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Potential of Urban Habitats as Reptile and Amphibian Refuges in West Virginia

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POTENTIAL OF URBAN HABITATS AS REPTILE AND AMPHIBIAN REFUGES IN WEST VIRGINIA

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ABSTRACT

Potential of Urban Habitats as Reptile and Amphibian Refuges in West Virginia

Scott Jones

Urban herpetology is a relatively new field, examining how reptiles and amphibians survive in areas that have been altered by humans. This study sought to add data on urban habitats to the knowledge within West Virginia. I studied six sites: two urban parks (Ritter Park and Barboursville Park), a nature area near an art museum (Huntington Museum of Art), two wildlife management areas (Green Bottom WMA and Chief Cornstalk WMA), and a state park (Beech Fork State Park). The state park and two wildlife management areas were considered non-urban habitats because they are more removed from developed areas than the urban sites. The objectives of this study were (1) to examine differences in both biotic and abiotic factors between urban and less-urban sites and (2) to determine how useful urban habitats were as wildlife conservation areas. This goal was achieved by determining reptile and amphibian species occupying these areas and by gathering data on various environmental variables at each site to better characterize the sites. Animals were observed with straight line transects and opportunistic searches at each study site. Each animal observed was weighed, measured, and its location data were recorded. Thirty two species were detected. Historic records from previous Marshall University graduate students were used to determine undetected species, and these data were incorporated into species richness and community similarity calculations. Total species richness at each site ranged from 7 species at Ritter Park, to 32 species at Beech Fork State Park. The Huntington Museum of Art (HMA) had a richness of 17. Community similarity values ranged from 0% between Green Bottom WMA and Ritter Park, to 57% between Beech Fork State Park and HMA. Trees were identified and measured at Ritter Park, the Huntington

Museum of Art, Barboursville Park, and Beech Fork State Park. These data were combined with several environmental variables for canonical correspondence analysis (CCA). CCA showed that the two sites closest to each other, Ritter Park and the Huntington Museum of Art, formed one group, and Barboursville Park and Beech Fork State Park formed a second group. Both groups were comprised of one site that showed more urban characteristics (Ritter and Barboursville) and one that was less urban (Beech Fork and the Huntington Museum of Art). Even though the Huntington Museum of Art grouped closely with Ritter Park, it was more similar in its animal community to Beech Fork State Park, and along with Beech Fork was the only one of the sites where a state threatened Midland Mud Salamander was found. The Huntington Museum of Art with its high species richness, low numbers of invasive plants, and lack of impervious surface provides a good model for how reptile and amphibian refuges can be created in urban areas.

INTRODUCTION

Amphibians and reptiles are strong bioindicators of the health of natural systems. Many species also provide services to humans as predators of invertebrates and rodents which are both vectors for disease and pest species. Pool-breeding amphibians eat mosquito larvae and many snakes eat mice and rats, helping to control the populations of these pest species. Since mosquitoes and rodents may carry diseases and rats and mice often damage crops, reptiles and amphibians offer a valuable service as pest control. Salamanders of the genus *Plethodon* represent major indicators of the health of forest habitats because they are widespread in North American forests (Welsh and Droege 2001). They also are effective study organisms because many *Plethodon* species can be found easily and in large numbers. One study found that salamander biomass was twice that of birds during peak bird densities and about the same as that of mammals (Burton and Likens 1975). Salamanders also are important because they function as interface organisms that draw out terrestrial and subterranean resources through their foraging, and pass this energy on to organisms that prey upon them (Hamilton 2002). Amphibians with aquatic larval stages are similarly able to take up aquatic resources and then make them available to terrestrial predators once they transform into adults that live on land. Other amphibians and reptiles are also important as links in the food chain. These organisms are integral components of ecosystems (Welsh and Droege 2001). For these reasons it is important to preserve amphibian and reptile species. In order to do this, it has become necessary to explore how reptiles and amphibians may be able to colonize and survive in areas that have large human populations and greatly altered habitat. This has given rise to the field of urban herpetology.

Urban herpetology is a relatively new field, examining how reptiles and amphibians survive in areas that have large, concentrated human populations and greatly reduced or altered original habitat. Due to its recent emergence, urban herpetology remains relatively understudied (Mitchell and Jung Brown 2008). The major threat to most species living today is habitat loss. As the human population expands and people seek a high quality of life, they often must harvest resources and use space, resulting in the destruction of many wildlife habitats. This destruction is not always complete and sometimes new habitats are left in the aftermath. Some species can utilize urban areas as habitat. Since these organisms are still able to utilize human disturbed areas, surveys are needed in anthropogenic habitats to determine the species assemblages of these areas and find out if rarer species might benefit from such habitats.

Examples of altered habitat include power line cuts, strip mined mountain tops, agricultural fields, and urban parks. A study by Luiselli and Akani (2002) of Nigerian snake populations found that diversity was slightly greater in altered habitat, while another study by Suazo-Ortuño *et al.* (2008) in Mexico discovered that there was no significant difference between the snake assemblages of disturbed versus pristine habitat. Suazo-Ortuño *et al.* (2008) did find, however, that anurans were less diverse in disturbed areas, but the abundance did not differ between disturbed and pristine conditions. Furthermore, lizards showed higher diversity and abundance in disturbed areas, while turtles showed lower abundance and diversity in the same areas (Suazo-Ortuño *et al.* 2008). Barrett and Guyer (2008) found that amphibian diversity decreased in urban watersheds in Georgia (United States), but that reptile diversity increased. McLeod and Gates (1998) found that reptiles in general were more prevalent in artificially maintained open canopy areas (burned pine forests and timber harvested hardwood forests) in Maryland in respect to more natural pine forests and old growth hardwood forests. They believed that reptiles favor these more open habitats due to the higher ambient temperatures resulting from more direct sunlight (McLeod and Gates 1998). In contrast, McLeod and Gates (1998) found that amphibians as a whole were less prevalent in the cut and burned areas than in the pristine forests. This is likely due to the fact that more sunlight and exposure will cause amphibians to desiccate faster and die, a problem not shared by reptiles. Several studies have shown that some reptiles, including snakes, favor artificial open canopy habitats to closed canopy areas (McLeod and Gates 1998; Hampton 2007; Barrett and Guyer 2008; Clark *et al.* 2008). McLeod and Gates (1998) found that snakes as a whole were less prevalent in naturally occurring hardwood forests as compared to cut hardwood forests, as were small mammals that serve as prey for many snakes. They also found that the cut forests had more open canopies, less trees, and smaller trees relative to the natural hardwood forests (McLeod and Gates 1998). Some snakes are probably more prevalent in open canopy habitats due to the increased ambient temperature resulting from more sun exposure (McLeod and Gates 1998; Barrett and Guyer 2008; Webb *et al.* 2005). Also, Cagle (2008) found that snakes in the American Midwest are declining overall in agricultural regions and that more specialized species are unable to cope with urbanized areas. Saunders (2009) suggested that human alterations to a natural cave in Kentucky, specifically walling up a cave entrance, may have benefited plethodontid salamanders by providing them with feeding stations due to increased invertebrate abundance in this area compared to other areas of the cave.

Hamilton (2002) found that relative abundance of salamanders was greater at control streams in southwestern West Virginia that were undisturbed relative to study streams impacted by mountaintop mining. She also found that Bragg Fork, the earliest reclaimed study site, had significantly higher salamander relative abundance than the other study streams. Salamander relative abundances were not significantly different between Bragg Fork and the control streams. One of the sites at Bragg Fork accounted for this with 150 salamanders, while the second site had significantly fewer salamanders with 52. The first site was located upstream from the sediment pond, and the second was located downstream, but much of the stream at the first site also ran underground. This could have provided a refuge for salamanders during mining and facilitated faster re-colonization of the stream once mining was finished. Williams (2003) found that snakes were more abundant and showed greater species richness in reclaimed mountaintop mining areas than in forested areas. She also found that terrestrial salamanders were less abundant in reclaimed mine sites and became more abundant as the reclaimed sites transitioned into forests. Even though disturbance in her sites had occurred 10 to 28 years prior, abundances still were not at the level of the intact forests and she suggested that it might take 15 to 70 years or longer for salamander populations to recover in the reclaimed sites. These reclaimed sites may be too hot and dry due to the lack of larger vegetation for terrestrial salamanders, resulting in mortality from desiccation if they remain in these areas for too long. Another study of an abandoned mine in southern West Virginia found that generalist species were most abundant (Loughman 2005). Most of the possible anuran species were present on the mine, but generalist species such as Northern Green Frogs (*Rana clamitans melanota*) and Spring Peepers (*Pseudacris* *crucifer*) were more abundant and better established than species with specific needs such as Wood Frogs (*Rana sylvatica*). Wood Frogs were mostly excluded from the site due to the lack of temporary ponds, which they require to breed. A similar trend was found for salamanders and snakes. Turtles were not successful at colonizing the area. Loughman (2005) suggested that efforts to support habitat heterogeneity after mines are abandoned could promote greater species diversity and colonization. These conflicting results mean human made and altered habitats in West Virginia require further study to be classified as beneficial or not.

A study on Eastern Box Turtles (*Terrapene c. carolina*) found that initial growth rates of turtles in urban areas were higher than those of similarly aged turtles in forested areas (Budischak *et al.* 2006). They also found that turtles in urban areas grew for a longer time period, but turtles in both sites did not significantly differ in size at maturity. The authors suggested that the size and growth rate differences could be due to anthropogenic food sources such as garbage being available to urban turtles and not those in the forests. More turtles over the age of 20 were found in forested than urban areas, suggesting that more turtles die in the urban areas.

Some urban habitats do seem to offer refuges for reptiles and amphibians. A breeding population of California Tiger Salamanders (*Ambystoma californiense*), a federally threatened species, utilizes a breeding pool in a park that is surrounded by varying levels of urbanization in California (Trenham and Cook 2008). The breeding adults were estimated at over 90 in the population both years of the study, and they navigated their way successfully from upland sites to the breeding pool. The authors suggest that for this species, preservation of upland areas near breeding sites is integral, as these upland areas are where adults spend most of their time outside of the breeding season. They suggest that populations may persist in urban areas if habitat corridors are available, but caution that more study is needed

One of the biggest problems of any urban herpetology study is that "urban" is a difficult term to define (Mitchell and Jung Brown 2008). Previous studies have used light pollution (Mitchell and Jung Brown 2008), housing density (McIntyre *et al.* 2000), percent impervious surface (Arnold and Gibbons 1996), road density (Egan and Paton 2008), and human population densities (Elmqvist *et al.* 2008) as measures of urbanization in study sites. Budischak *et al.* (2006) used local cover from aerial photographs combined with ArcGIS software to characterize how much urban, field, and forested land was found within 100 m of a Box Turtle's capture location. Some sites do not fit all of these characteristics though. For example, a park surrounded by neighborhoods but lacking any impervious surface within its boundaries would not be considered urban based on impervious surface, but might be urban based on light pollution or one of the other factors. Because of this, it is most accurate to use several or all of these measures together to fully characterize a site as being urban.

The goal of this study was to assess some of these urban areas in West Virginia and compare them to less disturbed areas. Ultimately this can be used to determine how useful these regions are for wildlife conservation, particularly rare species. Urban areas included parks and nature trails within cities, while less disturbed areas included a state park and two wildlife management areas. The data gathered in this study may be used to develop protocols for assessing urban habitats in other areas of West Virginia. These data can be used to give a general idea of what species are likely to be found in other urban sites in West Virginia and what constitutes urban in this region.

OBJECTIVES

There were two objectives in this study. First was to examine differences in both biotic and abiotic factors between urban and less-urban sites. Second was to determine how useful urban habitats are as reptile and amphibian conservation areas.

MATERIALS AND METHODS

STUDY SITES

The study took place at six separate sites, all in West Virginia (Figure 1). The urban study sites were Barboursville Park, Ritter Park, and the Huntington Museum of Art. These three sites were considered urban because they were surrounded by residential areas within the city of Huntington in the case of the Huntington Museum of Art and Ritter Park, and the town of Barboursville in the case of Barboursville Park. For comparison, research was also carried out at Beech Fork State Park, Green Bottom Wildlife Management Area (WMA), and Chief Cornstalk WMA. These latter three sites offered habitats that were more removed from urban areas with less development surrounding them. Beech Fork State Park covers an area of 1,272 ha (Beech Fork 2009) and is located in Wayne and Cabell counties. Ritter Park is in Cabell County and covers 30 ha (Clarkson 2004). The Huntington Museum of Art is also in Cabell County and it covers an area over 16 ha (Nature Trails 2010). Barboursville Park covers an area over 364 ha (Village of Barboursville 2008) in Cabell County. Chief Cornstalk Wildlife Management Area is in Mason County and covers 4,764 ha (WVDNR 2003). Green Bottom WMA covers 444 ha (WVDNR 2003) in Cabell County.

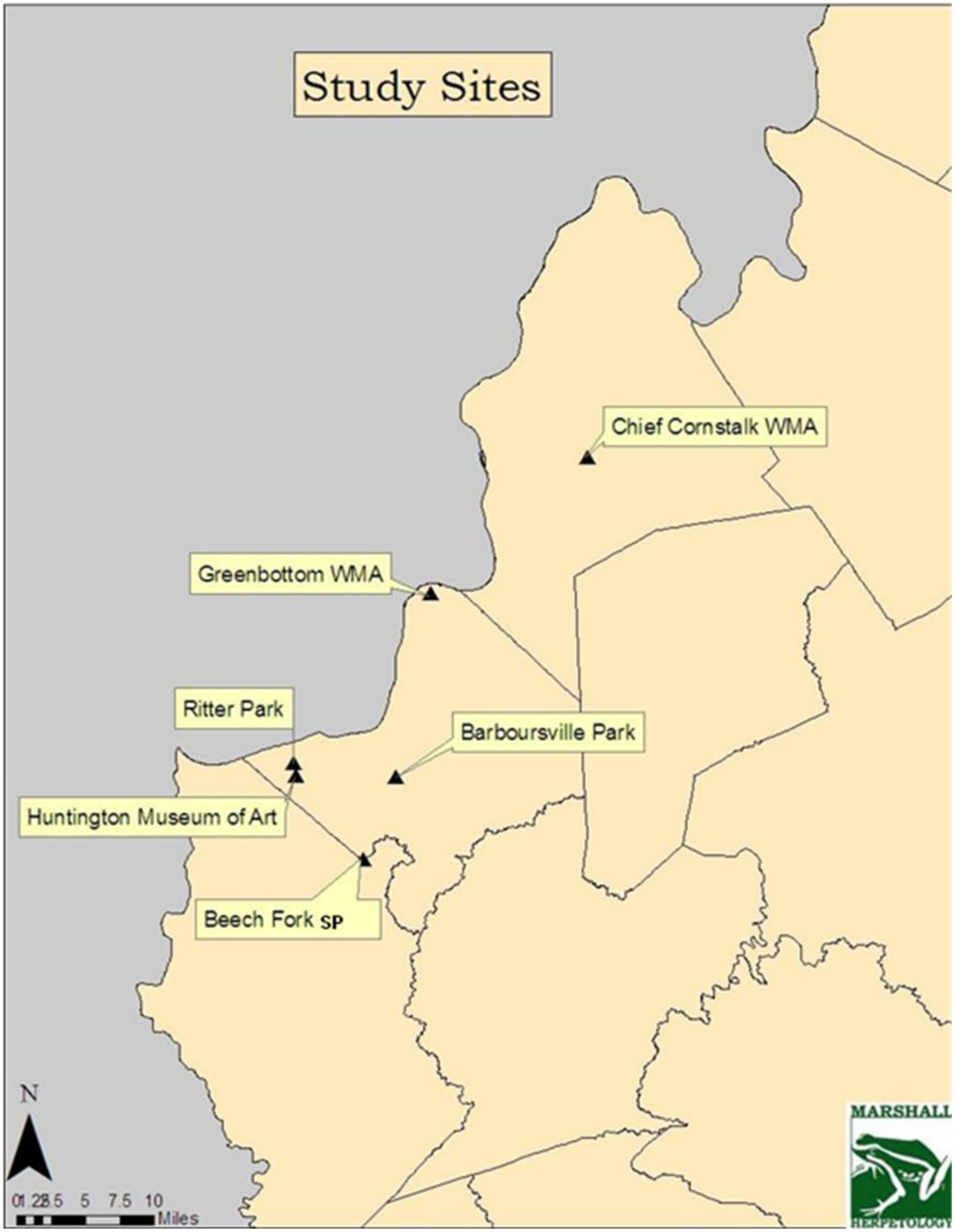

Figure 1. Location of the study sites in western West Virginia.

SAMPLING

TIME-CONSTRAINED SURVEYS

Time-constrained visual surveys were carried out to search for animals as described by Barrett and Guyer (1998); Suazo-Ortuño *et al.* (2008); Luiselli and Akani (2002); Stevenson *et al.* (2003); Dubey *et al.* (2008); and Wilson *et al.* (2006). These surveys consisted of both straight line transects and opportunistic searches at each study site. These visual surveys entailed searching areas for a set period of time. During the field season of March through October both daytime and nighttime surveys were conducted at each of the six study sites. Daytime surveys consisted of moving through the area and looking on the ground and flipping any cover objects such as rocks and logs that the surveyor came across and were similar to those used by Barrett and Guyer (1998) and Suazo-Ortuño *et al.* (2008). Trees were searched for the presence of certain snake, salamander, lizard, and frog species that might have climbed or perched in them. These included Common Five-lined Skinks (*Plestiodon fasciatus*), Eastern Ratsnakes (*Pantherophis obsoletis*), and Cope's Gray Treefrogs (*Hyla chyrsoscelis*) which are known to climb trees. Nighttime surveys occurred in the same areas as the daytime surveys, but the surveyors wore headlamps or used flashlights to spot animals as outlined by Wilson *et al.* (2006). Logs and rocks were flipped and trees were checked as described for the daytime searches to find as many animals as possible.

No night searches were made at Barboursville Park because the park is closed at night and previous attempts to get access to the grounds after dark were unsuccessful (T. K. Pauley 2009 personal communication). No night searches were conducted at Chief

Cornstalk WMA due to its greater distance and the fact that most species found in this study could be detected just as easily during the day as at night.

MORPHOMETRICS

Each animal observed was captured in either a pillow case or a plastic bag depending on the size of the animal. A GPS coordinate point was taken at the animal's location and the time, date, and several environmental variables were recorded. Each animal was weighed, measured for various lengths and widths, and its location data was recorded. Snout-vent length, cranial width, and mass were collected on snakes, frogs, toads, lizards, and salamanders. Total length and tail length were also measured in snakes, lizards, and salamanders. Snout-urostyle length, tibia length, snout length, and tympanum diameter were also taken on frogs. For toads, cranial crest position, number of warts per spot, relative percentages of belly mottling (in 25% intervals), whether the tibia warts were enlarged or not, and the area of the right parotoid gland were also recorded. Mass, straight-line carapace length, maximum carapace length, straight-line plastron length, maximum plastron length, maximum carapace width, carapace width after the second vertebral scute, plastron width at the bridge, bridge height on the left, and bridge height on the right were taken on turtles. Box turtles also had their hinge length measured. All animals were sexed when possible using secondary sexual characteristics. These included characters such as relative size of the tympanum in frogs, use of release calls in frogs and toads, presence of mental glands in male salamanders, and coloration of lizards.

Calipers were used to measure smaller animals and string and a tape measure were used to measure larger snakes. This method involved placing the string on the tip of the snake's snout, then following its spine all the way to the tip of the tail to get a total length as described by Rivas *et al.* (2008). The reason for this was that snakes often do not stretch out to their full length and it was much easier to get an accurate measure of the curves using the string rather than a rigid tape measure. String could then be stretched out along a tape measure to get an accurate length. This method was repeated to measure the snake's tail length and that was subtracted from the total length in order to get a snout-vent length. Any peculiarities or special behaviors were also noted.

The presence of any calling frogs and toads was recorded. Calls were also classified as a calling index of one, two, or three based on the North American Amphibian Monitoring Program guidelines (NAAMP 2009). An index of one entailed conditions where individuals could be counted and there was space between calls, two meant that individuals could be distinguished but there was some overlap in the calls, and three was characterized by a full chorus with constant and overlapping calls (NAAMP 2009).

ENVIRONMENTAL VARIABLES

Canopy cover data was taken at each site using a densiometer. This device is a handheld concave lens with 96 dots on a mirrored grid on its surface (Strickler, 1959). By counting how many dots were covered by the image of the canopy, a measure of canopy cover was achieved (Strickler, 1959). A reading was taken where the animal was found to the North, South, East, and West and then the four were averaged to get a more accurate reading of canopy cover (Strickler, 1959).

Air temperature and relative humidity were measured with a thermohygrometer. Soil temperature was also collected with a thermometer and the aspect of the study sites was determined with a handheld compass. Elevation was taken from the handheld GPS unit at each animal location and the cover object that the animal was using or if it was in the open was also recorded.

VEGETATION

Trees, defined as woody plants > 1 m in height and ≥ 2.5 cm in diameter at breast height (DBH), were counted and measured in plots. Each plot was a circle with a radius of 11.3 m. Plots were divided into four quadrants incorporating two of the cardinal directions each, resulting in a southeast, southwest, northeast, and northwest quadrant in each plot. These plots were similar to those used by Gilliam *et al.* (1995). Five plots were non-randomly located within each study site. The center of a plot was at or near a GPS point for an animal. The diameter at breast height data was used to determine basal area, relative basal area, density, relative density, and importance values of trees within the study sites. All trees were identified to species. Soil samples were taken to determine soil moisture percentage, organic matter percentage, and pH of the sites and these were randomly taken from one of the quadrants of the circle. A six-sided die was used to select the quadrant where the soil and leaf litter samples were collected. Leaf litter and organic soil were collected by placing a wooden square cover board with sides of 30.5 cm on the surface, cutting around its edges with a spade, and then removing all of the leaf litter and organic matter underneath the board. Once the researcher reached the inorganic soil layer, collection was stopped. The leaf litter and organic soil were placed together in a paper bag and the paper bag was then placed inside a quart re-sealable plastic bag. Both bags were labeled and taken back to determine leaf litter and organic soil combined mass. Some of the inorganic soil was then collected for the soil sample. This soil was placed in a sterile Whirl-Pak® bag and taken back for soil pH, organic matter percentage, and moisture percentage. Cover objects for reptiles and amphibians were also counted in the same quadrant of the circle where the leaf litter and soil sample were gathered.

Soil was placed in an airtight container (Whirl-Pak® bag), taken back to the laboratory, frozen until a week before weighing, thawed for 24 hours, then refrigerated another six days. Soil moisture was gathered by weighing the soil, drying it in an oven slightly above 100º C for 24 hours and then weighing the sample a second time as described by Taub (1961). The organic matter composition was also found by placing the oven dried soil samples back into the oven at a level of 500º C for five hours. The samples were then reweighed to determine the organic matter content. Mass of the combination of leaf litter and organic soil was gathered by setting the paper bags containing the material from the vegetation plots out to air dry for two weeks, then in an oven for two hours at 150º C, and then weighing the contents. Weighing was done by placing the bag on an analytical balance, recording the mass, then discarding the contents of the bag and reweighing the bag. The weight of the bag was then subtracted from the weight of the litter and the bag to ascertain the mass of the litter.

ANALYSIS

VEGETATION

Diameter at breast height (DBH) data were used to calculate basal area (BA). DBH was measured in cm, but basal area is measured in m^2/ha. Each DBH was squared and then multiplied by the conversion factor 0.00196 to get basal area in the proper units. This was done for each tree in each plot, and these values were then added up for each species at a site. Relative basal area was also calculated by dividing a species' total basal area by the sum of all of the basal areas within a site. Density was calculated in stems per ha by dividing the total number of stems of a given tree species by 400 m^2, the area of a plot, and multiplying by 25, the number of plots needed to add up to 1 ha. Relative density was also calculated by dividing the density of a species by the sum of the densities of all of the species found at a site and multiplying by 100. Importance values came from taking the average of the sum of a species' relative basal area and relative density. Average density, basal area, and cover object counts were compared across sites using a one-way analysis of variance (ANOVA) in SPSS version 15.0. A Tukey post-hoc test was applied to the results of the density ANOVA in SPSS.

SOIL AND LEAF LITTER

Moisture of the soil was calculated by finding the difference between the mass of the soil before drying and the mass of the soil after drying at 100º C. This difference was divided by the mass of the soil before drying and multiplied by 100 to get a percentage. The organic matter of the soil was calculated by finding the difference between the mass of the soil dried at 100º C and that dried at 500º C and then dividing that value by the mass of the soil dried at 100º C. This was then multiplied by 100 to get a percentage. Soil moisture percentage, soil organic matter percentage, pH, and combined leaf litter and organic soil mass were compared using an ANOVA in SPSS version 15.0. A Tukey post-hoc test was applied to the results of the combined leaf litter and organic soil mass ANOVA in SPSS.

CANONICAL CORRESPONDENCE ANALYSIS

Canoco 4.5 was used to run canonical correspondence analysis (CCA) on Barboursville Park, Beech Fork State Park, Ritter Park, and the Huntington Museum of

Art. All tree species documented in the vegetation plots were incorporated into this analysis with average basal areas for all plots. Average total tree density (D), total basal area (BA), soil pH (pH), soil moisture percentage (moisture), soil organic matter percentage (OM), and combined leaf litter and organic soil mass (litter) from all plots were also included as environmental variables. Centroid values with one standard error taken from the CCA were graphed in Microsoft Excel for comparison.

SPECIES RICHNESS AND COMMUNITY SIMILARITY

The measure of species richness used in this study was the number of species present at a site (Smith and Smith 2000). The equation for community similarity is the number of species in common between site one and site two multiplied by two and divided by the sum of the total species at site one and site two, all multiplied by 100 (Barbour *et al.* 1999, Smith and Smith 2000). Since the study was mostly done by a single researcher, and the study sites covered a large area, it was expected that not all species present at the sites would be detected. To help counteract this, a literature search was made of previous Marshall University theses that conducted research at these sites to find what species were previously documented at the study sites. These data were incorporated into both the species richness and community similarity calculations.

ARCGIS

A map was created for each of the study sites which incorporated the GPS data points of the animals encountered in this study. This visually shows how much impervious surface is within the sites and how close residential areas are to the sites.

RESULTS

Hours spent on time-constrained searches were 82.5 (Table 1). Opportunistic and transect searches were performed both during the day and at night. Nocturnal searches totaled 11.96 hours. Day searches accounted for 70.52 hours. Opportunistic searches were more prevalent than transect searches with 56.82 and 25.66 hours respectively.

Table 1. Hours spent searching for animals at all study sites showing the amount of effort spent on nighttime, daytime, opportunistic, and transect searches.

	Total	Night	Day	Opportunistic	Transect
Galleries	18.55	1.83	16.72	15.55	3.00
Ritter	9.51	1.45	8.06	6.76	2.75
Barboursville	9.75	0.00	9.75	5.32	4.43
Green Bottom	8.51	1.28	7.23	6.51	2.00
Cornstalk	21.64	0.00	21.64	15.56	6.08
Beech Fork	14.52	7.40	7.12	7.12	7.40
Sum	82.50	11.96	70.52	56.82	25.66

Across all six sites two species of toads, eight species of frogs, 10 species of salamanders, six species of snakes, five species of turtles, and two species of lizards were found (Figures 2 – 27, no pictures were taken of Northern Leopard Frogs, Wood Frogs, Seal Salamanders, Northern Watersnakes, Eastern Gartersnakes, Red-eared Sliders, or Little Brown Skinks during this study). Representatives from all of the groups were found at the Huntington Museum of Art, Chief Cornstalk Wildlife Management Area, and Beech Fork State Park. Total species richness (number of species) at each site from this study alone was six at Ritter Park, 13 at Chief Cornstalk WMA, 21 at Beech Fork State Park, nine at Green Bottom WMA, 14 at the Huntington Museum of Art, and eight at Barboursville Park. With historic data and personal communications these increased to seven for Ritter Park, 32 at Beech Fork State Park, 15 at Green Bottom WMA, 17 at the Huntington Museum of Art, and nine at Barboursville Park (Tables 2, 3, 4). There were no historical records for Chief Cornstalk Wildlife Management Area.

Figure 2. Eastern American Toad at the Huntington Museum of Art.

Figure 3. Cope’s Gray Treefrogs at Beech Fork State Park.

Figure 4. Mountain Chorus Frog at Beech Fork State Park.

Figure 5. Spring Peeper at Beech Fork State Park.

Figure 6. American Bullfrog at Green Bottom Wildlife Management Area.

Figure 7. Northern Green Frog at Green Bottom Wildlife Management Area.

Figure 8. Pickerel Frog at Beech Fork State Park, showing characteristic yellow coloration on the underside of the legs.

Figure 9. Eastern Spadefoot at Beech Fork State Park.

Figure 10. Jefferson Salamander at Beech Fork State Park.

Figure 11. Spotted Salamander at Beech Fork State Park.

Figure 12. Marbled Salamander at Beech Fork State Park.

Figure 13. Northern Dusky Salamander at Chief Cornstalk Wildlife Management Area.

Figure 14. Southern Two-lined Salamander at the Huntington Museum of Art.

Figure 15. Spring Salamander at the Huntington Museum of Art.

Figure 16. Red-spotted Newt at Beech Fork State Park.

Figure 17. Cumberland Plateau Salamander at the Huntington Museum of Art.

Figure 18. Southern Ravine Salamander at Ritter Park.

Figure 19. Eastern Wormsnake at the Huntington Museum of Art.

Figure 20. Northern Ring-necked Snake at Chief Cornstalk Wildlife Management Area.

Figure 21. Eastern Ratsnake at the Huntington Museum of Art.

Figure 22. Eastern Milksnake at Beech Fork State Park.

Figure 23. Common Snapping Turtle at Beech Fork State Park.

Figure 24. Midland Painted Turtle at Green Bottom Wildlife Management Area.

Figure 25. Stinkpot from Green Bottom Wildlife Management Area.

Figure 26. Eastern Box Turtle at Ritter Park.

Figure 27. Common Five-lined Skink at Beech Fork State Park.

Table 2. List of common and scientific names of the species found in this study. Names in bold were only found in historic records.

Common Name	Scientific Name
Eastern American Toad	*Bufo a. americanus*
Cope's Gray Treefrog	*Hyla chrysoscelis*
Mountain Chorus Frog	*Pseudacris brachyphona*
Spring Peeper	*Pseudacris crucifer*
American Bullfrog	*Rana catesbeiana*
Northern Green Frog	*Rana clamitans melanota*
Pickerel Frog	*Rana palustris*
Northern Leopard Frog	*Rana pipiens*
Wood Frog	*Rana sylvatica*
Eastern Spadefoot	*Scaphiopus holbrookii*
Jefferson Salamander	*Ambystoma jeffersonianum*
Spotted Salamander	*Ambystoma maculatum*
Marbled Salamander	*Ambystoma opacum*
Northern Dusky Salamander	*Desmognathus fuscus*
Seal Salamander	*Desmognathus monticola*
Southern Two-lined Salamander	*Eurycea cirrigera*
Long-tailed Salamander	***Eurycea l. longicauda***
Spring Salamander	*Gyrinophilus porphyriticus*
Red-spotted Newt	*Notophthalmus v. viridescens*
Northern Slimy Salamander	***Plethodon glutinosus***
Cumberland Plateau Salamander	*Plethodon kentucki*
Southern Ravine Salamander	*Plethodon richmondi*
Midland Mud Salamander	***Pseudotriton montanus diastictus***
Northern Copperhead	***Agkistrodon contortrix mokasen***
Eastern Wormsnake	*Carphophis a. amoenus*
Northern Ring-necked Snake	*Diadophis punctatus edwardsii*
Eastern Ratsnake	*Pantherophis alleghaniensis*
Eastern Milksnake	*Lampropeltis t. triangulum*
Northern Watersnake	*Nerodia s. sipedon*
Northern Rough Greensnake	***Opheodrys a. aestivus***
Eastern Gartersnake	*Thamnophis s. sirtalis*
Eastern Snapping Turtle	*Chelydra s. serpentina*
Midland Painted Turtle	*Chrysemys picta marginata*
Eastern Musk Turtle	*Sternotherus odoratus*
Eastern Box Turtle	*Terrapene c. carolina*

Table 2. continued

Common Name	Scientific Name
Red-eared Slider	*Trachemys scripta elegans*
Common Five-lined Skink	*Plestiodon fasciatus*
Broad-headed Skink	***Plestiodon laticeps***
Eastern Fence Lizard	***Sceloporus undulatus***
Little Brown Skink	*Scincella lateralis*

Table 3. Amphibian and reptile species found at Barboursville Park, Beech Fork State Park, and Chief Cornstalk WMA (species with text following the "y" are species that were not found in the present study but were found in past studies, with the author and year of the study indicated).

Species	Barboursville Park	Beech Fork State Park	Chief Cornstalk WMA
Bufo americanus	y	y	y
Hyla chrysoscelis	y	y	y
Pseudacris brachyphona	y	y	
Pseudacris crucifer		y	
Rana catesbeiana		y	y
Rana clamitans melanota	y	y	y
Rana palustris		y	
Rana pipiens			
Rana sylvatica	y	y (Myers 2003)	
Scaphiopus holbrookii		y	
Ambystoma jeffersonianum		y	
Ambystoma maculatum		y	
Ambystoma opacum		y	
Desmognathus fuscus		y (Brophy 1995)	y
Desmognathus monticola			
Eurycea cirrigera		y	y
Eurycea longicauda		y (Bailey 1992)	
Gyrinophilus porphyriticus		y	
Notophthalmus viridescens	y	y	y
Plethodon glutinosus		y (Bailey 1992)	
Plethodon kentucki		y	y
Plethodon richmondi		y	
Pseudotriton montanus		y (Bailey 1992)	
Agkistrodon contortrix		y (Bailey 1992)	
Carphophis amoenus	y	y (Bailey 1992)	y
Diadophis punctatus		y	y
Elaphe alleghaniensis			
Lampropeltis triangulum		y	
Nerodia sipedon			
Opheodrys aestivus	y (Baldwin 2007)		
Thamnophis sirtalis		y (Bailey 1992)	
Chelydra serpentina		y	
Chrysemys picta marginata			y
Sternotherus odoratus			
Terrapene carolina	y	y	y

Table 3. continued

Species	Barboursville Park	Beech Fork State Park	Chief Cornstalk WMA
Trachemys scripta elegans			
Eumeces fasciatus		y	y
Eumeces laticeps		y (Bailey 1992)	
Sceloporus undulatus		y (Bailey 1992)	
Scincella lateralis		y (Bailey 1992)	

Table 4. Amphibian and reptile species found at Huntington Museum of Art, Green Bottom WMA, and Ritter Park (species with a year indicated are species not found in the present study but that were found in past studies, with the year of the study indicated).

Species	Huntington Museum of Art	Green Bottom WMA	Ritter Park
Bufo americanus	y	y (Rogers 1999)	
Hyla chrysoscelis		y	
Pseudacris brachyphona	y		
Pseudacris crucifer		y	
Rana catesbeiana		y	
Rana clamitans melanota		y	
Rana palustris		y (Spriggs 2009)	
Rana pipiens		y	
Rana sylvatica	y (Kevin Saunders 2010 Personal Communication)	y (Sutton 2004)	
Scaphiopus holbrookii			
Ambystoma jeffersonianum			
Ambystoma maculatum		y (Sutton 2004)	
Ambystoma opacum			
Desmognathus fuscus	y		y
Desmognathus monticola	y		
Eurycea cirrigera	y		
Eurycea longicauda			
Gyrinophilus porphyriticus	y		
Notophthalmus viridescens		y (Rogers 1999)	
Plethodon glutinosus			
Plethodon kentucki	y		y
Plethodon richmondi	y		y
Pseudotriton montanus	y (Kevin Saunders 2010 Personal Communication)		
Agkistrodon contortrix			
Carphophis amoenus	y		
Diadophis punctatus	y		
Elaphe alleghaniensis	y		
Lampropeltis triangulum			
Nerodia sipedon			y
Opheodrys aestivus	y (Kevin Saunders 2010 Personal Communication)		y (Baldwin 2007)
Thamnophis sirtalis		y	
Chelydra serpentina		y	
Chrysemys picta marginata		y	

Table 4. continued

Species	Huntington Museum of Art	Green Bottom WMA	Ritter Park
Sternotherus odoratus		y	
Terrapene carolina	y		y
Trachemys scripta elegans		y (Aaron Gooley 2009 personal communication)	
Eumeces fasciatus	y		y
Eumeces laticeps			
Sceloporus undulatus			
Scincella lateralis	y		

Morphometrics were gathered on four turtles, seven snakes, 28 salamanders, 11 frogs, two toads, and zero lizards. Multiple species were caught and measured of each group at multiple sites, so the sample sizes were small for both species and sites.

Community similarity values ranged from 0% between Green Bottom WMA and Ritter Park, to 57.1% between Beech Fork State Park and the Huntington Museum of Art. Barboursville Park ranged from 25% similar to Ritter Park to 54.6% similar to Chief Cornstalk WMA (Table 5). The Huntington Museum of Art was from 12.5% similar to Green Bottom WMA to 57.1% similar to Beech Fork State Park. Ritter Park ranged from 0% similar to Green Bottom WMA to 50% similar to the Huntington Museum of Art. Beech Fork State Park was from 25.6% similar to Ritter Park to 57.1% similar to the Huntington Museum of Art. The range for Chief Cornstalk WMA was from 40% similar to Ritter Park to 54.6% similar to Barboursville Park. Green Bottom WMA ranged from 0% similar to Ritter Park to 46.8% similar to Beech Fork State Park.

Table 5. Matrix of Reptile and Amphibian Community Similarity Percentages.

	Barboursville	Beech Fork	Chief Cornstalk	Museum of Art	Greenbottom
Beech Fork	39.0	NA			
Chief Cornstalk	54.6	53.3	NA		
Museum of Art	46.2	57.1	53.3	NA	
Greenbottom	41.7	46.8	42.9	12.5	NA
Ritter	25.0	25.6	40.0	50.0	0.0

VEGETATION PLOTS

Plots were not used at Green Bottom Wildlife Management Area due to low numbers of trees that would fall within the limits set by this study. A list of Green Bottom’s trees was taken from a Marshall University thesis (Stark 1993). Plant species found at Green Bottom that might have been woody, at least 1 m in height, and had a DBH $\geq$ 2.5 cm are shown in Table 6. Plots were also not used at Chief Cornstalk WMA due to time constraints. Some tree species were recorded from Chief Cornstalk WMA during searches for animals (Table 7).

Table 6. Trees of Green Bottom WMA (Stark 1993).

Common Name	Scientific Name
Boxelder	*Acer negundo*
Red maple	*Acer rubrum*
Silver maple	*Acer saccharinum*
Yellow Buckeye	*Aesculus octandra*
Smooth/brookside alder	*Alnus serrulata*
Pawpaw	*Asimina triloba*
River/red birch	*Betula nigra*
Bitternut hickory	*Carya cordiformis*
Shellbark hickory	*Carya laciniosa*
Common catalpa	*Catalpa bignonioides*
Hackberry	*Celtis occidentalis*
Buttonbush	*Cephalanthus occidentalis*
Silky cornel, kinnikinnik, silky dogwood	*Cornus amomum*
Persimmon	*Diospyros virginiana*
White ash	*Fraxinus americana*
Green ash	*Fraxinus pennsylvanica*
Honey locust	*Gleditsia triacanthos*
Black walnut	*Juglans nigra*
Spicebush	*Lindera benzoin*
Osage orange	*Maclura pomifera*
White mulberry	*Morus alba*
Red mulberry	*Morus rubra*
Sycamore	*Platanus occidentalis*
Silver poplar	*Populus alba*
Cottonwood	*Populus deltoides*
Black Cherry	*Prunus serotina*
Black locust	*Robinia pseudoacacia*
Staghorn sumac	*Rhus typhina*
Sandbar willow	*Salix exigua*
Black willow	*Salix nigra*
Sassafras	*Sassafras albidum*
Slippery elm	*Ulmus rubra*

Table 7. Trees of Chief Cornstalk WMA found incidentally during this study.

Common Name	Scientific Name
Red maple	*Acer rubrum*
Sugar maple	*Acer saccharum*
Autumn olive	*Eleagnus umbellata*
Black oak	*Quercus velutina*
Hickory species	*Carya sp.*
Redbud	*Cercis canadensis*
Rock Chestnut oak	*Quercus prinus*
Flowering dogwood	*Cornus florida*
American beech	*Fagus grandifolia*
Black walnut	*Juglans nigra*
Spicebush	*Lindera benzoin*
Tulip poplar	*Liriodendron tulipifera*
White oak	*Quercus alba*
Oak species	*Quercus sp.*
Slippery elm	*Ulmus rubra*

There were 41 tree species found across the remaining four sites (Table 8). From here onward trees will be referred to by their four letter code (Table 8).

Table 8. List of tree species found at the Huntington Museum of Art, Ritter Park, Barboursville Park, and Beech Fork State Park in this study.

Species Name	Scientific Name	Code
Boxelder	*Acer negundo*	ACNE
Norway Maple	*Acer platanoides*	ACPL
Red Maple	*Acer rubrum*	ACRU
Silver Maple	*Acer saccharinum*	ACSN
Sugar Maple	*Acer saccharum*	ACSA
Yellow Buckeye	*Aesculus octandra*	AEOC
Tree of Heaven	*Ailanthus altissima*	AIAL
Black Birch	*Betula lenta*	BELE
Ironwood	*Carpinus caroliniana*	CACA
Bitternut Hickory	*Carya cordiformis*	CACO
Pignut Hickory	*Carya glabra*	CAGL
Shagbark Hickory	*Carya ovata*	CAOV
Mockernut Hickory	*Carya tomentosa*	CATO
Common Catalpa	*Catalpa bignonioides*	CABI
Redbud	*Cercis canadensis*	CECA
Flowering Dogwood	*Cornus florida*	COFL
Cockspur Hawthorn	*Crataegus crus-galli*	CRCR
Persimmon	*Diospyros virginiana*	DIVI
Autumn Olive	*Eleagnus umbellata*	ELUM
American Beech	*Fagus grandifolia*	FAGR
White Ash	*Fraxinus americana*	FRAM
Green Ash	*Fraxinus pennsylvanica*	FRPE
Eastern Red Cedar	*Juniperus virginiana*	JUVI
Tulip Poplar	*Liriodendron tulipifera*	LITU
Osage Orange	*Maclura pomifera*	MAPO
Red Mulberry	*Morus rubra*	MORU
Black Gum	*Nyssa sylvatica*	NYSY
Sourwood	*Oxydendrum arboreum*	OXAR
White Pine	*Pinus strobis*	PIST
Virginia Pine	*Pinus virginiana*	PIVI
Sycamore	*Platanus occidentalis*	PLOC
Black Cherry	*Prunus serotina*	PRSE
White Oak	*Quercus alba*	QUAL
Scarlet Oak	*Quercus coccinea*	QUCO
Chestnut Oak	*Quercus prinus*	QUPR

Table 8. continued

Species Name	Scientific Name	Code
Northern Red Oak	*Quercus rubra*	QURU
Post Oak	*Quercus stellata*	QUST
Black Oak	*Quercus velutina*	QUVE
Winged Sumac	*Rhus coppalina*	RHCO
Black Locust	*Robinia pseudoacacia*	ROPS
Slippery Elm	*Ulmus rubra*	ULRU

CANONICAL CORRESPONDENCE ANALYSIS

Relative length of the lines in the ordination depicts relative importance. Soil organic matter percentage (OM) was most important in separating the plots, then basal area (BA), then density (D) (Figure 28). Soil moisture percentage (“moisture”), pH, and combined organic soil and leaf litter mass (“litter”) did not have a very strong effect on separation of the plots. Soil moisture was more important than pH and combined organic matter and leaf litter mass. PIST and MORU were unique to Ritter Park and helped separate it from the other sites. PIVI and JUVI were unique to Beech Fork State Park and helped separate that site from the others. ELUM helped separate Barboursville Park from the other sites, but it was also found at Ritter Park. ROPS also helped separate Barboursville from the other sites, but it too was not unique to Barboursville. ULRU was an important tree for all of the sites.

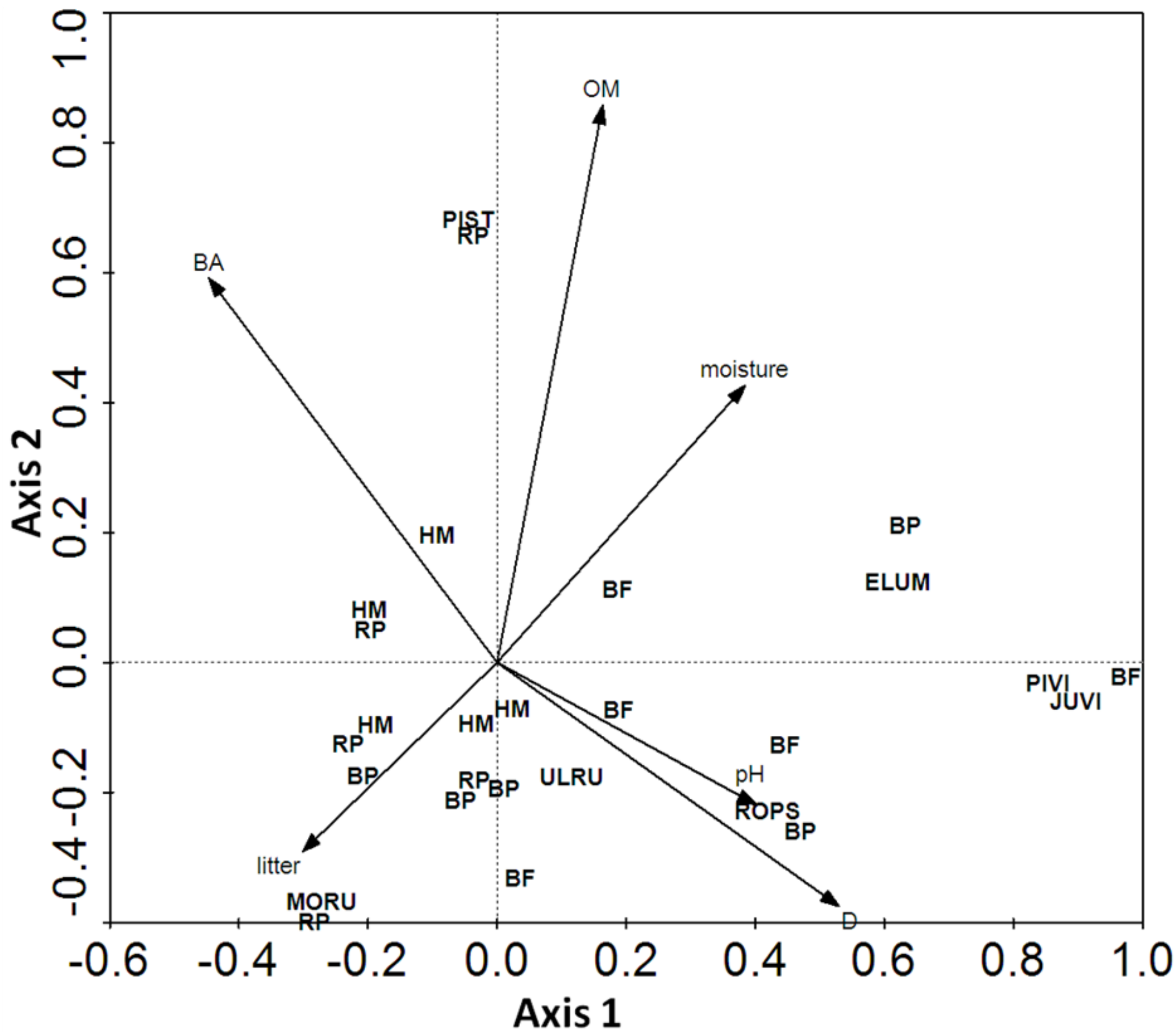

Figure 28. Canonical correspondence analysis (CCA) ordination plot for Beech Fork State Park (BF), Barboursville Park (BP), Ritter Park (RP), and the Huntington Museum of Art (HM). Only the top seven species, based on axis loading, are included. Eigenvalues: CCA 1 – 0.671, CCA 2 – 0.584; species – environment correlations: CCA 1 – 0.95, CCA 2 – 0.94

The centroids from CCA were graphed in Microsoft Excel to more clearly show the delineation of the sites (Figure 29). Barboursville Park and Beech Fork State Park formed a group and Ritter Park and the Huntington Museum of Art formed a group. Axis 1 explains most of the separation in the sites.

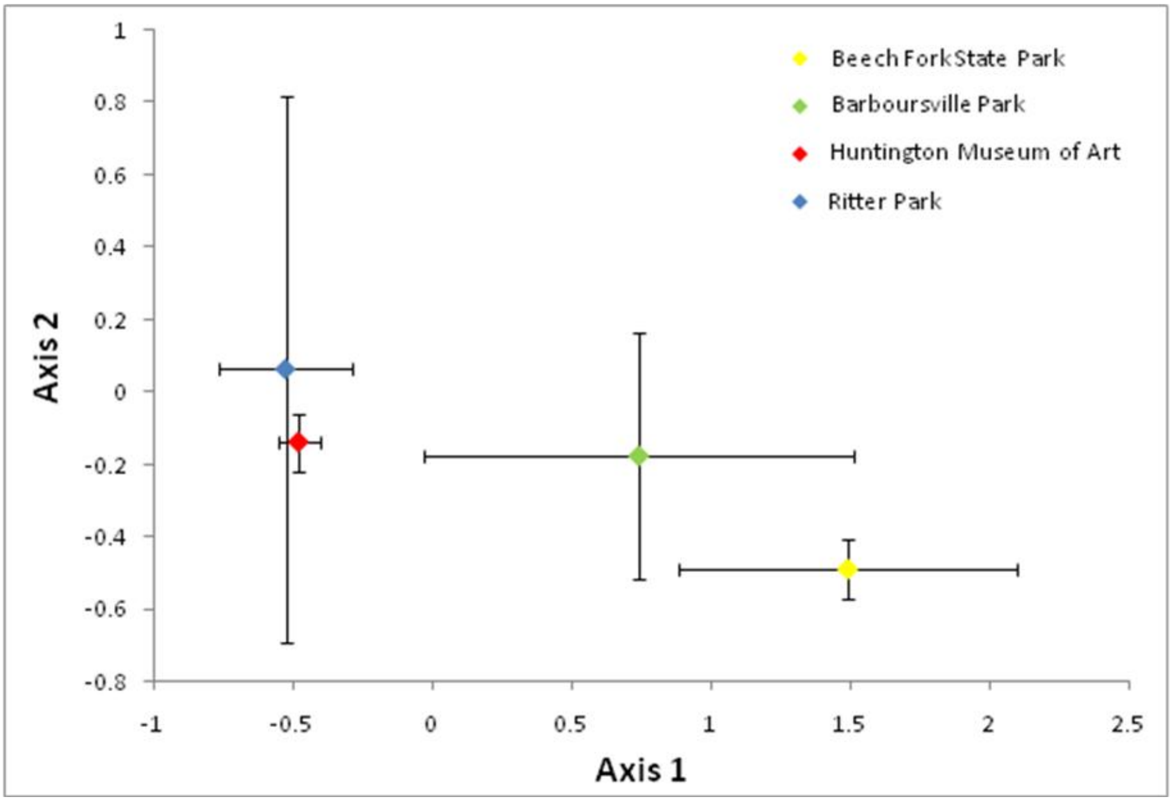

Figure 29. Centroid values of the canonical correspondence analysis (CCA) for Beech Fork State Park, Barboursville Park, Ritter Park, and the Huntington Museum of Art.

Fifteen tree species were recorded across the plots at the Huntington Museum of Art (Table 9). Three of these had importance values ≥10. ACSA had the highest importance value with 36.6%. Its importance was due to both density and basal area. QUPR and QUVE also had high importance values, 22.6% and 17.3% respectively, but basal area was the greater factor in their importance. Cover object counts revealed an average of 21 logs and four rocks per 100 m^2.

Table 9. Plant data from the Huntington Museum of Art (density is measured in plants per ha and basal area is in m^2, relative basal area, relative density, and importance values are percentages).

Code	Basal Area (BA)	Relative BA	Density	Relative Density	Importance Value
ACSA	20.0	15.1	4.1	58.0	36.6
QUPR	47.8	36.2	0.6	8.9	22.6
QUVE	37.4	28.3	0.4	6.3	17.3
LITU	14.7	11.1	0.3	3.6	7.3
FAGR	1.2	0.9	0.6	8.0	4.5
CAOV	5.9	4.5	0.3	3.6	4.0
QUCO	3.0	2.3	0.1	0.9	1.6
ACRU	0.4	0.3	0.1	1.8	1.1
NYSY	0.4	0.3	0.1	1.8	1.0
ULRU	0.2	0.2	0.1	1.8	1.0
CACO	0.0	0.0	0.1	1.8	0.9
QUAL	0.5	0.4	0.1	0.9	0.6
CATO	0.1	0.1	0.1	0.9	0.5
COFL	0.2	0.1	0.1	0.9	0.5
ROPS	0.3	0.2	0.1	0.9	0.5
Total	132.1	100.0	7.0	100.0	100.0

Twenty one species of trees were recorded at Barboursville Park, four of which had importance values ≥10 (Table 10). ACSA had the highest importance value of 15.7%, due to high density and high basal area. QUPR had the second highest importance value of 14.0%, but basal area contributed more to its importance than density. ELUM was third in importance with 14.0%, and its density had more of an effect on its importance value than basal area. QUVE was fourth in importance at 12.6%, due to a high basal area. For cover objects, averages at this site were 11 logs, eight rocks, and one piece of bark per 100 m^2.

Table 10. Plant data from Barboursville Park (density is measured in plants per ha and basal area is in m^2, relative basal area, relative density, and importance values are percentages).

Code	Basal Area (BA)	Relative BA	Density	Relative Density	Importance Value
ACSAC	9.4	9.7	2.3	21.7	15.7
ELUM	2.0	2.0	2.7	25.9	14.0
QUPR	22.6	23.2	0.5	4.8	14.0
QUVE	22.8	23.4	0.2	1.8	12.6
QUAL	12.2	12.5	0.5	4.8	8.7
MAPO	8.4	8.7	0.4	4.2	6.4
CAOV	2.0	2.0	0.8	7.2	4.6
QUCO	6.5	6.6	0.2	1.8	4.2
ROPS	3.1	3.2	0.4	4.2	3.7
QURU	3.7	3.8	0.3	2.4	3.1
FRPE	1.7	1.8	0.4	4.2	3.0
ULRU	0.3	0.4	0.4	4.2	2.3
CAGL	1.1	1.1	0.3	3.0	2.0
COFL	0.3	0.3	0.3	2.4	1.3
FAGR	0.1	0.2	0.3	2.4	1.3
ACRU	0.5	0.5	0.1	1.2	0.9
FRAM	0.2	0.2	0.1	1.2	0.7
LITU	0.2	0.2	0.1	0.6	0.4
NYSY	0.2	0.2	0.1	0.6	0.4
CECA	0.0	0.0	0.1	0.6	0.3
CRCR	0.1	0.1	0.1	0.6	0.3
Total	97.4	100.0	10.4	100.0	100.0

Twenty four species of trees occurred at Beech Fork State Park, but only two had importance values ≥10 (Table 11). Of these, PIVI had the highest importance value with 17.8%. It had high basal area and high density. QUAL was second, with an importance value of 11.7%. Basal area had a stronger influence than density on the importance value of QUAL. QUCO had an importance value almost ≥10, with 9.9%. Basal area played a larger role than density in the importance value of this species. Beech Fork State Park had an average of 11 rocks, 4 logs, and one piece of bark per 100 m^2.

Table 11. Plant data from Beech Fork State Park (density is measured in plants per ha and basal area is in m^2, relative basal area, relative density, and importance values are percentages).

Code	Basal Area (BA)	Relative BA	Density	Relative Density	Importance Value
PIVI	13.8	18.1	2.7	17.6	17.8
QUAL	13.2	17.2	0.9	6.1	11.7
QUCO	13.9	18.2	0.3	1.6	9.9
PLOC	9.9	12.9	0.6	3.7	8.3
FAGR	3.2	4.2	1.8	11.8	8.0
ACRU	2.1	2.7	1.9	12.2	7.5
ACSA	2.9	3.9	1.2	7.8	5.8
COFL	1.4	1.8	1.1	7.3	4.6
CAOV	1.5	2.0	0.9	6.1	4.1
ROPS	4.4	5.7	0.3	2.0	3.9
PRSE	2.9	3.8	0.5	3.3	3.5
QUST	1.8	2.4	0.6	3.7	3.0
AEOC	1.4	1.8	0.4	2.9	2.3
CACA	0.8	1.1	0.5	3.3	2.2
ULRU	0.6	0.8	0.4	2.4	1.6
DIVI	1.4	1.8	0.2	1.2	1.5
RHCO	0.2	0.3	0.3	2.0	1.2
OXAR	0.5	0.6	0.3	1.6	1.1
JUVI	0.2	0.3	0.2	1.2	0.7
LITU	0.3	0.4	0.1	0.4	0.4
ACNE	0.0	0.0	0.1	0.4	0.2
CECA	0.1	0.1	0.1	0.4	0.2
PIST	0.1	0.1	0.1	0.4	0.2
QUVE	0.0	0.0	0.1	0.4	0.2
Total	76.5	100.0	15.3	100.0	100.0

Ritter Park had 23 tree species and three had importance values ≥10 (Table 12). The ones with the highest importance values were ACSA at 22.2%, LITU at 16.0%, and PIST at 11.5%. Density was most important in the importance value of ACSA. Basal area was more important for the importance values of LITU and PIST. Ritter Park had an average of 25 rocks and 11 logs per 100 m^2.

Table 12. Plant data from Ritter Park (density is measured in plants per ha and basal area is in m^2, relative basal area, relative density, and importance values are percentages).

Total	Basal Area (BA)	Relative BA	Density	Relative Density	Importance Value
ACSA	3.5	2.3	3.9	42.2	22.2
LITU	39.2	25.3	0.6	6.8	16.0
PIST	30.4	19.6	0.3	3.4	11.5
QUVE	20.6	13.3	0.4	4.8	9.0
FAGR	23.4	15.1	0.1	1.4	8.2
PRSE	15.8	10.2	0.1	1.4	5.8
AIAL	7.2	4.7	0.4	4.8	4.7
CECA	1.6	1.0	0.4	4.8	2.9
ACNE	1.1	0.7	0.4	4.8	2.7
ACPL	2.7	1.7	0.3	2.7	2.2
AEOC	0.1	0.1	0.4	4.1	2.1
QUAL	5.1	3.3	0.1	0.7	2.0
ULRU	0.6	0.4	0.3	3.4	1.9
COFL	1.1	0.7	0.2	2.0	1.4
MORU	0.6	0.4	0.2	2.0	1.2
ACSN	0.4	0.3	0.2	2.0	1.1
CATO	0.3	0.2	0.1	1.4	0.8
ROPS	0.4	0.3	0.1	1.4	0.8
BELE	0.1	0.0	0.1	1.4	0.7
CACO	0.0	0.0	0.1	1.4	0.7
ELUM	0.0	0.0	0.1	1.4	0.7
NYSY	0.1	0.1	0.1	1.4	0.7
CABI	0.8	0.5	0.1	0.7	0.6
Total	155.1	100.0	9.2	100.0	100.0

Average basal area was not significantly different between sites ($F = 2.276$, $P = 0.119$). Density, however, was significantly different ($F = 4.461$, $P = 0.019$). This difference was between Beech Fork State Park and the Huntington Museum of Art ($P = 0.013$). Average density was almost statistically significant between Beech Fork and Ritter Park ($P = 0.082$). Average numbers of cover objects were not statistically different between sites ($F = 0.778$, $P = 0.523$).

TREE COMMUNITY SIMILARITY

Several additional tree species were found at Barboursville Park, Ritter Park, the Huntington Museum of Art, and Beech Fork State Park during animal searches. These were included in the tree community similarity analysis. At Ritter Park, red maple (*Acer rubrum*), bitternut hickory (*Carya cordiformis*), mockernut hickory (*C. tomentosa*), American holly (*Ilex opaca*), and sassafras (*Sassafras albidum*) were found outside of the vegetation plots. Bitternut hickory (*C. cordiformis*), honey locust (*Gleditsia triacanthos*), black walnut (*Juglans nigra*), eastern red cedar (*Juniperus virginiana*), spicebush (*Lindera benzoin*), and sassafras (*S. albidum*) were added to the species list for Barboursville Park. At the Huntington Museum of Art, yellow buckeye (*Aesculus octandra*), black birch (*Betula lenta*), American holly (*I. opaca*), and American basswood (*Tilia americana*) were found incidentally during searches for animals. White mulberry (*Morus alba*), autumn olive (*Eleagnus umbellata*), mockernut hickory (*C. tomentosa*), pignut hickory (*C. glabra*), and black birch (*B. lenta*) were found outside of the plots at Beech Fork State Park. Tree community similarity ranged from 17.8% between the Green Bottom WMA and Chief Cornstalk WMA and 66.7% between Ritter Park and the Huntington Museum of Art (Table 13). Barboursville Park was least similar to Green Bottom WMA with 37.3% and most similar to Chief Cornstalk WMA with 65.0%. Beech Fork State Park ranged from 29.5% similar to Green Bottom WMA to 61.8% similar to Ritter Park. Chief Cornstalk WMA ranged from 17.8% similar to Green Bottom WMA to 65.0% similar to Barboursville Park. Green Bottom WMA was least similar to Chief Cornstalk WMA with 17.8% and most similar to Ritter Park with 37.9%. The Huntington Museum of Art ranged from 19.6% similar to Green Bottom WMA to

66.7% similar to Ritter Park. Ritter Park ranged from 37.9% similar to Green Bottom WMA to 66.7% similar to the Huntington Museum of Art.

Table 13. Matrix of Tree Community Similarity Percentages.

	Barboursville	Beech Fork	Chief Cornstalk	Green Bottom	Museum of Art
Beech Fork	53.6	NA			
Chief Cornstalk	65.0	47.6	NA		
Green Bottom	37.3	29.5	17.8	NA	
Museum of Art	56.5	58.3	56.3	19.6	NA
Ritter	52.8	61.8	51.3	37.9	66.7

SOIL AND LEAF LITTER

The average pH was not statistically different among the sites (F = 0.55, P = 0.66) (Table 14). Moisture content was not significantly different between sites (F = 0.92, P = 0.45), though it was slightly lower at the Huntington Museum of Art. Organic matter in the soil was higher on average at Ritter Park than at the other three sites, but none of the sites were significantly different (F = 0.95, P = 0.44). Leaf litter and organic soil combined mass was almost significantly different between the sites (F = 3.17, P = 0.053). Ritter was almost significantly different (P = 0.055) from Beech Fork State Park in leaf litter and organic soil combined mass.

Table 14. Average soil pH, moisture percentage, organic matter percentage, and leaf litter mass with one standard deviation of the mean at Beech Fork State Park, Ritter Park, Barboursville Park, and the Huntington Museum of Art

Site	pH	Moisture	Organic Matter	Leaf Litter Mass
Unit		%	%	g
Beech Fork State Park	5.4±0.9	23.9±3.3	6.9±1.8	368.3±276.8
Barboursville Park	5.6±0.7	23.9±3.2	6.0±2.0	712.2±621.1
Ritter Park	5.6±0.3	23.7±3.8	8.3±3.2	1557.5±1135.6
Huntington Museum of Art	5.2±0.3	21.1±2.6	6.7±1.2	514.7±184.6

ARCGIS MAPS

Maps were created for all of the sites showing where animals were found and the amount of urbanization around and within sites (Figures 30-35). Ritter Park shows the most urbanization in terms of relative levels of impervious surface and proximity to developments, followed by Barboursville Park, then the Huntington Museum of Art, Beech Fork State Park, Green Bottom Wildlife Management Area, and Chief Cornstalk Wildlife Management Area shows the least urbanization. The Huntington Museum of Art is the smallest site and Chief Cornstalk is the largest. Beech Fork is second largest, then Green Bottom, followed by Barboursville Park, and Ritter Park is the second smallest.

Figure 30. Aerial view of Ritter Park showing the animals caught there and the amount of urbanization in and around the site.

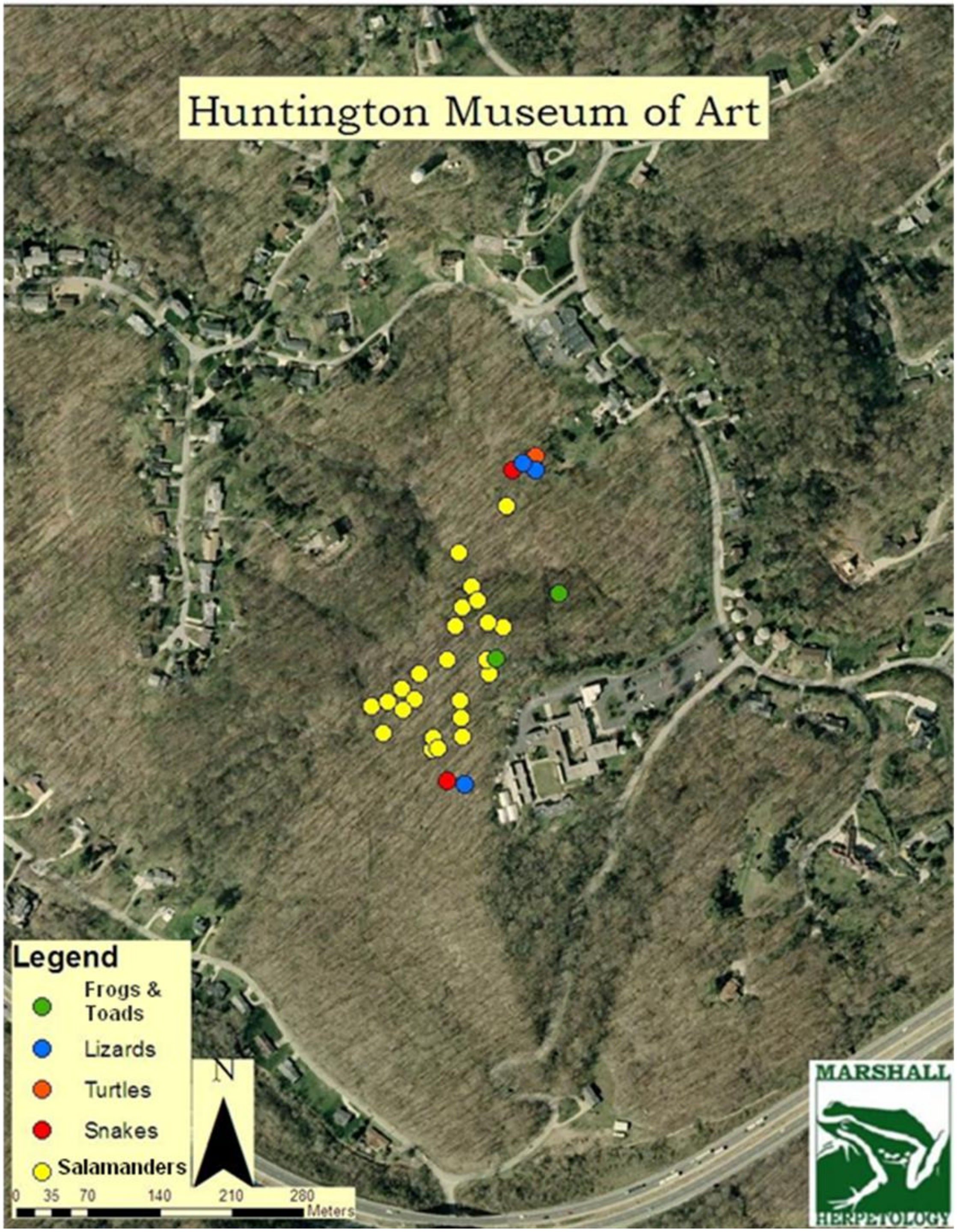

Figure 31. Aerial view of the Huntington Museum of Art showing the animals caught there and the amount of urbanization in and around the site.

Figure 32. Aerial view of Barboursville Park showing the animals caught there and the amount of urbanization in and around the site.

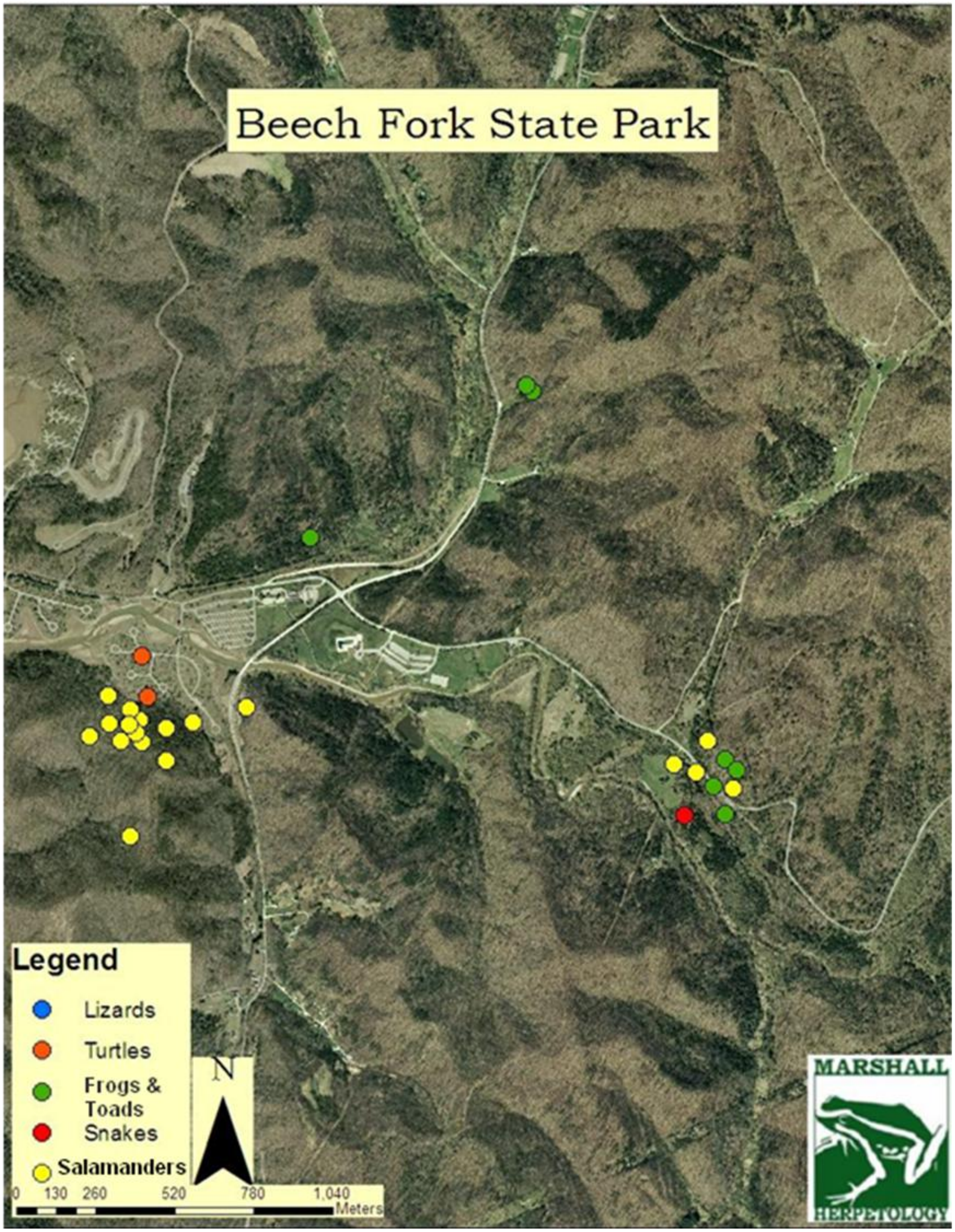

Figure 33. Aerial view of Beech Fork State Park showing the animals caught there and the amount of urbanization in and around the site.

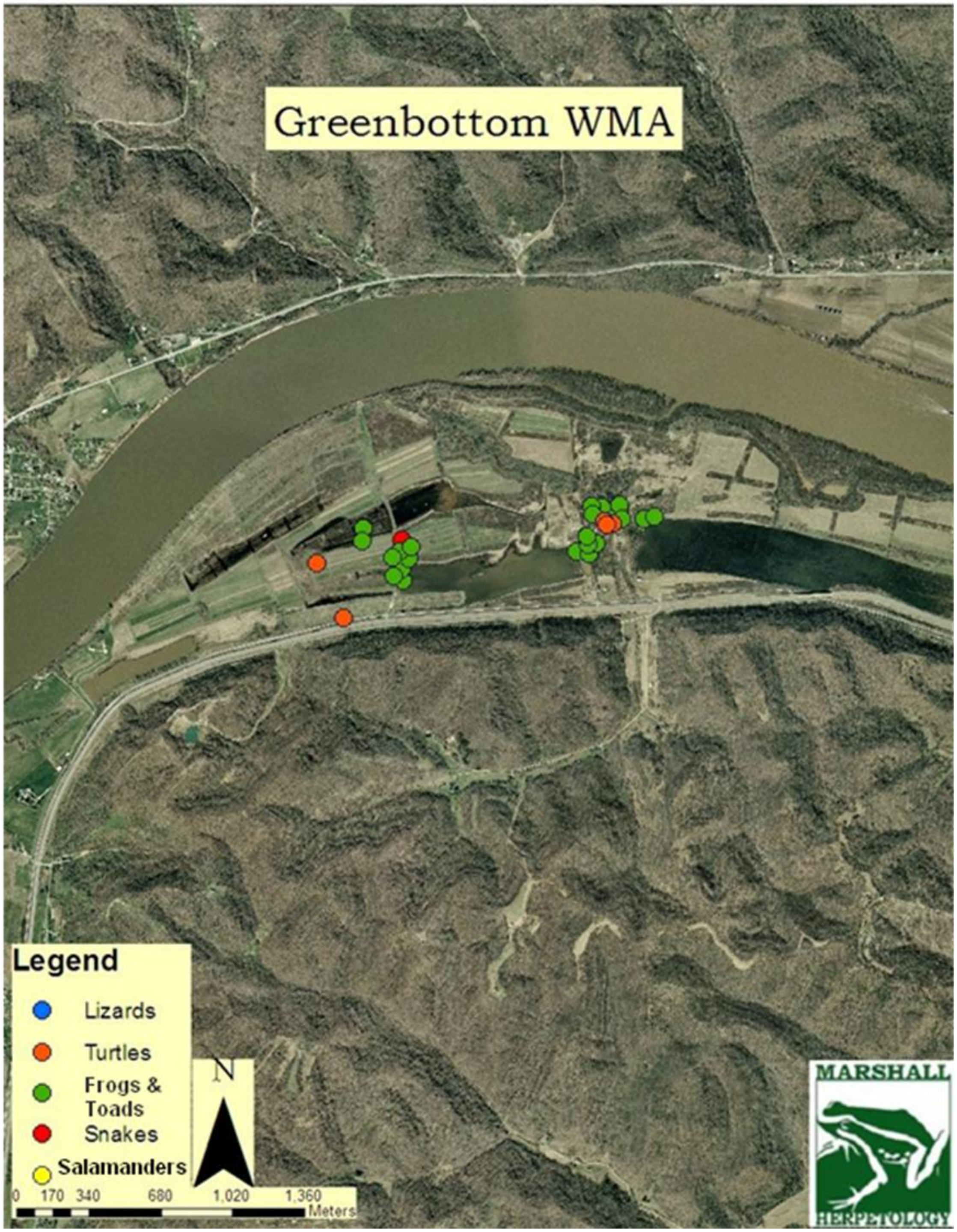

Figure 34. Aerial view of Green Bottom Wildlife Management Area showing the animals caught there and the amount of urbanization in and around the site.

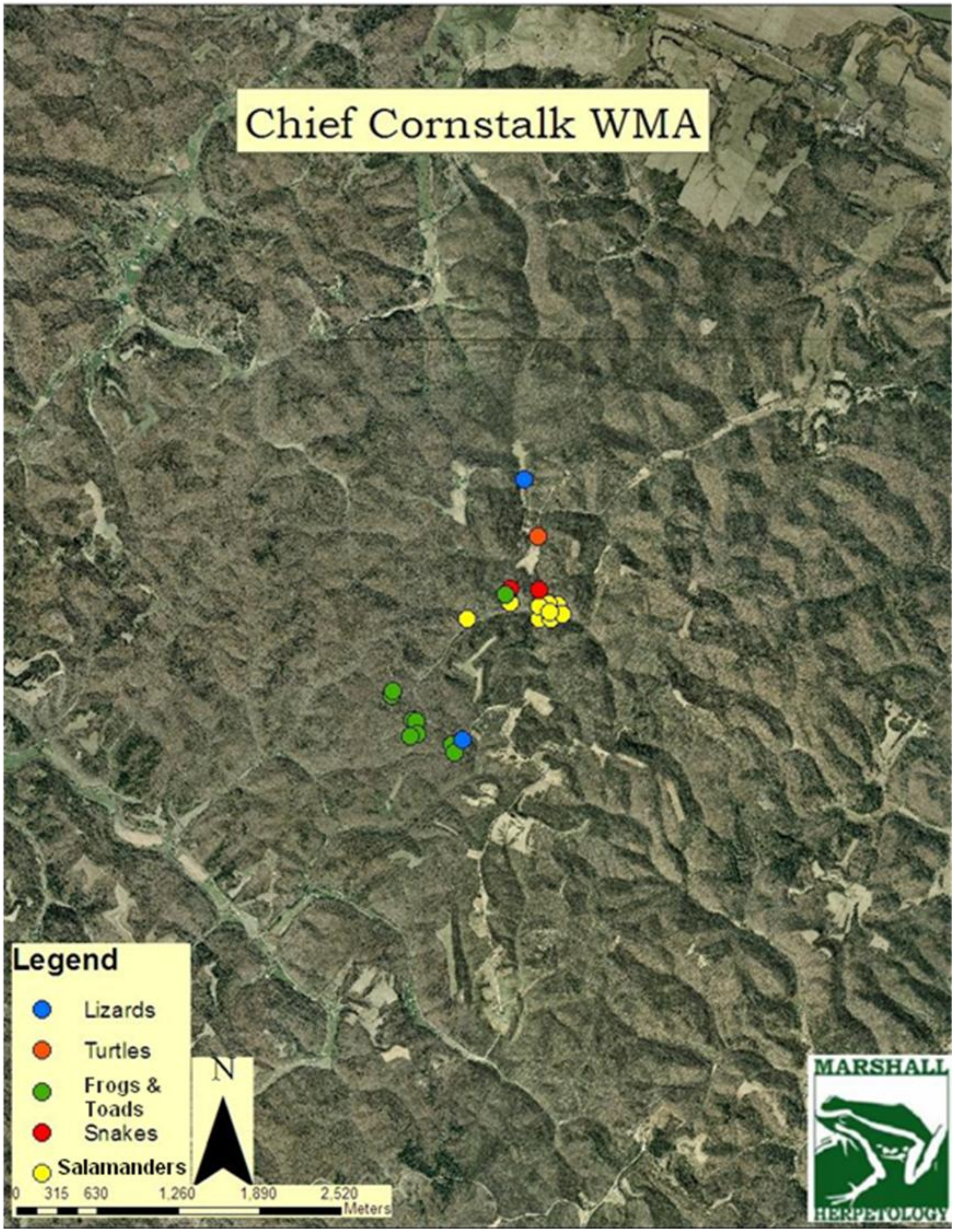

Figure 35. Aerial view of Chief Cornstalk Wildlife Management Area showing the animals caught there and the amount of urbanization in and around the site.

DISCUSSION

None of these sites was unaffected by human activity. There is a continuum of disturbance across the sites with Ritter Park being the most disturbed and Chief Cornstalk being the least disturbed. Ritter Park has more species of invasive plants, more trash, and more impervious surface than the other sites. Chief Cornstalk WMA has little trash, few invasive species, and less impervious surface than the other sites. Due to time constraints, percent impervious surface could not be quantified, so this distinction is relative. Chief Cornstalk also is much larger than the other sites, providing larger areas of undisturbed habitat.

The much greater time spent at the Huntington Museum of Art, Beech Fork State Park, and Chief Cornstalk WMA was due to several factors. One major factor was that more field assistance to search for species was available at each of these sites. The Huntington Museum of Art was conveniently located near Marshall University and it also supports a good level of diversity as can be seen by the results of this study, making it a stronger draw for field assistants. Beech Fork State Park had a high recorded level of diversity and is home to several species of amphibians such as Eastern Spadefoots (*Scaphiopus holbrookii*) and Jefferson Salamanders (*Ambystoma jeffersonianum*) that are not known from the other study sites, so this also was a strong draw for field assistants. Due to its greater distance from Huntington, more time was often spent on a given day at Chief Cornstalk WMA to make up for the increase in travel time which meant that more time was spent by an assistant in the field on these trips as well. Also transects did not result in a high level of animal captures which is why more effort was spent on opportunistic searches. Approximately 50% of the time at Beech Fork was spent on night searches because rare species such as Eastern Spadefoots and Jefferson Salamanders are more likely to be found on rainy nights than during the day.

Beech Fork had the highest richness of all of the sites both in this study and including the historic records. This is probably partly because it contains breeding habitats for temporary pond breeding species such as Eastern Spadefoots and Jefferson Salamanders. These habitats are lacking at Ritter Park, the Huntington Museum of Art, and to a large extent Green Bottom WMA. Spotted Salamanders and Wood Frogs have been found at Green Bottom (Sutton 2003), but none of the other temporary pool breeding species has been found at the site. Temporary pools were not found at Chief Cornstalk WMA or Barboursville Park, but they cannot be ruled out from these sites due to their large size and the difficulty this causes for a few researchers to cover the entire area. Ritter Park had the lowest richness, and this may be because Ritter has more impervious surface per unit area than the other sites. It also experiences a high volume of human traffic which results in a high human density due to its small size of 75 acres (Clarkson 2004). Further, Ritter has a lot of trash throughout (Figures 36-38) and a higher prevalence of invasive plant species such as AIAL, Japanese knotweed (*Polygonum cuspidatum*), and multiflora rose (*Rosa multiflora*) than the other sites. These invasive species often out-compete native plants and can form very thick vegetation patches that are difficult for animals to traverse. These patches also can block out light which reptiles need to thermoregulate. These factors make Ritter a poor habitat for reptiles and amphibians. Though it is also small at only 40 acres (Nature Trails 2010) and also within the limits of the city of Huntington like Ritter Park, the Huntington Museum of Art does not have as many invasive plants as Ritter Park, it has much less impervious surface, less trash (glass and plastic bottles and other objects that do not provide habitat for animals), and lower levels of human traffic. The Museum of Art supports a higher diversity than Ritter Park, with 17 species instead of seven, suggesting that it makes a better refuge for wildlife. A Midland Mud Salamander was found at the Huntington Museum of Art (Kevin Saunders 2010 Personal Communication), and this species has a state ranking of S1, meaning that it has "Five or fewer documented occurrences, or very few remaining individuals within the state. Extremely rare and critically imperiled." (WVDNR 2007). The only other site in this study that contained a Midland Mud Salamander was Beech Fork State Park (Bailey 1992). Out of the three less urban sites, Beech Fork State Park probably experiences the highest volume of human traffic and has the most impervious surface because it is often used for camping and has paved campgrounds as well as access roads throughout the park. The presence of temporary pond breeding areas seems to offset this though since Beech Fork's richness is so high. Chief Cornstalk WMA also has some access roads, but it does not have paved camp sites. If Cornstalk truly does lack the temporary pond breeding areas, then it certainly will have lower richness than Beech Fork. If, however, the breeding areas are there and were simply not discovered in this study, then Chief Cornstalk may have a richness level much closer to Beech Fork's. Green Bottom does not have much paved surface within its boundaries and there are only a few roads that run through it. As a wetland Green Bottom is limited in terms of its richness because only animal species that do well in highly mesic conditions will do well at this site. In particular it has low salamander diversity since it is too wet for the woodland salamanders and it also lacks the running water habitat that other lungless salamanders require.

Figure 36. Trash at Ritter Park.

Figure 37. Trash at Ritter Park.

Figure 38. Trash at Ritter Park.

COMMUNITY SIMILARITY

Chief Cornstalk WMA had the smallest range of similarity values from 40% similarity with Ritter Park to 55% similarity with Barboursville Park. Green Bottom WMA was least similar to Ritter Park, with 0% similarity and most similar to Beech Fork State Park with 43.48% similarity. Green Bottom WMA is a wetland area, so most of the species found there are amphibians, particularly frogs, and one salamander of the genus *Ambystoma*. It is probably most similar to Beech Fork State Park due to the fact that Beech Fork has a lot of breeding areas for amphibians, such as vernal pools for salamanders of the genus *Ambystoma* and ponds and road side ditches for various frog and toad species. The other four sites are fairly limited in amphibian breeding habitats, though this could be an artifact of having only one researcher. This was exacerbated by the large size of several of the sites, particularly Chief Cornstalk WMA. Barboursville Park may also have more breeding habitats than the researcher was able to discover, again due to limited manpower and relatively large size. Ritter Park was most similar to the Huntington Museum of Art, which may in part be due to the fact that these two sites are very close to each other, probably around a mile apart at the closest point. The Museum of Art, however, is most similar to Beech Fork State Park, and not Ritter Park, suggesting that it is less disturbed than Ritter Park or at least supports a higher diversity of species. Ritter Park does have a larger amount of impervious surface than the Huntington Museum of Art and sees a larger volume of human use. The site also has a great deal more trash in parts, consisting of glass and plastic bottles and other assorted items that do not provide refuges for animals. Ritter Park was the least similar site to all of the sites except for the Huntington Museum of Art. Ritter had the fewest species of any of the sites, and this is most likely due to the fact that little of the original habitat remains at this site. The low species richness could also be partly due to limited manpower and funds.

One of the major problems of this study was discovering all species of reptiles and amphibians that inhabit each of the study sites. In particular, snakes are a very cryptic group and were underrepresented in the results from the current study. Searches of historic records allowed some gaps to be filled, but these were not available for Chief Cornstalk Wildlife Management Area. Personal communications filled in some of the gaps for the Huntington Museum of Art and Green Bottom WMA. As a result the species composition for Chief Cornstalk WMA is almost certainly underestimated by this study. Further, the historic records for Barboursville Park and Ritter Park consist of only one snake species, the Rough Greensnake (*Opheodrys aestivus*) (Baldwin 2007). This means that Ritter Park and Barboursville Park are also likely to have more species than this study found. Future projects would benefit from more researchers or a single researcher focusing on fewer sites or setting up plots in areas that are likely to produce the full contingent of species when all are searched together. Visual surveys are often not very efficient. Relative to the time in the field in one study, snake capture rates were fairly low (0.45 specimens per hour), but this method resulted in 160 snake captures which was the highest of any of the methods used (Luiselli and Akani 2002). Similar investments of time can result in no snake captures or many snake captures depending on the conditions. A time of around 680 minutes yielded one snake on one occasion and the maximum value of 10 snakes on another day (Figure 39). Visual surveys were used in this study because they are relatively inexpensive, requiring only a vehicle to reach the sites and the researcher's time. Due to little funding, they were the only cost effective method for this study. If more funds had been available, these surveys would have been supplemented with drift fences and artificial cover.

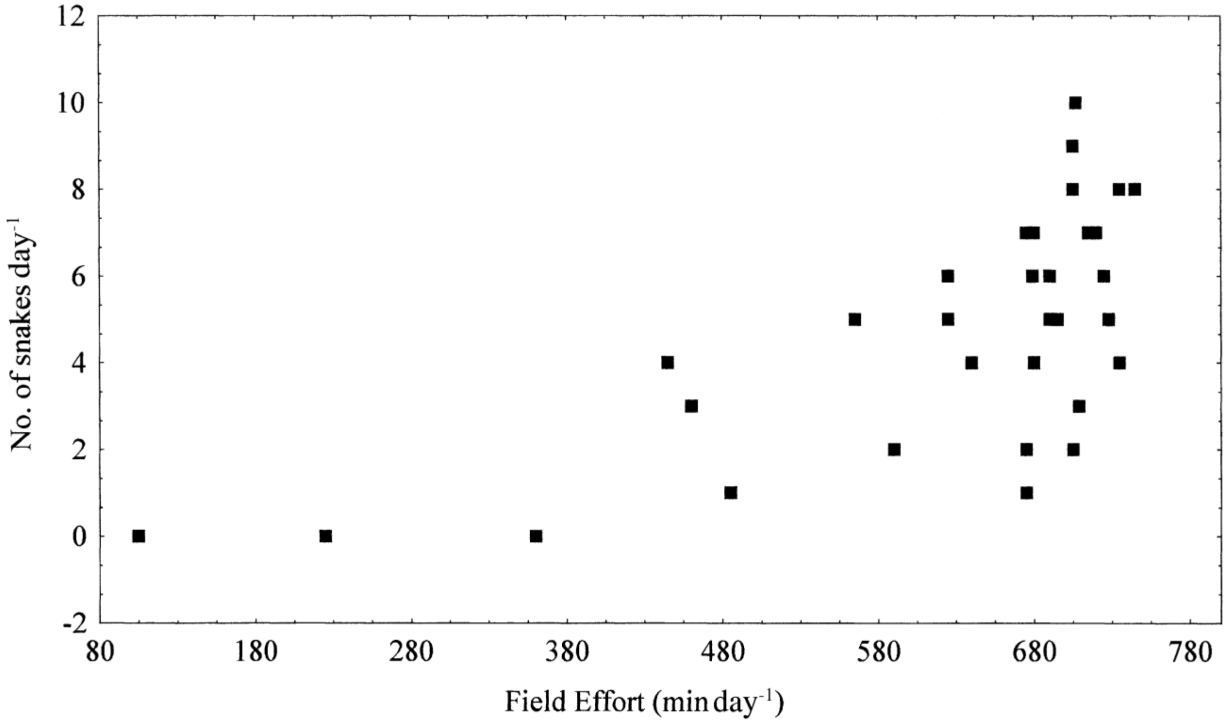

Figure 39. Relationships between daily field effort (number of minutes spent in the field during each day of research) and daily number of observed snakes at the study area in Nigeria. Taken from Luiselli and Akani (2002).

Due to low animal captures, there was insufficient morphological data for statistical analyses. This is again most likely due to study design and lack of funding. More animals would have been captured if drift fences, pitfall or other traps, and artificial cover had been used. Aspect, canopy cover, cover object, air temperature, soil temperature, relative humidity and elevation were taken at the location of each animal. Since animals were spread out across the sites and few were within the vegetation plots, these data were not used in the analysis. They will be incorporated into the West Virginia Herpetological Atlas currently being assembled by the Marshall University Herpetological Lab. Future studies might benefit from focusing on a single species or using traps and other more efficient capture methods to gather more morphological data.

This data could be used to compare body condition across sites and help determine whether or not resources aside from space are limited at urban sites.

VEGETATION

The CCA showed distinct groups among the sites. Barboursville Park and Beech Fork State Park were more similar to one another, and Ritter Park and the Huntington Museum of Art formed a second group and these groupings are explained more by the first axis than the second. Spatial location explains some of this grouping, since Ritter Park and the Huntington Museum of Art are close to each other within the city of Huntington, WV. The first axis in the CCA is more characteristic of compositional contrasts between the sites. Beech Fork and Barboursville are both east of Huntington, though Beech Fork is also south of the city. Similar soils and plant communities are likely at sites that are spatially close to one another. The second axis is more characteristic of disturbance at the sites, such as the presence of invasive species. Ritter Park and Barboursville Park show much more variation along this axis than Beech Fork or the Huntington Museum of Art, and Ritter and Barboursville have more disturbance, including invasive plant species, than the other two sites. Organic matter percentage was the most important environmental factor, so it is probably incorporated in the first axis. Density and basal area were also important, with basal area more important than density. Density and basal area are also inversely related, which is logical since more small trees than large ones can fit in the same area. Soil moisture percentage, pH, and combined organic soil and leaf litter mass were less important and moisture and litter mass were inversely related. This is probably because damp leaf litter decomposes more readily than dry leaf litter (Aerts 1997). The most important trees in the CCA were those that were either unique to a site or had a high prevalence at a site. JUVI, PIST, MORU, and PIVI were species that were unique to a site. JUVI and PIVI were only found at several plots at Beech Fork and MORU and PIST were only found at Ritter Park. ROPS was more prevalent at Barboursville Park and Beech Fork State Park than the other two sites, while ULRU was an important species for all of the sites.

Beech Fork State Park had 24 species of trees, Ritter Park 23, Barboursville Park 21, and the Huntington Museum of Art was least diverse with 15. The lower diversity at the art museum could be due to a combination of fewer microhabitats and less disturbance. There is a stream that runs through the art museum property, but there are not large standing bodies of water. Both Beech Fork State Park and Barboursville Park do have large ponds or other bodies of water that support more mesic species. These sites are also larger, which allows for more spatial variation and microhabitat availability. Since it is a small site that is within a city, and contains nature trails, it is unlikely that the Huntington Museum of Art experiences much disturbance. This is supported by the fact that ACSA had the highest importance value since maples tend to succeed oaks if there is no fire or other disturbance to regenerate the oaks (Blankenship and Arthur 2005). Fire suppression has been documented in West Virginia in a study by Schuler and McClain (2003). This study found that red oak recruitment ceased after 1937 in a West Virginia forest due to a 32 year fire gap from 1923 to 1955. There was no evidence of further oak recruitment even after fire was reintroduced to the system in 1955 and 1962, though the Schuler and McClain (2003) suggest this may be due to increased herbivory from deer and domestic livestock. Some oaks also had high importance values, low densities, and large basal areas at the Museum of Art, suggesting that they are old trees which have been left undisturbed and that there is low oak recruitment. Ritter Park is in a similar situation. ACSA had the highest importance value for Ritter Park as well, suggesting low disturbance, though Ritter also had low oak importance values. Ritter Park is further complicated by the fact that many non-native trees are present and some of these have been planted. These compete with the native species and can lower their importance values. ELUM is an invasive plant and it has a high importance value at Barboursville Park, suggesting high levels of disturbance at this park. The other three species at Barboursville Park with high importance values are ACSA and two oak species, suggesting that ACSA is probably succeeding the oaks at Barboursville Park as well since the oaks have lower densities than ACSA. Barboursville also appears to have higher levels of anthropogenic impact with more paved surfaces, manicured fields, power line rights-of-way, and planted trees. The Museum of Art does have drainage pipes and nature trails, but the pipes are small and the trails are not paved. The tree with the highest importance value at Beech Fork State Park was PIVI, with one plot having 41 stems, more than any other tree species in this study. PIVI is characteristic of xeric sites and its prevalence could mean that Beech Fork has more south facing slopes, which tend to be drier. Such conditions would also help explain the high reptile diversity at Beech Fork State Park, since reptiles tend to be found in areas with more solar radiation (McLeod and Gates 1998; Barrett and Guyer 2008; Webb *et al.* 2005) and south-facing slopes receive more radiation. Since Beech Fork is two orders of magnitude larger than the Museum of Art, its higher diversity could also be due to more microclimates. As a state park, the site may also be managed in such a way as to encourage disturbance. Beech Fork and the Huntington Museum of Art offer better wildlife habitat in terms of having lower levels of invasive plant species. This is reflected in the higher reptile and amphibian species richness levels of these sites compared to Ritter Park and Barboursville Park.

Basal area was not statistically different between the sites, but density was between Beech Fork State Park and the Huntington Museum of Art. The Museum of Art had lower densities than the other sites on average and Beech Fork had the highest densities. This is probably due to the high density of PIVI at one of the Beech Fork plots. There were 41 individuals of PIVI at that plot, which is the highest number for any single species in a plot. ACRU and FAGR may also have contributed to this difference because they also had fairly high densities at one plot each at Beech Fork. Both species were present at the Huntington Museum of Art, but neither occurred at high densities. PIVI did not occur at the Museum of Art.

Since this study was concerned with the presence of animals at each of these sites, it was decided to focus the collection of vegetation data only on areas where animals had been found. Green Bottom Wildlife Management Area had its vegetation well documented previously (Stark 1993), so these data was used for this study. It was not subjected to the same vegetation sampling method as the other sites due to the fact that it lacks many trees. Chief Cornstalk also did not have vegetation sampling due to its farther distance and time constraints. Vegetation there is similar to that of Beech Fork State Park and the Huntington Museum of Art.

Some tree species were recorded incidentally at all sites and these were combined with the vegetation plot data for a community similarity analysis of trees between the six sites. Chief Cornstalk Wildlife Management Area is underrepresented in this analysis because vegetation plots were not used at that site. Green Bottom WMA has the most complete tree data, since it was the subject of a survey by Stark (1993). The tree compliment of Barboursville Park, Ritter Park, the Huntington Museum of Art, and Beech Fork State Park were probably not complete, so the community similarity values may be higher or lower than if full plant surveys had been conducted at these sites. Green Bottom WMA was least similar to all of the sites due to the presence of unique wetland vegetation such as willows and poplars. Ritter and Barboursville were at least 37% similar to all the sites. This could be due to many native species being planted at Ritter Park and Barboursville Park as ornamentals or retention of native tree communities, even in small patches, throughout the park. ELUM was present at both Beech Fork State Park and Chief Cornstalk Wildlife Management Area, even though it was not found in the vegetation plots at Beech Fork State Park. It was not as common at these sites as it was at Barboursville Park or Ritter Park. Green Bottom WMA was most similar to Ritter Park and Barboursville Park. Ritter has a creek running through it and several tree species that prefer mesic environments grow along the creek. Some of these species are also found at Barboursville Park and Green Bottom WMA and this probably explains the higher similarity between the two urban parks and Green Bottom.

Cover objects consisted of primarily rocks and logs, but occasionally pieces of bark. Ritter had the highest amount of rocks on average with 25 per 100 m^2, followed by Beech Fork State Park at 11, then Barboursville Park with eight, and the Huntington Museum of Art had the least with four. The Museum of Art had the highest number of logs on average with 21, followed by Barboursville at 11, then Ritter with 10, and Beech Fork had the least with four. Both Beech Fork State Park and Barboursville Park had an average of one piece of bark per site. In general all of the sites had abundant cover objects, though some of the plots had no cover objects within them. The average of total cover objects was not statistically different between the sites.

Moisture percentage and pH were similar between Beech Fork State Park, Barboursville Park, Ritter Park, and the Huntington Museum of Art and neither was statistically significant. Organic matter percentage was higher at Ritter Park than the other sites, but this difference was not statistically significant. Combined leaf litter and organic soil mass was also higher at Ritter, but this difference also was not statistically significant. It was almost statistically significant with a p-value of 0.055, but this could be due to the small sample size since none of the other soil conditions were different between sites.

Overall size seems to be less important than impervious surface, invasive species, trash such as glass and plastic bottles, and the density in human traffic in determining how many reptile and amphibian species will use an urban area. Even though it is an urban area based on the fact that it is in close proximity to developed areas, the Huntington Museum of Art seems to provide good habitat for reptiles and amphibians since it supports at least 17 species, while Ritter Park and Barboursville Park seem to support less. Future studies should examine similar sites to determine if diversity is also high there, or if this is unique to the Huntington Museum of Art. Also genetic testing should be done on populations at sites such as the Museum of Art to determine how genetically isolated these animals are. If there is no gene flow between these individuals and other populations, then the value of such urban areas is reduced since small fragmented populations may not remain viable for a long time. Efforts should be made to catch and measure more animals to determine if body condition differs between urban and less urban sites. Future studies might also determine if individual reptiles and amphibians use different pockets of urban habitat or if they are confined to a single area. Due to low levels of impervious surface, few non-native plant species, little trash, low density human traffic, high species richness, and the presence of the rare Midland Mud Salamander, the Huntington Museum of Art is an urban habitat that is useful as a conservation area for reptiles and amphibians and offers a strong example for managing other urban habitats.

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Scott Jones Curriculum Vitae

5/5/2010

Scott Jones
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Doylestown, PA 18901
5/5/2010
215-595-7405
gojira2004@gmail.com

Education:

Marshall University of West Virginia, 2008 – 2010
Masters of Science in Biology
Huntington, WV 25755

Shippensburg University of Pennsylvania, 2004-2008
Received Bachelor's of Science in Biology and a Minor in German Studies
Shippensburg, PA 17257
Graduated Suma Cum Laude

Central Bucks West High School, 2001-2004
Received High School Diploma
Doylestown, PA 18901

Thesis:

My Master's thesis at Marshall University was on observing reptile and amphibian assemblages in urban habitats in and around Huntington, West Virginia. There were 6 study sites in my project, with 3 of the sites located within urban areas. The other 3 sites were 1 state park and 2 wildlife management areas that were more removed from urban locations. I accumulated 82.5 hours worth of data in the field primarily on reptile and amphibian species and some environmental variables. I detected 32 different reptile and amphibian species. I also gathered vegetation, soil sample, leaf litter, and cover object data at my study sites. I ran several analyses and found that the sites did not differ much in terms of environmental variables. Impervious surface, presence of invasive plant species, trash, and human density were good indicators of amphibian and reptile species richness. One of the urban sites, the Huntington Museum of Art, had higher species richness, less impervious surface, fewer invasive plant species, less trash, and lower human density. This site provides a good model for maintaining urban sites that support the highest diversity of reptiles and amphibians.

Honors and Awards:

Marshall University Graduate College Summer Thesis Research Grant of a value of $500 2009
Recipient of Commonwealth of Pennsylvania University Biologists Outstanding Biology Student Award for Shippensburg University 2008
Recipient of Senior Biology Award from Shippensburg University of Pennsylvania 2008
Tutoring Certification for CRLA Level 2 2008
Tutoring Certification for CRLA Level 1 2007
Shippensburg University Grant for Undergraduate Research of a value of $345 2007
Dean's List, Shippensburg University of Pennsylvania: Fall 2004, Spring 2005, Fall 2005, Spring 2006, Fall 2006, Spring 2007, Fall 2007, Spring 2008
Thomas Smyth Memorial Scholarship 2004-2008
Achieved a 5 out of 5 score on the Advanced Placement Biology Test 2004
Who's Who Among High School Students 2004
Eagle Scout 2003
Who's Who Among High School Students 2003
Who's Who Among High School Students 2002
Placed in 97th percentile on PSATs- October 2002, so I was entered in the National Merit Scholarship Competition
Central Bucks High School West Honor Roll 2000-2004

Principle Research and Teaching Interests:

My career goal is to become a herpetologist and study reptiles and amphibians, particularly in relation to conservation. I would like to attain a position at a university as a tenure track professor and spend my time teaching students and performing research on reptiles and amphibians.

Teaching Experience:

Marshall University Teaching Assistant Spring Semester 2010

Description: I am currently teaching and helping to prepare a genetics lab. The course work so far has been similar to the course work from the genetics lab I taught the previous semester at Marshall University. The main difference is that the students do more genetic problems in this class, and I have had the opportunity to help the students better understand and answer these problems. I also have been more involved in the set up for this lab, including running chromatography papers. I also proctored the exams written by the lecture professor for the section that I taught.

Marshall University Teaching Assistant Fall Semester 2009

Description: I taught a genetics lab. The course work entailed raising fruit flies (*Drosophila melanogaster*), paper chromatography, and gel electrophoresis. I administered, collected, and graded quizzes for each lab that were written by the lecture professor.

Marshall University Teaching Assistant Spring Semester 2009

Description: I taught an introductory level biology lab for non-majors. The course work entailed studies of the major systems in the human body, understanding basic genetics, and several other labs. I collected and graded data sheets for each lab.

Marshall University Teaching Assistant Fall Semester 2008

Description: I taught an introductory level biology lab for majors. The course work entailed column chromatography, enzyme activity, testing for biological molecules, understanding basic genetics, and several other labs. I collected and graded data sheets for each lab and also a research paper on a lab about amylase enzyme activity at varying temperatures and pH's. I also assisted a student who had Asperger's Syndrome in the class.

Shippensburg University Tutor Fall Semester 2007 and Spring Semester 2008

Description: I tutored students in Biology and Chemistry Coursework. My goal was to help them to learn to be more self-reliant and better able to deal with academic problems in the future. I accomplished this by pushing them to be actively involved in the process through working out the answers to questions themselves and drawing material out on a whiteboard.

Research:

May 2010

I assisted fellow graduate students with a project that entailed locating Eastern Spadefoots (*Scaphiopus holbrookii*) at a site in Ohio. We found the animals and are in the process of helping to establish the site as a preserve for this species.

January to March 2010

I assisted several fellow Marshall Graduate students with searches for rare and uncommon salamanders in the state. These species were the Stream-side Salamander (*Ambystoma barbouri*), Small-mouthed Salamander (*A. texanum*), and the Jefferson Salamander (*A. jeffersonianum*). We found adults of the Stream-side and Small-mouthed Salamanders and have found egg masses of the Jefferson Salamander. Searches entailed cruising roads on rainy nights and also setting out and checking minnow traps.

September 2009

I assisted a fellow Marshall Graduate student with his thesis on the natural history of Eastern Hellbenders (*Cryptobranchus alleganiensis alleganiensis*) in West Virginia. We performed nighttime searches for animals that were wandering in the stream and also flipped rocks during the day with a log peevee to find animals. Animals that were found either during the day or at night were pit tagged for mark recapture data, though all males with nest rocks were left undisturbed. I assisted in finding and capturing Eastern Hellbenders, but did not do any of the pit tagging.

August and September 2009

I assisted a fellow Marshall Graduate student with her thesis on the effect of ski slopes on snakes in eastern West Virginia. We flipped natural cover objects in search of snakes. All snakes caught were marked with portable medical cautery units for mark recapture data. Eastern Gartersnakes (*Thamnophis sirtalis sirtalis*), Northern Ring-necked Snakes (*Diadophis punctatus edwardsii*), and Northern Red-bellied Snakes (*Storeria occipitomaculata occipitomaculata*) were the main species that were caught and marked. We also measured the diameter at breast height (DBH) of trees within vegetation plots and recorded the number of ferns within the plots. DBH was measured with DBH sticks. I did not mark any of the snakes, but did capture them and assisted with gathering the vegetation data.

May 2009 to March 2010

I undertook my own thesis research on urban herpetology in and around Huntington, West Virginia. I performed daytime transect searches and opportunistic searches both during the day and at night to find reptiles and amphibians at six sites in West Virginia. The searches have mostly turned up common species such as Eastern American Toads (*Bufo americanus americanus*), Eastern Wormsnakes (*Carphophis amoenus amoenus*), Eastern Box Turtles (*Terrapene carolina carolina*), and Cumberland Plateau Salamanders (*Plethodon kentucki*), but less common species such as the Eastern Spadefoot (*Scaphiopus holbrookii*) have also been found at some sites. Environmental data such as canopy cover, site aspect, and elevation were also recorded. Data collection is still underway and once it is complete, the data will be used to help provide a definition for urban habitats in West Virginia.

May to October 2009

I assisted a fellow Marshall Graduate student with his thesis project on turtle behavior when crossing roads. We trapped aquatic turtles including Common Snapping Turtles (*Chelydra serpentina serpentina*) and Midland Painted Turtles (*Chrysemys picta marginata*) and also performed searches for Eastern Box Turtles (*Terrapene carolina carolina*) and Wood Turtles (*Glyptemys insculpta*) in several areas of West Virginia. I also drove a vehicle past turtles during road crossing sessions in order to elicit responses indicative of typical road crossing behavior in the face of vehicles.

May to July 2009

I assisted a fellow Marshall Graduate student with her thesis project on movement of Green Salamanders (*Aneides aeneus*). I helped check burlap and search for salamanders at night. I also dipped some animals in pigment powder and then followed their movement trails with an ultraviolet light the following evening. In addition to Green Salamanders, I also dipped and tracked Cumberland Plateau Salamanders (*Plethodon kentucki*) and a Southern Two-lined Salamander (*Eurycea cirrigera*).

April to May 2009

I was a volunteer for the North American Amphibian Monitoring Project in West Virginia. I followed a frog call route in southwestern West Virginia and listened for the calls of any frog species. I successfully detected several species, including the Mountain Chorus Frog (*Pseudacris brachyphona*) and Cope's Gray Treefrog (*Hyla chrysoscelis*).

March to April 2009

I assisted a fellow Marshall Graduate student with her thesis project on the natural history and current status of the Northern Leopard Frog (*Rana pipiens*) in West Virginia. I helped with call surveys for Northern Leopard Frogs at several sites in West Virginia. We did not detect this species at any of the sites that I visited.

March to April 2009

I assisted a fellow Marshall Graduate student with her thesis project on the natural history of Eastern American Toads (*Bufo americanus americanus*) in West Virginia. I helped find and capture toads.

February to April 2009

I assisted a fellow Marshall Graduate student with his thesis project on winter foraging in bats in Kentucky. We sat out at night looking for bats and monitoring several bat detection units called Anabats. We did not handle any bats during this study.

November 2008

I assisted a fellow Marshall Graduate student with his thesis project on Long-tailed Salamanders (*Eurycea longicauda longicauda*) in caves in Kentucky. I helped capture and photograph several species of salamanders including the Long-tailed, Southern Two-lined (*Eurycea cirrigera*), and the Cumberland Plateau Salamander (*Plethodon kentucki*).

October 2008

I assisted a fellow Marshall Graduate student with his thesis project on sampling West Virginia salamanders for the chytrid fungus. We did not find any of the species of interest for his study when I assisted him, though we did catch Northern Dusky Salamanders (*Desmognathus fuscus*) and Seal Salamanders (*Desmognathus monticola*).

September to October 2008

I assisted a fellow Marshall Graduate student with his thesis project on several of the plethodontid salamanders of the Valley and Ridge Province of West Virginia. I helped find and capture salamanders and recorded some data on them. The species observed were the Eastern Red-backed Salamander (*Plethodon cinereus*), Shenandoah Mountain Salamander (*Plethodon virginia*), Northern Slimy Salamander (*Plethodon glutinosus*), White-spotted Slimy Salamander (*Plethodon cylindraceus*), and Cow Knob Salamander (*Plethodon punctatus*).

August to November 2008

I assisted a fellow Marshall Graduate student with setting up transects for her thesis work studying the movement patterns of the federally threatened Cheat Mountain Salamander (*Plethodon nettingi*). I aided in the measuring out and marking of transects with flags, reflectors, and plastic flagging. I also assisted in the finding and identification of *P. nettingi*. Further I carried and placed cover boards for the salamanders to use as shelter at many of the transect sites.

August to September 2008

I assisted a fellow Marshall Graduate student with his thesis project on Eastern Box Turtle (*Terrapene carolina carolina*) activity patterns. I helped spot Box Turtles and also photograph them for mark recapture data.

April 2008

I assisted my undergraduate advisor with trapping and marking Spotted Turtles (*Clemmys guttata*). I helped with turtle handling, setting the hoop traps, and checking the hoop traps.

January to May 2007

I worked on an experiment with another student looking at how kinship and size variation affect cannibalism in the Jefferson Salamander (*Ambystoma jeffersonianum*). The data was not significant. It is not known whether this was a result of an error in the experimental setup, or whether this was due to the animal's typical behavior. I successfully wrote a grant for this research.

September 2006 to February 2008

I assisted a professor at Shippensburg University with the Pennsylvania Online Herpetological Atlas project. The goal of the project is to better understand the range and status of 36 reptile and amphibian species of special concern, and 1 invasive reptile species. My duties were data entry of older Herpetological Atlas information and of recent submissions using Microsoft Excel and creating distribution maps using ArcView. I also shared some of this information in a presentation at the Spring 2008 meeting of the Commonwealth of Pennsylvania University Biologists.

September 2005 to May 2006

I conducted an experiment on the effect of size variation on cannibalism in the larvae of the caddisfly *Ptilostimus postica*. I also assisted another student on a study examining the role of resource availability and density on cannibalism and survival in *P. postica*. We presented a joint poster on our results at the spring 2006 meeting of the Mid-Atlantic Chapter of the Ecological Society of America and the Spring 2006 meeting of the Commonwealth of Pennsylvania University Biologists. I am currently working on submitting a manuscript for this research for publication.

Publications and Presentations:

April 2010

I gave a presentation on my thesis research at the Association of Southeastern Biologists conference in Asheville, NC. My abstract for this presentation was also published in the conference proceedings.

March and April 2010

I gave a presentation to the Kanawha Master Naturalists on amphibians of West Virginia. I also led the Master Naturalists on a field trip in Kanawha County, WV looking for amphibians.

Spring 2008

I gave a presentation at a dinner honoring benefactors of Shippensburg University detailing my research experience with cannibalism in salamanders and caddisflies and as a recipient of a scholarship to the university. The talk included brief discussions of my research on cannibalism in the salamander *Ambystoma jeffersonianum* and also on cannibalism in the caddisfly *Ptilostomis postica*.

Spring 2008

I gave a presentation at the Commonwealth of Pennsylvania University Biologists conference on the Pennsylvania Online Herpetological Atlas and how it aids conservationists by allowing for more accurate monitoring of the status of many species of special concern in Pennsylvania.

Spring 2008

Scott P. Jones and T. J. Maret. The Pennsylvania Online Herpetological Atlas is intended as a tool to keep better track of Pennsylvania's reptile and amphibian species of special concern.

Abstract published at the Spring 2008 Commonwealth of Pennsylvania University Biologists conference.

Spring 2006

Berkstresser, S., S. Jones, and T. J. Maret

Abstract published at the Spring 2006 Commonwealth of Pennsylvania University Biologists conference on the effects of size variation, density, and protein availability on cannibalism in the caddisfly *Ptilostomis postica*.

Spring 2006

Fellow student S. Berkstresser and I presented a poster with the data from experiments on the effects of size variation, density, and protein availability on cannibalism in the caddisfly *Ptilostomis postica* at the Commonwealth of Pennsylvania University Biologists and Ecological Society of America conferences.

Works in Progress:

I am presently involved in writing the Mammalian Species Account for the Lesser Hedgehog Tenrec (*Echinops telfairi*) with Dr. Suzanne Strait, a mammalogist at Marshall University. The manuscript is still being edited.

I am currently working on a manuscript for Northeastern Naturalist on the research that I performed on the effect of size variation, density, and protein availability on the incidence of cannibalism in the caddisfly *Ptilostomis postica*. My coauthors are Stephen Berkstresser and T. J. Maret.

Related Professional Experience:

Jobs:
Marshall University
Supervisor: Susan Weinstein
e-mail: weinstei@marshall.edu
Worked August 2008 to present
Salary: ~$6000/ $7.50 per hour to start and to date
Description: Teach labs for the Marshall University Biology Department. Completed teaching an introductory biology lab for majors and an introductory biology lab for non-majors. Gained experience assisting a student with Asperger's Syndrome.

Shippensburg University Learning Center
Supervisor: Zach Grabosky
717-477-1420
e-mail: zgrabo@ship.edu
Worked August 2007 to May 2008
1871 Old Main Drive, Shippensburg, PA 17257
Salary: ~$3500/ $7.15 per hour start and end
Description: Tutored peers in general study skills and specific subjects, carried out receptionist duties sometimes, assisted with some new tutor training, scheduled appointments using computer.

Reptilrama
Supervisor: G. Leonard Knapp
215-257-6088
Worked April 2003- August 2005 (mostly summers)
Address varies based on location of educational programs
Salary: ~$1000/$20 per day
Description: Cleaned reptile cages, assisted in some reptile rescues and adoptions, worked retail at several fairs, assisted in checking on vendors and customers at Herpetological Expo, and helped handle animals (minimal) for educational programs to groups such as summer camps. Also handled photo snakes (*Boa constrictor* and ball python). Over the course of this job handled several tortoises, aquatic turtles, small lizards, and small to large snakes. The handling was minimal, but I have no fear of touching reptiles.

Organizations:

Student Member of the Herpetologists' League 2010
Student Member of the Society for the Study of Reptiles and Amphibians 2009-2010
Member of the Turtle Survival Alliance 2009-2010
Student Member of the American Society of Ichthyologists and Herpetologists 2009-2010
Member of Phi Kappa Phi 2007-2010
Member of the National Collegiate Honors Society 2007-2010
Member of Beta Beta Beta, the Science Honors Society 2006-2010

Vice President 2007-2008 (Helped president plan and carry out fundraising activities, carried out ordering honors cords, making updated members list, design and order of T-shirts)
Helped with judging several local science fairs Spring 2007, Spring 2008

Shippensburg Biology Club 2006-2008
Shippensburg Rotaract Club 2006-2007

Clothing and school supplies drive for people in Africa 2006

Shippensburg Ecology Club 2005-2008

Susquehana River Cleanup 2006

Shippensburg Honors Society 2004-2008

Helped with collecting soda tabs for Ronald McDonald House 2007
Relay for Life 2007, 2008
Dash for Drew Fall 2006, Fall 2007
Planting trees Spring 2005, Spring 2008
Rails to Trails cleanup Fall 2005, Spring 2006, Fall 2006

Shippensburg Student Environmental Action Coalition 2004-2007

Thompson Hollow Cleanup 2005
Children's Fair 2005
Burd Run Cleanup 2004-2006

Student Member of the Shippensburg University Environmental Steering Committee 2004-2008

Student Co-chair 2006-2008 (Helped institute more recycling measures on campus, gave input during plans to update campus)
Recyclemania 2007, 2008

National Junior Honors Society 1998-2001
Cub Scouts and Boy Scouts of America 1993-2008

Leadership Roles:

Troop 6 Assistant Scoutmaster, Troop 6 BSA, Doylestown United Methodist Church 2004-2008

Troop 6 Junior Assistant Scout Master September 2003 - September 2004

Eagle Scout 2003

Troop 6 Assistant Senior Patrol Leader-handle details of running the troop by working closely with Senior Patrol Leader, act as leader of other troop leadership positions, March 2003 to September 2003

Troop 6 Guide-advise and help patrols of scouts who have just joined the troop, September 2002 to March 2003

Community Service:

Served drinks and food at the annual Peach Festival at the Doylestown United Methodist Church, the funds were used to support the church which is the host for my troop, Troop 6.

Helped with various other Eagle Scout projects including repositioning tombstones in an underused graveyard, landscaping a nature trail at Linden Elementary School in Doylestown, Pennsylvania, landscaping Burpee Park in Doylestown, Pennsylvania, and building a handicapped accessible observation deck at Peace Valley Park.

My own Eagle project – I cleaned up a trail at Peace Valley Park, thinned the few areas where it was overgrown, put down brush to keep people out of sections that weren't trail, and put down a layer of stones over roughly half the trail to fight erosion.

Long Term Disciple Banquet – served dinner to the elder members of the Doylestown United Methodist Church congregation

Blue and Gold Banquet – served dinner to Cub Scouts and their families

Scouting for Food Drive – went door to door collecting canned goods for needy families

Skills:

I can read, write, and speak German moderately well. I also have knowledge of SPSS, Microsoft Word, Power Point, and Excel, ArcView and ArcGIS. I have gained introductory knowledge of gel electrophoresis, culturing of bacteria, pouring agar onto plates and slants, inoculating bacteria onto plates and slants, performing dilution series. I am also capable of performing titrations and other simple chemical reactions. Chemistry has given me experience in calculating percent yield, recovered mass, molar fractions, etc. I have some experience handling small to large snakes, small lizards, salamanders, turtles and tortoises, young alligators, frogs and toads.

GRE Scores:

General Test, taken December 2006 -

Verbal: 590
Quantitative: 710
Analytical Writing: 5.5

Subject Test, taken April 2007 -

Biology: 780
Cellular and Molecular Biology: 73
Organismal Biology: 81
Ecology, Evolution, Population Biology: 76

Course Work:

Marshall University in West Virginia:
Field Botany and Plant Taxonomy – Final Grade A

Herpetology – Final Grade A
Herpetology Journal Club – Final Grade A
Seminar 1 – Final Grade A
Mammalogy – Final Grade A
Seminar 2 Spring 2009 – Final Grade A
Advanced Vertebrate Morphology – Final Grade A
Natural History Journal Club – Final Grade A
Seminar 2 Fall 2009 – Final Grade A
Conservation Journal Club – Final Grade A
Plant Ecology – Final Grade A
Seminar 2 Spring 2010 – Final Grade A

Shippensburg University of Pennsylvania:
Principles of Biology 1 - Final Grade A
Advanced Placement Writing - Final Grade B
Honors Intro to Psychology - Final Grade B
Principles of Biology 2 - Final Grade A
Calculus 1 - Final Grade B+
Honors Intro to Sociology - Final Grade A
Ecology – Final Grade A
Intro to Statistics – Final Grade A
Chemical Bonding – Final Grade A
Chemistry Lab 1B Stoichiometry – Final Grade A
Honors Basic Oral Communications – Final Grade A-
Herpetology – Final Grade A
Genetics – Final Grade A
Chemical Dynamics – Final Grade B
Chemistry Lab 2B Equilibrium – Final Grade B
Biological Seminar: Insects and People – Final Grade A
Microbiology – Final Grade A
Field Botany and Plant Taxonomy – Final Grade A
Modern Organic Chemistry 1 – Final Grade A
Chemistry Lab 3B – Final Grade A
Principles of Macroeconomics – Final Grade A
Cell Biology - Final Grade A
Developmental Biology – Final Grade A
Introduction to Research – Final Grade Pass
Modern Organic Chemistry 2 – Final Grade A
Chemistry Lab 4B – Final Grade A
Intro to GIS 1 – Final Grade A
Honors Seminar on Ethics in Biotechnology – Final Grade A
Introduction to Physics 1 – Final Grade A
Introduction to Physics 1 Lab – Final Grade A
Plant Ecology – Final Grade A -
Research 2 – Final Grade A

Animal Physiology – Final Grade A
Principles of Evolution – Final Grade A
Biometry – Final Grade A
Field Zoology – Final Grade A
Biota of Florida – Final Grade A
Introduction to Physics 2 – Final Grade A
Introduction to Physics 2 Lab – Final Grade A

Central Bucks High School West:
Advanced Placement Biology – Transfer credit due to a 5 out of 5 on the AP Test

References:

1. Doctor Tim Maret
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2. Doctor Sherri Bergsten
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