NERODIA ERYTHROGASTER (PLAINBELLY WATER SNAKE) IN THE LOWER CUMBERLAND RIVER BASIN: AN EVALUATION OF ITS DISTRIBUTION, HABITAT, AND TAXONOMIC STATUS

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A Thesis

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suggest that specimens from the southern half of Tennessee Valley Authority's Land Between The Lakes (LBL) upstream throughout the remainder of the LCRB are *N. e. neglecta* (Copperbelly Water Snake) and that specimens from the northern half of LBL throughout the Jackson Purchase and Reelfoot Lake regions are intergrades between *N. e. neglecta* and *N. e. flavigaster* (Yellowbelly Water Snake). Data from this study also indicate that this area of intergradation encompasses northeastern Arkansas, southeastern Missouri, most of southern Illinois, and all drainages of the Mississippi River within the species range north of southern Illinois.

DEDICATION

This thesis is dedicated to my wife

Pamela Joy

for her support and encouragement.

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ABSTRACT

The distribution, habitat availability, and taxonomic status of the Plainbelly Water Snake (*Nerodia erythrogaster*) in the lower Cumberland River basin (LCRB) was studied to better understand the geographic, ecological, and phylogenetic relationships of populations in the LCRB with those to the north and west. Prior to this study, existing data suggested a distributional hiatus separating the Clarksville (Montgomery Co., Tennessee) population from the Dover (Stewart Co., Tennessee) population.

This study was conducted from the fall of 1996 to the winter of 1998. The field work was done mostly in the fall of 1996 whereas laboratory work was conducted throughout the study. Field work consisted mainly of walking and road-cruising searches for snakes in the vicinity of suitable habitat. Laboratory work focused on the analysis of National Wetland Inventory Maps in order to characterize habitat parameters, and examining specimens for taxonomic characteristics. I used digital image analysis techniques to provide initial quantitative data on pattern and pigment characteristics of snakes from across this entire region.

Excluding the stretches below Barkley Dam and above Ashland City, I found *Nerodia erythrogaster* in suitable palustrine habitat throughout the LCRB. These stretches of the river below Barkley Dam and above Ashland City had reduced habitat (especially the section above Ashland City), they also saw the least intensive field work, and might produce specimens in the future. From the early 1980's to the mid-1990's the LCRB underwent an 11% reduction in available habitat due mainly to draining wetlands for agricultural purposes.

Nerodia erythrogaster populations from the LCRB, the Jackson Purchase region of western Kentucky, and the Reelfoot Lake region of western Tennessee have a confusing taxonomic history, primarily because of only anecdotal analysis of these areas. My results

TABLE OF CONTENTS

LIST OF TABLES

TABLE PAGE

LIST OF FIGURES

FIGURE PAGE

CHAPTER I

INTRODUCTION

Nerodia erythrogaster (Plainbelly Water Snake) inhabits several types of aquatic habitats throughout the southeastern United States. Currently four subspecies are recognized (Conant & Collins 1998) in the United States based primarily on Conant's (1949) taxonomic work. Remnant populations of the subspecies *N. e. neglecta* (Copperbelly Water Snake) in northeastern Indiana, northwestern Ohio, and southern Michigan are listed by the United States Fish and Wildlife Service (USFWS) as threatened in accordance with the Endangered Species Act of 1973 (Buhlmann 1997). Putative populations of *N. e. neglecta* from southern Indiana, southern Illinois, and western Kentucky are not currently afforded such protection (Buhlmann 1997).

Natural history and taxonomic studies of *N. erythrogaster*, especially of those populations in the lower Cumberland River basin (LCRB), have been limited to anecdotal descriptions of its distribution, habitat, and taxonomic characteristics. My review of the literature demonstrated the need for a broad-based regional study of this species. My research focused on the distribution, availability of habitat, and taxonomic status of this species in the LCRB. This study provides the first quantitative analysis of the extent and intensity of pigmentation of ventral scales in adult specimens of *N. erythrogaster*.

Literature Review

Distribution

The distribution of *N. erythrogaster* in the LCRB of Tennessee and Kentucky has been poorly documented over the years. Gentry (1956) stated that *N. erythrogaster* was mostly

confined to western portions of the state, with few records east of the Tennessee River. Scott and Snyder (1968) published the first records of *N. erythrogaster* from the LCRB in Tennessee after finding a population in Montgomery County. This population was subsequently mapped by Conant (1975) as disjunct from the main western body of the distribution, which terminated at the Tennessee River. Whereas Conant and Collins (1998) still show this disjunct Montgomery County population, McCranie's (1990) map indicates a continuous distribution up the Cumberland River from western Kentucky to Montgomery County, Tennessee. Further anecdotal information on the distribution of *N. erythrogaster* in LBL was given by Snyder (1972), while Scott (1991) provided a detailed distribution map for LBL.

Habitat

Wright and Wright (1957), Conant (1949), Conant and Collins (1998), MacGregor (1994), McCranie (1990), and Sellers (1991) have described *N. erythrogaster* as inhabiting an array of aquatic habitats such as bayous, marshes, swamps, and wooded upland ponds. Recent research on *N. e. neglecta* (copperbelly subspecies) suggests that a viable population requires large (200-250 ha) tracts of palustrine bottomland hardwood swamp-forest with slow moving water (Sellers 1991). Upland ponds serve as secondary summer habitat, with relatively undisturbed wooded corridors between bottomland and upland sites serving as transitional habitat (Sellers 1991).

Taxonomy

Nerodia erythrogaster was widely recognized by herpetologists as having two subspecies (*N. e. erythrogaster* [Redbelly Water Snake] and *N. e. transversa* [Blotched Water Snake]) prior to Conant's (1949) descriptions of *N. e. flavigaster* (Yellowbelly Water Snake) and *N. e. neglecta* (Copperbelly Water Snake). Conant (1949) associated *N. e. flavigaster* with the Mississippi

River drainage south of the Missouri bootheel, and *N. e. neglecta* with scattered northern populations in Michigan and Ohio that extend southwest through Indiana, approaching the Ohio River via the Wabash River drainage. He further characterized western Tennessee (Reelfoot Lake) and western Kentucky as a zone of intergradation. Conant (1949) restricted the range of *N. e. erythrogaster* to the Coastal Plain Province of the southeastern United States and relegated *N. e. transversa* to the southwest portion of the species range, mainly in Kansas, Texas, and Oklahoma.

Chaos in the taxonomy of this species in the western regions of Tennessee and Kentucky really began when 1) Gentry (1956) described snakes from western Tennessee as *N. e. erythrogaster*, 2) indicated that *N. e. flavigaster* had not been documented for the state, and 3) made no mention of *N. e. neglecta* occurring anywhere in Tennessee. No other researcher suggested that *N. e. erythrogaster* occurs in Tennessee, but there has been considerable confusion over whether the LCRB is home to *N. e. flavigaster*, *N. e. neglecta*, or an intergrade of the two.

Comparing their specimens to Conant's (1949) subspecific description, Scott and Snyder (1968) felt the disjunct Montgomery County, Tennessee, population of *N. erythrogaster* most closely resembled the *neglecta* subspecies. Scott (1991) reported that LBL specimens appeared to be intergrades whereas Meade (1991) concluded that snakes from western Kentucky (Jackson Purchase) were *N. e. neglecta* with minimal *N. e. flavigaster* influence. MacGregor (1994) characterized the Jackson Purchase region as an area of intergradation between the two subspecies, with *N. e. flavigaster* influence being strongest to the southwest and *N. e. neglecta* influence being strongest to the northeast. Brandon and Blanford's (1995) preliminary genotypic analysis of specimens from southern Illinois helped little in resolving relationships at the subspecific level and did not allow them to discriminate reliably between subspecies and

intergrades. Conant and Collins (1998) indicate that the Montgomery County, Tennessee, population is *N. e. neglecta*, but the Tennessee Wildlife Resources Agency (TWRA) has listed this subspecies as only potentially occurring in the state (Withers and Christie 1997).

Goals and Objectives

The goals of this study were to: 1) document the distribution of, 2) characterize, quantify, and identify trends in available habitat for, and 3) determine the taxonomic status of *N. erythrogaster* in the LCRB. These goals involved the following specific objectives: 1) document the known populations of *N. erythrogaster* by surveying zoological museums likely to have specimens from the study area, and by searching the study area for living specimens; 2) quantify and describe the known and potential habitat of *N. erythrogaster* by determining the area and characteristics of documented habitat, the area and characteristics of potential habitat, and identifying any obvious trends in habitat quality and availability; and 3) determine the subspecific status of *N. erythrogaster* in the region by placing sample specimens into appropriate *a priori* groups, identifying distinguishing phenotypic characteristics, and analyzing those phenotypic characteristics.

Significance of Study

Prior to this study no comprehensive review of the distribution, habitat, and taxonomic status of *N. erythrogaster* had been conducted in the LCRB. In fact, McCranie (1990) felt that a thorough range-wide taxonomic study of this species was needed. Concern for threatened and endangered species, along with continued decline of wetlands in the southeastern U.S. (Hefner et. al. 1994), demonstrate the importance for broad-based local and regional natural history studies. Results from this research may aid in developing management plans for wetlands within

the LCRB, since further degradation of habitat across this region could eventually threaten its resident populations of *N. erythrogaster*. If protection is extended over the entire range of this subspecies it will be necessary to define more clearly areas of intergradation so that preservation and enforcement efforts are properly focused.

METHODS AND MATERIALS

The Study Area

My study area included the Cumberland River floodplain and adjacent uplands from its confluence with the Ohio River at Smithland (Livingston County), Kentucky upstream to Old Hickory Dam near Nashville (Davidson County), Tennessee. This 348 kilometer portion of the Cumberland River is within the Interior Low Plateaus Province (Miller 1974). From Old Hickory Dam the river flows from the Inner Central Basin through the Outer Central Basin and Western Highland Rim to the Ohio River (Burr & Warren 1986). Most of the study area was privately owned, but public lands occurred at LBL and Cross Creeks National Wildlife Refuge.

Distribution Analysis

Austin Peay State University's (APSU) Museum of Zoology housed most of the specimens, and its data bases contained all known records (some based on specimens in other museums) of *N. erythrogaster* for the LCRB. Additional distribution data were gathered from several local, regional, and national zoological museums (Appendix A) that housed Tennessee and Kentucky collections of *N. erythrogaster*. With these museum data and the aid of current distribution maps (Conant & Collins 1991), field work was concentrated on areas lacking documented populations of *N. erythrogaster*. Most field work consisted of day and night road cruising and walking searches in and near habitats thought attractive to the species. Another tactic included investigating reports of specimens by the general public. The majority of the field work was conducted in late summer through the fall of 1996.

Collection localities represented by voucher specimens were plotted on United States Fish

and Wildlife Service National Wetland Inventory (NWI) maps of the LCRB. These maps are based on aerial photographs taken between 1980 and 1983, and are formatted as a United States Geological Survey (USGS) 7.5-minute series quadrangle map. Many of the plotted locations are based on very accurate latitude-longitude determinations by the collector (Appendix B & C). Locations of specimens that did not have latitude-longitude data were plotted based on the written description of the locality data.

After the voucher specimen locales were plotted, they were grouped into "sub-populations" based on a "home range" index value. The home range index value was set as the average distance between sites where specimens were found outside the Cumberland River floodplain and the nearest wetland with a stable (seasonally flooded, semipermanently flooded, or permanently flooded) water regime. This distance was then used as the radius of a home-range circle drawn around the collection point of each voucher specimen. Sub-population sizes ranged from one to several individuals with overlapping home ranges.

Habitat Analysis

Area and habitat structure, based on NWI map habitat classification, of documented and potential *N. erythrogaster* habitat sites were determined for the LCRB. Documented habitat was taken to be any palustrine habitat found in association with historical or newly discovered sub-populations of *N. erythrogaster*. Potential habitat was assumed to be any palustrine habitat with habitat structure similar to documented habitat but not necessarily associated with *N. erythrogaster* sub-populations. The study area was subdivided into 10 "study zones" (each 34.8 river kilometers in length) to allow for comparison of habitat along the course of the river. Habitats were classified according to the NWI maps classification system, briefly outlined by Tiner (1984), and area was calculated using a map scales and equivalents modified area grid

(acetate overlay) from Forestry Suppliers, Inc. Based on published generalizations about *N. erythrogaster* habitat (Wright & Wright 1957; Snyder 1972; Conant & Collins 1998; Sellers 1991) and my own personal observations, I limited the wetland habitat analysis to the palustrine wetland system.

Analysis of Documented Habitat

The analysis of documented habitat focused on the wetlands associated with the sub-populations of *N. erythrogaster*. Wetlands falling within or touching the home range boundary of a sub-population, and all other contiguous wetlands, were included in the analysis. This provided a detailed habitat analysis with a breakdown of habitat types and their area for each of the sub-populations of *N. erythrogaster* identified in the study area.

Analysis of Potential Habitat

With information gleaned from the analysis of the documented habitat on dominant wetland types and area, the analysis of potential habitat considered wetland habitat availability regardless of voucher specimen locale. Potential habitats were analyzed by using a modified wandering-quarter sampling method (Brower et. al. 1990) to locate wetland habitats outlined on the NWI maps. The wandering-quarter sampling method is actually a field sampling technique for plant surveys, but I used its basic principles (modified so that the Cumberland River corridor was followed instead of a straight line transect) to locate wetlands.

Sampling began on the Smithland, KY-ILL NWI map at the confluence of the Cumberland and Ohio rivers in Livingston County, Kentucky (Smithland) and concluded on the Goodlettsville, TENN NWI map in Davidson County, Tennessee (Old Hickory Dam). Habitats selected were those with a stable water regime and at least 5.8 hectares of area. These

limitations on type and size of habitats were selected to avoid analysis of what would probably be marginal habitats. The size limitation is the median value for the largest single habitat with the desired water regime found within each sub-population of the analysis of documented habitat.

Habitat Trends

Aerial photographs were analyzed to determine changes in the LCRB's habitat that have occurred since the early 1980's. Aerial views (in the form of 35 mm slides) of the Cumberland River's floodplain taken during the summers of 1994 and 1995 from an altitude of 2590 m were obtained from various county offices of the United States Farm Service Agency (USFSA). The sites analyzed in the analyses of documented and potential *N. erythrogaster* habitat were then identified in the aerial slides and any detectable area changes determined. Whereas the "sampling technique" in the analysis of documented habitat was biased toward easily accessible habitats (e.g., public lands) and selection for a specific type of habitat, in the analysis of potential habitats the wandering-quarter sampling technique provided a systematic approach free of these biases. Because of the sampling bias inherent in the analysis of documented habitat, long-term projections are primarily based on the analysis of potential habitat.

Taxonomic Analysis

Nerodia erythrogaster specimens collected during the study, those housed in the APSU collection, and those borrowed from several zoological museums (Appendix A) were analyzed for juvenile and adult taxonomic characteristics. Specimens with a total length equal to or greater than 800 mm were considered adults with smaller individuals treated as juveniles (Sellers 1991). The phenotypic subspecific characteristics analyzed in both juveniles and adults were

those detailed by Conant (1949), and all references to these characteristics throughout the remainder of this section refer to this work.

Taxonomic Characteristics

Conant stated that, except for *N. e. flavigaster* and *N. e. neglecta*, the juveniles of the various subspecies of *N. erythrogaster* are indistinguishable. He characterized *N. e. flavigaster* juveniles as usually having a clean-cut pattern with very little fusing of mid-dorsal and lateral blotches, whereas *N. e. neglecta* juveniles usually have a confused pattern with extensive fusing of mid-dorsal and lateral blotches.

Adult *N. e. flavigaster* have an olive grey to dark greenish-grey unpatterned dorsum, with occasional individuals showing a remnant of the juvenile dorsal pattern. Some adult individuals also retain a parietal-spot and postparietal streak. Ventral coloration is yellow or lemon, with slight encroachment of the light-hued dorsal pigment onto the ventral scales.

Nerodia e. neglecta adults have a dark brown to black unpatterned dorsum. Rare individuals display a remnant of the juvenile dorsal pattern. Parietal-spots and postparietal streak are almost always absent in adults. Ventral coloration ranges from orange red to red or scarlet, with a heavy invasion of dark dorsal pigment onto the ventral scales.

Phenotypic Characters Analysis

Overall Analysis - Juvenile specimens with a visible pattern were scored as *N. e. flavigaster*, *N. e. neglecta*, or an intergrade of these two taxa, based on the amount of fusion among mid-dorsal and lateral blotches. Depending on the intensity of the dorsal pattern and postparietal streak, adults were scored on a scale from zero (not visible) to three (conspicuous). The conspicuousness of each of the two parietal-spots was scored from zero to three, and the average

of these two values was used in the statistical analysis. The extent (area) of pigment invasion from the dorsum onto the ventral scales, and pigment intensity, were measured using video image analysis of three systematically selected areas (for a total of nine ventral scales) of the venter in each adult specimen. Only anecdotal data could be gathered on ventral coloration because most of the specimens examined for this study were preserved. Snout-vent length (SVL), tail length (TL), sex (when discernible), and ventral scale number (excluding the plate) were determined for all adults in the analysis.

Equipment - Snout-vent length and TL were measured with a nylon string and a meter stick. Area and intensity characters were analyzed with a combination of video imaging, editing, and analysis software. Images were "captured" by two different photographic systems. The initial photographic system consisted of an 18 mm to 108 mm zoom lens attached to a Javelin Electronics Chromochip II MDS solid state CCTV camera (model JE3462HR). Images were taken as 24 color bit bitmap files (BMP) with a 160 X 120 frame size using Adobe Premiere 4.2 software. The remainder of the images were taken as 24 color bit tagged-image file format files (TIF) at super high resolution (1600 X 1200 pixels) using a Polaroid Digital Camera (PDC) 2000 and PDC direct software. Lighting was provided by three 100-watt incandescent lamps, each with its own custom-made filter consisting of a cardboard box frame and tracing paper. The PDC 2000 system had additional light from an automatic flash, and the autofocus option was used. Forceps were used to remove shedding scales and other extraneous material from the imaged area.

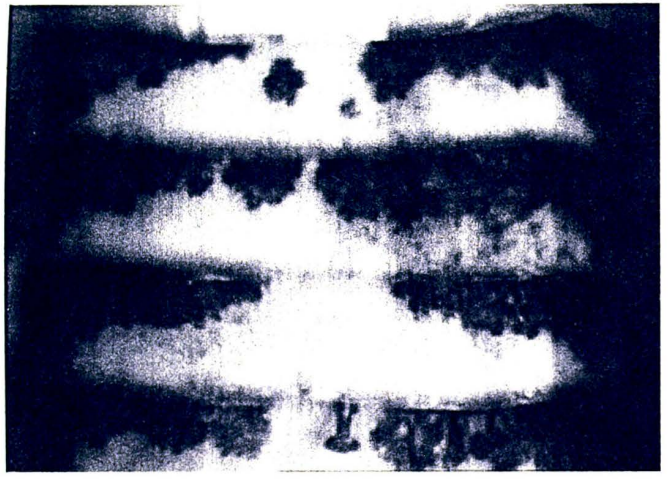
Image Location -Three sites from the venter of each specimen were imaged. Each image involved three contiguous scales. To standardize the siting of the images, I made a standardized ventral count and divided that number by four. The ventral scales of these images were, respectively, 1/4, ½, and 3/4 of the distance (measured by ventral scale number) back from scale

number one. In a few specimens the image sites were shifted anteriorly or posteriorly to avoid scarred or mutilated scales in the images.

Image Editing - Since the extent and intensity of pigment invasion of the ventral scales was the focus of this analysis, a "study image" was measured and cropped out of the original image using Sigma Scan Pro 4.01 (SigmaScan) image analysis software (Figure 1). The width of the study image was the middle half of the original image. The height of the study image extended from the anterior-most point of the anterior scale to the posterior-most point of the posterior scale. The study images taken with the PDC 2000 were converted from TIF files to BMP files using SigmaScan. The study images then went through final editing using Microsoft Paint and SigmaScan. Only the dark pigment invading from the dorsum onto the ventral scales needed to be analyzed, so all other pigment in the study image was erased using Microsoft Paint. SigmaScan was then used to transform the study images from a 24-color bit format to a grayscale format, which made intensity measurements possible.

Image Analysis - After editing was complete, area and intensity measurements were taken with SigmaScan to determine the number and average intensity of pixels of pigment in the study images. The percentage of pigment was calculated by adding the area values (**AV**) of individual pigment clusters (discrete areas of pigment within a given study image) resulting in a total area value (**TAV**), which was then divided by the total study image area and multiplied by 100. SigmaScan calculated an average intensity value (**AIV**) for each pigment cluster in a study image, the **AIV** was expressed on an arbitrary scale from zero (black) to 255 (white).

Study images had from one to several pigment clusters, of various sizes, so it was necessary to determine the relative average intensity value (**RAIV**) for each pigment cluster before an average image intensity value (**AIIV**) could be determined for any study image. To do this, the relative area (**RA**) for each pigment cluster was calculated by dividing its **AV** by the **TAV** for



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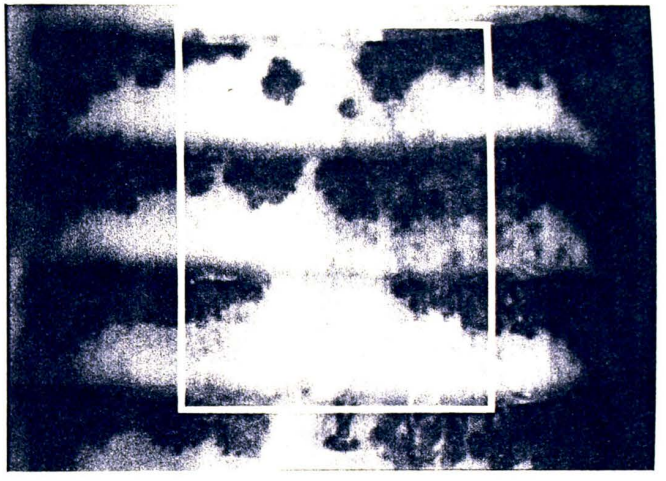

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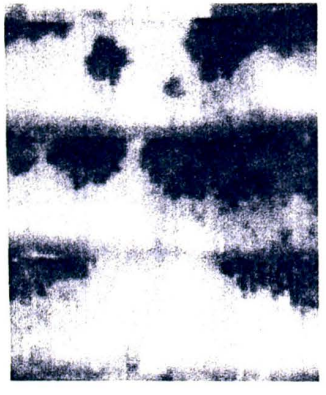

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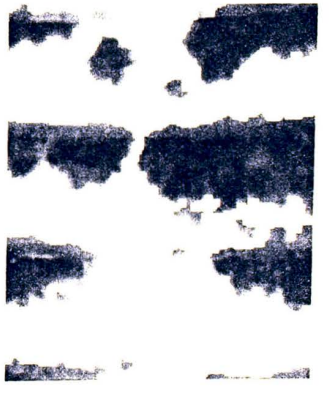

D

Figure 1. Steps in study image preparation for the analysis of ventral scales in *Nerodia erythrogaster*: A) original study image, B) area selected for analysis, C) analysis area cropped from original image, D) final study image preparation completed with the erasure of unwanted background pigment.

the study image. The **RA** then provided the percentage an individual pigment cluster contributed to the **TAV**, thus allowing for size correction in the **AIIV**. The **RAIV** equaled a pigment cluster's **AIV** multiplied by its **RA**. The **AIIV** for a study image equaled the sum of its **RAIV**s. The final step was to determine the total average intensity value (**TAIV**) for each specimen, by taking the three **AIIV**s for each specimen and calculating their mean.

Statistical Analysis

The statistical analyses of the habitat and taxonomic data were performed with StatSoft Statistica software. The habitat analysis was limited to descriptive statistics of various habitat types, and measurable characteristics of the distribution of available habitat. The taxonomic analysis of juvenile and adult data sets involved both nonparametric and parametric statistics, as appropriate.

The Shapiro-Wilk's W test (Royston 1982) for normality was used on the various taxonomic data sets to determine which were normally distributed. Data not normally distributed were subjected to nonparametric analyses, specifically the Spearman rank order correlation and the Median test (Sokal & Rohlf 1995). Parametric statistical tests were employed on normally distributed data, specifically the Pearson product-moment correlation, a one-way MANOVA with a *post hoc* (LSD) comparison, and a discriminate function analysis (DFA) (Sokal & Rohlf 1995).

CHAPTER III

RESULTS AND DISCUSSION

Distribution Analysis

The distribution data on *N. erythrogaster* in the LCRB prior to this study revealed a lack of specimens not only between eastern Stewart County, Tennessee (Cumberland City) and central Montgomery County, Tennessee (Clarksville), but also at both ends of the study area (Figure 2). The putative disjunct status of the Montgomery County population seemed to be an artifact of collecting, since apparently suitable habitats existed within the hiatus, there were no barriers to colonization, and this area had seen little collecting effort. During this study I and others collected several specimens from previously documented populations of *N. erythrogaster* and from within the distributional hiatus. But I found no specimens in the upper or lower ends of the study area (Figure 2, Appendix B & C). Further field work downstream from Barkley Dam, where potential habitat still exists, should yield specimens from the Livingston County, Kentucky area, but it is doubtful that specimens will be found upstream of Ashland City, Tennessee in Davidson County because of the scarcity of favorable habitat.

Habitat Analysis

Analysis of Documented Habitat

The average home-range radius of specimens from the LCRB was found to be 1.3 km (n=9). A total of 1221 ha of documented habitat was found to be associated with the 23 populations of *N. erythrogaster* known from the LCRB (Appendix D). Forested, emergent, and scrub-shrub

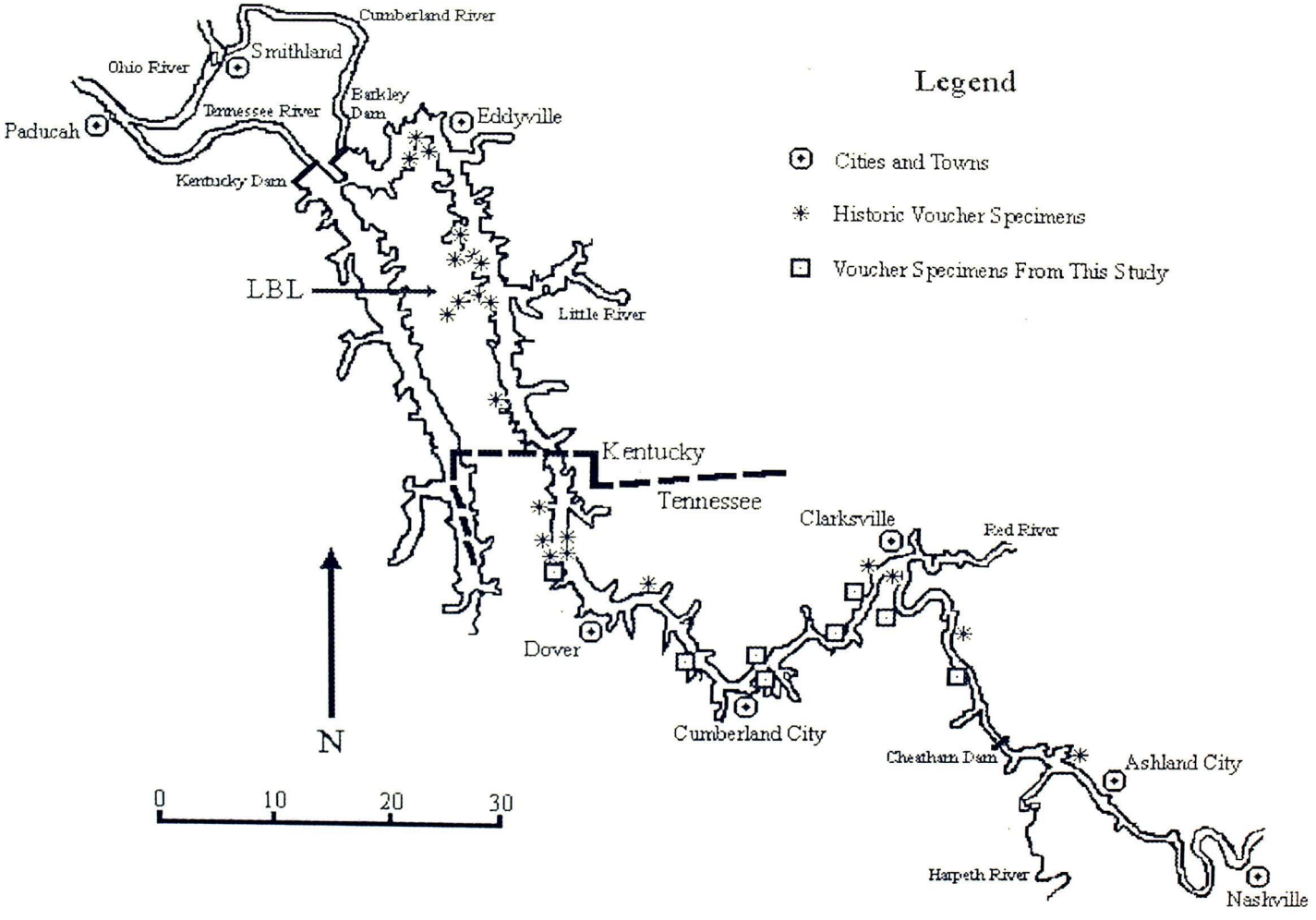

Figure 2. Distribution of *Nerodia erythrogaster* voucher specimens from the lower Cumberland River basin.

habitat accounted for more than 90% of this total (Figure 3). Documented *N. erythrogaster* habitat was found in study zones two through eight, whereas zones one, nine, and 10 lacked voucher specimens (Figure 4). More than 60% of the documented *N. erythrogaster* habitat was in the LBL area (zones two, three, and four), with the highest concentration of habitat occurring from the middle of study zone three through zone four (Figure 4).

The average size of contiguous habitats associated with the documented populations of *N. erythrogaster* across the 10 study zones had a distribution similar to the total values, with zones four, three, and five having, in that order, the most total documented habitat. Zones four, seven, and eight had, in that order, the largest average habitat size (Figure 5).

Analysis of Potential Habitat

Nine-hundred seventy-eight hectares of potential habitat were identified from the LCRB with forested, emergent, and scrub-shrub habitat accounting for more than 90% of that total (Figure 6). At least some potential habitat was found in all zones except one, nine, and 10. 32% of the total potential habitat was found within the LBL area (Figure 7). Zones four, five, and seven had, in that order, the highest concentration of potential habitat (Figure 7). The average amount of potential habitat per zone ranged from 5.8 to 16.2 hectares (Figure 8). Whereas study zone one had substantial potential habitat around Smithland, Kentucky, the upper and lower portions of the study area generally lacked potential *N. erythrogaster* habitat (Figure 7). The average distance between habitat sites was greatest in the terminal zones (Figure 9).

The habitat types associated with *N. erythrogaster* in the LCRB were similar to those described for the species by Wright and Wright (1957), Conant and Collins (1998), and Sellers (1991). Sellers (1991) observed that "southern mesic floodplain swamp-forest" is critical habitat for *N. e. neglecta*. Sellers (1991) stated that a viable population of *N. e. neglecta* needs

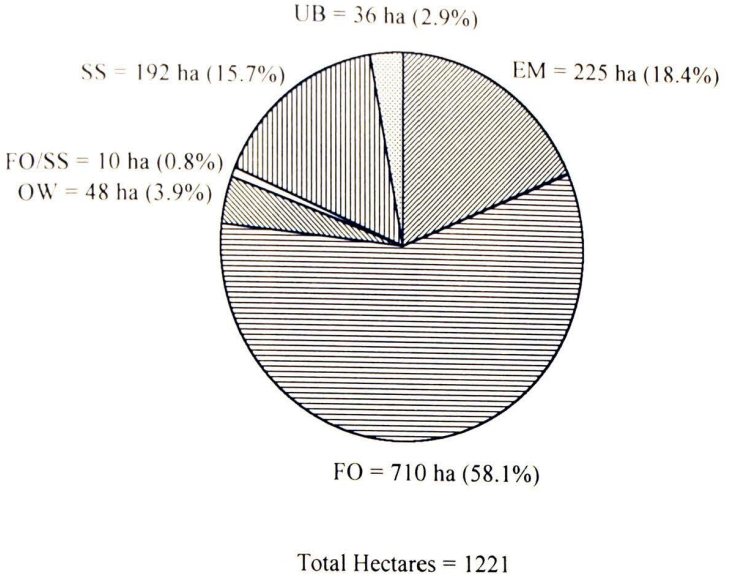

Figure 3. Total area of documented *Nerodia erythrogaster* habitat in the lower Cumberland River basin. Habitat categories: FO = forested, OW = open water, FO/SS = forested/scrub-shrub, UB = unconsolidated bottom (man-made ponds), EM = emergent vegetation.

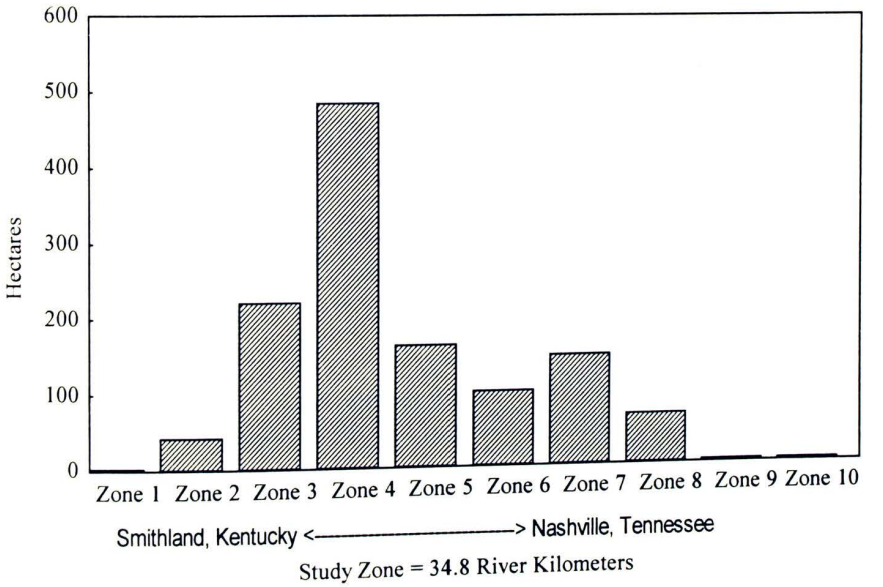

Figure 4. Total area of documented *Nerodia erythrogaster* habitat in each study zone along the lower Cumberland River basin between Smithland, Kentucky and Nashville, Tennessee.

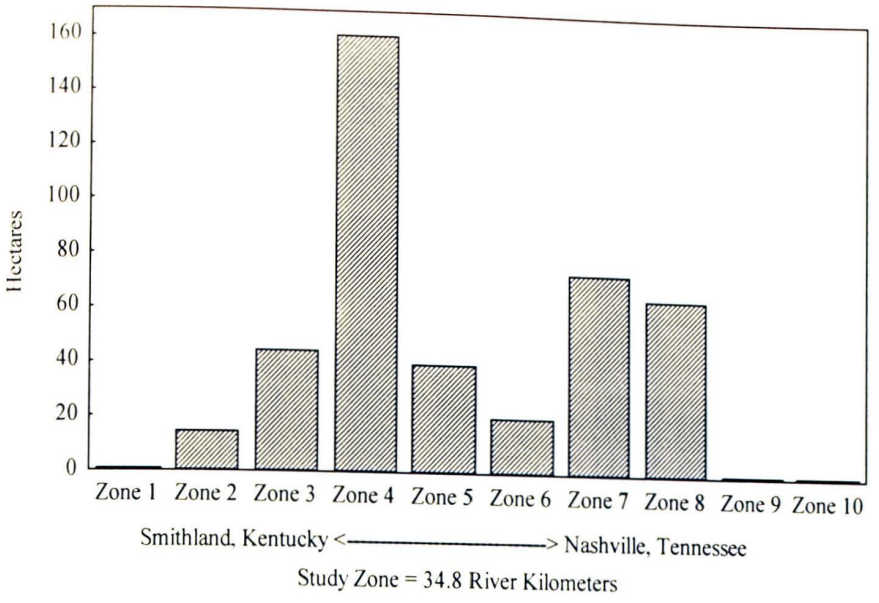

Figure 5. Average area of documented *Nerodia erythrogaster* habitat in each study zone of the lower Cumberland River basin between Smithland, Kentucky and Nashville, Tennessee.

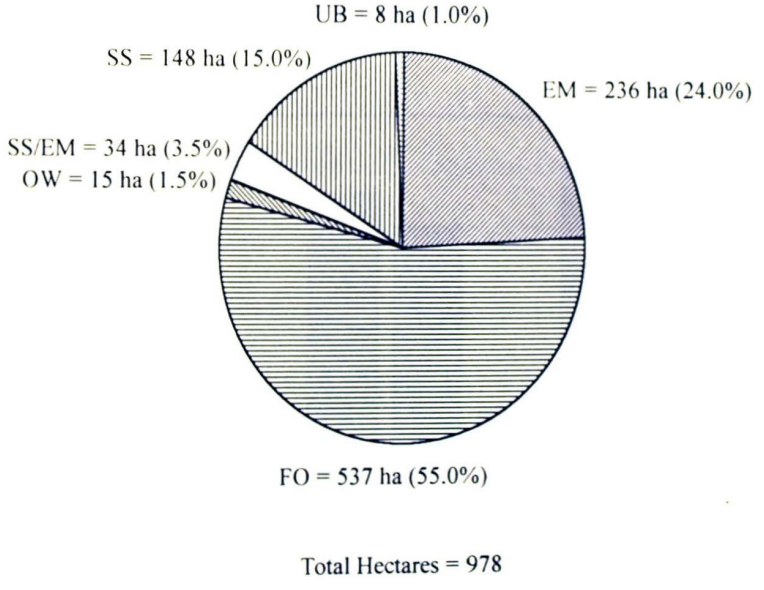

Figure 6. Total area of potential *Nerodia erythrogaster* habitat in the lower Cumberland River basin. Habitat categories: FO = forested, OW = open water, SS/EM = scrub-shrub/emergent vegetation, SS = scrub-shrub, UB = unconsolidated bottom (manmade ponds), EM = emergent vegetation.

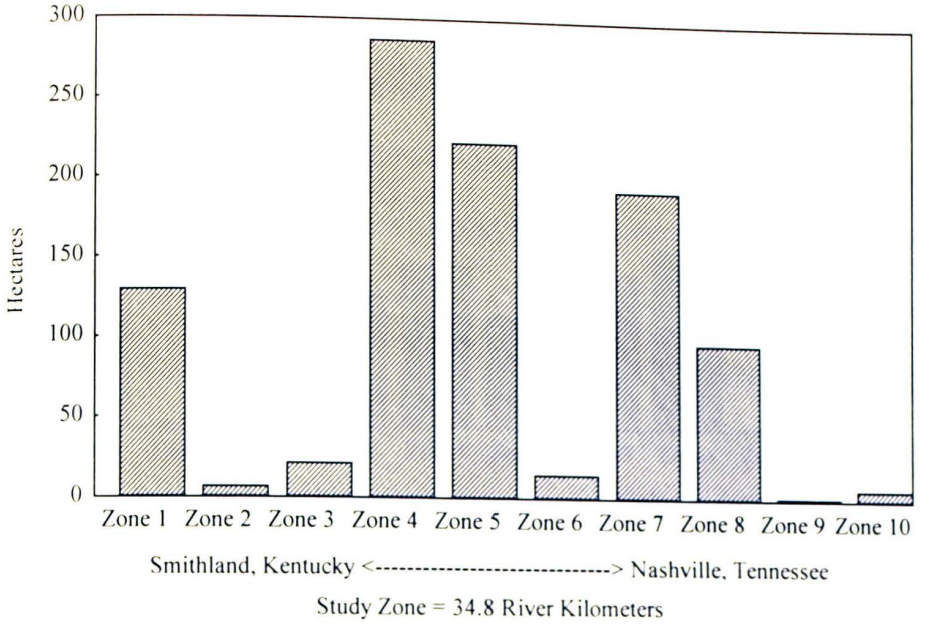

Figure 7. Total area of potential *Nerodia erythrogaster* habitat in each study zone of the lower Cumberland River basin between Smithland, Kentucky and Nashville, Tennessee.

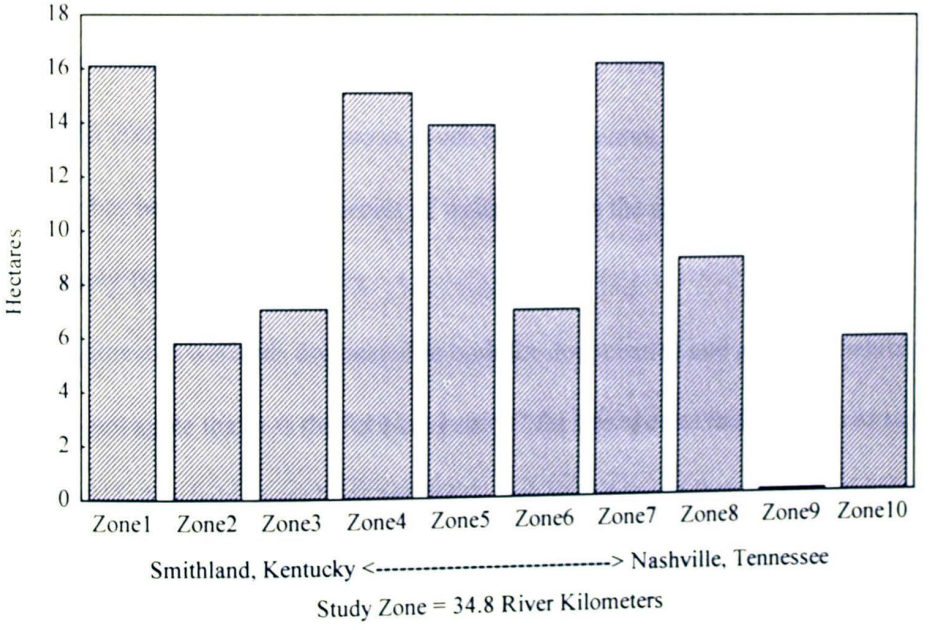

Figure 8. Average area of potential *Nerodia erythrogaster* habitat within each study zone of the lower Cumberland River basin between Smithland, Kentucky and Nashville, Tennessee.

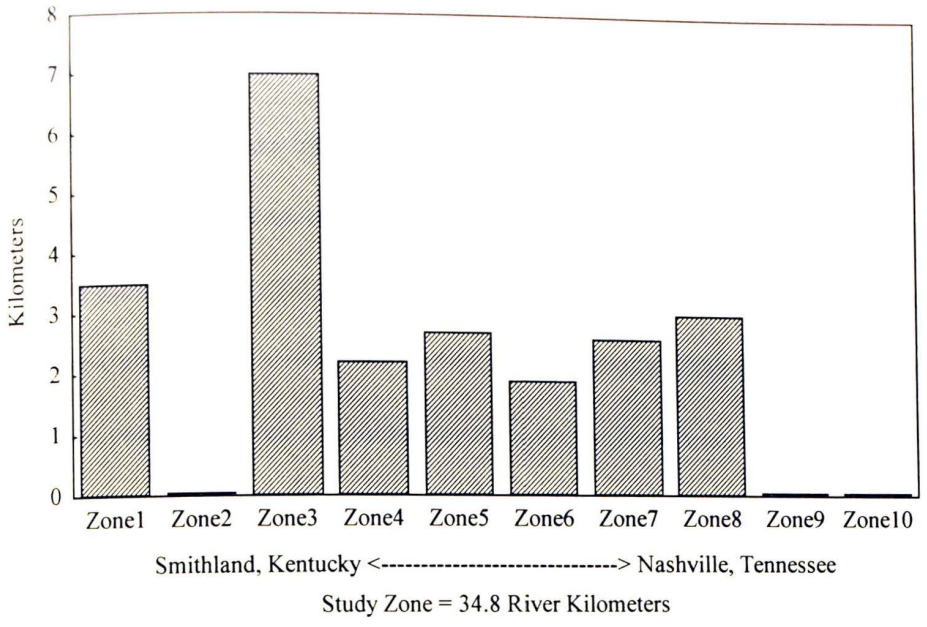

Figure 9. Average distance between locations of apparently suitable *Nerodia erythrogaster* habitat (no value possible for study zones with fewer than two habitat sites) in each study zone of the lower Cumberland River basin between Smithland, Kentucky and Nashville, Tennessee.

200-250 ha of continuous southern mesic floodplain swamp-forest habitat. I found no place in the LCRB with 200-250 ha of contiguous, much less continuous, palustrine habitat, yet *N. erythrogaster* has been a common species of water snake in the region since it was first collected there in the early 1950's (Appendix E).

Although forested wetlands dominated in both the documented and potential habitat analyses, I do not agree that it is the "critical habitat" for this species in the LCRB as suggested by Sellers (1991). My habitat analyses and field work both suggest that the critical habitat for this species is probably a combination of 1) palustrine habitats dominated by forested, emergent, and scrub-shrub wetlands, and 2) adequate hibernacula.

Habitat Trends

The LCRB experienced a 1.4% reduction of documented and a 10.8% reduction of potential *N. erythrogaster* habitat between the early 1980's and the mid-1990's. This rate of decline in documented habitat represented only about 30% of the 4.8% rate of decline for wetlands in the southeastern United States between the mid-1970s and the mid-1980s (Hefner et. al. 1994), but the decline in potential habitat was more than twice the regional rate. Documented habitat was lost in study zone seven (17 ha), whereas potential habitat was lost in study zones one (10 ha), five (48 ha), seven (24 ha), and eight (24 ha). *Nerodia erythrogaster* faces threats to its habitat from coal mining (MacGregor 1994), hydrologic modifications, and illegal collecting (Sellers 1991; Kingsbury 1993), but it is agricultural activity that has historically caused the greatest loss of habitat for this species (Sellers 1991), in the LCRB and elsewhere. Several specimens have been documented from upland pond sights throughout the years but I could not assess the stability of this habitat because of the difficulty in seeing woodland ponds in aerial slides.

Taxonomic Analysis

Test for Normal Distribution and Transformation of Data Set

The Shapiro-Wilk's W test was used to test the various data sets for normal distribution ($P < 0.05$). Data on juvenile pattern ($W = 0.782$, $P = 0.000$), adult pattern ($W = 0.805$, $P = 0.000$), adult parietal-spots ($W = 0.720$, $P = 0.000$), invasion of dorsal pigment onto the venter in adults ($W = 0.934$, $P = 0.000$) and intensity of invasion of dorsal pigment onto the venter in adults ($W = 0.982$, $P = 0.0296$) were not normally distributed. Data transformations of the juvenile pattern, adult pattern, and adult parietal-spot data were not effective because of the basic nature of the

scored data. Since surface area data are often better analyzed after being square-root-transformed (Sokal & Rohlf 1995), adult ventral pigment area (W = 0.984, $P = 0.051$) and intensity (W = 0.988, $P = 0.155$) data were transformed in this manner. After transformation, both data sets passed the Shapiro-Wilk's W test for normality. To accomplish the transformation, the pigment area data were left as decimal values, whereas the pigment intensity data were converted into decimals by dividing each datum by 255, the maximum value for the intensity scale of measurement which ranges from zero (black) to 255 (white).

Another concern was that body size might influence the adult ventral pigment area and intensity data, since this species tends to darken and ventral pigmentation to increase with age. Because of these tendencies size correction was done by calculating residuals for each variable regressed on SVL (Irschick & Shaffer 1997). Multiple regression analysis showed significant correlations ($P < 0.05$) between both the pigment area (beta = 0.259, $P = 0.001$) and intensity (beta = -0.171, $P = 0.028$) data and SVL; therefore, residual values are used in the analysis. The residual values for the pigment area (W = 0.990, $P = 0.325$) and intensity (W = 0.991, $P = 0.403$) data also passed the Shapiro-Wilk's W test for normality.

Correlations Between Adult Phenotypic Taxonomic Characteristics

Conant's (1949) description of the various subspecies suggests that correlations should exist among the various taxonomic characteristics. A review of my data revealed that the postparietal streak characteristic, present in two of the 165 adult specimens examined, is invalid as a taxonomic character. The other characteristics were regularly present. Since the pattern and parietal data were suited only to nonparametric analyses, the Spearman rank order correlation was used to look for relationships among the area, intensity, pattern, and parietal data.

The Spearman rank order analysis revealed correlations ($P < 0.05$) between pigment area and

pigment intensity (Spearman R = -0.566, $P = 0.000$), and adult pattern and parietal-spot (Spearman R = 0.219, $P = 0.005$) data. The Pearson product-moment correlation analysis confirmed the strong negative correlation ($P < 0.05$) between pigment area and pigment intensity (Pearson r = -0.576, $P = 0.000$). Thus, as dorsal pigment encroachment onto the ventral scales increases there was a corresponding darkening of the pigment intensity (Figure 10). The adult pattern and parietal-spot data were positively correlated, but less strongly. As pattern visibility increased so did parietal-spot visibility (Figure 11).

A Priori Groups

Irschick and Shaffer (1997) analyzed the phenotypic variation in *Ambystoma tigrinum* (Tiger Salamander) looking at 1353 larvae from across the species' range in hopes of clarifying taxonomic questions that had been debated for years (Collins et al. 1980). My study tested the validity of Conant's (1949) classification of *N. e. flavigaster* and *N. e. neglecta*, and outlined areas of intergradation between these two subspecies. Of the 530 specimens I examined, 242 were included in the analysis of juvenile characters and 165 in the analysis of adult characters (Appendix B). For various reasons the remaining 123 were excluded from the analysis (Appendix C). Irschich and Shaffer (1997) were able to place their 1353 specimens into 60 discrete populations (individual ponds) thus making both an *a priori* and an *a posteriori* analysis of their data possible. My data set did not provide me with an adequate number of individuals or groups to justify an *a posteriori* analysis, so my taxonomic analyses were performed on specimens placed into *a priori* groups based on distribution.

Specimens from Alabama, Mississippi, Louisiana, and southern Arkansas were grouped as typical *N. e. flavigaster* (FLAV). Specimens from Michigan, Ohio, Indiana, extreme southeastern Illinois (one specimen), and the coal field region of north-central Kentucky were

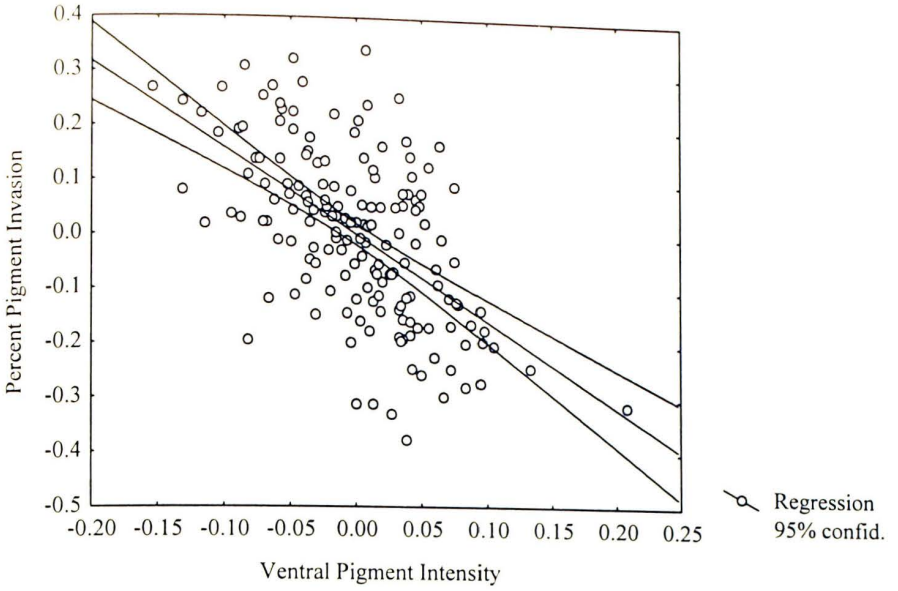

Figure 10. Relationship (Pearson r = -0.5762, P = 0.000) between the index of ventral pigment intensity and invasion of dorsal pigment onto ventral scales of adult *Nerodia erythrogaster*. Values are residuals of the square-root-transformed data.

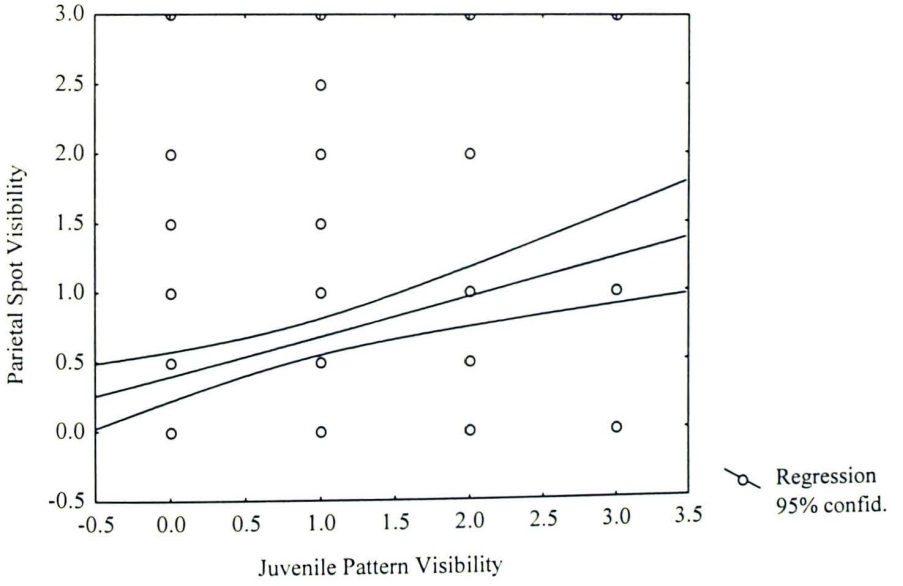

Figure 11. Relationship (Spearman R = 0.2187, P = 0.005) between the indices for juvenile pattern visibility and parietal-spot visibility in adult *Nerodia erythrogaster*.

grouped as typical *N. e. neglecta* (NEG). Specimens from western Tennessee, western Kentucky, and southern Illinois were grouped as intergrades (INT). Specimens from the northern half of LBL (based on Scott 1991) were grouped (LBL) to determine if they were more similar to the suspected intergrade population or to the snakes found upstream throughout the rest of the LCRB. Specimens from extreme northeastern Arkansas and extreme southeastern Missouri were grouped together (ARMO) in hopes of more clearly defining the zone of intergradation. These portions of Arkansas and Missouri are generally shown to be populated by *N. e. flavigaster* (Conant & Collins 1998), though specimens just east of the Mississippi River in western Kentucky (McGregor 1994) and western Tennessee (Conant 1949) are considered intergrades. Specimens from approximately the southern half of LBL upstream throughout the remainder of the LCRB were grouped (CUMB) to determine if this area is populated by intergrades or typical specimens of either subspecies.

Nonparametric Analysis

Since the juvenile pattern, adult pattern, and adult parietal-spot data were not normally distributed, my analyses of these data were limited to descriptive and nonparametric statistics. The Median test was chosen over the Kruskal-Wallis ANOVA by Ranks because of the artificial limits inherent in the scored data and many of the cases tended to fall at the extreme ends of the scale (Figures 12, 13, and 14). Results of the Median test indicate that there are statistically significant differences ($P < 0.05$) among the medians of the *a priori* groups for the juvenile (Chi-Square = 91.710, $P = 0.000$) and adult pattern (Chi-Square = 15.572, $P = 0.008$) data while the adult parietal-spot data do not show a significant difference (Chi-Square = 9.125, $P = 0.104$).

A review of the descriptive statistics for the juvenile data suggests that young *N. e. neglecta*

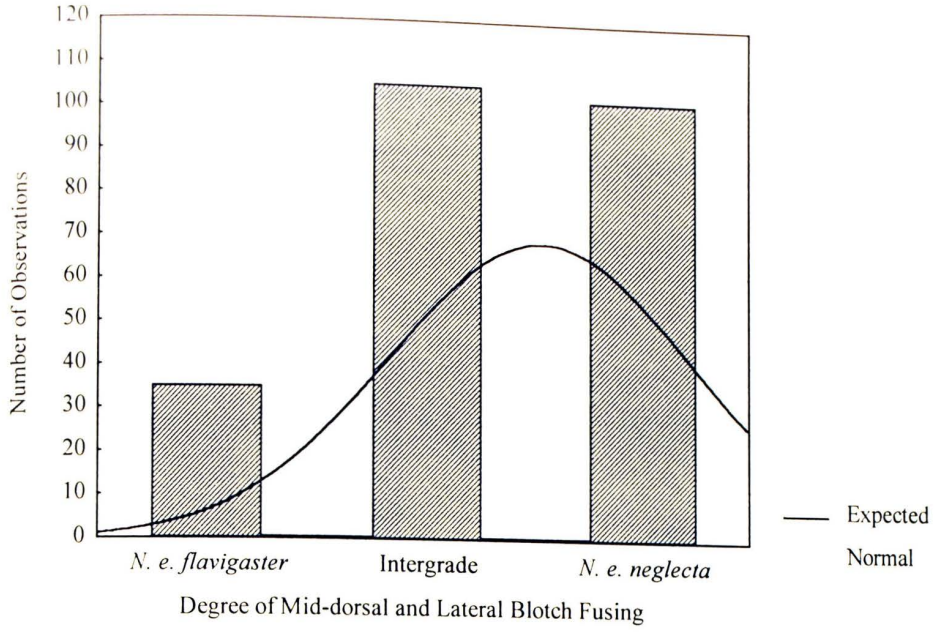

Figure 12. Distribution (Shapiro-Wilk's W = 0.7818, $P = 0.000$) of mid-dorsal and lateral blotch fusion data for juvenile *Nerodia erythrogaster*.

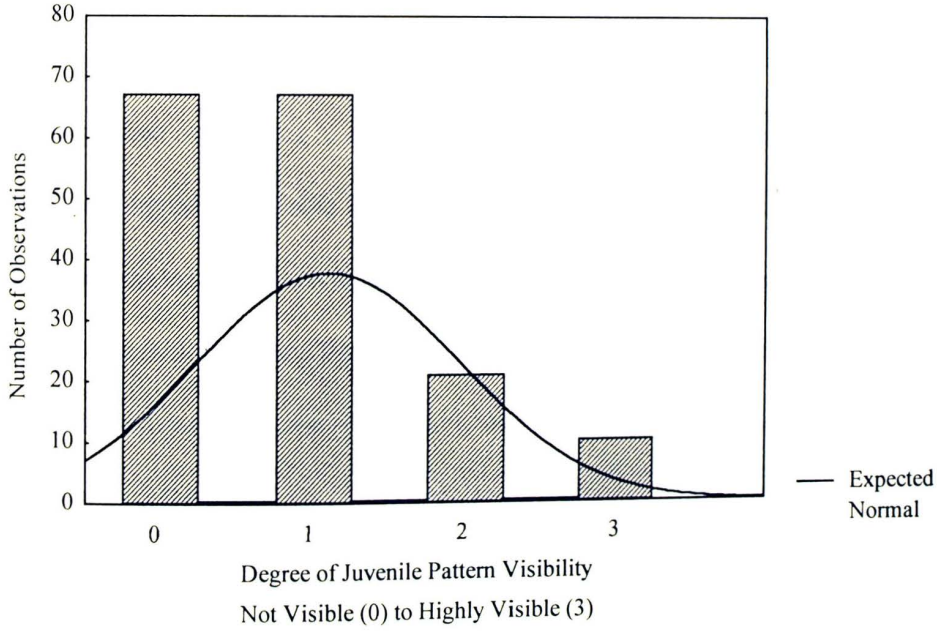

Figure 13. Distribution (Shapiro-Wilk's W = 0.8046, $P = 0.000$) of juvenile pattern visibility data for adult *Nerodia erythrogaster*.

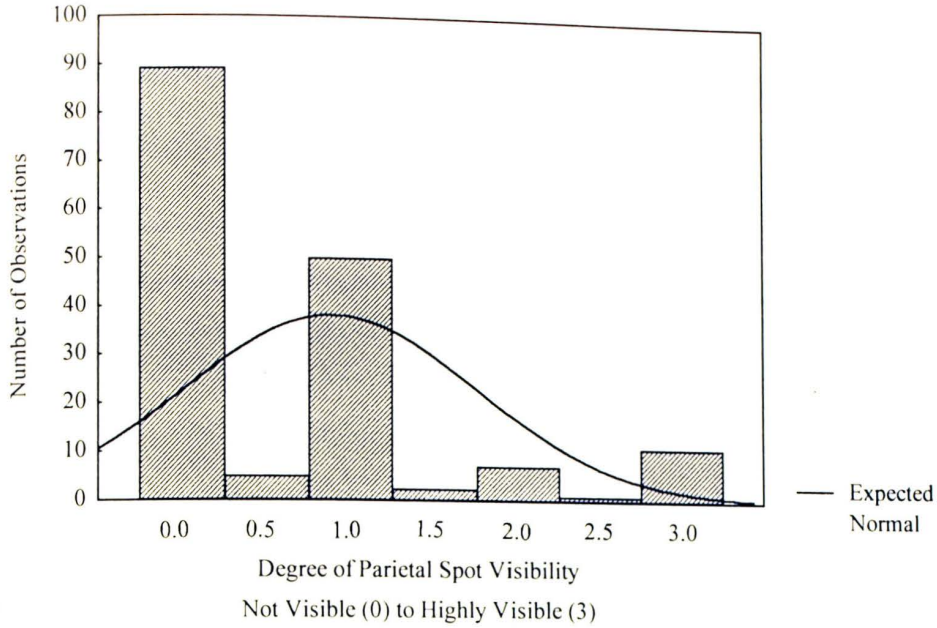

Figure 14. Distribution (Shapiro-Wilk's W = 0.7196, $P = 0.000$) of parietal-spot visibility data for adult *Nerodia erythrogaster*.

can be distinguished from young *N. e. flavigaster* and from intergrades, but that the latter two groups are indistinguishable (Table 1). This finding agrees with Conant's (1949) original description of these taxa. *Nerodia e. neglecta* juveniles tend to have a more confused pattern, with considerable mid-dorsal and lateral blotch fusion. *Nerodia e. flavigaster* and intergrade juveniles tend to have a more clean-cut pattern, with less fusion of mid-dorsal and lateral blotches. Based on these data, the LCRB population is more similar to the intergrade or the *N. e. flavigaster* phenotype than the *N. e. neglecta* phenotype. But, these data may be skewed because several groups of individuals from several litters were analyzed, possibly adding bias to the sample.

Results of the adult characters analysis suggest that pattern visibility are valid taxonomic characteristics, but that parietal spot visibility is not. The descriptive statistics (Table 2) reveal a

Table 1. Means ($\bar{x}$) and standard deviations (s) of the index for mid-dorsal and lateral blotch fusion in juvenile *Nerodia erythrogaster* from various parts of its range. See text for explanation of abbreviations.

A priori group	n	$\bar{x}$	s
FLAV	38	1.84	± 0.64
ARMO	53	1.76	± 0.70
INT	27	2.48	± 0.58
LBL	40	2.25	± 0.49
CUMB	32	2.44	± 0.56
NEG	52	2.94	± 0.24

considerable difference between the means of the pattern data for the various groups, suggesting a broad zone of intergradation between *N. e. flavigaster* and *N. e. neglecta* with the Cumberland River specimens most similar to the intergrade population. These results support Conant's (1949) and MacGregor's (1994) opinions that this region is an area of intergradation between these two subspecies.

Parametric Analysis

The adult pigment area and intensity data were analyzed by both a one-way MANOVA with a *post hoc* (LSD) comparison, and a discriminate function analysis (DFA). The descriptive statistics reveal a considerable difference between the pigment area and intensity data for the *a priori* groups (Table 3). The one-way MANOVA results indicate a significant difference ($P < 0.0008$) between the means of the pigment area and intensity data (Wilks' Lambda = 0.827, $P = 0.00076$). The results of the DFA show no discrimination ($P < 0.0008$) between the *a priori*

Table 2. Means ($\bar{x}$) and standard deviations (s) of the indices for pattern and parietal-spot characteristics in adult *Nerodia erythrogaster* from various parts of its range. See text for explanation of abbreviations.

		Body Pattern		Parietal-Spot	
A priori group	n	$\bar{x}$	s	$\bar{x}$	s
FLAV	45	1.24	± 0.98	0.80	± 0.96
ARMO	27	0.93	± 0.92	0.48	± 0.85
INT	45	0.67	± 0.83	0.44	± 0.63
LBL	7	0.86	± 0.69	0.93	± 0.73
CUMB	17	0.71	± 0.69	1.09	± 1.18
NEG	24	0.42	± 0.50	0.46	± 0.72

Table 3. Means ($\bar{x}$) and standard deviations (s) of raw values and residuals (RES) of the square-root-transformed values for ventral pigment area and intensity characteristics in adult *Nerodia erythrogaster* from various parts of its range. See text for explanation of abbreviations.

		Indices of Ventral Pigment Characters							
		Area				Intensity			
		Raw Value		RES Value		Raw Value		RES Value	
A priori group	n	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s
FLAV	45	12.0	±11.7	-0.08	±0.16	132.3	±21.6	0.02	±0.06
ARMO	27	16.6	±10.8	0.03	±0.13	133.0	±17.5	0.01	±0.05
INT	45	18.8	±13.9	0.03	±0.16	127.8	±18.0	0.00	±0.05
LBL	7	12.8	±5.8	-0.55	±0.07	131.5	±17.5	0.02	±0.04
CUMB	17	22.9	±9.8	0.06	±0.10	112.1	±17.5	-0.04	±0.05
NEG	24	20.0	±12.2	0.04	±0.15	118.9	±20.1	-0.02	±0.06

groups based on pigment area and intensity data (Wilks' Lambda = 0.827, $F_{10,316} = 3.14$, area $P = 0.013$, and intensity $P = 0.043$).

Post hoc (LSD) analysis of the pigment area data reveals a significant difference ($P < 0.05$) between the FLAV group and all other groups except the LBL group (Table 4). The same analysis of the pigment intensity data shows a more complex relationship. Although there is a significant difference between the pigment intensity data for the CUMB group and each of the other groups, there is also a significant difference between the data for the NEG group and the FLAV and ARMO groups (Table 5). A DFA classification matrix with each *a priori* group having the same classification probability ($P = 0.167$) correctly placed 42.2% of the FLAV, 29.6% of the ARMO, 11.1% of the INT, 42.9% of the LBL, 52.9% of the CUMB group, and only 8.3% of the NEG specimens into their respective *a priori* groups (Table 6).

After considering all the data, the six *a priori* groups were reorganized into three groups: *Nerodia erythrogaster flavigaster* includes the FLAV group; *Nerodia erythrogaster neglecta* is comprised of the combined CUMB and NEG groups; and an intergrade population is composed of the combined ARMO, INT, and LBL groups.

One-way MANOVA analysis resulted in a significant difference (Wilks' Lambda = 0.846, $P = 0.000$) between the means of the three groups. *Post hoc* (LSD) analysis of the pigment area data showed a significant difference between *N. e. flavigaster* and the *N. e. neglecta* and intergrade populations (Table 7). The intensity data showed a significant difference between *N. e. neglecta* and the *N. e. flavigaster* and intergrade populations (Tables 8). The DFA of these groups showed no discrimination ($P < 0.0008$) between these new *a priori* groups (equal *a priori* classification probabilities, $P = 0.333$) and the area and intensity data (Wilks' Lambda = 0.846, $F_{4,322} = 7.02$, area $P = 0.002$, and intensity $P = 0.006$), but review of the classification matrix

Table 4. *Post hoc* (LSD) comparison of one-way MANOVA results for adult ventral pigment area characteristic in *Nerodia erythrogaster* from various parts of its range. Probabilities values, in bold type, are significant (P <0.05). See text for explanation of abbreviations.

A priori group	n	FLAV	ARMO	INT	LBL	CUMB	NEG
FLAV	45		**0.005**	**0.001**	0.706	**0.002**	**0.003**
ARMO	27	**0.005**		0.876	0.208	0.476	0.783
INT	45	**0.001**	0.876		0.160	0.520	0.576
LBL	7	0.706	0.208	0.160		0.094	0.155
CUMB	17	**0.002**	0.476	0.520	0.094		0.650
NEG	24	**0.003**	0.783	0.876	0.155	0.650	

Table 5. *Post hoc* (LSD) comparison of one-way MANOVA results for adult pigment intensity characteristic in *Nerodia erythrogaster* from various parts of its range. Probability values, in bold type, are significant (P <0.05). See text for explanation of abbreviations.

A priori group	n	FLAV	ARMO	INT	LBL	CUMB	NEG
FLAV	45		0.804	0.196	0.859	**0.001**	**0.009**
ARMO	27	0.804		0.384	0.754	**0.006**	**0.031**
INT	45	0.197	0.384		0.396	**0.023**	0.117
LBL	7	0.859	0.754	0.396		**0.028**	0.085
CUMB	17	**0.001**	**0.006**	**0.023**	**0.028**		0.423
NEG	24	**0.009**	**0.031**	0.117	0.085	0.424	

Table 6. Discriminate function analysis classification matrix (equal *a priori* classification probability values, $P = 0.167$) of residuals for square-root-transformed ventral pigment area and intensity data from adult *Nerodia erythrogaster* from various parts of its range. Percentages in bold type indicate proper classification. See text for explanation of abbreviations.

A priori group	n	FLAV	ARMO	INT	LBL	CUMB	NEG
FLAV	45	**42.2**	20.0	4.4	11.1	20.0	2.2
ARMO	27	3.7	**29.6**	3.7	22.2	25.9	14.8
INT	45	20.0	24.4	**11.1**	13.3	26.7	4.4
LBL	7	14.3	25.6	0	**42.9**	14.3	0
CUMB	17	11.8	11.8	0	5.9	**52.9**	17.6
NEG	24	29.2	12.5	8.3	0	41.7	**8.3**

Table 7. *Post hoc* (LSD) comparison of one-way MANOVA analysis of adult ventral pigment area for proposed *Nerodia erythrogaster* taxa. Probability values, in bold type, are significant ($P < 0.05$).

Taxa	n	*N. e. flavigaster*	Intergrade	*N. e. neglecta*
N. e. flavigaster	45		**0.000**	**0.000**
Intergrades	79	**0.000**		0.397
N. e. neglecta	41	**0.000**	0.397	

Table 8. *Post hoc* (LSD) comparison of one-way MANOVA analysis of adult pigment intensity for proposed *Nerodia erythrogaster* taxa. Probability values, in bold type, are significant ($P < 0.05$).

Taxa	n	*N. e. flavigaster*	Intergrade	*N. e. neglecta*
N. e. flavigaster	45		0.363	**0.000**
Intergrades	79	0.363		**0.002**
N. e. neglecta	41	**0.000**	**0.002**	

showed that 53.3% of *N. e. flavigaster*, 61.0% of *N. e. neglecta*, and 34.2% of intergrades were properly classified (Table 9).

Reviewing Conant's (1949) descriptions of the various subspecies of *N. erythrogaster*, I suggest that the degree of fusion of mid-dorsal and lateral blotches can be used to distinguish the juveniles of *N. e. flavigaster* from *N. e. neglecta*, but that this character will not separate intergrades of these two taxa from *N. e. flavigaster* (Figure 15). Valid adult phenotypic characteristics are juvenile pattern visibility, ventral pigment intensity, and dorsal pigment invasion of the ventral scales. Adult retention of a juvenile pattern is not common in either subspecies, but is more prevalent in *N. e. flavigaster* (Figure 16). The quartile ranges (Figures 15& 16) illustrates how these data are strongly skewed, as seen in the *N. e. neglecta* data set for juvenile mid-dorsal and lateral blotch fusion, whereas individuals were scored for each phenotype, the median and both quartile values reflect the *N. e. neglecta* phenotype. *Nerodia e. neglecta* tends to be darker and have more dorsal pigment invasion onto the ventral scales than does *N. e. flavigaster* (Figures 17 & 18). Adult pattern and ventral pigment intensity of intergrades resembles the *N. e. flavigaster* phenotype, whereas the ventral pigment area of

Table 9. Discriminate function analysis classification matrix of residuals for square-root-transformed pigment area and intensity data from adult *Nerodia erythrogaster* in proposed taxa with equal *a priori* classification probability values ($P = 0.333$). Percentages in bold type indicate proper classification.

Taxa	n	*N. e. flavigaster*	Intergrade	*N. e. neglecta*
N. e. flavigaster	45	**53.3**	26.7	20.0
Intergrades	79	31.6	**34.2**	34.2
N. e. neglecta	41	24.4	14.6	**61.0**

intergrades resembles more the *N. e. neglecta* phenotype (Figures 17 & 18).

Ventral coloration is another important subspecific taxonomic characteristic (Conant 1949), but no data could be gathered for this characteristic because of the effects of preservation. My observations of *N. erythrogaster* captured from the LCRB seem to agree with those of Scott and Snyder (1968) in that most specimens' ventral coloration ranges from dull-to-bright orange. Within a subspecies it is not uncommon for an occasional individual to express a phenotype not consistent with the majority of its population (Mayr 1969). After completing the data analysis for this study, an adult *N. erythrogaster* was captured from Montgomery County, Tennessee (Haynes Bottoms Wildlife Management Area) that was dull-yellow on the venter and light grey on the dorsum. It also had a distinct juvenile pattern, and moderate dorsal pigment invasion onto the ventral scales.

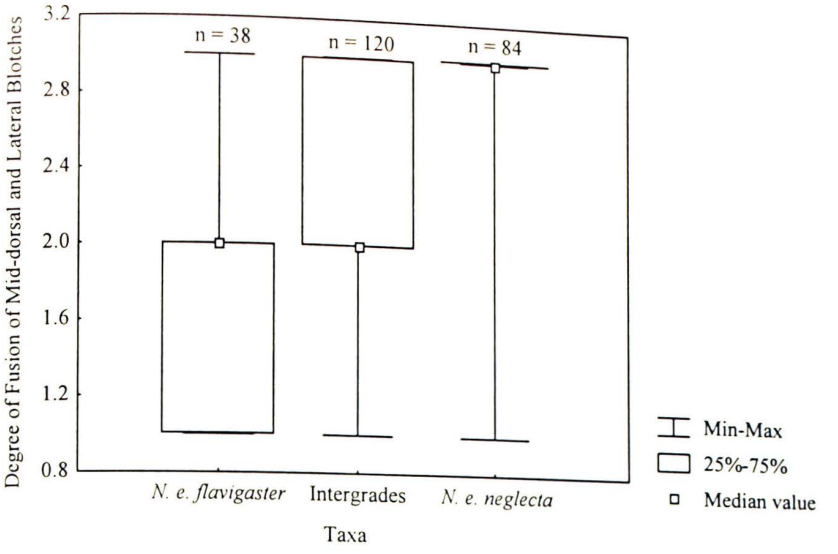

Figure 15. Medians, quartiles, and ranges for the degree of mid-dorsal and lateral blotch fusion in juvenile *Nerodia erythrogaster flavigaster*, *Nerodia erythrogaster neglecta*, and their intergrades. Degree of fusion ranges from 1.0 (very little) to 3.0 (extensive).

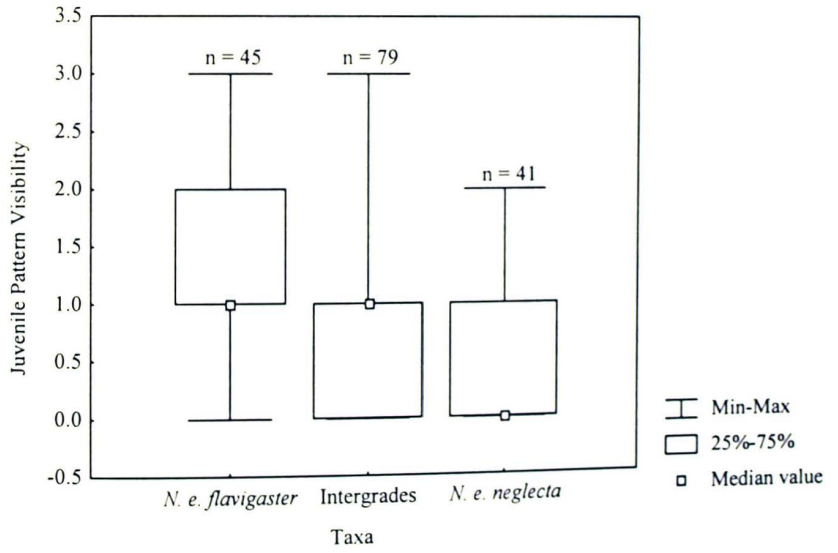

Figure 16. Medians, quartiles, and ranges for the degree of juvenile pattern visibility in adult *Nerodia erythrogaster flavigaster*, *Nerodia erythrogaster neglecta*, and their intergrades. Degree of visibility ranges from not visible (0) to very visible (3).

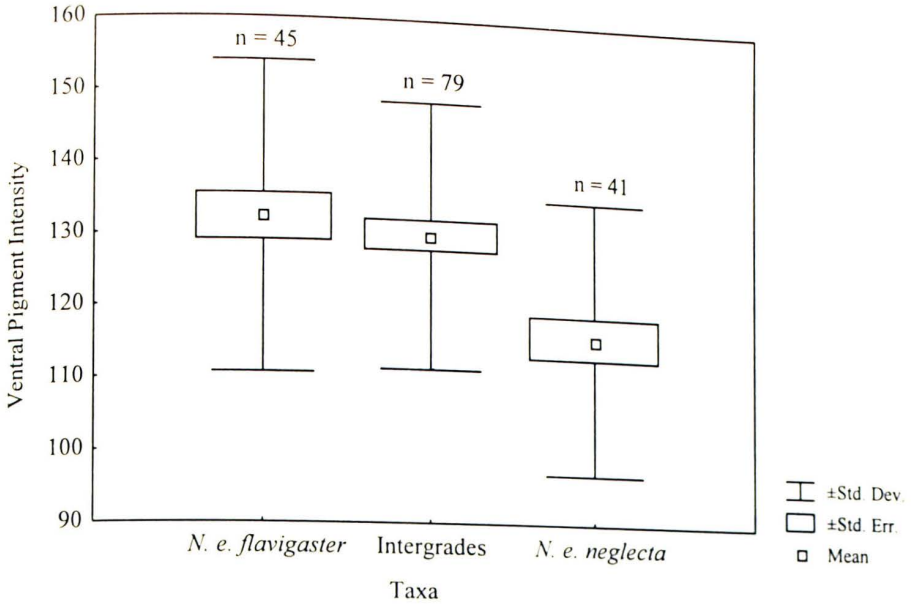

Figure 17. Means, standard errors, and standard deviations for ventral pigment intensity in adult *Nerodia erythrogaster flavigaster*, *Nerodia erythrogaster neglecta*, and their intergrades. Pigment intensity ranges from 0 (black) to 255 (white).

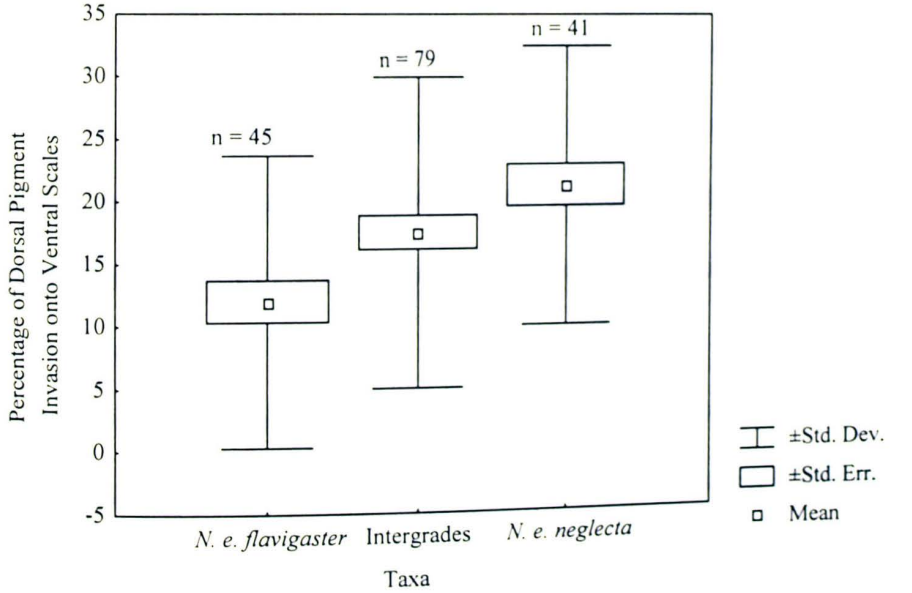

Figure 18. Means, standard errors, and standard deviations for dorsal pigment invasion of the ventral scales in adult *Nerodia erythrogaster flavigaster*, *Nerodia erythrogaster neglecta*, and their intergrades. Results are average percentages of dorsal pigment invasion of ventral scales.

CHAPTER IV

CONCLUSIONS

Where suitable habitat exists, *Nerodia erythrogaster* occurs in the LCRB from Ashland City, Tennessee down river to Barkley Dam, Kentucky. Below Barkley Dam additional field work should yield specimens, especially from favorable habitat in the Smithland, Kentucky area. Above Ashland City in Davidson County, Tennessee it seems unlikely that specimens will be found, because of the limited suitable habitat in that area.

The loss of potential habitat for *N. erythrogaster* in the LCRB has been twice the regional average, but I do not think there is any immediate danger to the LCRB population because much of the river drainage is public land. Populations of *N. erythrogaster* have been documented in or around LBL, Cross Creeks National Wildlife Refuge, several Army Corps of Engineers' sites, and at two sites (Shelton Ferry Wetlands Wildlife Management Area and Haynes Bottom Wildlife Management Area) recently acquired by the TWRA. Cooperative land owners (Marshall Creek sub-population) also afford protection to substantial populations of *N. erythrogaster* in the LCRB. To ensure the future of this species in the LCRB, I recommend that private and government agencies follow the example of the TWRA, and acquire additional habitat as it becomes available.

Nerodia erythrogaster from the southern half of LBL upstream throughout the LCRB are most like the *neglecta* subspecies, as originally reported by Scott and Snyder (1968). A broad area of intergradation occurs in the Mississippi River valley, including northeastern Arkansas, northwestern Tennessee, western Kentucky, southern Illinois, and the northern half of LBL. *Nerodia e. flavigaster* is apparently absent from Missouri, Kentucky, Illinois, and Iowa. The southern border of the intergrade population is probably somewhere between Reelfoot Lake and

Memphis, Tennessee. *Nerodia e. flavigaster* ranges southward in the Mississippi River drainage and over much of the Coastal Plain.

The results of this research have answered some basic questions, but several others have been raised. What is the minimum habitat requirements for this species and how important are upland habitats? What are the population dynamics of *N. erythrogaster* in the LCRB? While the taxonomic scope of this research was to determine subspecific relationships, based on accepted phenotypic characteristics, does such an analysis accurately depict evolutionary relationships? Is it even appropriate to recognize subspecies for *N. erythrogaster*?

Further research will undoubtably answer many of these questions. Whereas the findings of my research agree with the phenotypic classification scheme for these two subspecies, I would not be surprised if further genotypic research revealed that subspecific recognition for *N. erythrogaster* invalid. The biggest inefficiencies of this research were in the area of image analysis. While I became very efficient at processing specimens, it was still a very labor intensive and cumbersome task to take and edit images by myself.

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LITERATURE CITED

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APPENDICES

APPENDIX A

Contributing Zoological Museums

and their Standard Abbreviations

Contributing Zoological Museums and their Standard Abbreviations

Zoological Museum	Standard Abbreviation
Austin Peay State University Museum of Zoology	APSU
Monte L. Bean Life Science Museum Bringham Young University	BYU
Carnegie Museum of Natural History	CM
Field Museum of Natural History	FMNH
Natural History Museum, The University of Kansas	KU
Museum of Natural Science, Louisiana State University	LSU
Morehead State University, Museum of Zoology	MSU
The University of Louisville, Museum of Zoology	UL
The University of Michigan, Museum of Zoology	UMMZ
National Museum of Natural History	USNM

APPENDIX B

Specimens Used in Taxonomic Analysis

Nerodia erythrogaster Specimens Used in the Taxonomic Analysis

State	County/Parish	Museum/Number	Collection Locality	Collection Date	Collector	Data Set
AL	Coosa	UMMZ122208	7 mi. SW of Rockford, along Hatchet Creek	19 July 1951	H.G. Dowling	Adult
AL	Coosa	UMMZ96765	7 mi. SW of Weogufka	4 July 1943	Jesse Nicholls	Adult
AL	Elmore	UMMZ96766	1 mi. W of Wetumpka	5 July 1943	Jesse Nicholls	Adult
AL	Mobile	UMMZ97012	Unknown	Unknown	Loding & Van Aller	Adult
AL	Mobile	UMMZ97013	Unknown	May 1926	H.P. Loding	Adult
AL	Perry	CM72166	1.4 mi. W Hwy. 183 on Hwy. 49 (0.9 mi. N Sprott)	19 May 1979	R.C. Vogt, et al	Adult
AL	Perry	CM72167	1.4 mi. W Hwy. 183 on Hwy. 49 (0.9 mi. N Sprott)	19 May 1979	R.C. Vogt, et al	Juvenile
AL	Tuscaloosa	USNM260819	Tuscaloosa, 2.3 mi. S of Moody Swamp	20 April 1951	Richard M. Johnson	Adult
AR	Arkansas	USNM131503	Stuttgart	17 July 1951	Unknown	Adult
AR	Clay	UMMZ155654	6 mi. W of Boydsville, on Ark. 90	9 July 1974	P. Rosen	Adult
AR	Clay	UMMZ77680	1 mi. E of Corning	8 June 1934	Hartweg & Clanton	Juvenile
AR	Clay	UMMZ77684-A	2 mi. E of Corning	8 June 1934	Hartweg & Clanton	Juvenile
AR	Clay	UMMZ77684-B	2 mi. E of Corning	8 June 1934	Hartweg & Clanton	Juvenile
AR	Desha	CM23985	Rohwer	22 June 1944	R.H. McCauley	Adult
AR	Drew	FMNH40779	Monticello	April/May 1942	W.C. Hobgood	Juvenile
AR	Garland	UMMZ46646	Hotsprings	Unknown	Unknown	Juvenile
AR	Grant	BYU43672	Hurricane Cr., 0.5 mi. W of Hwy. 167	15 March 1974	Steven R. Hayes	Adult
AR	Grant	UMMZ109378	3.5 mi. E of Poyen	14 August 1953	A. Schwartz	Juvenile
AR	Greene	UMMZ71349	Paragould	July 1931	M.V. Parker	Adult
AR	Greene	UMMZ71350	Paragould	July 1931	M.V. Parker	Adult
AR	Greene	UMMZ76753-A	Paragould, born 10 Sept. 1934	Unknown	Jane Coffman	Juvenile
AR	Greene	UMMZ76753-B	Paragould, born 10 Sept. 1934	Unknown	Jane Coffman	Juvenile
AR	Greene	UMMZ76753-D	Paragould, born 10 Sept. 1934	Unknown	Jane Coffman	Juvenile
AR	Greene	UMMZ76753-F	Paragould, born 10 Sept. 1934	Unknown	Jane Coffman	Juvenile
AR	Greene	UMMZ76753-H	Paragould, born 10 Sept. 1934	Unknown	Jane Coffman	Juvenile
AR	Greene	UMMZ76753-M	Paragould, born 10 Sept. 1934	Unknown	Jane Coffman	Juvenile
AR	Greene	UMMZ76753-N	Paragould, born 10 Sept. 1934	Unknown	Jane Coffman	Juvenile
AR	Greene	UMMZ77683-B	2 mi. W of Paragould	8 June 1934	Hartweg & Clanton	Juvenile
AR	Greene	UMMZ81245	S of Marmadoke	5 May 1934	M. Parker	Adult
AR	Greene	UMMZ81247	8 mi. Cr, 3.5 mi. SE of Paragould, born 28 Sept. 1934	8 June 1934	Hartweg & Clanton	Adult
AR	Greene	UMMZ81247-B	8 mi. Cr, 3.5 mi. SE of Paragould, born 28 Sept. 1934	8 June 1934	Hartweg & Clanton	Juvenile
AR	Greene	UMMZ81247-D	8 mi. Cr, 3.5 mi. SE of Paragould, born 28 Sept. 1934	8 June 1934	Hartweg & Clanton	Juvenile
AR	Greene	UMMZ81247-F	8 mi. Cr, 3.5 mi. SE of Paragould, born 28 Sept. 1934	8 June 1934	Hartweg & Clanton	Juvenile
AR	Greene	UMMZ81247-H	8 mi. Cr, 3.5 mi. SE of Paragould, born 28 Sept. 1934	8 June 1934	Hartweg & Clanton	Juvenile
AR	Greene	UMMZ81247-I	8 mi. Cr, 3.5 mi. SE of Paragould, born 28 Sept. 1934	8 June 1934	Hartweg & Clanton	Juvenile
AR	Greene	UMMZ81247-K	8 mi. Cr, 3.5 mi. SE of Paragould, born 28 Sept. 1934	8 June 1934	Hartweg & Clanton	Juvenile
AR	Greene	UMMZ81247-L	8 mi. Cr, 3.5 mi. SE of Paragould, born 28 Sept. 1934	8 June 1934	Hartweg & Clanton	Juvenile
AR	Greene	UMMZ81247-M	8 mi. Cr, 3.5 mi. SE of Paragould, born 28 Sept. 1934	8 June 1934	Hartweg & Clanton	Juvenile
AR	Greene	UMMZ81247-Q	8 mi. Cr, 3.5 mi. SE of Paragould, born 28 Sept. 1934	8 June 1934	Hartweg & Clanton	Juvenile
AR	Independence	CM91803	Batesville	1 June 1964	W. Callaway	Adult
AR	Jackson	CM25041	Newport	10 May 1944	R.H. McCauley	Juvenile
AR	Jackson	CM25042	Newport	10 May 1944	R.H. McCauley	Juvenile
AR	Lafayette	UMMZ90198	4 mi. W of Louisville	May 1940	Geo Siegfried	Adult
AR	Lawrence	CMS5436	Imboden	10 June 1926	B.C. Marshal	Juvenile
AR	Lawrence	FMNH8501	Imboden	1925	Byron C. Marshall	Juvenile
AR	Lawrence	FMNH8502	Imboden	1925	Byron C. Marshall	Juvenile
AR	Lawrence	FMNH8726	6 mi. SW of Imboden	April 1926	Byron C. Marshall	Adult
AR	Lawrence	FMNH8727	6 mi. SW of Imboden	April 1926	Byron C. Marshall	Adult

Nerodia erythrogaster Specimens Used in the Taxonomic Analysis (Continued)

State	County/Parish	Museum/Number	Collection Locality	Collection Date	Collector	Data Set
AR	Lawrence	FMNH8728	6 mi. SW of Imboden	April 1926	Byron C. Marshall	Adult
AR	Lawrence	FMNH8729	6 mi. SW of Imboden	April 1926	Byron C. Marshall	Adult
AR	Lawrence	FMNH8730	6 mi. SW of Imboden	April 1926	Byron C. Marshall	Adult
AR	Lawrence	FMNH8962	Imboden	June 1926	Byron C. Marshall	Adult
AR	Lawrence	FMNH8967	Imboden	June 1926	Byron C. Marshall	Juvenile
AR	Lawrence	FMNH95263	Imboden	May 1929	Byron C. Marshall	Adult
AR	Pike	FMNH33896	Delight	September 1939	C.M. Barber	Juvenile
AR	Poinsett	CM24611	1 mi. W of Harrisburg, Ark 14	23 August 1944	R.H. McCauley	Juvenile
AR	Poinsett	CM24611-B	Offspring of CM24611	NA	NA	Juvenile
AR	Poinsett	CM24611-C	Offspring of CM24611	NA	NA	Juvenile
AR	Poinsett	CM24611-D	Offspring of CM24611	NA	NA	Juvenile
AR	Poinsett	CM24611-E	Offspring of CM24611	NA	NA	Juvenile
AR	Poinsett	CM24611-F	Offspring of CM24611	NA	NA	Juvenile
AR	Poinsett	CM24611-G	Offspring of CM24611	NA	NA	Juvenile
AR	Poinsett	CM24611-H	Offspring of CM24611	NA	NA	Juvenile
AR	Poinsett	CM24611-I	Offspring of CM24611	NA	NA	Juvenile
AR	Randolph	LSU43561	U.S. 67, 3 mi. NE of Pocahontas	Unavailable	Unavailable	Adult
AR	Randolph	UMMZ100424	10 mi. N of Pocohontas	7 July 1945	Sherman Minton Jr.	Juvenile
AR	St. Francis	USNM39266	Wheatley	1909	Unknown	Adult
AR	Stone	FMNH51960	Marcella	22 March 1948	Sanborn, Wonder, & Kalinowski	Juvenile
IL	Alexander	FMNH2229	Olive Branch, Horseshoe Lake	10 May 1907	C.M. Barber	Adult
IL	Alexander	FMNH2234	Olive Branch, Horseshoe Lake	9 May 1907	C.M. Barber	Adult
IL	Madison	USNM56545	Unknown	7 August 1911	Julius Hurter	Juvenile
IL	Randolph	USNM56546	Unknown	4 September 1896	Julius Hurter	Juvenile
IL	Richland	USNM14156	Olney	20 July 1885	John & Charles Walker	Adult
IL	St. Clair	USNM56543	Unknown	13 May 1894	Julius Hurter	Adult
IL	St. Clair	USNM56544	Unknown	7 October 1903	Julius Hurter	Adult
IL	Union	FMNH23733	0.5 mi. W of Ware, banks of dredge ditch	23 June 1936	D.D. Davis	Adult
IN	Gibson	UMMZ111887	4 mi. NE of Griffin	14 August 1954	Madge & Sherman Minton	Juvenile
IN	Gibson	UMMZ89738	South shore of Foots Pond	10 July 1940	K. Lagler & C.B. Obrecht	Adult
IN	Pike	CMS9759	4 mi. W of Winslow CCC Camp, Patoka Township	4 March 1936	D.C. & P.L. Swanson	Adult
IN	Scott	UMMZ116311	1.5 mi. SW of Austin	13 May 1956	K. Downey, K. Shaw, & S. Minton	Adult
IN	St. Joseph	FMNH245282	South Bend, South Bend Ave. & Corby Blvd.	17 June 1965	G. Sechrist	Adult
IN	Washington	UMMZ108088	4 mi. NW of Little York	9 May 1953	S.A. Minton & W. Reifsteck	Juvenile
IN	Wells	CMR1113	Bluffton	3 May 1905	E.B. Williamson	Juvenile
IN	Wells	CMR1114	Bluffton	3 May 1905	E.B. Williamson	Juvenile
IN	Wells	CMR1520	Bluffton	Unknown	E.B. Williamson	Adult
IN	Wells	CMR1928	Bluffton	28 June 1905	E.B. Williamson	Juvenile
IN	Wells	CMR1928-AA	Bluffton	28 June 1905	E.B. Williamson	Juvenile
IN	Wells	CMR1928-B	Bluffton	28 June 1905	E.B. Williamson	Juvenile
IN	Wells	CMR1928-BB	Bluffton	28 June 1905	E.B. Williamson	Juvenile
IN	Wells	CMR1928-C	Bluffton	28 June 1905	E.B. Williamson	Juvenile
IN	Wells	CMR1928-CC	Bluffton	28 June 1905	E.B. Williamson	Juvenile
IN	Wells	CMR1928-D	Bluffton	28 June 1905	E.B. Williamson	Juvenile

Nerodia erythrogaster Specimens Used in the Taxonomic Analysis (Continued)

State	County/Parish	Museum/Number	Collection Locality	Collection Date	Collector	Data Set
IN	Wells	CMR1928-DD	Bluffton	28 June 1905	E.B. Williamson	Juvenile
IN	Wells	CMR1928-E	Bluffton	28 June 1905	E.B. Williamson	Juvenile
IN	Wells	CMR1928-EE	Bluffton	28 June 1905	E.B. Williamson	Juvenile
IN	Wells	CMR1928-F	Bluffton	28 June 1905	E.B. Williamson	Juvenile
IN	Wells	CMR1928-FF	Bluffton	28 June 1905	E.B. Williamson	Juvenile
IN	Wells	CMR1928-G	Bluffton	28 June 1905	E.B. Williamson	Juvenile
IN	Wells	CMR1928-GG	Bluffton	28 June 1905	E.B. Williamson	Juvenile
IN	Wells	CMR1928-H	Bluffton	28 June 1905	E.B. Williamson	Juvenile
IN	Wells	CMR1928-HH	Bluffton	28 June 1905	E.B. Williamson	Juvenile
IN	Wells	CMR1928-I	Bluffton	28 June 1905	E.B. Williamson	Juvenile
IN	Wells	CMR1928-J	Bluffton	28 June 1905	E.B. Williamson	Juvenile
IN	Wells	CMR1928-K	Bluffton	28 June 1905	E.B. Williamson	Juvenile
IN	Wells	CMR1928-L	Bluffton	28 June 1905	E.B. Williamson	Juvenile
IN	Wells	CMR1928-M	Bluffton	28 June 1905	E.B. Williamson	Juvenile
IN	Wells	CMR1928-N	Bluffton	28 June 1905	E.B. Williamson	Juvenile
IN	Wells	CMR1928-O	Bluffton	28 June 1905	E.B. Williamson	Juvenile
IN	Wells	CMR1928-P	Bluffton	28 June 1905	E.B. Williamson	Juvenile
IN	Wells	CMR1928-Q	Bluffton	28 June 1905	E.B. Williamson	Juvenile
IN	Wells	CMR1928-R	Bluffton	28 June 1905	E.B. Williamson	Juvenile
IN	Wells	CMR1928-S	Bluffton	28 June 1905	E.B. Williamson	Juvenile
IN	Wells	CMR1928-T	Bluffton	28 June 1905	E.B. Williamson	Juvenile
IN	Wells	CMR1928-U	Bluffton	28 June 1905	E.B. Williamson	Juvenile
IN	Wells	CMR1928-V	Bluffton	28 June 1905	E.B. Williamson	Juvenile
IN	Wells	CMR1928-W	Bluffton	28 June 1905	E.B. Williamson	Juvenile
IN	Wells	CMR1928-X	Bluffton	28 June 1905	E.B. Williamson	Juvenile
IN	Wells	CMR1928-Y	Bluffton	28 June 1905	E.B. Williamson	Juvenile
IN	Wells	CMR1928-Z	Bluffton	28 June 1905	E.B. Williamson	Juvenile
KY	Ballard	KU214469	Axe Lake, 3 mi. NW of Barlow	12 May 1963	Julien C. Lee	Adult
KY	Ballard	KU214471	Barlow	14 May 1963	Julien C. Lee	Juvenile
KY	Ballard	UL7138	4 mi. W of Barlow	28 May 1976	Dale Fell	Juvenile
KY	Ballard	UL7142	4 mi. W of Barlow	29 May 1974	Susan Wilburn	Adult
KY	Ballard	USNM339511	Ballard St. WMA, Turkey Lk. Rd. at Beaverdam Slough	8 June 1983	J. Moriarty, M. Evans, & B.D. Anderson	Adult
KY	Ballard	USNM339512	Ballard St. WMA, Turkey Lk. Rd. at Beaverdam Slough	8 June 1983	J. Moriarty, M. Evans, & B.D. Anderson	Adult
KY	Ballard	USNM339513	Ballard St. WMA, Turkey Lk. Rd. at Beaverdam Slough	8 June 1983	J. Moriarty, M. Evans, & B.D. Anderson	Adult
KY	Ballard	USNM339514	Ballard St. WMA, Turkey Lk./Shelby Lk. spillway	8 June 1983	J. Moriarty, M. Evans, & B.D. Anderson	Adult
KY	Ballard	USNM339515	Ballard State Waterfowl Management Area	7 June 1983	Brian D. Anderson & Marc Evans	Juvenile
KY	Butler	MSUR4443	Roundabout Swamp	29 April 1989	Les Meade, et al	Adult
KY	Caldwell	USNM339516	Dawson Springs, W of U.S. 62 at Tradewater River	22 May 1980	Ronald S. Caldwell	Adult

Nerodia erythrogaster Specimens Used in the Taxonomic Analysis (Continued)

State	County/Parish	Museum/Number	Collection Locality	Collection Date	Collector	Data Set
KY	Carlisle	KU214476	5 mi. S of Wickliffe	18 April 1963	Julien C. Lee	Adult
KY	Carlisle	MSUR2849	Back Slough, Laketon	23 April 1983	Les Meade	Juvenile
KY	Carlisle	MSUR2903	Back Slough, Laketon	24 April 1983	John MacGregor	Adult
KY	Carlisle	MSUR3598	Back Slough, Laketon	April 1983	Les Meade, et al	Adult
KY	Carlisle	USNM339518	Laketon, NW of Black Slough	8 June 1983	John Moriarty	Juvenile
KY	Daviess	KU144825	3 mi. SE of Owensboro	Unknown	Joseph T. Collins	Juvenile
KY	Fulton	KU144824	Mississippi R. peninsula, NW of Reelfoot Lake	20 April 1967	Joseph T. Collins	Adult
KY	Fulton	KU154196	N end of Reelfoot Lake	16 May 1973	Joseph T. Collins	Adult
KY	Fulton	KU214466	3.5 mi. NNW of Fulton	11 May 1963	Julien C. Lee	Adult
KY	Fulton	KU214467	Approximately Fulton	12 May 1963	Julien C. Lee	Adult
KY	Fulton	KU214468	N end of Reelfoot Lake	24 May 1963	Julien C. Lee	Adult
KY	Fulton	MSUR2589	North end of Reelfoot Lake	26 April 1982	Les Meade & Matt Meadows	Adult
KY	Fulton	MSUR3584	North end of Reelfoot Lake	April 1985	Matt Meadows & Les Meade	Adult
KY	Fulton	MSUR770	North end of Reelfoot Lake	18 April 1981	Les Meade, et al	Adult
KY	Fulton	MSUR793	North end of Reelfoot Lake	18 April 1981	Les Meade & Matt Meadows	Adult
KY	Fulton	UL4769	3 mi. S.E. Bondurant	29 May 1974	Burt Monroe, Jr.	Adult
KY	Fulton	UL4770	3 mi. S.E. Bondurant	29 May 1974	Burt Monroe, Jr.	Juvenile
KY	Fulton	UL4771	3 mi. S.E. Bondurant	17 May 1972	Burt Monroe, Jr.	Juvenile
KY	Fulton	UL4772	3 mi. S.E. Bondurant	4 June 1971	Burt Monroe, Jr.	Juvenile
KY	Fulton	UL4773	3 mi. S.E. Bondurant	17 May 1972	Burt Monroe, Jr.	Juvenile
KY	Fulton	UL4774	3 mi. S.E. Bondurant	17 May 1972	Burt Monroe, Jr.	Juvenile
KY	Fulton	UL4775	3 mi. S.E. Bondurant	17 May 1972	Burt Monroe, Jr.	Adult
KY	Fulton	UL4777	3 mi. S.E. Bondurant	17 May 1972	Burt Monroe, Jr.	Adult
KY	Graves	CM40489	2 mi. S of Hardmoney, Blizzard Pond	14 April 1965	M.E. Sisk	Adult
KY	Hardin	UL4000	Weir's Creek, 4 mi. W. Nebo	29 May 1974	Monroe & Lattis	Adult
KY	Henderson	UMMZ61010	Near Smith Mills	15 June 1924	F.N. Blanchard	Adult
KY	Henderson	UMMZ61011	Near Smith Mills	15 June 1924	F.N. Blanchard	Adult
KY	Henderson	USNM339517	Cape Hill, 2 mi. (air) E of Jct. of RT 163 and RT 268	1 May 1980	Ronald S. Caldwell	Adult
KY	Hickman	KU214472	5 mi. N of Cayce	14 May 1963	Julien C. Lee	Juvenile
KY	Hickman	KU214473	5 mi. N of Cayce	14 May 1963	Julien C. Lee	Adult
KY	Hickman	KU214474	5 mi. N of Cayce	14 May 1963	Julien C. Lee	Adult
KY	Hickman	KU214475	7.5 mi. S of Kirbyton	31 May 1963	Julien C. Lee	Adult
KY	Hickman	MSUR769	Murphys Pond Area, near Obion Creek	17 April 1981	Les Meade, et al	Adult
KY	Hickman	UMMZ105578	Murphy Pond	7 June 1948	S.A. Minton	Adult
KY	Hopkins	APSU4310	5 mi. S Nebo at Clear Cr. bridge (Hwy. 502)	20 May 1982	Bernard Rottman	Adult
KY	Hopkins	UL3554	Weir's Creek, 6 mi. W. Nebo	18 May 1970	Burt L. Monroe, Jr.	Adult
KY	Hopkins	UL3997	Weir's Creek, 4 mi. W. Nebo	18 May 1970	Lattis & Monroe	Adult
KY	Hopkins	UL7137	Weir's Creek, 3 mi. S of Provodence	29 May 1974	Dale Fell	Adult

Nerodia erythrogaster Specimens Used in the Taxonomic Analysis (Continued)

State	County/Parish	Museum/Number	Collection Locality	Collection Date	Collector	Data Set
KY	Hopkins	UL7141	Weir's Creek, 3 mi. S of Provodence	17 May 1972	Glen Early	Adult
KY	Hopkins	UL7143	Weir's Creek, 3 mi. S of Provodence	Spring 1932	Alan Clubb	Adult
KY	Lyon	APSU335	365510N, 880045W; Honker Bay Pop.	20 April 1966	W. Nall	Adult
KY	Lyon	APSU885	1/2 mi. SW of Carmack Bay; Carmack Bay Pop.	18 July 1967	J.W. Sexton, Pardue	Adult
KY	Lyon	APSU933-1	Offspring of APSU885	NA	NA	Juvenile
KY	Lyon	APSU933-10	Offspring of APSU885	NA	NA	Juvenile
KY	Lyon	APSU933-11	Offspring of APSU885	NA	NA	Juvenile
KY	Lyon	APSU933-12	Offspring of APSU885	NA	NA	Juvenile
KY	Lyon	APSU933-13	Offspring of APSU885	NA	NA	Juvenile
KY	Lyon	APSU933-14	Offspring of APSU885	NA	NA	Juvenile
KY	Lyon	APSU933-15	Offspring of APSU885	NA	NA	Juvenile
KY	Lyon	APSU933-16	Offspring of APSU885	NA	NA	Juvenile
KY	Lyon	APSU933-17	Offspring of APSU885	NA	NA	Juvenile
KY	Lyon	APSU933-18	Offspring of APSU885	NA	NA	Juvenile
KY	Lyon	APSU933-19	Offspring of APSU885	NA	NA	Juvenile
KY	Lyon	APSU933-2	Offspring of APSU885	NA	NA	Juvenile
KY	Lyon	APSU933-20	Offspring of APSU885	NA	NA	Juvenile
KY	Lyon	APSU933-21	Offspring of APSU885	NA	NA	Juvenile
KY	Lyon	APSU933-22	Offspring of APSU885	NA	NA	Juvenile
KY	Lyon	APSU933-23	Offspring of APSU885	NA	NA	Juvenile
KY	Lyon	APSU933-24	Offspring of APSU885	NA	NA	Juvenile
KY	Lyon	APSU933-25	Offspring of APSU885	NA	NA	Juvenile
KY	Lyon	APSU933-26	Offspring of APSU885	NA	NA	Juvenile
KY	Lyon	APSU933-27	Offspring of APSU885	NA	NA	Juvenile
KY	Lyon	APSU933-28	Offspring of APSU885	NA	NA	Juvenile
KY	Lyon	APSU933-29	Offspring of APSU885	NA	NA	Juvenile
KY	Lyon	APSU933-3	Offspring of APSU885	NA	NA	Juvenile
KY	Lyon	APSU933-30	Offspring of APSU885	NA	NA	Juvenile
KY	Lyon	APSU933-31	Offspring of APSU885	NA	NA	Juvenile
KY	Lyon	APSU933-32	Offspring of APSU885	NA	NA	Juvenile
KY	Lyon	APSU933-33	Offspring of APSU885	NA	NA	Juvenile
KY	Lyon	APSU933-34	Offspring of APSU885	NA	NA	Juvenile
KY	Lyon	APSU933-35	Offspring of APSU885	NA	NA	Juvenile
KY	Lyon	APSU933-36	Offspring of APSU885	NA	NA	Juvenile
KY	Lyon	APSU933-37	Offspring of APSU885	NA	NA	Juvenile
KY	Lyon	APSU933-38	Offspring of APSU885	NA	NA	Juvenile
KY	Lyon	APSU933-39	Offspring of APSU885	NA	NA	Juvenile
KY	Lyon	APSU933-4	Offspring of APSU885	NA	NA	Juvenile

Nerodia erythrogaster Specimens Used in the Taxonomic Analysis (Continued)

State	County/Parish	Museum/Number	Collection Locality	Collection Date	Collector	Data Set
KY	Lyon	APSU933-40	Offspring of APSU885	NA	NA	Juvenile
KY	Lyon	APSU933-5	Offspring of APSU885	NA	NA	Juvenile
KY	Lyon	APSU933-6	Offspring of APSU885	NA	NA	Juvenile
KY	Lyon	APSU933-7	Offspring of APSU885	NA	NA	Juvenile
KY	Lyon	APSU933-8	Offspring of APSU885	NA	NA	Juvenile
KY	Lyon	APSU933-9	Offspring of APSU885	NA	NA	Juvenile
KY	Marshall	KU214487	4 mi. E of Kentucky Dam State Park	August 1964	Julien C. Lee	Adult
KY	McCracken	BYU31416	2 mi. W Paducah	April 1964	Don R. Harris	Adult
KY	McCracken	KU214477	5 mi. WNW of Paducah	29 May 1965	Julien C. Lee	Juvenile
KY	McCracken	KU214478	5 mi. WNW of Paducah	29 May 1965	Julien C. Lee	Juvenile
KY	McCracken	KU214479	5 mi. WNW of Paducah	29 May 1965	Julien C. Lee	Juvenile
KY	McCracken	KU214480	5 mi. WNW of Paducah	29 May 1965	Julien C. Lee	Juvenile
KY	McCracken	KU214481	5 mi. WNW of Paducah	29 May 1965	Julien C. Lee	Juvenile
KY	McCracken	KU214482	5 mi. WNW of Paducah	29 May 1965	Julien C. Lee	Juvenile
KY	McCracken	KU214483	5 mi. WNW of Paducah	29 May 1965	Julien C. Lee	Juvenile
KY	Muhlenberg	APSU2345	7.5 mi. SE of Greenville	22 June 1968	K. Duke	Juvenile
KY	Muhlenberg	KU144826	Black Lake swamp, NE of Bremen	15 April 1970	Joseph T. Collins	Adult
KY	Trigg	APSU4928	365113N, 880218W; Energy Lake Pop.	21 June 1987	T. Easterla	Adult
KY	Trigg	APSU4929	364942N, 880327W; Crooked Creek Pop.	17 June 1987	T. Easterla	Adult
KY	Trigg	UL1759	LBL, M-14, 8 mi. N, 2.5mi. E of Golden Pond; CCB Pop.	1 April 1967	Floore	Adult
KY	Trigg	UL2723	LBL, M-13; Honker Bay Pop.	20 June 1965	W.L. Thomas	Adult
KY	Trigg	UL2725	LBL, M-14, Arrowhead Island; Crooked Creek Bay Pop.	17 June 1966	John Morris	Adult
KY	Fulton	MSUR3472	North end of Reelfoot Lake	1 April 1985	Les Meade	Adult
LA	? Avoyelles	BYU13001	Camp Plauche	October 1945	D.E. Beck	Adult
LA	? Avoyelles	BYU13002	Camp Plauche	October 1945	D.E. Beck	Adult
LA	Ascension	LSU37788	74 Dutch Town	Unavailable	Unavailable	Juvenile
LA	Caddo	CM45346	Brooks Rd., between Norris Ferry/Wallace Lk. Rd.	7 June 1966	J. Forcey	Juvenile
LA	Caddo	FMNH7768	Gayle, near S line, 2 mi. E of Red R.	1924	L.S. Frierson	Adult
LA	Caddo	FMNH7769	Gayle, near S line, 2 mi. E of Red R.	1924	L.S. Frierson	Adult
LA	E. Baton Rouge	LSU55558	1544 Hobbiton, Baton Rouge	Unavailable	Unavailable	Adult
LA	E. Baton Rouge	LSU55877	East end of Honore Lake, Baton Rouge	Unavailable	Unavailable	Adult
LA	Franklin	KU176794	SW of Winnsboro	17 April 1965	Unknown	Juvenile
LA	Iberville	LSU40328	Spanish Lake	Unavailable	Unavailable	Juvenile
LA	Jefferson	FMNH245416	Hwy. 30, 3 mi. N of Lafitte	12 October 1952	R.E. Gordon & A. Chaney	Juvenile
LA	Jefferson	USNM307635	Lousiana RT 30	11 October 1934	Francis M. Uhler	Juvenile
LA	Morehouse	FMNH245411	LA 1488, 2 mi. N of Ouchita R. & Bayou Bartholomew	25 April 1957	R.E. Gordon	Juvenile
LA	Morehouse	USNM44548	Mer Rouge	3 June 1892	Unknown	Juvenile
LA	Orleans	USNM12892	New Orleans	1883	Robert W. Shufeldt	Adult

Nerodia erythrogaster Specimens Used in the Taxonomic Analysis (Continued)

State	County/Parish	Museum/Number	Collection Locality	Collection Date	Collector	Data Set
LA	Orleans	USNM12990	New Orleans	1883	Robert W. Shufeldt	Adult
LA	Orleans	USNM12991	New Orleans	1883	Robert W. Shufeldt	Adult
LA	Orleans	USNM12992	New Orleans	1883	Robert W. Shufeldt	Adult
LA	Orleans	USNM424	New Orleans	Unknown	Unknown	Adult
LA	Ouachita	FMNH245412	West Monroe, Sunshine Heights	15 June 1957	C. Baines	Juvenile
LA	Plaquemines	USNM238619	Belle Chasse, Tulane University, Riverside Campus	7 June 1981	Wayne Hoffman	Juvenile
LA	St. Charles	CM88862	4 mi. S of Boutte	29 September 197	D.M. Sever	Adult
LA	St. Charles	LSU47674	Jefferson Parish Rd., 3127 and Hwy. 90	Unavailable	Unavailable	Adult
LA	St. Charles	USNM238620	Boutte, 1 mi. E of U.S. 90	13 October 1979	Thomas H. Fritts	Juvenile
LA	St. Helena	KU145899	Rt. 16, 1.8 mi. N of Weiss	14 April 1967	Janalee P. Caldwell	Juvenile
LA	St. James	CM27834	Gramercy	20 June 1947	G.P. Meade	Adult
LA	St. James	LSU17946	St. James	Unavailable	Unavailable	Juvenile
LA	St. John the Bap.	LSU23864	Edgard	Unavailable	Unavailable	Juvenile
LA	St. Landry	CM66670	Thisslewaite Boy Scout Camp	24 June 1967	D.E. Hahn	Adult
LA	St. Landry	CM66671	Thisslewaite Game Management Area	29 March 1970	D.E. Hahn	Adult
LA	St. Tammany	LSU11403	Hwy. 190, 7 mi. W of Covington	Unavailable	Unavailable	Adult
LA	St. Tammany	USNM9025	Mandeville	May 1877	Unknown	Adult
LA	Vermilion	CM66668	On LA 700, 1.7 mi. N of junction with LA 699	25 April 1966	D.E. Hahn	Adult
LA	W. Baton Rouge	CM91799	2.5 mi. E of Erwinville along U.S. 190	4 April 1964	G.C. & A. Schaefer	Adult
LA	W. Feliciana	LSU39186	Tunica Hills, property of Merle Butler	Unavailable	Unavailable	Adult
LA	Orleans	LSU57543	End of Michaux Blvd., near Bayou Sauvage NWR	Unavailable	Unavailable	Adult
LA	Orleans	USNM12989	New Orleans	1883	Robert W. Shufeldt	Adult
MI	Eaton	UMMZ74510	1 mi. E of Olivet	17 May 1933	W.M.M. Clay	Adult
MI	Hillsdale	UMMZ122563	Reading Township, Lime Lake	September 1959	O.E. Ehrhart	Adult
MO	Butler	FMNH37580	12 mi. S of Poplar Bluffs	14 April 1941	K.P. & J.M. Schmidt	Juvenile
MO	Butler	KU82397	Wilhelmina	15 May 1939	Beverly Rose	Adult
MO	Butler	KU82398	Neelyville	Unknown	Beverly Rose	Adult
MO	Butler	KU82572	Wilhelmina	15 May 1939	J.E. Rose	Juvenile
MO	Butler	KU82573	Wilhelmina	15 May 1939	J.E. Rose	Juvenile
MO	Butler	KU82574	Wilhelmina	15 May 1939	J.E. Rose	Juvenile
MO	Butler	KU82575	Wilhelmina	15 May 1939	J.E. Rose	Juvenile
MO	Butler	KU82576	Wilhelmina	15 May 1939	J.E. Rose	Juvenile
MO	Butler	KU82578	Wilhelmina	15 May 1939	J.E. Rose	Juvenile
MO	Butler	KU82579	Wilhelmina	15 May 1939	J.E. Rose	Juvenile
MO	Butler	KU82580	Wilhelmina	15 May 1939	J.E. Rose	Juvenile
MO	Butler	KU82582	Wilhelmina	15 May 1939	J.E. Rose	Juvenile
MO	Butler	KU82583	Wilhelmina	15 May 1939	J.E. Rose	Juvenile
MO	Butler	KU82584	Wilhelmina	15 May 1939	J.E. Rose	Juvenile

Nerodia erythrogaster r Specimens Used in the Taxonomic Analysis (Continued)

State	County/Parish	Museum/Number	Collection Locality	Collection Date	Collector	Data Set
MO	Butler	KU82585	Wilhelmina	15 May 1939	J.E. Rose	Juvenile
MO	Butler	USNM56541	Unknown	6 September 1898	Julius Hurter	Juvenile
MO	Dunklin	KU82399	0.5 mi. E of Kennett	20 May 1962	Beverly Rose	Adult
MO	Dunklin	KU82403	Kennett	12 April 1961	Beverly Rose	Adult
MO	Dunklin	KU82404	4 mi. W of Kennett	Unknown	Beverly Rose	Adult
MO	Dunklin	KU82406	3 mi. NW of Kennett	8 April 162	Beverly Rose	Adult
MO	Dunklin	KU82407	Varney Ditch at Kennett	5 May 1962	Beverly Rose	Adult
MO	Dunklin	KU82410	0.25 mi W of Kennett	20 May 1962	Beverly Rose	Adult
MO	Dunklin	KU84331	4.5 mi. NW of Kennett	24 May 1962	Paul Anderson	Juvenile
MO	Dunklin	KU84596	Kennett	26 May 1962	J.L. Grimmer	Adult
MO	Dunklin	USNM56542	Unknown	15 June 1907	Julius Hurter	Adult
MO	Mississippi	KU82401	10 mi. S of Charleston	May 1962	Beverly Rose	Adult
MO	Mississippi	KU82408	10 Mile Pond, S of Charleston	5 May 1962	Beverly Rose	Adult
MO	Stoddard	FMNH33613	Hwy. 25, 1.5 mi. S of Cape Girardeau	28 May 1939	E.G.J. Falck	Juvenile
MO	Stoddard	KU82409	Mingo Wildlife Area	May 1962	Beverly Rose	Adult
MS	Attala	USNM260820	Kosciusko, ca. 3 mi. (air), W of S from Natches Trc. Pkw.	21 April 1957	R.M. & L. Johnson	Adult
MS	Bolivar	FMNH194594	Near Gunnison	2 April 1960	Bobby Moore	Juvenile
MS	George	LSU15917	Miss. 26, 3 mi. E of Pascagoula River	Unavailable	Unavailable	Juvenile
MS	Hinds	FMNH194559	6 mi. NE of Jackson, Pearl R., just below spillway	3 May 1963	A.D. Corban	Juvenile
MS	Itawamba	FMNH194598	6 mi. NE of Mantachie	3 May 1958	W.L. Stephens	Adult
MS	Lee	CM31909	Verona	23 March 1938	Unknown	Adult
MS	Newton	FMNH194607	5.5 mi. E of Decatur	24 February 1962	Harris	Juvenile
MS	Noxubee	FMNH194599	Noxubee River, near Bluff Lake	29 April 1959	George Vickers	Juvenile
MS	Noxubee	FMNH194606	1 mi. E of Bluff Lake	8 April 1958	Frank C. Page	Adult
MS	Oktibbeha	FMNH194584	Starkville, inside city limits	6 April 1958	Clyde Muse	Juvenile
MS	Oktibbeha	FMNH194585	7.7 mi. N of Starkville post office	8 April 1960	J.E. Ward	Juvenile
MS	Oktibbeha	FMNH194592	2 mi. E of Longview, old Hwy 12	24 May 1957	Frank Shropshire	Adult
MS	Oktibbeha	FMNH194595	7.7 mi. N of Starkville post office	8 April 1960	D.E. Ferguson	Juvenile
MS	Oktibbeha	FMNH194601	4 mi. E of Starkeville, Country Club	8 May 1961	Martin Tant	Adult
MS	Quitman	FMNH194603	2 mi. SE of Lambert	18 April 1964	J.E. Hollaway	Juvenile
MS	Rankin	FMNH194596	6 mi. SE of Byram, near the Pearl River	27 April 1958	L.S. Cambre	Adult
MS	Washington	APSU2630	16 mi. W on Hwy 12 from Hwy 49	12 July 1972	Mack Finley	Adult
MS	Sharkey	LSU47885	Blue Lake, ca. 7 airline mi. SE of Rolling Fork	Unavailable	Unavailable	Adult
OH	Hamilton	KU21463	Unknown	June 1940	Unknown	Adult
OH	Williams	UMMZ113111	NW Township, Curtis Mock Farm, 1 mi. W of Mud Lk.	May 1955	O.E. Ehrhart	Adult
OH	Williams	UMMZ178066	Lake Lasuan, born 6 Sept. 1976	NA	Mark Warsell	Juvenile
OH	Williams	UMMZ178067	Lake Lasuan, born 6 Sept. 1976	NA	Mark Warsell	Juvenile
OH	Williams	UMMZ178068	Lake Lasuan, born 6 Sept. 1976	NA	Mark Warsell	Juvenile

Nerodia erythrogaster Specimens Used in the Taxonomic Analysis (Continued)

State	County/Parish	Museum/Number	Collection Locality	Collection Date	Collector	Data Set
OH	Williams	UMMZ178069	Lake Lasuan, born 6 Sept. 1976	NA	Mark Warsell	Juvenile
OH	Williams	UMMZ178070	Lake Lasuan, born 6 Sept. 1976	NA	Mark Warsell	Juvenile
OH	Williams	UMMZ178071	Lake Lasuan, born 6 Sept. 1976	NA	Mark Warsell	Juvenile
OH	Williams	UMMZ178072	Lake Lasuan, born 6 Sept. 1976	NA	Mark Warsell	Juvenile
OH	Williams	UMMZ178073	Pioneer Boy Scout Res., born 10-21 Sept. ??	NA	Fred Kraus	Juvenile
OH	Williams	UMMZ178074	Pioneer Boy Scout Res., born 10-21 Sept. ??	NA	Fred Kraus	Juvenile
OH	Williams	UMMZ178075	Pioneer Boy Scout Res., born 10-21 Sept. ??	NA	Fred Kraus	Juvenile
OH	Williams	UMMZ178076	Pioneer Boy Scout Res., born 10-21 Sept. ??	NA	Fred Kraus	Juvenile
OH	Williams	UMMZ178077	Pioneer Boy Scout Res., born 10-21 Sept. ??	NA	Fred Kraus	Juvenile
OH	Williams	UMMZ178078	Pioneer Boy Scout Res., born 10-21 Sept. ??	NA	Fred Kraus	Juvenile
OH	Williams	UMMZ74512	Unknown	22 April 1933	W.M.M. Clay	Adult
OH	Williams	KU144827	Unknown	20 May 1961	Joseph T. Collins	Adult
TN	Cheatham	APSU4316	361735N, 870557W; Cheatham Res. WMA Pop.	30 September 198	Shawn Snyder	Adult
TN	Cheatham	APSU5967	361728N, 870558W; Cheatham Res. WMA Pop.	April 1998	Brant Smith	Adult
TN	Henderson	APSU2604	3 mi. NE of Lexington	3 June 1973	D.H. Snyder	Adult
TN	Lake	KU82974	Blue Bank on Reelfoot Lake	30 April 1939	Paul Anderson	Juvenile
TN	Lake	KU82975	Blue Bank on Reelfoot Lake	30 April 1939	Paul Anderson	Juvenile
TN	Lake	MSUR3520	Air Park, Reelfoot Lake State Park	21 April 1984	Les Meade	Juvenile
TN	Lake	MSUR3521	Air Park, Reelfoot Lake State Park	21 April 1984	Les Meade	Juvenile
TN	Lake	MSUR4407	Near Miss. R. Levee, ca. 12 mi. S of Tiptonville	25 April 1983	Les Meade & Ron Purvis	Adult
TN	Lake	MSUR780	Reelfoot Lake Wildlife Refuge, near Tiptonville	18 April 1981	Les Meade & Matt Meadows	Adult
TN	Montgomery	APSU2116	362520N, 871853W; Mark's Slough Pop.	15 June 1966	A.F. Scott	Adult
TN	Montgomery	APSU2125-1	Offspring of APSU2116	NA	NA	Juvenile
TN	Montgomery	APSU2125-10	Offspring of APSU2116	NA	NA	Juvenile
TN	Montgomery	APSU2125-11	Offspring of APSU2116	NA	NA	Juvenile
TN	Montgomery	APSU2125-12	Offspring of APSU2116	NA	NA	Juvenile
TN	Montgomery	APSU2125-13	Offspring of APSU2116	NA	NA	Juvenile
TN	Montgomery	APSU2125-14	Offspring of APSU2116	NA	NA	Juvenile
TN	Montgomery	APSU2125-2	Offspring of APSU2116	NA	NA	Juvenile
TN	Montgomery	APSU2125-3	Offspring of APSU2116	NA	NA	Juvenile
TN	Montgomery	APSU2125-4	Offspring of APSU2116	NA	NA	Juvenile
TN	Montgomery	APSU2125-5	Offspring of APSU2116	NA	NA	Juvenile
TN	Montgomery	APSU2125-6	Offspring of APSU2116	NA	NA	Juvenile
TN	Montgomery	APSU2125-7	Offspring of APSU2116	NA	NA	Juvenile
TN	Montgomery	APSU2125-8	Offspring of APSU2116	NA	NA	Juvenile
TN	Montgomery	APSU2125-9	Offspring of APSU2116	NA	NA	Juvenile
TN	Montgomery	APSU2130	Not Determined	6 October 1965	E. Wofford	Juvenile
TN	Montgomery	APSU2230	362635N, 871755W; Mark's Slough Pop.	October 1965	Howard Yarbrough	Adult

Nerodia erythrogaster Specimens Used in the Taxonomic Analysis (Continued)

State	County/Parish	Museum/Number	Collection Locality	Collection Date	Collector	Data Set
TN	Montgomery	APSU4309	On Zinc Plant property; Zinc Plant Pop.	4 May 1980	Ralph Thompson	Juvenile
TN	Montgomery	APSU4486	0.5 air mi. NW of N end of Long Pond Slough; LPS Pop.	8 August 1978	E.W. Chester	Adult
TN	Montgomery	APSU5457	362337N, 871718W; Shelton Ferry Wetland Pop.	14 April 1996	Angelo P. Bufalino	Adult
TN	Montgomery	APSU5463	362923N, 872720W; Cummings Creek Pop.	28 August 1996	Angelo P. Bufalino	Adult
TN	Montgomery	APSU5481	Offspring of APSU5463	NA	NA	Juvenile
TN	Montgomery	APSU5488-4	Offspring of APSU5463	NA	NA	Juvenile
TN	Montgomery	APSU5488-5	Offspring of APSU5463	NA	NA	Juvenile
TN	Montgomery	APSU5488-6	Offspring of APSU5463	NA	NA	Juvenile
TN	Montgomery	APSU5488-7	Offspring of APSU5463	NA	NA	Juvenile
TN	Montgomery	APSU5488-8	Offspring of APSU5463	NA	NA	Juvenile
TN	Montgomery	APSU5491-1	Offspring of APSU5463	NA	NA	Juvenile
TN	Montgomery	APSU5491-2	Offspring of APSU5463	NA	NA	Juvenile
TN	Montgomery	APSU5491-3	Offspring of APSU5463	NA	NA	Juvenile
TN	Montgomery	APSU5491-4	Offspring of APSU5463	NA	NA	Juvenile
TN	Montgomery	APSU5492	Offspring of APSU5463	NA	NA	Juvenile
TN	Montgomery	APSU5493	Offspring of APSU5463	NA	NA	Juvenile
TN	Montgomery	APSU5495	Offspring of APSU5463	NA	NA	Juvenile
TN	Montgomery	APSU5496	Offspring of APSU5463	NA	NA	Juvenile
TN	Montgomery	APSU5499	362542N, 853712W; Marshall Creek Pop.	11 October 1996	Angelo P. Bufalino	Adult
TN	Montgomery	APSU5977	362715N, 872231W; Round Pond Pop.	15 May 1998	A.F. Scott	Adult
TN	Montgomery	APSU6013	362700N, 872925W; Haynes Bottom WMA	23 May 1999	Scott Williams	Adult
TN	Montgomery	APSU6014	362700N, 872925W; Haynes Bottom WMA	1 June 1999	Scott Williams	Adult
TN	Obion	APSU2171	362751N, 891916W	6 August 1965	J.R. Heltsley	Juvenile
TN	Obion	APSU2184	Reelfoot Lake	6 August 1965	G.M. Kennedy	Adult
TN	Obion	APSU2211	362751N, 891916W	6 August 1965	Herpetology Class	Adult
TN	Obion	APSU3031	On Walnut Log Road	26 October 1973	R. Chaote	Adult
TN	Obion	KU154144	Reelfoot Lake	17 May 1973	Joseph T. Collins	Juvenile
TN	Obion	KU206544	NE edge of Reelfoot Lake, ca. Walnut Log	11 September 198	Joseph T. Collins	Adult
TN	Obion	MSUR253	Reelfoot Lake, near spillway	22 April 1977	Les Meade, et al	Adult
TN	Stewart	APSU2190	Bellwood Creek at river mi. 93; Bellwood Branch Pop.	1 October 1966	Billy C. Evans	Adult
TN	Stewart	APSU2944	3 mi. SW of Bumpus Mills; Bear Creek Pop.	30 March 1968	D.H. Snyder	Juvenile
TN	Stewart	APSU4749	364011N, 880304W; Kentucky Lake drainage	5 June 1992	F. Scott & J. Koons	Adult
TN	Stewart	APSU4926	363859N, 875643W; Crockett Creek Pop.	23 June 1987	F. Scott, et al	Juvenile
TN	Stewart	APSU5459	362548N, 874205W; Big Elk Creek Pop.	26 September 199	Angelo P. Bufalino	Adult
TN	Stewart	APSU5462	363226N, 875308W; Bear Creek Pop.	13 June 1995	Angelo P. Bufalino	Adult
TN	Stewart	APSU5498	363114N, 875253W; Bear Creek Pop.	30 September 199	Angelo P. Bufalino	Adult
TN	Stewart	APSU633	363333N, 875412W; Bear Creek Pop.	24 June1967	D.H. Snyder	Adult
TN	Lake	MSUR3586	Near Miss. R. Levee, ca. 12 mi. S of Tiptonville	April 1984	Les Meade	Adult

Nerodia erythrogaster Specimens Used in the Taxonomic Analysis (Continued)

State	County/Parish	Museum/Number	Collection Locality	Collection Date	Collector	Data Set
TX	Leon	FMNH41050	Burton farm, 5 mi. W Marquez	11 June 1943	J.E. Johnson	Juvenile
TX	Leon	FMNH41051	Burton farm, 5 mi. W Marquez	11 June 1943	J.E. Johnson	Juvenile
TX	Leon	FMNH41052	Burton farm, 5 mi. W Marquez	11 June 1943	J.E. Johnson	Juvenile
TX	Leon	FMNH41703	Burton farm, 5 mi. W Marquez, along Navasota R.	21 March 1944	Johnson & Sparks	Adult
TX	Leon	FMNH46323	5 mi. W of Marquez	17 April 1945	Johnson, Sparks, & Schmidt	Juvenile
TX	Leon	FMNH46324	5 mi. W of Marquez	17 April 1945	Johnson, Sparks, & Schmidt	Juvenile
TX	Leon	FMNH46325	5 mi. W of Marquez	17 April 1945	Johnson, Sparks, & Schmidt	Juvenile
TX	Leon	FMNH46326	5 mi. W of Marquez	17 April 1945	Johnson, Sparks, & Schmidt	Juvenile
TX	Leon	FMNH46327	5 mi. W of Marquez	17 April 1945	Johnson, Sparks, & Schmidt	Juvenile
TX	McLennan	FMNH41702	Unknown	21 March 1944	Johnson & Sparks	Juvenile
TX	Nacogdoches	FMNH35044	Nacogdoches	December 1939	G.E. Arnold	Juvenile

APPENDIX C

Specimens Excluded from the Taxonomic Analysis and Reasons for Exclusion

Nerodia erythrogaster Specimens Excluded From the Taxonomic Analysis and Reasons Why

State	County/Parish	Museum/Number	Collection Locality	Collection Date	Collector	Reason Excluded
AL	Elmore	UMMZ96764	1 mi. N of Tallapossa River	3 March 1943	Jesse Nicholls	Subadult
AL	Hale	CM72141	Black Warrior R. lock Juvenile5, ca. 5 mi. SW Cedarville	18 May 1979	R.C. Vogt, et al	Subadult
AL	Morgan	UL5549(4233)	Decatur	17 May 1972	A.B. Cahn	Subadult
AL	Perry	CM70030	S of Sprott on State Highway 14	28 July 1978	B. Bury & R. Luckenbach	Subadult
AL	Perry	CM70048	Cahaba River, 1.5 mi. W of Sprott	29 July 1978	P.S. Freed	Subadult
AL	Perry	CM72168	1.4 mi. W Hwy. 183 on Hwy. 49 (0.9 mi. N Sprott)	19 May 1979	R.C. Vogt, et al	Adult
AL	Sumter	UMMZ89900	Norwood L. at Gainesville	19 April 1940	F.S. Barkalow Jr.	Badly damaged
AL	Tuscaloosa	FMNH194602	Foster's fish hatchery	18 June 1963	Albert Stewart	Subadult
AL	Tuscaloosa	FMNH194604	Foster's fish hatchery	2 July 1963	Unknown	Subadult
AR	Clay	UMMZ81246	Black River, Corning	26 May 1934	M. Parker	Subadult
AR	Crittenden	CM24540	Turrell	May 1944	R.H. McCauley	Subadult
AR	Drew	FMNH40778	Monticello	April/May 1942	W.C. Hobgood	Subadult
AR	Greene	UMMZ77681	22 mi. N of Paragould	8 June 1934	Hartweg & Clanton	Subadult
AR	Greene	UMMZ77682	22 mi. N of Paragould	8 June 1934	Hartweg & Clanton	Faded (sun)
AR	Greene	UMMZ77683-A	2 mi. W of Paragould	8 June 1934	Hartweg & Clanton	Subadult
AR	Greene	USNM99698	10 mi. SE of Paragould	11 June 1934	Charles E. Burt	Subadult
AR	Hot Springs	FMNH35994	Malvern	September 1940	C.M. Barber	Subadult
AR	Jackson	UMMZ113155	5.5 mi. N of Tuckerman	4 June 1955	A. & P. Starrett	Subadult
AR	Lonoke	CM23999	6 mi. W of Carlisle on U.S. 70	12 June 1944	R.H. McCauley	Subadult
IL	Alexander	FMNH2241	Olive Branch, Horseshoe Lake	26 May 1907	C.M. Barber	Adult
IL	Pope	UL5147	Next to brige on Ill. 146, E of Jct. of Ill. 145	17 May 1972	Wilbur Curless	Subadult
IL	Richland	USNM14188	Olney, spc. labeled USNM14188, data from USNM14168	20 July 1885	John & Charles Walker	Subadult
IN	Clay	UMMZ117442	1 mi. S of Clay City	Unknown	S.A. Minton Jr.	Subadult
IN	Pike	UMMZ206562	1 mi. N of Pakota River	28 May 1993	W.J. McCoy	Subadult
IN	Posey	UMMZ110642	3 mi. E of Griffin	8 May 1954	Madge & Sherman Minton	Subadult
KY	Ballard	KU214470	0.5 mi. S of Barlow	12 May 1963	Julien C. Lee	Subadult
KY	Ballard	UL4366	4 mi. W Barlow	29 May 1974	B.L. Monroe, Jr. & Ralph Taylor	Subadult
KY	Ballard	UL6951	Oscsar	12 June 1936	R. Giannini	Subadult
KY	Carlisle	MSUR2567	Back Slough, Laketon	24 April 1982	L. Meade, M. Meadows, & G. Eldridge	Subadult
KY	Fulton	KU144823	Ken Point, N end of Reelfoot Lake	18 April 1962	Joseph T. Collins	Subadult
KY	Fulton	KU214464	5 mi. WSW of Hickman	10 May 1963	Julien C. Lee	Subadult
KY	Fulton	KU214465	5 mi. WSW of Hickman	10 May 1963	Julien C. Lee	Subadult
KY	Fulton	UL4776	3 mi. S.E. Bondurant	17 May 1972	Burt Monroe, Jr.	Subadult
KY	Graves	CM40488	2 mi. S of Hardmoney, Blizzard Pond	14 April 1965	M.E. Sisk	Subadult
KY	Hickman	MSUR252	Murphys Pond	22 April 1977	Les Meade, et al	Subadult
KY	Hickman	MSUR2583	Murphys Pond Area, near Obion Creek	26 April 1982	L. Meade, T. Stone, & G. Eldridge	Subadult
KY	Hopkins	UL7135	Weir's Creek, 3 mi. S of Provodence	23 April 1970	Mike Little	Subadult
KY	Hopkins	UL7136	Weir's Creek, 3 mi. S of Provodence	15 April 1972	Glen Early	Subadult
KY	Lyon	APSU4538-1	370112N, 880546W; Dickerson Cemetary Pop.	1 October 1988	E. Twombley, et al	Subadult
KY	Lyon	APSU4538-2	370112N, 880546W; Dickerson Cemetary Pop.	1 October 1988	E. Twombley, et al	Subadult
KY	Lyon	APSU4927	370234N, 880630W; Kuttawa Landing Pop.	24 June 1987	J. Twombly	Subadult
KY	Lyon	UKR1026	LBL, Honker Lake, river mi. 53-54; Honker Bay Pop.	15 June 1953	Barbour & Winchester	Did not request
KY	Lyon	UKR646	LBL, Honker Lake, river mi. 53-54; Honker Bay Pop.	6 June 1951	Barbour, et al	Did not request
KY	Lyon	UL3120	LBL, M-11; Honker Bay Pop.	15 July 1967	W.L. Redmon	Subadult
KY	McCracken	BYU31413	2 mi. W Paducah	April 1964	Don R. Harris	Subadult
KY	McCracken	BYU31414	2 mi. W Paducah	April 1964	Don R. Harris	Subadult
KY	McCracken	BYU31415	2 mi. W Paducah	April 1964	Don R. Harris	Subadult
KY	McCracken	BYU31417	2 mi. W Paducah	April 1964	Don R. Harris	Subadult

Nerodia erythrogaster Specimens Excluded From the Taxonomic Analysis and Reasons Why (Continued)

State	County/Parish	Museum/Number	Collection Locality	Collection Date	Collector	Reason Excluded
KY	McCracken	BYU31418	2 mi. W Paducah	April 1964	Don R. Harris	Subadult
KY	McCracken	BYU31419	2 mi. W Paducah	April 1964	Don R. Harris	Subadult
KY	McCracken	BYU31420	2 mi. W Paducah	April 1964	Don R. Harris	Subadult
KY	McCracken	BYU31421	2 mi. W of Paducah	Apil 1964	Don R. Harris	Excessive ventral slits
KY	McCracken	KU214484	5 mi. WNW of Paducah	29 May 1965	Julien C. Lee	Subadult
KY	McCracken	KU214485	5 mi. WNW of Paducah	29 May 1965	Julien C. Lee	Subadult
KY	McCracken	KU214486	5 mi. WNW of Paducah	29 May 1965	Julien C. Lee	Subadult
KY	Trigg	APSU5380	364348N, 885941W; Lick Creek Pop.	18 July 1989	J. Smith & E. Padgett	Subadult
KY	Trigg	APSU5464	LBL, Hematite Lake; Honker Bay Pop.	2 July 1994	Sally Noel	Photographic record
KY	Trigg	UL2724	LBL, Barkley Lake, river mi. 56; Honker Bay Pop.	3 August 1965	L. Thomas	Could not locate
KY	Trigg	UL2726	LBL, Barkley Lake, river mi. 59; Crooked Creek Bay Pop.	19 June 1965	Maxine Bingham	Could not locate
LA	? Avoyelles	BYU6904	Camp Plauche	16 March 1944	D.E. Beck	Subadult
LA	Caddo	FMNH8034	Gayle	June 1925	L.S. Frierson Jr.	Subadult
LA	E. Baton Roug	CM66669	Baton Rouge, Southern University	15 April 1966	F. Rabelais	Should have scored adult
LA	E. Baton Roug	LSU1545	Baton Rouge	Unavailable	Unavailable	Subadult
LA	E. Baton Roug	LSU1546	Baton Rouge	Unavailable	Unavailable	Excessive ventral slits
LA	E. Baton Roug	LSU22909	Bayou Manchac	Unavailable	Unavailable	Subadult
LA	Livingston	LSU57074	0.75 mi. N of Frost	Unavailable	Unavailable	Subadult
LA	Morehouse	CM44185	3 mi. S Bastrop, on Hwy. 165	24 June 1966	N.H. Douglas	Subadult
LA	Morehouse	USNM1118	Prarie Mer Rouge	Unknown	Unknown	Adult
LA	Ouachita	CM45353	Farm Pond on Slocum Rd., Calhoun	3 July 1964	J. Forcey & R. Delouche	Subadult
LA	St. Charles	CM88863	2 mi. S of Boutte	12 November 1971	D.M. Sever	Subadult
LA	St. Charles	LSU47246	Boutte	Unavailable	Unavailable	Subadult
LA	Tangipahoa	BYU21264	5 mi. E Ponchatoula	13 June 1962	J.W. Heinrichs	Subadult
LA	Orleans	KU82396	New Orleans	April 1945	Beverly Rose	Subadult
MI	Eaton	UMMZ74511	1 mi. E of Olivet	17 May 1933	W.M.M. Clay	Subadult
MO	Butler	KU82577	Wilhelmina	15 May 1939	J.E. Rose	Underdeveloped
MO	Butler	KU82581	Wilhelmina	15 May 1939	J.E. Rose	Underdeveloped
MO	Dunklin	KU82400	St. Francis River, ca. Cardwell	20 May 1962	Beverly Rose	Subadult
MO	Dunklin	KU82405	Varney Ditch, ca. Kennett	7 April 1962	Beverly Rose	Subadult
MO	New Madrid	KU82402	Portageville	May 1962	Beverly Rose	Subadult
MS	Claiborne	CM88864	2.3 mi. S of Reganton, Big Sandy River	10 March 1972	D.M. Sever	Subadult
MS	George	USNM99850	Leatherberry Slew	27 August 1934	Unknown	Subadult
MS	Greene	CM70000	9.8 mi. N of Leakesville on Route 57	19 July 1978	P.S. Freed	Subadult
MS	Harrison	USNM1346	Cat Island	Unknown	Unknown	Subadult
MS	Hinds	FMNH194605	Jackson	15 June 1963	B. Culley	Subadult
MS	Itawamba	FMNH194600	6 mi. NE of Mantachie	3 may 1958	W.L. Stephens	Subadult
MS	Lafayatte	CM31910	6 mi. S of Oxford	6 August 1938	C. Peeples	Faded (sun)
MS	Lee	CM31949	10 mi. NE of Oxford	27 June 1938	L. Leister	Subadult
MS	Lee	CM32006	E of Verona	14 September 1938	J.E. Porter	Faded (sun)
MS	Noxubee	FMNH194587	N shore of Bluff Lake	11 July 1963	W. Langdon	Subadult
MS	Oktibbeha	FMNH194593	Noxubee Refuge	31 March 1959	James Buttram	Subadult
MS	Oktibbeha	FMNH194597	4 mi. NE of Starkville	21 April 1959	Andrew J. Bond	Subadult
MS	Pearl River	CM21099	8 mi. W of Poplarville	30 August 1941	R.D. Hamilton	Subadult
MS	Quitman	FMNH194588	2 mi. SE of Lambert	18 April 1964	J.E. Hollaway	Subadult
MS	Smith	LSU47665	5 mi. N of Summerland	Unavailable	Unavailable	Subadult
MS	Tishomingo	CM31950	2.5 mi. W of Burnsville	12 May 1937	Unknown	Faded (sun)
MS	Wilkinson	LSU55821	Along Crooked Cr., 10 mi W, 1.3 N by air of Crosby	Unavailable	Unavailable	Subadult

Nerodia erythrogaster Specimens Excluded From the Taxonomic Analysis and Reasons Why (Continued)

State	County/Parish	Museum/Number	Collection Locality	Collection Date	Collector	Reason Excluded
OH	Williams	UMMZ7466	Blakeslee	7 May 1933	Roger Conant	Adult
TN	Hardeman	LSU44001	Hornsby	Unavailable	Unavailable	Subadult
TN	Hardin	LSU34931	Near Pocahontas	Unavailable	Unavailable	Head only
TN	Lake	MSUR2926	Near Miss. R. Levee, ca. 12 mi. S of Tiptonville	25 April 1983	Les Meade & Ron Purvis	Subadult
TN	Lake	MSUR2927	Near Miss. R. Levee, ca. 12 mi. S of Tiptonville	25 April 1983	Les Meade & Ron Purvis	Subadult
TN	Lake	MSUR2928	Near Miss. R. Levee, ca. 12 mi. S of Tiptonville	25 April 1983	Les Meade & Ron Purvis	Subadult
TN	Lake	MSUR3530	Air Park, Reelfoot Lake State Park	22 April 1984	Les Meade	Subadult
TN	Montgomery	APSU2078	362635N, 871755W; Mark's Slough Pop.	26 July 1965	D.H. Snyder	Underdeveloped
TN	Montgomery	APSU2129	362635N, 871755W; Mark's Slough Pop.	26 July 1965	D.H. Snyder	Underdeveloped
TN	Montgomery	APSU5488-1	Offspring of APSU5463	NA	NA	Underdeveloped
TN	Montgomery	APSU5488-2	Offspring of APSU5463	NA	NA	Underdeveloped
TN	Montgomery	APSU5488-3	Offspring of APSU5463	NA	NA	Underdeveloped
TN	Montgomery	APSU5494	Offspring of APSU5463	NA	NA	Subadult
TN	Montgomery	APSU5990	362420N, 871710W; Shelton Ferry Wetland Pop.	5 August 1997	B. Smith & K. Wallace	Subadult
TN	Obion	KU82411	Reelfoot Lake	28 April 1939	Beverly Rose	Subadult
TN	Obion	LSU43978	Half Moon Lake, S of Union City	Unavailable	Unavailable	Subadult
TN	Obion & Lake	UL3898	Reelfoot Lake	9 May 1969	Ronald L. Vaeger	Subadult
TN	Stewart	APSU280	3 mi. SW of Bumpus Mills; Bear Creek Pop.	15 June 1966	D.H. Snyder	Subadult
TN	Stewart	APSU5465	362431N, 873644W; Guices Creek Pop.	29 August 1996	A.F. Scott & A.P. Bufalino	Subadult
TN	Stewart	APSU5497	362440N, 873616W; Guices Creek Pop.	30 September 1996	Angelo P. Bufalino	Subadult
TN	Stewart	APSU703	363440N, 875406W; Bear Creek Pop.	7 July 1967	J.W. Sexton, Pardue	Subadult
TN	Stewart	APSU800	LBL, Lake Barkley, river mi. 81; Bear Creek Pop.	11 July 1967	A.F. Scott, et al	Observation record
TN	Stewart	APSU801	LBL, Neville Bay area; Neville Bay Pop.	12 July 1967	A.F. Scott, et al	Observation record
TX	Newton	CM88865	RT1416, 0.2 mi. NE of JCT RT87	2 May 1973	B. Sutton	Subadult
Unk.	Unknown	UL7161(1)	Stillborn in captivity	15 August 1974	B.L. Monroe, Jr.	Subadult
Unk.	Unknown	UL7161(2)	Stillborn in captivity	15 August 1974	B.L. Monroe, Jr.	Subadult
Unk.	Unknown	UL7161(3)	Stillborn in captivity	15 August 1974	B.L. Monroe, Jr.	Subadult

APPENDIX D

Extent and Classification of Habitats at Documented *Nerodia erythrogaster* Sites in the Lower Cumberland River Basin

Extent (Hectares) and Classification of Wetland Habitats at Documented *Nerodia erythrogaster* Sites in the Lower Cumberland River Basin

	Wetland Classifaction																														
Site	PUBH	PUBHh	PUBHx	PUBF	PUBFh	PUBFx	PEM1A	PEM1Ah	PEM1C	PEM1Ch	PEM1Cd	PEM1F	PEM1Fh	PEM1Sh	PSS1A	PSS1Ah	PSS1C	PSS1Ch	PSS1Fh	PFO/SS1A	PFO/SS1C	PFO/SS1F	PFO1A	PFO1Ah	PFO1C	PFO1Ch	PFO1F	PFO1Fh	PFO1/5F	POWH	POWHh	POWHx	Total ha
1 - Carmack Bay	-	-	-	-	-	-	-	-	-	2.3	-	-	-	-	-	2.3	-	-	-	-	-	-	-	5.2	-	-	-	-	-	-	-	-	9.8
2 - Kuttawa Landing	-	0.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	8.7	-	-	-	-	-	-	-	-	9.3
3 - Dickerson Cemetery	-	3.5	-	1.7	-	-	-	-	-	-	-	-	-	0.6	-	-	-	-	-	-	-	-	16	-	-	-	-	-	-	-	-	-	22
4 - Honker Bay	0.6	0.6	0.6	-	-	-	-	-	-	26	-	-	5.8	-	-	6.9	-	1.7	-	-	-	-	42	6.9	-	8.1	0.6	-	-	-	-	-	99.5
5 - Energy Lake	0.6	0.6	0.6	-	-	-	25	-	2.9	9.3	-	1.7	-	-	13	1.7	8.1	5.2	-	-	-	-	4.6	-	17	-	-	-	-	-	-	-	90.3
6 - Crooked Creek	0.6	-	-	-	-	-	-	-	-	-	-	0.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.2
7 - Crooked Creek Bay	-	1.7	-	-	-	-	-	-	-	1.2	-	-	2.3	-	-	0.6	-	-	-	-	-	-	3.5	0.6	-	-	-	-	-	-	-	-	9.9
8 - Lick Creek	-	0.6	-	-	-	-	-	-	-	-	-	-	-	-	3.5	4.6	-	4.6	-	-	-	-	6.4	1.7	-	-	-	-	-	-	-	-	21.4
9 - Crockett Creek	-	-	-	0.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.6
10 - Neville Bay	-	-	0.6	-	-	-	-	-	-	-	-	-	1.2	-	1.2	-	-	-	-	-	-	-	4.6	-	-	-	-	-	-	-	-	-	7.6
11 - Bear Creek	1.2	5.2	1.2	-	0.6	-	2.3	2.9	-	59	-	-	27	-	-	13	-	41	24	-	-	-	17	151	5.8	120	-	3.5	-	-	-	-	476
12 - Bellwood Branch	-	2.9	0.6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.2	1.2	-	-	-	-	8.7	-	19	-	-	-	-	-	-	33.1
13 - Big Elk Creek	2.3	0.6	-	-	-	-	-	-	1.7	1.7	-	-	0.6	-	-	-	-	1.2	2.9	-	-	-	-	-	2.3	2.3	-	-	-	-	-	-	15.6
14 - Guices Creek	1.2	2.9	-	-	1.2	-	5.2	-	0.6	16	0.6	0.6	-	-	-	7.5	5.2	8.7	1.2	-	-	-	4.1	16	-	2.3	-	-	-	-	-	-	72.5
15 - Marshall Creek	1.7	0.6	0.6	-	-	-	-	-	-	1.2	-	-	2.9	-	-	-	12	1.7	-	-	-	-	5.2	10	2.3	2.3	-	-	-	-	-	-	40.5
16 - Cummings Creek	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	11	-	-	-	-	-	-	-	4.1	1.2	16.3
17-Haynes Bottom WMA	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	19	-	-	2.9	-	-	-	4.1	3.5	-	29
18 - Long Pond Slough	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	18	-	8.1	-	-	-	-	-	13	3.5	42.2
19 - Zinc Plant	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4.1	-	-	-	-	-	2.3	-	6.4
20 - Round Pond	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4.1	0.6	4.7
21 - Mark's Slough	-	-	-	-	-	-	8.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10	-	12	-	-	-	-	-	1.2	-	31.9
22 - Shelton Ferry	-	-	-	-	-	-	-	-	2.9	0.6	-	2.9	-	-	7.5	-	5.2	-	-	-	2.3	1.7	32	-	21	-	15	-	20	4.1	2.3	-	116
23 - Cheatham Res. WM	-	-	-	-	-	-	2.3	-	4.1	0.6	-	2.9	-	-	-	-	5.2	-	-	5.8	-	-	13	-	6.4	-	-	-	21	-	2.3	1.7	65.4

Wetlands Classification Key[1]

System

P = Palustrine

Class/Subclass

UB = Unconsolidated Bottom
EM = Emergent/1 = Persistent
SS = Scrub-Shrub/1 = Broad-Leaved Deciduous
FO = Forested/1 = Broad-Leaved Deciduous, 5 = Dead
OW = Open Water

Modifiers

A = Temporarily Flooded
C = Seasonally Flooded
F = Semipermanently Flooded
H = Permanently Flooded
S = Temporary-Tidal
d = Partially Drained/Ditched
h = Diked/Impounded
x = Excavated

[1] From United States Department of Interior Wetlands Inventory Maps

APPENDIX E

Extent and Classification of Habitats at Potential *Nerodia erythrogaster* Sites in the Lower Cumberland River Basin

Extent (Hectares) and Classification of Wetland Habitats at Potential Nerodia erythrogaster Sites in the Lower Cumberland River Basin

	Wetland Classification																
Study Zone	PUBF	PEM1A	PEM1Ch	PEM1Cd	PEM1Fh	PSS1C	PSS1Ch	PSS1Fh	PSS/EM1C	PFO1C	PFO1Ch	PFO1F	PFO1Fh	PFO1/5F	POWHh	POWHx	Total ha
Zone 1	-	-	-	-	-	-	-	-	-	128	-	-	-	-	-	-	128
Zone 2	-	-	-	-	-	-	5.8	-	-	-	-	-	-	-	-	-	5.8
Zone 3	-	-	15	-	-	-	6.9	-	-	-	-	-	-	-	-	-	21
Zone 4	-	-	42	-	-	-	75	14	-	-	156	-	-	-	-	-	287
Zone 5	7.5	-	141	-	-	11	35	-	-	-	27	-	-	-	-	-	222
Zone 6	-	-	-	-	-	-	-	-	-	5.8	-	-	-	-	8.1	-	14
Zone 7	-	9.3	-	16	-	-	-	-	9.8	132	-	5.8	-	21	-	-	194
Zone 8	-	-	-	-	14	-	-	-	24	23	13	-	19	-	-	6.9	99
Zone 9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	*0*
Zone 10	-	-	-	-	-	-	-	-	-	5.8	-	-	-	-	-	-	*5.8*

Wetlands Classification Key[1]

System	Class/Subclass	Modifiers	
P = Palustrine	UB = Unconsolidated Bottom	A = Temporarily Flooded	d = Partially Drained/Ditched
	EM = Emergent/1 = Persistent	C = Seasonally Flooded	h = Diked/Impounded
	SS = Scrub-Shrub/1 = Broad-Leaved Deciduous	F = Semipermanently Flooded	x = Excavated
	FO = Forested/1 = Broad-Leaved Deciduous, 5 = Dead	H = Permanently Flooded	
	OW = Open Water		

[1] From United States Department of Interior Wetlands Inventory Maps

VITA

Angelo Paul Bufalino was born in Longbeach California, 18 May 1970, the son of Salvatore A. and Catherine H. Bufalino. He spent his early years in southern California and southwestern Arizona, finally settling in St. Louis, Missouri during the fall of 1976. In St. Louis he attended public schools in the Parkway School District, graduating from Parkway North Senior High School in May 1989. In the fall of 1989 he attended Northwest Missouri State University and in May 1994 received the degree of Bachelor of Science in Wildlife Ecology and Conservation under the guidance of Dr. David A. Easterla. In August 1994 he entered Austin Peay State University (APSU), Clarksville, Tennessee and in December 1999 received a Master of Science degree in Biology. While at APSU he worked closely with Dr. A. Floyd Scott on a variety of ecological research projects.

He has been employed at Specialized Assays (Nashville division of Testamerica) since January 1997 and is currently the Operations Manager there. He looks forward to continuing his education and pursuing a career in academia.