HERPETOFAUNAL DIVERSITY AND ABUNDANCE AT CATTLE-ACCESS AND NON-CATTLE ACCESS PONDS AT THE MILAN ARMY AMMUNITION PLANT, GIBSON AND CARROLL COUNTIES, TENNESSEE

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HERPETOFAUNAL DIVERSITY AND ABUNDANCE AT CATTLE-ACCESS AND NON-CATTLE ACCESS PONDS AT THE MILAN ARMY AMMUNITION PLANT, GIBSON AND CARROLL COUNTIES, TENNESSEE

A Thesis

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Benjamin Beas

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I am submitting herewith a thesis written by Benjamin J. Beas entitled" Herpetofaunal Diversity and Abundance at Cattle-Access and Non-Cattle Access Ponds at the Milan Army Ammunition Plant, Gibson and Carroll Counties, Tennessee." I have examined the final 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, with a major in biology.

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Benjamin J. Beas

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DEDICATION

This thesis is dedicated to my parents,

for without them, I wouldn't be where I am today.

AKNOWLEDGMENTS

First, I would like to thank my major professor, Dr. A. Floyd Scott, for his endless patience in every realm of this project. It was through his constant guidance from start to finish, that made this thesis possible. I would also like to thank Dr. Steven Hamilton for his help with water quality issues that I faced, to Dr. Andrew Barrass for his continued encouragement throughout the project and to Dr. Edward Chester for his assistance in identifying the flora of the area.

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ABSTRACT

Cattle have the ability to alter the terrain of a given area, thus making the habitat potentially unsuitable to many types of herpetofauna. Their cloven hooves can collapse burrows, cause direct mortalities, or disturb habitat of leaf-litter dwelling species. Their heavy grazing pressures have the ability to remove vegetation cover, simplify vegetative structure, and change invertebrate communities which are essential to many types of herpetofauna.

Some work has been done to assess the impact of cattle on reptile and amphibian populations but many of the studies included ponds that contained fish which can limit amphibian populations. This study took place at the Milan Army Ammunition Plant in Carroll and Gibson counties, Tennessee and sought to compare the herpetofauna in and around nine fishless ponds of two types: those accessible to cattle and those not accessible to cattle.

Three sampling techniques were used: 1) aquatic minnow traps deployed seasonally, 2) terrestrial cover object set along transects that were checked monthly, and 3) monthly samples of treefrogs with PVC-pipe refuges attached to shoreline trees.

The aquatic capture data showed that the total number of individual amphibians captured over the course of the study at the two pond types was statistically different, with non-cattle ponds exceeding cattle ponds. However, the average total mass per sampling session was not. Cattle ponds dominated the number of species and individuals found under the cover objects with *Diadophis punctatus* being the most abundant animal found. The PVC-pipe refuges yielded over two-and-a-half times more individuals at non-

cattle ponds, but the individuals captured at cattle ponds had a significantly greater snout-vent length and mass.

These results suggest the following about the amphibian and reptile populations in and around ponds on the Milan Army Ammunition Plant: 1) numbers of individual amphibians is greatest at non-cattle ponds, but biomass is similar overall at each; 2) abundance of terrestrial herpetofauna in the area surrounding ponds is greatest where cattle are present; and 3) gray treefrog numbers are much higher around ponds where cattle are absent. It is likely that factors other than the presence or absence of cattle (e.g. amount of solar radiation reaching the water, nutrient load, density and composition of vegetation, and proximity to row-crop fields) were involved in producing these results.

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CHAPTER I

INTRODUCTION

There has been little work done on the effects of cattle on co-existing populations of amphibians and reptiles. Much of the previous works (Burton et al. 2006, Maret et al. 2006) deals with cattle ponds that are inhabited by fish. Fish are known predators of anuran and salamander populations (Maret et al. 2006, Knutson et al. 2004) thus can limit the potential amphibian diversity in a given area.

Many reptile communities partition the environment according to the amount of insolation reaching the soil surface (Bradshaw 1981) and the structural diversity of vegetation (Pianka 1966). Grazing by cattle therefore can affect reptile communities through the removal of vegetation cover and simplification of vegetative structure (Lillywhite 1977, Jones 1981). Cloven-hoofed livestock can collapse burrows, cause direct mortalities, or disturb habitat of litter-dwelling species (Busack and Bury 1974, Ehmann 1980). In addition, Vitt and Ohmart (1974) suggested that invertebrate communities, which are a major food source for most reptiles may also be affected by heavy grazing pressure.

Amphibians can be used as indictors of ecosystem health (Wake 1991). Their thin, moist, highly permeable skin; jellied, unshelled eggs; possession of aquatic and terrestrial life histories; restricted home range; and limited dispersal abilities of many species make amphibians effective biomonitors (U.S. EPA 2002).

The use of reptiles as bioindicators is controversial. Reptile may also be useful indicators of ecosystem health because they are easily sampled (Bock et al. 1990), respond quickly to environmental change (van Rooy and Stumpel 1995), and are not subject to dramatic, seasonal influenced fluctuations in population size and composition (Newsome and Corbett 1975, Schodde 1982). Read (2002) however found that the use of reptiles as early warning indicators of unsustainable grazing was unsupported and in some species, there was a greater abundance of individuals in grazed areas compared to that of ungrazed areas.

Grazing around ponds results in disturbance from livestock through wading and defecating in the pond. This activity uproots aquatic and emergent vegetation in the pond and prevents trees and shrubs from taking root along the perimeter of the pond. The direct input of high levels or nitrogen through urine and manure and the turbidity induced by livestock disturbance leads to poorer water quality, low dissolved oxygen, and an adverse environment for amphibian eggs and tadpoles (Knutson et al., 2004). Highly productive ponds experience wide ranges in dissolved oxygen and pH that can be detrimental to the survival of amphibian eggs and larvae (Freda and Gonzalez 1986). In addition, reports show that the presence of livestock and their grazing in and around water bodies creates negative geomorphologic conditions (Trimble 1994).

The purpose of this study is to compare selected abiotic factors and herpetofuanal communities in and around a sample of fishless ponds, half with cattle present and the rest with cattle absent.

CHAPTER II

STUDY AREA

Location and Size

The ponds that were examined were all present on the Milan Army Ammunition Plant (MLAPP) which is located in Gibson and Carroll counties, Tennessee, just east of U.S. Highway 45E from Milan city to Medina (Figs. 1 and 2). It comprises 9,077 ha (22,419 ac) and is divided into northern and southern sections by state highway 104 West (Brew and Markol, 2001).

History

MLAAP is an active army installation, constructed in 1941 and opened in 1942, with the mission of loading, assembling, packaging, storing, and shipping medium- and large-caliber ammunition. The installation includes 10 ammunition load, assemble, and package (LAP) lines, one washout/rework line, one central x-ray facility, one test area, two shop maintenance areas, 12 magazine storage areas, a demolition and burning grounds area, an administrative area, and a family housing area. In addition, the site has seven industrial waste water treatment plants. Administrative support, storage and disposal facilities, as well as active and inactive production facilities are dispersed among wooded and cultivated fields (Higgs 2005). Since 1949, the plant has leased fenced in areas for cattle grazing (areas P/L and MOD).

Physiography, Topography, Soils, Geology

MLAAP is located on the eastern flank of the Upper Mississippi River Embayment of the Gulf Coastal Plain Physiographic Province (Moore, 1965).

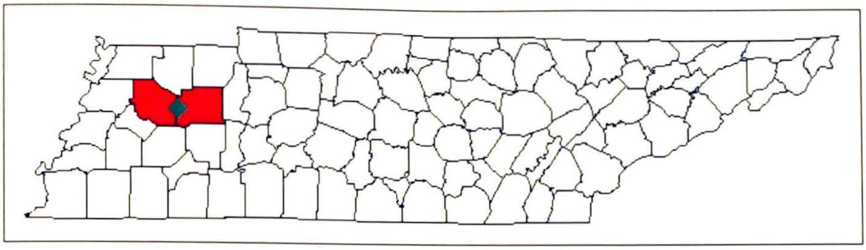

Figure 1. County map of Tennessee showing the location of the Milan Army Ammunition Plant (Green Dot).

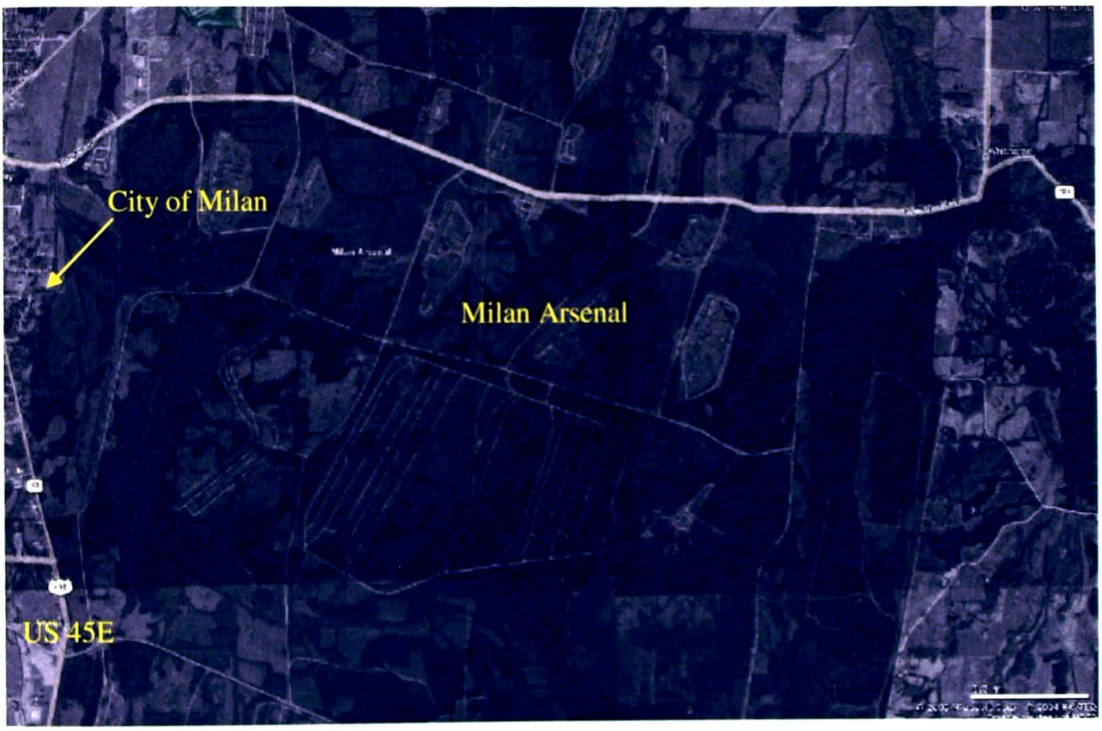

Figure 2. Aerial photo showing the middle and upper portions of the Milan Army Ammunition Plant.

The soil types that occur on MLAAP include Memphis, Loring, Grenada, Calloway, Henry, Falaya, and Waverly soil associations (Higgs 2005).

The Mississippi Embayment is structurally a down-warped, down-faulted trough, the axis of which approximates the present course of the Mississippi River. MLAAP and surroundings contains sediments and sedimentary rocks ranging in age from Cretaceous to recent. The Milan area is underlain, from oldest to youngest groups, by the Cretaceous McNairy Sand, the Porters Creek Clay, the Wilcox Group, the Clairborne Group, and the Quaternary age loess, fluvial, and alluvial deposits (Park and Carmichael, 1990).

Vegetation

Milan Army Ammunition Plant is part of the Western Mesophytic Forest Region as described by Braun (1950). In 1964, Kuchler described the region as Oak-Hickory Vegetation Type with a composition of medium tall to tall broadleaf deciduous trees. Dominants of this region include: white oak (*Quercus alba*), northern red oak (*Quercus rubra*), black oak (*Quercus velutina*), shagbark hickory (*Carya ovata*), and bitternut hickory (*Carya cordiformis*) (Kuchler 1964).

Weather and Climate

The area of Milan is characterized by a temperate and continental climate. There is no dry season, and snowfall is variable from year to year (Higgs 2005). Figures 3, 4 and 5 show the averages of historic monthly (1930-2005) high and low temperatures and total precipitation compared to those average monthly temperatures and precipitation during the sampling period of this study.

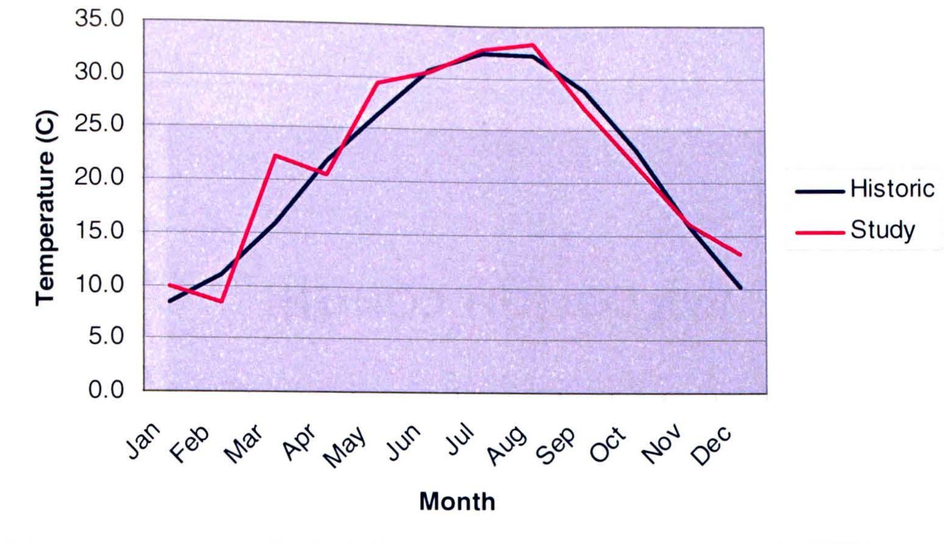

Figure 3. Average maximum monthly temperatures historically (1935-2005) compared to the average maximum monthly temperature during the sampling period (June 2006 – May 2007)
Data source: http://www.dnr.state.sc.us/water/climate/sercc).

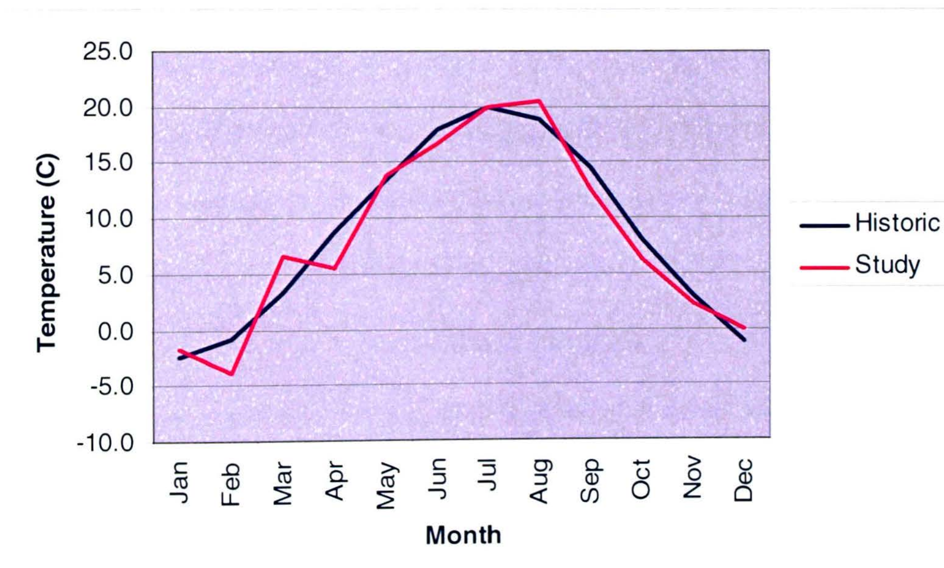

Figure 4. Average minimum monthly temperatures historically (1935-2005) compared to the average minimum monthly temperature during the sampling period (June 2006 – May 2007)
(Data source: http://www.dnr.state.sc.us/water/climate/sercc).

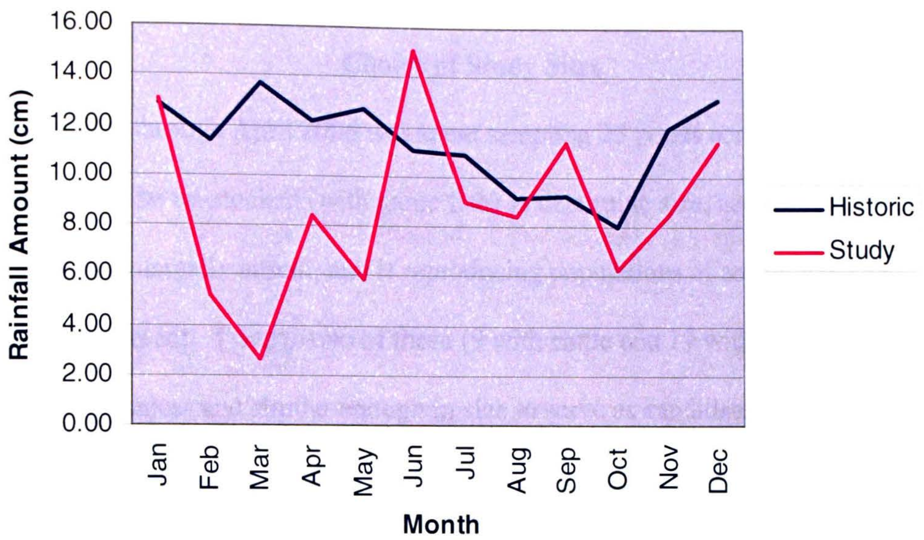

Figure 5. The historical (1935-2005) average monthly rainfall compared to the monthly total rainfall during the sampling period (June 2006 – May 2007) (Data source: http://www.dnr.state.sc.us/water/climate/sercc).

CHAPTER III

METHODS AND MATERIALS

Choice of Study Sites

January through April 2006 was spent sampling 25 ponds across MLAAP that were thought to be un-stocked (with game fish) to determine size, accessibility, whether or not fish were actually absent, and if reproducing populations of amphibians and reptiles were present. Twenty-two of these (9 with cattle and 13 without cattle) were confirmed as fishless and similar enough in size to serve as candidate study sites. All nine of the cattle ponds were selected and nine of the ponds without cattle were chosen randomly using the random numbers generator at http://www.random.org. The 18 chosen ponds (Appendix A) are shown in Figure 6.

Target and Accessible Populations

The target and sampled population for this study included all amphibians and reptiles living in and around the 18 selected ponds for this survey at MLAAP. Major groups included members of the orders Caudata (salamanders), Anura (frogs and toads), Testudines (turtles), and Squamata (lizards and snakes).

Marking and Measuring

All captured individuals were assessed for the following: mass (using an Ohaus CS2000 compact electronic scale), snout-vent length (SVL) (or carapace length, CL, if a turtle), age class (juvenile or adult), sex (if detected externally), and reproductive condition (National Park Service, 2003a). Adults and juveniles of sufficient size were marked by either toe-clipping or scale notching depending on the type of animal

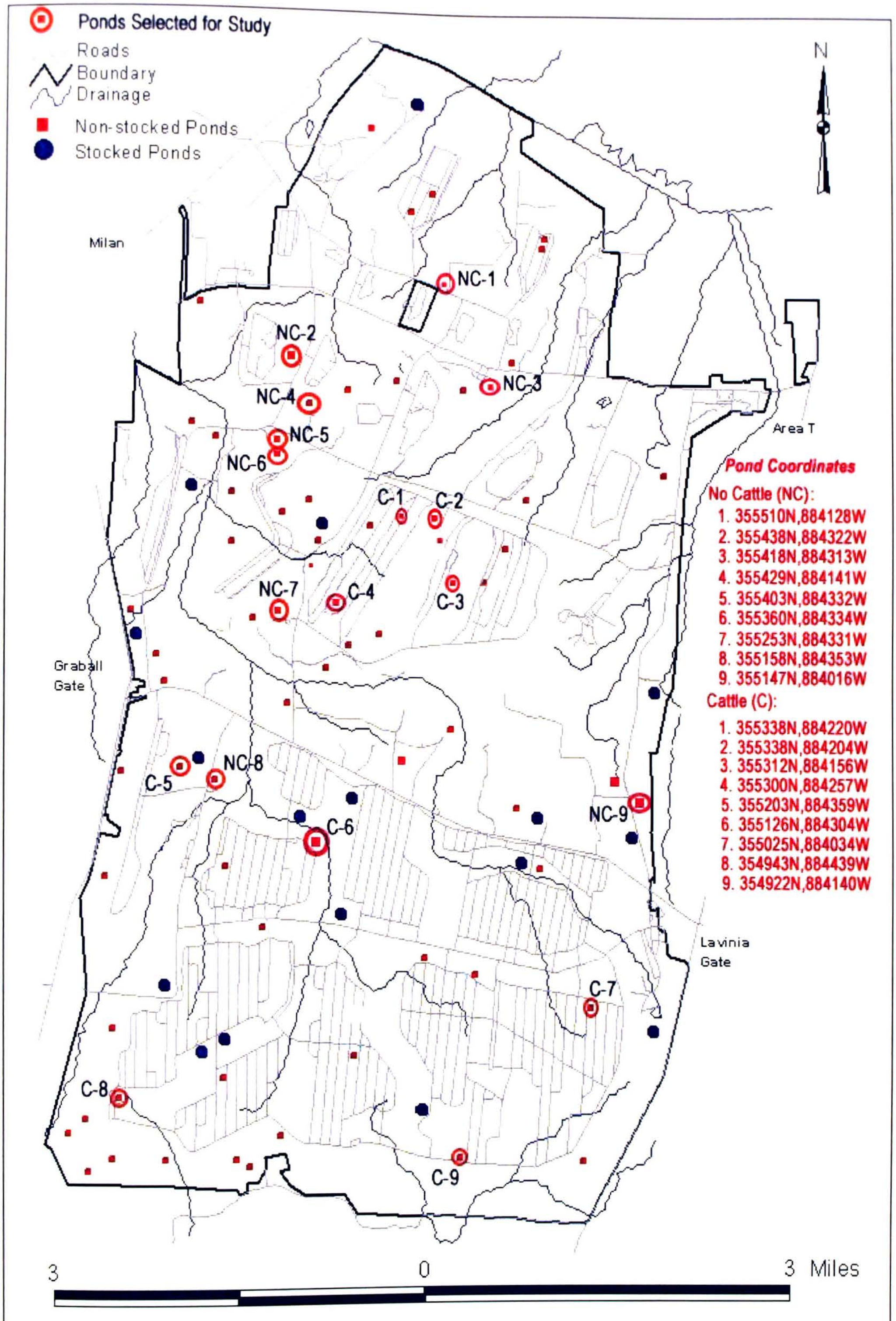

Figure 6. A map of the plant showing the ponds that were selected for the study.

involved. Frogs, toads, salamanders, and lizards were marked by clipping the second toe on the right forelimb. Snakes were marked by clipping the second ventral scute anterior to the anal scale; turtles were marked by notching one of the marginal scutes as described by Cagle (1939).

Capture Methods

Minnow Traps

Each pond was sampled using six minnow traps as illustrated in Fig. 7. Four of the minnow traps were placed near the edge, in shallow water, along north-south and east-west lines that bisected the pond. The other two traps were set in the middle of the pond equidistant from each other along the north-south line mentioned above. Minnow traps were set the day before sampling was to occur and checked within 48 hours to prevent possible drowning of individuals.

Cover Objects

At every pond surveyed, a twenty-cover-object transect was established along a line extending outward through surrounding habitat(s). An attempt was made to incorporate as many different habitats as possible when constructing the transects. Pieces of plywood (Fig. 8) and roofing tin (Fig. 9) each measuring 1.22m x 0.61 m were placed in alternating fashion every five meters starting with a piece of plywood. The cover objects were numbered 1 to 20 (with orange spray paint) starting with the cover object closest to the pond. On surveying days, the temperature was taken simultaneously under and on top of cover objects 1, 2, 7, 8, 13, 14, 19, and 20.

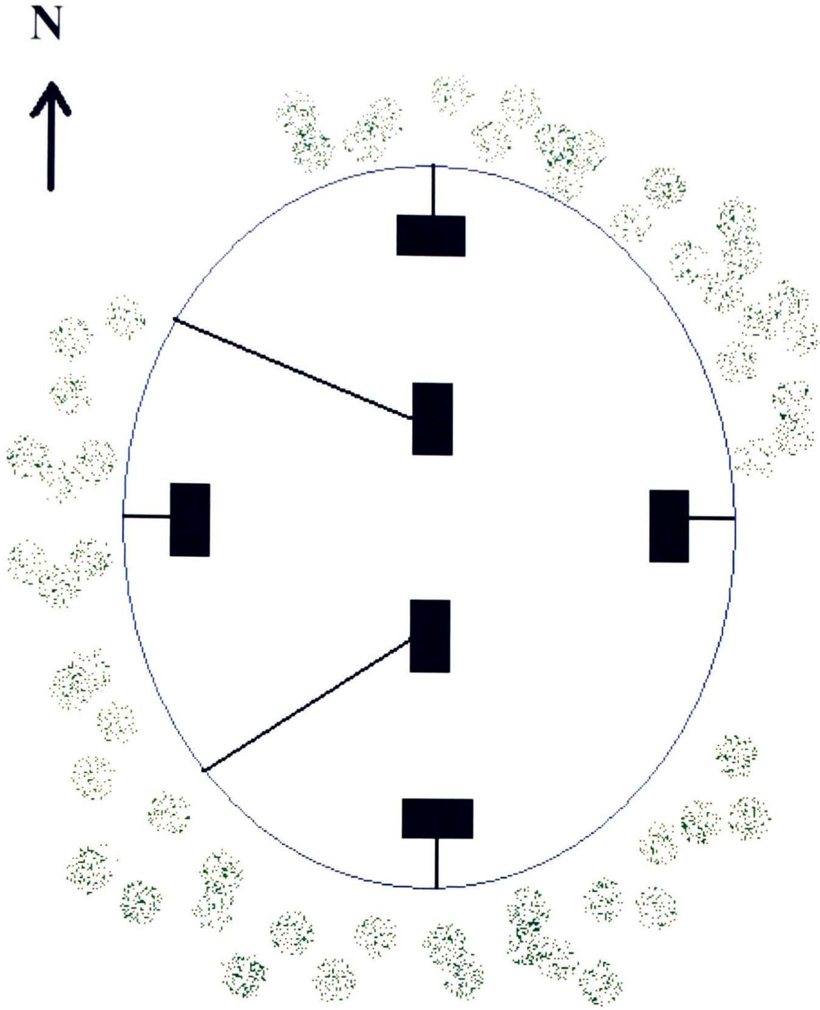

Figure 7. Representation of minnow trap layout around a typical pond. Lines from black rectangles (minnow traps) represent cords used to anchor and retrieve traps.

Figure 8. Plywood cover object at transect NC1.

Figure 9. Tin cover object at transect NC1.

PVC-Pipe Refuges

Ten PVC-pipe refuges, intended to attract treefrogs, were haphazardly placed on trees around the edge of each pond. Each refuge was 60-cm long with a diameter of 3.8 cm (Boughton and Staiger, 2000). The bottom end of each pipe was capped using a PVC male adapter and a twist cap to allow for water retention within the pipe. Two drain holes (0.5cm) were drilled 15 cm from the bottom of the pipe (Boughton and Staiger, 2000) to keep the water from potentially filling the entire pipe. Another hole was drilled at the top of one side of the pipe to allow for attachment to the tree (Fig. 10). The refuges at each pond were hung on a nail two meters up from the base of the tree. To prevent the refuges at cattle ponds from be knocked of the trees, they were lashed to the tree using Bungee cords in addition to being hung from a nail (Fig. 11). All PVC-pipe refuges at each pond were numbered in a clockwise direction, starting with the one closest to the north shoreline marker. On surveying days, temperature was taken simultaneously below (in water) and above (air within the tube) the drainage holes in pipes 1, 2, 6, and 7, at each pond.

Leaf samples were taken, pressed, and later identified for each tree that contained a PVC-pipe refuge. Canopy densities at the edge of the water were taken at the cardinal points of each pond during the last sampling period, May 2007.

Vegetation

Each tree that a PVC-pipe refuge was placed on was identified (Appendix B). Using a densitometer, the canopy density was taken at the water's edge at the cardinal points of the ponds using a scale of one to 4 (1 = 0-25% cover, 2 = 26-50%, 3 = 51-75%, 4 = 75 – 100%).

Figure 10. Picture of a PVC-pipe refuge at a non-cattle pond.

Figure 11. Picture of a PVC-pipe refuge at a cattle pond.

Abiotic Data and Water Quality

Water quality parameters were measured using a YSI (model 650 MDS) multi-parameter instrument. Parameters that were measured included: pH, temperature, specific conductance, total dissolved solids, and dissolved oxygen. For consistency, the YSI unit was always deployed on the north end of each pond. Ambient temperature was taken using an alcohol based thermometer. Weather conditions including cloud cover, wind, and precipitation were recorded. Also start time and end time at each site was recorded.

Two ponds of each type (cattle vs. non-cattle) were chosen randomly (www.random.org) to contain two temperature data loggers. One of the data loggers at each pond was attached to a tree trunk approximately 1.5 meters above ground on the north side of the pond; the other was secured to a PVC pipe in the center of the pond in a manner that allowed it to rise and fall with changing water levels but to remain at a constant depth of around 10 cm. The data loggers were set to record temperatures every five hours over a period of 11 months (8 Aug. 2006 – 8 July 2007).

Coordinates of Ponds and Sample Devices

Coordinates of all ponds, PVC-pipe refuges, and cover objects was determined by use of a Trimble™ GPS receiver and Trimble Survey Controller™ (Appendix C). The data collected were used to create digital maps depicting these areas using GIS software ESRI ArcGIS 9. Digital maps showing land use (Fig. 12), and major roads and drainages (Fig. 13) were obtained from MLAAP's GIS technician.

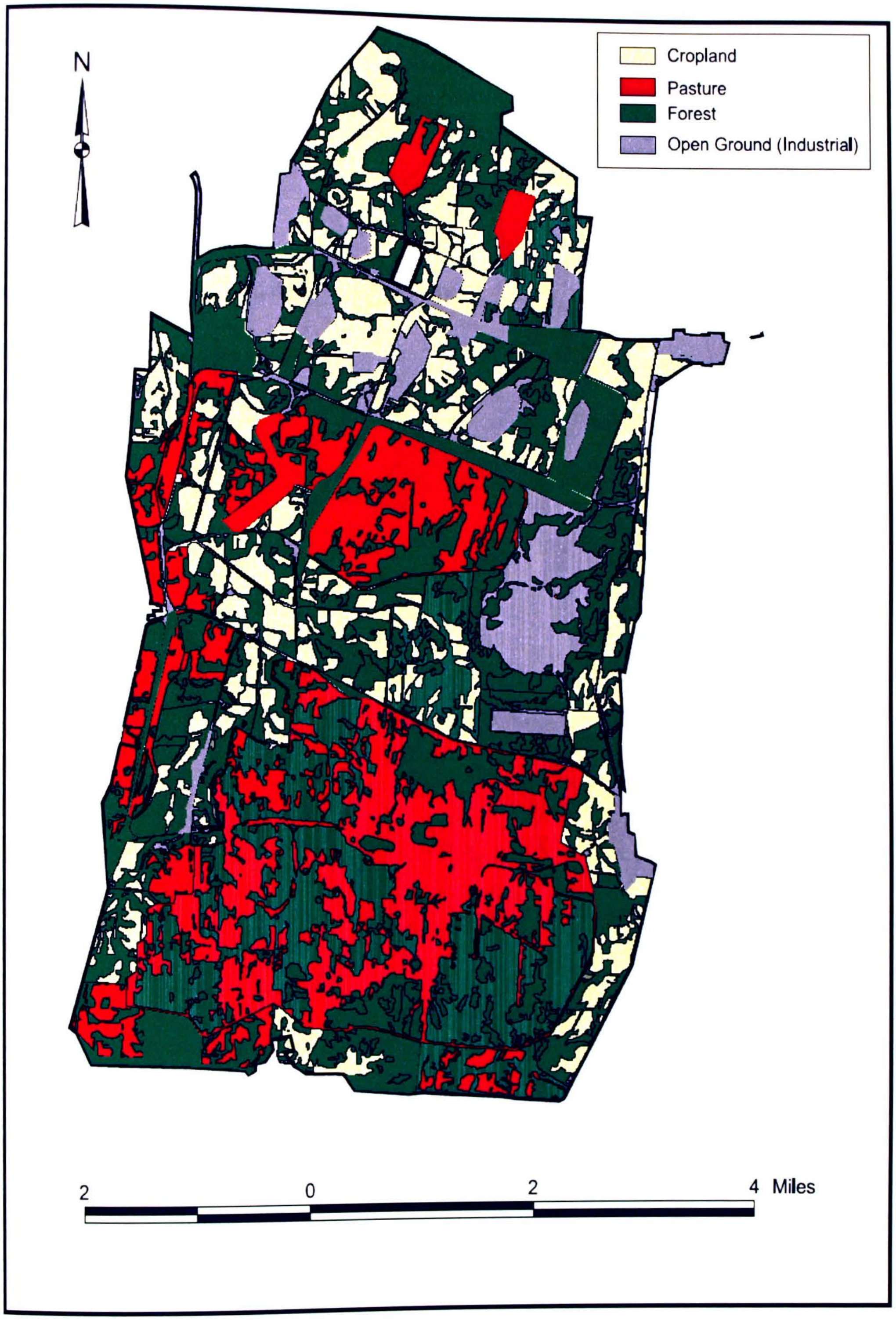

Figure 12. Map of MAALP depicting land use.

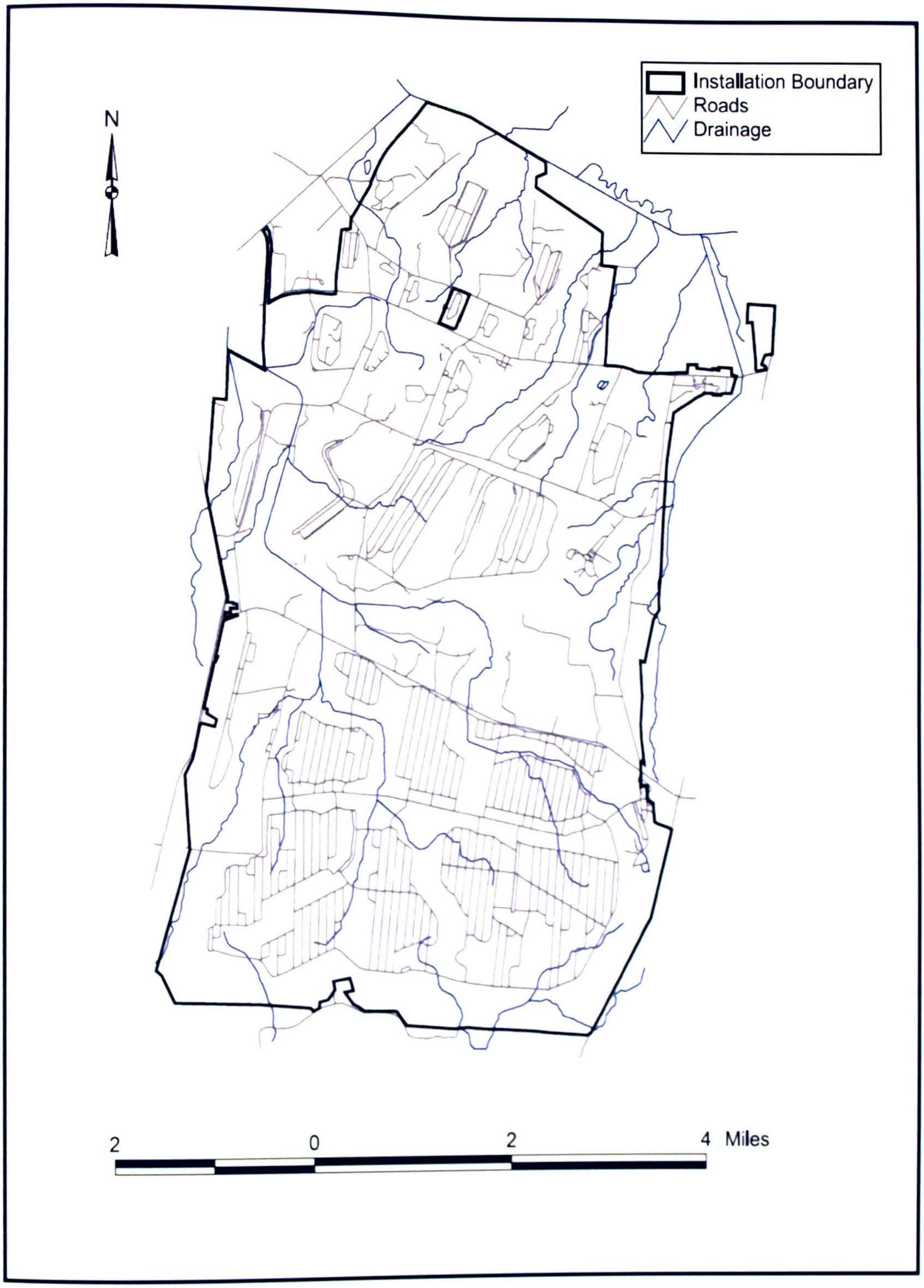

Figure 13. Map depicting roads and drainages at MLAAP.

Sampling Schedule

Aquatic pond surveys were conducted once per season and cover objects, PVC-pipe refuges, and water quality parameters were checked monthly. Ponds, cover objects, PVC-pipe refuges and water quality parameters were checked in a different order each sampling period in attempt to minimize differences in average temperatures among sites over the period of the project. The project commenced in June 2006 and concluded May 2007.

Cover objects and PVC-pipe refuges were sampled a total of eleven times. The month of October was sampled twice, once at the beginning and the end of the month. No sampling was conducted in September due logistical difficulties, hence the double sampling period in October. February was not sampled due to inclement weather conditions.

Water quality parameters were taken a total of seven times. May was sampled twice, the beginning and end of the month.

Identification and Nomenclature

Taxa identification was aided by the keys and field guides of Altig (1970), Conant and Collins (1991), and Pfingsten and Downs (1989). A. Floyd Scott and Nathan Parker also contributed to this task. Scientific nomenclature of individuals follows that used by Crother et al. (2000).

Record Keeping and Voucher Specimens

All data obtained during this study was recorded in the field on custom designed data sheets (Appendix D) and later transferred to a Microsoft Excel data base file for management and analysis. For documentation purposes, a voucher (either specimen or photograph) of each species found during the study was accessioned into the Museum of Zoology at Austin Peay State University. All original field notes and documentations were deposited into the Snyder Museum of Zoology at Austin Peay State University.

CHAPTER IV

RESULTS

Aquatic Sampling (Biotic)

Sampling for pond-dwelling amphibians and reptiles was conducted four times over the course of the study: summer (June 2006), Fall (October 2006), Spring I (March 2007), Spring II (May 2007). Figure 14 shows the species richness encountered during each sampling effort. Tables (1, 2, 3, 4) show the taxa caught per sample session along with their combined mass and number of individuals (larvae and adults are lumped together). Summer was the only sampling period in which the non-cattle ponds had a lower grand total of individuals (179) and combined mass (427 g). A two-tailed t-test revealed no significant difference in the averages of mass per sampling session (P = 0.201). However, there was a significant difference in the total number of individuals between the two pond types over the course of the study ($X^2 = 983$, df = 1, $P < 0.001$). There was no significant difference in total species richness between pond types over the course of the study ($X^2 = 0$, df = 1 , $P > 0.10$).

Cover Objects (Biotic)

Cover objects at cattle ponds yielded a greater number of individuals (52 vs. 16) and species (15 vs. 9) than those at ponds where cattle were absent (Table 5). To determine if these findings were significantly different between pond types, a Chi Square goodness of fit test was used with an expected ratio of 1:1. Analysis showed that only the number of individuals were significantly different (number of individuals: $X^2 = 19.06$, df = 1, $P < 0.001$; number of species: $X^2 = 1.5$, df = 1, $P > 0.10$).

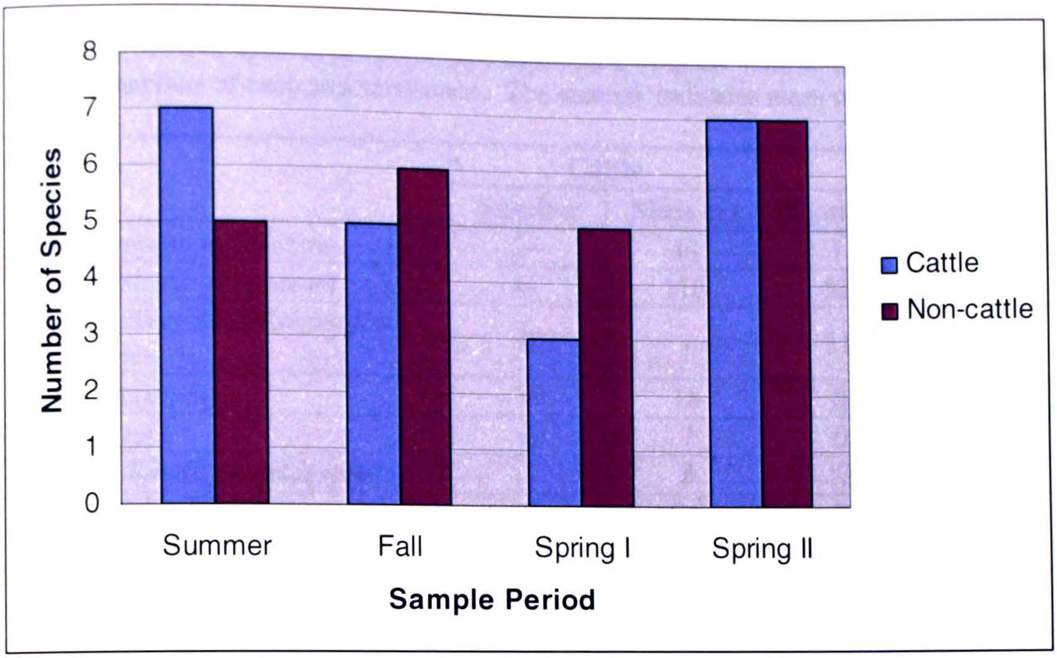

Figure 14. Species richness per aquatic sampling period of the two pond types.

Table 1. List of species per pond type captured during the summer aquatic sample along with numbers of each and total mass. The asterisk indicates mass was no measured.

Taxa	Cattle		Non-cattle	
	Number	Mass (g)	Number	Mass (g)
Ambystoma maculatum	24	40	1	2
Ambystoma talpoideum	41	116	52	174
Hyla chrysoscelis/versicolor complex	0	-	51	*
Hyla cinerea	19	18	0	-
Hyla spp.	6	7	0	-
Notophthalmus viridescens	3	8	12	24
Rana catesbeiana	3	38	0	-
Rana clamitans	8	47	60	220
Rana sp.	137	624	0	-
Unidentifiable tadpoles	0	-	3	7
Totals	**241**	**898**	**179**	**427**

Table 2. List of species per pond type captured during the fall aquatic sample along with numbers of each and total mass.

Taxa	Cattle		Non-cattle	
	Number	Mass (g)	Number	Mass (g)
Acris crepitans	0	-	1	1
Ambystoma talpoideum	58	225	101	597
Notophthalmus viridescens	9	25	56	127
Rana catesbeiana	1	7	0	-
Rana clamitans	30	45	5	13
Rana sp.	145	352	260	461
Scaphiopus holbrookii	0	-	2	1
Unidentifiable tadpoles	0	-	50	17
Totals	**243**	**654**	**475**	**1217**

Table 3. List of species per pond type captured during the Spring I aquatic sample along with numbers of each and total mass.

Taxa	**Cattle**		**Non-cattle**	
	Number	**Mass (g)**	**Number**	**Mass (g)**
Ambystoma maculatum	0	0	4	4.9
Ambystoma talpoideum	11	72	60	453.4
Notophthalmus viridescens	17	40.55	141	423.93
Pseudacris crucifer	0	-	2	5.85
Rana clamitans	108	320.3	1444	2224.7
Totals	**136**	**432.85**	**1651**	**3112.78**

Table 4. List of species per pond type captured during the Spring II aquatic sample along with numbers of each and total mass

Taxa	**Cattle**		**Non-cattle**	
	Number	**Mass (g)**	**Number**	**Mass(g)**
Ambystoma opacum	1	1	0	-
Ambystoma talpoideum	36	51	10	25
Ambystoma tigrinum	6	65	0	-
Ambystoma maculatum	0	-	3	5
Hyla spp.	0	-	19	11
Nerodia sipedon	0	-	1	139
Notophthalmus viridescens	12	30	30	66
Pseudacris crucifer	3	1	8	5
Rana catesbeiana	1	9	0	-
Rana clamitans	119	393	261	878
Rana sp.	2	3	0	-
Unknown tadpoles	0	-	2	1
Totals	**180**	**553**	**334**	**1130**

Table 5. List of species encountered and numbers of each that were found under or on top of the cover objects during the period of study.

Species Encountered	**Number of Individuals**	
	Cattle	**Non-cattle**
Acris crepitans	0	1
Ambystoma maculatum	1	0
Ambystoma talpoideum	6	0
Ambystoma tigrinum	2	0
Carphophis amoenus	2	2
Coluber constrictor	3	1
Colubridae sp.	1	1
Diadophis punctatus	21	1
Elaphe spiloides	0	4
Eumeces laticeps	1	0
Eumeces sp.	3	3
Lampropeltis calligaster	2	0
Plethodon mississippi	1	1
Rana clamitans	1	2
Scincella lateralis	6	0
Storeria dekayi	1	0
Thamnophis sp.	1	0
Individual Total	**52**	**14**

For each pond type, there was a greater number of individuals and species of reptiles captured overall along the cover object transect than amphibians. At cattle ponds, 42 reptiles to 10 amphibians were logged and where no cattle were present, the ratio was 13 to 3. Numbers of species of reptiles to amphibians detected with cover objects at cattle ponds was 11:4; at non-cattle ponds it was 7:2. There was no significant difference in the total species richness ($X^2 = 1.5$, df = 1, $P > 0.10$), reptile species richness ($X^2 = 0.888$, df = 1, $P > 0.10$), or amphibian species richness ($X^2 = 0.666$, df = 1, $P > 0.10$) between the two pond types. The Ring-necked Snake (*Diadophis punctatus*) was the most abundant reptile and the Mole Salamander (*Ambystoma talpoideum*) was the most abundant amphibian found at the cattle ponds. The most common reptile and amphibian found at non-cattle ponds were the Eastern Rat Snake (*Elaphe spiloides*) and the Green Frog (*Rana clamitans*). The month with the greatest number of individuals captured was April for both pond types (Fig. 15) while the greatest number of species found was the first and second sampling periods in October for cattle ponds and April for the non-cattle ponds (Fig. 16).

PVC-pipe (Biotic)

In the year of the study, except for one dead Broad-headed Skink (*Eumeces fasciatus*), the only animals caught in the PVC-pipe refuges were Gray treefrogs (*Hyla chrysoscelis/versicolor* complex). For both pond types, the August sample yielded the greatest number of captures.

The total number of captures was nearly three times (231:87) as great at non-cattle ponds than at ponds with cattle present (Table 6). A Chi Square goodness of fit test showed this difference to be significant ($X^2 = 65.21$, df = 1, P < 0.001). Of all individuals

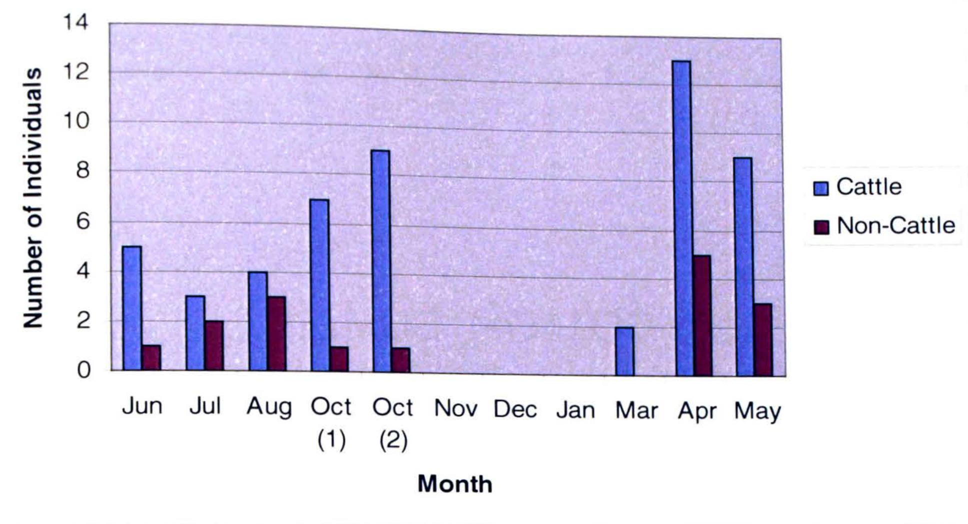

Figure 15. Numbers of individual amphibian and reptiles caught under or on top of cover objects during each monthly sampling period (June 2006 – May 2007).

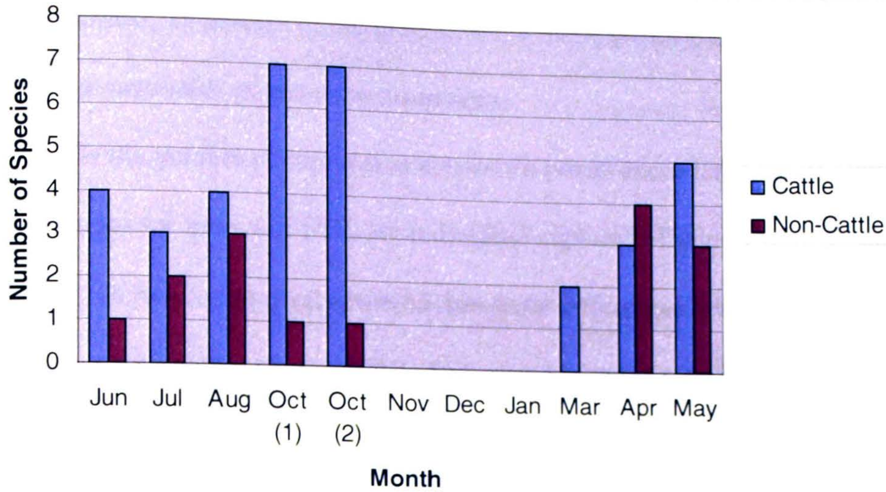

Figure 16. Numbers of species of amphibians and reptiles caught under or on top of cover objects during each monthly sampling period (June 2006 – May 2007).

captures recorded, 28 percent of the individuals at cattle ponds and 40 percent of the individuals at non-cattle ponds were recaptures.

While the number of captures at non-cattle ponds exceeded those at cattle ponds, overall averages for mass and SVL per individual captured (Table 6) were greater at cattle ponds. A two-tailed t-test revealed that these differences where significant (mass comparison: $t = 4.71$ $df = 13$, $P < 0.001$; SVL comparison: $t = 4.13$, $df = 13$, $P = 0.001$).

Canopy Coverage

On a canopy coverage scale of 1 = 0-25%, 2 = 26-50%, 3 = 51-74%, and 4 = 76-100%, the average index value at non-cattle ponds (3.28) was significantly greater than at cattle ponds (2.08). This was determined using a Mann-Whitney U test where the N1 and N2 were 9 each, resulting U statistic was 66.0, and P (two-tailed) was 0.024.

Water Quality

The averages for water quality parameters sampled at each pond type per month were calculated and plotted together (Figs. 17, 18, 19, 20, and 21). For each parameter the averages of monthly means were consistently higher at cattle ponds than at ponds with no cattle. When a two-tailed t-test was performed to look for statistical differences between pond types for each of the overall means of water quality parameters, significant differences ($P<.05$) resulted between four of the five parameters (Table 7).

Table 6. Numbers of captures and averages of mass (grams) and SVL (mm) of the tree frogs captured during each sample and overall. Values in parentheses following means are standard deviations. Asterisk indicates a dead frog that was caught in the pipe; no measurements were taken.

Sample	Cattle			Non-Cattle		
	No.	**Avg. Mass (g)**	**Avg. SVL (mm)**	**No.**	**Avg. Mass (g)**	**Avg. SVL (mm)**
June	12	6.25 (1.54)	39.33 (4.01)	12	5.22 (0.83)	36.90 (3.41)
July	17	6.08 (2.47)	41.46 (4.43)	39	5.38 (1.58)	39.97 (3.51)
August	21	6.85 (2.23)	43.15 (4.49)	51	5.92 (2.11)	36.81 (4.19)
October I	13	7.75 (2.90)	40.62 (7.27)	39	6.00 (2.54)	39.05 (5.73)
October II	0	-	-	10	5.10 (2.73)	35.20 (6.21)
November	1	*	*	0	-	-
December	0	-	-	0	-	-
January	0	-	-	0	-	-
March	1	6.65 (0)	42.00 (0)	10	5.77 (2.38)	38.11 (5.21)
April	12	7.75 (3.65)	46.67 (5.12)	48	5.49 (2.38)	38.87 (5.90)
May	10	7.56 (1.33)	43.20 (2.49)	22	6.14 (1.19)	39.64 (3.85)
Overall	**87**	**6.98 (0.71)**	**42.35 (2.35)**	**231**	**5.63 (0.38)**	**38.07 (1.64)**

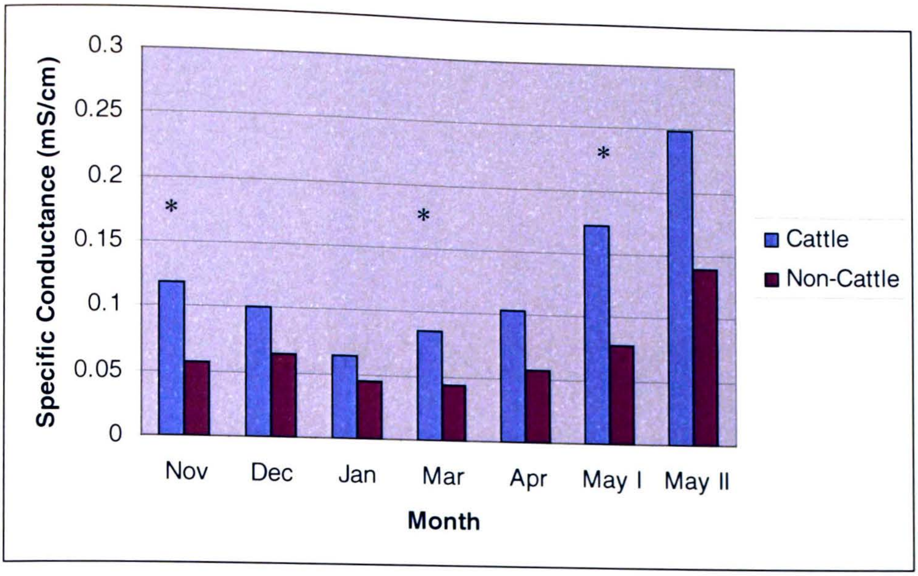

Figure 17. Average specific conductance per pond type by month (17 Nov 2006 – 31 May 2007). Asterisk indicates significant difference within months

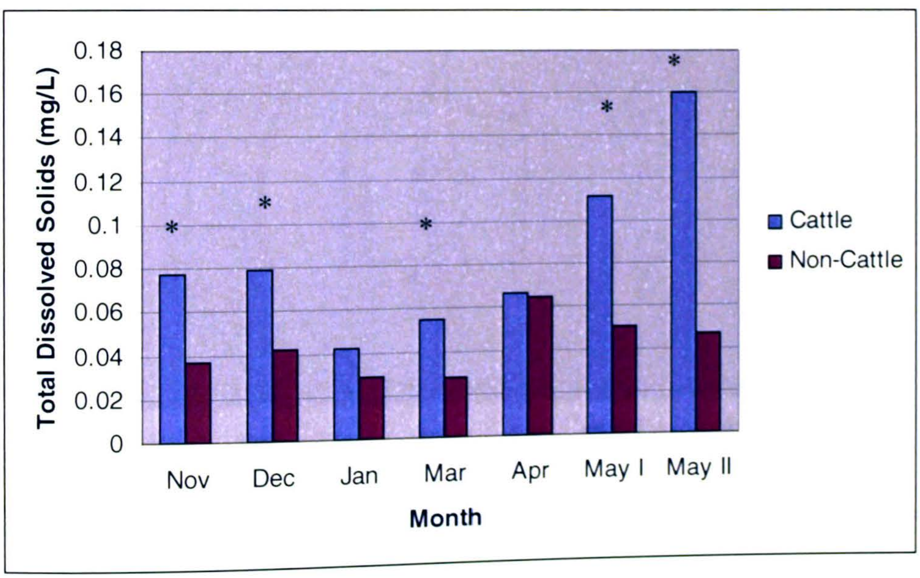

Figure 18. Average total dissolved solids per pond type by month (17 Nov 2006 – 31 May 2007). Asterisk indicates significant difference within months.

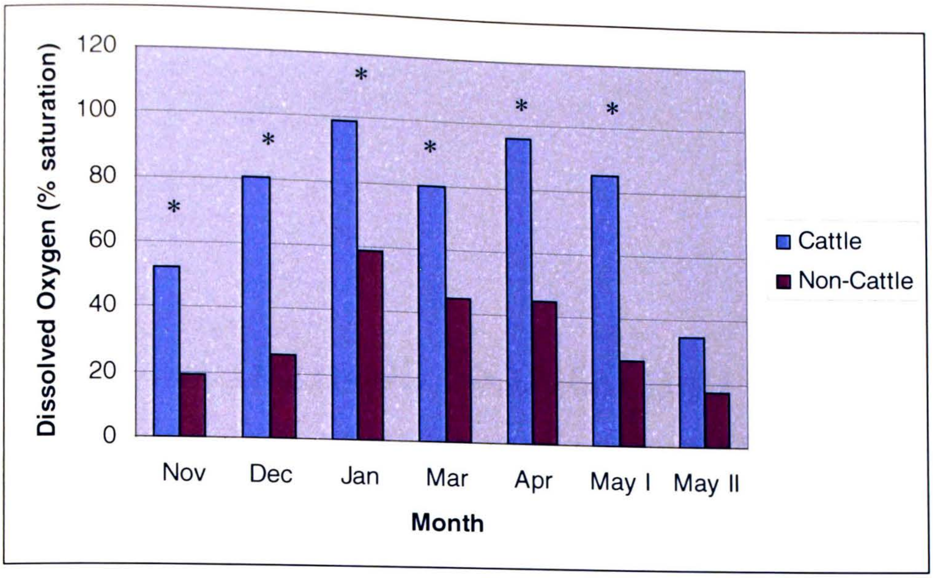

Figure 19. Average percent dissolved oxygen saturation per pond type by month (17 Nov 2006 – 31 May 2007). Asterisk indicates significant difference within months.

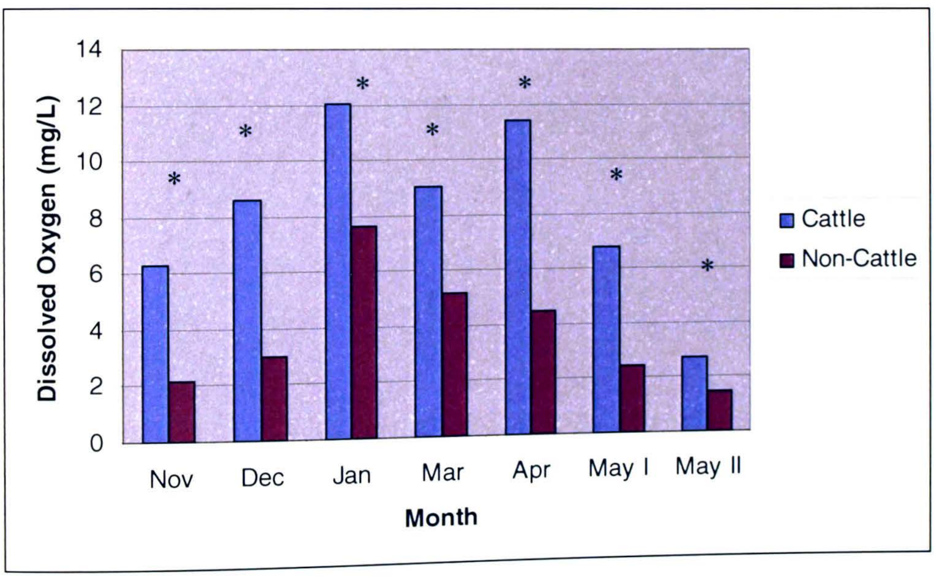

Figure 20. Average dissolved oxygen per pond type by month (17 Nov 2006 – 31 May 2007). Asterisk indicates significant difference within months.

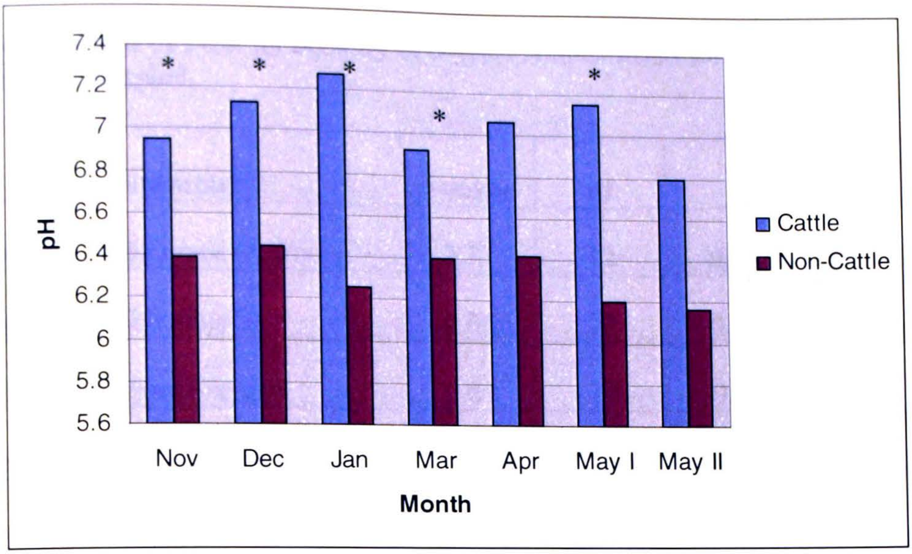

Figure 21. Average pH per pond type by month (17 Nov 2006 – 31 May 2007). Asterisk indicates significant difference within months.

Table 7. Results of t-test for equality of overall sample means for various water quality parameters sampled.

Parameter	t-value	df	P	Mean difference
Specific Conductance (mS/cm)	2.17	12	0.051	0.0583
Dissolved Solids (mg/L)	2.65	12	0.021	0.0420
Percent Dissolved Oxygen	3.87	12	0.002	41.4290
Dissolved Oxygen (mg/L)	3.00	12	0.011	4.3671
pH	9.57	12	5.71^{E-07}	0.7157

CHAPTER V

DISCUSSION

Aquatic Sampling and Water Quality

The biotic data from pond sampling is somewhat contradictory. The first sampling session (summer 2006), was the only period in which cattle ponds had a greater number and total mass of amphibians than that of non-cattle ponds. In the other three sampling periods, non-cattle ponds nearly doubled the number of individuals and mass of that at cattle ponds; during the first spring sampling period, non-cattle ponds had over 12 times the number of individuals and seven times the amount of mass.

With a greater amount of canopy cover, non-cattle ponds tended to have a greater density of leaf litter on the bottom than the cattle ponds possibly creating better habitat for amphibians. The cattle ponds tended to have mucky, yet firm mud bottoms. While more leaf litter on the pond bottoms may have provided better amphibian habitat, it might have also lowered the oxygen content of the water because of an increase in oxygen demand created by elevated levels of organic decomposition. The lower oxygen content observed in non-cattle ponds could shed some light on why cattle ponds had a higher number of individuals during the summer sampling session. The dissolved oxygen content may have been below levels needed to sustain amphibians, especially larvae. Several times, when traps were pulled from the water, tadpoles and some larval ambystomatids where observed dead possibly due to confined movement in a restricted oxygen environment.

If low dissolved oxygen indeed accounted for the lower number of individuals found at non-cattle ponds during the summer sample session, then what accounted for the increase in numbers of individuals and biomass in non-cattle ponds vs. cattle ponds? Lower cattle pond numbers could have resulted from the trampling and stress that cattle place on these environments. A reason for greater numbers at non-cattle ponds could be that our summer sample, taken in June, missed the late-breeding ranids, which accounted for over a third of the fall sample. Additionally, *Ambystoma talpoideum* accounted for nearly half the total mass in the fall sample suggesting that their larvae might have been too small in the summer session for trapping.

The number of individuals taken in first spring sample at cattle ponds was down compared to the fall sample, but at non-cattle ponds the number exploded. The large increase in numbers and biomass as non-cattle ponds was due primarily to more *Rana clamitans* present. In the second spring sample, the number of individuals and total biomass at cattle ponds was comparable to that in the first spring sample, but dropped precipitously at the cattle ponds. This might have been due to a wave of metamorphosis among the *R. clamitans* tadpoles which had grown to such large numbers in the first spring sample.

The pH between pond types was significantly different for five of the seven sampling periods. The pH at cattle ponds tended to be around 7.0 while at non-cattle ponds it was around 6.3. The lower pH at non-cattle ponds could have resulted from the interplay of a lack of limestone in the area to buffer the water systems. Without sufficient calcium carbonate, decomposing organic matter (which was greater in the non-cattle ponds), releases carbon dioxide which combines with water to form a weak acid, carbonic acid. In great enough quantities, carbonic acid can lower the water's pH. Since cattle ponds had less organic debris lining the bottom of the ponds and in some cases, plants (mostly duckweed) growing in the pond, they should have been able to absorb the carbon dioxide, eliminate bicarbonates, precipitate carbonates, and form hydroxyl ions (Cole 1983). Since large numbers of amphibians were caught at non-cattle ponds, the lower pH of these ponds may not have had an effect.

Specific conductance and total dissolved solids go hand in hand, and both were greater at cattle ponds than at non-cattle ponds, likely due to stirring of substrate through cattle use. Still, the levels detected at cattle ponds were not considered high enough to negatively impact amphibian abundance and diversity.

Cover Object Sampling

The number of individuals and species caught at cattle ponds exceeded that of non-cattle ponds. This was somewhat puzzling since it has been documented that cattle can create unsuitable habitats for herpetofauna.

This unexpected result may be explained through the vegetation structure at the two pond types. Vegetation structure is an important habitat component of herpetofuana because it provides site-specific conditions that reptiles and amphibians use for temperature and moisture regulation (McDiarmid 1994, Petranka 1998, Mitchell and Klemens 2000). Vegetation along the transects was not quantified so only hypothetical conclusions can be offered. The cattle ponds appeared in general to be surrounded by more open-field habitat than the non-cattle ponds. If this was indeed the case, the greater amount of disturbed, open habitat around cattle ponds would provide additional basking and egg-laying sites for reptiles in the vicinity.

Many of the non-cattle ponds were near or adjacent to row-crop fields. These areas might provide areas for basking, but would not be suitable for egg deposition and embryonic development because of the threat from tillage and pesticide/herbicide poisoning. Pesticides/herbicides levels were not analyzed in any of the ponds so no comparison was possible between concentrations at the two pond types.

PVC-Pipe Refuge Sampling

The only treefrogs caught using the PVC-pipe refuges during the study belonged to the gray treefrog complex (*Hyla versicolor/chrysoscelis*). Barking treefrogs (*Hyla gratiosa*), bird-voiced treefrogs (*Hyla avivoca*), and green treefrogs *(Hyla cinerea*) have been documented within Gibson, Carroll, or both counties (Redmond and Scott 1996), but none were found in this study using the refuges.

Over two-and-a-half times the number of individual treefrogs were captured at non-cattle ponds than at cattle ponds, but those captured at the cattle ponds were significantly larger on average (mass and SVL). Three possible reasons are given to explain this: 1) Cattle may have trampled the smaller treefrogs resulting in a lower number of individuals and larger average size; 2) forest habitat at the non-cattle sites was more abundant than at cattle sites and theoretically could support a denser population of treefrogs; and 3) the individuals at cattle ponds being fewer in number would have less competition resulting in a greater supply of food which it turn could lead to larger average size.

CHAPTER VI

CONCLUSIONS

1. Except for the summer aquatic sampling session, numbers of individuals and total mass was greater at non-cattle ponds than cattle ponds.
2. The terrestrial area around cattle ponds had more species and a greater number of individuals than non-cattle ponds. *Diadophis punctatus* seems to thrive in areas where cattle are present.
3. Treefrogs were three times as abundant at non-cattle ponds than cattle ponds, but the individuals captured at cattle ponds had a larger overall snout-vent length and a greater mass.
4. Cattle ponds tended to have a more neutral pH compared to non-cattle ponds but had a greater percent of dissolved oxygen and a higher amount of total dissolved solids and specific conductance compared to non-cattle ponds.
5. Comparing ponds of more similar canopy cover and surrounding vegetation densities may yield more comparable results.
6. Fencing of ponds to prevent cattle from wading in the ponds may prove beneficial for the aquatic stages of amphibian life.

LITERATURE CITED

LITERATURE CITED

Altig, R.A. 1970. A key to tadpoles of the continental United States and Canada. Herpetologica 26: 180-207

Bock, C.E., H.M. Smith, and J.H. Bock. 1990. The effect of livestock grazing upon abundance of the lizard, *Sceloporus scalaris*, in southeastern Arizona. Journal of Herpetology 24: 445-446.

Boughton, R. E. and J. Staiger. 2000. Use of PVC pipe refugia as a sampling technique for hylid treefrogs. American Midland Naturalist 144:168-177.

Bradshaw, S.D. 1981. Ecophysiology of Australian desert lizards: studies on the genus *Amphibolurus*. Ecological Biogeography of Australia: 1395-1434.

Braun, E.L. 1950. Deciduous forests of eastern North America. The Blakiston Publishing Co., Philadelphia, Pennsylvania.

Brew, P. and J. Markol. 2001. Installation action plan for Milan Army Ammunition Plant. Unpublished Report.

Burton, E. C., M. J. Gray, and A. C. Schmutzer. 2006. Influence of cattle on Cumberland Plateau amphibians in a predator-rich environment. Southeastern Biologist 53: 242.

Busack, S.D. and R.B. Bury. 1974. Some effects of off-road vehicles and sheep grazing on lizard populations in the Mojave Desert. Biological Conservation 6: 179-183.

Cagle. 1939. A system of marking turtles for future identification. Herpetological Notes 3:107-173.

Cole, G.A. 1983. Textbook of Limnology. The C.V. Mosby Co., St. Louis, MO.

Conant R. and J.T. Collins. 1991. A field guide to reptiles and amphibians of eastern and central North America, 3rd ed. Houghton Mifflin Co., Boston Massachusetts.

Crother, B.I., J. Boundy, J.A. Campbell, K. De Queiroz, D.R. Frost, R. Highton, M.E. Seidel, J.W. Sites Jr., T.W. Taggart, S.G. Tilley, and D.B. Wake. 2000. Scientific and standard English names of amphibians and reptiles of North America North of Mexico, with comments regarding confidence in our understanding. Soc. Study Amphib. Rep. Herpetol. Cir. Num. 29.

Ehmann, H. 1980. The natural history and conservation of the Bronzeback (*Ophidiocephalus taeniatus* Lucus and Frost) (Lacertilia, Pygopidae). Proceedings of the Melbourne Herpetological Symposium: 7-13.

Freda, J. and R.J. Gonzalez. 1986. Daily movements of the treefrog, *Hyla andersoni*. Journal of Herpetology 20: 469-471.

Higgs, P. 2005. Second five year review for Milan Army Ammunition Plant. Unpublished Report.

Jones, K.B. 1981. Effects of grazing on lizard abundance and diversity in western Arizona. Southwest Naturalist 26: 107-115.

Kuchler, A.W. 1964. Potential natural vegetation of conterminous United States. American Geographic Society, Spec. Publ. 36.

Knutson, M.G., W.B. Richardson, D.M. Reineke, B.R. Gray, J.R. Parmelee, and S.E. Weick. 2004. Agricultural ponds support amphibian populations. Ecological Applications 14: 669-684.

Lillywhite, H.B. 1977. Effects of chaparral conversion on small vertebrates in southern California. Biological Conservation 11: 171-184.

Maret, T. J., J. D. Snyder, and J. P. Collins. 2006. Altered drying regime controls distribution of endangered salamanders and introduced predators. Biological Conservation 127: 129-138.

McDiarmid, R.W. 1994. Amphibian diversity and natural history: an overview. Pages 5-15 *in* W.R. Heyer, M.A. Donnelly, R.W. McDiarmid, L.D. Hayek and M.S. Foster, editors. Measuring and monitoring biological diversity: standard methods for amphibians. Smithsonian Institution, Washington, D.C.

Moore. 1965. Geology and hydrogeology of the Claiborne group in western Tennessee. Contributions to the hydrogeology of the United States U.S. geological survey water supply paper 1809-F. Washington D.C. 1965.

National Park Service. 2003a. Statement of work: inventory of herpetofuana for 1 park in the Cumberland Piedmont network. National Park Service, unpublished document.

Newsome, A.E. and L.K. Corbett. 1975. Outbreaks of rodents in semi-arid and arid Australia: causes, preventions and evolutionary considerations. Rodents in Deserty Environments: 117-153.

Parks and Carmichael. 1990. Geologic map showing upper Cretaceous Paleocene and lower and middle Eocene units and distribution of younger fluvial deposits in western Tennessee. U.S. Geological Survey miscellaneous Investigations Map 1-916. U.S. Government Printing Office, Washington D.C. 1975.

Read, J.L. 2002. Experimental trial of Australian arid zone reptiles as early warning indicators of overgrazing by cattle. Austral Ecology 27: 55-66.

Redmond, W.H. and A.F. Scott. 1996. Atlas of Amphibians in Tennessee. Miscellaneous Publication No. 12; The Center for Field Biology, Clarksville, TN.

Pfingsten, R.A. and F.L. Downs. 1989. Salamanders of Ohio. Ohio Biol. Surv. Bull. New Series Vol. 7: 315 p.

Pianka, E.R. 1966. Convexity, desert lizards, and spatial heterogeneity. Ecology 47: 1055-1059.

Schodde, R. 1982. Origin, adaptation and evolution of birds in arid Australia. Evolution of the Flora and Fauna or Arid Australia: 191-224.

Southeast Regional Climate Center. 2007. Historical Summaries for Tennessee. http://www.dnr.state.sc.us/water/climate/sercc. Accessed 10 June 2005.

Trimble, S.W. 1994. Erosional effects of cattle on stream-banks in Tennessee, U.S.A. Earth Surface Processes and Landforms 19: 451-464.

True Random Number Service. 2006. http://www.random.org. Accessed 2 May 2006.

U.S. EPA. 2002. Methods for evaluating wetland condition: using amphibians in bioassessments of wetlands. Office of Water, U.S. Environmental Protection Agency, Washington DC. EPA-822-R-02-022.

Van Roy, P.T.J.C. and A.H.P. Stumpel. 1995. Ecological impact of economic development on Sardinian herpetofuana. Conservation Biology 9: 263-269.

Vitt, L.J. and R.D. Ohmart. 1974. Ecology and reproduction of Lower Colorado River lizards. II. *Cnemidophorus tigris* (Teiidae) with comparisons. Herpetologica 33: 223-233.

Wake, D.B. 1991. Declining amphibian populations. Science 253: 860.

APPENDIX A

Photographs of the sampled ponds at the Milan Army Ammunition Plant.

Photos were taken May 2007. The cattle ponds pictures will be shown first followed by the non-cattle ponds.

Figure A-1. View one of pond C1. Taken May 2007.

Figure A-2. View two of pond C1. Taken May 2007.

Figure A-3. View one of pond C2. Taken May 2007.

Figure A-4. View two of pond C2. Taken May 2007.

Figure A-5. View one of pond C3. Taken May 2007.

Figure A-6. View two of pond C3. Taken May 2007.

Figure A-7. View one of pond C4. Taken May 2007.

Figure A-8. View two of pond C4. Taken May 2007.

Figure A-9. View one of pond C5 taken May 2007.

Figure A-10. View two of pond C5 taken May 2007.

Figure A-11. View one of C6 taken May 2007.

Figure A-12. View two of pond C6 taken May 2007.

Figure A-13. View one of pond C7. Taken May 2007.

Figure A-14. View two of pond C7. Taken May 2007.

Figure A-15. View one of pond C8. Pond is dry. Taken May 2007.

Figure A-16. View two of pond C8. Pond is dry. Taken May 2006.

Figure A-17. Picture one of pond C9. Taken May 2007.

Figure A-18. Picture two of pond C9. Taken May 2007.

Figure A-19. View one of pond NC1. Pond is dry. Taken May 2007.

Figure A-20. View two of pond NC1. Pond is dry. Taken May 2007.

Figure A-21. View one of pond NC2. Taken May 2007.

Figure A-22. View two of pond NC2. Taken May 2007.

Figure A-23. View two of pond NC3. Taken May 2007.

Figure A-24. View two of pond NC3. Taken May 2007.

Figure A-25. View one of pond NC4. Pond is dry. Taken May 2007

Figure A-26. View two of pond NC4. Pond is dry. Taken May 2007.

Figure A-27. View one of pond NC5. Taken May 2007.

Figure A-28. View two of pond NC5. Taken May 2007.

Figure A-29. View one of pond NC6. Taken May 2007.

Figure A-30. View two of pond NC6. Taken May 2007.

Figure A-31. View one of pond NC7. Taken May 2007.

Figure A-32. View two of pond NC7. Taken May 2007.

Figure A-33. View one of pond NC8. Taken May 2007.

Figure A-34. View two of pond NC8. Taken May 2007.

Figure A-35. View one of pond NC9. Taken May 2007.

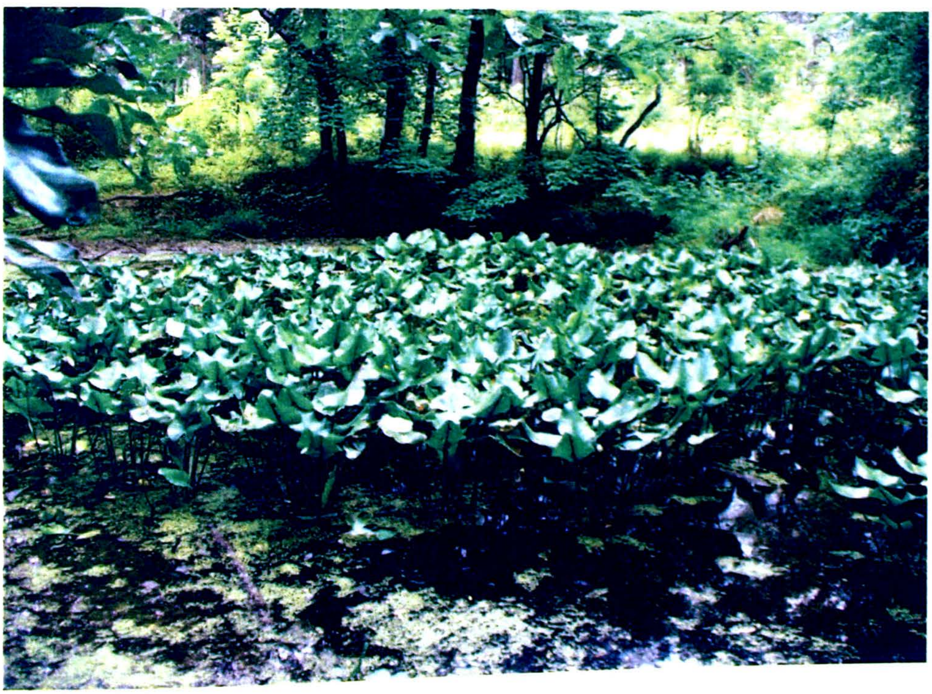

Figure A-36. View two of pond NC9. Taken May 2007.

APPENDIX B

The trees that the PVC pipes were placed on at each pond cite along with the number of treefrogs caught at each tree in parentheses.

C 1

1. Dead Tree
2. Slippery Elm
3. Slippery Elm
4. Slippery Elm
5. Sweetgum
6. Slippery Elm (2)
7. Dead Tree (2)
8. Persimmon
9. Persimmon
10. Winged Elm

NC 2

1. Red Maple (14)
2. Southern Red Oak (6)
3. Red Maple (9)
4. Sycamore (7)
5. Red Maple (4)
6. Red Maple (6)
7. Red Maple (3)
8. Red Maple
9. Southern Red Oak (2)
10. Elm sp. (4)

NC 3

1. Red Cedar
2. Osage Orange (4)
3. Sweetgum (1)
4. Southern Red Oak
5. Sweetgum (4)
6. Persimmon (1)
7. Sweetgum (2)
8. Persimmon
9. Sweetgum
10. Sweetgum

NC 4

1. Honey Locust (1)
2. Black Cherry
3. Ostrya (2)
4. Honey Locust (2)
5. Black Walnut (1)
6. Hackberry (1)
7. Grape Vine (2)
8. Honey Locust
9. Red Cedar (1)
10. Green Ash (3)

NC 5

1. Ostrya (3)
2. Sweetgum (1)
3. Sweetgum (1)
4. White Oak (6)
5. Northern Red Oak (1)
6. Persimmon (9)
7. Sweetgum (5)
8. Red Maple (5)
9. Sweetgum (5)
10. White Oak (3)

NC 6

1. Sweetgum (3)
2. Sweetgum (3)
3. Sweetgum (6)
4. Sweetgum (4)
5. Northern Red Oak (4)
6. Southern Red Oak (10)
7. Northern Red Oak (2)
8. Elm sp. (3)
9. Sweetgum (6)
10. Sweetgum

NC 7

1. Sweetgum (2)
2. Sweetgum (2)
3. Red Maple (1)
4. Quercus sp. (1)
5. Sweetgum (3)
6. Sweetgum (5)
7. Sweetgum (1)
8. Sweetgum (1)
9. Sweetgum
10. Sweetgum (1)

NC 8

1. Sycamore
2. Box Elder
3. Sweetgum (3)
4. Box Elder
5. Red Maple (2)
6. Sweetgum
7. Sweetgum (2)
8. Sweetgum (4)
9. Sweetgum (5)
10. Sweetgum (2)

NC 9

1. Sweetgum (1)
2. Shingle Oak (4)
3. Honey Locust (6)
4. Red Cedar (6)
5. Flowering Dogwood (7)
6. Persimmon
7. Persimmon (3)
8. American Elm (1)
9. Sweetgum (2)
10. Sweetgum

C 1

1. Red Cedar
2. Black Cherry
3. Black Willow
4. Blackgum
5. Black Willow
6. Persimmon
7. Persimmon (6)
8. Persimmon (2)
9. Persimmon (2)
10. Persimmon

C 2

1. Elm sp.
2. Northern Red Oak
3. Sweetgum (1)
4. Blackgum
5. Dead Willow Oak
6. Willow Oak
7. Dead Black Cherry
8. Persimmon (2)
9. Persimmon (1)
10. Blackjack Oak

C 3

1. Persimmon
2. Sycamore (1)
3. Persimmon (4)
4. Persimmon
5. Sweetgum (5)
6. Persimmon
7. Persimmon (2)
8. Persimmon
9. Persimmon
10. Persimmon (1)

C 4

1. Persimmon (2)
2. Persimmon (1)
3. Sweetgum
4. Sycamore (1)
5. Sycamore (1)
6. Sycamore (4)
7. Sycamore
8. Sweetgum (5)
9. Black Willow
10. Sweetgum

C 5

1. Sweetgum (4)
2. Sweetgum
3. Sweetgum (2)
4. Sycamore
5. Sweetgum
6. Red Maple (2)
7. Sweetgum (3)
8. Black Willow (2)
9. Crab Apple (1)
10. Sycamore

C 6

1. Winged Elm
2. Persimmon (4)
3. River Birch
4. River Birch
5. Winged Elm (1)
6. River Birch (1)
7. Osage Orange
8. Osage Orange
9. Winged Elm (1)
10. River Birch

C 7

1. Persimmon (2)
2. Persimmon
3. Red Cedar
4. Persimmon (4)
5. Black Willow (1)
6. Black Willow (2)
7. Black Willow (1)
8. Persimmon
9. Red Cedar (1)
10. Black Cherry (2)

C 8

1. Black Walnut
2. Persimmon
3. Black Walnut (2)
4. Winged Elm (2)
5. Southern Red Oak (1)
6. Blackjack Oak (1)
7. Northern Red Oak
8. Blackjack Oak
9. Blackjack Oak
10. Blackjack Oak

C 9

1. Yellow Poplar
2. Sweetgum (2)
3. Sweetgum (1)
4. Sweetgum
5. Yellow Poplar
6. Box Elder (2)
7. Red Maple
8. Yellow Poplar (2)
9. Flowering Dogwood
10. Sycamore

APPENDIX C

The GPS points of the cardinal points around the ponds where the minnow traps were cast from, the cover object transects, and the placement of the PVC-pipe refuges.

Pond and Cardinal Point	Latitude	Longitude	Height above sea level
C1-e	-88.70530008640	35.89412532030	475.26283826600
C1-n	-88.70548109250	35.89424796450	475.73754143100
C1-s	-88.70560435050	35.89378322830	476.19829472500
C1-w	-88.70566413740	35.89392441040	474.64022709300
C2-e	-88.70107737550	35.89369576840	472.49826559500
C2-n	-88.70114119000	35.89394075890	472.14918871600
C2-s	-88.70129765470	35.89353418810	471.84859837400
C2-w	-88.70142582140	35.89371658380	470.90396830000
C3-e	-88.69820145420	35.88695546060	505.94999096800
C3-n	-88.69838722920	35.88714211270	508.39469389400
C3-s	-88.69839610270	35.88682186030	506.54177906200
C3-w	-88.69857579140	35.88699775880	506.30724968000
C4-e	-88.71561239950	35.88323622800	469.83526361500
C4-n	-88.71567474980	35.88347238850	462.17688294300
C4-s	-88.71582873460	35.88312885690	463.20001476800
C4-w	-88.71586083000	35.88328401210	462.42311910000
C5-e	-88.73292134710	35.86764792640	475.14251991600
C5-n	-88.73306032050	35.86772891410	487.88405519400
C5-s	-88.73294811890	35.86748221330	474.65693382300
C5-w	-88.73313753890	35.86752270940	478.80964065000
C6-e	-88.71749959900	35.85700469560	460.04730546800
C6-n	-88.71755071500	35.85706626230	463.20137576900
C6-s	-88.71765781480	35.85682310750	457.24381934100
C6-w	-88.71774232420	35.85693105850	461.10502002700
C7-e	-88.67607240590	35.84034088580	551.57357218300
C7-n	-88.67624363760	35.84043244020	561.81281687900
C7-s	-88.67610162990	35.84014991480	550.48360848600
C7-w	-88.67633664320	35.84013043530	547.20059183100
C8-e	-88.74406055920	35.82825815990	525.65327296000
C8-n	-88.74421182000	35.82829644610	520.66268301900
C8-s	-88.74422127210	35.82810796280	523.77006565600
C8-w	-88.74426029490	35.82815795480	522.69370695000
C9-e	-88.69450238490	35.82263908120	497.34245112800
C9-n	-88.69456619870	35.82278292320	491.32335379200
C9-s	-88.69460169160	35.82257422110	481.25026638600
C9-w	-88.69470236680	35.82262029820	481.12910132800

Pond and Cardinal Point	Latitude	Longitude	Height above sea level
NC1-e	-88.70055217800	35.91973832640	442.08864551700
NC1-n	-88.70059593390	35.91989260380	438.49868768600
NC1-s	-88.70070759070	35.91966928080	447.71189808500
NC1-w	-88.70073825810	35.91975534990	447.22963437000
NC2-e	-88.72266594780	35.91034186180	459.98304100500
NC2-n	-88.71565370890	35.88342352420	462.12158664900
NC2-s	-88.72296987680	35.91027152970	460.92078281400
NC2-w	-88.72302640410	35.91032747550	457.45498929500
NC3-e	-88.69434469570	35.90793485540	470.22571886600
NC3-n	-88.69443321400	35.90796552510	483.91676030800
NC3-s	-88.69433217390	35.90768661840	471.47298261100
NC3-w	-88.69451351430	35.90770471960	478.41396398200
NC4-e	-88.72045150660	35.90480721740	466.21039196900
NC4-n	-88.72030520980	35.90502078800	465.32251110200
NC4-s	-88.72024946400	35.90475942310	461.09695960900
NC4-w	-88.72009554670	35.90482890240	460.20552331500
NC5-e	-88.72530331810	35.90053618200	464.12421835900
NC5-n	-88.72536191390	35.90072709880	464.20556278100
NC5-s	-88.72550953420	35.90045666000	456.88589537300
NC5-w	-88.72557678160	35.90064623320	452.87927569400
NC6-e	-88.72586075270	35.89986618420	460.24263539400
NC6-n	-88.72610155710	35.89992166240	458.90886503300
NC6-s	-88.72599514400	35.89977492210	457.31277859600
NC6-w	-88.72610201620	35.89985036980	460.17729486500
NC7-e	-88.72519242260	35.88164516910	461.86043704000
NC7-n	-88.72540751840	35.88173816440	451.66309520200
NC7-s	-88.72525663870	35.88152512450	483.12002085300
NC7-w	-88.72548295590	35.88165679990	462.47650559200
NC8-e	-88.73123820470	35.86610263980	480.14210254200
NC8-n	-88.73137852210	35.86618741690	472.43179035300
NC8-s	-88.73132151270	35.86595584490	462.87471971700
NC8-w	-88.73144851350	35.86599557470	465.20964591600
NC9-e	-88.67080015940	35.86288803610	518.82126926300
NC9-n	-88.67083373530	35.86303892310	519.65872915700
NC9-s	-88.67097125450	35.86288020090	521.29217739300
NC9-w	-88.67099923810	35.86296627420	521.60399711700

Pond and Cover Object No.	Latitude	Longitude	Feet Above Sea Level
C1:1	-88.70575728900	35.89374094350	466.54587480500
C1:2	-88.70577532780	35.89371211930	466.69493095800
C1:3	-88.70580547910	35.89367459420	466.37076667100
C1:4	-88.70583685560	35.89362604720	465.56928200600
C1:5	-88.70586894550	35.89358711930	465.93254202400
C1:6	-88.70589374600	35.89354852720	466.05085359700
C1:7	-88.70592077440	35.89351361030	465.48302850500
C1:8	-88.70601315990	35.89338387230	465.70092284600
C1:9	-88.70605435080	35.89334288310	466.17240313200
C1:10	-88.70607748020	35.89330962840	465.83842693600
C1:11	-88.70610819940	35.89327561760	465.48089187300
C1:12	-88.70614756470	35.89324192570	465.49258710300
C1:13	-88.70617902650	35.89319815430	465.30509139700
C1:14	-88.70620955000	35.89316237580	464.64437067900
C1:15	-88.70623725650	35.89312767350	465.51005040800
C1:16	-88.70626812020	35.89309277160	465.71527280500
C1:17	-88.70630134240	35.89304681120	464.76765056200
C1:18	-88.70633898010	35.89301799300	464.63187763500
C1:19	-88.70636357280	35.89297401370	465.11617225300
C1:20	-88.70640152680	35.89294401650	465.34911395200
C2:1	-88.70106696620	35.89402541930	472.81741791400
C2:2	-88.70106284240	35.89406145450	469.83214072300
C2:3	-88.70107232730	35.89409695110	475.23019244400
C2:4	-88.70108387830	35.89413546430	472.33231275300
C2:5	-88.70107848050	35.89419294060	470.76489768700
C2:6	-88.70107248570	35.89423848580	471.35140752200
C2:7	-88.70107406650	35.89429029090	468.58765186700
C2:8	-88.70107556730	35.89433689320	467.45635056200
C2:9	-88.70107794190	35.89439708590	468.43837005600
C2:10	-88.70106136500	35.89443472200	475.32269945700
C2:11	-88.70106583390	35.89447010530	468.52400259500
C2:12	-88.70107279420	35.89449823640	470.77732583600
C2:13	-88.70108444020	35.89453724650	485.00555752600
C2:14	-88.70107769010	35.89459351720	457.29798379200
C2:15	-88.70107686630	35.89464046810	466.24699096300
C2:16	-88.70107516710	35.89467343510	465.45805338900
C2:17	-88.70107941540	35.89472183450	470.79945292200
C2:18	-88.70107632440	35.89477926300	474.83818169600
C2:19	-88.70106635920	35.89481026900	476.69811885900
C2:20	-88.70106371790	35.89485345800	476.39748971000

Pond and Cover Object No.	Latitude	Longitude	Feet Above Sea Level
C3:1	-88.69805018200	35.88738153870	506.81198132500
C3:2	-88.69804504520	35.88744040240	515.18074179800
C3:3	-88.69804104010	35.88747145140	511.29045260000
C3:4	-88.69804024520	35.88751670590	507.35648282400
C3:5	-88.69804854290	35.88761988580	506.13926151300
C3:6	-88.69805091160	35.88766086940	504.15886667300
C3:7	-88.69806531070	35.88770801950	505.99397857600
C3:8	-88.69805669790	35.88776381330	501.36671330300
C3:9	-88.69804801760	35.88780367390	501.01517680400
C3:10	-88.69803309150	35.88784989020	499.87109941500
C3:11	-88.69805183700	35.88788631570	507.42528065200
C3:12	-88.69805517630	35.88792927620	507.52272337300
C3:13	-88.69804790750	35.88797330970	501.77708643100
C3:14	-88.69804639920	35.88801994370	501.35835116100
C3:15	-88.69804825520	35.88806086480	500.05667739700
C3:16	-88.69803677840	35.88810339680	503.54498330200
C3:17	-88.69802700010	35.88814463220	503.54048112100
C3:18	-88.69803289310	35.88819131960	502.25523067700
C3:19	-88.69803143740	35.88824660900	508.97613194200
C3:20	-88.69803924310	35.88828279430	500.56685086800
C4:1	-88.71518674310	35.88368572850	466.13990073700
C4:2	-88.71518046990	35.88372424750	466.39667916500
C4:3	-88.71517900580	35.88376859450	464.92252428600
C4:4	-88.71517058150	35.88381300910	464.76286121700
C4:5	-88.71516046620	35.88385018330	464.94806950500
C4:6	-88.71515539030	35.88389915350	463.84631116400
C4:7	-88.71513061080	35.88394037060	463.25381776700
C4:8	-88.71513556340	35.88400306880	464.36668093000
C4:9	-88.71511910160	35.88403975770	461.05361561700
C4:10	-88.71512065900	35.88407836600	458.99304843700
C4:11	-88.71510982010	35.88411440290	462.24568788600
C4:12	-88.71510395040	35.88417055020	466.12355969900
C4:13	-88.71509820410	35.88421383580	465.75085502100
C4:14	-88.71509857770	35.88425932430	466.42610460500
C4:15	-88.71508745190	35.88429981520	466.62538856300
C4:16	-88.71508476050	35.88434088640	466.58932888100
C4:17	-88.71507616610	35.88439077040	467.81044137300
C4:18	-88.71507000960	35.88443405610	467.98455402600
C4:19	-88.71506534050	35.88447573840	466.45811804400
C4:20	-88.71505727970	35.88452207480	467.23229035800

Pond and Cover Object No.	Latitude	Longitude	Feet Above Sea Level
C5:1	-88.73325615200	35.86750123010	474.20286100600
C5:2	-88.73329880400	35.86748302530	477.33701336900
C5:3	-88.73333774740	35.86746134820	473.73072356800
C5:4	-88.73337906870	35.86744216320	473.76588297300
C5:5	-88.73343494420	35.86741945570	475.58983299400
C5:6	-88.73348034980	35.86740320190	476.23214953400
C5:7	-88.73352099520	35.86738624530	475.68468254600
C5:8	-88.73358078270	35.86736067800	475.74788869600
C5:9	-88.73362661800	35.86733655890	475.76434384000
C5:10	-88.73365813040	35.86733146740	476.11414237300
C5:11	-88.73371823920	35.86729942600	475.55181088600
C5:12	-88.73375493590	35.86728887810	475.24199662800
C5:13	-88.73381698620	35.86727958310	474.66936886300
C5:14	-88.73385693070	35.86725480240	478.37995330400
C5:15	-88.73390967240	35.86722444330	477.46769812200
C5:16	-88.73395248780	35.86719988210	478.56358092500
C5:17	-88.73403152740	35.86715577630	489.85501597900
C5:18	-88.73406564500	35.86714825610	481.88592488300
C5:19	-88.73417393640	35.86709708800	486.20337455900
C6:1	-88.71726718270	35.85695321560	455.93649810500
C6:2	-88.71721061360	35.85692785670	453.78269720700
C6:3	-88.71716390610	35.85690366000	453.81679947100
C6:4	-88.71713409410	35.85686851520	452.63583204900
C6:5	-88.71708454970	35.85684321590	452.93699569700
C6:6	-88.71703329880	35.85683075990	457.66120749400
C6:7	-88.71698940950	35.85680323870	460.23566586100
C6:8	-88.71695369270	35.85678044690	456.76190135600
C6:9	-88.71690575630	35.85675532290	456.72972374100
C6:10	-88.71685953920	35.85672315150	455.57794377200
C6:11	-88.71682026890	35.85671071890	457.16228393600
C6:12	-88.71676797530	35.85668346730	459.07953265600
C6:13	-88.71673647240	35.85665284070	467.54523658100
C6:14	-88.71668642320	35.85662554030	464.28420746600
C6:15	-88.71663287890	35.85658540550	466.26790881200
C6:16	-88.71659246480	35.85657055370	471.86906520800
C6:17	-88.71655152860	35.85652957960	480.86330800200
C6:18	-88.71648789580	35.85650575630	491.64199275700
C6:19	-88.71645126860	35.85649312350	474.33255170300
C6:20	-88.71641654070	35.85646847980	485.48554151600

Pond and Cover Object No.	Latitude	Longitude	Feet Above Sea Level
C7:1	-88.67617910170	35.83988026020	548.80321031600
C7:2	-88.67618864290	35.83983954920	556.47358153000
C7:3	-88.67617503420	35.83979114090	554.34997230400
C7:4	-88.67617205850	35.83974403500	550.83131663000
C7:5	-88.67618020060	35.83970948380	553.99168549800
C7:6	-88.67617501880	35.83966448890	555.22264708800
C7:7	-88.67617493460	35.83961555700	552.72819653600
C7:8	-88.67617505550	35.83957397560	555.23496494200
C7:9	-88.67617170080	35.83952505120	555.51391745100
C7:10	-88.67617531640	35.83948395000	556.01369626700
C7:11	-88.67616986070	35.83944163230	556.57569049500
C7:12	-88.67616898020	35.83940359600	557.06950470000
C7:13	-88.67617413080	35.83935522440	557.34734084800
C7:14	-88.67616914290	35.83930977350	556.76948411000
C7:15	-88.67616880700	35.83927015970	556.63680960300
C7:16	-88.67616279410	35.83921834380	558.75698209400
C7:17	-88.67614600800	35.83916861320	557.46151654000
C7:18	-88.67615744430	35.83912650150	557.23469183900
C7:19	-88.67615869390	35.83907107790	557.62627915600
C7:20	-88.67616263930	35.83903029600	556.84854636600
C8:1	-88.74409099980	35.82844335190	521.56024051600
C8:2	-88.74410702810	35.82849595240	519.07423536000
C8:3	-88.74409616580	35.82853757380	518.70443004300
C8:4	-88.74409226040	35.82859634910	523.97646212100
C8:5	-88.74408794150	35.82863530920	534.90626883900
C8:6	-88.74408557030	35.82868038410	522.33719239400
C8:7	-88.74409156010	35.82872723500	522.18756213500
C8:8	-88.74409344100	35.82877125770	527.44324605400
C8:9	-88.74408862860	35.82881597740	523.47108570700
C8:10	-88.74409730970	35.82885299980	537.41228189700
C8:11	-88.74410280590	35.82889917360	536.98126481700
C8:12	-88.74409437490	35.82894012480	530.12241498100
C8:13	-88.74409156340	35.82899201820	538.25698205300
C8:14	-88.74409394130	35.82904149370	532.49769682700
C8:15	-88.74409050620	35.82908409900	526.77702463700
C8:16	-88.74409811010	35.82912150160	525.70236280400
C8:17	-88.74409586900	35.82916250950	524.44695329600
C8:18	-88.74409897060	35.82920945030	525.37477464700
C8:19	-88.74410383970	35.82925625780	523.64439207100
C8:20	-88.74411117690	35.82930459610	523.19983506400

Pond and Cover Object No.	Latitude	Longitude	Feet Above Sea Level
C9:1	-88.69441433110	35.82283809450	483.83220465900
C9:2	-88.69439984610	35.82289100510	487.25865740700
C9:3	-88.69440838050	35.82294442600	489.30815911800
C9:4	-88.69443303820	35.82299022960	482.52874265000
C9:5	-88.69442767710	35.82302698520	484.54501726100
C9:6	-88.69443462740	35.82307470320	482.75921846800
C9:7	-88.69441769030	35.82311141880	481.88290096000
C9:8	-88.69440308110	35.82314921820	472.80122137200
C9:9	-88.69444354370	35.82319224710	506.71103064700
C9:10	-88.69442780390	35.82324759570	488.14816620600
C9:11	-88.69441899270	35.82329229540	478.94729440300
C9:12	-88.69441771870	35.82333529750	483.89851522900
C9:13	-88.69442039670	35.82337520480	491.44633466200
C9:14	-88.69439496190	35.82345758730	475.56455454500
C9:15	-88.69436246020	35.82347595010	482.45173264000
C9:16	-88.69436107110	35.82354265780	478.62405328200
C9:17	-88.69437442800	35.82358039060	475.42482119600
C9:18	-88.69439419320	35.82363212730	496.19237620500
C9:19	-88.69438620440	35.82366946320	485.16006443600
C9:20	-88.69438323090	35.82371931560	482.47788558700
NC1:1	-88.70093970560	35.91988955970	456.50124424700
NC1:2	-88.70101713220	35.91988967640	457.02227859100
NC1:3	-88.70106017100	35.91990513440	451.45832460100
NC1:4	-88.70110081700	35.91990484090	453.67320463800
NC1:5	-88.70114647890	35.91990825940	450.66977400500
NC1:6	-88.70120544930	35.91991476610	448.88270585900
NC1:7	-88.70125900860	35.91992142620	447.67499225500
NC1:8	-88.70131350330	35.91992160620	451.19971535800
NC1:9	-88.70136281380	35.91991971860	449.60339658800
NC1:10	-88.70140839390	35.91991291840	451.58946112700
NC1:11	-88.70146165310	35.91992421760	447.05854767900
NC1:12	-88.70151519900	35.91993081430	448.36533957200
NC1:13	-88.70157132460	35.91992947030	450.19914163400
NC1:14	-88.70164117900	35.91990965340	448.83704775000
NC1:15	-88.70168550690	35.91990260310	450.44153948900
NC1:16	-88.70174090210	35.91990277650	448.77500409600
NC1:17	-88.70180722630	35.91991484280	444.82274389100
NC1:18	-88.70188259020	35.91989668340	447.10365197700
NC1:19	-88.70191130830	35.91991734070	452.94368306800
NC1:20	-88.70239996200	35.91989459570	455.27699053400

Pond and Cover Object No.	Latitude	Longitude	Feet Above Sea Level
NC2:1	-88.72320053270	35.91017063580	445.97205148400
NC2:2	-88.72319425280	35.91012080170	446.60510942300
NC2:3	-88.72319191160	35.91008347710	445.78812168300
NC2:4	-88.72319045420	35.91002754700	452.20614773600
NC2:5	-88.72319292880	35.91000284760	430.17833329100
NC2:6	-88.72318851150	35.90994714720	435.01904506900
NC2:7	-88.72319488980	35.90990917260	434.78795882400
NC2:8	-88.72317089080	35.90987018580	443.25808746900
NC2:9	-88.72317337540	35.90981592450	444.26773408900
NC2:10	-88.72317826790	35.90976595870	442.61016118500
NC2:11	-88.72317080240	35.90972302490	438.38293866100
NC2:12	-88.72315666680	35.90968302930	450.98381099400
NC2:13	-88.72317808450	35.90963850970	433.03891637500
NC2:14	-88.72317838130	35.90958210060	452.08055069800
NC2:15	-88.72317378720	35.90953657040	450.95366926200
NC2:16	-88.72316243640	35.90948263260	440.97646819300
NC2:17	-88.72316055990	35.90944433510	436.30357823400
NC2:18	-88.72315190100	35.90940041190	447.70293775000
NC2:19	-88.72315841430	35.90934986080	449.35500347500
NC2:20	-88.72314761880	35.90931454260	437.07919939200
NC3:1	-88.69416549530	35.90746510210	470.99340358300
NC3:2	-88.69416733790	35.90742263690	472.98885785400
NC3:3	-88.69416695940	35.90738032170	470.39084199000
NC3:4	-88.69417137330	35.90733638410	472.68487924700
NC3:5	-88.69416353760	35.90729032700	474.33539228300
NC3:6	-88.69416487080	35.90724739820	486.24788535800
NC3:7	-88.69416595300	35.90721263020	476.53569633000
NC3:8	-88.69417998110	35.90716924290	473.91665422000
NC3:9	-88.69417845610	35.90712186340	484.18903163500
NC3:10	-88.69416602720	35.90706283630	475.61476917100
NC3:11	-88.69417219210	35.90702148330	459.73798184500
NC3:12	-88.69417987430	35.90697468920	471.77085248100
NC3:13	-88.69419060320	35.90693422500	476.10382022500
NC3:14	-88.69418600170	35.90689436940	474.01193901200
NC3:15	-88.69420135380	35.90685452720	473.94796146400
NC3:16	-88.69419761850	35.90680734960	479.31735179400
NC3:17	-88.69419264840	35.90676907650	477.85512011900
NC3:18	-88.69418996620	35.90671470840	468.90445215100
NC3:19	-88.69419175710	35.90667798280	444.95220944900
NC3:20	-88.69420015150	35.90663433700	466.86173148500

Pond and Cover Object No.	Latitude	Longitude	Feet Above Sea Level
NC4:1	-88.72131059470	35.90527446570	471.50606963400
NC4:2	-88.72130930070	35.90523114330	474.57768307700
NC4:3	-88.72132221730	35.90518702720	476.83174490500
NC4:4	-88.72131969770	35.90514198740	475.58815715800
NC4:5	-88.72131124340	35.90508801280	496.47237609800
NC4:6	-88.72130328930	35.90504711180	481.99874786700
NC4:7	-88.72131141510	35.90500577880	472.25412096200
NC4:8	-88.72130151670	35.90495739880	471.75125141700
NC4:9	-88.72130136660	35.90491165690	481.82089593600
NC4:10	-88.72130636250	35.90486806940	478.40440791300
NC4:11	-88.72129100460	35.90480965930	498.53744108200
NC4:12	-88.72129195730	35.90477767500	480.71053970200
NC4:13	-88.72129338750	35.90473320150	469.88490190500
NC4:14	-88.72129172830	35.90468470820	470.04203037700
NC4:15	-88.72128317050	35.90464108240	488.64728443600
NC4:16	-88.72128918700	35.90459048960	485.86445818300
NC4:17	-88.72127801120	35.90455103260	470.76143214600
NC4:18	-88.72128856500	35.90450173720	479.34307019700
NC4:19	-88.72128705090	35.90446390600	469.03335526400
NC4:20	-88.72128697250	35.90441542100	478.37371721800
NC5:1	-88.72529633360	35.90033967730	450.09375374200
NC5:2	-88.72530825640	35.90029849610	449.92431688600
NC5:3	-88.72531281210	35.90024555880	449.71648488500
NC5:4	-88.72533002430	35.90018424050	475.40217235300
NC5:5	-88.72530387410	35.90015484540	456.26280871600
NC5:6	-88.72530252340	35.90010905170	459.78577843200
NC5:7	-88.72531332900	35.90006751030	453.59169791600
NC5:8	-88.72532252710	35.90001417610	464.55046224500
NC5:9	-88.72532173670	35.89996419370	454.56659633400
NC5:10	-88.72534366130	35.89988924500	501.12395126600
NC5:11	-88.72531971900	35.89988943510	454.33395573900
NC5:12	-88.72532013250	35.89982732810	447.29512475000
NC5:13	-88.72532436140	35.89981793830	468.73869254100
NC5:14	-88.72534052970	35.89975006990	475.34419581500
NC5:15	-88.72532785320	35.89971854700	444.40892521000
NC5:16	-88.72533847200	35.89966864460	458.61047094200
NC5:17	-88.72534867720	35.89961527880	455.31279226600
NC5:18	-88.72533975260	35.89956054220	464.94834758800
NC5:19	-88.72534553230	35.89955366200	471.05011023800
NC5:20	-88.72535383660	35.89947378080	459.43937210100

Pond and Cover Object No	Latitude	Longitude	Feet Above Sea Level
NC6:1	-88.72604900510	35.89968945200	486.21356393500
NC6:2	-88.72602974510	35.89967502120	435.65781167000
NC6:3	-88.72603482780	35.89964718020	434.38823665300
NC6:4	-88.72604396250	35.89959751790	430.87125971600
NC6:5	-88.72602957840	35.89954514090	438.10473479500
NC6:6	-88.72603160610	35.89950912230	435.12545609300
NC6:7	-88.72603394730	35.89945015190	442.37130204800
NC6:8	-88.72603986700	35.89941559740	430.99017867400
NC6:9	-88.72603004200	35.89937845830	424.31301369700
NC6:10	-88.72603990370	35.89932642480	447.04749328400
NC6:11	-88.72603245320	35.89928968250	442.96863973200
NC6:12	-88.72602392550	35.89924322190	434.75785130500
NC6:13	-88.72603272670	35.89918449490	446.32551558200
NC6:14	-88.72603565320	35.89914748920	434.06579396300
NC6:15	-88.72603469440	35.89910013810	433.30837660600
NC6:16	-88.72604536320	35.89900919780	477.45469325400
NC6:17	-88.72601875950	35.89901173580	432.66500699500
NC6:18	-88.72604039400	35.89893991880	461.00010466100
NC6:19	-88.72603206300	35.89891969500	441.21588867100
NC6:20	-88.72603123590	35.89889671320	465.74883829100
NC7:1	-88.72513963280	35.88184874280	465.98364396300
NC7:2	-88.72513268580	35.88188566510	461.26697632600
NC7:3	-88.72512594570	35.88192556740	466.70153406400
NC7:4	-88.72512112320	35.88198200150	478.81907077500
NC7:5	-88.72514411170	35.88201874880	475.55408743300
NC7:6	-88.72513180650	35.88206598310	466.31458725800
NC7:7	-88.72509305870	35.88210074270	493.34991984300
NC7:8	-88.72514253420	35.88215348990	463.46572021400
NC7:9	-88.72512648930	35.88220508490	459.44972389000
NC7:10	-88.72512365620	35.88224996050	461.92607318100
NC7:11	-88.72509285530	35.88226539350	469.75018429600
NC7:12	-88.72512783670	35.88232591890	463.80221396500
NC7:13	-88.72513467020	35.88237696680	458.18876646700
NC7:14	-88.72515248270	35.88243553370	463.18358605500
NC7:15	-88.72512873710	35.88248024930	477.42851735700
NC7:16	-88.72513194210	35.88250919670	466.87026616600
NC7:17	-88.72515356660	35.88256762020	462.87935590100
NC7:18	-88.72513428000	35.88260700550	465.03909394100
NC7:19	-88.72515701840	35.88266752340	460.59165696800
NC7:20	-88.72515280950	35.88270550570	458.97599606500

Pond and Cover Object No	Latitude	Longitude	Feet Above Sea Level
NC8:1	-88.73099326940	35.86612091960	473.88237614600
NC8:2	-88.73100137140	35.86614601860	472.42092274100
NC8:3	-88.73100705650	35.86618648380	466.34570252100
NC8:4	-88.73100404880	35.86623831240	453.64375011500
NC8:5	-88.73101372880	35.86627171960	459.98385078100
NC8:6	-88.73100522220	35.86633904230	460.52944935700
NC8:7	-88.73100518670	35.86636598920	456.83038855000
NC8:8	-88.73097961790	35.86641742840	448.88457679800
NC8:9	-88.73098295960	35.86644252380	461.45230422800
NC8:10	-88.73098856590	35.86650982380	459.33470422200
NC8:11	-88.73099312710	35.86655483030	459.73876214700
NC8:12	-88.73098792660	35.86660427130	473.86185661900
NC8:13	-88.73097797870	35.86665361640	468.70076376500
NC8:14	-88.73097989140	35.86669763650	464.74993307900
NC8:15	-88.73097739450	35.86675361100	468.39191632700
NC8:16	-88.73097569810	35.86680105450	464.12692828800
NC8:17	-88.73097381710	35.86684298240	460.02756478600
NC8:18	-88.73097918440	35.86687054480	463.21748487700
NC8:19	-88.73096960610	35.86693309650	473.44775665000
NC8:20	-88.73097316130	35.86695987060	476.66370365000
NC9:1	-88.67067550470	35.86301492150	520.79150519900
NC9:2	-88.67070158140	35.86300027340	517.81802036200
NC9:3	-88.67056618970	35.86300515160	523.01015007300
NC9:4	-88.67052574440	35.86299273290	520.87768779000
NC9:5	-88.67046411640	35.86299416990	520.77166512900
NC9:6	-88.67041421400	35.86298332570	519.49879727200
NC9:7	-88.67036946830	35.86299377490	517.69631271100
NC9:8	-88.67033361810	35.86299055830	518.53045048900
NC9:9	-88.67024713910	35.86297767500	516.65264362500
NC9:10	-88.67019022740	35.86297445230	516.29043801100
NC9:11	-88.67015780580	35.86297128720	519.49999685600
NC9:12	-88.67010112700	35.86296311340	518.62902684900
NC9:13	-88.67005117340	35.86295997110	523.01016763800
NC9:14	-88.67000291510	35.86294309550	537.48930888500
NC9:15	-88.66994480590	35.86295012970	525.21705422300
NC9:16	-88.66988051270	35.86296104120	523.96691944800
NC9:17	-88.66982364480	35.86297447210	524.21030419600
NC9:18	-88.66979818950	35.86297493230	527.46110713900
NC9:19	-88.66969411950	35.86297653270	526.88780604500
NC9:20	-88.66966870650	35.86297769070	524.77476339100

APPENDIX D

Data sheets used during the course of the study to record data.

Aquatic Pond Samples

Pond Code:__________ Date:______________ Observers:______________________ Time Start:________ Time End:_________ Total:__________

Current Weather:
Air Temp (C):___________
Precipitation: None Light Moderate Heavy (Rain Snow)
Wind: Calm Light Moderate Gusty Strong
Sky: Clear Partly Cloudy Mostly Cloudy Overcast

Abiotic Measurement (aquatic):
Temp (C): N__________, S__________, E__________, W__________
Sp. Con. (ms/cm): N__________, S__________, E__________, W__________
TDS (g/L): N__________, S__________, E__________, W__________
D.O. (mb/L): N__________, S__________, E__________, W__________
D.O. (mb/L): N__________, S__________, E__________, W__________

Previous Weather (last 24 hours):____

Comments: ____

Rec. No.	Trap Loc.	Species	Age	Sex	Repro. Cond.	SVL (mm)	Weight (g)	Remarks

Cover Object Samples

Pond Code:______________ Date:______________ Observers:______________________________

Time Start:__________________________ Time End:____________________________ Total:____________________________

Air Temp (C):_______ Cover object temp (C): (1)_______ (2)_______ (7)_______ (8)_______ (13)_______ (14)_______ (19)_______ (20)_______

Current Weather:
Precipitation: None Light Moderate Heavy (Rain Snow)
Wind: Calm Light Moderate Gusty Strong
Sky: Clear Partly Cloudy Mostly Cloudy Overcast

Previous Weather (last 24 hours):____

Comments: ____

Rec. No.	C.O. No.	Species	Age	Sex	Repro. Cond.	SVL (mm)	Weight (g)	Remarks

Long-term Monitoring Project for Amphibians and Reptiles
Milan Army Ammunition Plant

PVC Pipe Sampling

Pond Cod ____________ Date: ____________ Observers: ____________

Time Start: ____________ Time End: ____________ Total:

Air Temp: ____________ Pipe Temperature: (1) w______,a______ (2) w______,a______ (6) w______,a______ (7) w______,a______

Current Weather:
Precipitation: None Light Moderate Heavy (Rain Snow)
Wind: Calm Light Moderate Gusty Strong
Sky: Clear Partly Cloudy Mostly Cloudy Overcast

Previous Weather (last 24 hours): ____________

Comments: ____________

Rec. No.	Pipe No.	Species	Age	Sex	Repro. Cond.	SVL (mm)	Weight (g)	Remarks

Water Quality Check

Pond Code: Date: Observers: Time Start:________ Time End:__________ Tot:________

Current Weather:

Air Temp (C):___________

Precipitation: None Light Moderate Heavy (Rain Snow)

Wind: Calm Light Moderate Gusty Strong

Sky: Clear Partly Cloudy Mostly Cloudy Overcast

Abiotic Measurement (aquatic):

Temp (C): ______________________________

Sp. Con. (ms/cm): ______________________________

TDS (g/L): ______________________________

D.O. (mb/L): ______________________________

D.O. (mb/L): ______________________________

pH: ______________________________

Previous Weather (last 24hours): ______________________________

Comments: ______________________________

VITA

Benjamin James Beas was born in Warwick, Rhode Island on 6 November 1982 to James and Denise Beas of Johnstown, Pennsylvania. He has one younger brother, Todd Christopher Beas. He graduated from The Kiski School in Saltsburg, Pennsylvania in May 2001. After graduation, he enrolled in Juniata College, a small 4-year, liberal arts institution located in Huntingdon, Pennsylvania. While at Juniata College, he worked as a field assistant for Roy D. Nagle on Eastern Box Turtle (*Terrapene carolina carolina*) nesting ecology and presented at the 2005 National Conference for Undergraduate Research (NCUR). He graduated in May 2005 with a Bachelor of Science Degree in Biology. The summer following graduation, he worked for the Smithsonian Migratory Bird Center in conjunction with Virginia Tech University researching the nesting ecology of the Coastal Swamp Sparrow. In August of 2005, he enrolled at Austin Peay State University for his Master of Science Degree in Biology under the tutelage of Dr. A. Floyd Scott.

He plans to continue research in the area of herpetology and ecology with an emphasis in conservation while pursuing a Doctorate of Philosophy from the University of Louisville. He plans to work with the Chytrid Fungus that is currently causing amphibian die-offs worldwide.