SEASONAL ACTIVITY AND MOVEMENTS OF WESTERN COTTONMOUTHS (AGKISTRODON PISCIVORUS LEUCOSTOMA) ALONG THE CUMBERLAND RIVER BICENTENNIAL TRAIL, ASHLAND CITY, TENNESSEE

NATHALIE SMITH

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A Thesis

Presented for the Master of Science Degree

Austin Peay State University

Nathalie Smith

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TO THE GRADUATE COUNCIL:

I am submitting herewith a thesis written by Nathalie D. Smith entitled: Seasonal Activity and Movements of Western Cottonmouths (*Agkistrodon piscivorus leucostoma*) along the Cumberland River Bicentennial Trail, Ashland City, Tennessee. I have examined the final paper copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science in Biology.

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DEDICATION

This thesis is dedicated to my mother, my best friend. Everything that I am I owe to you. You have inspired, encouraged and shown me that anything is possible. Thanks for putting up with having snakes, crabs and various other creepy crawlers loose in the house. I'm so very proud to be your daughter and love you more than you will ever know.

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I would also like to thank Andrea English, Danny Bryan and the Tennessee Wildlife Resources Agency for their assistance in getting this project started and for providing and inserting transmitters! I truly believe we were able to open the eyes of many trail visitors and helped to protect the future of snakes along this trail. The Center of Excellence for Field Biology and the Office of Graduate Studies (Austin Peay State University) provided much needed vehicles, funding, supplies and support to keep the project going. Mike Wilson also assisted with much needed GIS help. Thank you!

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ABSTRACT

The Cumberland River Bicentennial Trail (CRBT) near Ashland City, Tennessee is a popular recreational corridor that bisects the winter and summer habitats of a well established Western Cottonmouth (*Agkistrodon piscivorus leucostoma*) population. The objectives of this study were to determine the seasonal movements of these snakes and the attitudes of trail users towards snakes they encounter in the area.

To gather data on the first objective, manual searches were conducted for snakes on and along the trail. All captured snakes were measured, weighed, and marked for future identification. In addition, five individuals were tracked using radio telemetry technology. After fourteen months of study, ninety-four individuals were encountered and their movements mapped with GIS software. Ingression into hibernacula began in early October at air temperatures around 17 °C, and appeared to be complete by late October. Egression from hibernacula began in early March at air temperatures around 15°C and appeared to be complete by early April. The second objective was addressed by distributing a survey with questions concerning attitudes toward snakes to trail users.

The two radio-tagged males had smaller home ranges than the three radio-tagged females and average distances moved between successive locations ranged from 64 to 130 m. Using the Schnabel and Schumacher's methods an estimated population size ranged from 202 to 216 individuals. Fourteen other snake species were recorded on the study area including several individuals of the federal listed Copper-bellied Watersnake.

Habitat preferences included regions of the slough that were heavily dominated by various forms of aquatic vegetation. Snakes were rarely observed in open (non-covered) portions of the slough. All chosen hibernacula were located within the limestone bluffs bordering the trail and study area.

Sixty-six trail visitors were surveyed along the CRBT ranging in age from teenagers to seventies. Results varied (based on the question asked and age group surveyed) but overall at least 55% of those surveyed were fearful of snakes, felt that snakes are important to the environment, could identify a venomous snake from a non-venomous snake, felt they needed to protect others from snakes and would be interested in learning more about snakes in the region.

Conservation strategies should include habitat preservation, snake monitoring during October and March when temperatures are averaging around 15°C, and further developing citizen education.

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LIST OF ABBREVIATIONS USED IN TABLES AND APPENDICES

ADM	Average Distance Moved
AT	Air Temperature
ATS	Advanced Telemetry Systems
Avg	Average
BB	Buttonbush
BL	Body Length
BW	Body Weight
CB	Cover Board
CLWMA	Cheatham Lake Wildlife Management Area
cm	Centimeters
CM	Capture Method
CRBT	Cumberland River Bicentennial Trail
df	Degrees of Freedom
DM	Distance Moved
Freq	Frequency
ft	Feet
g	Gram
ha	Hectares
HR	Home Range
km	Kilometer
m	Meters
m^2	Meters squared
mm	Millimeter
min	Minutes
MCWMA	Mark's Creek Wildlife Management Area
ml	Milliliter
RM/BB	Red Maple/Buttonbush
RT	Radio-tagged
SC	Scale Clip Number
SD	Standard Deviation
SNAP	Sex Nor Age Provided
SVL	Snout Vent Length
TBL	Total Body Length
TJ	Turkey Junction
TJS	Turkey Junction Stream
TWRA	Tennessee Wildlife Resources Agency
W	Weight
WMA	Wildlife Management Area
WT	Water Temperature

CHAPTER I

INTRODUCTION

The overall decrease in biodiversity and species richness around the world is becoming an ever increasing conservation concern. Within this scope of concern, a group of animals in need of further investigation is snakes. These organisms are constantly being exposed to dangerous threats, and when compared to other herpetofauna, some believe they are the group at greatest risk of extinction worldwide (Gibbons et al., 2000). Six categories of concern have been linked to herpetofaunal declines by the Partners in Amphibian and Reptile Conservation (Gibbons and Stangel, 1999). These factors include habitat loss and degradation, introduced invasive species, environmental pollution, disease and parasitism, unsustainable use, and global climate change.

In addition to these environmental issues, another major threat reptiles are encountering is that of human disturbance and interference. Many people are still unaware of the importance of conserving native organisms and often dismiss snakes as being unimportant and sometimes evil organisms. They have been feared, worshiped, exploited, studied and used in magic, witchcraft, religion, medicine, war, torture, sport, science, commerce and entertainment (Morris and Morris, 1965).

Objectives

Because the Cumberland River Bicentennial Trail (CRBT) intersects the winter and summer habitats of many snake species, human and snake interactions are becoming more of a concern as snakes make their way to and from their hibernacula. Andrea English, a Tennessee Wildlife Resources Agency biologist, has documented several intentional killings on the trail (personal communication). Without an educational intervention effort these attacks are sure to continue. Providing evidence to trail users for reasons against committing such acts was a special objective associated with this project. Raphael et al. (2007) provide evidence which includes emphasizing the ethical, ecological, evolutionary and legal aspects associated with harming an animal. Being able to confront both the environmental and social threats facing these reptiles is also an important factor in ensuring their success.

An overall assessment of the snake fauna in this region was carried out but the majority of research focused on the Western Cottonmouth (*Agkistrodon piscivorus leucostoma*). Special attention was also given to the Copper-bellied Watersnake (*Nerodia erythrogaster neglecta*), a species listed under the federal Endangered Species Act whose presence in the area was documented by Bufalino and Scott (2003). This species tends to travel long distances, therefore increasing their chances of mortality (Gibbons and Dorcas, 2005). The status of this population was of concern because the CRBT is at the eastern-most extent of this species' range in Tennessee. The Copper-bellied Watersnake is commonly found near water sources such as ponds and sloughs that contain a high abundance of basking platforms (Lacki et al., 1994). Due to habitat preferences shown by both of these species, the CRBT is prime habitat for studying them and getting an overall assessment of the health of the reptile community to which they belong.

In order to understand the conservation needs associated with these populations, their distribution and movement patterns were studied. The attitudes of local citizens toward snakes were also examined. Specific objectives of this study included:

1. Determine movements, home ranges and habitat preferences of *A. p. leucostoma*;
2. Determine when during spring and fall the majority of cottonmouths are moving across the trail and how this compares to trail usage by humans;
3. Compare snake movements and behavior with temperature;
4. Educate trail visitors on the importance of conserving these animals;
5. Develop a better understanding of how citizens and trail visitors view snakes;
6. Develop a management strategy for protecting snakes along the CRBT.

CHAPTER II

STUDY AREA

Cumberland River Bicentennial Trail

This study was conducted in the lower Cumberland River Basin near Ashland City, Tennessee (Figure 1). Smith (2005) studied Western Cottonmouths in this region and found them occupying the forested floodplain swamps when active and crevices of neighboring limestone bluffs when hibernating. The region of greatest concern for this study was a 10.46-km trail known as the Cumberland River Bicentennial Trail (CRBT).

Field work was conducted between February 2008 and May 2009 on and along the first 2.4 km of the CRBT. After consultation with naturalists in the area and after surveying the area prior to the beginning of the study it was determined that the wooded swamp below this initial section of the trail has the highest concentration of cottonmouths. Snakes are most likely found along the initial 2.4 km of the trail due to the fact that past this point the slough habitat disappears and is replaced by the open backwater of Sycamore Creek, thus providing less suitable summer habitat. Cottonmouths are a species that prefer covered forested areas (Keck, 1998).

The CRBT, which was originally a railroad bed, was converted to a trail in 1997. In 2004, the first 6.4 km were paved starting at Marks Creek trail head and ending at Sycamore Creek trail head. The second 4.02 km known as Eagle Pass remain a gravel path. This trail, which is situated between swampy floodplains and high rocky bluffs, is now a heavily traveled recreational pathway (Figure 2).

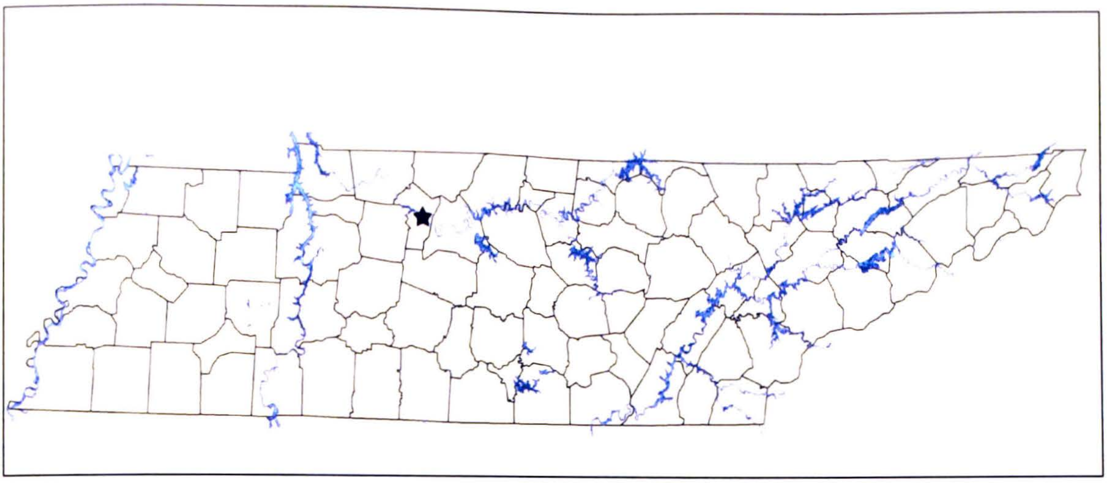

Figure 1. County map of Tennessee showing the location of the CRBT (star) near Ashland City, Tennessee. (Map provided by A. Floyd Scott).

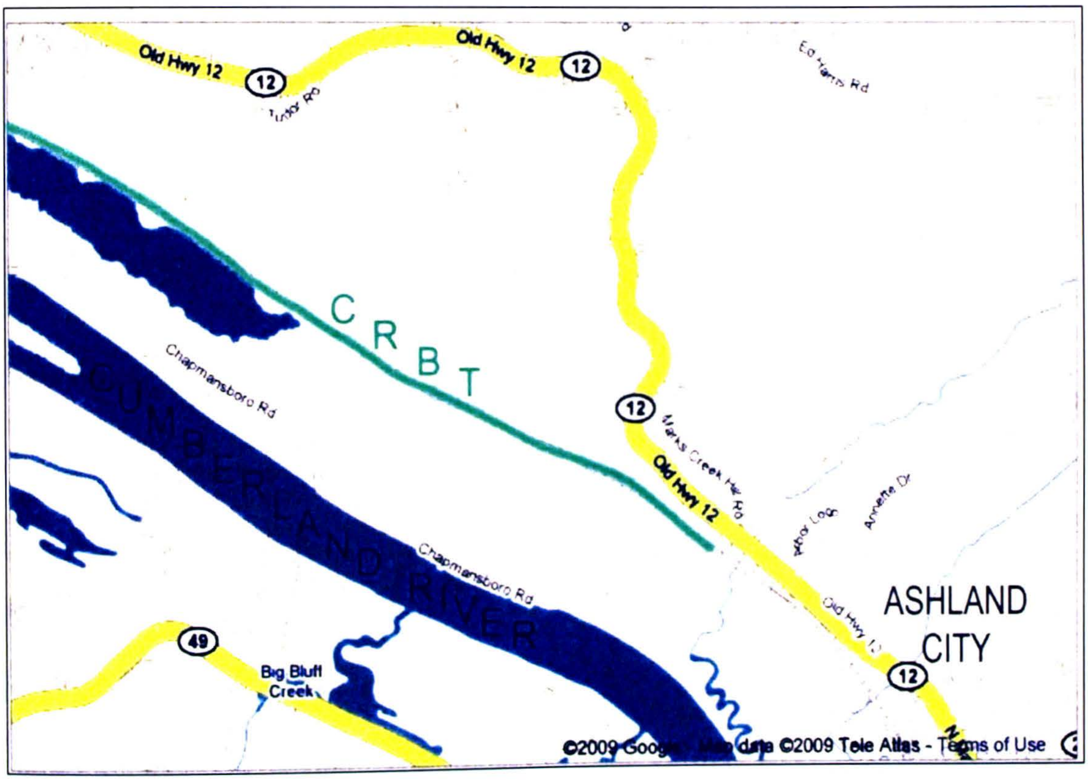

Figure 2. Location of the Cumberland River Bicentennial Trail (green line) in relation to nearby roads and streams.

Cheatham Lake Wildlife Management Area

The Cheatham Lake Wildlife Management Area (Figure 3) encompasses the Mark's Creek Wildlife Management Area (MCWMA) which borders the trail and contains the summer slough habitat these snakes rely on. In 1957, the Cheatham lake Dam on the Cumberland River was closed to form what is now known as Cheatham Lake. In the 1980's the Cheatham Reservoir Wildlife Management Area was officially renamed the Cheatham Lake Wildlife Management Area (CLWMA). The overall size of the CLWMA is 2084.9 ha plus the open water hectares of Cheatham Lake (Cromer and Thompson, 2006). The MCWMA is approximately 1 km northwest of Ashland City, Tennessee in Cheatham County. Approximate slough size within the MCWMA is 32.8 ha. This area is monitored and managed for water fowl and is flooded each fall in preparation for winter hunting. Water levels are controlled by a levee and water control system (Smith, 2005).

Lower Tennessee-Cumberland Ecosystem

The Lower Tennessee-Cumberland Ecosystem contains two watersheds. These include the lower half of the Tennessee River and the entire drainage of the Cumberland River (U.S. Fish and Wildlife Service, 1995). My study area included bottomland that lies along the Cumberland River (Cromer and Thompson, 2006). Overall, the Cumberland River has a drainage area of 45,579 square km and has elevations ranging from 92 to 1262 m (U.S. Fish and Wildlife Service, 1995). Major tributaries to this river include the Harpeth River and Sycamore Creek (Cromer and Thompson, 2006).

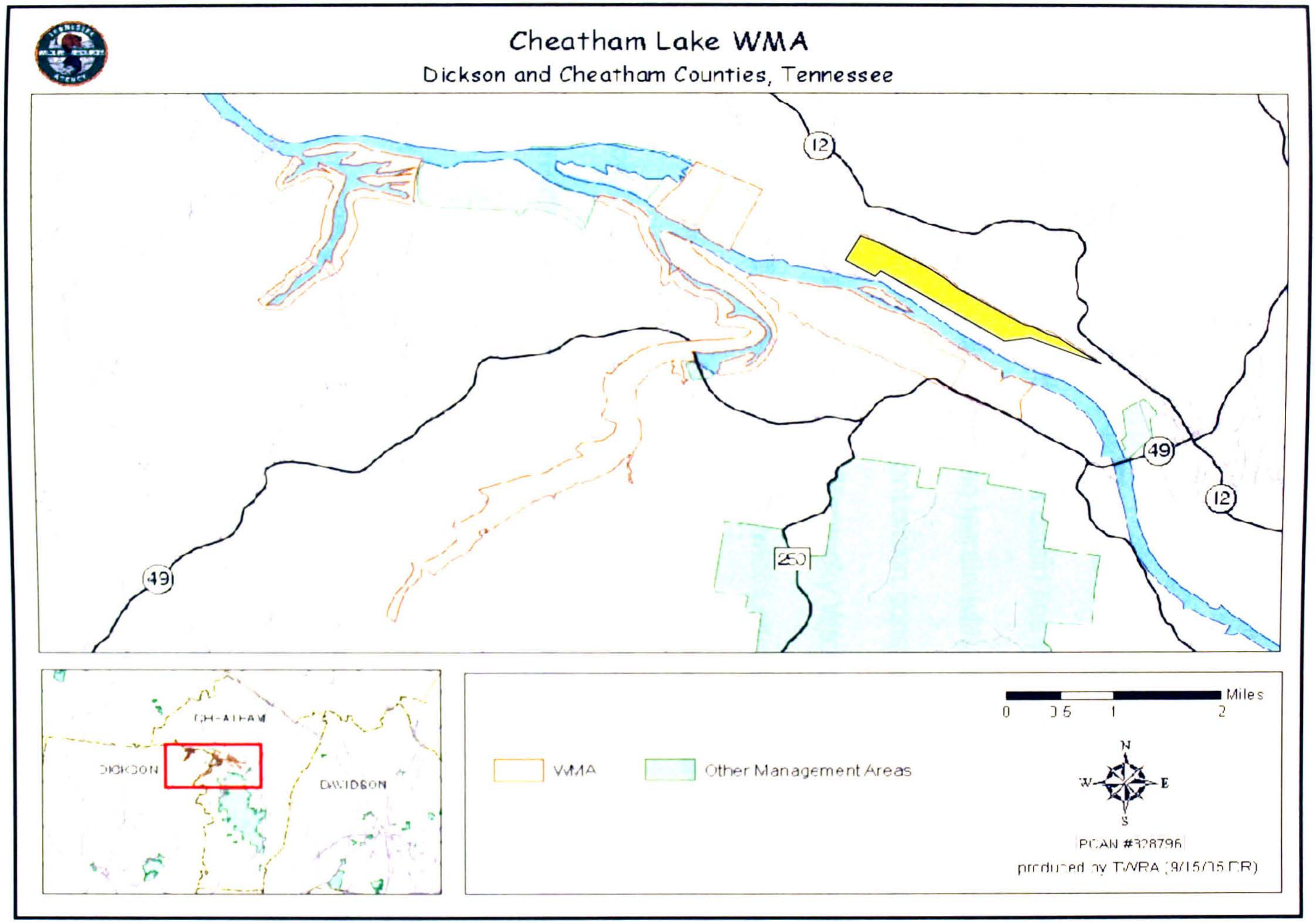

Figure 3. The Cheatham Lake Wildlife Management Area (Tennessee Wildlife Resources Agency, 2009), with cottonmouth's summer slough habitat highlighted in yellow.

Average rainfall for this region is generally around 127 cm a year and ecological communities include savannas of oak and ash, closed forests of oak and oak-hickory, mesophytic forests on loess bluffs, bottomland hardwood swamps, cave systems, cedar glades, transient lakes and coldwater streams (U.S. Fish and Wildlife Service, 1995).

Physiography

The Lower Cumberland River Basin lies within the Western Pennyroyal physiographic region. Gently rolling terrain with Mississippian age limestone characterizes this karst environment which consists of "sinkholes, subsurface drainage and limestone caverns" (Kentucky Water Organization, 2009). Specifically, the CLWMA lies in the Interior Low Plateaus within the Central Basin subregion as well as within the Southeastern Coastal Plain (Cromer and Thompson, 2006). The Southeastern Coastal Plain is known for its "extensive riverine swamps and marsh complexes" (American Bird Conservancy, 2007).

Land Use

Within the Cheatham Lake Wildlife Management Area, there are 398 ha of farmable property, 878 ha of bottomland hardwood, secondary growth hardwood and natural wetlands. There are also 809 ha of impounded permanent water. In regards to farmable land, ninety percent is sharecropped and ten percent is cultivated by the Tennessee Wildlife Resources Agency (TWRA) (Cromer and Thompson, 2006). A major source of nonpoint source pollution in this basin comes from agricultural practices including croplands, pasture lands and animal holding areas. Logging, sewage treatment plants, septic tanks and industrial sources also contribute to the impacts of this region (Kentucky Water Organization, 2009). Eighty percent of the original bottomland hardwood forests have been converted into primarily agricultural regions (Four Rivers Basin Team, 1999).

Vegetation

The CLWMA is comprised of river bottom agricultural fields, woodlands and flooded, forested swamps (Smith, 2005). Studies on the vegetation within the CLWMA are few; those that exist have been conducted in similar environments within neighboring counties. Chester et al. (1995) studied forest communities in Montgomery and Stewart counties and characterized common vegetation on limestone bluffs along the Cumberland River and bottomland hardwood forests in the Cross Creeks National Wildlife Refuge. The "xeric bluffs" examined in their study were characterized by thin alkaline soils, steepness and westward/southern exposure. Similar bluffs occur along the CRBT. The most common vegetative species found along the bluffs in their study included Eastern Red Cedars (*Juniperus virginiana)*, White Ash (*Fraxinus Americana)* and Chinkapin Oaks (*Quercus muehlenbergii)*. Common species found within their bottomland-hardwood forests were "mesic-hydric" species including Box Elders (*Acer negundo)*, Silver Maples (*A. saccharinum)* and Sycamores (*Platanus occidentalis)*.

Smith (2005) surveyed the woody species of vegetation on the limestone bluffs and in the flooded swamp at MCWMA (see Table 1 in his paper) and identified several of the same species listed for the Cross Creeks refuge by Chester et al. (1995).

Climate and Weather

Average annual temperatures taken from the Cheatham Lock and Dam Weather Station from 1936 to 2008 ranged from 6°C to 21°C. Average annual precipitation was 11 cm. A complete list of monthly averages for minimum and maximum temperatures as well as monthly precipitation can be seen in Table 1. This information was obtained from http://www.climate-charts.com/USA-Stations/TN/TN401663.php.

Table 1. Average minimum and maximum temperatures as well as monthly precipitation (from 1936 to 2008) from Cheatham Lock and Dam Weather Station.

Statistic	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Avg
Minimum Temp (°C)	-5.3	-4.2	0.3	4.4	9.8	15.0	17.9	17.0	12.9	5.9	0.8	-3.2	6.0
Maximum Temp (°C)	7.7	10.8	16.5	21.1	25.5	29.9	32.3	31.8	28.2	22.1	15.6	10.3	21.0
Monthly Precip. (cm)	9.8	11.0	14.0	10.7	13.8	11.7	11.4	7.2	9.7	8.2	11.4	12.6	10.9

CHAPTER III

THE STUDY ANIMAL

Nomenclature

Snakes of the *Agkistrodon* complex are relatively primitive members of the family Crotalidae (Burkett, 1966) and are the only genera found in both the old and new world. There are three sub-species of cottonmouths found in the United States: the Western Cottonmouth (*A. p. leucostoma*), the Eastern Cottonmouth (*A. p. piscivorus*) and the Florida Cottonmouth (*A. p. conanti*) (Gloyd and Conant, 1990). De Beauvois first proposed the genus *Agkistrodon* in 1836, deriving it from the Greek words for hook and tooth (Klauber, 1956). Troost (1836) first described the subspecies from a specimen presumed to be from West Tennessee and assigned it the binomial *Ancontias leucostoma*. He referred to it as the "white-mouthed *Acontias*, generally known by the name of the Cotton-mouthed snake." Common names include cottonmouth, water moccasin, water adder, gapper, Congo snake, blunt-tail moccasin, swamp lion and trap jaw (Gloyd and Conant, 1990; Burkett, 1966). The name "cottonmouth" reflects the snake's open-mouth reaction to threats (Greene, 1997).

Description

The members of this subspecies are easily identified by their heavy bodies, vertical pupil, facial pit, keeled scales, single anal plate and a distinctive black line that projects from the eye to the back of their lower jaw. Adults often have a dark gray-brown coloration with dimly defined lateral banding (Tennant, 2003). Belly patterns have irregularly spaced yellow and brown blotches

(Gibbons and Dorcas, 2005). Juveniles tend to have a more brownish coloration with more clearly defined patterning than the adults. The tails of these young have green tips which assist in luring and capturing potential prey. Adult cottonmouths can vary in length, ranging from 62 cm to 157.5 cm. However, larger snakes over 106 cm are sometimes (but seldom) seen (Gloyd and Conant, 1990). The largest Western Cottonmouth recorded was 160 cm in length (Tennant, 2003). A visual example of this species can be seen in Figure 4.

Cottonmouths are venomous snakes that contain primarily hemotoxic venom. The venom breaks down blood cells and has anticoagulant properties; however, few deaths have resulted from this species (Gibbons and Dorcas, 2005). The primary function of their venom is to cause rapid death in prey animals and to begin digestion of prey tissues (Burkett, 1966). The venom of cottonmouths has been given an LD_{50} value of 2.04. Two hollow, articulated fangs average 11 mm and characterize this species as having a "solenoglyphous venom delivery system" (Ernst and Barbour, 1989). Fangs are occasionally shed and are generally replaced one side at a time. During this process, it is possible that four functional fangs can occur at once (Ernst, 1982).

Distribution

The Western Cottonmouth is found throughout the south-central United States within an area (Figure 5) that extends from southern Alabama to southeastern and central Texas, then northward to southern and eastern Oklahoma, southern Missouri, southern Illinois, southern Indiana, western Kentucky and western Tennessee (Gloyd and Conant, 1990).

Figure 4. A male Western Cottonmouth (Photograph by Lisa Powers, 2008).

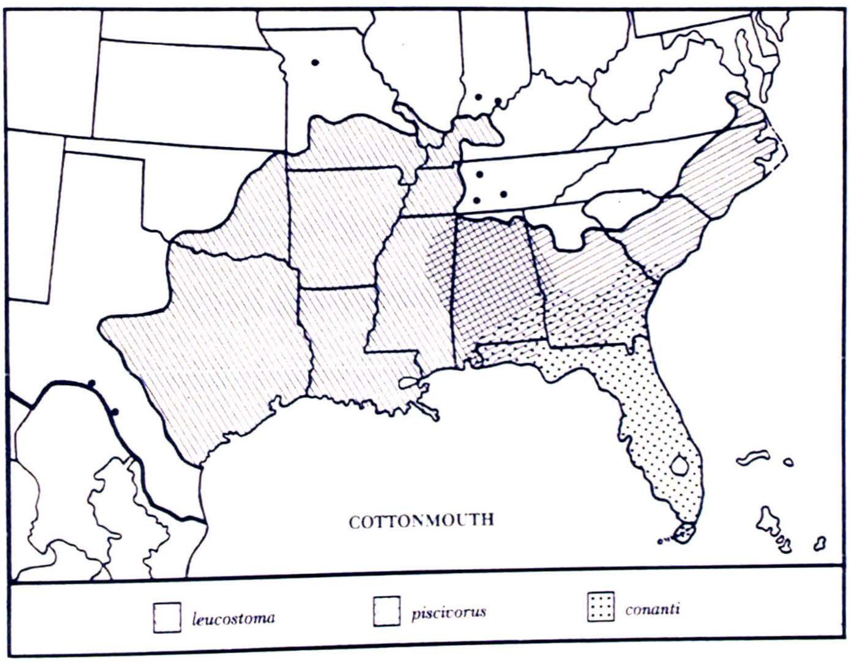

Figure 5. Distribution of the Cottonmouth showing ranges of subspecies, areas of intergradation, and outlier populations (From Gloyd and Conant, 1990). Details of the distribution of *A. p. leucostoma* in Tennessee can be found at http://apsu.edu/reptatlas/ (Scott and Redmond, 2008).

In Tennessee, populations extend eastward up the Cumberland, Duck, and Buffalo Rivers into the central part of the state (Scott and Redmond, 2008). In states where cottonmouths occur, they are absent from most of the Piedmont and mountainous areas (Gibbons and Dorcas, 2005).

Habitat

Western Cottonmouths tend to be found within half a mile of permanent water although they have also been observed in dry forests, grasslands and cornfields (Tennant, 2003). They can also inhabit salt marshes and saline barrier islands bordering the Gulf coast (Tennant, 2003), and are the only semi-aquatic viper (Greene, 1997). More commonly, however, this species is found in still water situations such a backwater sloughs, drainage ditches and oxbow swamps (Collins, 1977). They are frequently found on the edge of a pool or slough and on some pile of emergent vegetation (Gloyd and Conant, 1990). Small, clear, rocky bottomed streams have been reported as habitat in Missouri (Anderson, 1965), Arkansas (Collins, 1977) and Tennessee (A. Floyd Scott, personal communication). Cottonmouths also overwinter in hibernacula located within rocky outcrops and various underground retreats including crayfish holes and rodent burrows (Gloyd and Conant, 1990). This ability to exploit such a wide range of hibernacula is an important characteristic for an often temperate-zoned species (Blouin-Demers et al., 2000).

Feeding and Diet

The main food source for the Western Cottonmouth tends to be amphibians and fish; however, they are indiscriminate and opportunistic predators that are quite capable of altering their diets based on prey availability (Tennant, 2003). Food preference is also known to shift with the age of the animal. Overall, cottonmouths have been known to eat cicadas, fish, frogs, salamanders, turtles, baby alligators, birds, eggs, lizards, serpents and mammals (Greene, 1997). They are also one of the few snake species known to feed on carrion (DeVault and Krochmal, 2002). Individuals found on small islands in the Gulf of Mexico have been observed lying directly under the nests of water birds, and feeding on regurgitated food of the parents (Greene, 1997). When feeding on live prey they typically strike and hold the food source but can also bite and release, tracking the animal by their scent (Gibbons and Dorcas, 2005).

Sexual Maturity and Reproduction

When compared to non-viperid species, the Western Cottonmouth tends to have delayed maturation and low reproductive frequency. Sexual maturity is thought to occur around three years of age (Jensen et al., 2008). Based on ovary development, females are estimated to become sexually mature at snout-vent lengths of around 450 mm (Burkett, 1966). Males are thought to reach sexual maturity at lengths of around 650 mm (Wharton, 1966). Mating occurs during the spring and juveniles are typically born between August and October. These live-bearing snakes typically bear three to twelve offspring per litter; however, it is thought that relatively few offspring have high first year survival (Ford et al., 2004). This species is also capable of producing young every year (Tennant, 2003). Squamates often lack parental care but female cottonmouths have been known to remain with their young for five to ten days after birth

(Greene, 1997). They have also been known to congregate when giving birth (Gibbons and Dorcas, 2005).

Movement

Cottonmouths move throughout their habitat in both the daytime and at night. During hot summer days they are more commonly found moving at night on the prowl or actively swimming (Gloyd and Conant, 1990). It is not uncommon to find them on land, but in general they are seldom seen far from an aquatic habitat. (Gibbons and Dorcas, 2005). Reasons for movement include foraging, avoiding predators or physical extremes, and finding other cottonmouths. It has also been suggested that social interactions between snakes may affect the movements and dispersion factors of various snake species (Whitaker and Shine, 2003). No known studies have specifically linked this find to cottonmouths.

Threats

The greatest threat facing the Western Cottonmouth is humans. Indirectly, humans destroy and alter their natural habitat, but when directly encountered in the field they are usually killed (Gloyd and Conant, 1990). Natural predators include alligators, king snakes, larger cottonmouths, mammals, and a few species of birds (Gibbons and Dorcas, 2005). Channelization of streams, lowered water levels and soybean cultivation has also taken over much of this snake's habitat (Gloyd and Conant, 1990). As a whole, cottonmouths are not threatened and are classified as a species of least concern.

CHAPTER IV

MATERIALS AND METHODS

Capture Techniques

To survey the area, snakes were captured by manually searching the trail and surrounding habitats. Traps and cover boards were also deployed throughout the study area and were positioned and concealed in such a way as to prevent trail visitors from disturbing them and the study animals.

Data Collection and Management

Once captured, animals were marked, measured, weighed and re-released at the capture site. In the event that marking of individuals could not be done in the field, animals were taken back to the lab and returned either later that day or the following morning. The method of marking individuals followed that described by Brown and Parker (1976) where a portion of one or two coded ventral scales was removed using surgical scissors. Smaller snake species such as the Smooth Earthsnake (*Virginia valeriae*), Dekay's Brownsnake (*Storeria dekayi*), Red-bellied Snake (*Storeria occipitomaculata*) and Ring-necked Snake (*Diadophis punctatus*) were not marked if their ventral scales were too minute.

Hobo® data loggers were deployed and abiotic data collected from inside and outside the hibernacula during hibernating months. Temperature, relative humidity and light intensity levels were measured every hour throughout this period. Water temperatures were also recorded by Hobo® data loggers throughout most of the study. Temperatures occurring before or after Hobo® data loggers were placed in the field were obtained from wunderground.com.

Radio-Telemetry

Radio telemetry was another tool used in this study. Relying on direct observation is not always a viable technique in that once snakes are found they can quickly escape before data can successfully be recorded (Fitch, 1987). Radiotelemetry ensured the retrieval of accurate information and data on the snakes under investigation.

Two male and three female cottonmouths were implanted with Advanced Telemetry Systems (ATS) 1680 transmitters (Figure 6) by Danny Bryan of Cumberland University. Each transmitter weighed 3.6 g and each selected snake weighted a minimum of 400 g to ensure that the transmitter represented less than 5% of the snakes total body weight. A modified version of Reinert and Cundall's (1982) technique was used to implant the transmitters. Five cottonmouths were anesthetized with 5 ml of isoflurane in a clear plastic snake tube. The anesthetizer was constructed from a one-pint Rubbermaid® plastic liquid container that was modified with 2 ft of clear plastic tubing and sealed with silicon. The isoflurane was sprayed onto a piece of cotton gauze and inserted into the plastic container. From this point it was pumped into the plastic tube (which was sealed with a towel at the base) that contained the snake. The usefulness of this technique is that it prevents over anesthetizing the snake and the potential of its skin adhering to the tube. It also provides a quicker recovery rate than other methods. The transmitters were inserted into the peritoneal cavity at a location 75% of each snake's body length (Figure 7). The incision site was sutured with 4-0 Vicryl absorbable sutures by Ethicon.

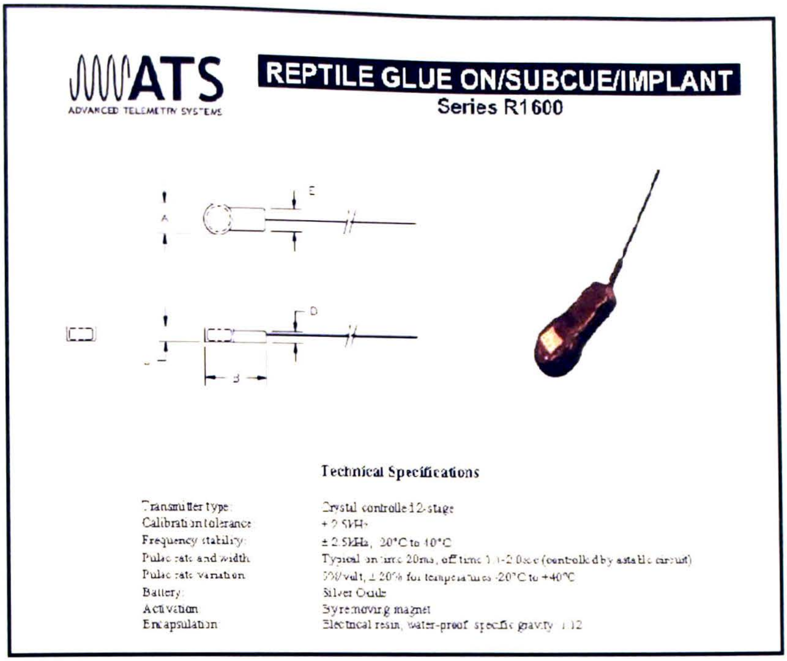

Figure 6. Transmitter design and specifications (Advanced Telemetry Systems, 2009).

Figure 7. ATS transmitter being implanted into the peritoneal cavity of a Western Cottonmouth (Photograph by Lisa Powers).

Once the surgeries were completed, snakes were brought back to the lab at Austin Peay State University. They were monitored for two weeks to ensure a healthy recovery and complete healing of the incision site. For laboratory safety precautions they were housed in locked cages within a locked portion of the lab at all times. Once the snakes completely recovered, they were taken back to the CRBT and released at the site of capture.

Tracking

Tracking of each snake occurred two to three times a week until ingression into their hibernacula. Each time a snake was relocated, its exact location was determined with GPS receiver (Garmin® etrex Vista Cx) and the coordinates recorded. The data from both marked and radio-tagged cottonmouths were later used to determine where and when this species was crossing the trail en route to their hibernacula.

Citizen Education

To work with citizens in the surrounding area and with individuals on the trail, communication and education was a large component of this study. Communication with locals occurred throughout the study on the importance of the trail and of conserving the reptile community that surrounds it. Anonymous surveys were also available to those who were willing to participate. This contributed to a better understanding of the average mindset of citizens in the area. Survey questions were as follows:

1. Are you fearful of snakes?
2. Do you feel that snakes play an important role in the environment?

3. Can you identify a venomous snake from a non-venomous snake?
4. Would you kill a non-venomous snake if you came across one?
5. Would you kill a venomous snake if you came across one?
6. Do you believe that snakes intentionally chase after humans?
7. Do you feel that you need to protect others from snakes?
8. Would you be interested in learning more about snakes and reptiles in your area?

Data Analyses

Snake movements were analyzed with ARC GIS using coordinate data for recapture locations. The distance moved between each GPS coordinate was determined by entering the data into http://boulter.com/gps/distance. Once the radio-tagged individuals entered their dens they were monitored once a month and on warmer winter days from November 2008 to February 2009. To determine home range, the minimum convex polygon method was used by connecting the outermost points of the snakes' movements. The area within this polygon was calculated using ARC GIS. To determine an approximate cottonmouth population size, data were analyzed using version 6.1 of the software program Ecological Methodology and the Schnabel and Schumacher methods of population estimation. Statistical analyses included the use of Spearman's Rank Correlation, Chi-squared goodness of fit test and t-tests.

CHAPTER V

RESULTS

Capture Success

The most successful method of capturing cottonmouths and non-target species was by manually searching the study area. Traps and cover boards were unsuccessful in that no cottonmouths were captured using these methods. Three non-target individuals, a Gray Ratsnake (*Pantherophis obsoleta spiloides*), Ring-necked Snake and Eastern Ribbonsnake (*Thamnophis sauritus*) were captured using cover boards. No species were captured using funnel traps.

Ninety-four cottonmouths were observed and captured throughout the entirety of this project (Figure 8). Seventy-five of these individuals were captured, marked and released at the site of capture.

Thirteen cottonmouth recaptures were recorded overall. One of these recaptured snakes was caught a total of six times within fifteen days; however, due to this individual's unhealthy appearance and behavior it was only counted as a recapture once in calculations. The average weights and measurements of the 94 captured cottonmouths are as follows: body weight (BW), 75.07 g (SD=191.35); snout vent length (SVL), 56.07 cm (SD=14.46); body length (BL), 66.26 cm (SD=16.93).

Ingression and Egression

Ingression into hibernacula occurred over a shorter time span than that of egression. The five radio-tagged cottonmouths moved into their hibernacula during the period from 7 October to 23 October 2008 (17 days) (Figure 9).

Figure 8. Locations where cottonmouths were observed and/or captured along the CRBT near Ashland City, Tennessee.

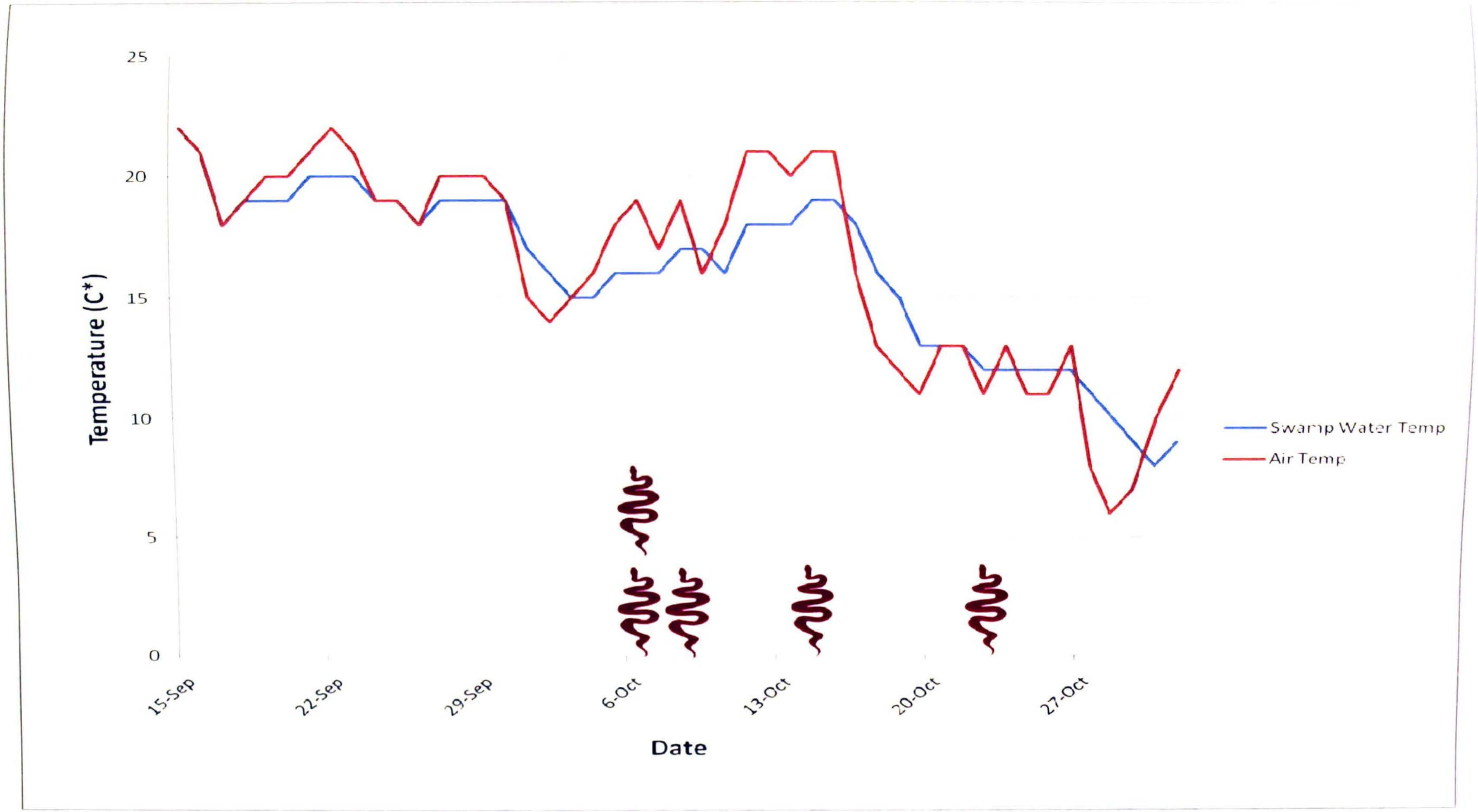

Figure 9. Daily (24 hours) average air and water temperatures (°C) during snake ingression (Fall 2008). Snake symbols represent the number of radio-tagged snakes moving into hibernacula on the date indicated.

When egressing, these same snakes left their dens between 6 March and 4 April 2009, a period of 30 days (Figure 10). The last unmarked cottonmouth observed entering its den was on 14 November 2008 during an average daily temperature of 14°C. Consistent movement back north in the direction of the hibernacula began in September of 2008. The first unmarked cottonmouth observed leaving its den in the spring of 2008 occurred on 1 March during an average daily temperature of 7°C. In examining the role of hibernacula temperatures on the emergence of cottonmouths, it was found that den temperatures ranged from 10-13°C during emergence. In the spring of 2009 the first cottonmouth observed leaving its den was on 6 March during an average daily temperature of 17°C.

The number of snakes crossing the trail dramatically decreased during the beginning of May 2008 and May 2009 when temperatures averaged around 21°C, and the number of snakes crossing the trail during the fall of 2008 appeared to dramatically decrease during the end of October when temperatures averaged around 8°C. No movement or emergence was detected from December 2008 to February 2009 and no apparent relationship was found between entrance and emergence when compared to snake gender or size.

Mortality

All snakes found dead in this study were logged as such along with one of the following causes of death: intentional killing, unintentional killing (e.g. killed by bicycle or lawnmower) or unknown (no obvious cause of death). From March 2008 to May 2009, three intentional cottonmouth killings were recorded.

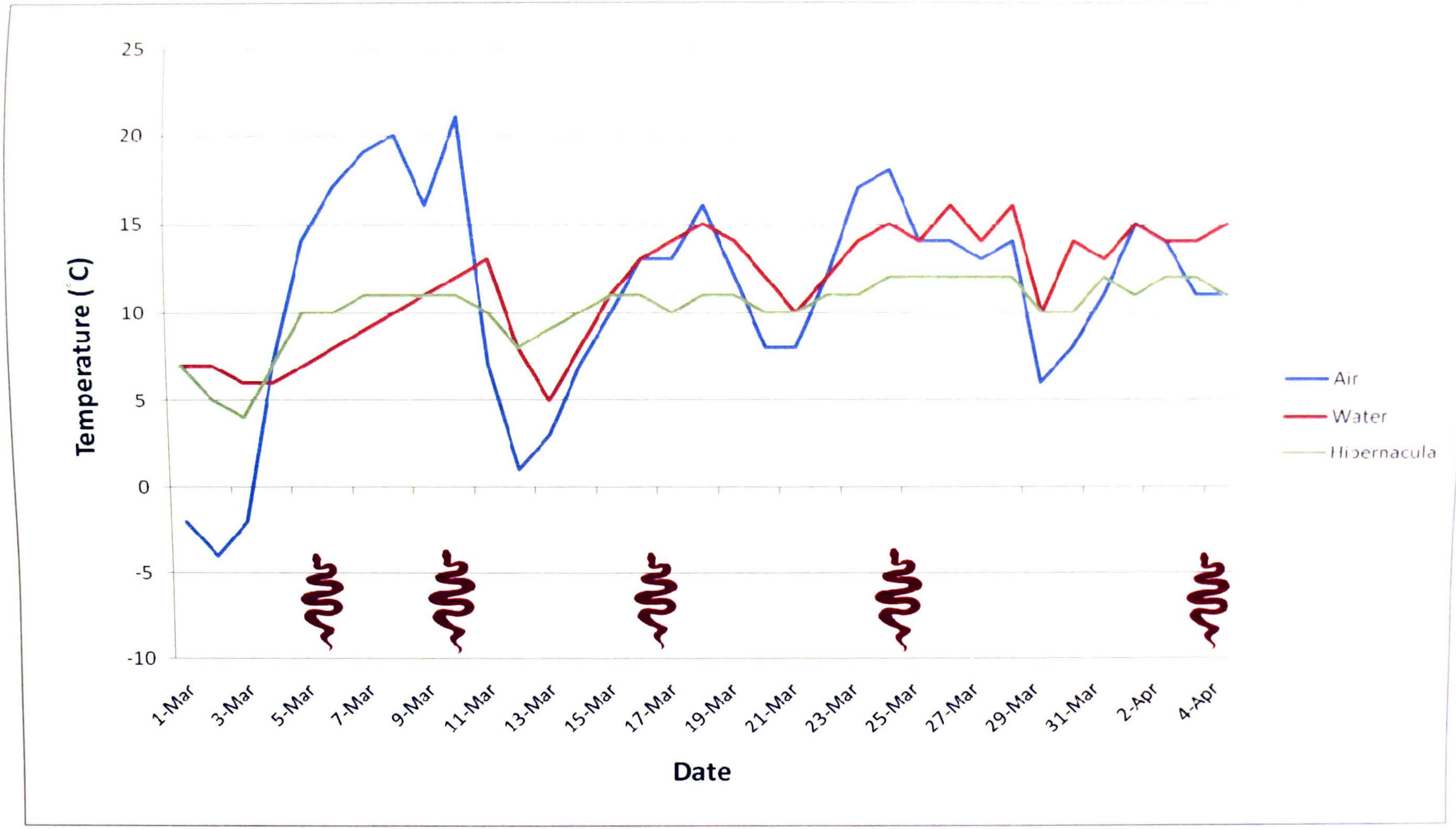

Figure 10. Daily (24 hours) average air, water and hibernacula temperatures (°C) during snake egression (Spring 2009). Snake symbols represent the number of radio-tagged snakes moving out of hibernacula on the dates indicated.

During this same period, one each of the following were found dead and the cause of death listed as unknown: Western Cottonmouth, Copper-bellied Watersnake, Eastern Garter snake (*Thamnophis sirtalis sirtalis*), Gray Ratsnake (*Pantherophis obsoleta spiloides*), and Smooth Earthsnake. Dead individuals of three Smooth Earthsnakes and one Milksnake (*Lampropeltis triangulum*) were also found and listed as accidental.

Movement and Ranges

Movement and home range size varied per individual snake. The majority of movements were multidirectional in that no consistent movement pattern was focused in a single direction. The only unidirectional movements were observed during the week prior to ingression when snakes moved north to enter hibernacula. The capture locations, relocation sites, and hibernacula of each of the five radio-tagged cottonmouths can be seen in Figure 11.

The size of home ranges, the distance of hibernacula from the center of the estimated home range, the average distances moved between successive locations, SVL and weight per snake can be observed in Table 2.

Table 2. Home range (HR), average distance moved (ADM) between successive locations, the distance between the centers of home ranges to selected hibernacula, SVL and weight of radio-tagged cottonmouths

Snake (Freq.)	Home Range (m^2)	ADM (m)	Hibernacula/ Home Range Distance (m)	SVL (cm)	Weight (g)
101	49,568	64.4	255.9	84.1	470
203	101,298	127.7	342.7	95.3	670
305	102,131	130.5	436.3	80.2	460
403	49,168	97.95	290.8	80.7	450
503	39,262	65.5	246.3	110.3	1200

Figure 11. Capture locations (stars), relocation sites (dots), and hibernacula locations (triangles) for each of the five radio-tagged cottonmouths. Each color represents a separate individual.

The size of home ranges can be visualized in Figure 12. The maximum distance moved between successive locations was 510 m. The distance that snakes moved was calculated as a straight-line distance between the two points. Therefore, calculations did not account for meandering that occurred on non-tracking days.

Spearman's Rank Correlation was used to determine if there was any correlation between the following: home range size vs. average distance moved, home range size vs. snout vent length, home range size vs. weight, average distance moved vs. snout vent length and average distance moved vs. weight. No significant correlations were found in any of these comparisons as can be seen in Table 3.

Both radio-tagged males in this study had smaller home ranges than any of the three females. However, in examining this relationship there was no significant difference in the results (t= 0.139, df = 3). There was also no significant difference when comparing the average distance moved by males vs. females (t= 0.409, df = 3).

Table 3. Spearman's Rank Correlation results and probability values. Refer to Table 2 for the values of variables compared. (n for all comparisons is equal to 5). Abbreviations are as in Table 2.

Variables Compared	r_s	P
Home Range vs. ADM	0.7	>0.05
Home Range vs. SVL	-0.6	>0.05
Home Range vs. Weight	-0.3	>0.05
ADM vs. SVL	-0.5	>0.05
ADM vs. Weight	-0.3	>0.05

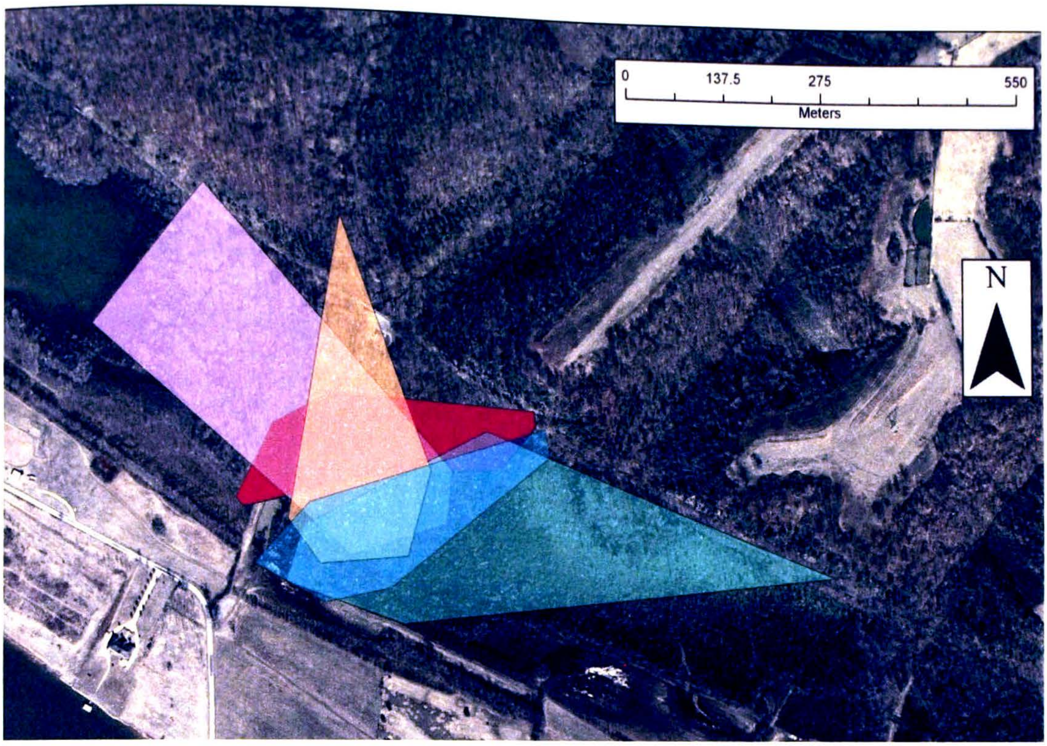

Figure 12. Home range for each of the five radio-tagged cottonmouths. Color corresponds with separate individuals: Pink- Freq.101 (Female), Purple-Freq.203 (Female), Green-Freq. 305 (Female), Orange-Freq.403 (Male), Blue-Freq.503 (Male).

Habitat Selection and Distribution

The majority (62 of 87, including recaptures) of cottonmouths were distributed in areas of the slough that were covered with various forms of live vegetation. Slough vegetation was heavily dominated by Red Maples (*Acer rubrum*) and Buttonbushes (*Cephalanthus occidentalis).* Habitat characteristics preferred were shallow-rooted forms of aquatic vegetation, root masses formed from red maples and buttonbushes, and downed trees that provided suitable protection and cover. Snakes were rarely seen in open water that lacked trees and cover. Several cottonmouths were captured (16 of 87, including recaptures) in a semi-open region of the slough during night searches conducted during the summer of 2008; however, none were captured in this location during daylight hours. Habitat preferences of observed and captured cottonmouths can be seen in Figure 13.

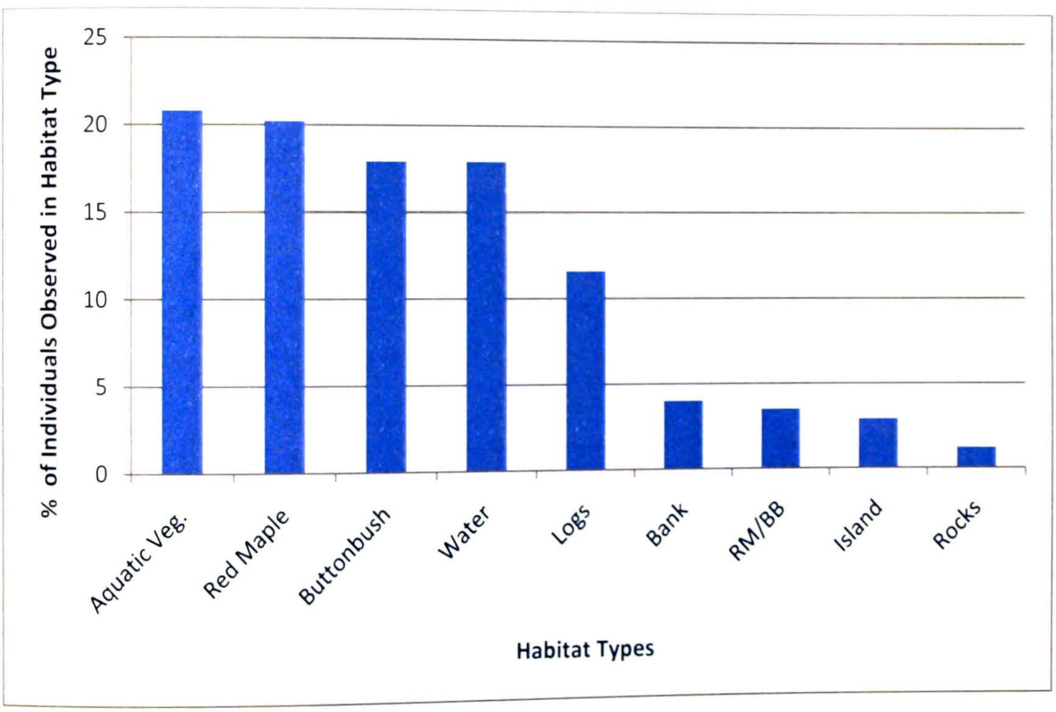

Figure 13. Habitat preferences (%) of observed and captured cottonmouths.

Four radio-tagged cottonmouths selected hibernacula occurring immediately parallel to the CRBT as can be seen in Figure 10. One radio-tagged cottonmouth chose a hibernacula positioned on a south-facing slope approximately 90 meters north of the CRBT. All chosen den sites were located within a portion of the south facing limestone bluffs. Photographs of each of the selected hibernacula appear in Figures 14-18.

Figure 14. Photograph of hibernacula chosen by cottonmouth with radio frequency #101.

Figure 15. Photograph of hibernacula chosen by cottonmouth with radio frequency #203.

Figure 16. Photograph of hibernacula chosen by cottonmouth with radio frequency #305.

Figure 17. Photograph of hibernacula chosen by cottonmouth with radio frequency #403.

Figure 18. Photograph of hibernacula chosen by cottonmouth with radio frequency #503.

Attitude Surveys

Sixty-six trail visitors were surveyed over the course of this project for their attitudes toward snakes. All age categories (teen-79) were accounted for; however 35% (23 individuals) of those surveyed were in their fifties (my largest sampled age group) and only 1.5% (one individual) were in their seventies. Figures 19-26 describe the results of each question for each surveyed group (overall, males, females, sex nor age provided [SNAP], teens, twenties, thirties, forties, fifties, sixties and seventies). Exact numbers and percentages can be seen in Tables 4 and 5. Numbers in parentheses behind each of the surveyed groups represent the number of individuals surveyed within that group.

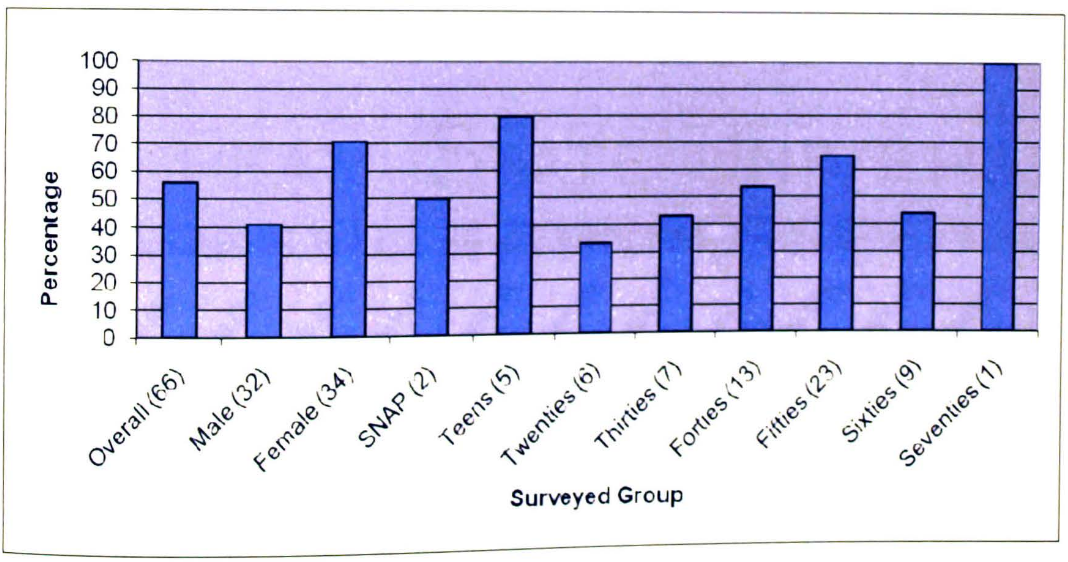

Figure 19. "Yes" responses to question: Are you fearful of snakes?

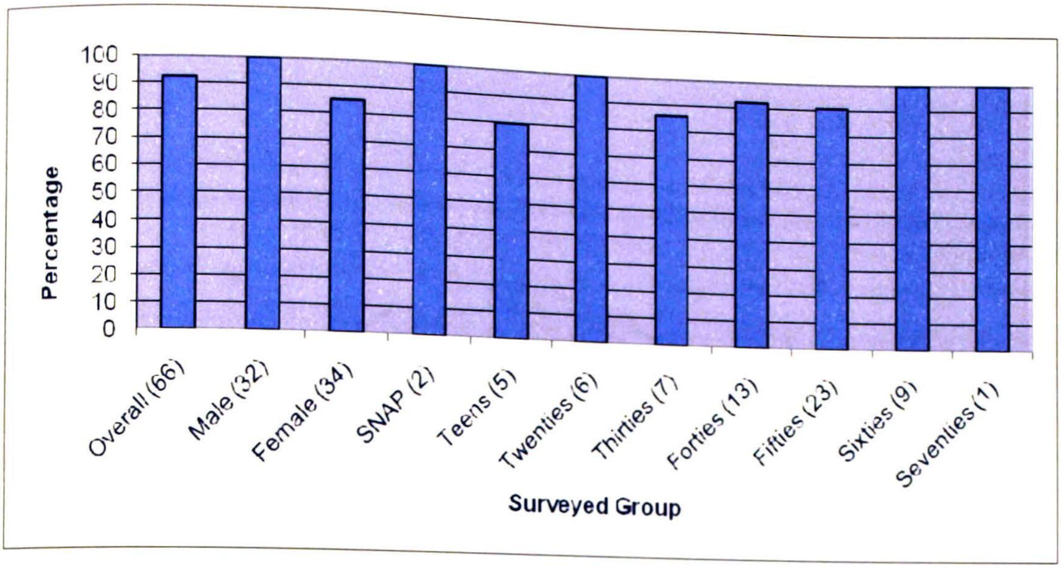

Figure 20. "Yes" responses to question: Do you feel that snakes play an important role in the environment?

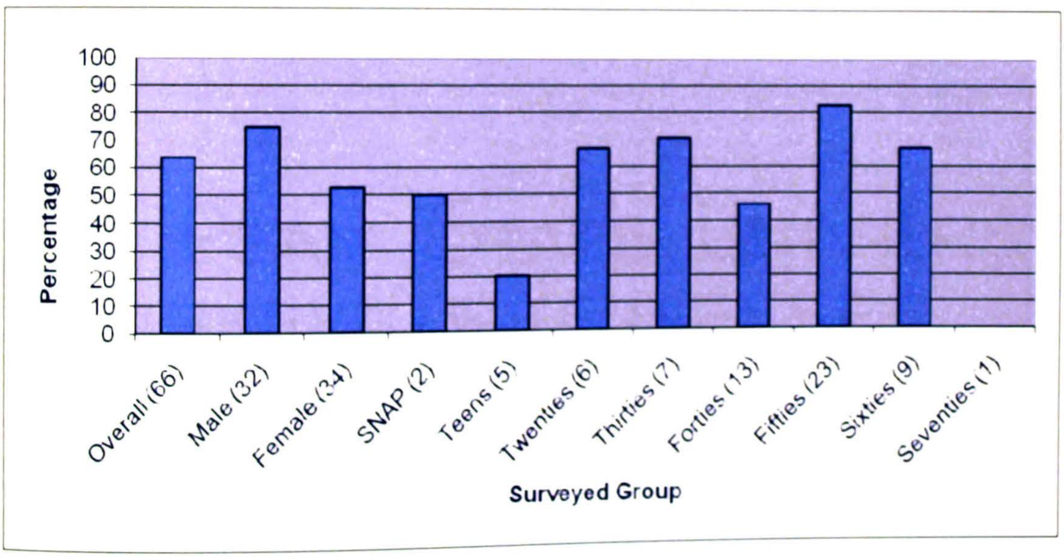

Figure 21. "Yes" responses to question: Can you identify a venomous snake from a non-venomous snake?

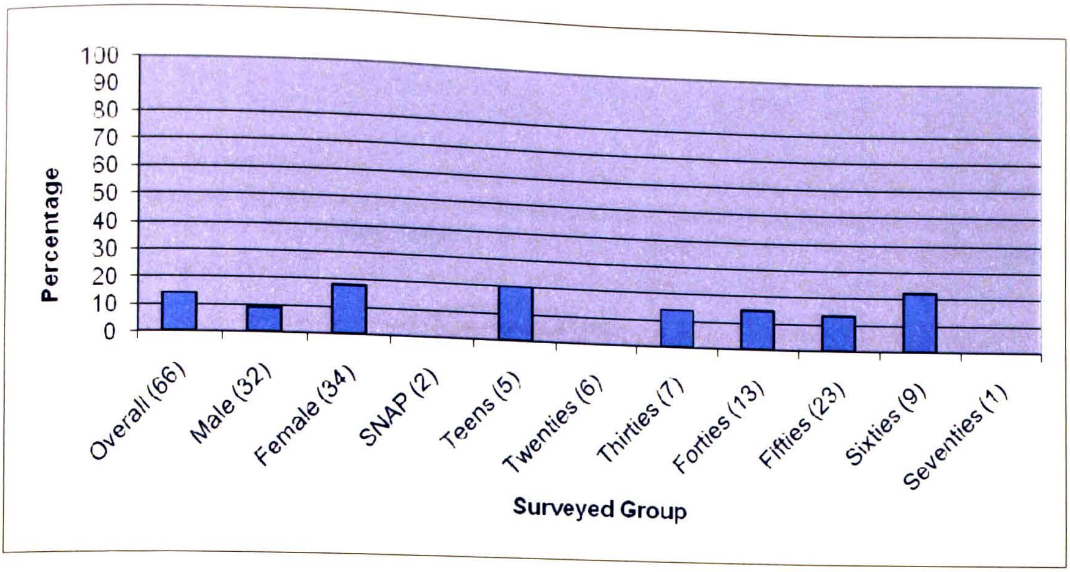

Figure 22. "Yes" responses to question: Would you kill a non-venomous snake if you came across one?

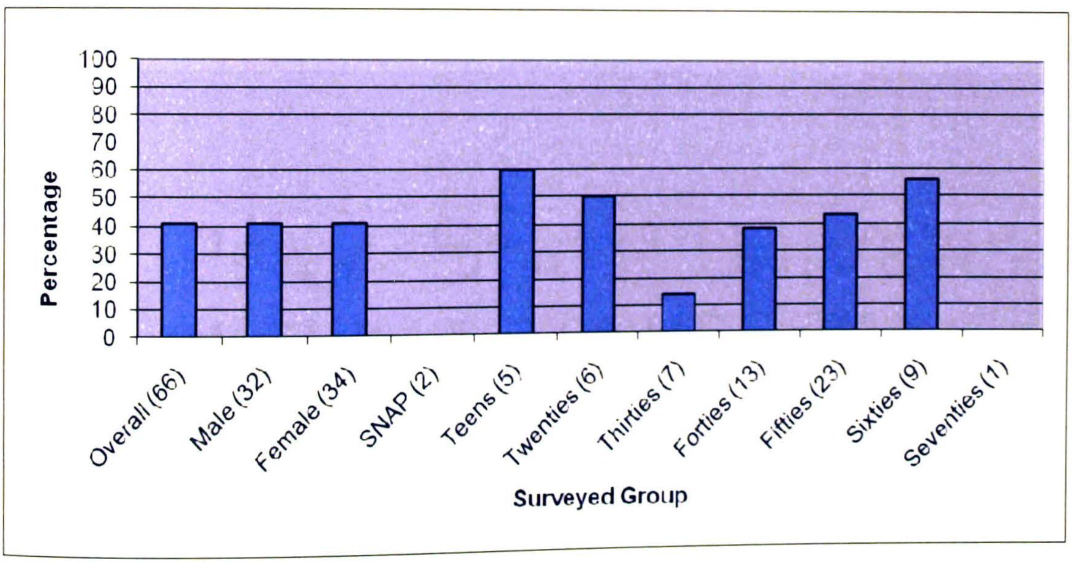

Figure 23. "Yes" responses to question: Would you kill a venomous snake if you came across one?

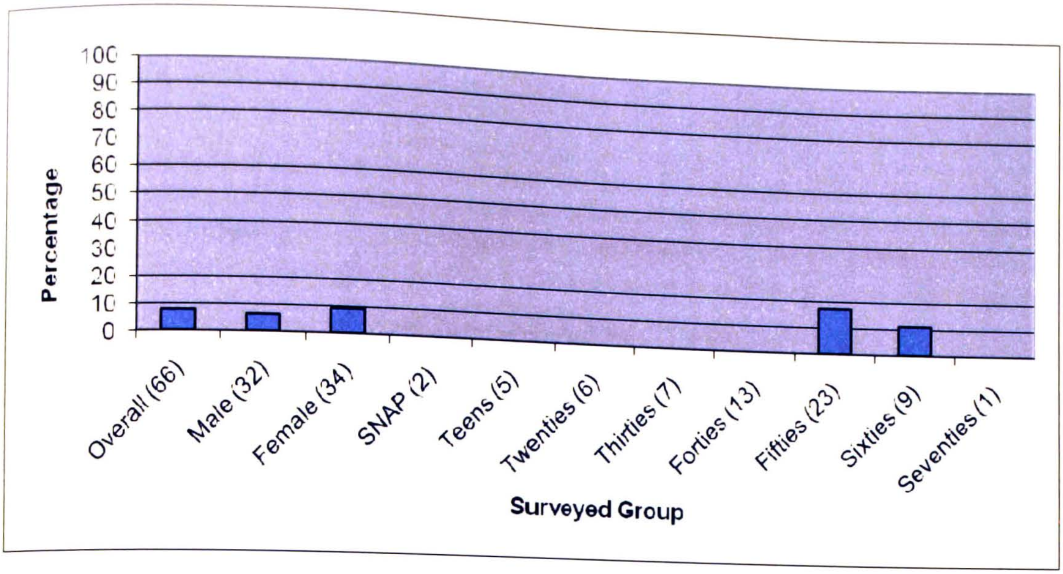

Figure 24 "Yes" responses to question: Do you believe that snakes intentionally chase after humans?

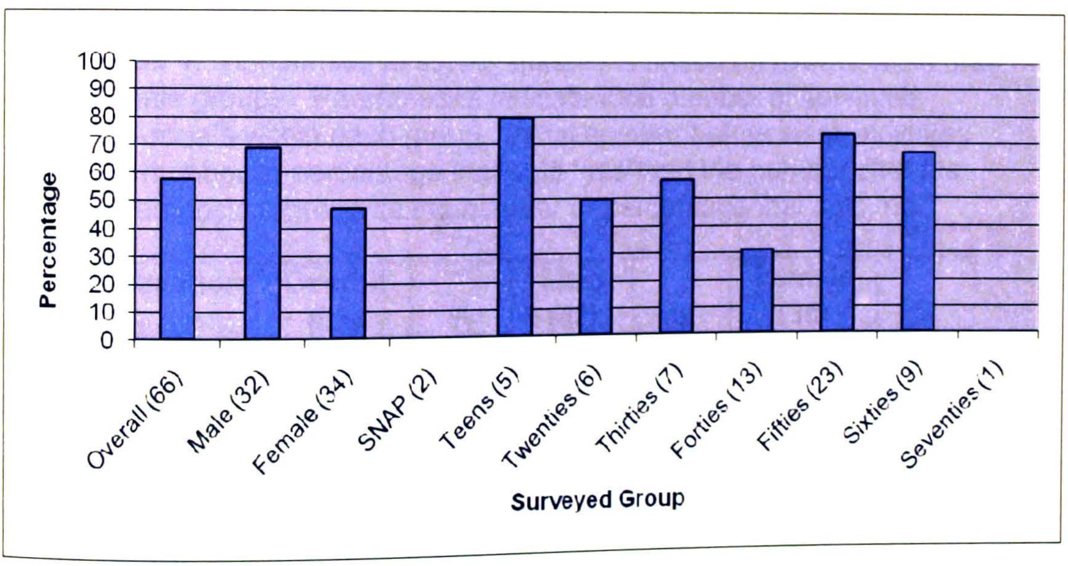

Figure 25. "Yes" responses to question: Do you feel that you need to protect others from snakes?

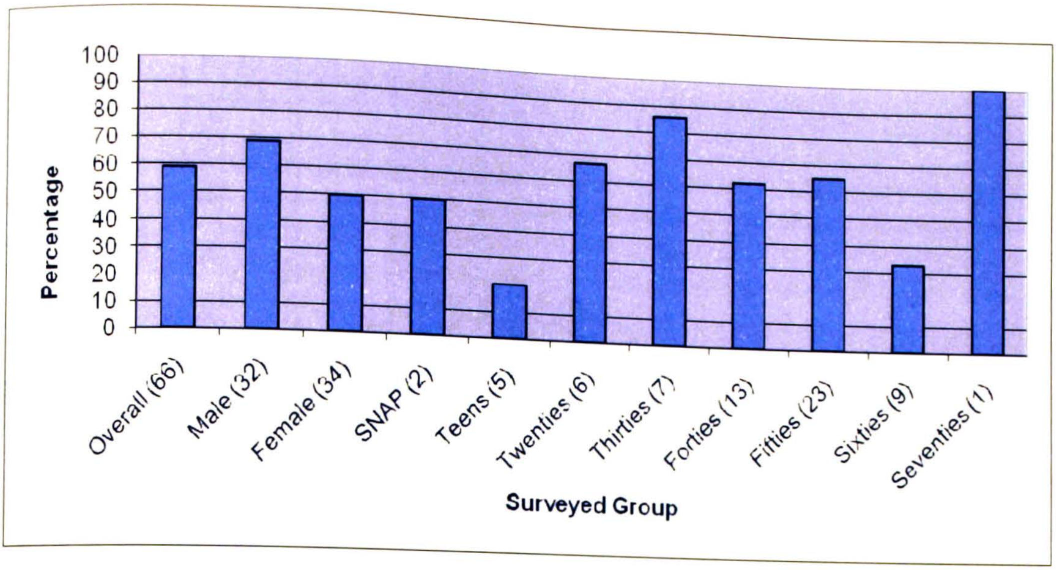

Figure 26. "Yes" responses to question: Would you be interested in learning more about snakes and reptiles in your area.

Table 4. Responses to survey questions based on overall, male and female groups. Parentheses indicate total number of surveyed individuals within each group. Initial number before slash indicates the number or percentage that said "yes" and the number after the parenthesis represents the number or percentage that said "no."

Question #	Overall (66)	%	Male (32)	%	Female (34)	%
1.	37/29	56/44	13/19	41/59	24/10	71/29
2.	61/5	92/8	32/0	100/0	29/5	85/15
3.	42/24	64/36	24/8	75/25	18/16	53/47
4.	9/57	14/86	3/29	9/91	6/28	18/82
5.	27/39	41/59	13/19	41/59	14/20	41/59
6.	5/61	8/92	2/30	6/94	3/31	9/91
7.	38/28	58/42	22/10	69/31	16/18	47/53
8.	39/27	59/41	22/10	69/31	17/17	50/50

Table 5. Responses to survey questions based on age groups. Parentheses indicate total number of surveyed individuals within each group. Initial number before slash indicates the number or percentage that said "yes" and the number after the parenthesis represents the number or percentage that said "no."

Question #	SNAP (2)	%	10-19 (5)	%	20-29 (6)	%	30-39 (7)	%	40-49 (13)	%	50-59 (23)	%	60-69 (9)	%	70-79 (1)	%
1	1/1	50/50	4/1	80/20	2/4	33/67	3/4	43/57	7/6	54/46	15/8	65/35	4/5	44/56	1/0	100/0
2	2/0	100/0	4/1	80/20	6/0	100/0	6/1	86/14	12/1	92/8	21/2	91/9	9/0	100/0	1/0	100/0
3	1/1	50/50	1/4	20/80	4/2	67/33	5/2	71/29	6/7	46/54	19/4	83/17	6/3	67/33	0/1	0/100
4	0/2	0/100	1/4	20/80	0/6	0/100	1/6	14/86	2/11	15/85	3/20	13/87	2/7	22/78	0/1	0/100
5	0/2	0/100	3/2	60/40	3/3	50/50	1/6	14/86	5/8	38/62	10/13	43/57	5/4	56/44	0/1	0/100
6	0/2	0/100	0/5	0/100	0/6	0/100	0/7	0/100	0/13	0/100	4/19	17/83	1/8	11/89	0/1	0/100
7	0/2	0/100	4/1	80/20	3/3	50/50	4/3	57/43	4/9	31/69	17/6	74/26	6/3	67/33	0/1	0/100
8	1/1	50/50	1/4	20/80	4/2	67/33	6/1	86/14	8/5	62/38	15/8	65/35	3/6	33/67	1/0	100/0

Population Estimates

In examining population size, the Schnabel and Schumacher methods were used to estimate approximate abundance. Only cottonmouths captured within routinely searched regions of the slough (an approximate area of 12.1 ha) were used in this analysis. The Schnabel method resulted in an estimated population size of 202.8 individuals. At confidence limits of 95% the resulting numbers were between 117.1-419.1 individuals. The Schumacher method resulted in an estimated population of 216.3 individuals. Confidence limits (95%) for this method resulted in 150.8-382.4 individuals.

Both of these analyses assume that the population is closed and that they do not change during the sampling period. Since this assumption is not a completely realistic approach in nature, the above estimates may be somewhat biased and therefore should only be used as an indices of the population size (Krebs, 1989).

Non-Target Species

Thirteen non-target species were observed and captured throughout this project. Ninety-one non-target individuals were captured and measured, but only two, an Eastern Ribbonsnake and a Copper-bellied Watersnake were recaptured. Capture locations along the CRBT and exact numbers (captured and observed) for each species can be seen in Figure 27 and Figure 28.

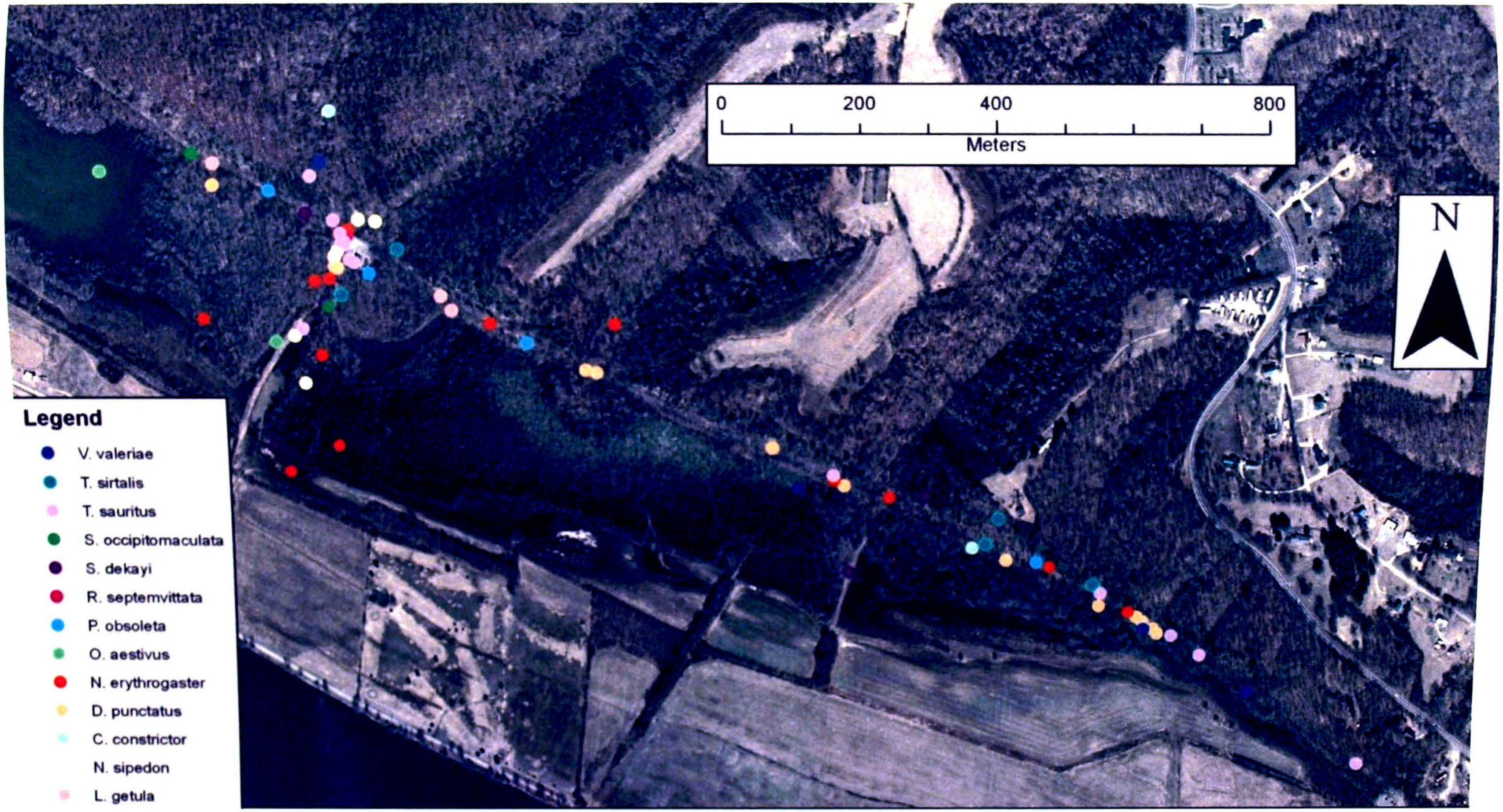

Figure 27. Locations where non-target species were observed or captured along the CRBT. (Note: overlap between species is obstructing the view of some dots).

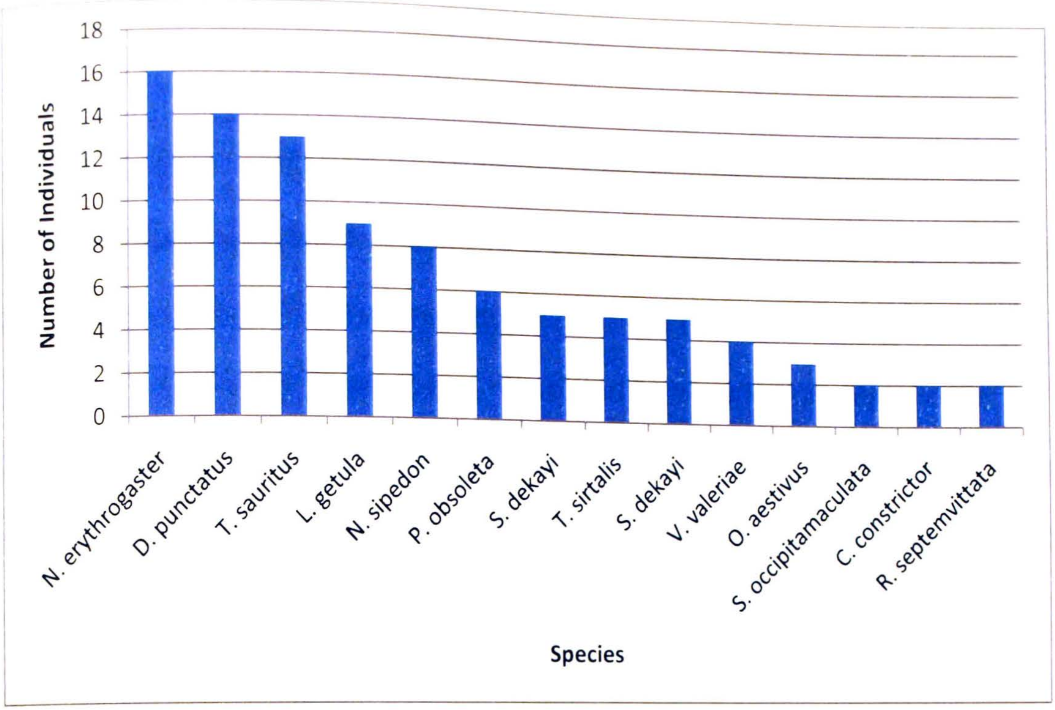

Figure 28. Number of observed and captured individuals of non-target species on and along the CRBT.

CHAPTER VI

DISCUSSION

Ingression and Egression

Movements to and from hibernacula appear to occur when daily (24 hours) average temperatures drop to around 15°C in fall and rise to around 17°C in late winter or early spring. These temperatures generally occur during the months of March, April, September and October. Ernst and Barbour (1989) describe the emergence of cottonmouths during April and occasionally during March if temperatures are high enough. They also indicated movement back toward hibernacula in early September with all ingression complete by early November. Our findings support these statements.

Ernst and Zug (1996) suggest that movement into hibernacula is triggered by low temperatures (facultative hibernation) rather than internal clues (obligatory hibernation). Ingression also occurred at faster rates than egression. A possible explanation for quicker ingression could be due to the fact that motor performance of snakes declines as temperatures drop (Heckrotte, 1967). Therefore, quicker movement into dens could be a strategy for preventing predation (Prior and Weatherhead, 1994) and of limiting their exposure during heightened states of vulnerability.

Many studies have examined the entrance and emergence of snake species to and from hibernation with varying results. Some studies (Whitaker and Shine, 2003; Gregory, 1974) have indicated that males enter their burrows earlier and emerge earlier than females. Others (Blouin-Demers et al., 2000) have found that females emerge slightly earlier than males. Gregory (1984) suggested that in species that mate immediately following emergence, males and females should exit their dens at the same time. This statement also supports the idea that sexually mature snakes may emerge before those that are not sexually mature (Blouin-Demers et al., 2000). It has also been found that in some species, larger individuals emerge earlier than smaller individuals whereas in others smaller individuals emerge earlier than large individuals (Blouin-Demers et al., 2000). Since cottonmouths mate in early spring, my findings could support simultaneous emergence. My results, based on a small sample size, neither support nor refute any of the above theories.

Regarding hibernacula temperature, it is important to emphasize that the Hobo® data logger recording temperatures within the hibernacula was in a stationary position and depth. Snakes most likely moved deeper or closer to the entrance depending on their temperature requirements. Therefore, these results are only an estimate of the average temperature these snakes experienced while in hibernation. If snakes do respond directly to changes in temperature within their hibernacula, then hibernacula specific factors (such as depth and exposure) should determine when snakes emerge (Blouin-Demers et al., 2000).

Threats and Mortality

Movements to and from den sites unfortunately occur during times of the year when moderate temperatures bring more trail visitors to the area. Therefore, more people are present during a critical period when snakes are crossing the trail to get to and from their hibernacula. While only three intentional killings were documented during this project, I think that this number may actually be higher as trail visitors reported observing others killing cottonmouths and disposing their bodies off to the side of the CRBT. Trail visitors that have admitted to killing snakes have been informed by state officials that their actions are illegal, thus they may be disposing of snake bodies as a way of covering up their actions. This may explain why fewer carcasses were observed along the trail than have been seen in previous years. Or possibly, people are killing fewer snakes as a result of knowing that their actions are illegal. In examining accidental deaths, many unintentional killings may occur because visitors and maintenance workers simply do not see these animals as they traverse the area on bikes and service vehicles. Several species were found injured or dead after trail maintenance and mowing occurred.

In examining the impact of the CRBT and its influence on snake movement and mortality, comparisons can be made with the results of studies that have dealt with "road ecology" (Forman et al., 2003). Andrews and Gibbons (2005) conducted a study on the behavioral responses of snakes to roads. Their results indicated that venomous snakes cross roads more slowly than non-venomous species and that their movements can be so slow that they likely go unnoticed. They also found that 50% of the time, cottonmouths retreated when attempting to avoid interference; a behavior that increases their chances of mortality. These findings are consistent with observations made during this study. Cottonmouths were most commonly seen moving slowly across the CRBT and were often found basking or coiled on the trail. This may be a tactic at remaining cryptic, a better defense than drawing attention to themselves (Prior and Weatherhead, 1994). On several occasions, trail visitors either running or biking were oblivious to the fact that a snake was present.

However, when noticed, snake vulnerability increased as this group of animals is subject to intentional killings as they attempt to cross roads (Langley et al., 1989).

Movement and Home Ranges

Results from the nine months of radio-tracking indicate that cottonmouths do not tend to move great distances from their original capture location. Each of the five individuals carrying radio transmitters moved in various directions to different locations throughout the slough, but none strayed more than 349 m from where it was first found (excluding the distances to their hibernacula).

In examining home range size, I found that females tend to occupy a larger home range than that of males (although the differences between males and females were not statistically significant). These findings are inconsistent with previous studies conducted by Keck (1998) and Roth (2005b). Both of these studies found that males occupied larger home ranges than females. Roth also found that body size positively correlated with home range size, something not seen in this study. The probable explanation for these differences is the small sample size in this study as compared to those cited above.

Two of the females in this study had home ranges of 101,298 m^2 and 102,131 m^2. One female had a home range of 49,568 m^2. Reproductive females are thought to have smaller home ranges than non-reproductive females (Whitaker and Shine, 2003) which could account for this difference. The female with the home range of 49, 568 m^2 could be a sexually immature individual where as the other two females could be sexually mature.

Habitat Selection and Distribution

The majority of hibernacula used by snakes with transmitters ran parallel with the length of the trail and were situated on upland rocky south-facing bluffs. Blem and Blem (1995) documented the Eastern Cottonmouth in Virginia as having more upland than swampland hibernacula as is seen in this population. Potential hibernacula along the CRBT are substantial and this availability along with suitable summer habitats could explain the relatively high number of individual's within this population. Suitable hibernacula also explain the persistence of populations in colder climates which would be necessary at the border of this species range (Prior and Weatherhead, 1996). Roth (2005a) emphasizes the importance in having suitable buffer zones around snake habitats. Since cottonmouths inhabit shoreline, using both terrestrial and aquatic resources, it is important to conserve buffer zones around and along the slough habitat.

Capture Success

Based on the number of cottonmouths captured and observed, the population of these snakes along the CRBT appears to be healthy. Because this region of Tennessee is an area where there is an intermingling of upland and lowland habitats, there is a high diversity of snake species. This high level of snake diversity (15 species accounted for) is another important reason for conserving and protecting snake populations and their habitats within this area.

One species, the Copper-bellied Watersnake was one of the most common non-target species observed. This is an important finding indicating that this region provides suitable habitat to support a sub-species considered federally threatened in

Indiana, Ohio and Michigan (USFWS, 2008). This animal thrives in habitats composed of wetlands distributed in a forested upland matrix and by wetlands that are seasonally flooded (USFWS, 2008). Beaver dens, animal burrows and piles of brush or rocks have also been suggested as suitable hibernacula (Ernst and Barbour, 1989). All of these habitat characteristics are plentiful within and along the CRBT slough. Another important reason in protecting this species is that as they migrate, they increase their risk of predation and malicious killings while traveling (Kingsbury and Coppola, 2000).

Attitude Surveys

In examining the responses of trail visitors to questions in the survey concerning attitudes towards snakes it is important to point out that these results may be different than results one may obtain if surveys were provided to individuals on the street. As a whole, individuals using the trail most likely have a more "nature minded" point of view than that of the general public. One question in particular ties in with this assumption. When asked if snakes play an important role in the environment, 92% of those surveyed responded with a "yes." This indicates that a large majority of those surveyed have somewhat of a general understanding of how snakes benefit the environment.

When asked about ones fear of snakes the results varied across all groups; however, it was found that females tend to be more fearful than males (χ^2=6.01, df=1, $P<0.05$). This is consistent with the question "Would you kill a non-venomous snake if you came across one." Likewise, more females answered "yes" to this question which is consistent with the results of the first question. If an individual is truly afraid of these creatures, they will kill one even if there is no obvious threat to humans.

When asked if they would kill a venomous snake the percentage that answered "yes" was identical for males, females and the group as a whole. When trail visitors discussed their answers openly, many of them mentioned that they would kill a venomous snake because they felt the need to protect others. This was interesting in that it tied in with the seventh question of "Do you feel you need to protect others from snakes?" Overall, 58% answered "yes" to this question, many of them mentioning that children need to be protected.

Also interesting were the results of the question asking if they could identify a venomous snake from a non-venomous snake. Over 60% answered yes; however, 52% of those who answered "yes" to killing a venomous snake also answered "no" to being able to distinguish a venomous from non-venomous snake. This indicates that since they cannot tell the difference they may be killing non-venomous snakes as well, even if they answered "no" to that question. Burkett (1966) emphasizes this find by stating that because of the general publics fear of snakes and their reluctance to learn to discriminate between venomous and harmless species, numerous snakes are assumed to be cottonmouths.

When asked if they believe snakes intentionally chase after humans only 8% answered "yes." However, 4-5 individuals surveyed said that they did not believe snakes intentionally chase after humans, except for cottonmouths. Many trail visitors also mentioned getting chased in boats by cottonmouths. Finally, when asked if they would be interested in learning more about snakes in their area, 59%

responded with a "yes." This is an important find in that at least one half of those surveyed are willing to expand their knowledge on these often misunderstood animals.

Teens were among the most fearful of age groups as well as the age group most likely to say that they would kill a venomous snake. This could be due to the fact that they are the least educated about the importance of conserving these animals. This find supports directing educational efforts toward children and young adults.

Citizen Education

Statistically it is estimated that 7000-8000 people per year are bitten by venomous snakes in the United States. Out of those bitten five die as a result of their injuries (CDC, 2009). The mortality rate of those inflicted by cottonmouths is less than one person per year (Tennant, 2003), an important statistic when discussing the threat of cottonmouths with concerned trail visitors. People often want obvious reasons for conserving a species that can be harmful. Some reasons to conserve the cottonmouth includes a source of antivenin, the fact that they prevent various "pest" organisms (e.g. rodents) from becoming too abundant, and the use of their venom for various therapeutic treatments for blood clots, hemorrhagic conditions and rheumatoid arthritis (Burkett, 1966).

Cottonmouths have a reputation of being extremely aggressive. This stereotype was consistently overheard and discussed by trail visitors. Gibbons and Dorcas (2002) put this particular reputation to test. They found that when free-ranging cottonmouths were confronted, 51% tried to escape, a finding that challenges the "conventional wisdom" typically associated with this species. Wright and Wright (1957) report having encountered these snakes on countless occasions, often almost stepping on them, but never being bitten. Prior and Weatherhead (1994) emphasize that when attempting to preserve snake populations, public goodwill must be involved, a challenging and difficult goal with venomous snakes.

Behavior

Several behavioral observations were noted over the course of this study. One included the sightings of occasional groupings of cottonmouths on large downed trees and root masses. The largest grouping observed included a minimum of seven cottonmouths basking on a single root mass. Aggregation is sometimes thought to be a tactic for avoiding extreme weather (by sharing sunlight and reducing the loss of heat and water) but cottonmouths are also known to bask, feed and breed in groups (Greene, 1997).

Cottonmouths were also observed burrowing into the silt and debris of the slough bottoms. On many occasions, when an individual appeared threatened or confronted it would dive under the water and stay hidden. When radio-tagged individuals were tracked it was often found that once they dive and burrow into the substrate, they generally stay put refusing to move even with harassment. One radio-tagged individual was observed burrowing into the substrate and only moving a few feet at a time as it was prodded. After approximately 30 minutes it was observed surfacing for only a moment and then submerging once again. This finding was interesting in that cottonmouths are usually observed swimming and hunting with their heads elevated above the water (Ernst and Barbour, 1989).

Bothner (1974) observed a cottonmouth capturing fish and hunting underwater but noted that it was a previously unknown behavior. Retreating under the water surface could not only be a possible escape and survival technique, but a hunting tactic.

Behavioral responses were also associated with seasonal and temperature changes. From March to May, snakes could easily be found and captured during the day, but once temperatures increased it became apparent that they were less active during the day and more active at night. According to Ernst and Zug (1996) this is a response to the seasonal fluctuations where by they become more nocturnal during the hottest period of the summer. Cottonmouths have been known to emerge from underground hibernacula to warm up in the sun, even on cold winter days (Gibbons and Dorcas, 2005). However, this behavior was not observed during this study.

Management Strategy

Possible solutions for preventing the rate of negative snake and human interactions could simply be closing the trail for a few weeks when snakes are migrating to and from their summer and winter habitats. Such actions have been implemented in other regions of the country including the Shawnee National Forest where they close the area to vehicular traffic several weeks each spring and autumn (Gloyd and Conant, 1990). Downsides to this solution are that this response to wildlife-human conflicts can be a concern to citizens with opposing interests and viewpoints (Dorrance, 1983).

Also, communicating and educating citizens who use the trail on the value of snakes and other wildlife should result in a greater chance of decreasing their concerns with these animals. Robertson and Hull (2001) emphasize the fact that people are part of nature and that we as conservationists cannot overlook the fact that humans are an integral component of ecological and environmental processes. Posting volunteers along the trail during critical times of snake movement and posting educational signs would be beneficial. Without the support of local citizens, successfully maintaining populations of often misunderstood animals will prove to be difficult. Hopefully, when people understand that they have threatened and environmentally important species in the area, they will be encouraged to respect and protect them.

CHAPTER VII

CONCLUSIONS

The results of this study indicate that special attention should be given to the CRBT snake population during October and March when temperatures are reaching an average of around 15°C. This appears to be the time of year when most snakes are crossing the trail and encountering conflicts with trail users. While triggers that initiate ingression and egression seem to be linked to temperature changes, it is likely that a combination of factors play a role. These could include the gender, size, reproductive status and health of the snake plus photoperiod air, water and hibernacula temperatures. Understanding how these variables influence the timing of snake movements may enable natural resource agencies to develop more efficient management programs (Blouin-Demers et al., 2000).

Movements and home range of this species should be given further attention. My results indicated that females may have larger home ranges than males and that there is no relationship between the distance these snakes move and their gender. Contrary to the results of previous studies these findings are suspect because of the small sample size. More accurate data on movements and home range could help to reduce the incidence of snake and human encounters by identifying times of the year and places along the CRBT to avoid.

Important habitat features used by snakes in this study included covered areas of the slough that had a plentiful amount of shallow water vegetation, red maples, and buttonbushes. These characteristics along with adequate buffer zones of at least ten meters (Roth, 2005a) should be maintained to preserve suitable habitat for this species.

Overall, the largest threat facing this species is human disturbance when these animals are crossing the trail. Continuing to monitor human behavior and taking the time to educate and discuss the situation with trail visitors is a vital aspect in the overall preservation of this and other snake species. The simple act of walking the trail and showing interest in the snake population is enough to grab the attention of trail visitors. On many occasions after being informed about why the research was being done, individuals who initially showed little concern for the well being of these snakes joined the effort of finding them along the trail. Educating the general public was part of the overall goal and seemed to be a key factor in opening their minds to the idea of conservation of this and other species. Understanding the overall attitude people have toward snake conservation is an important tool.

The results of this study indicate a stable population of the Western Cottonmouth along the CRBT and, as suggested by Gloyd and Conant (1990), as long as the persecution and destruction of this species and their habitat is not too severe it should remain a common snake throughout its range.

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APPENDIX A

Capture data of target and non-target species

Date	Time	AT (°C)	WT (°C)	Researchers	GPS (N)	GPS (W)	Capture	Species	SC	CM	Location	W(g)	SVL(cm)	TBL(cm)
1-Mar-08	12:51	7	-	NS/SM	36.29036	-87.09883	New	*A. piscivorus*	-	Manual	Trail	-	-	-
5-Mar-08	14:48	5	-	NS/SM	36.28795	-87.08390	Unknown	*D. punctatus*	-	Manual	Trail	-	-	-
5-Mar-08	16:04	5	-	NS/SM	36.28997	-87.08997	New	*V. valeriae*	-	Manual	Trail	-	-	-
5-Apr-08	16:15	10	-	NS/SM	36.29221	-87.09525	Unknown	*A. piscivorus*	-	Manual	Trail	-	-	-
5-Apr-08	16:23	10	-	NS/SM	36.29224	-87.09538	Unknown	*A. piscivorus*	-	Manual	Trail	-	-	-
5-Apr-08	16:27	10	-	NS/SM	36.29278	-87.09542	Unknown	*A. piscivorus*	-	Manual	Trail	-	-	-
7-Apr-08	17:10	17	-	NS/SM	36.28915	-87.08705	New	*C. constrictor*	-	Manual	Trail	-	-	-
7-Apr-08	18:55	17	-	NS/SM	36.29008	-87.08938	Unknown	*N. erythrogaster*	-	Manual	Trail	-	-	-
7-Apr-08	16:42	17	-	NS/SM	36.28610	-87.08043	New	*T. sauritus*	-	Manual	Trail	-	-	-
7-Apr-08	17:50	17	-	NS/SM	36.29360	-87.09760	New	*T. sauritus*	-	Manual	Trail	-	-	-
7-Apr-08	16:45	17	-	NS/SM	36.29048	-87.09862	New	*A. piscivorus*	1	Manual	Trail	-	-	-
7-Apr-08	16:50	17	-	NS/SM	36.29126	-87.09898	New	*A. piscivorus*	2	Manual	Trail	-	-	-
25-Apr-08	13:17	24	-	NS/SM/CO	36.30790	-87.13195	New	*P. obsoleta*	-	Manual	Trail	-	-	-
5-May-08	9:58	17	-	NS/SM	36.29053	-87.09040	Unknown	*D. punctatus*	-	Manual	Trail	<10	24.8	30.6
5-May-08	10:35	17	-	NS/SM	36.29205	-87.09483	New	*A. piscivorus*	3	Manual	Slough	610	79.5	95.25
6-May-08	18:55	20	-	NS/SM	36.28863	-87.08502	Unknown	*T. sirtalis*	-	CB	Trail	-	-	-
9-May-08	17:10	20	-	NS/SM/AW	36.28812	-87.08415	Unknown	*D. punctatus*	-	Manual	Trail	<10	18.7	24.6
9-May-08	17:17	20	-	NS/SM/AW	36.28802	-87.08398	Unknown	*D. punctatus*	-	Manual	Trail	<10	22	28.3
9-May-08	14:21	20	-	NS/SM/AW	36.29435	-87.09957	New	*L. getula*	1	Manual	Trail	150	71.88	84.84
9-May-08	15:45	20	-	NS/SM/AW	36.28888	-87.08575	Unknown	*N. erythrogaster*	-	Manual	Slope	-	-	-
9-May-08	15:30	20	-	NS/SM/AW	36.29048	-87.09862	New	*S. dekayi*	2	Manual	Trail	<10	22.4	26.6
9-May-08	15:30	20	-	NS/SM/AW	36.28712	-87.08235	New	*V. valeriae*	-	Manual	Trail	<10	22.4	26.6
20-May-08	19:59	22	-	NS/SM	36.29158	-87.09348	Unknown	*D. punctatus*	-	Manual	Trail	<10	24.13	29.21
20-May-08	18:20	22	-	NS/SM	36.30790	-87.13195	New	*P. obsoleta*	1	Manual	Trail	330	101.85	122.43
21-May-08	12:05	18	-	NS/SM	36.29221	-87.09505	Unknown	*N. erythrogaster*	-	Manual	Slope	-	-	-
21-May-08	9:59	18	-	NS/WD	36.29243	-87.09563	New	*A. piscivorus*	4	Manual	TJ	420	59.44	68.33
22-May-08	9:45	20	-	NS/AW/AH/SM	36.28898	-87.08648	Unknown	*D. punctatus*	-	Manual	Trail	<10	12.7	15.9
22-May-08	9:50	20	-	NS/AW/AH/SM	36.28898	-87.08648	Unknown	*D. punctatus*	-	Manual	Trail	<10	12	15.1
22-May-08	11:08	20	-	NS/AW/AH/SM	36.29337	-87.09744	New	*L. getula*	2	Manual	Trail	340	87.5	96.4
22-May-08	11:23	20	-	NS/AW/AH/SM	36.29288	-87.09702	New	*P. obsoleta*	2	CB	#7	460	113	130.2
22-May-08	11:47	20	-	NS/AW/AH/SM	36.29327	-87.09741	Recap	*T. sauritus*	1	Manual	Trail	<10	48.9	57.15
22-May-08	12:24	20	-	NS/AW/AH/SM	36.29258	-87.09747	New	*T. sirtalis*	1	Manual	Trail	50	39	49.1
22-May-08	11:50	20	-	NS/SM/AH/SM	36.29113	-87.09227	New	*A. piscivorus*	5	Manual	Slough	360	78	91.4
22-May-08	12:20	20	-	NS/SM/AH/SM	36.29043	-87.09113	Unknown	*A. piscivorus*	-	Manual	Slough	-	-	-

Date	Time	AT (°C)	WT (°C)	Researchers	GPS (N)	GPS (W)	Capture	Species	SC	CM	Location	W(g)	SVL(cm)	TBL(cm)
26-May-08	14:07	22	-	NS/SM	36.29307	-87.09733	Unknown	*T. sauritus*	-	Manual	TJ	-	-	-
27-May-08	16:50	25	-	NS/SM	36.29195	-87.09445	New	*O. aestivus*	1	Manual	Trail	<10	38.9	68.2
27-May-08	16:45	25	-	NS/SM	36.29195	-87.09445	New	*P. obsoleta*	3	Manual	Trail	290	99.7	121.9
30-May-08	12:08	26	-	NS/SM/CO	36.29280	-87.09766	Unknown	*N. erythrogaster*	-	Manual	TJS	-	-	-
30-May-08	11:40	26	-	NS/SM/CO	36.29339	-87.09742	Unknown	*N. sipedon*	-	Manual	Trail	-	-	-
30-May-08	12:17	26	-	NS/SM/CO	36.29243	-87.09769	New	*S. occipitamaculata*	1	Manual	Woods	<10	18.3	24.5
30-May-08	10:39	26	-	NS/SM/CO/FS	36.28792	-87.08366	New	*T. sauritus*	2	Manual	Trail	<10	33.9	53.1
30-May-08	11:45	26	-	NS/SM/CO	36.29332	-87.09742	Unknown	*T. sauritus*	-	Manual	Trail	-	-	-
30-May-08	11:52	26	-	NS/SM/CO	36.29303	-87.09726	New	*T. sauritus*	3	Manual	TJ	40	45.8	70.7
30-May-08	12:50	26	-	NS/SM/CO	36.29211	-87.09811	Unknown	*T. sauritus*	-	Manual	Slough	-	-	-
30-May-08	12:28	26	-	NS/SM/CO	36.29328	-87.09713	New	*A. piscivorus*	6	Manual	Slough	420	70.1	84.1
30-May-08	13:07	26	-	NS/SM/CO	36.29146	-87.09825	Recap	*A. piscivorus*	5	Manual	Slough	390	78.7	92.7
2-Jun-08	16:34	27	-	NS/WD	36.29002	-87.08921	Unknown	*D. punctatus*	-	Manual	Trail	<10	13.3	16.5
2-Jun-08	16:34	27	-	NS/WD	36.29002	-87.08922	New	*L. getula*	3	Manual	Trail	50	46.1	53.5
2-Jun-08	13:47	27	-	NS/WD	36.36592	-87.19272	Unknown	*N. erythrogaster*	-	Manual	Trail	-	-	-
2-Jun-08	15:11	27	-	NS/WD	36.29145	-87.09821	Recap	*A. piscivorus*	5	Manual	Slough	330	78	92
2-Jun-08	15:39	27	-	NS/WD	36.29219	-87.09804	New	*A. piscivorus*	7	Manual	Slough	510	58.4	68.4
4-Jun-08	12:18	29	-	NS/AW/DE	36.28825	-87.08442	Unknown	*N. erythrogaster*	-	Manual	Trail	-	-	-
4-Jun-08	15:18	29	-	NS/AW/DE	36.29222	-87.09302	Unknown	*N. erythrogaster*	-	Manual	Trail	-	-	-
4-Jun-08	13:03	29	-	NS/AW/DE	36.29358	-87.09692	Unknown	*N. sipedon*	-	Manual	TJS	-	-	-
4-Jun-08	12:20	29	-	NS/AW/DE	36.28852	-87.08488	Unknown	*T. sauritus*	-	Manual	Trail	-	-	-
4-Jun-08	13:17	29	-	NS/AW/DE	36.29173	-87.09808	New	*A. piscivorus*	8	Manual	Slough	190	56.6	66.7
4-Jun-08	13:30	29	-	NS/AW/DE	36.29205	-87.09813	Recap	*A. piscivorus*	5	Manual	Slough	330	78.9	93.1
4-Jun-08	14:05	29	-	NS/AW/DE	36.29156	-87.09806	New	*A. piscivorus*	9	Manual	Slough	80	47.2	55.3
4-Jun-08	14:38	29	-	NS/AW/DE	36.29207	-87.09805	New	*A. piscivorus*	-	Manual	Slough	-	-	-
5-Jun-08	15:04	29	-	NS/SM/NP	36.29238	-87.09568	New	*L. getula*	5	Manual	Woods	460	93.6	109.1
5-Jun-08	14:30	29	-	NS/SM/NP	36.29175	-87.09780	New	*N. erythrogaster*	1	Manual	Slough	190	68.3	85
5-Jun-08	13:30	29	-	NS/SM/NP	36.29205	-87.09813	New	*A. piscivorus*	10	Manual	Slough	310	68.3	81.4
5-Jun-08	13:25	29	-	NS/SM/NP	36.29187	-87.09707	Recap	*A. piscivorus*	5	Manual	Slough	350	73.2	90.1
5-Jun-08	14:16	29	-	NS/SM/NP	36.29175	-87.09727	New	*A. piscivorus*	11	Manual	Slough	80	32.9	38.8
6-Jun-08	12:00	30	-	NS/SM	36.29006	-87.08987	New	*L. getula*	6	Manual	Trail	190	76.7	83.2
6-Jun-08	10:45	30	-	NS/SM	36.29208	-87.09858	Recap	*A. piscivorus*	5	Manual	Slough	370	72.9	91.1
6-Jun-08	11:05	30	-	NS/SM	36.29205	-87.09813	New	*A. piscivorus*	12	Manual	Slough	400	61.9	73.6
10-Jun-08	10:10	25	24	NS/AW	36.29167	-87.09795	New	*A. piscivorus*	13	Manual	Slough	390	60.8	65.6

Date	Time	AT (*C)	WT (*C)	Researchers	GPS (N)	GPS (W)	Capture	Species	SC	CM	Location	W(g)	SVL(cm)	TBL(cm)
11-Jun-08	8:40	22	23	NS/AH	36.29193	-87.09855	New	*O. aestivus*	-	Manual	Slough	<10	17.2	26.7
11-Jun-08	8:40	22	23	NS/AH	36.29205	-87.09813	Unknown	*A. piscivorus*	-	Manual	Slough	-	-	-
11-Jun-08	9:50	24	23	NS/AH	36.29197	-87.09857	New	*A. piscivorus*	14	Manual	Slough	420	65.1	77.8
13-Jun-08	9:48	25	23	NS/AH/JR	36.29223	-87.09973	New	*N. erythrogaster*	2	Manual	Slough	270	79	99.5
13-Jun-08	9:25	25	23	NS/AH/JR	36.29167	-87.09818	New	*A. piscivorus*	15	Manual	TJS	420	68.8	82.9
16-Jun-08	14:44	30	23	NS/SM/LP	36.29155	-87.09330	New	*D. punctatus*	-	CB	#5	<10	16.7	21.3
16-Jun-08	17:15	28	23	NS/SM/LP	36.28920	-87.08683	New	*T. sirtalis*	2	Manual	Trail	130	59	69.25
16-Jun-08	15:45	29	23	NS/SM/LP	36.29193	-87.09855	New	*A. piscivorus*	16	Manual	Slough	190	52.5	62.6
19-Jun-08	19:40	23	20	Tour	36.29295	-87.09753	Unknown	*D. punctatus*	-	Manual	Trail	<10	19.6	23.5
19-Jun-08	19:45	23	20	Tour	36.28818	-87.08427	Unknown	*D. punctatus*	-	Manual	Trail	-	-	-
19-Jun-08	19:45	23	20	Tour	36.28818	-87.08427	Unknown	*D. punctatus*	-	Manual	Trail	-	-	-
19-Jun-08	19:55	23	20	Tour	36.28833	-87.08490	Unknown	*D. punctatus*	-	Manual	Trail	<10	27.7	33.9
19-Jun-08	22:07	19	23	NS/SM/AW	-	-	New	*N. sipedon*	1	Manual	Slough	220	60.7	75.9
19-Jun-08	21:00	20	20	Tour	36.29448	-87.09992	New	*S. occipitamaculata*	-	Manual	Trail	<10	19.1	22.5
19-Jun-08	9:30	22	20	NS/CO	36.29342	-87.09748	New	*T. sauritus*	4	Manual	Trail	<10	45.7	71.2
19-Jun-08	17:40	26	21	NS/SM/CO/NP	36.29140	-87.09685	New	*A. piscivorus*	17	Manual	Slough	300	64.2	77.5
19-Jun-08	18:00	26	21	NS/SM/CO/NP	36.29233	-87.09943	New	*A. piscivorus*	18	Manual	Slough	310	65.4	78.1
19-Jun-08	21:15	20	20	NS/SM	36.29165	-87.09850	New	*A. piscivorus*	19	Manual	Slough	<10	27.2	32.7
19-Jun-08	21:20	20	20	NS/SM	36.29130	-87.09900	New	*A. piscivorus*	20	Manual	Slough	250	60.4	71.1
23-Jun-08	19:58	24	21	NS/SM	36.29172	-87.09722	New	*A. piscivorus*	21	Manual	Slough	400	72	84.7
23-Jun-08	20:43	22	21	NS/SM	36.29187	-87.09845	New	*A. piscivorus*	22	Manual	Slough	<10	25.6	30.9
23-Jun-08	21:43	21	21	NS/SM	36.29168	-87.09860	New	*A. piscivorus*	23	Manual	Slough	320	65.2	77.8
23-Jun-08	22:00	20	21	NS/SM	36.29145	-87.09920	New	*A. piscivorus*	24	Manual	Slough	180	57.6	67
23-Jun-08	22:21	20	21	NS/SM	36.29178	-87.09813	New	*A. piscivorus*	25	Manual	Slough	240	57.1	69.9
25-Jun-08	9:45	26	21	NS/AW	36.29047	-87.09858	New	*A. piscivorus*	26	Manual	Slough	300	56.6	67.2
25-Jun-08	9:45	26	21	NS/AW	36.28982	-87.09808	New	*A. piscivorus*	27	Manual	Slough	300	67.4	80.1
25-Jun-08	10:12	27	21	NS/AW	36.29005	-87.09817	Unknown	*A. piscivorus*	-	Manual	Slough	-	-	-
25-Jun-08	10:55	28	21	NS/AW	36.29128	-87.09910	Unknown	*A. piscivorus*	-	Manual	Slough	-	-	-
26-Jun-08	20:24	27	22	NS/SM	36.29128	-87.09910	New	*A. piscivorus*	28	Manual	Slough	<10	32.4	38.2
26-Jun-08	20:45	27	22	NS/SM	36.29157	-87.09763	New	*A. piscivorus*	29	Manual	Slough	370	63.5	73.3
26-Jun-08	20:40	27	22	NS/SM	36.29158	-87.09788	Recap	*A. piscivorus*	20	Manual	Slough	290	59.8	70.2
26-Jun-08	21:55	27	22	NS/SM	36.29130	-87.09893	New	*A. piscivorus*	30	Manual	Slough	440	73	85.7
26-Jun-08	22:30	26	22	NS/SM	36.29148	-87.09903	Recap	*A. piscivorus*	22	Manual	Slough	<10	24.5	29.6
30-Jun-08	20:45	20	22	NS/SM/RP	36.29145	-87.09903	New	*A. piscivorus*	31	Manual	Slough	150	48.8	59.9

Date	Time	AT (°C)	WT (°C)	Researchers	GPS (N)	GPS (W)	Capture	Species	SC	CM	Location	W(g)	SVL(cm)	TBL(cm)
30-Jun-08	21:14	19	22	NS/SM/RP	36.29213	-87.09827	Recap	*A. piscivorus*	17	Manual	Slough	310	63.9	76.1
30-Jun-08	21:25	19	22	NS/SM/RP	36.29168	-87.09805	New	*A. piscivorus*	32	Manual	Slough	<10	29.2	34.7
30-Jun-08	22:12	18	22	NS/SM/RP	36.29148	-87.09918	New	*A. piscivorus*	33	Manual	Slough	190	50.2	55.9
30-Jun-08	23:00	18	22	NS/SM/RP	36.29173	-87.09875	New	*A. piscivorus*	34	Manual	Slough	190	52.5	62.1
2-Jul-08	21:01	21	21	NS/SM/NP	36.29190	-87.09855	Recap	*A. piscivorus*	15	Manual	Slough	470	73.3	87.3
2-Jul-08	22:06	20	21	NS/SM/NP	36.29208	-87.09818	New	*A. piscivorus*	35	Manual	Slough	170	51.3	61
2-Jul-08	22:47	20	21	NS/SM/NP	36.29002	-87.09835	New	*A. piscivorus*	36	Manual	Slough	380	59.3	69.9
2-Jul-08	22:48	20	21	NS/SM/NP	36.29168	-87.09887	New	*A. piscivorus*	37	Manual	Slough	190	51.4	60.7
2-Jul-08	22:52	20	21	NS/SM/NP	36.29013	-87.09860	Unknown	*A. piscivorus*	-	Manual	Slough	-	-	-
2-Jul-08	23:12	20	21	NS/SM/NP	36.28982	-87.09808	New	*A. piscivorus*	38	Manual	Slough	250	57.3	68.9
15-Jul-08	23:12	21	22	NS/SM/NP/TS/AW	36.29013	-87.09837	Unknown	*N. erythrogaster*	-	Manual	Slough	-	-	-
15-Jul-08	21:00	21	22	NS/SM/NP/TS/AW/AH	36.28998	-87.09823	New	*A. piscivorus*	40	Manual	Slough	230	54.5	64.1
15-Jul-08	21:33	21	22	NS/SM/NP/TS/AW/AH	36.29065	-87.09092	New	*A. piscivorus*	42	Manual	Slough	670	81.6	95.3
15-Jul-08	21:44	21	22	NS/SM/NP/TS/AW/AH	36.29042	-87.09895	New	*A. piscivorus*	41	Manual	Slough	60	33.2	39.8
15-Jul-08	22:39	20	22	NS/SM/NP/TS/AW/AH	36.29158	-87.09930	New	*A. piscivorus*	44	Manual	Slough	290	58.7	69.2
15-Jul-08	22:57	20	22	NS/SM/NP/TS/AW/AH	36.29168	-87.09050	New	*A. piscivorus*	43	Manual	Slough	<10	29.3	34.9
17-Jul-08	23:23	16	22	NS/SM/AW/RP/JE/TS	36.29137	-87.09808	Unknown	*N. sipedon*	-	Manual	Slough	-	-	-
17-Jul-08	20:50	26	22	NS/SM/AW/RP/JE/TS	36.29163	-87.09904	New	*A. piscivorus*	45	Manual	Slough	470	71.5	84.1
17-Jul-08	21:00	24	22	NS/SM/AW/RP/JE/TS	36.28983	-87.09782	New	*A. piscivorus*	46	Manual	Slough	240	57.3	68.2
17-Jul-08	21:20	24	22	NS/SM/AW/RP/JE/TS	36.29015	-87.09868	New	*A. piscivorus*	47	Manual	Slough	260	55.9	65.9
17-Jul-08	22:15	23	22	NS/SM/AW/RP/JE/TS	36.29203	-87.09865	Recap	*A. piscivorus*	30	Manual	Slough	450	67.3	80.7
17-Jul-08	22:30	23	22	NS/SM/AW/RP/JE/TS	36.29217	-87.09813	Recap	*A. piscivorus*	27	Manual	Slough	270	60.5	72.2
17-Jul-08	22:31	23	22	NS/SM/AW/RP/JE/TS	36.29153	-87.09824	New	*A. piscivorus*	48	Manual	Slough	270	57.3	69.1
17-Jul-08	22:45	23	22	NS/SM/AW/RP/JE/TS	36.29176	-87.09810	New	*A. piscivorus*	49	Manual	Slough	190	50.7	60.9
17-Jul-08	22:53	23	22	NS/SM/AW/RP/JE/TS	36.27426	-87.09888	New	*A. piscivorus*	50	Manual	Slough	130	36.1	43
17-Jul-08	23:14	22	22	NS/SM/AW/RP/JE/TS	36.29018	-87.09855	New	*A. piscivorus*	51	Manual	Slough	220	57.3	68.1
17-Jul-08	23:22	22	22	NS/SM/AW/RP/JE/TS	36.29018	-87.09855	New	*A. piscivorus*	52	Manual	Slough	380	69.7	82.6
19-Jul-08	22:06	24	23	NS/SM/AW	36.28988	-87.09797	New	*A. piscivorus*	53	Manual	Slough	140	48.8	57.5
19-Jul-08	23:02	24	23	NS/SM/AW	36.29020	-87.09790	Recap	*A. piscivorus*	34	Manual	Slough	280	57.5	67.6
20-Jul-08	22:45	26	24	SM	36.29018	-87.09788	New	*A. piscivorus*	54	Manual	Slough	80	36.4	44.2
20-Jul-08	22:30	26	24	SM	36.29137	-87.09828	New	*A. piscivorus*	55	Manual	Slough	320	58.5	69.3
20-Jul-08	0:00	24	24	SM	36.29017	-87.09853	New	*A. piscivorus*	56	Manual	Slough	<10	28.4	34.1
23-Jul-08	12:15	28	24	NS/SM	36.28963	-87.09617	Recap	*A. piscivorus*	16	Manual	Slough	220	52.6	62.9
23-Jul-08	13:45	29	24	NS/SM	36.29075	-87.09835	Recap	*A. piscivorus*	21	Manual	Slough	400	75.8	88.5

Date	Time	AT (*C)	WT (*C)	Researchers	GPS (N)	GPS (W)	Capture	Species	SC	CM	Location	W(g)	SVL(cm)	TBL(cm)
23-Jul-08	13:35	29	24	NS/SM	36.29047	-87.09700	New	*A. piscivorus*	39	Manual	Slough	460	68.5	80.2
23-Jul-08	13:25	29	24	NS/SM	36.29047	-87.09700	New	*A. piscivorus*	57	Manual	Slough	1200	93.1	110.3
21-Aug-08	10:39	24	21	NS	36.29187	-87.09878	Unknown	*A. piscivorus*	-	Manual	Slough	-	-	-
28-Aug-08	12:56	27	21	NS/TD	36.29057	-87.09903	Unknown	*A. piscivorus*	-	Manual	Slough	-	-	-
7-Sep-08	9:27	23	23	NS	36.29050	-87.09755	Unknown	*N. erythrogaster*	-	Manual	Slough	-	-	-
7-Sep-08	9:46	23	23	NS	36.29025	-87.09852	Unknown	*A. piscivorus*	-	Manual	Slough	-	-	-
7-Sep-08	9:46	23	23	NS	36.29017	-87.09800	Unknown	*A. piscivorus*	-	Manual	Slough	-	-	-
21-Sep-08	11:59	23	20	NS	36.29171	-87.09520	Unknown	*A. piscivorus*	-	Manual	Slough	-	-	-
27-Sep-08	11:04	24	18	NS	36.29117	-87.09625	Unknown	*A. piscivorus*	-	Manual	Slough	-	-	-
7-Oct-08	19:25	17	16	NS/NP/SM	36.29423	-87.10141	New	*O. aestivus*	-	Manual	Slough	-	-	-
7-Oct-08	19:35	17	16	NS/NP/SM	36.29416	-87.10034	Unknown	*A. piscivorus*	-	Manual	Slough	-	-	-
9-Oct-08	12:20	20	17	NS/LP	36.29366	-87.09791	New	*A. piscivorus*	59	Manual	Trail	180	46.8	57
11-Oct-08	16:37	24	17	SM/NP	36.29258	-87.09585	New	*L. getula*	7	Manual	Trail	310	96	107.5
11-Oct-08	15:02	27	17	SM/NP	36.28985	-87.08846	New	*N. erythrogaster*	2	Manual	Slough	170	65	81
11-Oct-08	16:03	24	17	SM/NP	36.29419	-87.09798	New	*T. sauritus*	-	Manual	Trail	<10	35.2	55.4
11-Oct-08	16:05	24	17	SM/NP	36.29438	-87.09783	New	*V. valeriae*	-	Manual	Trail	<10	10.8	12.9
11-Oct-08	18:07	23	17	SM/NP	36.28801	-87.08414	New	*V. valeriae*	-	Manual	Trail	<10	20.4	24.9
23-Oct-08	14:00	17	12	NS/SM/AJ	36.28566	-87.07996	Recap	*A. piscivorus*	45	Manual	Trail	600	67.6	80.1
6-Mar-09	13:37	20	8	NS/TS	36.28764	-87.08317	New	*T. sauritus*	19	Manual	Trail	<10	35.6	54.2
7-Mar-09	13:58	23	9	NS/TS	-	-	Unknown	*A. piscivorus*	-	Manual	Trail	-	-	-
9-Mar-09	14:29	26	11	SM/NP	36.29336	-87.09740	Unknown	*R. septemvittata*	-	Manual	TJS	-	-	-
9-Mar-09	14:28	26	11	NS/TS	36.29016	-87.08939	New	*T. sauritus*	20	Manual	Trail	<10	39.3	60.7
17-Mar-09	13:29	23	144	NS/SM	36.28988	-87.08785	Unknown	*S. dekayi*	-	Manual	Trail	<10	22.7	29.2
17-Mar-09	15:21	23	17	NS/SM	36.29335	-87.09749	New	*A. piscivorus*	-	Manual	TJ	<10	23.8	28.2
17-Mar-09	14:23	24	16	NS/SM	36.29012	-87.09005	Unknown	*A. piscivorus*	-	Manual	Trail	-	-	-
17-Mar-09	14:21	24	16	NS/SM	36.29108	-87.09209	Recap	*A. piscivorus*	2	Manual	Trail	330	57.4	67.3
20-Mar-09	12:11	17	15	NS/NP/Terry	36.29245	-87.09773	Unknown	*S. dekayi*	-	Manual	Trail	<10	22.5	29.2
24-Mar-09	16:37	23	20	NS/SM/NP	36.29406	-87.09957	Unknown	*D. punctatus*	-	Manual	Trail	<10	19.1	23.6
24-Mar-09	13:55	24	22	NS/SM/NP	36.29295	-87.09756	New	*L. getula*	7	Manual	Trail	280	82.5	91
24-Mar-09	14:03	25	23	NS/SM/NP	36.29298	-87.09758	New	*L. getula*	8	Manual	Trail	390	90.2	104.6
24-Mar-09	13:48	24	22	NS/SM/NP	36.29277	-87.09790	New	*N. erythrogaster*	5	Manual	TJS	70	49.4	60.7
24-Mar-09	16:52	23	20	NS/SM/NP	36.29318	-87.09753	New	*N. sipedon*	3	Manual	TJS	50	40.3	53.4
24-Mar-09	16:56	23	20	NS/SM/NP	36.29311	-87.09758	New	*N. sipedon*	4	Manual	TJS	130	54.8	73.5
24-Mar-09	14:44	25	23	NS/SM/NP	36.29399	-87.09865	New	*P. obsoleta*	7	Manual	Trail	220	88.4	104.3

Date	Time	AT (*C)	WT (*C)	Researchers	GPS (N)	GPS (W)	Capture	Species	SC	CM	Location	W(g)	SVL(cm)	TBL(cm)
24-Mar-09	14:16	25	23	NS/SM/NP	36.29336	-87.09740	Unknown	*R. septemvittata*	-	Manual	TJS	-	-	-
24-Mar-09	14:43	25	23	NS/SM/NP	36.29369	-87.09805	Unknown	*S. dekayi*	-	Manual	Trail	<10	22.6	27.4
24-Mar-09	15:15	24	22	NS/SM/NP	36.28879	-87.08910	Unknown	*S. dekayi*	-	Manual	Trail	<10	22.5	30
24-Mar-09	16:22	23	20	NS/SM/NP	36.29321	-87.09656	Unknown	*T. sirtalis*	-	Manual	Trail	<10	28.6	36.1
24-Mar-09	15:33	24	21	NS/SM/NP	36.29078	-87.09139	New	*A. piscivorus*	62	Manual	Trail	140	47.7	58
24-Mar-09	16:00	23	20	NS/SM/NP	36.29081	-87.09169	New	*A. piscivorus*	63	Manual	Trail	420	65.8	78.6
24-Mar-09	16:00	23	20	NS/SM/NP	36.28974	-87.08857	New	*A. piscivorus*	64	Manual	Trail	380	63.1	75.1
24-Mar-09	16:06	23	20	NS/SM/NP	36.29094	-87.09175	New	*A. piscivorus*	65	Manual	Trail	220	53.1	62.3
24-Mar-09	16:12	23	20	NS/SM/NP	36.29015	-87.08918	New	*A. piscivorus*	66	Manual	Trail	520	71.5	84.1
28-Mar-09	13:45	21	20	NS/TS/MW	36.29347	-87.09736	New	*N. erythrogaster*	6	Manual	TJS	300		
28-Mar-09	13:55	21	20	NS/TS/MW	36.29340	-87.09737	New	*N. erythrogaster*	7	Manual	Slope	330		
28-Mar-09	15:03	21	20	NS/TS/MW	36.29347	-87.09737	Recap	*N. erythrogaster*	6	Manual	Slope	300		
28-Mar-09	14:29	21	20	NS/TS/MW	36.28957	-87.08663	Unknown	*T. sirtalis*	15	Manual	Trail	60	-	-
28-Mar-09	13:10	21	20	NS/TS/MW	36.29461	-87.10001	New	*A. piscivorus*	67	Manual	Trail	230	61.2	70.8
28-Mar-09	13:15	21	20	NS/TS/MW	36.29479	-87.10000	New	*A. piscivorus*	68	Manual	Trail	240	61.8	72.4
28-Mar-09	14:30	21	20	NS/TS/MW	36.28874	-87.08729	New	*A. piscivorus*	69	Manual	Trail	410	68.2	78.9
28-Mar-09	14:55	21	20	NS/TS/MW	36.29126	-87.09364	New	*A. piscivorus*	70	Manual	Trail	270	62.3	71.7
5-Apr-09	14:09	23	25	NS/NP/SM	36.53239	-87.35105	New	*L. getula*	9	Manual	Trail	240	63	94.8
5-Apr-09	14:38	23	25	NS/NP/SM	36.29342	-87.09750	New	*N. erythrogaster*	-	Manual	Trail	<10	23	30.3
5-Apr-09	15:02	22	25	NS/NP/SM	36.29361	-87.09719	New	*N. sipedon*	-	Manual	TJS	<10	16	20.6
5-Apr-09	15:24	22	25	NS/NP/SM	36.28895	-87.08597	New	*P. obsoleta*	8	Manual	Trail	550	113.5	137.7
20-Apr-09	14:09	21	27	NS/TS	36.29196	-87.09879	New	*A. piscivorus*	71	Manual	Slough	200	51.5	61.2
20-Apr-09	16:15	21	23	NS/TS	36.29111	-87.09627	New	*A. piscivorus*	72	Manual	Slough	180	42.7	51.5
20-Apr-09	15:35	20	25	NS/TS	36.29187	-87.09871	RT	*A. piscivorus*	42	Radio	Slough	670	79.3	92.8
24-Apr-09	12:23	46	37	NS/TS/MW	36.28990	-87.09675	RT	*A. piscivorus*	39	Radio	Slough	490	66.8	79
24-Apr-09	14:08	39	34	NS/TS/MW	36.29172	-87.09557	RT	*A. piscivorus*	45	Radio	Slough	450	71.4	83.1
24-Apr-09	11:57	46	37	NS/TS/MW	36.29017	-87.09686	New	*A. piscivorus*	73	Manual	Slough	630	72.7	85.3
24-Apr-09	13:39	43	35	NS/TS/MW	36.29159	-87.09546	New	*A. piscivorus*	74	Manual	Slough	<10	38.5	45.2
19-May-09	12:13	15	-	NS/SM/KY	36.29507	-87.09768	Unknown	*C. constrictor*	-	Manual	Trail	-	-	-
19-May-09	11:09	15	-	NS/SM/KY	36.29202	-87.09824	Unknown	*N. sipedon*	-	Manual	Slough	-	-	-
19-May-09	13:24	15	-	NS/SM/KY	36.29115	-87.09785	RT	*A. piscivorus*	30	Radio	Slough	370	65.7	75.8
19-May-09	12:37	15	-	NS/SM/KY	36.29155	-87.09779	Recap	*A. piscivorus*	14	Manual	Slough	450	68	81
19-May-09	14:00	15	-	NS/SM/KY	36.29131	-87.09772	New	*A. piscivorus*	76	Manual	Slough	340	69.3	79.5

APPENDIX B

Radio-telemetry data for radio-tagged cottonmouths

Snake (Freq.)	Date	Time	GPS (N)	GPS (W)	DM (m)	Cover	Visual
101	17-Jul	20:50	36.29203	-87.09865	-	grass/veg	Yes
101	12-Aug	15:45	36.29223	-87.09820	100	under grass on island	Yes
101	14-Aug	11:04	36.29220	-87.09823	4	grass/veg	No
101	16-Aug	11:59	36.29217	-87.09813	9	grass/veg	No
101	21-Aug	9:07	36.29240	-87.09790	32	grass/veg	No
101	28-Aug	11:02	36.29111	-87.09918	310	grass/veg	No
101	31-Aug	14:25	36.29127	-87.09914	0	grass/veg	No
101	2-Sep	14:20	36.29188	-87.09863	230	aquatic veg	Yes
101	7-Sep	10:18	36.29183	-87.09867	6	aquatic veg	Yes
101	9-Sep	14:18	36.29190	-87.09862	8	aquatic veg	Yes
101	11-Sep	17:32	36.29121	-87.09928	96	aquatic veg	No
101	18-Sep	18:12	36.29184	-87.09864	90	aquatic veg	No
101	21-Sep	12:33	36.29153	-87.09702	150	aquatic veg	No
101	23-Sep	13:05	36.53259	-87.35133	0	aquatic veg	No
101	27-Sep	11:39	36.29208	-87.09823	120	aquatic veg	No
101	30-Sep	14:20	36.29208	-87.09823	0	aquatic veg	No
101	2-Oct	14:57	36.29208	-87.09823	0	aquatic veg	No
101	7-Oct	15:15	36.29208	-87.09823	0	aquatic veg	No
101	9-Oct	10:21	36.29208	-87.09823	0	aquatic veg	No
101	11-Oct	14:36	36.29218	-87.09840	18	aquatic veg	No
101	16-Oct	15:05	36.29218	-87.09840	0	aquatic veg	No
101	19-Oct	15:29	36.29218	-87.09840	0	aquatic veg	No
101	23-Oct	14:00	36.29212	-87.09487	320	On Trail	Yes
101	26-Oct	9:22	36.29223	-87.09487	12	In hibernacula	No
101	28-Oct	11:16	36.29223	-87.09487	0	In hibernacula	No
101	2-Nov	13:20	36.29223	-87.09487	0	In hibernacula	No
101	6-Nov	9:18	36.29223	-87.09487	0	In hibernacula	No
101	13-Nov	10:48	36.29223	-87.09487	0	In hibernacula	No
101	16-Nov	2:13	36.29223	-87.09487	0	In hibernacula	No
101	6-Mar	9:12	36.29223	-87.09487	0	In hibernacula	No
101	7-Mar	14:02	36.29223	-87.09487	0	In hibernacula	No
101	9-Mar	14:52	36.29223	-87.09487	0	In hibernacula	No
101	17-Mar	12:28	-	-	-	In slough	No
101	20-Apr	16:54	36.29161	87.09531	79	In root mass	No
101	24-Apr	14:08	36.29172	87.09557	26	Under Log	Yes
203	15-Jul	21:23	36.29168	-87.09883	-	Red Maple	Yes
203	12-Aug	16:34	36.29348	-87.10112	290	Root Mass	Yes
203	14-Aug	11:24	36.29328	-87.10128	26	Buttonbush	No
203	16-Aug	10:09	36.29318	-87.10142	16	Buttonbush	No
203	21-Aug	9:26	36.29108	-87.09815	370	Red Maple	Yes
203	28-Aug	11:29	36.29067	-87.09767	62	Red Maple	Yes
203	31-Aug	14:39	36.29130	-87.09685	100	Red Maple/Buttonbush	No
203	2-Sep	16:05	36.29107	-87.09647	42	Buttonbush	No
203	7-Sep	10:04	36.29142	-87.09648	38	Trees	Yes

Snake (Freq.)	Date	Time	GPS (N)	GPS (W)	DM (m)	Cover	Visual
203	9-Sep	14:05	36.29150	-87.09765	110	Logs	Yes
203	11-Sep	17:02	36.29108	-87.09798	55	Buttonbush	No
203	18-Sep	10:29	36.29139	-87.09641	150	Buttonbush	No
203	21-Sep	12:16	36.29156	-87.09702	57	Logs	No
203	23-Sep	13:54	36.29148	-87.09616	77	BB Rootmass	No
203	27-Sep	11:04	36.29117	-87.09625	35	Red Maple/BB Rootmass	No
203	30-Sep	13:44	36.29099	-87.09620	20	Red Maple	No
203	2-Oct	15:38	36.29123	-87.09633	29	Buttonbush	Yes
203	7-Oct	17:44	36.29466	-87.09989	500	Hibernacula	No
203	9-Oct	12:02	36.29466	-87.09989	0	Hibernacula	No
203	11-Oct	15:05	36.29466	-87.09989	0	Hibernacula	No
203	16-Oct	15:15	36.29466	-87.09989	0	Hibernacula	No
203	19-Oct	15:02	36.29466	-87.09989	0	Hibernacula	No
203	23-Oct	14:02	36.29466	-87.09989	0	Hibernacula	No
203	26-Oct	9:26	36.29466	-87.09989	0	Hibernacula	No
203	28-Oct	11:28	36.29466	-87.09989	0	Hibernacula	No
203	2-Nov	13:20	36.29466	-87.09989	0	Hibernacula	No
203	6-Nov	9:18	36.29466	-87.09989	0	Hibernacula	No
203	13-Nov	10:48	36.29466	-87.09989	0	Hibernacula	No
203	16-Nov	2:13	36.29466	-87.09989	0	Hibernacula	No
203	6-Mar	9:18	36.29466	-87.09989	0	Hibernacula	No
203	7-Mar	14:26	36.29466	-87.09989	0	Hibernacula	No
203	9-Mar	14:33	36.29466	-87.09989	0	Hibernacula	No
203	17-Mar	12:41	36.29466	-87.09989	0	Hibernacula	No
203	20-Mar	12:33	36.29466	-87.09989	0	Hibernacula	No
203	24-Mar	15:03	36.29466	-87.09989	0	Hibernacula	No
203	28-Mar	13:46	-	-	-	In slough	No
203	20-Apr	15:35	36.29187	-87.09871	330	Under log	Yes
203	24-Apr	12:39	36.291278	-87.09761	120	Downed Logs	No
305	23-Jul	11:35	36.29025	-87.09852	-	Aquatic Veg	Yes
305	16-Aug	11:05	36.29035	-87.09723	270	Aquatic Veg	No
305	21-Aug	10:28	36.29005	-87.09550	160	Trees	No
305	28-Aug	12:13	36.29028	-87.09643	87	Buttonbush	No
305	31-Aug	15:09	36.29013	-87.09615	30	Buttonbush/Red Maple	No
305	2-Sep	16:27	36.29010	-87.09622	7	Red Maples	No
305	7-Sep	9:22	36.29048	-87.09768	140	Red Maple Mound	No
305	9-Sep	13:15	36.29078	-87.09785	36	Log/Aquatic Veg	No
305	11-Sep	18:00	36.29067	-87.09757	27	Log/Aquatic Veg	No
305	18-Sep	12:03	36.29038	-87.09766	33	Red Maple Mass	No
305	21-Sep	11:21	36.29086	-87.09821	72	Buttonbush	No
305	23-Sep	14:22	36.29062	-87.09758	62	Buttonbush/Logs	No
305	27-Sep	10:36	36.29077	-87.09812	51	Buttonbush	No
305	30-Sep	13:39	36.29070	-87.09615	180	Red Maple Mass	No
305	2-Oct	15:30	36.29116	-87.09587	56	Red Maple/Buttonbush	No

Snake (Freq.)	Date	Time	GPS (N)	GPS (W)	DM (m)	Cover	Visual
305	7-Oct	15:50	36.29194	-87.09548	93	Red Maple Mass	No
305	9-Oct	11:05	36.29048	-87.09003	520	Hibernacula	No
305	11-Oct	13:53	36.29048	-87.09003	0	Hibernacula	No
305	16-Oct	14:55	36.29048	-87.09003	0	Hibernacula	No
305	19-Oct	15:30	36.29048	-87.09003	0	Hibernacula	No
305	23-Oct	14:02	36.29048	-87.09003	0	Hibernacula	No
305	26-Oct	8:45	36.29048	-87.09003	0	Hibernacula	No
305	28-Oct	11:28	36.29048	-87.09003	0	Hibernacula	No
305	2-Nov	13:20	36.29048	-87.09003	0	Hibernacula	No
305	6-Nov	9:18	36.29048	-87.09003	0	Hibernacula	No
305	13-Nov	10:48	36.29048	-87.09003	0	Hibernacula	No
305	16-Nov	2:13	36.29048	-87.09003	0	Hibernacula	No
305	6-Mar	13:58	36.29037	-87.09064	56	West Slope	No
305	7-Mar	13:10	36.29082	-87.09177	110	Log/Aquatic Veg	Yes
305	20-Apr	14:49	36.29065	-87.09748	510	Buttonbush	No
305	24-Apr	12:23	36.28990	-87.09675	110	Roots	Yes
403	17-Jul	22:15	36.29176	-87.09810	-	Trees	Yes
403	12-Aug	17:33	36.29105	-87.09788	130	Red Maple Mass	No
403	14-Aug	10:44	36.29072	-87.09782	37	Veg/Trees	Yes
403	16-Aug	10:50	36.29057	-87.09803	25	Trees	Yes
403	21-Aug	9:26	36.29108	-87.09815	57	Red Maple Mass	Yes
403	28-Aug	11:51	36.29062	-87.09682	130	Red Maple Mass	Yes
403	31-Aug	14:07	36.29105	-87.09788	111	Buttonbush	No
403	2-Sep	15:30	36.29100	-87.09843	49	Trees	No
403	7-Sep	9:35	36.29072	-87.09787	59	Red Maple/Buttonbush	No
403	9-Sep	13:40	36.29113	-87.09828	58	Red Maple/Buttonbush	No
403	11-Sep	14:00	36.29124	-87.09837	14	Buttonbush	No
403	18-Sep	11:56	36.29082	-87.09778	70	Buttonbush	No
403	21-Sep	11:12	36.29055	-87.09751	190	Downed Logs	No
403	23-Sep	14:29	36.29082	-87.09800	19	Red Maples/Buttonbush	No
403	27-Sep	10:50	36.29064	-87.09713	80	Red Maples/Buttonbush	No
403	30-Sep	14:11	36.29126	-87.09805	111	Downed Logs	No
403	2-Oct	15:33	36.29119	-87.09787	17	Downed Logs	No
403	7-Oct	15:38	36.29363	-87.09794	270	Hibernacula	No
403	9-Oct	11:27	36.29448	-87.09783	94	Hibernacula	No
403	11-Oct	16:17	36.29448	-87.09783	0	Hibernacula	No
403	16-Oct	15:45	36.29448	-87.09783	0	Hibernacula	No
403	19-Oct	15:59	36.29448	-87.09783	0	Hibernacula	No
403	23-Oct	14:02	36.29448	-87.09783	0	Hibernacula	No
403	26-Oct	9:26	36.29448	-87.09783	0	Hibernacula	No
403	28-Oct	11:28	36.29448	-87.09783	0	Hibernacula	No
403	2-Nov	13:20	36.29448	-87.09783	0	Hibernacula	No
403	6-Nov	9:18	36.29448	-87.09783	0	Hibernacula	No
403	13-Nov	10:48	36.29448	-87.09783	0	Hibernacula	No

Snake (Freq.)	Date	Time	GPS (N)	GPS (W)	DM (m)	Cover	Visual
403	16-Nov	2:13	36.29448	-87.09783	0	Hibernacula	No
403	6-Mar	8:55	36.29448	-87.09783	0	Hibernacula	No
403	7-Mar	14:02	36.29448	-87.09783	0	Hibernacula	No
403	9-Mar	14:45	36.29448	-87.09783	0	Hibernacula	No
403	17-Mar	12:00	36.29448	-87.09783	0	Hibernacula	No
403	20-Mar	12:36	36.29448	-87.09783	0	Hibernacula	No
403	24-Mar	15:59	36.29448	-87.09783	0	Hibernacula	No
403	28-Mar	14:16	36.29448	-87.09783	0	Hibernacula	No
403	4-Apr	11:06	-	-	-	In slough	No
403	20-Apr	16:36	36.29152	-87.09645	350	Downed Logs	No
403	24-Apr	12:00	36.291294	-87.09740	88	Downed Logs	No
503	23-Jul	11:25	36.29017	-87.09800	-	Buttonbush	Yes
503	16-Aug	11:15	36.29028	-87.09707	84	Buttonbush	Yes
503	21-Aug	9:26	36.29108	-87.09815	130	Red Maple	Yes
503	28-Aug	13:06	36.29048	-87.09853	74	Buttonbush	No
503	31-Aug	13:46	36.29053	-87.09880	24	Veg	No
503	2-Sep	15:11	36.29050	-87.09890	9	Veg/Thick	No
503	7-Sep	9:01	36.29048	-87.09855	31	Veg/Thick	No
503	9-Sep	12:50	36.29063	-87.09885	31	Veg/Downed Logs	No
503	11-Sep	13:12	36.29080	-87.09740	130	Veg/Downed Logs	No
503	18-Sep	10:12	36.29128	-87.09571	160	Buttonbushes	No
503	21-Sep	11:59	36.29171	-87.09520	66	Red Maple Root Mass	No
503	23-Sep	13:43	36.29180	-87.09491	27	Buttonbushes	No
503	27-Sep	11:25	36.29175	-87.09467	22	Buttonbushes	No
503	30-Sep	14:00	36.29175	-87.09467	0	Buttonbushes	No
503	2-Oct	15:11	36.29171	-87.09489	20	Buttonbushes	No
503	7-Oct	15:31	36.29212	-87.09461	51	Hibernacula	No
503	9-Oct	11:45	36.29212	-87.09461	0	Hibernacula	No
503	11-Oct	14:11	36.29212	-87.09461	0	Hibernacula	No
503	16-Oct	15:20	36.29212	-87.09461	0	Hibernacula	No
503	19-Oct	15:59	36.29212	-87.09461	0	Hibernacula	No
503	23-Oct	14:02	36.29212	-87.09461	0	Hibernacula	No
503	26-Oct	9:26	36.29212	-87.09461	0	Hibernacula	No
503	28-Oct	11:28	36.29212	-87.09461	0	Hibernacula	No
503	2-Nov	13:20	36.29212	-87.09461	0	Hibernacula	No
503	6-Nov	9:18	36.29212	-87.09461	0	Hibernacula	No
503	13-Nov	10:48	36.29212	-87.09461	0	Hibernacula	No
503	16-Nov	2:13	36.29212	-87.09461	0	Hibernacula	No
503	6-Mar	9:12	36.29212	-87.09461	0	Hibernacula	No
503	7-Mar	14:02	36.29212	-87.09461	0	In slough	No
503	9-Mar	14:52	-	-	-	Red Maple Mass	No
503	20-Apr	16:17	36.29152	-87.09642	180	Buttonbushs	No
503	24-Apr	13:20	36.29097	-87.09592	75		

APPENDIX C

Data sheets used during the course of the study

Cumberland River Bicentennial Trail Snake Capture Data

Property of Austin Peay State University Center of Excellence for Field Biology

Nathalie Smith: (816) 304-6182

Date: ______ Sky: ______ Mass: ______
Time: ______ Wind: ______ SVL: ______
Air Temp: ______ Precip: ______ TBL: ______
H20 Temp: ______ Weather: ______
Species: ______ Scale Clip #: ______
Coordin: N ______ W ______ (+/-) ______
Researchers: ______
Capture Method: Manual Funneltrap Coverboard
Capture History: New Capture Recapture
Activity/Capture Location: ______
Notes: ______

Date: ______ Sky: ______ Mass: ______
Time: ______ Wind: ______ SVL: ______
Air Temp: ______ Precip: ______ TBL: ______
H20 Temp: ______ Weather: ______
Species: ______ Scale Clip #: ______
Coordin: N ______ W ______ (+/-) ______
Researchers: ______
Capture Method: Manual Funneltrap Coverboard
Capture History: New Capture Recapture
Activity/Capture Location: ______
Notes: ______

Date: ______ Sky: ______ Mass: ______
Time: ______ Wind: ______ SVL: ______
Air Temp: ______ Precip: ______ TBL: ______
H20 Temp: ______ Weather: ______
Species: ______ Scale Clip #: ______
Coordin: N ______ W ______ (+/-) ______
Researchers: ______
Capture Method: Manual Funneltrap Coverboard
Capture History: New Capture Recapture
Activity/Capture Location: ______
Notes: ______

Agkistrodon piscivorus leucostoma Telemetry Data

Property of Austin Peay State University Center of Excellence for Field Biology

Nathalie Smith: (816) 304-6182

Frequency

Date:__________ Time:__________ H20 Temp:__________ Air Temp:__________

Sky:__________ Wind:__________ Precip:__________

Coordinates: N__________ W__________ +/-__________

Cover:__________

Canopy:__________ Visual Sighting: Yes No

Behavior:__________

Date:__________ Time:__________ H20 Temp:__________ Air Temp:__________

Sky:__________ Wind:__________ Precip:__________

Coordinates: N__________ W__________ +/-__________

Cover:__________

Canopy:__________ Visual Sighting: Yes No

Behavior:__________

Date:__________ Time:__________ H20 Temp:__________ Air Temp:__________

Sky:__________ Wind:__________ Precip:__________

Coordinates: N__________ W__________ +/-__________

Cover:__________

Canopy:__________ Visual Sighting: Yes No

Behavior:__________

VITA

Nathalie Briend-Smith was born in Kansas City, Missouri on August 5, 1983. She was raised in Lee's Summit, Missouri and went to grade school and junior high school at Pleasant Lee Elementary and Junior High. She graduated from Lee's Summit High School in 2002. From there, she went to the University of Tampa and received a B.S. in Marine Science and Biology in 2006. In August of 2007, she enrolled at Austin Peay State University to pursue her Master's in Biology. She plans to continue research in the biological sciences.