

A SURVEY OF THE HERPETOFAUNA OF
FORT CAMPBELL MILITARY RESERVATION,
KENTUCKY AND TENNESSEE

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A Survey of the Herpetofauna of
Fort Campbell Military Reservation,
Kentucky and Tennessee

An Abstract

Presented to the
Graduate and Research Council of
Austin Peay State University

In Partial Fulfillment
of the Requirements for the Degree
Master of Science

by

Gene A. Zirkle

July 1993

Abstract

Fort Campbell is a 42,669-hectare military reservation on the northwestern Highland Rim in southern Kentucky and northern Tennessee. Despite considerable information from surrounding areas, knowledge of its herpetofauna is essentially nonexistent. Only one documented historical occurrence (an unpublished record of *Cryptobranchus alleganiensis* in Austin Peay State University's Museum of Zoology) of any amphibian or reptile from the reservation was located. To fill this gap in knowledge of the region's biota, a herpetofaunal survey of the reservation (excluding firing ranges, munitions impact areas, and cantonment areas) was conducted from June 1992 through June 1993. All major habitats were sampled each season using standard collecting techniques. Forty-eight species (25 amphibians and 23 reptiles) representing 13 families and 29 genera were encountered. Two state-listed "special concern" taxa, *Hyla gratiosa* and *Ambystoma talpoideum*, were among the amphibians found. No new records of *Cryptobranchus alleganiensis* (listed "special concern" in Tennessee and "category 2" by federal authorities) were obtained. Evidence of intergradation was found in specimens of four species: *Notophthalmus viridescens*, *Agkistrodon contortrix*, *Diadophis punctatus*, and *Elaphe obsoleta*). Results augment existing knowledge of the amphibians and reptiles in the lower Cumberland Basin.

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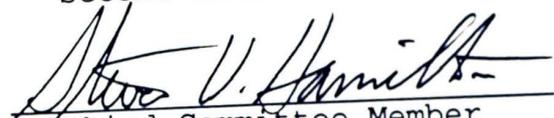
To the Graduate and Research Council:

I am submitting herewith a thesis written by Gene Allen Zirkle entitled "A Survey of the Herpetofauna of Fort Campbell Military Reservation, Kentucky and Tennessee." I have examined the final copy of this paper for form and content, and I recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in biology.


 Major Professor

We have read this thesis and recommend its acceptance:


 Second Committee Member


 Third Committee Member

Accepted for the Graduate and
 Research Council:


 Dean of the Graduate School

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ACKNOWLEDGMENTS

I wish to thank Dr. Arthur Floyd Scott, Department of Biology, Austin Peay State University, for his advice, guidance, and help in identifications. Appreciation is extended to Drs. Edward W. Chester and Steven W. Hamilton, both from the Department of Biology, Austin Peay State University, for their help with the manuscript.

Thanks are also extended to Dr. Cindy Taylor, Department of Biology, Austin Peay State University, for her aid in identifying larval amphibians.

I wish to thank my family for their help in the field and encouragement during the study. Many thanks also are extended for their patience and understanding.

To my fiancée, Patricia L. Mansfield, thanks is extended for her aid in field work and her love, understanding, and support during the study.

Further thanks are extended Charles Rozelle, Carolee Mitchell, and Rhonda Beyke for donating specimens during the study.

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CHAPTER I

INTRODUCTION

Much has been written about amphibians and reptiles in the lower Cumberland River Basin of Kentucky and Tennessee (e.g. Barbour, 1971; Gentry, 1955 and 1956; Meade, 1991; Scott, 1967; Scott and Snyder, 1968; Snyder, 1972; Redmond, 1985; Redmond et al., 1990). However, little of this information is based on data collected from Fort Campbell Military Reservation, a United States Department of Defense installation that constitutes a considerable portion of the region in both states. This is due to the limited access civilians have had to the reservation and the difficulty of obtaining permission to move freely about it. This study was undertaken to fill this gap in the knowledge of amphibians and reptiles in the region.

Goals and Objectives

The goals of this study were to 1) inventory the herpetofauna of Fort Campbell by identifying and sampling all major habitats present during each season of one annual cycle and 2) compare results with those of other studies in the region.

To reach these goals, the following specific objectives were pursued:

- 1) survey the literature for information on the herpetology of southwestern Kentucky and north-central Tennessee;
- 2) survey Fort Campbell Military Reservation to

- identify and describe major habitats present;
- 3) sample selected examples of major habitats during all seasons of one annual cycle for species present and microhabitats being utilized;
 - 4) analyze results for differences in species richness (total number of species present) between various habitats sampled and changes in species richness from season to season within habitats;
 - 5) evaluate specimens of selected species for evidence of intergradation.

Literature Review

Several general studies concerning amphibians and reptiles in the physiographic region (Western Highland Rim) that includes Fort Campbell Military Reservation have appeared since the late 1950s. These vary in scope from state-wide to local and emphasize surveys, habitat usage, and geographic distribution. Gentry (1955-1956) published separate annotated checklists of amphibians and reptiles of Tennessee. Redmond (1985) expanded on Gentry's (1955) data and analyzed quantitatively the biogeography of Tennessee's amphibian fauna. Barbour (1971) described, illustrated, and provided range maps of Kentucky's herpetofauna. Meade (1991) updated Barbour's (1971) information on Kentucky's snakes. Scott (1967) and Scott and Snyder (1968) discussed the herpetofauna of Montgomery County, Tennessee. Snyder (1972) surveyed the herpetofauna of The Tennessee Valley

Authority's Land Between The Lakes, the area between the impounded lower reaches of the Tennessee and Cumberland rivers in Stewart County, Tennessee, and Trigg and Lyon counties, Kentucky. Scott (1991) surveyed the herpetofauna of Barnett Woods Natural Area, an oak-hickory forest in Montgomery County, Tennessee, owned by the Nature Conservancy. Redmond et al. (1990) contributed an annotated checklist and bibliography of Tennessee's herpetofauna which was an update of earlier state works (Gentry, 1955-56; Redmond, 1985), plus the first comprehensive listing of the state's herpetological literature.

Other relevant publications deal with the taxonomy and/or distributions of one or a few species in the vicinity of Fort Campbell. For Kentucky, these include the works of Barbour (1950) on *Carphophis amoenus*, Snyder et al. (1967) on *Sistrurus miliaris*, Barbour and Ernst (1971) on the genus *Eumeces*, Barbour and Hays (1957) on the genus *Desmognathus*, Monroe and Taylor (1972) and Monroe and Giannini (1977) on *Hyla gratiosa*, and Scott et al. (1984) on a unique amphibian community in Caldwell County. For Tennessee, these include papers concerning *Hyla gratiosa* (Scott and Harker, 1968; VanNorman and Scott, 1987; VanNorman, 1985), *Ambystoma talpoideum* (Scott et al., 1981), and *Regina septemvittata* (Scott and Zirkle, 1992). Papers including parts of both states are those of Scott (1990) on federal and state listed species of amphibians and reptiles in Land Between The

Lakes, Ernst (1970) on intergradation in *Chrysemys picta*,
Williams (1978) on the systematics and natural history of
Lampropeltis triangulum, and Burkett (1991) on ecological
comparisons of some closely related species of amphibians in
Land Between The Lakes and the mid-south.

CHAPTER II

DESCRIPTION OF THE STUDY AREA

Location and Size

Fort Campbell Military Reservation (referred to hereafter as Fort Campbell or "the reservation") is a 42,669-hectare (105,434-acre) U.S. Department of Defense installation in northwestern middle Tennessee and southwestern Kentucky (Hart, 1978) (Figure 1). The reservation includes parts of Montgomery and Stewart counties in Tennessee, and Christian and Trigg counties in Kentucky. The majority of the reservation (67%) is in Tennessee. Approximately 7700 hectares (19,000 acres) are designated small arms and artillery impact areas and are off-limits. Over 4600 hectares (11,400-acres) are devoted to cantonment areas, schools, shopping areas, and recreation areas. Neither the impact areas, cantonment and related areas, nor other such areas as the airport and heliport were sampled during the study.

History

Fort Campbell was established in early 1942 through government land acquisition procedures (Hart, 1978; Jonas, 1973). Prior to government acquisition, land use was primarily agricultural (mostly tobacco) (Jonas, 1973). Land incorporated into the reservation was some of the richest farmland in lower Kentucky and upper Tennessee (Jonas, 1973). The uplands had been indiscriminately cleared for farming or grazing, but hardwood stands still remained

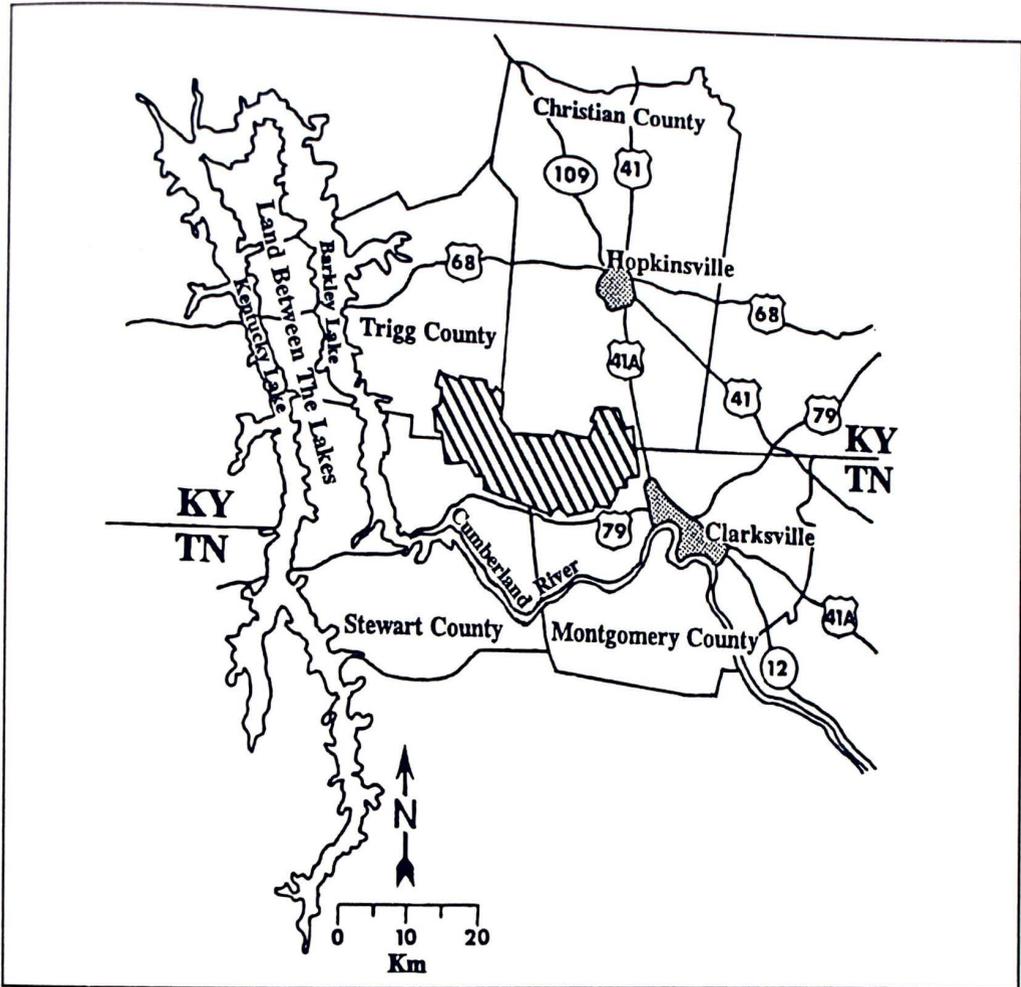


Figure 1. Location of Fort Campbell Military Reservation (hatched area) in relation to major streams, highways, and political boundaries in the surrounding area.

throughout the area (Jonas, 1973). Following establishment of Fort Campbell, some areas were heavily impacted by development of the cantonment and related areas. Most of the rear area training zones have been and continue to be impacted by military exercises.

Physiography and Topography

The reservation includes parts of two subsections of the Highland Rim Section of the Interior Low Plateaus physiographic province as defined by Quarterman and Powell (1978). The extreme western portion (Figure 1) is part of the Western Highland Rim, while the rest of the reservation is part of the Pennyroyal Plain. The entire reservation is characterized by karst terrain (Fenneman, 1938; Quarterman and Powell, 1978); portions on the Pennyroyal Plain are often referred to as "sinkhole plains" due to the numerous sinkholes and sinking streams (Quarterman and Powell, 1978). The Western Highland Rim portion contains ridges and valleys with moderate slopes and lacks the numerous sinkholes commonly found on the Pennyroyal Plain (Quarterman and Powell, 1978).

Geology

The reservation is underlain by Fort Payne Chert and a variety of limestones, all of Mississippian age (Hardeman, 1966; Quarterman and Powell, 1978). Ste. Genevieve limestone, accompanied by sinkholes and frequently inundated depressions, predominates in the Pennyroyal Plain (Hardeman,

1966). St. Louis and Warsaw limestones are common to both physiographic subsections in the areas where sinking streams occur (Quarterman and Powell, 1978). Fort Payne Chert is localized along the ridgetops and moderate slopes within the Western Highland Rim subsection (USDA, 1953). Distinct areas of limestone outcrops are found within the Pennyroyal Plain subsection in Christian and Montgomery counties.

Hydrology

Numerous intermittent and permanent streams, all part of the Cumberland River drainage, meander through the reservation (USDA, 1975). Surface streams often flow into sinkholes, underground channels, and sinking streams; seeps often appear along stream beds and limestone outcrops. Two small impoundments (Lake Kyle, Stewart County, and Lake Taal, Montgomery County), each containing more than one hectare in surface area, are present, as are numerous small ponds, marshy lowlands, and beaver swamps.

Soils

Soil associations on the reservation include Pembroke-Crider, Nicholson, and Dickson-Mountview (USDA, 1975, 1980). Pembroke-Crider soils are found in areas identified as barrens on the eastern side of the reservation (USDA, 1980). Nicholson soils are found on ridges, plateaus, and slopes adjacent to streams (USDA, 1975). Dickson-Mountview soils are found mostly on gently rolling plains; the majority of the reservation contains this association. Several series

(Dickson-Guthrie, Hammack-Baxter-Nicholson, Nicholson-Hammack, Baxter-Hammack-Brandon, Lax-Brandon, and Bewleyville silt loam) are found throughout the upland plains of the reservation (USDA, 1953; USDA, 1981). All series are associated with hardwood forests.

Vegetation

The reservation is part of the Western Mesophytic Forest Region of Braun (1950). This ecotonal region includes a variety of forest community types, depending upon specific site conditions. However, all are oak dominated except on the most mesic slopes where such mesophytes as beech (*Fagus grandifolia*), sugar maple (*Acer saccharum*), and tulip popular (*Liriodendron tulipifera*) become important. The region also includes barrens, upland wet woods, and alluvial forests (see Duncan and Ellis, 1969; Chester and Ellis, 1989; Chester, 1988; Deslem, 1988 for discussions of floristic and vegetational patterns). All of these features occur at the reservation, but farming operations prior to 1940, and military usage since then, have impacted all natural communities severely. In addition, there are extensive plantations of loblolly pine (*P. taeda*) and black walnut (*Juglans nigra*).

Climate

The climate of Fort Campbell is warm and temperate (USDA, 1975). Based on climatological data taken over a 37-year period (1950-1987) at Campbell Army Air Base, the

average temperature for July (hottest month), is 30.8°C , and the average for January (coldest month) is 6°C . Average yearly precipitation is 118 centimeters.

CHAPTER III

MATERIALS AND METHODS

A survey of the literature and perusal of Austin Peay State University's herpetological collection was conducted to locate published and unpublished records and/or specimens from the reservation. Field surveys involving all parts of the reservation (except areas previously noted) were carried out from June 1992 to June 1993 (Figure 2). Overall, 69 collecting trips (43 in 1992; 26 in 1993) were logged.

Habitat Survey

During June and July 1992, a reservation-wide survey was conducted to qualitatively delimit the major habitats present. The resulting classification was based on several factors, including vegetation, physiography, topography, and hydrology.

Data Collection

Information on amphibian and reptile species composition, relative abundance, distribution, and habitat use was collected by several methods. After locating and delimiting the habitats on the base, seasonal collecting trips to each major habitat within each training area were conducted. Various methods were employed to capture specimens. In terrestrial habitats collecting involved: 1) cruising roads at night, especially during or just after periods of rain, 2) installation of drift fences and pit traps at selected sites along ridge lines and around wetlands, and 3) intensive daytime searches during which

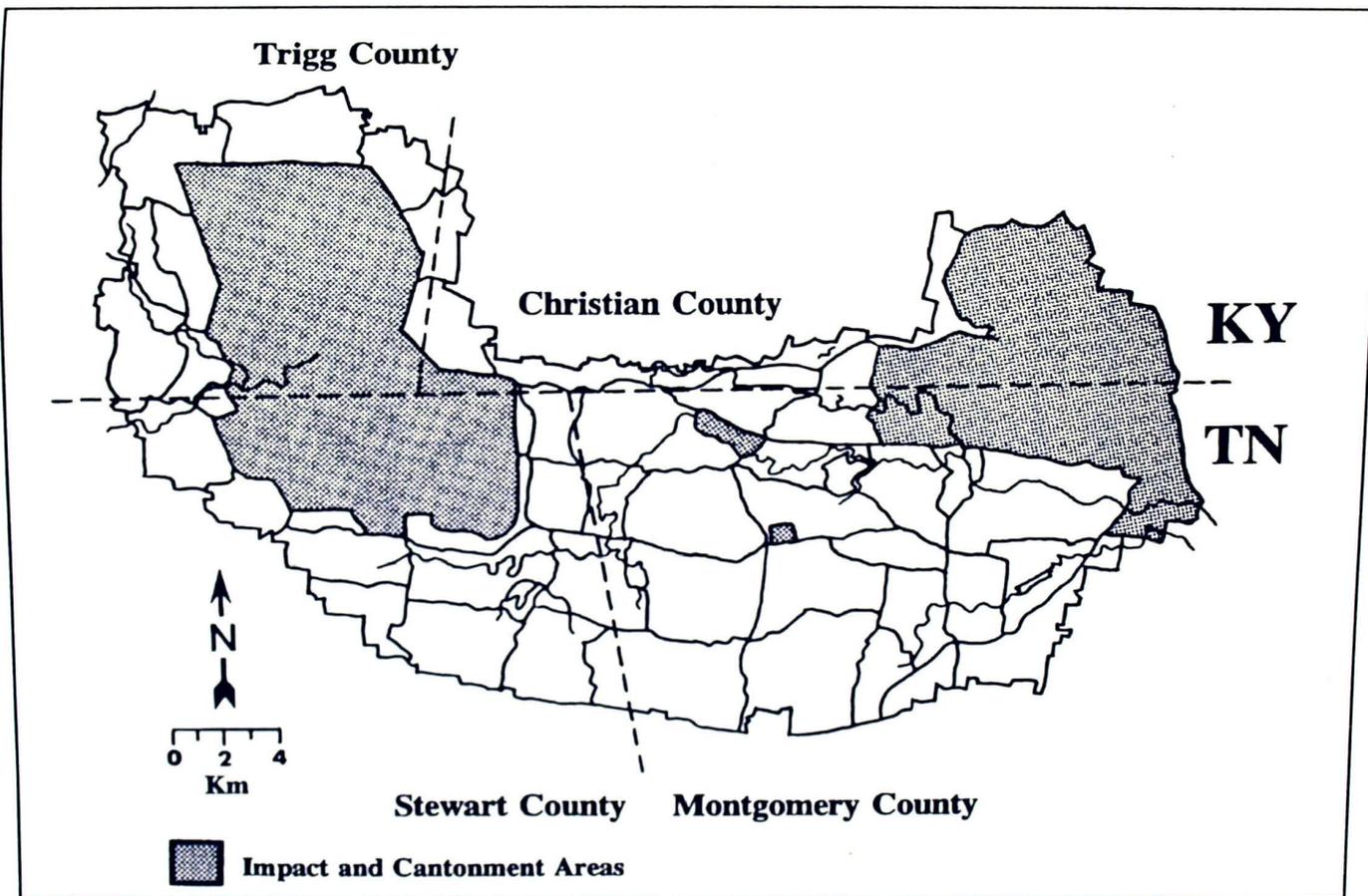


Figure 2. Fort Campbell Military Reservation showing political boundaries, roads, streams, and areas not sampled (shaded) during this study.

logs, rocks, and other likely types of cover were overturned in quest for specimens. Aquatic habitats were sampled with minnow traps, dip nets, hoop traps, and seines. Most captured animals were released where found, following recording of data. However, a few individuals of each species were prepared as vouchers.

Preparation of Voucher Specimens

Preparation and preservation of voucher specimens generally followed the recommendations published by Pisani (1973), with these exceptions: 1) amphibians were immersed in 55% ethanol until dead, 2) larval amphibians were killed in 10% formalin, and, 3) reptiles were killed by freezing. Voucher specimens were added to Austin Peay State University's herpetology collection (APSU 5073 to 5278).

Identification and Nomenclature

Identifications were made from keys by Altig (1970), Brandon (1961), Conant and Collins (1991), and Wright and Wright (1949). Scientific and vernacular names follow those by Collins (1990).

Record Keeping

Field data recorded for each collection or observation included: 1) species, 2) location, 3) date, 4) time of day, 5) general weather conditions, 6) air or water temperature, 7) number of individuals, 8) habitat types (macrohabitat and microhabitat), and 9) remarks on behavior. Data collected were transcribed to a computer file managed by Quatro Pro

Spreadsheet (1989). A copy of the field notes and catalog of voucher specimens were deposited in the Austin Peay State University Museum of Zoology for future reference.

CHAPTER IV

RESULTS AND DISCUSSION

Forty-nine species of herptiles were recorded from the reservation (Table 1). These included 26 species of amphibians (14 salamanders and 12 frogs and toads) representing 8 families and 13 genera, and 23 species of reptiles (4 turtles, 4 lizards, and 15 snakes) representing 7 families and 17 genera. All were species previously reported from the Western Highland Rim (Scott, 1967; Snyder, 1972).

Seven habitat types were identified and categorized into three main groups: woodlands, non-forested areas, and wetlands (Table 1). All are described in Appendix A.

Amphibians

Seasonal abundance of amphibian species is shown in Figure 3. Amphibians were most prevalent in spring, followed in descending order by summer, winter, and fall. This seasonal abundance pattern holds for salamanders, but frogs were most prevalent in summer, closely followed by spring, then off substantially in fall; their low point was in winter.

Plethodon dorsalis and *Ambystoma maculatum* were the most abundant woodland salamanders encountered. Both were found in a wide array of habitats (e.g. deciduous forest, mixed deciduous forest, lowland woods, old fields, barrens, permanent streams, ponds) throughout the year, although *Ambystoma maculatum* occurred predominantly in

Table 1. Amphibians and reptiles recorded from Fort Campbell Military Reservation, Kentucky and Tennessee, between 1 June 1992 and 30 June 1993, listed by major groups and habitats. (DF=deciduous forest, PP=pine plantation, SF=successional fields and barrens, MF=maintained fields, S=stream, S/M=swamp and marsh, SI=small impoundments, and P=ponds).

Major Group Species/subspecies	Habitat Types							
	DF	PP	SF	MF	S	S/M	SI	P
Salamanders								
<i>Cryptobranchus a. alleganiensis</i>					X			
<i>Notophthalmus viridescens</i>	X				X	X		X
<i>Ambystoma maculatum</i>	X		X					X
<i>Ambystoma opacum</i>	X		X					
<i>Ambystoma talpoideum</i>	X	X						X
<i>Ambystoma texanum</i>	X							
<i>Ambystoma tigrinum tigrinum</i>	X							X
<i>Desmognathus fuscus conanti</i>						X		
<i>Eurycea cirrigera</i>						X		
<i>Eurycea longicauda longicauda</i>	X					X		
<i>Eurycea lucifuga</i>	X		X	X	X			
<i>Plethodon glutinosus</i>	X							
<i>Plethodon dorsalis dorsalis</i>	X	X				X		
<i>Pseudotriton ruber vioscai</i>	X							
Frogs and Toads								
<i>Bufo americanus americanus</i>	X	X	X	X	X	X		
<i>Bufo woodhousii fowleri</i>	X		X	X	X			X
<i>Acris crepitans blanchardi</i>	X	X	X		X	X	X	
<i>Hyla chrysoscelis</i>	X	X	X					
<i>Hyla gratiosa</i>	X					X		
<i>Pseudacris crucifer crucifer</i>	X		X	X		X		
<i>Pseudacris feriarum</i>	X		X	X		X		
<i>Gastrophryne carolinensis</i>	X	X	X			X	X	X
<i>Rana catesbeiana</i>	X							X
<i>Rana clamitans</i>	X							
<i>Rana palustris</i>	X	X	X	X	X	X	X	X
<i>Rana utricularia</i>								
Turtles								
<i>Chelydra serpentina serpentina</i>						X	X	X
<i>Sternotherus odoratus</i>						X	X	X
<i>Terrepene carolina carolina</i>	X	X	X	X		X	X	X
<i>Trachemys scripta elegans</i>								
Lizards								
<i>Eumeces faciatus</i>	X					X		
<i>Eumeces laticeps</i>	X							
<i>Sceloporus undulatus hyacinthinus</i>	X	X	X	X				
<i>Scincella lateralis</i>	X							

Table 1 (con't).

Major Groups Species\subspecies	Habitat Types							
	DF	PP	SF	MF	S	S/M	SI	P
Snakes								
<i>Agkistrodon contortrix</i>	X				X	X		
<i>Carphophis amoenus helenae</i>	X							
<i>Coluber constrictor priapus</i>	X		X	X	X			
<i>Diadophis punctatus edwardsi</i>	X							
<i>Diadophis punctatus</i>	X				X	X		
<i>Elaphe obsoleta</i>	X	X		X				
<i>Heterodon platirhinos</i>	X							
<i>Lampropeltis c. calligaster</i>	X		X					
<i>Lampropeltis getula nigra</i>	X	X	X					
<i>Lampropeltis t. triangulum</i>	X			X				
<i>Nerodia sipedon pleuralis</i>					X	X	X	
<i>Opheodrys aestivus</i>	X	X						
<i>Storeria dekayi wrightorum</i>	X		X					
<i>Storeria o. occipitomaculata</i>	X	X						
<i>Thamnophis sirtalis sirtalis</i>	X			X				X

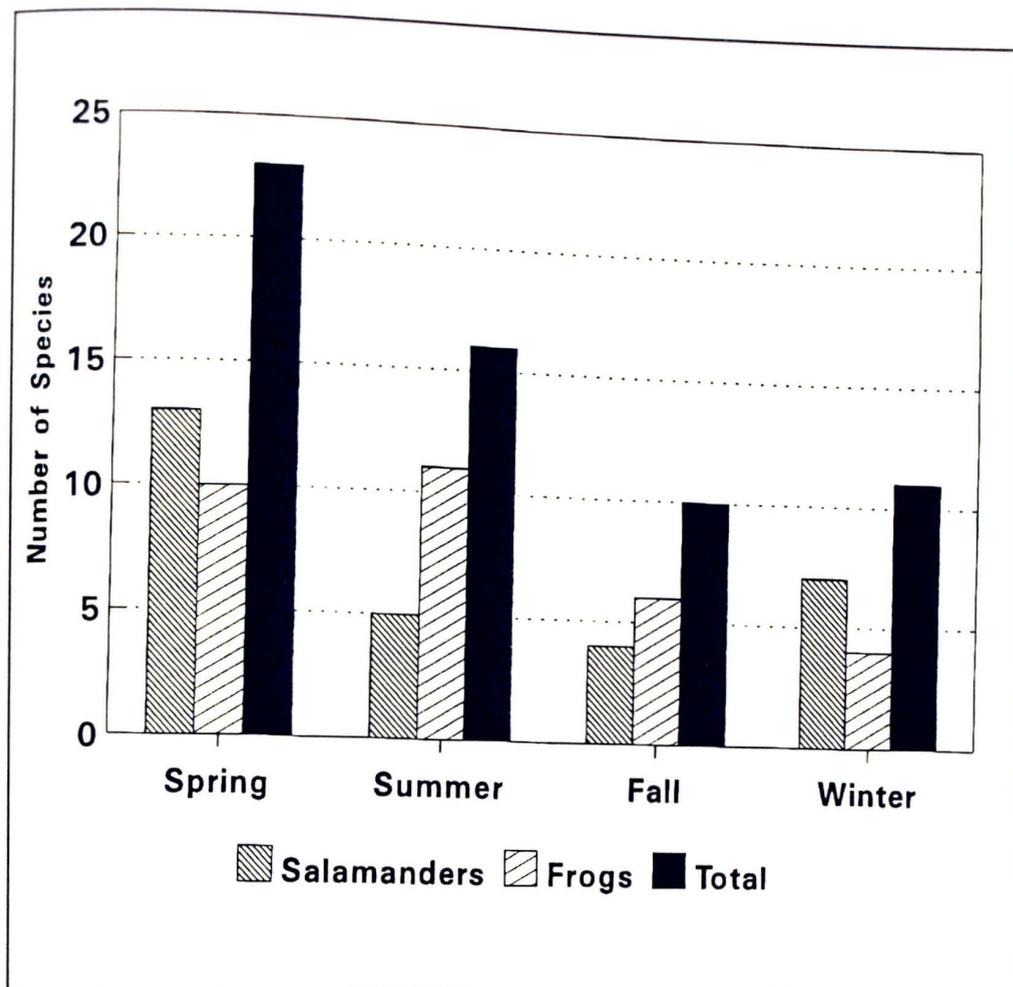


Figure 3. Seasonal abundance of amphibian species recorded from Fort Campbell Military Reservation, Kentucky and Tennessee, between 1 June 1992 and 30 June 1993.

wetland habitats during the early months of the year.

Desmognathus fuscus, *Eurycea cirrigera*, *E. longicauda*, and *E. lucifuga* were the most common streamside salamanders encountered. All were encountered every season.

Twelve taxa of frogs were encountered. Of these, eight (*Bufo americanus americanus*, *B. woodhousii fowleri*, *Gastrophryne carolinensis*, *Pseudacris crucifer*, *P. feriarum*, *Hyla chrysoscelis*, *Rana catesbeiana*, and *R. u. utricularia*) ranged throughout the reservation.

Both species of *Bufo* and *G. carolinensis* were abundant during the spring, summer, and fall, but were rare in winter. *Bufo americanus* and *B. woodhousii fowleri* were recorded from every upland habitat type and selected wetland habitats. *Gastrophryne carolinensis* was recorded from numerous field habitats and on occasion within successional/forested areas. All hylid taxa were recorded from deciduous and wetland areas throughout the spring and summer months. Ranid taxa were most abundant during the summer and fall, although records of spring observations were numerous. All frogs were found within a variety of habitat types and all occurred close to water.

Reptiles

Seasonal abundance of reptile species is shown in Figure 4. Combined, they were most prevalent in summer, followed by spring, then fall and winter when numbers were equal and lowest. Snakes were most abundant in summer,

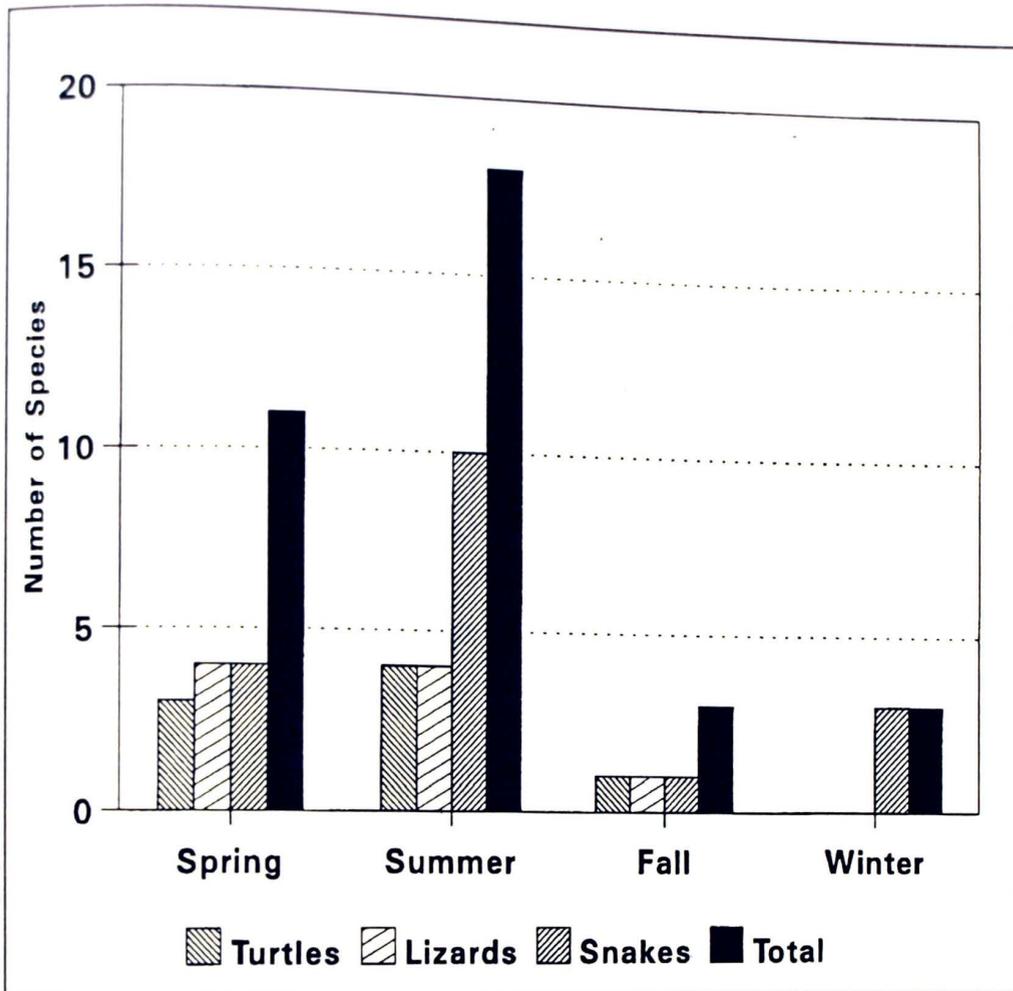


Figure 4. Seasonal abundance of reptile species recorded from Fort Campbell Military Reservation, Kentucky and Tennessee, between 1 June 1992 and 30 June 1993.

followed in descending order by spring, winter, and fall; turtles were prevalent in summer, closely followed by spring, fall, and lacking in winter; lizards were equally numerous in spring and summer, followed by fall, and absent in winter.

Four turtle species were recorded. *Terrepenne c. carolina* was widely distributed in terrestrial habitats and was found in all upland forested and field habitats during summer and fall. *Trachemys scripta elegans* was found in all permanent aquatic habitats (swamps, streams, small impoundments). *Sternotherus odoratus* and *Chelydra s. serpentina* were recorded in stream and swamp habitats in Montgomery and Stewart counties.

Four lizard species were recorded. All were common in upland deciduous forest, but less abundant in pine plantations. Of the four, *Sceloporus undulatus hyacinthinus* was seen most frequently.

Snakes exhibited the greatest species richness (12 species) among reptiles. *Agkistrodon contortrix*, *Coluber constrictor priapus*, *Elaphe obsoleta*, and *Nerodia sipedon pleuralis* were the most common species encountered.

Species Richness Among Habitats

Species richness varied for both amphibians and reptiles in each habitat type (Figures 5 and 6). Amphibian richness was highest (23 taxa) in the deciduous forest habitat and lowest (3 taxa) in small impoundments. Reptile

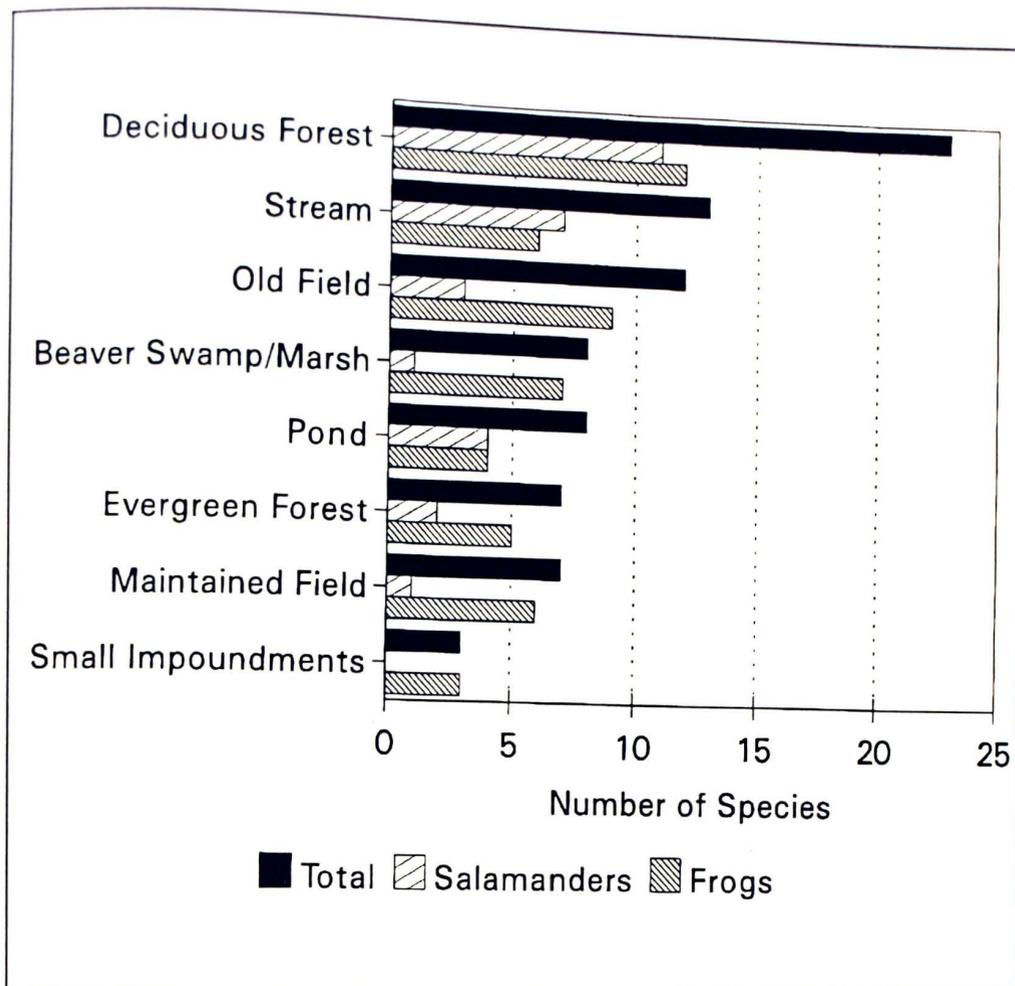


Figure 5. Amphibian species richness per habitat at Fort Campbell Military Reservation, Kentucky and Tennessee, between 1 June 1992 and 30 June 1993.

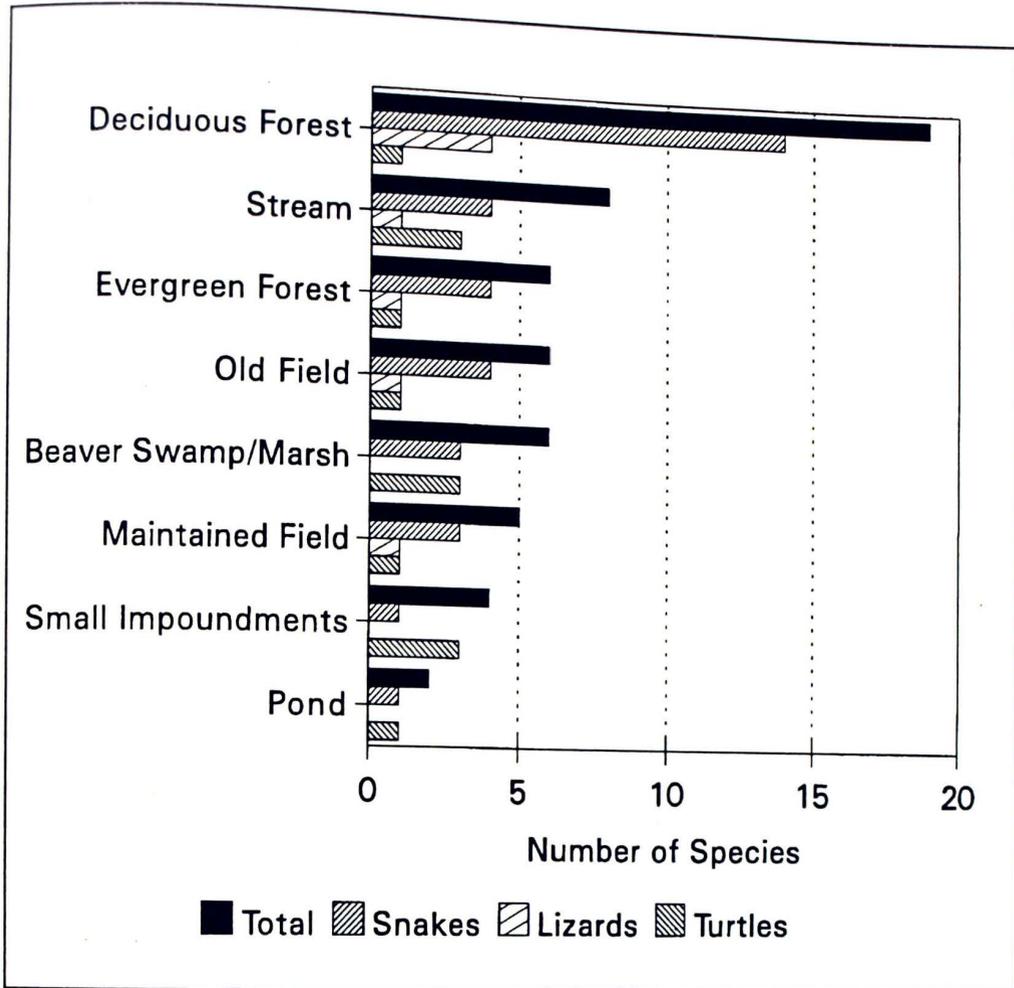


Figure 6. Reptile species richness per habitat at Fort Campbell Military Reservation, Kentucky and Tennessee, between 1 June 1992 and 30 June 1993.

richness paralleled that of amphibians with the deciduous forest habitat supporting the highest number of taxa (19). Ponds yielded the fewest reptile taxa with two.

The eight habitat types identified on the reservation were used differently by the resident amphibians and reptiles. Amphibians used upland woodland habitats more in summer and wetland habitats in late winter and spring. This is because many amphibians utilize wetland areas during winter for breeding and occupy surrounding habitats the rest of the year. Reptiles were common in woodland habitats in both spring and summer, and appeared to prefer deciduous over evergreen forests. The data may not show the true habitat utilization of reptiles, as it does for amphibians, due to their ability to move farther away from a water source. More studies are needed to clearly define reptilian habitat utilization on the reservation.

Intergradation

Evidence of intergradation was seen in four species: *Notophthalmus viridescens*, *Agkistrodon contortrix*, *Diadophis punctatus*, and *Elaphe obsoleta*. This is based on comparisons of published descriptions (Blanchard, 1942; Mecham, 1967; Barbour, 1971; Ernst and Barbour, 1989; Gloyd and Conant, 1990; Mount, 1975; Meade, 1991) of the subspecies involved with specimens from the reservation.

Twelve specimens of *Notophthalmus viridescens* were examined; all exhibited characteristics of both *N. v.*

viridescens and *N. v. louisianensis* (Table 2). All had small black spots (instead of flecks) on their venters, but, regarding encirclement of lateral red spots and demarcation between dorsal and ventral colors, most were like *N. v. louisianensis*. Page and Scott (1990) described *Notophthalmus viridescens* populations from Land Between The Lakes as intergrades between *N. v. viridescens* and *N. v. louisianensis*.

Five *A. contortrix* were examined; all were intermediate in physical appearance between *A. c. mokasen* and *A. c. contortrix* (Table 3). Typical *A. c. contortrix* characteristics were present in all specimens, but *A. c. mokasen* characteristics were dominant. Three (60%) had the darker coloration, but all showed the dumbbell pattern characteristic of *A. c. mokasen*. Conant and Collins (1991) depict *Agkistrodon contortrix mokasen* as the copperhead inhabiting the Fort Campbell area with no range overlap of *A. c. contortrix*. However, all examined specimens revealed characteristics of both subspecies, although more *A. c. mokasen* influence was present.

Specimens (N=8) of *Diadophis punctatus* exhibited a blending of characteristics typical of *D. p. edwardsi* and *D. p. stictogenys* (Table 4). Ranges of dorsal and ventral scale counts fell within those given for *D. p. edwardsii* but exceeded slightly those for *D. p. stictogenys*. Upper labial scale counts were split among the two subspecies with 63%

Table 2. Nature of selected physical characteristics exhibited by specimens (N=12) of *Notophthalmus viridescens* from Fort Campbell, Kentucky and Tennessee, and of the subspecies *N. v. viridescens* and *N. v. louisianensis* as given by Meacham (1967).

<i>N. v. viridescens</i>	<i>N. v. louisianensis</i>	Fort Campbell Specimens
TL = 72-112mm	TL = 65-100mm	TL = 67-121mm
SVL = 33-51mm	SVL = 31-48mm	SVL = 32-55mm
Venter with small black spots	Venter with fine black specks	All with small black spots on venter
Red spots completely ringed with black	Red spots incompletely ringed with black	1 with completely ringed red spots, 8 with incompletely ringed red spots, 1 with both types of spots, 2 without spot rings
No clear demarcation between dorsal and ventral coloration	Clear demarcation between dorsal and ventral coloration	10 with clear demarcation, 2 without clear demarcation

Table 3. Nature of selected characteristics exhibited by specimens (N=5) of *Agkistrodon contortrix* from Fort Campbell, Kentucky and Tennessee, and of the subspecies *A. c. contortrix* and *A. c. mokasen* as given by Gloyd and Conant (1990).

<i>A. c. contortrix</i>	<i>A. c. mokasen</i>	Fort Campbell Specimens
Ventrals=139-156	Ventrals=141-157	Ventrals=147-168
Caudals=37-51	Caudals=38-52	Caudals=47-49
Pale dorsal color (pale tan to pinkish tan)	Dark dorsal color (brown, tan, or russet)	3 with dark color, 2 with pale color
Hourglass pattern	Dumbbell pattern	All dumbbell shaped
Dorsal pattern narrow at midbody (2 or less scales)	Dorsal pattern wide at midbody (3 or more scales)	4 with wide dorsal pattern, 1 with narrow dorsal pattern
Dorsal blotches may or may not meet	Dorsal blotches meet	Most dorsal blotches met on all specimens, but each contained 2-3 blotches not meeting
Divided subcaudals	Incidence of undivided subcaudals	All undivided except for tip of tail

Table 4. Nature of selected physical characteristics exhibited by specimens (N=8) of *Diadophis punctatus* from Fort Campbell, Kentucky and Tennessee, and of the subspecies *D. p. edwardsii* and *D. p. stictogenys* as given by Blanchard (1942).

<i>D. p. edwardsii</i>	<i>D. p. stictogenys</i>	Fort Campbell Specimens
Ventrals= 139-176	Ventrals= 126-150	Ventrals= 140-160
Caudals= 41-65	Caudals= 33-51	Caudals= 47-54
Upper labials= 8	Upper labials= 7	5 had 7 upper labials, 3 had 8 upper labials
Venter unspotted	Venter spotted irregularly	1 unspotted, 7 spotted
Underside of chin and tail unspotted	Underside of chin and tail spotted	6 unspotted, 2 spotted
Neck-ring unbroken	Neck-ring broken	1 broken, 7 unbroken

being like *D. p. stictogenys* and 37% like *D. p. edwardsii*. Pigmentation of the venter was most similar to *D. p. stictogenys*, as 88% were spotted and 12% unspotted. Color of chin and under the tail was most similar to *D. p. edwardsii* (75% unspotted, 25% spotted). *Diadophis punctatus* populations in western Kentucky and north-central Tennessee (Montgomery County) were described as intermediate between *D. P. edwardsi* and *D. p. stictogenys* by Meade (1991) and Scott and Snyder (1968).

Specimens of *Elaphe obsoleta* appeared intermediate between *E. o. spiloides* and *E. o. obsoleta* (Table 5). Of seven specimens examined, dorsal coloration was light grayish-brown (like *E. o. spiloides*) in four (57%) and black (like *E. o. obsoleta*) in three (43%). The blotched pattern of *E. o. spiloides* was present in six (86%) individuals. Of these six, five (71%) had lateral blotches. Evidence of *Elaphe obsoleta* intergrading in western Kentucky and Tennessee is scarce. Defining intergrades on morphology alone is difficult. Each subspecies exhibits similar characteristics during part of their life cycle. Both subspecies exhibit blotched patterns as juveniles and dorsal darkening with age, which may hide *E. o. spiloides* characteristics. Conant and Collins (1991) show both *E. o. obsoleta* and *E. o. spiloides* in the Fort Campbell area. Meade (1991) described Kentucky populations as *E. o. obsoleta*, although specimens from the Fort Campbell area

Table 5. Nature of selected physical characteristics exhibited by specimens (N=7) of *Elaphe obsoleta* from Fort Campbell, Kentucky and Tennessee, and of the subspecies *E. o. obsoleta* and *E. o. spiloides* as given by Barbour (1971), Ernst and Barbour (1989), and Mount (1975).

<i>E. o. obsoleta</i>	<i>E. o. spiloides</i>	Fort Campbell Specimens
Dorsal coloration black to dark brown	Dorsal coloration gray to brown or yellowish brown	3 with dark dorsal coloration, 4 with light gray to brown color
Dorsum with faintly discernible blotches	Dorsum with a series of blotches	1 without blotches, 6 with blotches
Sides without blotches	Sides with alternating series of blotches	2 without blotches, 5 with blotches

"occasionally had *spiloides*-like characteristics." Barbour (1971), Ernst and Barbour (1989), and Mount (1975) describe western Kentucky and Tennessee populations as intergrading populations. Data suggest that *E. obsoleta* populations from the reservation are intergrades. Further studies comparing Fort Campbell specimens to specimens from well within each subspecific range are needed to reveal the true extent of this intergradation.

State-listed Taxa

Three state-listed species (Egar and Hatcher, no date; Warren et al., 1986), all amphibians, were documented on the reservation (Figure 7). *Ambystoma talpoideum*, listed as special concern in Tennessee, was encountered on roads in Montgomery and Stewart counties, a woodland pond and swamp in Montgomery County, and an inundated low woods in Christian County. *Cryptobranchus a. alleganiensis*, listed as special concern in Tennessee and Category 2 by the United States Fish and Wildlife Service, was recorded from a stream in Montgomery County. *Hyla gratiosa*, listed as special concern in both Kentucky and Tennessee, was collected from a forested swamp in south-central Christian County. Both species were previously recorded from areas outside but near the reservation (Monroe and Giannini, 1977; Monroe and Taylor, 1972; Redmond, 1985; Redmond et al., 1990; Scott, 1990; Scott and Harker, 1968; Scott and Snyder, 1968; Scott et al., 1981; Snyder, 1972; VanNorman and Scott, 1987).

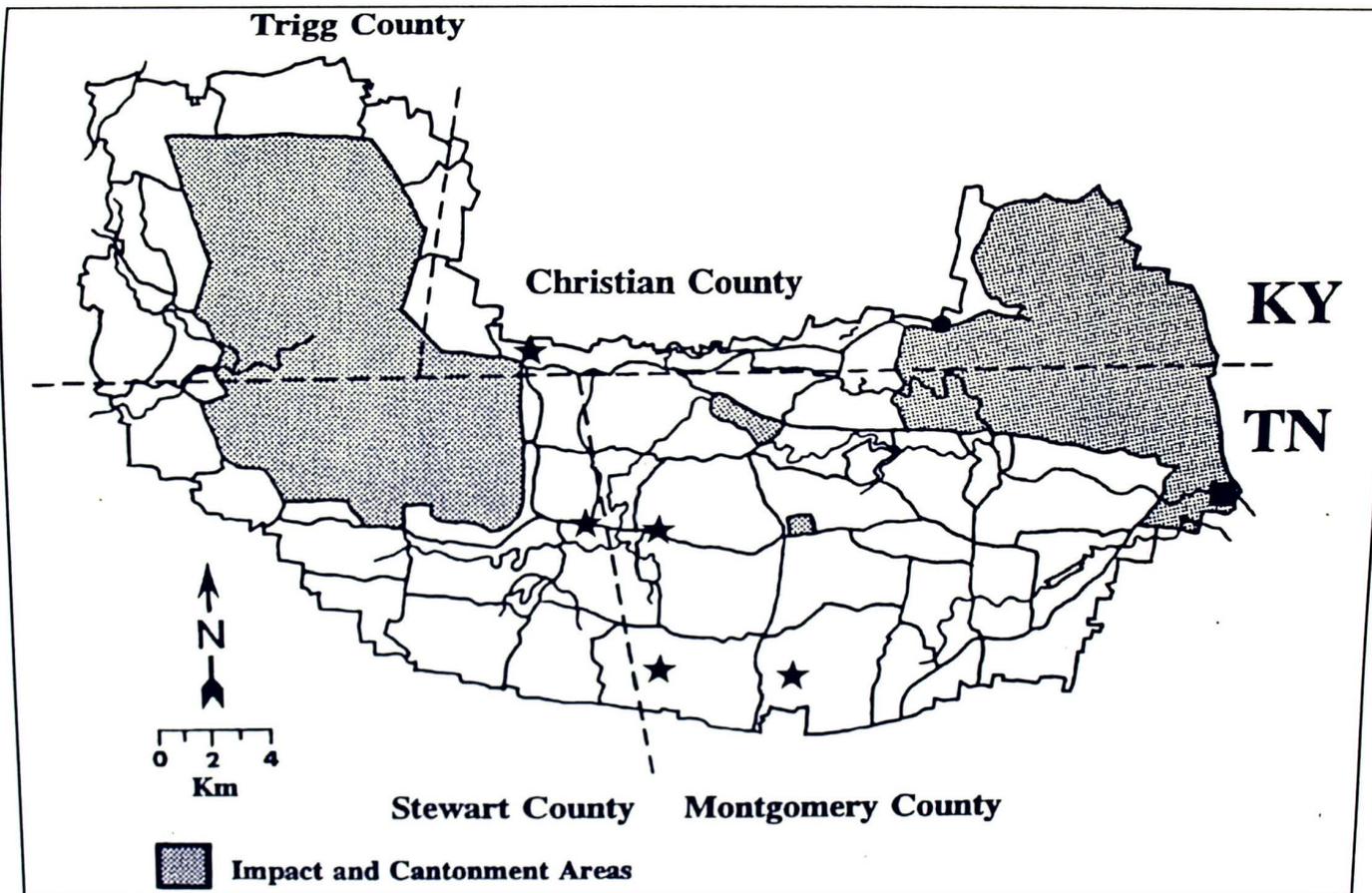


Figure 7. Distribution of *Ambystoma talpoideum* (stars), *Cryptobranchus alleganiensis* (square), and *Hyla gratiosa* (circle) records from Fort Campbell Military Reservation.

CHAPTER V

CONCLUSIONS

The data obtained lead to the following conclusions:

1. Fort Campbell Military Reservation includes most of the habitats found across the Western Highland Rim, excepting the riverine and associated floodplain habitats associated with larger streams.

2. The herpetofauna of the study area is similar to that found elsewhere on the Western Highland Rim, but lacks those species adapted to rivers and their floodplains.

3. Woodland habitats support the greatest variety of species and are utilized throughout the year.

4. *Notophthalmus viridescens*, *Diadophis punctatus*, *Agkistrodon contortrix*, and *Elaphe obsoleta* are represented by individuals that appear to be the product of intergradation.

5. Further studies are needed to reveal the impact of military maneuvers on herpetofaunal communities and populations.

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APPENDIX A
DESCRIPTION OF HABITATS IDENTIFIED ON
FORT CAMPBELL MILITARY RESERVATION,
KENTUCKY AND TENNESSEE.

The following is my classification of the habitats present at the reservation. The classification involves three main categories, (woodland, non-forested areas, and wetland), each broken down into two or more subcategories.

1. Woodlands.

A. Native Remnants. Mostly deciduous, oak-dominated, on ridges, slopes of various aspect, streamside, alluvium, and upland flats. All are secondary with on-going disturbance, including timber harvest.

B. Plantations. Extensive areas planted in pines (most *Pinus taeda*) and black walnut. Walnut plantations date to the late 1960s. Pine plantations date to the 1940s and most are being thinned for pulpwood.

2. Non-forested Areas.

A. Successional fields. Most were in agriculture prior to 1940, but have been kept open for training exercises by clipping and burning at irregular intervals. Some barren remnants remain on the Pennyroyal Plain. All seres are represented and many, if not most, are disturbed by military training exercises, which have resulted in scalped vegetation, ditches, large holes, and deep trenches from tanks and other heavy equipment.

B. Maintained fields. Extensive areas are leased to area farmers and planted in corn, wheat, soybeans, or hay. Others are clipped regularly.

3. Wetlands.

A. Intermittent streams. Numerous intermittent streams traverse the karst terrain. They typically flow only for short periods during or after heavy rainfall, but may flow for several months.

B. Permanent streams. Several permanent streams meander through the reservation. Each stream varies with the surrounding terrain and is sharply defined by the surrounding vegetation. Streamside habitats range from mesic slopes to limestone rock outcrops.

C. Swamps and marshes. These wetlands include all habitats that are frequently inundated or contain permanent standing water throughout most of the year.

D. Ponds and small impoundments. Numerous woodland and sinkhole ponds are scattered throughout. Both man-made and natural ponds occur in most habitat types and are influenced by their surrounding vegetation. Two small impoundments are present (Lake Taal in Montgomery County and Lake Kyle in Stewart County). Both are surrounded by a mature white oak forest and are heavily impacted by recreationists.

APPENDIX B
ANNOTATED CHECK LIST OF THE AMPHIBIANS AND
REPTILES OF FORT CAMPBELL MILITARY RESERVATION,
KENTUCKY AND TENNESSEE

This annotated list treats all species of amphibians and reptiles recorded on Fort Campbell Military Reservation between 1 June 1992 and 30 June 1993. Also included, and marked with an asterisk, are species that were not documented on the reservation, but are expected based on known ranges and habitat preferences. Higher taxa are arranged in phylogenetic order; genera and species are alphabetical within families.

Class Amphibia

Order Caudata

Family Cryptobranchidae

Cryptobranchus a. alleganiensis (Daudin). Eastern Hellbender. One specimen was recorded from Little West Fork Creek in 1982 (APSU 5247).

Family Salamandridae

Notophthalmus viridescens (Rafinesque). Eastern Newt. Common in upland wooded habitats during summer and fall, and within inundated lowland areas and small woodland ponds during winter and early spring. The population at Fort Campbell appears intermediate in physical appearance between *N. v. viridescens* and *N. v. louisianensis*.

Family Ambystomatidae

Ambystoma maculatum (Shaw). Spotted Salamander. Very common salamander of the uplands. Many sexually active adults were collected from small woodland ponds and inundated lowland areas in early spring.

Ambystoma opacum (Gravenhorst). Marbled Salamander. Adults were collected on roads after heavy rains during the fall, presumably moving to breeding sites.

Ambystoma talpoideum (Holbrook). Mole Salamander. Several individuals were encountered in Montgomery, Stewart, and Trigg counties. All were found in inundated lowland areas and fishless woodland ponds.

Ambystoma texanum (Matthes). Smallmouth Salamander. Several were recorded on roads in Montgomery County during late March, presumably moving to breeding sites. Collection efforts in other parts of the reservation were unsuccessful.

Ambystoma tigrinum tigrinum (Green). Eastern Tiger Salamander. Several individuals were collected from Montgomery and Christian counties from inundated lowland areas and fishless woodland ponds.

Family Plethodontidae

Desmognathus fuscus conanti Rossman. Spotted Dusky Salamander. Very common year-round, streamside inhabitant at both permanent and intermittent streams throughout the reservation.

Eurycea cirrigera (Green). Southern Two-lined Salamander. Another very common streamside salamander that was taken from permanent and intermittent streams throughout the reservation during all seasons.

Eurycea longicauda longicauda (Green). Longtail Salamander. Commonly found along streams with abundant rocky outcrops throughout the reservation.

Eurycea lucifuga Rafinesque. Cave Salamander. Taken regularly from streams with rocky outcrops, spring habitats, and once from a cave entrance in Christian County.

**Hemidactylium scutatum* (Temminck and Schlegel). Four-toed Salamander. Although not recorded during this study, the reservation's permanently inundated low areas with an abundant moss flora might harbor this animal.

Plethodon dorsalis dorsalis Cope. Eastern Zigzag Salamander. Both patterned and dark phases were common in deciduous forests on mesic slopes throughout the reservation. Numerous specimens were observed on paved roads during or after heavy spring rains.

Plethodon glutinosus complex (Green). Slimy Salamanders. Taken from streamside habitats and mesic slopes under logs and other streamside debris.

**Pseudotriton montanus diastictus* Bishop. Midland Mud Salamander. Although it possibly occurs at Fort Campbell, this salamander was not found in this study. It should be looked for in the vicinity of springs and spring runs.

Pseudotriton ruber vioscai Bishop. Southern Red Salamander. One specimen was taken from a road in Christian County. However, these salamanders may well occur in and near springs and small streams throughout the reservation.

Order Anura

Family Bufonidae

Bufo americanus americanus Holbrook. Eastern American Toad. Very common species found throughout from early spring through fall.

**Bufo americanus charlesmithi* Bragg. Dwarf American Toad. Although not recorded during this study, it is expected, especially in the Kentucky portion of the reservation.

Bufo woodhousii fowleri Hinckley. Fowler's Toad. Very common species found throughout the reservation from late spring through fall.

Family Pelobatidae

**Scaphiopus holbrooki holbrooki* (Harlan). Eastern Spadefoot. None was recorded in this study, although the reservation is well within its range. Chance encounters could occur during or after heavy rain in spring and summer.

Family Hylidae

Acris crepitans blanchardi Harper. Blanchard's Cricket Frog. Common along both permanent and intermittent streams, and around ponds and small impoundments in summer.

**Hyla avivoca* Vioscai. Bird-voiced Treefrog. None was recorded from the reservation; however this frog possibly occurs in permanent wooded swamps along creeks and larger waterways.

Hyla chrysoscelis Cope. Cope's Gray Treefrog. Common in both deciduous and evergreen forests. Calling males were taken from trees and roadside ditches, both sexes were collected from paved roads.

Hyla gratiosa LeConte. Barking Treefrog. One specimen was collected from a beaver impacted stream (now a lowland swamp) in south-central Christian County. Other records exist from the same general area outside the reservation.

Pseudacris crucifer crucifer (Wied-Neuwied). Northern Spring Peeper. Commonly found calling from flooded fields and lowland wooded areas during spring. Also found in woodland habitats during summer.

Pseudacris feriarum feriarum (Baird). Upland Chorus Frog. Common springtime inhabitant of most wetland habitats, including inundated fields, where it was often heard calling. Also found around ponds and small impoundments during summer.

Family Microhylidae

Gastrophryne carolinensis (Holbrook). Eastern Narrowmouth Toad. Apparently widespread throughout the reservation, this species was commonly found in field habitats. Two specimens were also collected in an old field

Family Ranidae

Rana catesbeiana Shaw. Bullfrog. Abundant at most permanent wetland sites on the reservation. Breeding choruses were heard throughout the summer months.

Rana clamitans melanota (Rafinesque). Green Frog. Collected only in the talpole stage, this frog was found at only two localities, a woodland pond in Montgomery County and lowland swamp in Christian County. Should be found in other areas similar to those supporting the Bullfrog.

Rana palustris LeConte. Pickerel Frog. Common along intermittent and permanent streams in upland areas of Montgomery, Stewart, and Trigg counties.

Rana utricularia utricularia Harlan. Southern Leopard Frog. Possibly the most abundant amphibian on the reservation, it was collected from every habitat type.

Class Reptilia

Order Testudines

Family Kinosternidae

**Kinosternon subrubrum subrubrum* (Lacepede). Eastern Mud Turtle. None was recorded from the reservation, but it is expected in its ponds, lakes, swamps, and marshes.

Sternotherus odoratus (Latreille). Common Musk Turtle. Specimens were collected from Fletcher's Fork Creek in Montgomery County and from a swamp and Lake Kyle in Stewart County. Further collection efforts should yield others from

Family Chelydridae

Chelydra serpentina serpentina (Linnaeus). Common Snapping Turtle. One was observed sunning on the surface of Fletcher's Fork Creek in late April. Collection efforts within the two small impoundments and within the several permanent streams were unsuccessful.

Family Emydidae

**Chrysemys picta marginata* Agassiz. Midland Painted Turtle. Although not recorded from the reservation, it is expected in some ponds, lakes, and swamps.

Terrepenne carolina carolina (Linnaeus). Eastern Box Turtle. Common in most terrestrial habitats.

Trachemys scripta elegans (Wied). Red-eared Slider. Very common aquatic turtle in small impoundments, swamps, and other permanent bodies of water.

Family Trionychidae

**Apalone spinifera spinifera* (LeSueur). Eastern Spiny Softshell. Although not found in this study, it possibly occurs in some of the larger streams and small impoundments on the fort.

Order Squamata

Suborder Sauria

Family Anguinae

**Ophisaurus attenuatus longicaudus* McConkey. Eastern Slender Glass Lizard. Although not recorded in this study,

specimens exists from just south of the reservation. It is expected on the reservation in cut-over woods, dry grasslands, and other brushy areas.

Family Iguanidae

Sceloporus undulatus hyacinthinus (Green). Northern Fence Lizard. Common in upland forests and dry successional fields.

Family Scincidae

Eumeces faciatus (Linnaeus). Five-lined Skink. Collected from disturbed sites within Stewart County and observed at numerous cemeteries across the fort.

Eumeces laticeps (Schneider). Broadhead Skink. Although not collected, one adult male was observed at close range in a mature deciduous forest in Stewart County.

Scincella lateralis (Say). Ground Skink. Several specimens were collected from under logs in upland deciduous forests.

Family Teiidae

**Cnemidophorus sexlineatus sexlineatus* (Linnaeus). Six-lined Racerunner. None was recorded from the reservation; however this lizard may occur in barrens, old fields, and open woodlands.

Suborder Serpentes

Family Colubridae

Carphophis amoenus helenae (Kennicott). Midwest Worm Snake. One specimen was found under a log in a deciduous

forest in Montgomery County. Probably occurs throughout the reservation in similar habitats.

**Cemophora coccinea copei* Jan. Northern Scarlet Snake. Although not recorded from the reservation, this secretive snake may occur there in wooded habitats.

Coluber constrictor priapus Dunn and Wood. Southern Black Racer. Among the most common snakes on the fort, it was found in a wide variety of habitats.

Diadophis punctatus (Linnaeus). Ringneck Snake. Several specimens intermediate in appearance between *D. p. edwardsii* and *D. p. stictogenys* were collected from mesic slopes in Montgomery County. Further collection efforts may yield a broader distribution across the reservation.

Elaphe obsoleta (Say). Rat Snake. Although Conant and Collins (1991) show *E. o. obsoleta* (Black Rat Snake) occurring in the Fort Campbell area, no specimens matching its description were collected. Instead, they appear more like *E. o. spiloides* (Gray Rat Snake) or intergrades between the two subspecies. Possibly the most abundant snake on the reservation, it was found throughout most upland habitats and on occasion in wetlands.

Heterodon platirhinos Latreille. Eastern Hognose Snake. One specimen was collected from Montgomery County in an old field.

Lampropeltis calligaster calligaster (Harlan). Prairie Kingsnake. One dead specimen was collected from a road in

an open field in Christian County. One live specimen was observed in a successional field in Montgomery County.

Lampropeltis getula nigra (Yarrow). Black Kingsnake. Two specimens were collected dead on roads in Christian and Montgomery counties.

Lampropeltis triangulum triangulum (Cope). Eastern Milk Snake. One individual matching descriptions of this subspecies was collected from a maintained field in Montgomery County. *L. t. sypila* x *L. t. elapsoides* and *L. t. sypila* x *L. t. triangulum* intergrades have been found to the west of Fort Campbell in Land Between The Lakes.

Nerodia sipedon pleuralis (Cope). Midland Water Snake. Common at wetland habitats, especially permanent streams.

Opheodrys aestivus (Linnaeus). Rough Green Snake. One specimen was taken from a mixed deciduous/evergreen forest in Stewart County.

**Pituophis melanoleucus* (Daudin). Pine Snake. None was collected; however, additional efforts might yield this snake in woodland areas of the reservation.

**Regina septemvittata* (Say). Queen Snake. None was recorded from the reservation, but it possibly occurs along the margins of small rocky streams.

Storeria dekayi wrightorum Trapido. Midland Brown Snake. Two specimens were recorded in Montgomery County. One was collected from an upland deciduous forest, the other in a barren.

Storeria occipitomaculata occipitomaculata (Storer).
Northern Redbelly Snake. Two specimens were collected from
moist upland forest sites in Stewart and Trigg counties.

**Tantilla coronata* Baird and Girard. Southeastern
Crowned Snake. None was recorded from the reservation.
However, it should be looked for there in woodland areas, as
it occurs a short distance to the west in Land Between The
Lakes (Snyder, 1972).

Thamnophis sirtalis sirtalis (Linnaeus). Eastern
Garter Snake. Four specimens were recorded, all from areas
adjacent to water. Three came from a woodpile near a beaver
swamp in Montgomery County; one was observed dead on a road
by a stream in Christian County.

**Virginia valeriae elegans* Kennicott. Western Earth
Snake. Although not recorded from the reservation, it may
be there in mesic woods under rocks and logs.

Family Viperidae

Agkistrodon contortrix (Linnaeus). Copperhead.
Collected from several scattered sites in a variety of
terrestrial habitats.

Crotalus horridus Linnaeus. Timber Rattlesnake.
Although not recorded from the reservation, this snake
probably occurs there, especially in the older forest of the
Trigg County portion.