THE HERPETOFAUNA OF DUNBAR CAVE STATE NATURAL AREA, MONTGOMERY COUNTY, TENNESSEE

KEVIN CHRISTOPHER FITCH

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The Herpetofauna of Dunbar Cave State Natural Area, Montgomery County, Tennessee

A Thesis

Presented for the

Master of Science Degree

Austin Peay State University

Kevin Christopher Fitch

May 1998

DEDICATION

This thesis is dedicated to my parents,

Mr. Maurice McKay Fitch

and

Mrs. Janice Mary Kramarz Fitch

for their love and support,

and in the memory of my grandmother,

Mrs. Kathleen McKay Fitch.

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I would like to thank APSU's Center for Field Biology for funding this research and the staff of Dunbar Cave State Natural Area for their cooperation and assistance. I also would like to extend my sincerest thanks to Dr. A. Floyd Scott for his help, guidance, and friendship during this and many other projects. I would like to thank Dr. Edward W. Chester and Dr. Steven W. Hamilton for their comments and support. Additional help was provided by Dr. Don C. Daily, Laurina I. Lyle, Angelo P. Bufalino, Alan K. Bottomlee, Brant T. Smith, Aaron B. Hirsch, Scott Brown, Hal Wade, Mare Lynn Fitch, Jeremy Nichols, Kellie Wallace, John T. Dailey, Amie S. Truitt, Dr. Cindy L. Taylor, Bryan A. Truitt, Ashley Meyer, Lillian F. Hayslip-Barber, Tommy A. Williams, Dudley W. Rives, Dr. Carol J. Baskauf, and Mickey Fitch.

ABSTRACT

The amphibians and reptiles of Dunbar Cave State Natural Area, Montgomery County Tennessee, were sampled from September 1996 through, October 1997. Terrestrial habitats (deciduous forest, old field, and open areas) were sampled by hand collecting, sight and audible identification, and terrestrial drift fences with pit and funnel traps. The only aquatic habitat a, 5-ha impoundment, was sampled with nylon hoop nets. Twelve species of amphibians (4 salamanders, and 8 frogs and toads) and 14 species of reptiles (5 turtles, 2 lizards, and 7 snakes) were documented. Another 3 species of amphibians (1 salamander and 2 frogs) and 4 species of reptiles (1 turtle and 3 snakes) were reported (but not documented) by the natural areas staff. Individuals of 2 species (*Chrysemys picta* and *Diadophis punctatus*) appeared to be the product of intergradation between the following species: *C. p. dorsalis* X *marginata* and *D. p. stictogenys* X *edwardsii*. All species were already known from Montgomery County; one of these (*Hyla gratiosa*) is listed in Tennessee as a species of special concern. Reptile activity levels over the year correlated positively with temperature. *Plethodon* spp. (but not amphibians in general) activity levels correlated positively with rainfall. Estimates of the numbers of individual *Chelydra serpentina* and *Trachemys scripta* in the impoundment were 72 and 380, respectively. Mean minimum home range size for 4 *C. serpentina* and 4 *T. scripta* were 1.03 ha and 0.45 ha, respectively.

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CHAPTER I

INTRODUCTION

Several former studies concern directly or indirectly the herpetofauna of northwestern Middle Tennessee (defined here as the area occupied by Stewart, Montgomery, Robertson, Houston, and Dickson counties). Gentry (1955, 1956), in his checklist of amphibians and reptiles of Tennessee, cited 13 species occurring in one or more of the region's counties and an additional 55 species occurring either state-wide or generally throughout Middle Tennessee. Scott and Snyder (1968) found 64 species during a herpetological survey of Montgomery County, an area of 139,605 ha (USDA 1975). Snyder (1972) surveyed the amphibians and reptiles of the 66,000-ha area known as Land Between The Lakes (LBL), the southern one-third of which is in Stewart County, and documented 69 species. Additional information on LBL's herpetofauna was provided in studies of its state-listed herptiles (Scott 1990) and pond-dwelling amphibians (Scott and Twombly 1994). VanNorman and Scott (1987) studied the distribution and breeding habitat of *Hyla gratiosa* (Barking Treefrog) across the Pennyroyal Plain of southern Kentucky and north-central Tennessee and found the species at many sites in Montgomery and Robertson counties. Scott (1991) documented 25 species of herpetofauna at Barnett Woods Natural Area (ca. 16 ha) in Montgomery County. Zirkle (1993) surveyed the amphibians and reptiles of Fort Campbell Military Reservation (42,686 ha), including portions of Montgomery and Stewart counties that

were off-limits to previous herpetofaunal surveys, and found 49 species. Most recently, Rozelle and Scott (1995) sampled the amphibians and reptiles of Shelton Ferry Wetland, a 176-ha Tennessee Wildlife Resources Agency holding along the Cumberland River in southern Montgomery County. They found 24 species.

Despite all of the information generated by the studies cited above, very little is known of the herpetofauna of Dunbar Cave State Natural Area (DCSNA), a Tennessee State Parks' property in Montgomery County. The only herpetological-oriented study on the area examined seasonal changes in *Eurycea lucifuga* (Cave Salamander) populations occupying the twilight zone of Dunbar Cave (White 1997).

The main purpose of this study was to conduct a one-year survey of DCSNA's herpetofauna and to evaluate the results in relation to community composition, species richness, relative abundance, and habitat relationships. A secondary objective was to conduct a mark-capture-recapture study of turtles in the area's man-made lake to yield data on population size and dispersion, movements, and home range of the marked individuals.

CHAPTER II

DESCRIPTION OF THE STUDY AREA

Location and Size

Dunbar Cave State Natural Area is a 44-ha recreational and educational facility within the city of Clarksville, Tennessee. It is approximately 2 km north of the Red River, which enters the Cumberland River some 6 km to the west. The Natural Area is named for Thomas Dunbar and a cave that opens just north of the 5-ha man-made lake at the southern end of the site (Fig. 1). The state acquired the property in 1973.

Vegetation

Vegetationally, DCSNA is within the Western Mesophytic Forest Region described by Braun (1950) and more recently interpreted by Bryant *et al.* (1993). This transitional region includes floristic elements from more xeric regions to the west (Oak-Hickory Forest Region) and more mesic regions to the east (Mixed Mesophytic Forest Region). There is no single climax and the mosaic of forest types is determined by local conditions (Chester *et al.* 1995). Most forests are dominated by various species of oaks, elms, hickories, and maples, with topography and slope aspect of primary importance in determining forest composition (Chester *et al.* 1995). All DCSNA forests (ca. 40 ha) are secondary and represent the range of slope and ravine community types described by Chester *et al.* (1995) for Montgomery and Stewart counties. Most of the area (ca. 29 ha) consists of deciduous forest while a few hectares (ca. 11) are

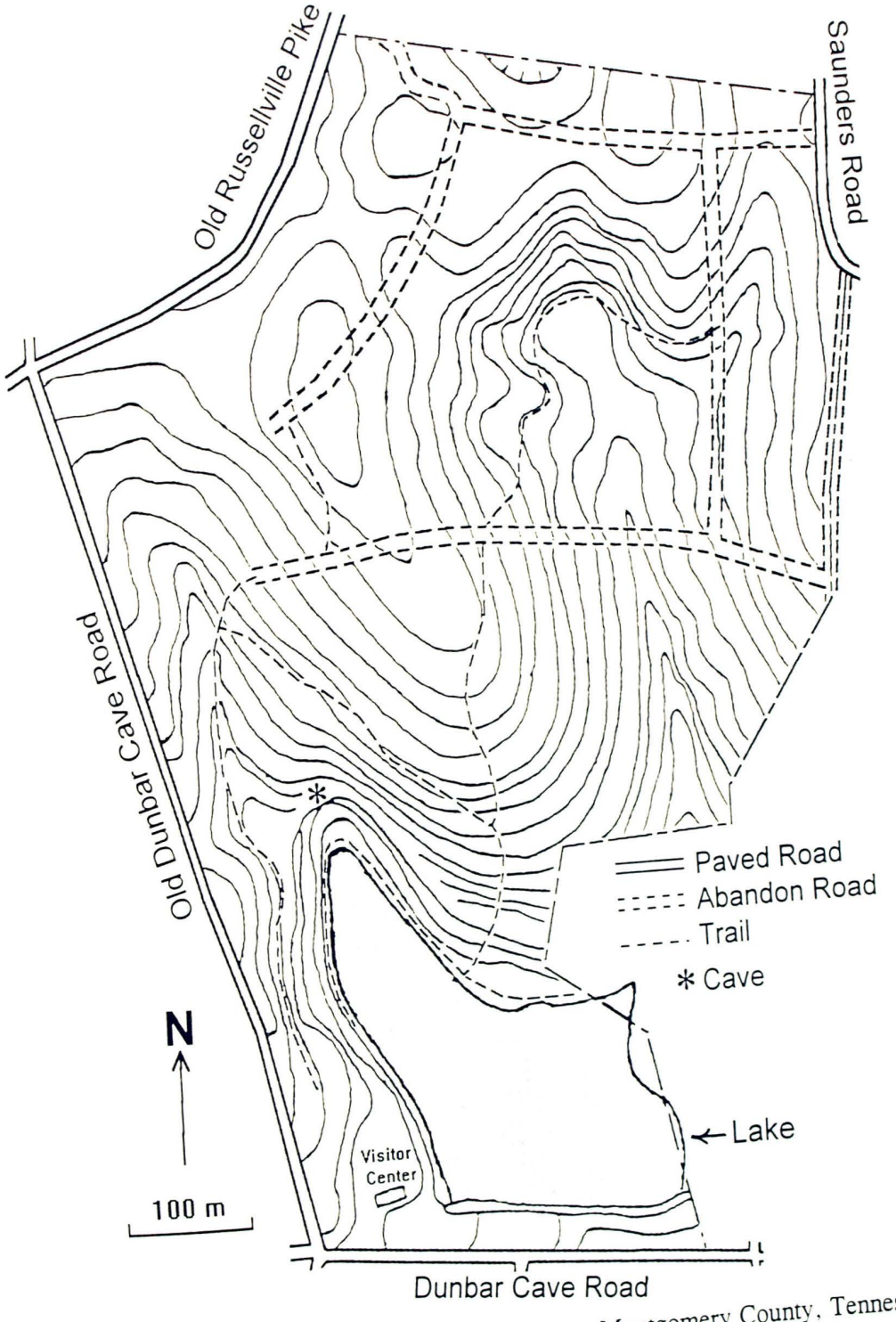

Fig. 1. Map of Dunbar Cave State Natural Area, Montgomery County, Tennessee (adapted from the 1957 Clarksville, Tennessee U.S.G.S Topographic Quadrangle). Contour interval 3 meters.

occupied by successional "old-field" vegetation (Fig. 2) that is dominated by eastern red cedar (*Juniperus virginiana*) and flowering dogwood (*Cornus florida*).

Physiography, Geology, and Topography

Physiographically, DCSNA is part of the Highland Rim Section, Western Highland Rim Subsection of the Interior Low Plateaus Province (Quarterman and Powell 1978). The geology of the site is upper Mississippian age consisting mostly of St. Louis Limestone and a small area of Warsaw Limestone below the 128 m (420 ft) elevation (Marsh 1973). The topography consists of alternating ravines and slopes that face south, southeast, and southwest (Fig. 1 and 2).

Weather and Climate

Temperature was successfully monitored on the study site from 6 October 1996, through 11 October 1997, using a Hobo data logger. Monthly means of these data are included in Table 1. The coldest month was December 1996, and the warmest month was July 1997. Precipitation data for the study period were obtained from the Clarksville waste water treatment facility (Table 1.). The wettest month was March 1997, and the driest month was July 1997. Total rainfall during the study was 152.8 cm. Long-term climatic data (based on records obtained from the Clarksville sewer plant) are as follows: the mean annual precipitation between 1931 and 1995 was 123.8 cm, with the maximum (13.5 cm) occurring in March and the minimum (7.8 cm) occurring in October. The mean temperature between 1961 and 1990 was 14.1 ^{0}C, with January (1.1 ^{0}C), normally the coldest month, and July (25.6 ^{0}C), normally the hottest.

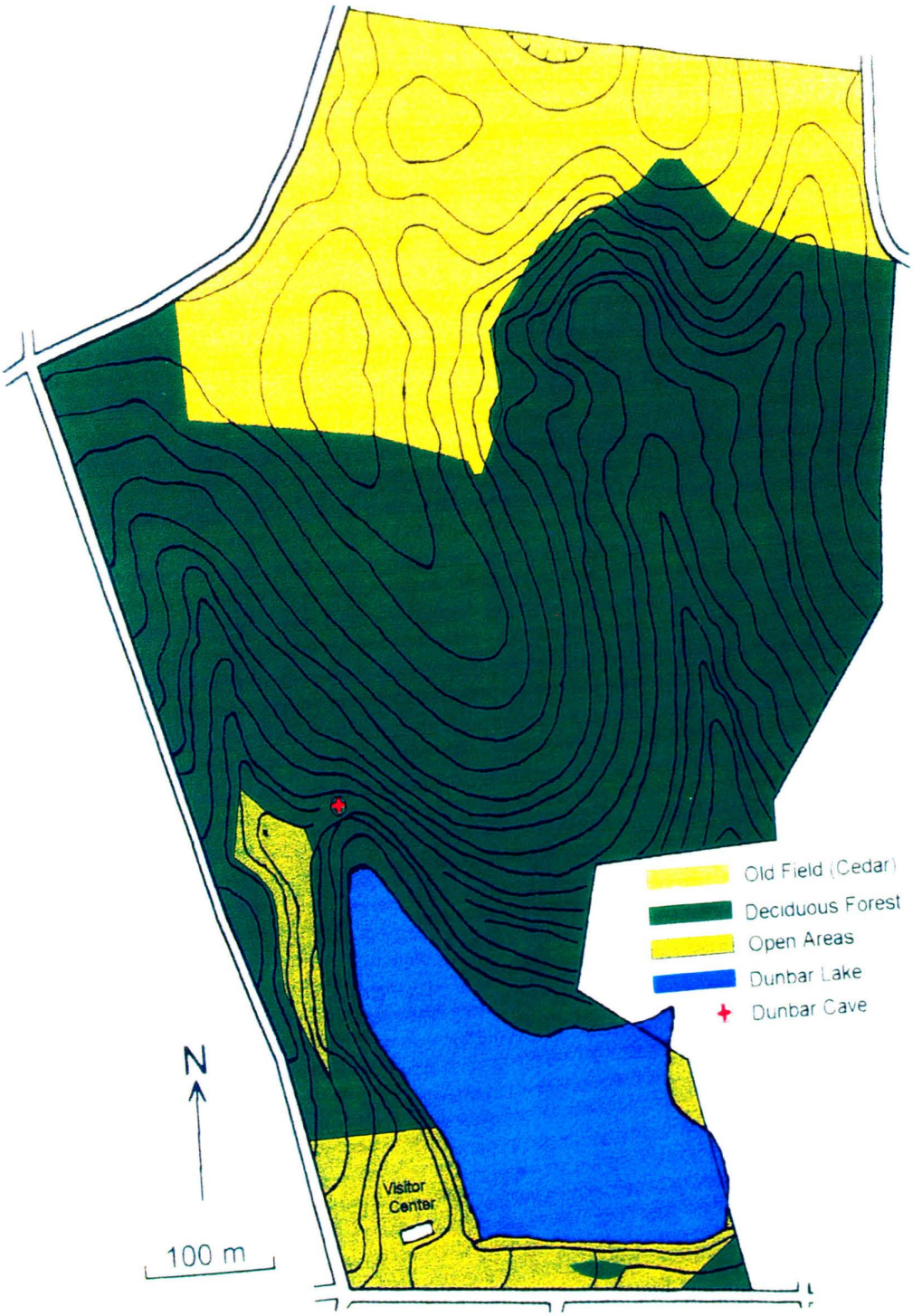

Fig. 2. Habitat map of Dunbar Cave State Natural Area, Montgomery County, Tennessee. Contour interval 3 meters.

Table 1. Monthly mean air temperatures and total precipitation occurring during a herpetofauna survey of Dunbar Cave State Natural Area, Montgomery County Tennessee.

Month	Mean Air Temp (^{0}C)[1].	Total Precipitation (cm)[2].
October 1996 (starting Oct 6th)	14.46	10.57
November 1996	6.88	15.57
December 1996	6.12	12.80
January 1997	6.49	12.17
February 1997	7.09	13.36
March 1997	11.59	27.91
April 1997	10.97	8.43
May 1997	16.98	10.13
June 1997	21.77	23.22
July 1997	24.19	3.78
August 1997	22.73	8.33
September 1997	19.27	6.48
October 1997 (ending Oct 11th)	19.36	0.08
Duration of the study	14.45	152.82

1. Recorded on site
2. Recorded at Clarksville water treatment plant 2.5 km from the study site.

Chapter III

METHODS

General Survey

Historical records of amphibians and reptiles taken at or near DCSNA were obtained via a search of the literature, from holdings in Austin Peay State University's Museum of Zoology (APSUMZ), and from interviews with the natural area's staff.

On-site collecting was conducted from October 1996, through September 1997, and took place in all major habitats within the area (Fig. 2). Drift-fence arrays with funnel traps and pitfall traps were placed in the 2 habitats of greatest extent: deciduous forest (2 arrays) and old field (1 array). Drift fences were constructed of 10-m lengths of aluminum flashing and were 35 cm high. The fences were painted brown to camouflage the arrays from curious visitors and buried approximately 5 cm at their base. Funnel traps constructed from window screen (Karns 1986) and covered with burlap were placed centrally along each drift fence (Fig. 3). Fences were arranged in arrays according to the design by Jones (1981). Arrays were checked twice a week and all captured herpetofauna identified and enumerated. A transect traversing all major habitats within the park was also established and followed once each week. Herpetofauna encountered along the transect were identified and counted, and the

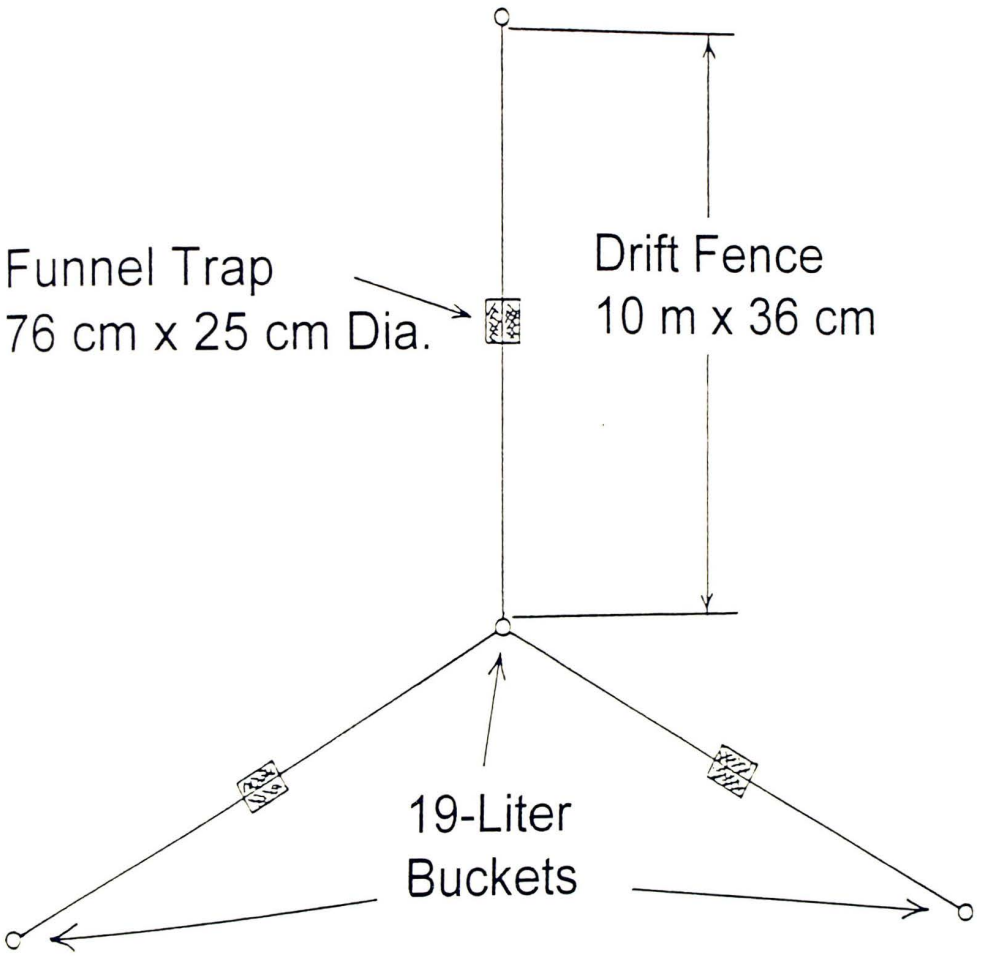

Fig. 3. Overhead view of drift fence array design used in a herpetofaunal survey of Dunbar Cave State Natural Area, Montgomery County, Tennessee.

results added to the array data. All voucher specimens were accessioned into the APSUMZ collection (APSU 5554 to 5580).

Correlation analyses comparing terrestrial captures with temperature and precipitation data from the area were conducted using Spearman's Rank Correlation Coefficient.

Aquatic Turtle Study

Twenty-four trapping stations were established along the shoreline of the area's lake. The stations were spaced roughly equidistant from each other at a distance of 47 m. This enabled systematic and equal sampling of the entire lake's edge. Commercially available (Memphis Net and Twine Co.), nylon mesh (2.54 cm), hoop (0.91 m dia.) traps baited with fresh fish or sardines were used. The first rotation around the lake was in the fall of 1996. Four stations were sampled simultaneous for one week, then traps were moved to the next 4 stations. This routine was continued until all stations had been sampled. Two more rotations were carried out in spring and summer 1997, to complete the sampling.

All turtles captured were marked by notching the marginal scutes with a hacksaw in a pattern that enabled accurate individual recognition. Following the first and all recaptures, the following data were recorded for each individual: notch code, species, sex, carapace length, and station. Population size was estimated using the method developed by Chao (1987). In this method the population size estimate is determined by analyzing the turtle captures and recaptures, assuming that most of the turtles were captured only one or two times. This method assumes a closed population

and that no births, deaths, immigration, or emigration has occurred during sampling. Of course the assumption cannot be guaranteed; however this method is considered to be one of the more accurate estimators of actual population size (Manning *et al.*1995). The Chi Square Goodness of fit test was used to determine if turtle captures were significantly higher in areas along shore with cover than in areas with no cover. Home ranges of selected individuals of the two most frequently captured species were determined according to the method originally described by Stickel (1954) and later addressed by Jennrich and Turner (1969).

CHAPTER IV

RESULTS AND DISCUSSION

General Survey

Funnel traps accounted for 51.5% of all terrestrial records. Hand collecting and audible detection along the transect accounted for another 30.9%, and pitfall traps the remaining 17.6%. Thirty-three percent of the individuals caught were dead when found. All of the dead animals were in funnel and pitfall traps. Death appeared to be the result of dessication, drowning, and predation from local omnivores (*e.g.*, opossum and racoon).

Survey results, which include my records, APSU museum records, and the Natural Area's staff site records are summarized in Table 2. All documented species, with one exception, are common in the region and not listed by any state or federal agency as species in need of special attention. The exception is *Hyla gratiosa*, a specimen of which was found 30 years ago (Scott and Harker 1968) on a road bordering the dam below Dunbar Lake. At present this species is listed "special concern" and "deemed in need of management" in Tennessee (Eager and Hatcher 1980). Although the roadbed at the site where the *Hyla gratiosa* was found has since been raised and some swampy habitat along it eliminated, the potential for its occurrence at DCSNA still exists and this should be considered in future management decisions.

Table 2. Amphibians and reptiles of Dunbar Cave State Natural Area (Montgomery County, Tennessee), based on specimens obtained in this study ([1]), collection in APSUMZ ([2]), and unvouchered records from the natural area's staff ([3]). Habitat types include deciduous forest (D), old field (Cedar) growth (F), lake area (L), cave area (C), and open areas (O). Taxa arranged phylogenetically within major groups.

Major groups and their taxa	Habitat Types				
	D	F	L	C	O
SALAMANDERS					
Notophthalmus viridescens viridescens[2]	X				
Eurycea longicauda longicauda[3]				X	
Eurycea lucifuga[1]				X	
Plethodon dorsalis[1]	X	X			
Plethodon glutinosus complex[1]	X				
FROGS AND TOADS					
Bufo americanus americanus[1]	X				
Bufo fowleri[3]					X
Acris crepitans crepitans[1]			X		
Hyla versicolor complex[1]	X	X			
Hyla gratiosa[2]			X		
Pseudacris feriarum feriarum[3]			X		
Gastrophryne carolinensis[1]		X			
Rana catesbeiana[1]	X	X	X		
Rana clamitans melanota[1]	X	X	X	X	
Rana palustris[3]				X	
Rana sphenocephala utricularius[1]	X	X	X		
TURTLES					
Sternotherus odoratus[1]			X		
Chelydra serpentina serpentina[1]			X		
Chrysemys picta[1]**			X		
Terrapene carolina carolina[1]	X	X			
Trachemys scripta elegans[1]			X		
Apalone sp.[3]			X		
LIZARDS					
Eumeces fasciatus[1]	X			X	X
Scincella lateralis[1]	X	X			

Table 2. continued

Major groups and their taxa	Habitat Types				
	D	F	L	C	O
SNAKES					
Carphophis amoenus helenae[1]	X				
Coluber constrictor priapus[1]	X				
Diadophis punctatus[1]*	X	X		X	
Elaphe obsoleta spiloides[1]	X				
Nerodia sipedon sipedon[1]			X		
Opheodrys aestivus[3]	X				
Storeria occipitomaculata occipitomaculata[3]	X				
Thamnophis sirtalis sirtalis[1]	X	X			
Virginia valeriae elegans[1]	X				
Agkistrodon contortrix mokasen[3]	X				X

* The single individual examined appears to be intermediate between *D. p. stictogenys and D. p. edwardsii*.

**Four individuals that were examined appear intermediate between *C. p. dorsalis and C. p. marginata*.

Individuals of two species appear to be intergrades between overlapping subspecies based on the diagnostic features listed by Conant and Collins (1991). Of 15 individuals of *Diadophis punctatus* (Ringneck Snake), 4 appeared intermediate between *D. p. edwardsii* and *D. p. stictogenys*. The one individual of *Chrysemys picta* (Painted Turtle) had a blending of characters ascribed to *C. p. dorsalis* and *C. p. marginata*. Intergrades involving these same subspecies in Montgomery County were reported by Scott and Snyder (1968) and Ernst (1970).

As hypothesized, reptile activity (as expressed by number of captures) was positively correlated with temperature, both on a weekly and monthly basis (Table 3, Figs. 4 and 5). However, contrary to what was expected, overall amphibian activity was not significantly linked to precipitation (Table 3). Only total monthly captures of *Plethodon* spp. (Woodland Salamanders) versus total monthly rainfall resulted in a significant correlation (Table 3 and Fig. 6). The lack of a correlation between overall amphibian activity and precipitation may be due to two rain events, March and June, that were well above average and reaching or approaching flash flood levels, this decreasing effectiveness of pit and funnel traps. Removal of animals from traps by predators before counts were taken might also have been involved.

Aquatic Turtle Study

For the entire lake, *Chelydra serpentina serpentina* (Common Snapping Turtle) population estimate was 72.33 ($\pm$ 9.82, $P<0.05$); the *Trachemys scripta elegans* (Red-eared Slider) estimate was 379.96 ($\pm$ 72.06, $P<0.05$); and the *Sternotherus odoratus* (Common Musk Turtle) estimate was 65.00 ($\pm$86.23, $P<0.05$).

Table 3. Correlations coefficients (Spearman's r_s) and results of significance tests ($P < 0.05$) for comparisons of numbers of terrestrial captures (various groups) with weekly and monthly temperature and precipitation data (means and totals, respectively) collected during a year long (Oct. 1996, through Sept. 1997) survey of the herpetofauna of Dunbar Cave State Natural Area, Montgomery County, Tennessee.

Various Comparisons	Weekly Data		Monthly Data	
	r_s	Significance	r_s	Significance
Reptiles vs. Temperature	0.652	**Positive**	0.878	**Positive**
Reptiles vs. Precipitation	-0.002	none	-0.125	none
Amphibians vs. Temperature	0.099	none	0.131	none
Amphibians vs. Precipitation	0.231	none	0.481	none
Plethodons vs. Temperature	-0.417	none	-0.543	none
Plethodons vs. Precipitation	0.239	none	0.630	**Positive**

The estimate for *S. odoratus* is considered insufficient because, of the sixteen individuals captured, only two were recaptured.

Location of turtle captures around the lake (Fig. 7) were analyzed to see if turtles seemed to prefer shoreline areas bordered by cover (trees, shrubs, or tall grass and herbs) more than areas devoid of cover. Stations 1-6, 8-12, and 24 all had some degree of shoreline cover. The other 12 stations lacked cover along the shore. The extent of shoreline area covered by these two types, *i. e.* with and without cover, were essentially equal. Turtle captures had a ratio of 1.5 to 1 for shoreline with cover versus shoreline without cover. This deviates significantly (chi square 20.21, $P<0.001$) from the expected of 1 to 1, cover verses no cover. The two most abundant

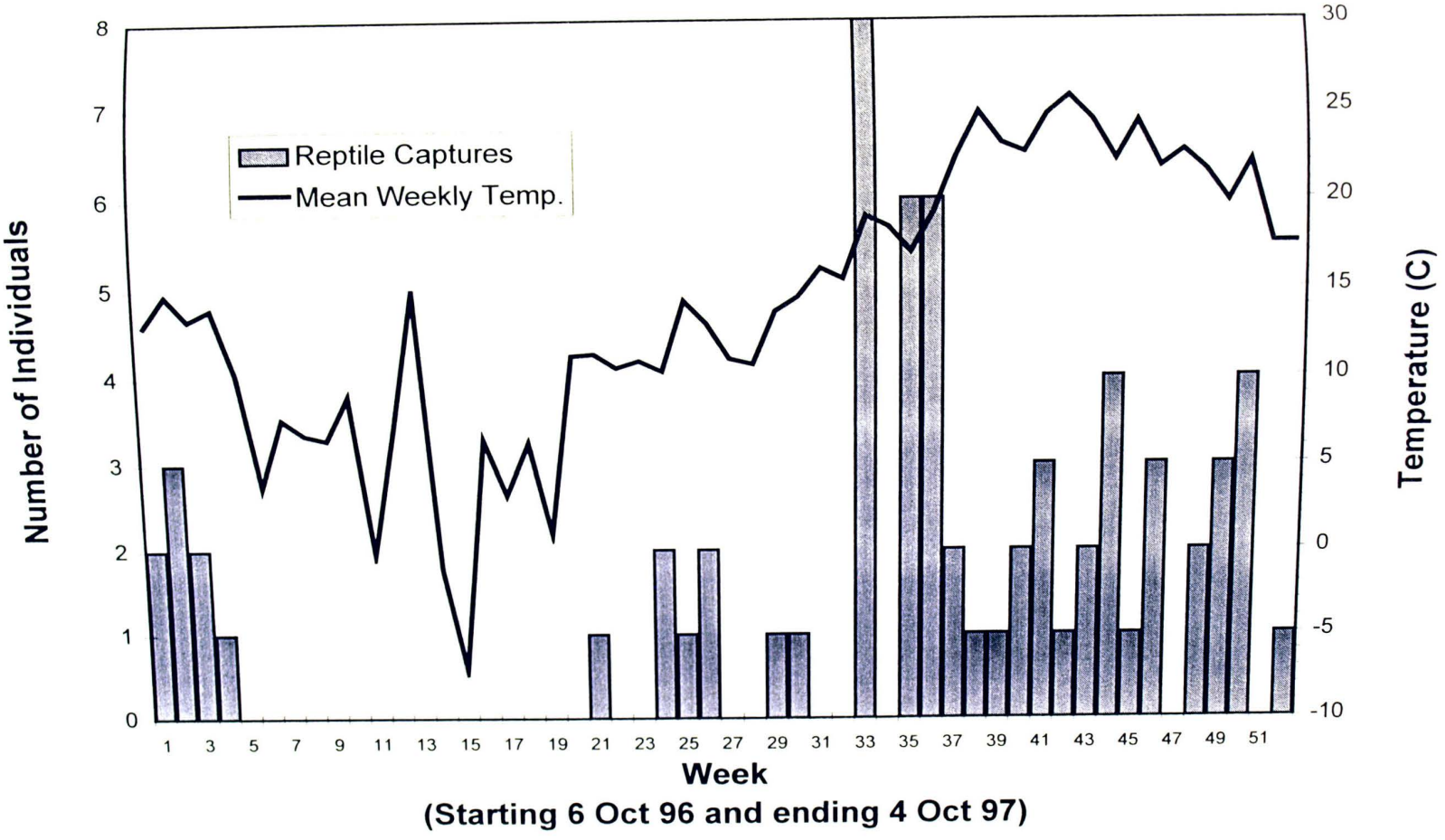

Fig. 4. Comparisons of the total weekly terrestrial reptile captures and mean weekly temperatures obtained during a one-year herpetological survey of Dunbar Cave State Natural Area, Montgomery County, Tennessee.

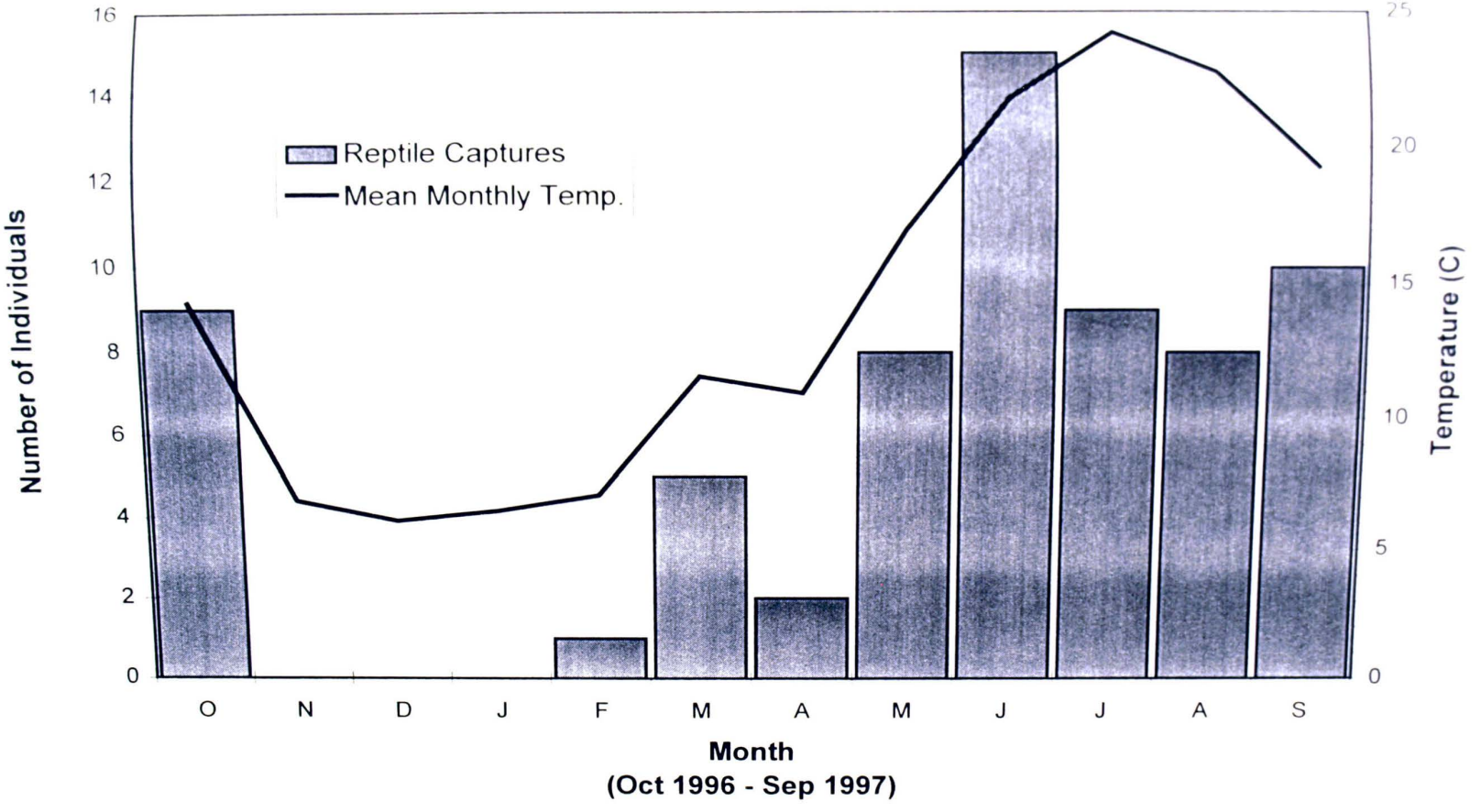

Fig. 5. Comparisons of the total monthly terrestrial reptile captures and mean monthly temperatures obtained during a one-year herpetological survey of Dunbar Cave State Natural Area, Montgomery County, Tennessee.

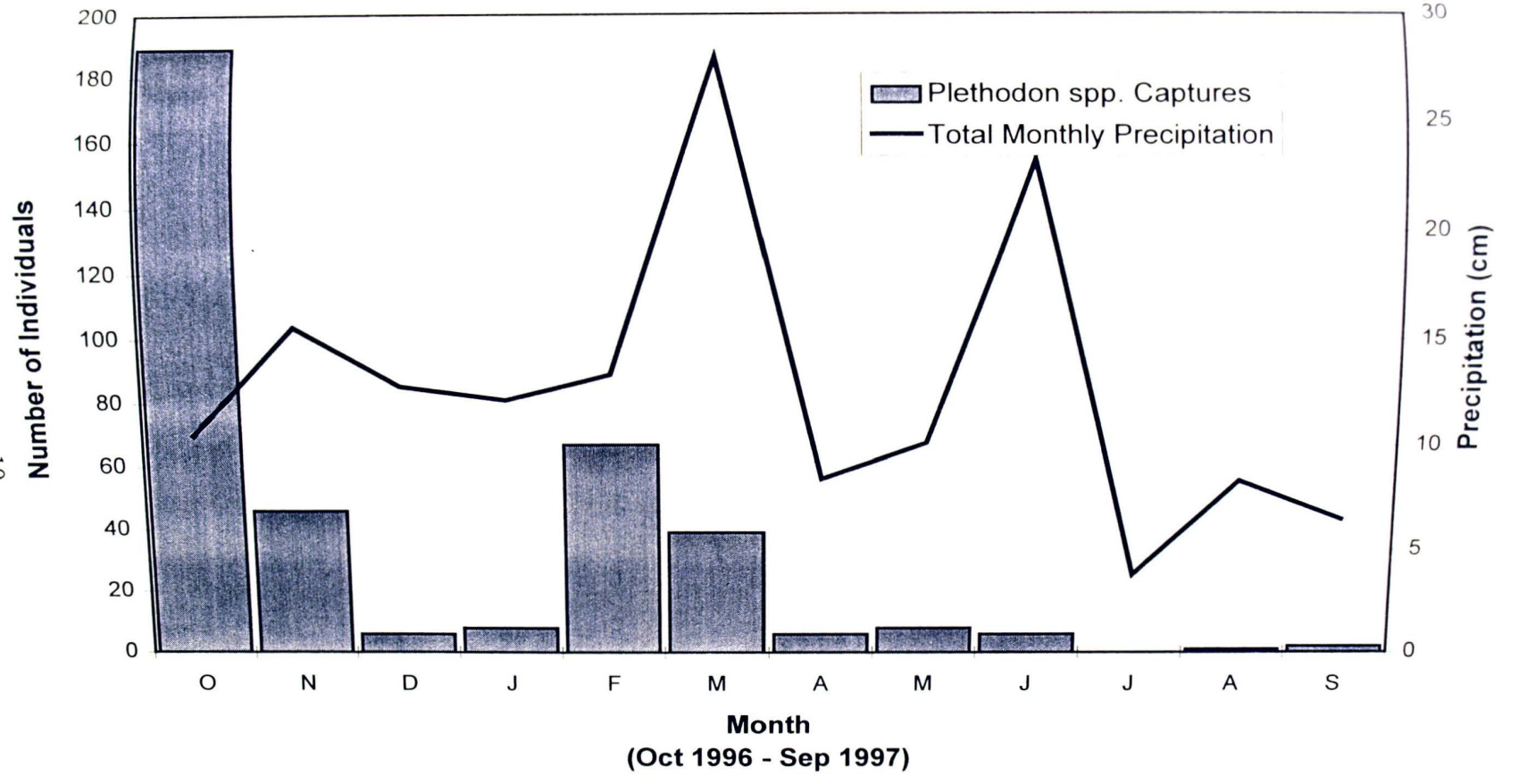

Fig. 6. Comparisons of total monthly *Plethodon* spp. captures and mean monthly precipitation obtained during a one-year herpetological survey of Dunbar Cave State Natural Area, Montgomery County, Tennessee.

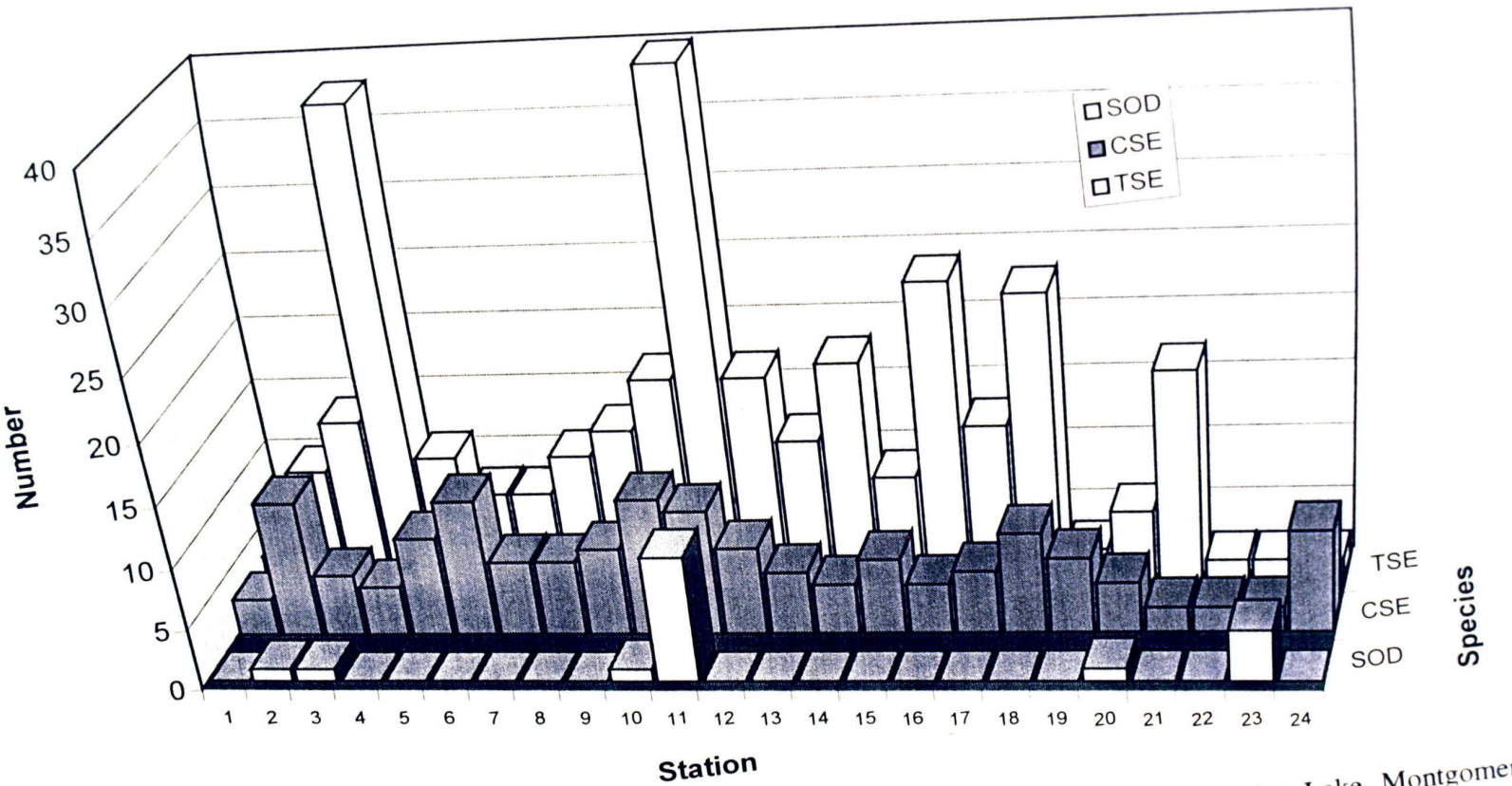

Fig. 7. Numbers of captures of selected turtle taxa recorded at each trapping station around Dunbar Lake, Montgomery County, Tennessee. Taxa represented here are *Trachemys scripta elegans* (TSE), *Chelydra serpentina serpentina* (CSE), and *Sternotherus odoratus* (SOD).

aquatic turtle species (*T. s. elegans* and *C. s. serpentina*) occurred in areas with shoreline cover 47.4% of the time. They occurred 27.4% of the time in clear areas and 25.2% of the time in both areas. Visual observations indicated that turtles tended to flee an area when people were present, especially in open areas. Gibbons (1990) found that turtle spatial distribution may be influenced by environmental, daily and seasonal temperature patterns, recent experience, and most importantly habitat type/condition.

The home ranges of 4 *T. s. elegans* and 4 *C. s. serpentina* from Dunbar Lake were calculated. The mean minimum home range size of the 4 *T. s. elegans* was 0.45 ha; for the 4 *C. s. serpentina* it was 1.03 ha. Figures 8 and 9 depict these home ranges and the sequence of captures within each. The home ranges of *T. s. elegans* appears to be strongly influenced by the presence of premium basking logs within those areas. Although no counts were taken, I have seen large numbers of *T. s. elegans* present on these logs. Turtles CSE 3-3 (Fig. 8.) and TSE 1-7 (Fig. 9.) show that these turtles have used opposite areas of the lake at different times within the sampling period. Using the same method of calculation, Gibbons (1990) studied the turtles in a South Carolina lake and found the home ranges for four female *T. s. elegans* to be 3.29 ha (mean 0.82), and one female and four male *C. s. serpentina* to be 1.54 ha (mean 0.31). It should be noted that analysis of home ranges based on mark-recapture data results in severe underestimates (Gibbons 1990) and the calculated ranges only should be considered minimum ranges.

Turtle capture data may be biased because trap netting was torn on several occasions presumably by Muskrats (*Ondatra zibethica*). This allowed any trapped

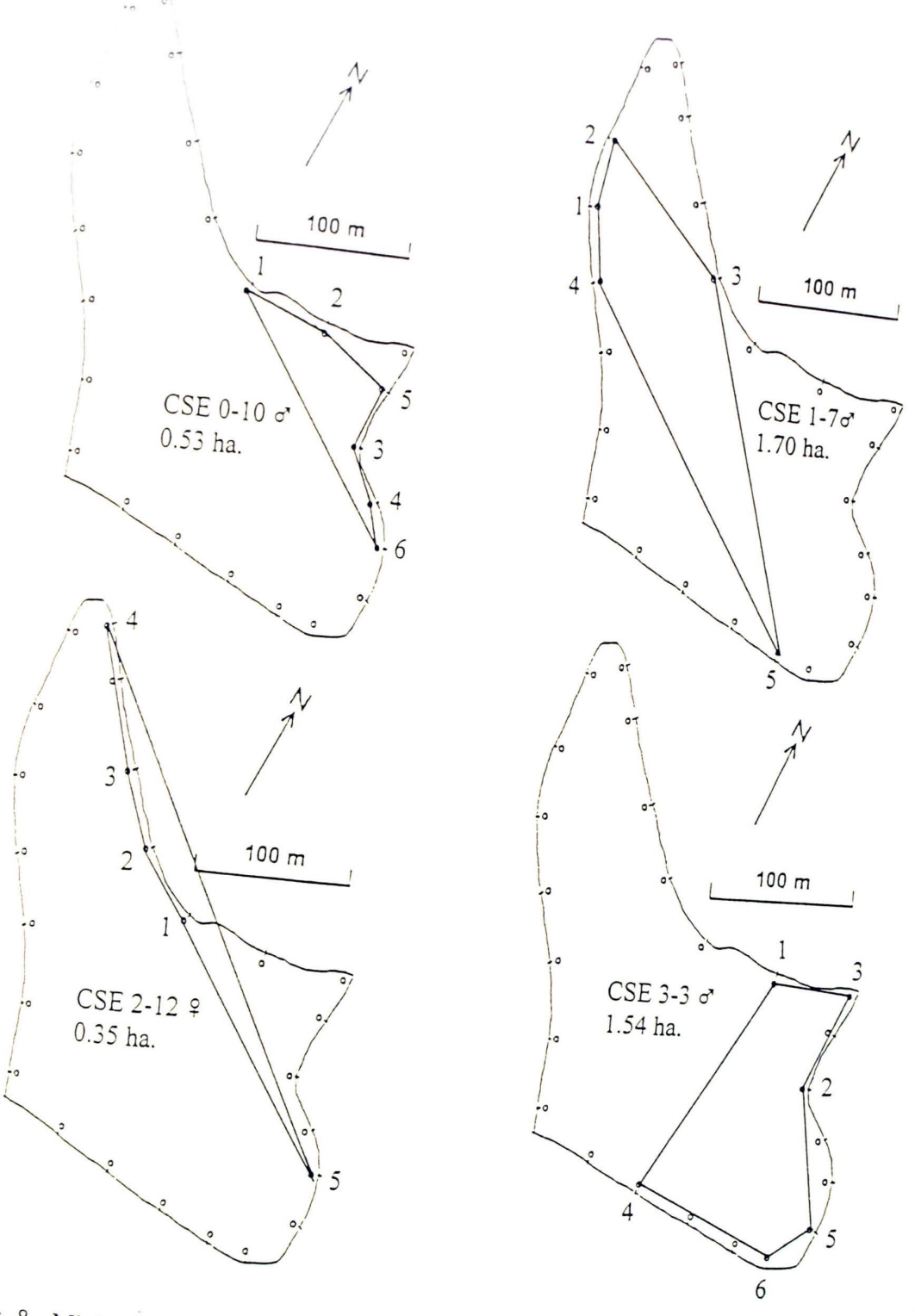

Fig. 8. Minimum home ranges (=area within the polygon minus land mass) for four *Chelydra serpentina serpentina* captured during a mark-capture-recapture study in Dunbar Lake, Montgomery County, Tennessee. Numerals indicate sequence of captures.

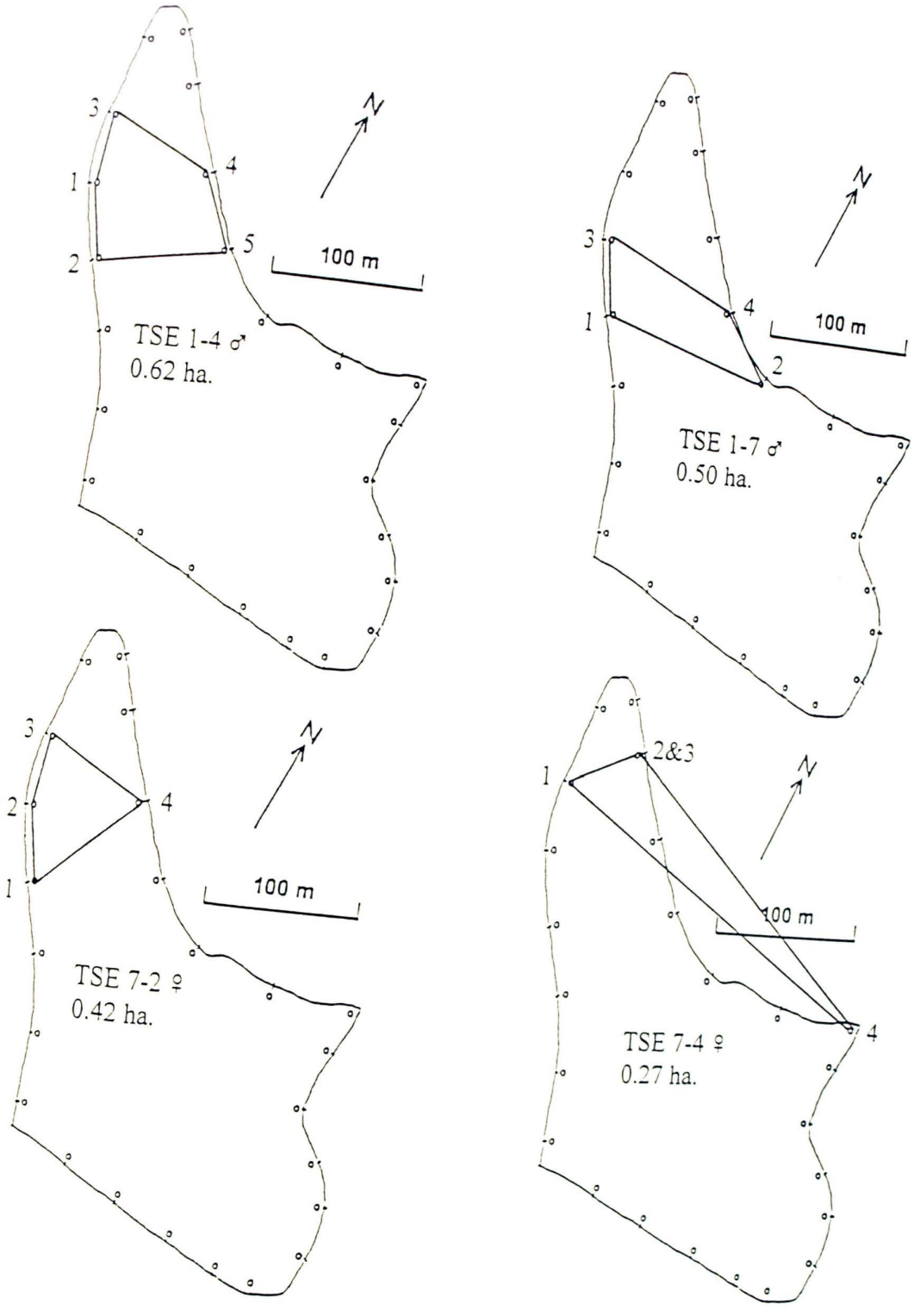

Fig. 9. Minimum home ranges (=area within the polygon minus land mass) for four *Trachemys scripta elegans* captured during a mark-capture-recapture study in Dunbar Lake, Montgomery County, Tennessee. Numerals indicate sequence of captures.

turtles to escape before traps were checked. Bias also could have resulted from using two kinds of bait. Fish from the lake were used when available; sardines served as bait when no fish could be caught. No records of bait usage were kept so an analysis of bait preference is not possible.

CHAPTER V

CONCLUSIONS

The following conclusions are offered concerning DCSNA's herpetofauna:

1. Of the 34 species reported from the area, 26 have been documented by voucher specimens; the other eight are sight records only.
2. Deciduous forest is the dominant terrestrial habitat type and a man-made lake is the only aquatic habitat type; combined, they support most of the species observed.
3. Of the abiotic factors considered, temperature had the strongest influence on reptile activity, whereas precipitation correlated most closely with salamander (*Plethodon* spp.) activity.
4. *Chrysemys picta* and *Diadophis punctatus* populations appear intergradient between overlapping subspecies in the region.
5. Population sizes and home ranges of *T. s. elegans* and *C. s. serpentina* are possibly determined by the size and type of habitat.
6. Future monitoring of DCSNA's herpitle community is recommended to reveal any undetected species and/or shifts in species composition and richness.

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VITA

Kevin Christopher Fitch was born in Lewiston, New York on November 30, 1971. He attended elementary school in Lewiston Porter District until moving to Humacao, Puerto Rico in 1979. There he attended San Benito Academy from 1979 through 1982. In 1982 he moved to Clarksville, Tennessee, where he attended East Montgomery Elementary School for one year. In 1985 he entered Richview Middle School and attended for three years. In 1986 he moved to Columbia, Tennessee, where he attended Central High School and graduated in 1990. He then attended Columbia State Community College for one year. In 1991 he entered Austin Peay State University, Clarksville Tennessee, with studies in biology and geology. He graduated from APSU in 1995 with a Bachelor of Science in biology. He then entered the graduate program and completed the Master of Science Degree in May of 1998.