A Herpetological Survey of the Edith J. Carrier Arboretum at James Madison University (Harrisonburg, Virginia)

Matt Graziano, David Weisenbeck, David S. McLeod
Department of Biology, James Madison University
951 Carrier Drive MSC 7801,
Harrisonburg, VA 22807
corresponding author: mcleodds@jmu.edu

Abstract: The Edith J. Carrier Arboretum is a 50-hectare site located in Harrisonburg, VA. A herpetofaunal survey was conducted on the site from October 2017–August 2018 using visual encounter, bioacoustics surveys, cover boards, and aquatic turtle traps. A total 2 amphibian species and 8 reptile species and subspecies were documented, including two species of special concern (*Chelydra serpentina* and *Terrapene Carolina carolina*) and two introduced species (*Trachemys scripta scripta* and *Trachemys scripta elegans*). This represents an increase from the five species previously documented in the City of Harrisonburg, of which only one species (*Plethodon cinereus*) was found during this study. These surveys help to document the amphibian and reptile diversity of the City of Harrisonburg and inform educational programs at the Edith J. Carrier Arboretum.

Key Words: Herpetological survey, Edith J. Carrier Arboretum, City of Harrisonburg, *Trachemys scripta*, *Chelydra serpentina*, *Terrapene carolina*

INTRODUCTION

The Edith J. Carrier (EJC) Arboretum was established in 1989 on the campus of James Madison University (JMU) in Harrisonburg, Virginia. The EJC Arboretum is state-owned and maintained by JMU with financial support for staff, programs, and facilities provided by public and private donors. The 50-hectare site ranges in elevation from 400–500 m a.s.l. (Figure 1). The site is

dominated by 100-year old oak (*Quercus sp.*) and hickory (*Carya sp.*) forests with a riparian area dominated by Eastern Redbuds (*Cercis canadensis)* and American Sycamore (*Platanus occidentallis)*. An ephemeral stream feeds a man-made pond (approximately 1400 square meters) that is surrounded by Bald Cypress (*Taxodium distichum*) and Sycamore. The arboretum contains both naturally occurring and intentionally planted native species of trees, shrubs, woody vines, perennial herbaceous vegetation, and wildflowers (H. Griscom, pers. comm). The EJC Arboretum serves as a public venue and outdoor classroom for formal and informal educational programs that serve Harrisonburg and the surrounding area. Self-guided and docent-guided tours are available in addition to summer camps and other outreach activities (James Madison University, 2018). Despite this strong infrastructure little information about the herpetofauna of the site has been available either online or in print.

Five species of amphibians and reptiles have previously been documented from the independent City of Harrisonburg (Rockingham Co, VA) (*Ambystoma maculatum, Eurycea bislineata, Notophthalmus viridescens viridescens, Plethodon cinereus,* and *P. punctatus*; VHS database, 2019). Most of these represent specimens collected in 1937 or 1944 (United States Geological Survey, 2019). Harrisonburg has undergone significant development since then, and it is worth investigating whether these species are still present in the city. Similarly, the taxonomy and systematics of many species has been revised since these records were first made and it is worth noting that *P. punctatus* is not known to occur in this area and the historical record may be specimens confused with *P. cylindraceus* (Graham, 2007), Because of the low number of previous records from Harrisonburg City and because species distributions do not follow political boundaries, we considered the species documented from surrounding Rockingham County, where a total of 56 species and subspecies have been documented, 19 of which are salamanders (VHS database, 2019). Despite the diversity of flora and habitat types present within the EJC Arboretum it is not anticipated that all species occurring within Rockingham County will be present at this site. The EJC arboretum represents a forest fragment bordered by roads, apartments, and urban development that are likely to serve as barriers to the immigration and emigration of amphibians and reptiles. Prior to this study, the arboretum has been the focus of occasional surveys for common species of reptiles and amphibians (e.g., *Thamnophis sirtalis* and *Plethodon cinereus*) and course-related projects conducted by JMU students. To our knowledge, none of these studies have resulted in published accounts of the herpetofauna of the EJC arboretum. In response to a recognized need for a faunal inventory at this site that could facilitate formal and informal education as well as current and future research, a herpetofaunal survey was conducted from October 2017–August 2018.

Study Site

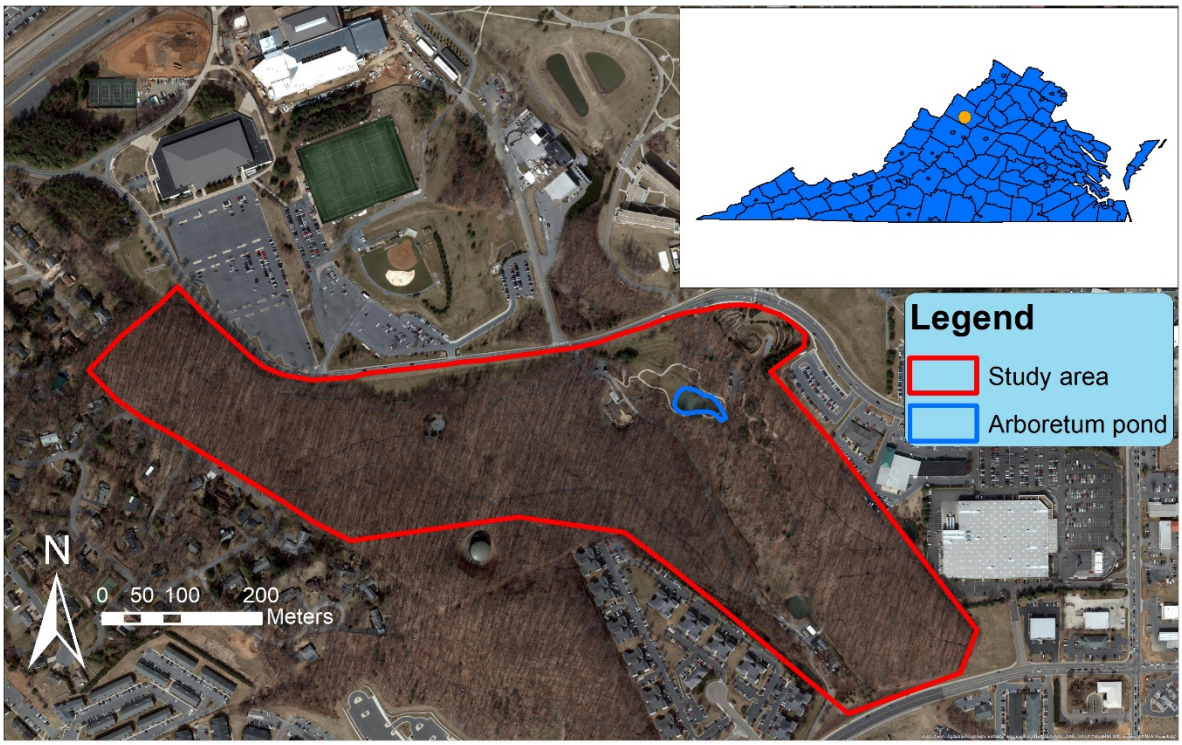

Figure 1. Area surrounding EJC arboretum. The study site outlined in red, and the pond in the Arboretum is outlined in blue. Orange circle in inset indicates location of the study site.

MATERIALS AND METHODS

This survey was initiated as a course-embedded research project for JMU's Herpetology course (BIO 427) during the spring semester 2018. The project was used to introduce field survey methods including visual encounter surveys, bioacoustic surveys for amphibians, and the use of baited hoop traps for turtles, and artificial coverboards for detecting amphibians and reptiles during repeated survey efforts. Additional survey efforts were made by the authors subsequent to the completion of the course. All individuals encoutered were photographed, measured with a straight ruler (snout–vent length), weighed using a digital scale, and released. Field notes documented conditions at the time of capture including date, time, temperature, humidity, weather conditions, and the specific method of observation. A Kestrel 5500 hand held weather station was used to document temperature, wind speed, and relative humidity. Bioaccoustic observations of calling frogs were verified by comparison to published calls (*e.g.*, http://www.virginiaherpetologicalsociety.com). Artificial cover objects included 30 pieces of 61x30x1.5 cm rubber stall matting and four pieces of 91x91cm corrugated metal sheets. The use of both rubber matting (Marsh and Goicochea, 2003) and metal sheeting (Engelstoft and Ovaska, 2000) has been shown to be an effective survey

method for amphibians (especially salamanders) and reptiles. Cover boards were placed in areas throughout the arboretum representing different habitat types (Figure 2). All coverboards were tethered to a tent stake to prevent re-location or removal. We used a 91cm diameter hoop-trap to collect turtles in the arboretum pond. Traps were baited with dry dog food, suspended in perforated plastic containers and placed so the opening was fully submerged while keeping the opposite end partially exposed above the water line (Figure 3). A single trap was deployed to multiple locations within the pond from April–August 2018. Traps were checked daily and removed when heavy rains were forecasted to ensure no turtles were drowned in the traps. Turtles caught in the traps were given individual marks on their marginal scutes (following Nagle *et al*. 2017) to prevent double counting and to allow for future studies of population dynamics. The total effort for each method is provided in Table 1.

Additional observational records of amphibians and reptiles at the EJC Arboretum were obtained from citizen-scientist data documented using iNaturalist (https://www.inaturalist.org/). iNaturalist observations include a photograph of the specimen, date, time, temperature, and other details relevenat to the collection of observation and are posted online for public use and knowledge. Records from iNaturalist were only included in the results if latitudinal/longitudinal data placed the observation within the EJC Arboretum, and secondly if the species observed could be verified from the image provided in iNaturalist.

Table 1. Summary of survey efforts by number of participants and time spent per survey method used in the EJC arboretum. Visual Encounter Surveys =VES.

	VES	Bioacoustic	Coverboards	Turtle Traps	Total
Number of Surveyors	2	2	3	1	
Hours Surveyed (h)	15	2	10		
Number of trap days (td)				29	
Total	30h	4h	30h	29td	64h/29td

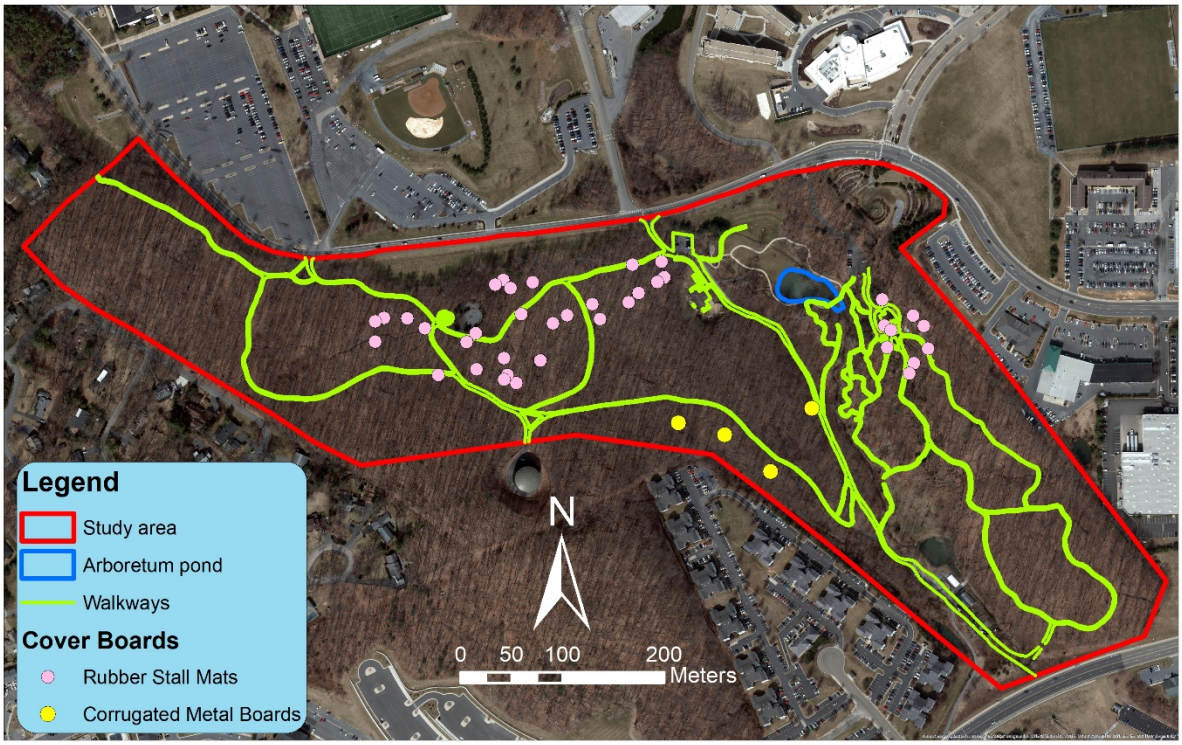

Figure 2. Locations of coverboards in the Edith J. Carrier Arboretum. Pink dots represent rubber stall mats and yellow dots represent corrugated metal cover boards.

Figure 3. Turtle trap in water. Traps were partially submerged and baited with dry dog food placed inside a perforated plastic container suspended inside the trap.

RESULTS

We documented 68 individuals representing nine species in the EJC Arboretum during this survey. Two species of amphibians and seven species of reptiles

were observed. Among these, more observations were made of *Plethodon cinereus* than any other species. Only five species (*Lithobates catesbeianus, Pantherophis alleghaniensis, P. cinereus, Trachemys scripta elegans,* and *T. s. scripta*) were documented using iNaturalist (Table 2).

Table 2. Total number of individual amphibian and reptiles recorded in the EJC Arboretum.

Amphibians		**Direct**	**iNaturalist**	**Total**
Plethodon cinereus	Eastern Red-backed Salamander	32	7	39
Lithobates catesbeianus	American Bull Frog	4	2	6
Reptiles				
Chelydra serpentina	Common Snapping Turtle	2		2
Chrysemys picta	Eastern Painted Turtle	2		2
Diadophis punctatus edwarsii	Northern Ring-Necked Snake	1		1
Pantherophis alleghenensis	Eastern Ratsnake	3	1	4
Terrapene carolina carolina	Woodland Box Turtle	1		
Thamnophis siritalis siritalis	Eastern Garter Snake	3		3
Trachemys scripta elegans	Red-Eared Slider	7	3	10
Trachemys scripta scripta	Yellow Bellied Slider	1	1	2
	Total:	55	14	69

Annotated Checklist

Amphibians

1. Plethodon cinereus (Eastern Red-backed Salamander). A total of 39 *P. cinereus* were found. Most (32) were observed under artificial and natural cover objects throughout the arboretum. Two color morphs of the Eastern Red-backed Salamander (red-backed morph and lead-backed) occur at the EJC Arboretum and are pictured below.

2. *Lithobates catesbeianus* (American Bull Frog). Four individuals were observed, two of these were heard calling from the bank of the EJC Arboretum pond. Two observations of this species were recorded on iNaturalist.

Reptiles

3. *Chelydra serpentina* (Common Snapping Turtle). Two *C. serpentina* individuals were caught in the turtle traps.

4. *Chrysemys picta* (Eastern Painted Turtle). Two *C. picta* were found in turtle traps. One individual was caught in the turtle traps at the same time as two *C. serpentina.*

5. *Diadophis punctatus edwarsii* (Northern Ring-necked Snake). One *D. p. edwarsii* was found on leaf litter under a piece of bark.

6. *Pantherophis alleghenehsis* (Eastern Ratsnake). On iNaturalist a single record of P. *alleghenensis* found dead on the road that bordered the EJC Arboretum. Three individuals were found; one on a mulched trail, one under a log, and one resting on a log.

7. *Terrapene Carolina carolina* (Woodland Box Turtle) No *T. c. carolina* were found during initial surveys. However, an individual was encountered on 26 September 2019. Arboretum staff noted seeing multiple individuals in 2018 and 2019 (R. Wood, pers. comm.).

8. *Thamnophis siritalis siritalis* (Eastern Garter Snake) One *T. s. siritalis* individual was found under the metal corrugated sheets that were placed in the EJC Arboretum. Two others were found resting on top of leaf litter.

9. *Trachemys scripta elegans* (Red-eared Slider). Seven *T. s. elegans* were collected using turtle traps in the EJC Arboretum pond. Each turtle was individually marked and released. Three indivduals were documented on iNaturalist.

10. *Trachemys scripta scripta* (Yellow Bellied Slider). One *T. s. scripta* was found in the pond and one was documented on iNaturalist.

DISCUSSION

The goal of this survey was to document the presence of amphibians and reptiles in the EJC Arboretum. Because of the nature of the study, we make no attempt to assess population sizes. The data presented here should be considered a baseline from which other studies can address quantitative aspects of the herpetofaunal community. We employed both direct (e.g., visual encounter surveys) and indirect (e.g., iNaturalist) methods for documenting species presence at this site. It is not unreasonable that the individuals recorded in our surveys were the same as those found by citizen-scientists who documented them using iNaturalist, and we have not made any efforts to reconcile these observations because they achieve the goal of providing evidence of a species occurrence at this site. Additionally, we recognize that additional survey work may reveal more species than encountered in our study. We recommend the continued use of citizen-scientist data via iNaturalist as an effective way of gathering data and engaging the broader community in the study of the biodiversity of the EJC Arboretum.

A total of 55 individuals representing two species of amphibians and seven species of reptiles were recorded via direct observation during the EJC Arboretum survey. An additional 13 records, representing five

species were made concurrently by community members via iNaturalist. These represent a significant increase from the five species previously reported from Harrisonburg City. Of the previously reported species, we found only *P. cinereus*. In comparison to the herpetofauna of Rockingham county, the EJC Arboretum seems to have relatively low diversity (VHS database, 2019). Many of the 19 salamander species (and subspecies) known to occur in Rockingham County and Harrisonburg City were not found in the survey (Beane *et. al.,* 2010; VHS database, 2019). It is worth noting that two species found within the EJC Arboretum (*Trachemys scripta scripta* and *Chelydra serpentina*) are considered species in need of moderate conservation in Virginia, and one species (*Terrapene carolina*) is considered a species of high conservation need (Virginia Wildlife Action Plan, 2015). *Trachemys scripta scripta* is native to southeast Virginia in the Coastal Plain and Tidewater Region but not the Valley and Ridge Region of Virginia (Mitchell and Reay, 1999; Tobey, 1985). It therefore seems likely that this species has been introduced to this site. We found only one specimen of *T. s. scripta* during our survey and recommend future studies to determine the actual population status of this species in the EJC Arboretum. Similarly, *T. s. elegans* is a non-native and extremely successful invasive species that has been globally introduced through the pet trade. Its presence at the EJC Arboretum is not surprising. Our data suggest that non-native turtles are more abundant at the EJC Arboretum than native species. Given that the focus of the EJC Arboretum is native flora and fauna, it would seem worthwhile to consider the establishment of a management plan for invasive species of amphibians and reptiles at this site. Moreover, we strongly discourage the practice of the release of captive animals, especially into non-native locations because of the devastating consequences to entire ecosystems, including the extirpation of local and native species, introduction of disease, and disruption of established communities. (Doherty, *et al.* 2016).

With respect to the absence of other species that are known to occur within Rockingham County, it would seem that anthropogenic effects (*i.e.,* urbanization, herbicides/ pesticides in runoff water, and etc.) and habitat availability are the two greatest limiting factors. The EJC Arboretum is situated on the JMU campus within the city of Harrisonburg. It is bordered on three sides by roads with speed limits of 25–35mph; the fourth border is an apartment complex. This forest fragment has no connection to other natural forest habitats, thereby limiting opportunities for immigration and emigration of native species. The isolation of this site could also limit the re-establishment of a population if any of the current species were ever extirpated.

Habitat alteration at the site may also contribute to the low diversity documented during our study. The pond is man-made and has been drained and renovated at least two times since 2015 (McLeod, pers. obs) for the purpose of repair to the pond liner and flood water mitigation. Similarly, the intermittent stream has been reconstructed recently and has had significant changes made to it (channelization and bank repair) in an effort to improve flood control measures and enhance the aesthetics of the site. Because of the ephemeral, and man-made nature of the stream it is unlikely that aquatic and semi-aquatic salamanders (e.g., *Desmognathus, Eurycea,* and *Gyrinophilus*), though present in the county are not expected to occur at this site. Additionally, the pond contains a mixture of ornamental (e.g., *Cyprinus rubrofuscus*) and natural fish species (e.g., *Lepomis cyanellus*, *Ictalurus punctatus*, and

C. carpio) which has been shown to be a limiting factor for amphibian species that breed exclusively in fish free ephemeral ponds (Hopey and Petranka, 1994). Herpetofaunal diversity at a site can decrease when fish are introduced and subsequently feed on eggs, larvae, and post-metamorphic amphibians (Holbrook and Dorn, 2015). *Lithobates catesbeiana, L. clamitans, Acris crepitans,* and *Anaxyrus americanus* are all known to occur at ponds containing fish, though some may be less successful at these sites than at fish-free ponds (Werner and McPeek, 1994; Smith and Dibble, 2012). These species are also known to be successful human commensals, and all are documented elsewhere in Rockingham County (Mitchell and Reay, 1999). It is therefore somewhat surprising that only *L. catesbeianus* was at this site during our study.

Our study of the herpetofauna of the EJC Arboretum was conducted over multiple months and used a variety of survey methods. Nevertheless, it is likely that other species occur at this site but were undetected during our study. For example, due to the elusive nature and small size of *Carphophis amoenus amoenus* (Eastern wormsnake), detection of the species could have easily been overlooked (Ernst, Orr, Creque, 2003). Species in the *Plestiodon* genus (toothy skinks) are extremely quick and have the ability to climb trees making them difficult detect. Therefore, camera traps may be a more effective method for detecting any *Plestiodon* species (Adams, *et al.* 2017). It seems likely that future studies at this site and the use of citizen-scientist efforts in documenting diversity will result in additional discoveries and a broader understanding of the herpetofaunal community.

Further studies throughout Harrisonburg are warranted to better document the herpetofauna of the city and determine if the species originally documented in the area are still present. It is our hope that the results of this study will inform and facilitate both formal and informal scientific activities at the EJC Arboretum and around Harrisonburg.

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