphe obsoleta</i>           | Serpentes  | PO         | R         |             | TRS TRA RCE PFT STT LTT DFE MAR CRE AST TSE |                 |
| EASTERN HOGNOSE SNAKE      | <i>Heterodon platyrhinos</i>     | Serpentes  | R          | R         |             | TRS TRA RCE PFT STT LTT DFE MAR CRE AST TSE |                 |
| EASTERN MILK SNAKE         | <i>Lampropeltis triangulum</i>   | Serpentes  | R          | R         |             | TRS TRA RCE PFT STT LTT DFE MAR CRE AST TSE |                 |
| NORTHERN WATER SNAKE       | <i>Nerodia sipedon</i>           | Serpentes  | PTC PO     | R         |             | SNR TRS TRA PFT LTT DFE MAR CRE TSE         | LTR             |
| SMOOTH GREEN SNAKE         | <i>Opheodrys vernalis</i>        | Serpentes  | R          | R         |             | TRS TRA RCE PFT STT LTT DFE MAR CRE AST TSE |                 |
| QUEEN SNAKE                | <i>Regina septemvittata</i>      | Serpentes  | R          | R         |             | SNR TRS TRA PFT LTT DFE MAR CRE TSE         |                 |
| BROWN SNAKE                | <i>Storeria dekayi</i>           | Serpentes  | R          | R         |             | TRS TRA RCE PFT STT LTT DFE MAR CRE AST TSE |                 |
| NORTHERN RED-BELLIED SNAKE | <i>Storeria occipitomaculata</i> | Serpentes  | R          | R         |             | TRS TRA RCE PFT STT LTT DFE MAR CRE AST TSE |                 |
| EASTERN RIBBON SNAKE       | <i>Thamnophis sauritus</i>       | Serpentes  | R          | R         |             | TRS TRA RCE PFT STT LTT DFE MAR CRE AST TSE |                 |
| EASTERN GARTER SNAKE       | <i>Thamnophis sirtalis</i>       | Serpentes  | PTC PO WOC | R         |             | TRS TRA RCE PFT STT LTT DFE MAR CRE AST TSE | LTR CVB PFT DFE |
| SMOOTH EARTH SNAKE         | <i>Virginia valeriae</i>         | Serpentes  | R          | R         |             | TRS TRA RCE PFT STT LTT DFE MAR CRE AST TSE |                 |
| NORTHERN COPPERHEAD        | <i>Agkistrodon contortrix</i>    | Serpentes  | R          | R         |             | TRS TRA RCE PFT STT LTT DFE MAR CRE AST TSE |                 |
| TIMBER RATTLESNAKE         | <i>Crotalus horridus</i>         | Serpentes  | R          | R         |             | TRS TRA RCE PFT STT LTT DFE MAR CRE AST TSE |                 |

**Appendix 3. Amphibian and reptilian section of the Faunal Database for Valley Forge National Historical Park through 30 June 1996.**



## APPENDIX 3.

| COMMON NAME                   | SCIENTIFIC NAME                     | PRO-CITE   | OCCURRENCE | RESIDENCY | LEGAL       | PROTOCOL                                | FIELD TESTED |
|-------------------------------|-------------------------------------|------------|------------|-----------|-------------|-----------------------------------------|--------------|
|                               |                                     | GROUP NAME | STATUS     | STATUS    | POP. STATUS |                                         | PROTOCOL     |
| HELLBENDER                    | <i>Cryptobranchus alleganiensis</i> | Caudata    | R          | R         |             | NIG TRS LTT MAR CRE TSE                 |              |
| EASTERN NEWT                  | <i>Notophthalmus viridescens</i>    | Caudata    | R          | R         |             | TRS PFT LTT DFE MAR CRE LTR CVB TSE     |              |
| JEFFERSON SALAMANDER          | <i>Ambystoma jeffersonianum</i>     | Caudata    | R          | R         |             | TRS PFT LTT DFE MAR CRE LTR CVB TSE     |              |
| SPOTTED SALAMANDER            | <i>Ambystoma maculatum</i>          | Caudata    | R          | R         |             | TRS PFT LTT DFE MAR CRE LTR CVB TSE     |              |
| MARbled SALAMANDER            | <i>Ambystoma opacum</i>             | Caudata    | R          | R         |             | TRS PFT LTT DFE MAR CRE LTR CVB TSE     |              |
| NORTHERN DUSKY SALAMANDER     | <i>Desmognathus fuscus</i>          | Caudata    | WOC        | R         |             | TRS PFT LTT DFE MAR CRE LTR CVB TSE     |              |
| MOUNTAIN DUSKY SALAMANDER     | <i>Desmognathus ochrophaeus</i>     | Caudata    | R          | R         |             | TRS PFT LTT DFE MAR CRE LTR CVB TSE     |              |
| NORTHERN TWO-LINED SALAMANDER | <i>Eurycea bislineata</i>           | Caudata    | WOC        | R         |             | TRS PFT LTT DFE MAR CRE LTR CVB TSE     |              |
| LONG-TAILED SALAMANDER        | <i>Eurycea longicauda</i>           | Caudata    | WOC        | R         |             | TRS PFT LTT DFE MAR CRE LTR CVB TSE     |              |
| NORTHERN SPRING SALAMANDER    | <i>Gyrinophilus porphyriticus</i>   | Caudata    | R          | R         |             | TRS PFT LTT DFE MAR CRE LTR CVB TSE     |              |
| FOUR-TOED SALAMANDER          | <i>Hemidactylium scutatum</i>       | Caudata    | R          | R         |             | TRS PFT LTT DFE MAR CRE LTR CVB TSE     |              |
| RED-BACKED SALAMANDER         | <i>Plethodon cinereus</i>           | Caudata    | PTC WOC    | R         |             | TRS PFT LTT DFE MAR CRE LTR CVB TSE     | LTR CVB      |
| SLIMY SALAMANDER              | <i>Plethodon glutinosus</i>         | Caudata    | R          | R         |             | TRS PFT LTT DFE MAR CRE LTR CVB TSE     |              |
| VALLEY AND RIDGE SALAMANDER   | <i>Plethodon hoffmani</i>           | Caudata    | R          | R         |             | TRS PFT LTT DFE MAR CRE LTR CVB TSE     |              |
| NORTHERN RED SALAMANDER       | <i>Pseudotriton ruber</i>           | Caudata    | WOC        | R         |             | TRS PFT LTT DFE MAR CRE LTR CVB TSE     |              |
| EASTERN SPADEFOOT             | <i>Scaphiopus holbrookii</i>        | Salientia  | WOC        | R         |             | TRS V&C RCE PFT LTT DFE TSE             |              |
| BULLFROG                      | <i>Rana catesbeiana</i>             | Salientia  | WOC        | R         |             | TRS V&C RCE TNE PFT LTT DFE TSE         |              |
| GREEN FROG                    | <i>Rana clamitans</i>               | Salientia  | PTC WOC    | R         |             | TRS V&C RCE TNE PFT LTT DFE TSE         | RCE          |
| NORTHERN LEOPARD FROG         | <i>Rana pipiens</i>                 | Salientia  | PTC        | R         |             | TRS V&C RCE TNE PFT LTT DFE TSE         | RCE          |
| PICKEREL FROG                 | <i>Rana palustris</i>               | Salientia  | PTC WOC    | R         |             | TRS V&C RCE TNE PFT LTT DFE TSE         | LTR RCE      |
| WOOD FROG                     | <i>Rana sylvatica</i>               | Salientia  | PTC WOC    | R         |             | TRS V&C RCE TNE PFT LTT DFE TSE         | RCE          |
| EASTERN AMERICAN TOAD         | <i>Bufo americanus</i>              | Salientia  | PTC WOC    | R         |             | TRS V&C RCE TNE PFT LTT DFE TSE         | LTR RCE      |
| WOODHOUSE'S TOAD              | <i>Bufo woodhousei</i>              | Salientia  | WOC        | R         |             | TRS V&C RCE TNE PFT LTT DFE TSE         |              |
| COMMON GRAY TREEFROG          | <i>Hyla versicolor</i>              | Salientia  | PTC WOC    | R         |             | TRS V&C RCE TNE PFT LTT DFE TSE         | RCE          |
| NORTHERN SPRING PEEPER        | <i>Hyla crucifer</i>                | Salientia  | PTC WOC    | R         |             | TRS V&C RCE TNE PFT LTT DFE TSE         | RCE          |
| WESTERN CHORUS FROG           | <i>Pseudacris triseriata</i>        | Salientia  | R          | R         |             | TRS V&C RCE TNE PFT LTT DFE TSE         |              |
| COMMON SNAPPING TURTLE        | <i>Chelydra serpentina</i>          | Testudines | WOC        | R         |             | TRS TRA SOU BTR PFT LTT DFE MAR CRE TSE |              |
| STINKPOT                      | <i>Stemotherus odoratus</i>         | Testudines | R          | R         |             | TRS TRA SOU BTR PFT LTT DFE MAR CRE TSE |              |
| PAINTED TURTLE                | <i>Chrysemys picta</i>              | Testudines | PO WOC     | R         |             | TRS TRA SOU BTR PFT LTT DFE MAR CRE TSE |              |
| SPOTTED TURTLE                | <i>Clemmys guttata</i>              | Testudines | WOC        | R         |             | TRS TRA SOU BTR PFT LTT DFE MAR CRE TSE |              |
| WOOD TURTLE                   | <i>Clemmys insculpta</i>            | Testudines | R          | R         |             | TRS TRA SOU BTR PFT LTT DFE MAR CRE TSE |              |
| BOG TURTLE                    | <i>Clemmys muhlenbergi</i>          | Testudines | R          | R         | SE          | TRS TRA SOU BTR PFT LTT DFE MAR CRE TSE |              |

## APPENDIX 3. (continued)

| COMMON NAME                | SCIENTIFIC NAME                  | PRO-CITE   | OCCURRENCE | RESIDENCY | LEGAL       | PROTOCOL                                    | FIELD TESTED |
|----------------------------|----------------------------------|------------|------------|-----------|-------------|---------------------------------------------|--------------|
|                            |                                  | GROUP NAME | STATUS     | STATUS    | POP. STATUS |                                             | PROTOCOL     |
| MAP TURTLE                 | <i>Graptemys geographica</i>     | Testudines | R          | R         |             | TRS TRA SOU BTR PFT LTT DFE MAR CRE TSE     |              |
| EASTERN BOX TURTLE         | <i>Terrapene carolina</i>        | Testudines | PTC WOC    | R         |             | TRS TRA SOU PFT LTT DFE MAR CRE TSE RCE     | LTR          |
| SLIDER                     | <i>Chrysemys scripta</i>         | Testudines | WOC        | R         |             | TRS TRA SOU BTR PFT LTT DFE MAR CRE TSE     |              |
| REDBELLY TURTLE            | <i>Chrysemys rubriventris</i>    | Testudines | WOC        | R         | SE          | TRS TRA SOU BTR PFT LTT DFE MAR CRE TSE     |              |
| COAL SKINK                 | <i>Eumeces anthracinus</i>       | Lacertilia | R          | R         |             | TRS SNR PFT STT LTT DFE MAR CRE TSE         |              |
| FIVE-LINED SKINK           | <i>Eumeces fasciatus</i>         | Lacertilia | R          | R         |             | TRS SNR PFT STT LTT DFE MAR CRE TSE         |              |
| EASTERN WORM SNAKE         | <i>Carphophis amoenus</i>        | Serpentes  | R          | R         |             | TRS TRA RCE PFT STT LTT DFE MAR CRE AST TSE |              |
| NORTHERN BLACK RACER       | <i>Coluber constrictor</i>       | Serpentes  | R          | R         |             | TRS TRA RCE PFT STT LTT DFE MAR CRE AST TSE |              |
| RINGNECK SNAKE             | <i>Diadophis punctatus</i>       | Serpentes  | WOC        | R         |             | TRS TRA RCE PFT STT LTT DFE MAR CRE AST TSE |              |
| CORN SNAKE                 | <i>Elaphe guttata</i>            | Serpentes  | R          | R         |             | TRS TRA RCE PFT STT LTT DFE MAR CRE AST TSE |              |
| BLACK RAT SNAKE            | <i>Elaphe obsoleta</i>           | Serpentes  | WOC        | R         |             | TRS TRA RCE PFT STT LTT DFE MAR CRE AST TSE |              |
| EASTERN HOGNOSE SNAKE      | <i>Heterodon platyrhinos</i>     | Serpentes  | R          | R         |             | TRS TRA RCE PFT STT LTT DFE MAR CRE AST TSE |              |
| EASTERN MILK SNAKE         | <i>Lampropeltis triangulum</i>   | Serpentes  | PTC WOC    | R         |             | TRS TRA RCE PFT STT LTT DFE MAR CRE AST TSE | LTR          |
| NORTHERN WATER SNAKE       | <i>Nerodia sipedon</i>           | Serpentes  | WOC        | R         |             | SNR TRS TRA PFT LTT DFE MAR CRE TSE         |              |
| SMOOTH GREEN SNAKE         | <i>Ophedrys vernalis</i>         | Serpentes  | R          | R         |             | TRS TRA RCE PFT STT LTT DFE MAR CRE AST TSE |              |
| QUEEN SNAKE                | <i>Regina septemvittata</i>      | Serpentes  | R          | R         |             | SNR TRS TRA PFT LTT DFE MAR CRE TSE         |              |
| NORTHERN BROWN SNAKE       | <i>Storeria dekayi</i>           | Serpentes  | R          | R         |             | TRS TRA RCE PFT STT LTT DFE MAR CRE AST TSE |              |
| NORTHERN RED-BELLIED SNAKE | <i>Storeria occipitomaculata</i> | Serpentes  | R          | R         |             | TRS TRA RCE PFT STT LTT DFE MAR CRE AST TSE |              |
| EASTERN RIBBON SNAKE       | <i>Thamnophis sauritus</i>       | Serpentes  | R          | R         |             | TRS TRA RCE PFT STT LTT DFE MAR CRE AST TSE |              |
| EASTERN GARTER SNAKE       | <i>Thamnophis sirtalis</i>       | Serpentes  | PO WOC     | R         |             | TRS TRA RCE PFT STT LTT DFE MAR CRE AST TSE |              |
| SMOOTH EARTH SNAKE         | <i>Virginia valeriae</i>         | Serpentes  | R          | R         |             | TRS TRA RCE PFT STT LTT DFE MAR CRE AST TSE |              |
| NORTHERN COPPERHEAD        | <i>Agkistrodon contortrix</i>    | Serpentes  | WOC        | R         |             | TRS TRA RCE PFT STT LTT DFE MAR CRE AST TSE |              |
| TIMBER RATTLESNAKE         | <i>Crotalus horridus</i>         | Serpentes  | R          | R         |             | TRS TRA RCE PFT STT LTT DFE MAR CRE AST TSE |              |

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

| <i>Pro-Cite</i> Group | Fauna       |
|-----------------------|-------------|
| Amphibia              |             |
| Caudata               | Salamanders |
| Salientia             | Frogs       |
| Reptilia              |             |
| Testudines            | Turtles     |
| Lacertilia            | Lizards     |
| Serpentes             | Snakes      |



Appendix 5. Codes for sources of documentation used for the occurrence status in the Faunal Database for Gettysburg National Military Park, 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 amphibian and reptilian species in the Faunal Database for Gettysburg National Military Park, 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 amphibian and reptilian species in the Faunal Database for Gettysburg National Military Park, Eisenhower National Historic Site, Hopewell Furnace National Historic Site, Valley Forge National Historical Park (Variable No. 10)

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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

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

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|      |   |                                        |
|------|---|----------------------------------------|
| 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                          |

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## 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" 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.

