

ABSTRACT

The District Wildlife Action Plan was developed in 2001 and the District Department of the Environment, Fisheries and Wildlife Division, is responsible for implementing the plan. The purpose of the District herpetofauna survey is to monitor the condition of herpetofauna populations in order to better conserve species of greatest conservation need and their habitats. Currently, there are a total of 38 reptile and amphibian species listed as species of greatest conservation need in the District (22 and 16 respectively). The 2007 and 2008 surveys worked towards these objectives, and the 2009 surveys furthered the objectives, but there is still limited information on the population and diversity of herpetofauna. The purpose of the 2010 study was to further conduct surveys that would create a more complete inventory and also begin a monitoring protocol of the herpetofauna in the District. A variety of methods were implemented in this study in order to encompass a greater diversity of herpetofauna, thus, creating a better inventory for monitoring purposes.

Keywords: Wildlife Action Plan, Herpetofauna, Surveys, Inventory, Monitoring

**INVENTORY AND MONITORING OF HERPETOFAUNA IN THE DISTRICT
OF COLUMBIA**

District Department of Environment
Division of Fisheries and Wildlife
1200 First Street, NE, 5th Floor
Washington, DC 20002

INTRODUCTION

Herpetofauna is a term to relate to the reptiles (snakes, lizards, and turtles) and amphibians (frogs, toads, salamanders, and sirens) of a given area. Both reptiles and amphibians are on a global decline due to many factors such as habitat loss and degradation, invasive species, environmental pollution, and disease (Gibbons et al. 2000). Reptiles and amphibians are key biological indicators as they are in close contact with water and soil, and any toxins can be absorbed through the skin (especially in the highly permeable skin of amphibians). Also, most have small home ranges, making it hard to avoid disturbances.

With a global decline of amphibians and reptiles, much attention has been paid to conservation efforts of the species (Gibbons et al. 2000; Row and Blouin-Demeres 2006). And according to the DC Wildlife Action Plan (WAP), over half of the amphibian and reptile species located in the District are listed as species of greatest conservation need (SGCN) (Chapter 3, pp46-47). With their habitat being infringed upon by human activity, it is important to understand where these species live and the habitat they require to survive in order to prevent further decline (Corn and Bury 1990).

Locating amphibian and reptiles can be a complex task given their cryptic nature and monitoring their populations can be difficult (Mazerolle et al. 2007). The key to generating an inventory comes from knowing the habitat each the species requires and implementing a number of different sampling methods (Scott 1976). Once the species are located and documented, the task of monitoring the population and restoring habitat becomes slightly less daunting.

Along with the goals of identifying species and their habitats and increasing the understanding of these species, the goals of the WAP are to conserve species and their habitats, create partnerships with other leading conservation agencies, educate and engage the public in the understanding of conservation needs, and to strengthen the current conservation actions and regulations (District Department of the Environment, WAP 2006). With these goals, the WAP acts to save species from becoming endangered or extinct and work towards getting funding to protect species that have not historically been given funding (District Department of the Environment, WAP 2006).

Objective(s):

1. To encompass a greater number of study areas throughout the District to fill the gaps of potential herpetofauna found in the city.
2. To implement several different survey methods in order to obtain abundance or population estimates, or occupancy and detection estimates for the herpetofauna of the District.
3. To identify key habitats within study areas that support species diversity in order to establish monitoring sites.

4. To target species listed as SGCN in the WAP, such as *Clemmys guttata* (Spotted Turtle) and *Regina septemvittata* (Queen Snake), in order to implement the best monitoring strategies.

Study Areas

Chesapeake and Ohio Canal National Historic Park is owned by the National Park Service and incorporates 185 miles of Potomac Riverfront with approximately 12,000 acres. Only a small portion on the eastern side of this park is located in the District of Columbia. This narrow site contains emergent non-tidal wetlands and forested wetlands/riparian forests/floodplain (District Department of Environment 2006).

Inventory Sampling Methods

Sampling for herpetofauna species took place from February through October 2010. Sampling for each species type involved various types of methods to effectively monitor species.

Radio-telemetry of *Clemmys guttata* in the District of Columbia

Survey Protocol

Clemmys guttata (Spotted Turtle) is listed as a species of concern in every state that it is found and is federally listed as a vulnerable species (IUCN 2009). Within the District of Columbia, the spotted turtle is critically imperiled (WAP Chapter 6; p. 64; District Department of the Environment 2006). Because of their status, they are a priority species of study.

Radio-telemetry studies are used to determine their locations, movements, and activity within the District. In 2009, *C. guttata* had been captured and released in the U.S. National Arboretum during the freshwater turtle trapping and had been seen on two separate occasions at Kenilworth Park and Aquatic Gardens. These areas and other areas within the National Park Service were proposed for surveyed from March through November for *C. guttata*, with priority months being April-June, when the turtle is most active. Turtles were to be captured by hand or dipnets, measured (carapace length and width and plastron length and width), weighed, and fitted with PD-2 (Holohil Systems Ltd., Woodlawn, ON, Canada) transmitters before being released (Haxton and Berrill 2001). Transmitters were to be mounted to the carapace with brass tabs and screws, just above a back leg. Transmitters weigh approximately 4g and turtles were not have transmitters mounted with the weight exceeds 5% of their body weight. The turtles were to be tracked using TRX-16S Rech receiver and 3-element folding Yagi antenna (Wildlife Materials Inc., Murphysboro, IL) 2-3 times weekly until they enter hibernation (March/April to November) and once weekly during the winter months (November to March; Haxton and Berrill 2001).

Results

Due to funding limitations, the radio telemetry project of *C. guttata* in the District was not carried out this season.

Literature Cited:

- Corn, P.S. and Bury, R.B. 1990. Sampling Methods for Terrestrial Amphibians and Reptiles. Portland, OR, USA, USDA Forest Service, General Technical Report PNW-GTR-256: 34.
- District Department of Environment. 2006. District of Columbia Wildlife Action Plan. District Department of Environment, Division of Fisheries and Wildlife, Washington, DC.
- Gibbons, J.W., D.E. Scott, T.J. Ryan, K.A. Buhlmann, T.B. Tuberville, B.S. Metts, J.L. Greene, T. Mills, Y. Leiden, S. Poppy, and C.T. Winne. 2000. The Global Decline of Reptiles, Déjà vu Amphibians. *BioScience*. 50: 653-666.
- Haxton, T. and M. Berril. 2001. Seasonal Activity of Spotted Turtles (*Clemmys guttata*) at the Northern Limit of Their Range. *J. Herp.* 35: 606-614.
- Mazzerolle, M.J., L.L. Bailey, W.L. Kendall, J.A. Royle, S.J. Converse, and J.D. Nichols. 2007. Making Great Leaps Forward: Accounting for Detectability in Herpetological Field Studies. *J. Herp.* 41: 672-689.
- Row, J.R. and Blouin-Demeres, G. 2006. An Effective and Durable Funnel Trap for Sampling Terrestrial Herpetofauna. *Herpetological Review* 37: 183-185.
- Scott, N.J. Jr. 1976. The abundance and diversity of the herpetofaunas of tropical forest litter. Pp. 78-84. *In* W. Ronald Heyer, Maureen A. Donnelly, Roy W. McDiarmid, Lee-Ann C. Hayek, and Mercedes S. Foster (eds.). *Measuring and Monitoring Biological Diversity: Standard Methods for Amphibians*. Smithsonian Institution Press. Washington, D.C. and London, England.
- Teaming with Wildlife. 2006. State Wildlife Action Plans, http://www.teaming.com/state_wildlife_strategies.htm, Association of Fish and Wildlife Agencies. Accessed: 20 December 2006.

Night time frog call surveys in the District of Columbia

Introduction

Frogs and toads are often times very cryptic and difficult to visually locate. Using surveys based on vocalizations during the breeding season can be used to determine the presence/absence of species and the proportion of area occupied (PAO).

Previous studies have been centered on the Chesapeake and Ohio Canal and Rock Creek Park within the National Capital Region, identifying amphibians as a priority group that required long-term inventory and monitoring (Mattfeldt, Grant, and Bailey 2007). Research for this extensive monitoring began in 2005, with the goal to document 90% of the amphibian species located within the National Capital Region, specifically the Chesapeake and Ohio Canal and Rock Creek Park (Mattfeldt, Grant, and Bailey 2008).

Other amphibian monitoring has been based in Maryland. These studies have followed protocols based from the North American Amphibian Monitoring Program (NAAMP), and focused on models to determine anuran detection and site occupancy based on anuran calling as outlined by the United States Geological Survey Amphibian Research and Monitoring Initiative (USGS-ARMI; Weir et al. 2005).

Survey Protocol

Frog calls were conducted from March through June following the North American Amphibian Monitoring Protocol (NAAMP). Routes were set in the Chesapeake and Ohio Canal, National Capital Parks East, Fort Lincoln and Kingman and Heritage Islands, and the U.S. National Arboretum. Routes were established prior to surveying and remained the same throughout the survey period. Each route was run a minimum of once monthly from March through June, giving preference to nights following rainfall. Surveys were not conducted during heavy rainfall or below the set temperature parameters. Any amphibians seen crossing roads were also noted. Additional information collected for occupancy estimates included wetland type, the hydroperiod of the wetland, distance to the road, and distance to the trail. Information collected for detection probabilities included ambient temperature, sky and wind codes, moon phase, noise index, the number of cars that passed during the survey, and minutes after sunset.

Results

There were a total of five species heard calling during surveys: *Anaxyrus fowleri* (Fowler's Toad), *Hyla versicolor* (Gray Treefrog), *Lithobates catesbeiana* (American Bullfrog), *Lithobates clamitans* (Green Frog), and *Pseudacris crucifer* (Spring Peeper). Species and their locations can be found in Table 1. Occupancy and detection probability of the five anuran species heard calling through the season were estimated by running models with different site and sampling covariates in program PRESENCE (Hines 2006) to determine which factors had an effect on occupancy and detectability of the species. Because of the numerous models run, the top five models for each species were selected

based on Akaike's Information Criterion (AIC) values (Appendix C). In general, the top models differed only by the inclusion or exclusion of a few factors.

Detection Factors.- In the top five models for all species, the date of the survey explained the variation in detection in four of the five species, accounting for the seasonal variation within the anuran breeding season. Temperature was standardized to be run in the models and was found to explain variation in detection for two out of the five species documented. The number of passing cars, the phase of the moon, and the noise index only explained variation in one of the species.

Occupancy Factors. – In the top five models for all species, variation in occupancy for four of the five species was not influenced by any of the factors, but rather when occupancy was constant (psi(.)). The distance to the nearest road, the type of wetland, and the hydroperiod of the wetland explained variation in occupancy in all five species. This variation would be expected as the seasonal pools have a shorter hydroperiod and dry up earlier in the season, thus, not being occupied by species.

Literature Cited:

Hines. J.E. 2006. PRESENCE2 – Software to estimate patch occupancy and related parameters. USGS-PWRC.

<http://www.mbr-pwrc.usgs.gov/software/presence/html>.

Mattfeldt, S., E. Grant, and L. Bailey. 2008. *Amphibian Monitoring in the National Capital Region: A focus on lentic and lotic habitats* [Online]. Available: https://science1.nature.nps.gov/naturebib/biodiversity/2008-9-25/NCRN_Amphib_Monitoring_Rpt_2007.pdf.

North American Amphibian Monitoring Program. 2009. North American Amphibian Monitoring Protocol. <http://www.pwrc.usgs.gov/naamp/index.cfm?fuseaction=app.protocol>. Accessed 16 Feb. 2009

Weir, L. A., J.A. Royle, P. Nanjappa, and R.E. Jung. 2005. Modeling Anuran Detection and Site Occupancy on North American Amphibian Monitoring Program (NAAMP) Routes in Maryland. *Journal of Herpetology*. 39: 627-639.

Inventory and monitoring of herpetofauna in the District of Columbia

INTRODUCTION

Inventorying and monitoring of herpetofauna should begin in the spring when most species are starting to emerge, and continue through the summer and early fall months, when activity is greatest (Karns 1986). The types of species and how many largely depends on many other factors such as temperature, rainfall, time of day, and the habitat

being surveyed (Karns 1986). For these reasons, baseline inventories of herpetofauna often requires more than one type of survey in order to locate and document as many species as possible.

In the District, previous herpetofauna information is limited to a few reports from the Chesapeake and Ohio Canal and Rock Creek Park in the National Park Service's NPSpecies database (<https://science1.nature.nps.gov/npspecies/web/main/start>). Other than limited inventories, most of the information has been centered on amphibians and amphibian breeding. In 2009, the District Department of the Environment Fisheries and Wildlife Division (DDOE FWD) began inventorying herpetofauna in the District more closely and surveys were added to collect gaps of herpetofauna inventory data and during the 2010 season population monitoring was implemented.

The purpose of the inventory and monitoring surveys in 2010 is to incorporate more survey methods that encompass a larger amount of herpetofauna species that may not all be attracted to similar types of traps or covers. Trap nights and search time during field visits were based around locating and documenting the greatest number of species possible. Although targeting all species, SGCN and the habitats they were located in were significant finds.

Survey Protocol

Visual Encounter/Egg Mass Surveys

Egg mass surveys can indicate the presence of amphibians such as *Rana sylvatica* (Wood Frog) and *Ambystoma maculatum* (Spotted Salamander). Egg mass surveys were conducted twice, from March through April, during the breeding season for these seasonal pool obligate species. Surveys took place during the day and used two observers that circumnavigated the wetlands in the same direction. Each observer recorded the number and species of all egg masses, keeping data from the first half of the pool separated from the second half. The data was compared and the highest number of positively identified egg masses recorded for each half was used for data analysis (Mattfeldt, Grant, and Bailey 2008; Jung, Funk, and Nanjappa). Additional information collected for occupancy estimates included wetland type, the hydroperiod of the wetland, flood potential, distance to the road, and distance to the trail. Information collected for detection probabilities included ambient temperature, water temperature, sky and wind codes, observer, canopy cover, percent aquatic vegetation, pH, and turbidity. During September and October, areas were visited to look for the presence of *Ambystoma opacum* (Marbled Salamander).

Dip Net Surveys

Lentic dip net surveys were to be conducted twice, later in the season, after egg mass surveys were completed. The target was to be larval species, and surveys were to be conducted similarly to the egg mass surveys (Mattfeldt, Grant, and Bailey 2008). Two observers were to sample around the perimeter of the pond, taking sample every 10-15 m

for ponds with an area greater than 1000 m², every 7-10 m for ponds with an area greater than 300 m², and every 5-7 m for ponds with an area less than 300 m². Sampling was to take place at depths at least 1 m deep and at least 3 m apart. The number of sweeps may vary; with the more sweeps taken, the greater chance of encounter a rare species (Gascon 1994; Shaffer et al. 1994). Larvae were to be identified by species and recorded. Lotic dip net surveys also took place in streams twice during July using methods in Bailey, Grant, and Mattfeldt (2007). Larvae and adults species were identified, measured, weighed, and recorded. Additional information collected for occupancy estimates surrounding area types, distance to the road, and distance to the trail. Information collected for detection probabilities included ambient temperature, water temperature, sky and wind codes, pH, turbidity, rain, and days since rain.

Night time Road Surveys

Many reptiles and amphibians can be seen crossing roads during the night while they are searching for food or during particular seasons (Shaffer and Juterbock 1994). Establishing routes along roads can be beneficial and seeing different species. Methods were to be similar to those in Shaffer and Juterbock (1994). Routes were to be established prior to fieldwork and were to be driven monthly or bimonthly. If possible, routes were to be driven twice during each run; species to be assumed to be constantly moving. Vehicle speed was to be between 23-30 mph, and 15 minutes was to be allowed after each run before repeating the route. As the roads were driven, flashlights were to be used to search for any species crossing the road. And because amphibians tend to prefer rainy nights, preference was to be given to nights during or following a rain event. Species were to be measured for total length and/or SVL and weighed.

Artificial Cover Surveys and Visual Encounter Surveys (VES)

Reptiles and amphibians frequently take cover under objects such as logs, boards, and rocks; therefore adding artificial cover to their habitats increases the probability of encountering many species (Fellers and Drost 1994; Kinkead 2006). Coverboards (0.6m x 0.6m cut pieces of plywood) were set up in grids (Kinkead 2006). The points of coverboard placement were marked with a GPS for future reference. The boards were checked an average of seven times from April through October, with more frequent checks allowing for a greater detection of species. Species were measured for total length and/or SVL and weighed.

In conjunction with the artificial cover surveys, visual encounter surveys (VES) were conducted within the grids. Captures were measured for total length and/or SVL and weighed. Additional information collected for occupancy estimates included surrounding area type, distance to the road, and distance to the trail. Information collected for detection probabilities included ambient temperature, sky and wind codes, canopy cover, and whether it was raining at the visit.

Results

Visual Encounter/Egg Mass Surveys

At total of ten wetlands were surveyed for egg masses at the Chesapeake and Ohio Canal during 2010. Each site was surveyed twice between March and April, with the exception of wetlands that had dried before the second survey.

During the visual encounter/egg mass surveys, two species of egg masses were detected: *A. maculatum* and *L. sylvatica*. Locations of species can be found in Table 2. Occupancy and detection probability of species were estimated by running models with different site and sampling covariates in program PRESENCE (Hines 2006) to determine which factors had an effect on occupancy and detectability of the species. Because of the numerous models run, the top five models for each species were selected based on Akaike's Information Criterion (AIC) values (Appendix C). In general, the top models differed only by the inclusion or exclusion of a few factors.

Detection Factors. – In the top five models for both species, the canopy cover and pH of the wetlands explained the variation in detectability. In one of the models, temperature was also factor in detectability of *L. sylvatica*.

Occupancy Factors. – In the top five models for both species, occupancy was either constant for all sites or had the hydroperiod of the wetland, distance of the wetland to the road, or the flood potential of the wetland explaining the variation in occupancy across sites. Hydroperiod would be expected to explain variation because wetlands with a short hydroperiod dry earlier in the season, not giving larvae a chance to metamorphose. Flood potential of the wetland was added as a factor because prior to surveying, heavy rains flooded several wetlands to the river, which may explain whether or not the site was occupied.

During September and October, wetlands that were surveyed in the spring had dried and were potential *A. opacum* breeding sites. Of all the wetland sites searched, the Chesapeake and Ohio Canal was the only site where one of the wetlands surveyed contained *A. opacum* eggs, although no adults were ever seen.

Dip Net Surveys

Due to personnel constraints, lentic dipnet surveys for larval species were not carried out this season.

There were no species documented during the lotic dipnet surveys at the Chesapeake and Ohio Canal.

Night time Road Surveys

Due to time constraints, nighttime road surveys were not carried out this season.

Artificial Cover Surveys and Visual Encounter Surveys (VES)

Artificial cover boards were placed in 30 locations within the District that were randomly selected based on habitat stratification. There were a total of six habitats, and five artificial cover plots were placed in each habitat. The habitats included: Dry-mixed hardwood forest (DMHF), wet-mixed hardwood forest (WMHF), dry evergreen forest (DEF), wet evergreen forest (WEF), dry meadow shrub-scrub (DMSS), and wet meadow shrub-scrub (WMSS). The boards were checked a minimum of seven times from May through October. The plots that were placed at the Chesapeake and Ohio Canal were in WMHF and DMSS.

There were a total of five species found during the artificial cover surveys. Species and their locations can be found in Table 3. Occupancy and detection probability of the species were estimated by running models with different site and sampling covariates in program PRESENCE (Hines 2006) to determine which factors had an effect on occupancy and detectability of the species. Because of the numerous models run, the top five models for each species were selected based on Akaike's Information Criterion (AIC) values (Appendix C). In general, the top models differed only by the inclusion or exclusion of a few factors.

Detection Factors. – In the top five models for all species, detection in all five species was influenced by percent canopy cover. For four of the five species, detection was not affected by any of the factors selected, but rather when p was constant ($p(.)$). For three of the five species, the variation in detection was explained by the wind index and for two of the five species, temperature was a factor in the detection variability. Other factors that influenced detection on one of the species included rain and the sky.

Occupancy Factors. – For all five species, occupancy was not affected by any of the factors selected, but when ψ was constant ($\psi(.)$). For eight of the ten species, however, occupancy was influenced by the distance to the road and for seven of the ten species, whether the site was occupied was influenced by the distance to the trail.

Incidental Observations

Several species were noted while conducting different surveys at the sites. A list of these species and their locations can be found in Table 4.

Literature Cited:

Bailey, L.L., E.H.C. Grant, and S. D. Mattfeldt. 2007. National Capital Region Network: Amphibian Monitoring Protocol. Northeast Amphibian and Research Monitoring Initiative. USGS – PWRC. [Online]. Available: http://science.nature.nps.gov/im/units/ncrn/monitoring_amphibians.cfm.

- Fellers, G.M. and C.A. Drost. 1994. Sampling with Artificial Cover, p. 146-150. *In*: Heyer, W.R., M.A. Donnelly, R.W. McDiarmid, L.C. Hayek, and M.S. Foster, (eds.). *Measuring and Monitoring Biological Diversity: Standard Methods for Amphibians*. Smithsonian Institution Press: Washington, D.C. 364p.
- Gascon, C. 1994. Sampling with Artificial Ponds, p.144-146. *In*: Heyer, W.R., M.A. Donnelly, R.W. McDiarmid, L.C. Hayek, and M.S. Foster, (eds.). *Measuring and Monitoring Biological Diversity: Standard Methods for Amphibians*. Smithsonian Institution Press: Washington, D.C. 364p..
- Hines. J.E. 2006. PRESENCE2 – Software to estimate patch occupancy and related parameters. USGS-PWRC.
<http://www.mbr-pwrc.usgs.gov/software/presence/html>.
- Kinkead, K. 2006. Iowa Multiple Species Inventory and Monitoring Program Technical Manual [Online]. Available:
http://www.iowadnr.gov/wildlife/diversity/msim_manual.html
- Mattfeldt, S., E. Grant, and L. Bailey. 2008. *Amphibian Monitoring in the National Capital Region: A focus on lentic and lotic habitats* [Online]. Available:
https://science1.nature.nps.gov/naturebib/biodiversity/2008-9-25/NCRN_Amphib_Monitoring_Rpt_2007.pdf.
- Shaffer, H.B. and J.E. Juterbock. 1994. Night Driving, p. 163-166. *In*: Heyer, W.R., M.A. Donnelly, R.W. McDiarmid, L.C. Hayek, and M.S. Foster, (eds.). *Measuring and Monitoring Biological Diversity: Standard Methods for Amphibians*. Smithsonian Institution Press: Washington, D.C. 364p.
- Shaffer, H.B, R.A. Alford, B.D. Woodward, S.J. Richards, R.G. Altig, and C. Gascon. 1994. Quantitative Sampling of Amphibian Larvae, p. 130-141. *In*: Heyer, W.R., M.A. Donnelly, R.W. McDiarmid, L.C. Hayek, and M.S. Foster, (eds.). *Measuring and Monitoring Biological Diversity: Standard Methods for Amphibians*. Smithsonian Institution Press: Washington, D.C. 364p.

Turtle trapping mark-recapture population estimation in the District of Columbia

Introduction

Estimates for aquatic turtle populations are often obtained by visually observing basking turtles or physically trapping turtles. The downside to visually observing turtles is that many are shy and will move into the water before properly identified and distinguishing between species can be difficult when the carapaces are dry. Also, there are several species of turtles that do not bask. For these reasons, population estimates were based solely on mark-recapture methods from trapping, thus allowing for future recognition and monitoring.

Survey Protocol

Turtle trapping took place from June through August in freshwater habitats located on National Park Service land and at the National Arboretum. Aquatic turtles were inventoried by the mark-recapture method using hoop nets (Sterling Net and Twine Co., Montclair, NJ). Nets were submerged under water, leaving enough of the trap exposed so trapped turtles are able to come up for air. Traps were placed parallel to the shoreline and rotated, as to reduce trap shyness. Traps were baited with fish and checked daily. Turtles will be measured for plastron and carapace lengths and widths, weighed, sexed (if possible), marked, and released. A three edge taper file was used to mark the marginal scutes on the turtles (Ernst, Hershey, and Barbour 1974).

Results

Population estimates were generated in program MARK (White and Burnham 1999) for each species at each sampling location from the 2009-2010 data, with the exception of *Chelydra serpentina* (Common Snapping Turtle) because species were not uniquely marked in 2009 (Figure 1). The Chesapeake and Ohio Canal was only trapped in 2010, therefore, only a single season of data was able to be run.

There were a total of 60 trap nights during the 2010 season. *Chelydra serpentina* and *Trachemys scripta elegans* (Red-eared Slider), *Chrysemys picta picta* (Eastern Painted Turtle), *Pseudemys rubriventris* (Redbelly Turtle) and *Sternotherus odoratus* (Musk Turtle) were present at the Chesapeake and Ohio Canal. Of these five species trapped, three are SGCN. Actual numbers of species caught at each site can be found in Figure 2.

At the Chesapeake and Ohio Canal, *C. serpentina* was the only species recaptured during the survey period for 2010, and therefore, was the only species a population estimate could be generated for. Population estimates for *C. serpentina* was 146.44 ± 131.14 ($n \pm se$), based on the estimates from averaging POPAN Jolly-Seber models run in MARK.

Literature Cited:

- Ernst, C.H., M.F. Hershey, and R.W. Barbour. 1974. A New Coding System for Hardshell Turtles. Transactions of the Kentucky Academy of Science. 35: 27-28.
- White, G.C. and K. P. Burnham. 1999. Program MARK: Survival estimation from populations of marked animals. Bird Study 46 Supplement, 120-138.

APPENDIX A

TABLES

Table 1. Night time frog call survey locations and species in the District, 2010.

Species	National Arboretum	Chesapeake and Ohio Canal	National Capital Parks East	Fort Lincoln	Kingman and Heritage Island
<i>Anaxyrus americanus</i>					X
<i>Anaxyrus fowleri</i>		X	X		
<i>Hyla versicolor</i>	X	X	X		
<i>Lithobates catesbeiana</i>	X	X	X		
<i>Lithobates clamitans</i>	X	X	X	X	
<i>Lithobates palustris</i>	X		X		
<i>Lithobates sphenoccephala</i>	X		X	X	
<i>Pseudacris crucifer</i>	X	X	X	X	X

X= indicates species was heard calling at that location.

Table 2. Visual encounter/egg mass survey locations and species documented in the Chesapeake and Ohio Canal, 2010.

Site	Wetland	<i>Ambystoma maculatum</i>	<i>Lithobates Sylvatica</i>
Chesapeake and Ohio Canal	CHOHVP1		
Chesapeake and Ohio Canal	CHOHVP2	X	
Chesapeake and Ohio Canal	CHOHVP3	X	X
Chesapeake and Ohio Canal	CHOHVP4		
Chesapeake and Ohio Canal	CHOHWET01	X	X
Chesapeake and Ohio Canal	CHOHWET02	X	
Chesapeake and Ohio Canal	CHOHWET03		
Chesapeake and Ohio Canal	CHOHWET04		
Chesapeake and Ohio Canal	CHOHWET05		
Chesapeake and Ohio Canal	DCFWDCH05		

Table 3. Species locations and habitat types for species present in the Chesapeake and Ohio Canal during artificial cover surveys, 2010.

Site	Plot	Species
Chesapeake and Ohio Canal	DMSS	<i>Storeria dekayi</i>
Chesapeake and Ohio Canal	WMHF	<i>Ambystoma maculatum</i>
Chesapeake and Ohio Canal	WMHF	<i>Plestiodon fasciatus</i>
Chesapeake and Ohio Canal	WMHF	<i>Thamnophis sirtalis</i>
Chesapeake and Ohio Canal	WMHF	<i>Lithobates palustris</i>

Table 4. Incidental findings of species in the Chesapeake and Ohio Canal during the 2010 field season.

Date	Species	Location	SGCN
03/26/10	<i>Cheyldra serpentina</i>	Chesapeake and Ohio Canal	
03/26/10	<i>Plethodon cinereus</i>	Chesapeake and Ohio Canal	X
05/24/10	<i>Plestiodon fasciatus</i>	Chesapeake and Ohio Canal	X
05/24/10	<i>Thamnophis sirtalis</i>	Chesapeake and Ohio Canal	X
06/11/10	<i>Plestiodon fasciatus</i>	Chesapeake and Ohio Canal	X
06/11/10	<i>Ambystoma maculatum</i>	Chesapeake and Ohio Canal	X
09/17/10	<i>Plestiodon fasciatus</i>	Chesapeake and Ohio Canal	X

APPENDIX B

FIGURES

**Figure 1. Freshwater turtle population estimates in the District
2009-2010.**

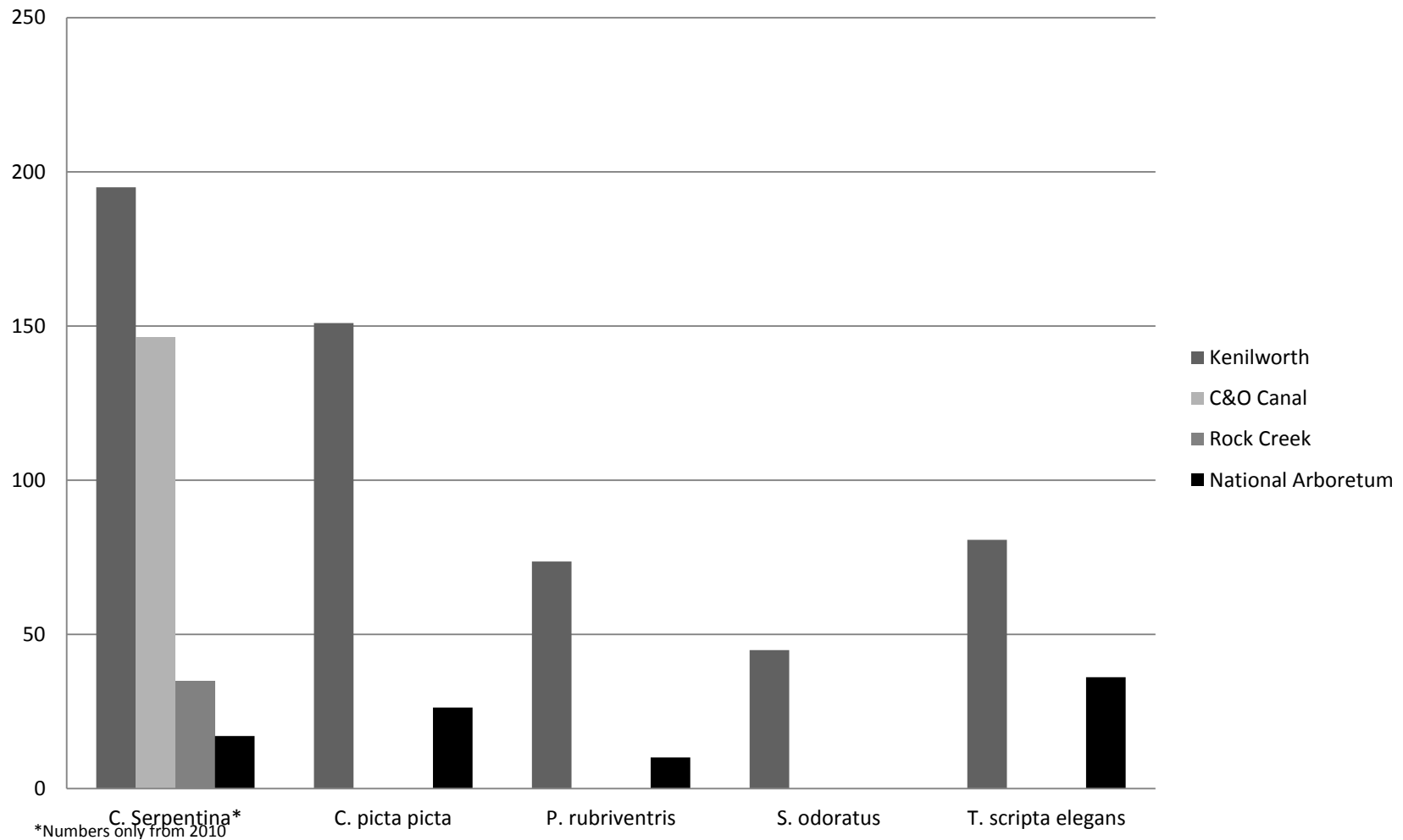
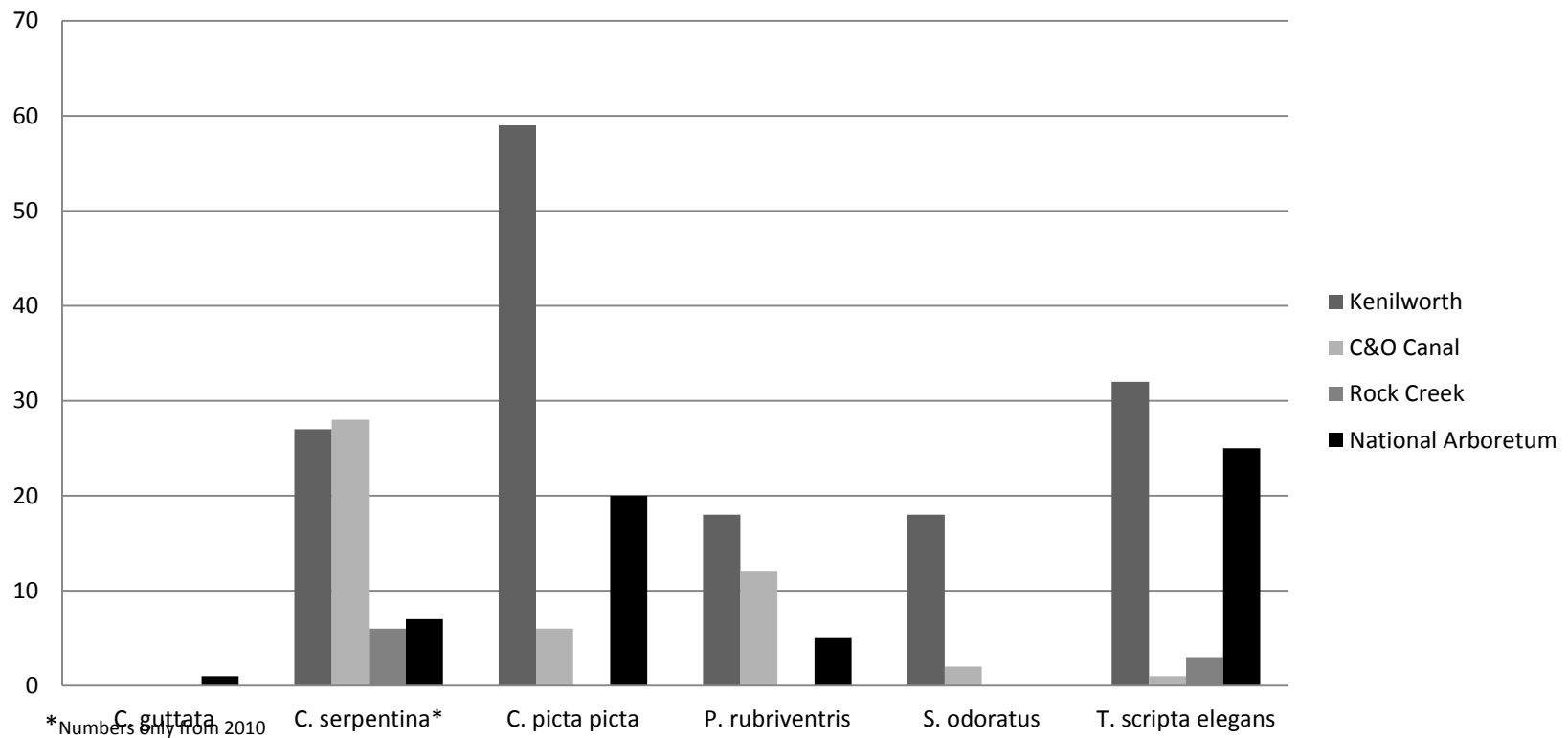


**Figure 2. Actual captures of freshwater turtles in the District
2009-2010.**



APPENDIX C

For the anuran species detected in the nighttime frog call surveys during 2010, the top five models using Akaike's Information Criterion (AIC).

Species		Occupancy Factors				Detection Factors								
Models		.	Distance to Road	Wetland Type	Hydroperiod	.	Day	Temp	Cars	Minutes After Sunset	Moon	Noise	AIC	Weight
Anaxyrus fowleri														
1		1	0	0	0	0	1	0	0	0	0	0	57.6	0.244
2		0	1	0	0	0	1	0	0	0	0	0	57.83	0.2175
3		0	0	1	0	0	1	0	0	0	0	0	58.93	0.1255
4		0	0	0	1	0	1	0	0	0	0	0	60.32	0.0626
5		0	1	1	0	0	1	0	0	0	0	0	60.93	0.0462
Hyla versicolor														
1		1	0	0	0	0	1	0	0	0	0	0	134.7	0.4059
2		0	0	0	1	0	1	0	0	0	0	0	138.4	0.0645
3		0	1	1	0	0	1	0	0	0	0	0	139.1	0.0439
4		0	1	0	1	0	1	0	0	0	0	0	139.3	0.0403
5		0	0	1	1	0	1	0	0	0	0	0	139.7	0.0323
Lithobates catesbeiana														
1		1	0	0	0	0	1	0	0	0	0	0	68.49	0.3182
2		0	0	0	1	0	1	0	0	0	0	0	70.6	0.1108
3		0	1	1	0	0	1	0	0	0	0	0	71.31	0.0777
4		0	1	0	1	0	1	0	0	0	0	0	71.35	0.0761
5		0	0	1	1	0	1	0	0	0	0	0	71.58	0.0679

Continued.

Species		Occupancy Factors				Detection Factors								
Models		.	Distance to Road	Wetland Type	Hydroperiod	.	Day	Temp	Cars	Minutes After Sunset	Moon	Noise	AIC	Weight
Lithobates clamitans														
1		0	0	1	0	0	1	0	0	0	0	0	117.6	0.4386
2		0	0	0	1	0	1	0	0	0	0	0	119.3	0.1856
3		0	1	1	0	0	1	0	0	0	0	0	119.6	0.1646
4		0	1	0	1	0	1	0	0	0	0	0	120.9	0.0838
5		0	0	1	1	0	1	0	0	0	0	0	121.8	0.0553
Pseudacris crucifer														
1		1	0	0	0	0	1	0	0	0	0	0	173.2	0.3222
2		0	0	0	1	0	0	1	0	0	1	1	176.5	0.0628
3		0	0	0	1	0	1	0	0	0	0	0	176.8	0.0549
4		0	0	1	0	0	0	1	0	0	1	1	177	0.0494
5		0	1	0	1	0	1	0	0	0	0	0	177.2	0.0445

The top five models using Akaike's Information Criterion (AIC) for visual encounter/egg mass surveys during 2010.

Species		Occupancy Factors				Detection Factors				
Models		.	Flood Potential	Hydroperiod	Distance to Road	pH	Canopy	Temperature	AIC	Weight
Ambystoma maculatum										
1		1	0	0	0	1	1	0	44.60	0.2750
2		0	0	1	0	1	0	0	44.82	0.2297
3		0	1	1	0	1	1	0	46.29	0.2068
4		0	0	1	0	1	0	0	48.06	0.0992
5		0	0	1	0	0	1	0	48.06	0.0409
Lithobates sylvatica										
1		1	0	0	0	1	0	0	11.61	0.3128
2		1	0	0	0	1	0	1	12.98	0.1577
3		0	0	1	0	1	0	0	13.74	0.1078
4		0	1	0	1	1	0	0	14.46	0.0752
5		0	0	0	1	1	0	0	14.77	0.0644

For the five species detected in the artificial cover surveys during 2010, the top five models using Akaike's Information Criterion (AIC).

Species		Occupancy Factors			Detection Factors								
Models		.	Distance to Trail	Distance to Road	.	Wind	Canopy	Temp	Day	Sky	Rain	AIC	Weight
Ambystoma maculatum													
1		1	0	0	0	0	0	1	0	0	0	11	0.2638
2		1	0	0	0	1	0	1	0	0	0	12	0.16
3		0	0	0	0	1	0	1	0	0	0	12	0.16
4		0	0	1	0	1	0	1	0	0	0	12	0.16
5		1	0	0	0	1	1	1	0	0	0	14	0.0589
Lithobates palustris													
1		0	1	0	1	0	0	0	0	0	0	16.31	0.3202
2		0	0	1	1	0	0	0	0	0	0	16.52	0.2882
3		1	0	0	1	0	0	0	0	0	0	16.7	0.2634
4		1	0	0	0	0	1	0	0	0	0	20.94	0.0316
5		1	0	0	0	0	0	1	0	0	0	21.35	0.0258
Plestiodon fasciatus													
1		1	0	0	0	0	1	0	0	0	0	20.66	0.1872
2		1	0	0	1	0	0	0	0	0	0	20.93	0.1635
3		1	0	0	0	0	1	0	0	0	0	21.04	0.1548
4		1	0	0	0	1	1	0	0	0	0	21.49	0.1236
5		1	0	0	0	0	0	0	0	0	1	22.5	0.0746

