

AMPHIBIANS AND REPTILES OF FORT DONELSON NATIONAL BATTLEFIELD,
STEWART COUNTY, TENNESSEE

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ABSTRACT—Fort Donelson National Battlefield is a 234-ha tract of federal land along the Cumberland River in Stewart County, Tennessee. Located on the western edge of the Western Highland Rim, the battlefield is a highly dissected area of ridges and ravines covered mainly by oak-hickory forest. Prior to this study, despite much work in surrounding areas, no information was available on the herpetofauna of this site. The objectives of this study were 1) to inventory the herpetofauna within the battlefield's boundaries and 2) to provide information on the species richness, relative abundance, and habitat selection of these animals. Sampling techniques included cover-board arrays and area searches in randomly selected plots, time-constrained searches along stream stretches, drift fences with pit and funnel traps at a vernal pond, night and day road surveys, and hand capture upon incidental encounters. The study was conducted from January 2004 to August 2005 with 37 species of herpetofauna (17 amphibians and 20 reptiles) documented. This represents 66% of the 56 species considered possible for the area. None of the species found are considered rare, endangered, or of special concern by federal or state authorities.

Survey work identifying herpetofaunal distribution and relative abundance needs to be conducted to determine these species' habitat use and potential management needs. Several studies have focused on the herpetofauna of Land Between the Lakes (LBL) and adjacent areas of the northwestern Highland Rim region of Middle Tennessee and south-central Kentucky (Scott and Snyder, 1968; Scott et al., 1980; Redmond et al., 1982; Van Norman and Scott, 1987; Scott, 1991; Zirkle, 1993; Rozelle and Scott, 1995; Scott et al., 1995; White, 1997; Fitch, 1998; Rozelle, 1999; Scott and Williamson, 1999; Williamson, 2001; Scott et al., 2000; Bufalino and Scott, 2002; and Scott, 2002). Despite the wealth of information on the amphibians and reptiles of the region, no published data were found on the herpetofauna inhabiting Fort Donelson National Battlefield (FODO), located just south and east of LBL. Thus, this study was conducted to provide data on these organisms within the boundaries of FODO.

More specifically, our objective was to provide information on the species richness, relative abundance, and habitat selection of FODO's herpetofauna that will serve to assist land managers as they confront the conservation needs of these animals on the area.

METHODS

Study Area—Fort Donelson is a 234-ha national battlefield (National Park Service, 2003a) located adjacent to and just west of Dover in Stewart County, Tennessee. Fort Donelson is bordered by Lake Barkley (impounded Cumberland River) to the north and can be accessed via US Highway 79, which bisects its southern section (Fig. 1). Fort Donelson is located in the Highland Rim Section, Western Highland Rim Subsection, of the Interior Low Plateau physiographic province (Chester, 1986). The bedrock of FODO is of upper

Mississippian age composed of various slowly soluble cherty limestones (United States Department of Agriculture, 1953). Narrow ridges, hills, ravines, steep slopes, and floodplains provide FODO with diverse habitats and topography (Fig. 1). Also, one vernal pond, one ephemeral pool in a ravine wash, and two permanent streams provide potential living and breeding areas for amphibians. Hickman Creek borders the northwest boundary of FODO as a sizable embayment of Barkley Lake. Indian Creek also takes the form of an embayment along its lower reaches north of US Highway 79, but is a shallow, free-flowing stream with gravel substrate upstream to FODO's southern boundary. Elevations across FODO range from 110 m (360 ft) on the river to 168 m (550 ft) on the ridges (Chester, 1986).

Fort Donelson's vegetation, as defined by Braun (1950), falls within the Mississippian Plateau Section of the western Mesophytic Forest Region that is part of the Deciduous Forest Formation. The forest is dominated by species of oaks (*Quercus* spp.) and hickories (*Carya* spp.) but also includes maples (*Acer* spp.) and elms (*Ulmus* spp.) (Chester, 1986). Most of FODO is covered by deciduous forest with a scattering of open areas including mowed and successional fields, roads and roadsides, parking lots, and a cemetery. At the time of this study, some fields were being restored with native warm-season grasses while others were being mowed for aesthetic value. The forest within FODO is considered secondary forest that developed following logging and agricultural disturbances prior to acquisition by the federal government (Chester and Wallace, 1997).

Sampling Efforts and Techniques—Fort Donelson was visited at least twice monthly, with many visits occurring weekly, especially during periods of peak amphibian and reptile activity. Based on published records and range maps (Redmond and Scott, 1996; Conant and Collins, 1998; and

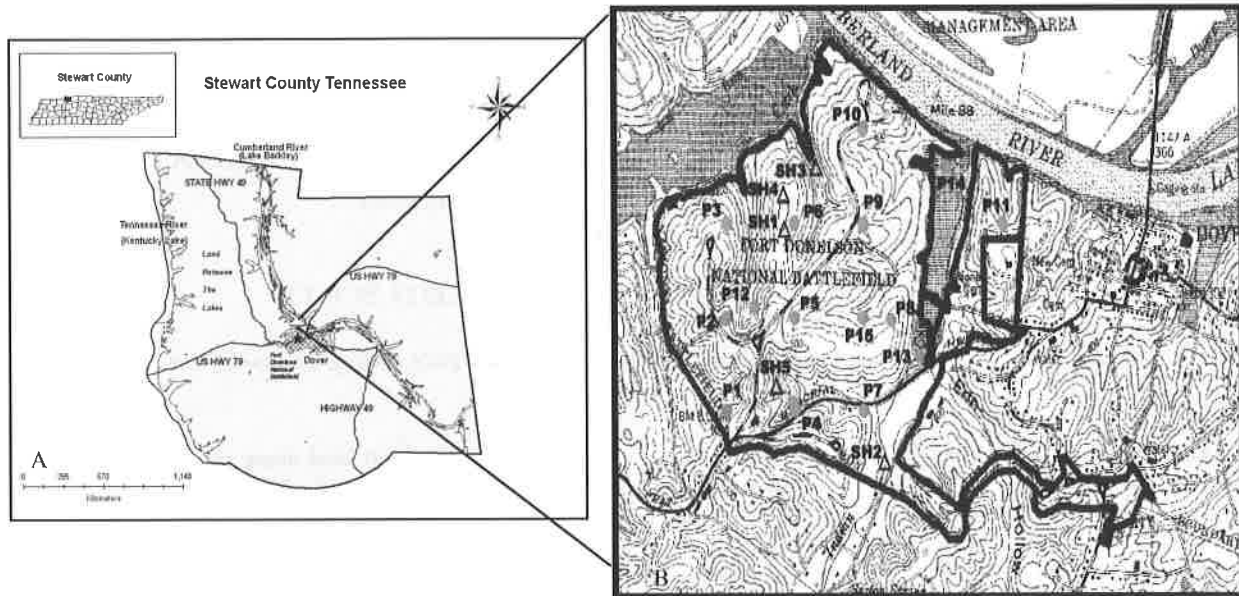


FIG. 1. A) Location of Fort Donelson (star) 1.6 km west of Dover in Stewart County, Tennessee. B) Topographical map of the Dover, Tennessee, area showing the boundary of Fort Donelson National Battlefield (heavy dark line) and locations of 15 random plots (grey dots) and five special habitats (open triangles) identified for use in this study.

others cited in the introduction) and unpublished records in the Austin Peay State University Museum of Zoology database, we expected 24 amphibian and 32 reptile species to potentially occur within FODO's boundaries (list available upon request).

Sampling devices were installed at random plots and special habitats during the fall of 2003. Systematic sampling began in January 2004 and continued through the end of August 2005. Sampling was conducted using several methods aimed at detecting the variety of herpetofauna expected on the area. Fifteen randomly selected 1-ha plots served as the basis for sampling FODO's herpetofauna. These plots were established by NatureServe for use by all researchers involved in inventorying the biodiversity of the battlefield. Twelve of these plots fell within forested habitats across FODO, whereas three were in partially open, successional, or maintained fields. Each 1-ha plot was divided into quadrants by two intersecting transects that terminated at the plot's circumference (National Park Service, 2003b). One transect ran east-west, while the other ran north-south. Ten meters out from the intersection in each direction along each transect, one piece of artificial cover measuring 122 cm \times 122 cm was placed on the ground. The artificial covers placed along one transect were sheets of roofing tin, while along the other transect they were 0.64-cm thick sheets of untreated plywood, varying the artificial cover material that organisms would encounter. Also, along each transect beginning at 12 m from the center of each plot and extending outward to 20 m, subplots measuring 8 m \times 8 m were established and used for area-constrained searches (National Park Service, 2003b).

At the one ephemeral pond (SH1) on FODO, a discontinuous drift fence accompanied by pit and funnel traps was erected. To capture animals moving along each side of the three sections of drift fence, we installed a pair of pit traps (5-L plastic buckets) and two pairs (four total with two on each side of the fence) of wire funnel traps near their center points and a

single terminal pit trap at each of the fence ends. The basic drift-fence followed the design described by Dodd and Scott (1994).

A section of Indian Creek upstream from US Highway 79 (SH2) and a small tributary to Hickman Creek (SH3) were sampled once monthly using the area-constrained search technique (Heyer et al., 1994). Starting at the same point each time, one individual would work upstream for a distance of 100 m searching for amphibians and reptiles under rocks and other cover objects, which were returned to their original positions after overturning.

Road cruising (Shaffer and Juterbock, 1994) along FODO's 3.7 km of roads was conducted both day and night during each of the four seasons in search of living or road-killed specimens. Efforts of this nature during the day involved driving around FODO from random plot to random plot or special habitat during weekly visits; at night road cruising usually occurred during or soon after periods of rain and involved a regular route covering the length of most paved roads on FODO.

Furthermore, a transect of approximately 150 m was established across the long axis of a grass- and herb-dominated field (SH4, Fig. 1B). This transect was established to increase the amount of sampling effort occurring in open areas of FODO (not well represented in the random plots). At 10-m intervals along the transect, pieces of galvanized roofing tin were placed firmly on top of the existing vegetation to provide potential cover for amphibians and reptiles moving in the area. The tin transect was checked biweekly for the presence of animals taking shelter beneath the pieces of roofing tin.

Throughout the sampling period, opportunistic encounters with individual amphibians or reptiles were recorded and used to augment data being accumulated by other sampling methods. Most of these records resulted from fortuitous sightings and hand captures made while walking trails or traversing woods and fields en route to random plots. Searches

TABLE 1. Species of amphibians and reptiles documented from January 2004 through August 2005 at Fort Donelson National Battlefield along with sampling methods (DF = Drift Fence, HS = Haphazard Searches, RC = Road Cruising, RP = Random Plots, SS = Stream Searches, and TT = Tin Transect) detected by and numbers of individuals encountered overall and in each major habitat recognized on the area.

Species	Sampling method(s)	Major habitats				Totals
		Stream or streamside	Pond	Field	Forest	
Salamanders						
<i>Ambystoma maculatum</i> - Spotted Salamander	DF, RC	0	1	0	1	2
<i>Desmognathus conanti</i> - Spotted Dusky Salamander	SS	15	0	0	0	15
<i>Eurycea cirrigera</i> - Southern Two-lined Salamander	SS, RP	7	0	0	0	7
<i>Eurycea lucifuga</i> - Cave Salamander	HS, RP	1	0	1	1	3
<i>Notophthalmus viridescens</i> - Eastern Newt	RC	0	0	1	0	1
<i>Plethodon dorsalis</i> - Northern Zigzag Salamander	DF, HS, RP	0	0	0	74	74
<i>Plethodon glutinosus</i> - Northern Slimy Salamander	DF, RP	0	0	0	39	39
Subtotals		23	1	2	115	141
Frogs or toads						
<i>Acris crepitans</i> - Northern Cricket Frog	HS	2	0	0	0	2
<i>Anaxyrus americanus</i> - American Toad	DF, HS, RC, RP, TT	1	9	0	19	29
<i>Anaxyrus fowleri</i> - Fowler's Toad	ALL	4	21	5	24	54
<i>Hyla versicolor</i> complex - Gray Treefrogs	RC	0	0	0	2	2
<i>Hyla cinerea</i> - Green Treefrog	RC, RP	1	0	1	7	9
<i>Lithobates catesbeianus</i> - American Bullfrog	DF, HS, SS	2	2	0	0	4
<i>Lithobates clamitans</i> - Green Frog	RC	0	0	0	1	1
<i>Lithobates sphenoccephalus</i> - Southern Leopard Frog	DF, HS, RP, SS	5	13	0	3	21
<i>Pseudacris crucifer</i> - Spring Peeper	HS	0	6	0	0	6
<i>Pseudacris feriarum</i> - Upland Chorus Frog	HS	0	8	0	3	11
Subtotals		15	59	6	59	139
Turtles						
<i>Terrapene carolina</i> - Eastern Box Turtle	HS, RC, RP, TT	2	0	3	36	41
<i>Trachemys scripta</i> - Pond Slider	HS, RC, RP	2	0	0	3	5
Subtotals		4	0	3	39	46
Lizards						
<i>Plestiodon fasciatus</i> - Common Five-lined Skink	HS, RP	0	0	1	3	4
<i>Plestiodon laticeps</i> - Broad-headed Skink	DF, RP	0	0	0	2	2
<i>Sceloporus undulatus</i> - Eastern Fence Lizard	DF, HS, RC, RP, TT	0	0	2	7	9
<i>Scincella lateralis</i> - Little Brown Skink	HS, RP	0	0	2	13	15
Subtotals		0	0	5	25	30
Snakes						
<i>Agkistrodon contortrix</i> - Copperhead	RC	0	0	0	1	1
<i>Carphophis amoenus</i> - Eastern Wormsnake	RP, TT	0	0	0	4	4
<i>Coluber constrictor</i> - North American Racer	HS, RC, RP, TT	0	0	9	5	14
<i>Diadophis punctatus</i> - Ring-necked Snake	RP, TT	0	0	5	17	22
<i>Lampropeltis getula</i> - Common Kingsnake	RC, RP, TT	0	0	8	5	13
<i>Lampropeltis triangulum</i> - Milksnake	RC	0	0	0	1	1
<i>Nerodia sipedon</i> - Northern Watersnake	HS, SS	2	0	0	0	2
<i>Opheodrys aestivus</i> - Rough Greensnake	RC	0	0	0	1	1
<i>Pantherophis spiloides</i> - Gray Ratsnake	RC	0	0	0	1	1
<i>Regina septemvittata</i> - Queensnake	SS	1	0	0	0	1
<i>Storeria dekayi</i> - Dekay's Brownsnake	TT	0	0	2	0	2
<i>Storeria occipitomaculata</i> - Red-bellied Snake	TT	0	0	1	0	1
<i>Thamnophis sirtalis</i> - Common Gartersnake	RC, RP	1	0	0	1	2
<i>Virginia valeriae</i> - Smooth Earthsnake	RP, TT	0	0	9	3	12
Subtotals		4	0	34	39	77
Grand Totals for All Species		46	60	50	277	433

TABLE 2. Totals for the numbers of specimens and species detected by each of six sampling methods used during an inventory of amphibians and reptiles at Fort Donelson National Battlefield near Dover, Tennessee, January 2004 through August 2005.

Sampling method	Total no. of individuals found	Total no. of species found	No. of species found only by this method
Random plots	134	20	0
Drift fence	107	9	0
Road cruising	53	17	6
Tin transect	45	11	2
Haphazard searching	41	15	2
Searches along streams	30	9	2

were also conducted at an ephemeral pool (SH5) located along a steep-gradient, intermittent stream behind the FODO Visitor Center (Fig. 1B).

Data Categories and Management—Information recorded upon encountering specimens included species, date, plot or site code, Universal Transverse Mercator (UTM) coordinates, time of day, mass (g), sex (if discernible externally), level of maturity (larva, juvenile, adult), reproductive condition (if evident), body measurements, notes on habitat, and abiotic parameters. UTM coordinates were read with a Garmin GPSIII Plus receiver. Specimens were weighed with Pesola spring scales or an Ohaus CS-2000 balance unit. In the field, data were routinely recorded in a field notebook and on field data sheets. Then, back in the lab, data were digitized using Microsoft Excel (2005) software. Identifications were made using our personal knowledge, as well as keys by Altig (1970) and Powell et al. (1998). Scientific and common names follow those used by Crother (2008). Because no listed species (those on the official Tennessee and/or United States government list of endangered or threatened fauna) were encountered, one to less than five specimens (including several road-killed individuals) of each taxon were collected and processed as voucher specimens. These specimens are housed in Austin Peay State University's David H. Snyder Museum of Zoology (APSU 18056-18125).

Statistical Analysis—To determine if there was a correlation between species richness and survey area size, we performed a Pearson-Product Moment Analysis using data from this and several previous studies in the region (Table 3). These data were log-transformed prior to the analysis to improve linearity and to meet statistical assumptions. A relationship was considered statistically significant at $P \leq 0.05$ (SAS Institute, 2005).

RESULTS

Species Richness, Relative Abundance, and Habitat Selection—Overall, 37 species—17 amphibian and 20 reptile represented by 433 individuals—were encountered (Table 1). Among the amphibians were seven species of salamanders and ten species of frogs and toads. Species numbers for the major groups of reptiles included two turtles, four lizards, and fourteen snakes. The survey methods were successful in detecting 66% of the previously reported regional herpetofauna (Table 2). One survey method, road cruising, proved

useful for revealing some species that other methods did not reveal (Table 2).

Two species, each in the genus *Plethodon*, dominated among the group of seven salamanders encountered. The most abundant salamanders were *P. dorsalis* and *P. glutinosus*, representing 53% and 28%, respectively, of all salamanders observed. All records for each of these species came from forested areas of the battlefield. *Desmognathus conanti* was the most abundant of the three species of salamanders found in or along streams, accounting for 65% (15 of 23) of the stream salamander records.

Among frogs and toads, two species of *Anaxyrus* were encountered most frequently: *A. fowleri* records represented 39% of all anuran encounters; and *A. americanus* accounted for another 21%. Unlike salamanders, anurans were distributed more evenly among habitat types in the FODO but were especially found in association with the ephemeral pond.

Only two species of turtles were documented within the study area. Eighty-nine percent of the turtle records were for *Terrapene carolina*. The remaining turtle encounters (5 of 46) were with *Trachemys scripta* at or near streams bordering or penetrating the battlefield grounds. Four lizard species were encountered, with *Scincella lateralis* representing 50% (15 of 30) of all lizard records. Thirteen of these encounters were in forest habitat and two in field habitat.

Encounters with snakes totaled 77, distributed among 14 species. Only four of these were represented by 10% or greater of all snake encounters. In descending order according to percent of snake records logged, these were *Diadophis punctatus* (29%), *Coluber constrictor* (18%), *Lampropeltis getula* (17%), and *Virginia valeriae* (16%). All but four encounters with snakes occurred in either forest or field habitats.

Species Detected Compared to Those Expected—Sixty-six percent (37 of 56) of the expected species of amphibians and reptiles were documented in this study. This included 71% (17 of 24) of amphibians and 63% (20 of 32) of reptiles on the list. No species among those found within the battlefield's boundaries was on any state or federal list of taxa considered endangered, threatened, or otherwise of conservation concern (Tennessee Department of Environment and Conservation, 2004).

Fort Donelson Herpetofauna Compared to Those of Other Studies in Lower Cumberland Basin—When the numbers of herpetofauna species documented in the present study are

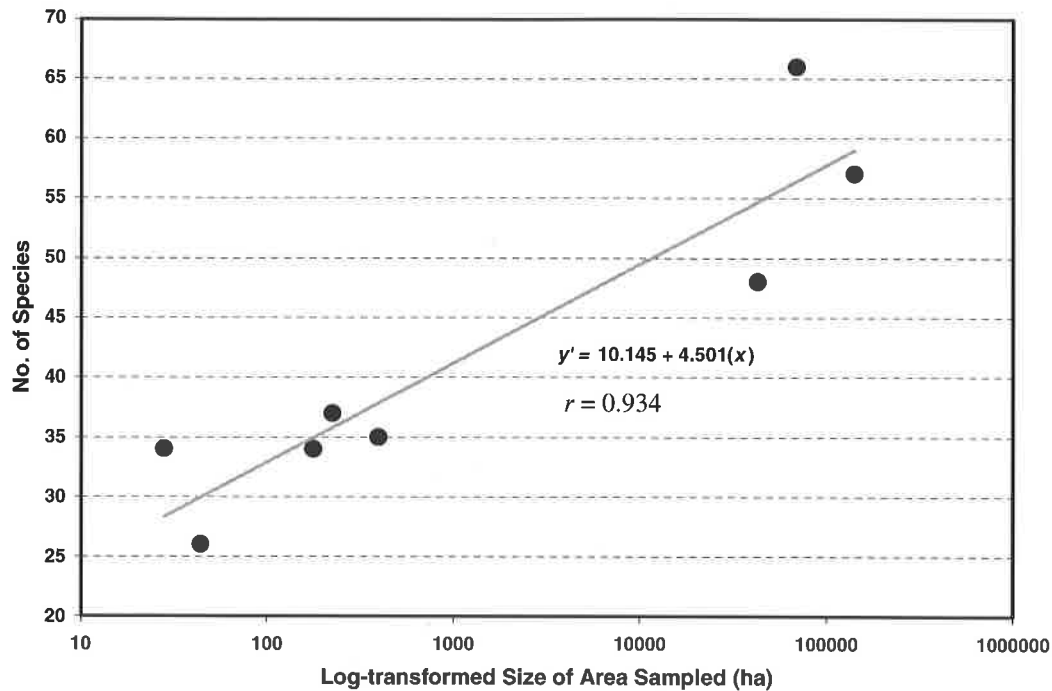


FIG. 2. Relationship between the size of area sampled (after log transformation) and the number of species detected during inventories of the herpetofauna of eight different tracts of land in the lower Cumberland River Basin. See Table 3 for tract names, authors of project reports, and years reports were published or submitted.

plotted against the log-transformed size of the areas surveyed (Fig. 2), a highly significant positive correlation is obtained ($r = 0.934$, $P < 0.01$, $df = 5$).

DISCUSSION

Lack of Habitat and Species Rarity—Only seven of the 12 salamander species (58%) expected on the area were documented. Three of the species not found (*Ambystoma opacum*, *A. texanum*, and *A. tigrinum*) probably owe their absence to the paucity of favorable breeding sites (fishless ponds that contain water at least from mid-winter through early summer) at FODO. The only member of the genus *Ambystoma* to be documented was *A. maculatum*, and it was represented by only

two adults. Two streamside salamanders that were expected but not detected were *Eurycea longicauda* and *Pseudotriton ruber*. Although possibly overlooked, they are described by Petranka (1998) as inhabitants of seepage areas and springs, two aquatic features not associated with the streams in FODO. We found 83% (10 of 12) of the frog and toad species which were expected to occur within the boundary of the battlefield. The two missing species were *Gastrophryne carolinensis* and *Scaphiopus holbrookii*, each recognized as being secretive, burrowing anurans that favor habitats with sandy, gravelly, or other loose soils (Conant and Collins, 1998).

Of the six lizard species expected at FODO, four species were encountered during this study—*Sceloporus undulatus*, *Plestiodon fasciatus*, *P. laticeps*, and *Scincella lateralis*—

TABLE 3. List of areas, including Fort Donelson National Battlefield, in the lower Cumberland drainage basin that have been inventoried for amphibians and reptiles, along with author(s) of each study, date report was filed or published, size or area (ha) surveyed, and number of species documented.

Area inventoried	Study's author(s)	Year of report	Size of area (ha)	No. species documented
Montgomery County	Scott and Snyder	1967	140,634	58
Land Between The Lakes	Snyder	1972	68,799	66
Fort Campbell Military Reservation	Zirkle	1993	42,699	48
Fort Donelson National Battlefield	Davenport and Scott	2005	234	37
Haynes Bottom Wildlife Management Area	Scott and Williamson	1999	393	35
Shelton Ferry Wetland	Rozelle and Scott	1995	176	34
Dunbar Cave State Natural Area	Fitch	1998	44	26
Barnett Woods Natural Area	Scott	1991	28	25

whereas two were not found—*Cnemidophorus sexlineatus* and *Plestiodon inexpectatus*. One of the undocumented lizards (*C. sexlineatus*) was reported by Snyder (1972:51) to be locally abundant in nearby LBL, occurring “in scattered colonies in areas of dry, loose soils with lots of sun,” a habitat not commonly found at FODO. The other species (*P. inexpectatus*) is considered rare in LBL (Scott et al., 1999) and the surrounding region. The most common turtle species encountered was *Terrapene carolina*, a common inhabitant of oak-hickory and other forest associations in eastern North America (Dodd, 2001).

Twenty-one species of non-venomous snakes (Family Colubridae) were expected at FODO, but only 13 (62%) were documented (Table 1). Of the eight species not encountered, one (*Pituophis melanoleucus*) was considered highly likely to occur (mainly because a specimen found dead on US Highway 79 less than 1.6 km west of the battlefield boundary resides in the reptile collection at Austin Peay State University). However, a lack of habitat and scarcity in the region are likely reasons why we failed to document some of the colubrid snakes.

Only one of three species of venomous snake (Family Viperidae) expected for FODO was found during the study. This was *Agkistrodon contortrix*, the species considered by Snyder (1972) to be the most common of the venomous snakes in LBL. Neither *Crotalus horridus* nor *Sistrurus miliarius* was found during the course of this study.

Fort Donelson Herpetofauna Compared to Those of Other Studies in Lower Cumberland Basin—Inventories conducted of the herpetofauna of seven other areas in the lower Cumberland drainage basin yielded species totals ranging from 34 to 66 (Table 3). A highly significant positive correlation is obtained suggesting that as the size of the area increases, the number of species present increases in a corresponding manner. This suggests the results of the present study are in line with other herpetological surveys conducted in the region. Totalling 37 species on an area of 223 ha, our results compare most closely to those obtained during the Haynes Bottom Wildlife Management Area inventory (Scott and Williamson, 1999) in which 35 species were documented on a tract of 393 ha that borders the Cumberland River some 43 km upstream from FODO in southwestern Montgomery County, Tennessee. Herpetofaunal community composition at FODO was not different from the fauna at any other similarly sized areas of the region. The total species richness was different in comparison to one rather large area, Land Between the Lakes (LBL), likely due to the sheer size of that area. LBL covers 68,799 hectares in comparison to 234 hectares at FODO. This substantial increase in study area size increases the likelihood of certain important habitats occurring (*i.e.*, ponds), especially for amphibians. Based on the data obtained from this survey, FODO does not appear to have any species that are not found on other public lands and is not likely to be a reservoir for herpetofaunal species.

Conclusions—During the course of this inventory, January 2004 through August 2005, we found 37 herpetofauna species (17 amphibians and 20 reptiles), representing 66% of the 56 species considered possible for the region. When results from the FODO inventory are compared to other herpetofauna inventories in the region, we find that the species richness is correlated with size of the area surveyed. Specifically, our total of 37 herpetofauna species is similar to totals from areas of

similar size in the region. None of the species found is considered rare, endangered, or of special concern by federal or state authorities.

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